REPORT

OF THE

INDIAN IRRIGATION COMMISSION,

1901-1903.



Agents for the Sale of Books published by the Superintendent of Government Printing, India, Calcutta.

In England.

E. A. Arnold, 37, Bedford Street, Strand, London, W. C.

Constable & Co., 2, Whitehall Gardens, London, S. W.

Sampson Low, Marston & Co., St. Dunstan's House, Fetter Lane, London, E. C.

B. A. Quaritch, 15, Piccadilly, London, W.

P. S. King & Son, 2 and 4, Great Smith Street, Westminster, London, S. W.

Luzac & Co., 46, Great Russel Street, London, W. C.

Kegan Paul, Trench, Trübner & Co., Charing Cross Road, London, W. C.

Williams and Norgate, Oxford.

Deighton Bell & Co., Cambridge.

On the Continent.

R. Friedländer & Sohn, 11, Carlstrasse, Berlin.

Otto Harrassowitz, Leipzig.

Karl W. Hiersemann, Leipzig.

Ernest Leroux, 28, Rue Bonaparte, Paris.

Martinus Nijhoff, The Hague.

In India.

Thacker, Spink & Co., Calcutta and Simla.

Newman & Co., Calcutta.

Thacker & Co., Ld., Bombay.

A. J. Combridge & Co., Bombay.

D. B. Taraporevala Sons & Co., Bombay

Higginbotham & Co., Madras.

V. Kalyanarama Iyer & Co., Madras.

Superintendent, American Baptist Mission Press, Rangoon.

Rai Sahib M. Gulab Singh & Sons, Mufid-i-Am Press, Lahore.

Radhabai Atmaram Sagoon, Bombay.

R. Cambray & Co., Calcutta.

S. K. Lahiri & Co., Calcutta.

G. A. Natesan & Co., Madras.

N. B. Mathur, Superintendent, Nazair Kanun Hind Press, Allahabad.

REPORT

OF THE

INDIAN IRRIGATION COMMISSION,

1901-03.

PART II.—PROVINCIAL.

सत्यमेव जयते

CALCUTTA:
OFFICE OF THE SUPERINTENDENT OF GOVERNMENT PRINTING, INDIA.
1903.

Price Two Rupees Eight Annas.
English Price 3s. 9d.

COMMISSION APPOINTED TO REPORT ON THE IRRIGATION OF INDIA AS A PROTECTION AGAINST FAMINE.

COLONEL SIR COLIN C. SCOTT-MONCRIEFF, K.C.S.I., K.C.M.G., *President.*

MEMBERS :

SIR THOMAS HIGHAM, K.C.I.E., M. INST. C.E., Secretary to the Government of India in the Public Works Department, and Inspector General of Irrigation.

The HON'BLE MR. DENZIL C. J. IBBETSON, C.S.I., I.C.S., Chief Commissioner of the Central Provinces *(up to 18th February 1902)*.

The HON'BLE MR. JOHN W. P. MUIR-MACKENZIE, I.C.S., Chief Secretary to the Government of Bombay *(after 13th January 1902)*.

DIWAN BAHÁDUR P. RAJARATNA MUDALIAR, C.I.E., late Inspector General of Registration, Member of the Legislative Council of Madras.

SECRETARY :

MR. W. B. GORDON, M. INST. C.E., Superintending Engineer, Public Works Department, United Provinces of Agra and Oudh.



TABLE OF CONTENTS.

Para.	Subject.	Page.
	PART II.—PROVINCIAL.	
	ABSTRACT.	
	CHAPTER—	
1—80	XIV.—Punjab	1
81—212	XV.—Bombay	38
213—305	XVI.—Madras	89
306—379	XVII.—Central Provinces	126
380—464	XVIII.—Bengal	150
465—557	XIX.—United Provinces	181
558—572	XX.—Upper Burma and Baluchistan . . .	208
573—740	XXI.—Native States	212
	DETAILS.	
	CHAPTER XIV.—THE PUNJAB.	
	(Including the North-West Frontier Province.)	
	(i).—Local conditions; use and value of irrigation	
1	The Punjab as an irrigation province	1
2	Soil	*ib.*
3—6	Conditions in different tracts	2
7—8	Conditions in tracts A and B	3
9	Conditions in tract C	*ib.*
10	Native States	4
	(ii).—Existing State irrigation works.	
11	Major and minor works in the Punjab correspond with perennial and inundation canals	*ib.*
	Major irrigation works or perennial canals.	
12	Major works, their productive and protective value . . .	5
13	Financial results of major works	*ib.*
14	Capital cost of major works per acre irrigated, and rates for gross revenue and maintenance	*ib.*
15	Normal area irrigated by major works and growth of irrigation .	6
16	Expansion of irrigation from major works during the last decade .	7
17	Results of expenditure against open Capital accounts . . .	*ib.*
18	Chenab canal	8
19	Jhelum canal	9

Para.	Subject.	Page.
	CHAPTER XIV.—THE PUNJAB—*contd.*	
	(*ii*).—*Existing State irrigation works*—concld.	
	Minor irrigation works or inundation canals.	
20	Minor irrigation works	9
21	Protective value of inundation canals	*ib.*
22	Productive value of minor works. Works with Capital account .	10
23	Productive value of minor works for which Capital accounts are not kept.	*ib.*
24	Inundation canals in Firozpur and Bahawalpur	11
25	Stationary condition of inundation canals	*ib.*
26	Reason for slow development of irrigation or inundation canals .	12
	(*iii*).—*Scope for further extensions of State irrigation works.*	
27	Lower Bari Doab canal	*ib.*
28	Interference with the supply to the Sutlej inundation canals . .	13
29	Effect of the opening of the Sirhind canal on the Sutlej inundation canals.	*ib.*
30	Possible improvements in the inundation canals	14
31	Inadequacy of improvements proposed	15
32	Proposed construction of weirs across river. The Sutlej Valley canals project.	*ib.*
33	Projects for Lower Bari Doab canal and Sutlej Valley canals should be prosecuted concurrently.	16
34—39	Mr. Wilson's objections to the present Lower Bari Doab canal project	*ib.*
40	Sind-Sagar canal	18
41	Extensions of existing perennial canals	19
42—45	Western Jumna canal. Curtailment of cold weather supply in certain tracts.	20
46	Supplementary supplies from the Jumna	21
47—48	Reduction of the Eastern Jumna canal's share of the supply in the river	*ib.*
49—50	Storage works and puddling of canal channels	22
51	Extensions of the Sirhind canal	23
52	Limits to possible extensions from the Western Jumna and Sirhind canals into famine districts.	*ib.*
53	Extensions of inundation canals	*ib.*
54—55	New provincial irrigation works	24
	The Jalalpur canal and necessity for similar works . . .	25
	Drainage works in Umballa and Karnal districts	*ib.*

Para.	Subject.	Page.
	CHAPTER V.—THE PUNJAB—*concld.*	
	(*iv*).—*Private irrigation works.*	
58	District irrigation works, Firozpur canals . . .	
59	Gurgaon irrigation works	
60	Other district irrigation works	27
61	Connection of district boards with irrigation works . . .	*ib.*
62	Private irrigation works. Inundation canals	28
63	Private irrigation works in hill districts	*ib.*
64	Area irrigated by private irrigation works other than wells . .	29
65	Royalty and legislation	*ib.*
66	Wells	*ib.*
67	Progress in well construction during the past ten years . . .	30
68	Temporary wells	31
69	Districts in which the well-irrigated area has not increased . .	*ib.*
70	Extension of well irrigation	32
71	Wells in tracts A and B	*ib.*
72	Wells in tract C	*ib.*
73	Character of the cultivators to be considered . . .	33
	(*v*).—*Famine works and programmes.*	
74	Relief works executed during famines of 1897 and 1899 . .	*ib.*
75	Provincial programmes of relief works. The three south-eastern districts	34
76	Programmes in other districts	35
77—79	Programmes not complete	*ib.*
80	Possible additions to programmes	36
	CHAPTER XV.—BOMBAY.	
	SECTION I.—*Introductory.*	
81—82	Divisions of the Presidency to be considered	38
	SECTION II.—*Sind.*	
	(*i*).—*Local conditions ; use and value of irrigation.*	
83	General conditions	*ib.*
84	Dependence of cultivation on irrigation	39
85	Proportion of total area of the province which is commanded by the canals	*ib.*

Para.	Subject.	Page.
	CHAPTER XV.—Bom *contd.*	
	SECTION II.—*Sind*—concld.	
	cal conditions; use and value of irrigation—concld.	
	erritory	40
	ulation compared with the cultivated area	*ib.*
	(*ii*).—*Existing State irrigation works.*	
88	Extent and growth of irrigation from the State canals . . .	*ib.*
89	Productive and financial results	*ib.*
90	Revenue credited to canals	41
91	Lift and flow irrigation	*ib.*
	(*iii*).—*Scope for further extensions of State irrigation works.*	
92	Extensions of existing canals	*ib.*
93	Possibility of making the canals perennial	42
94	Advantages of the Bukkur site for a weir	43
95	Mr. Dawson's note on the Bukkur site	*ib.*
96	General remarks on the weir proposal	44
	(*iv*).—*Private irrigation works.*	
97	Private canals in Sind	45
98	Wells	*ib.*
	(*v*).—*Famine works and programmes.*	
99	Famine relief works not required	46
	SECTION III.—*Gujerat.*	
	(*i*).—*Local conditions; use and value of irrigation.*	
100	Liability to famine	*ib.*
101	Area protected by irrigation	*ib.*
102	Soils and cultivation	*ib.*
103	Irrigation required for rice only	47
104	Irrigation in black cotton soil	*ib.*
105	Soils suitable for irrigation	48
106	Cultivators in the Panch Mahals	*ib.*
107	Manure	*ib.*
108	Drainage	*ib.*

Para.	Subject.	Page.
	CHAPTER XV.—BOMBAY—*contd.*	
	SECTION III.—*Gujerat*—concld.	
	(*ii*).—*Existing State irrigation works.*	
109	...lass irrigation works	49
110	Second class irrigation works	*ib.*
111	Other small irrigation tanks	50
112—114	Repairs of tanks	*ib.*
115	Liability for petty repairs	51
116	Relinquishment of small tanks	*ib.*
	(*iii*).—*Scope for further extensions of State irrigation works.*	
117—118	Construction of large canals from the principal rivers	*ib.*
119	The Sabarmati scheme	52
120	Mahi river scheme	53
121	The Nerbudda	*ib.*
122—125	The Tapti	54
126—127	General recommendations	55
128	River gauges	56
129	Minor irrigation works	*ib.*
130	Drains	57
	(*iv*).—*Private irrigation works.*	
131	Well irrigation	*ib.*
132	Extension of well irrigation	58
133	Necessity for a subsoil water survey	*ib.*
134	Steam pumps for irrigation	*ib.*
135	New private tanks	59
136	Bunds in Ahmadabad	*ib.*
137—138	Importance of encouraging private works	*ib.*
	(*v*).—*Famine works and programmes.*	
139	Works constructed during the famine of 1899—1901	60
140	Possible irrigation works for future famines	61
	SECTION IV.—*The Deccan.*	
	(*i*).—*Local conditions; use and value of irrigation.*	
141	Demand for irrigation in the Deccan	*ib.*
142	Soils	62

Para.	Subject.	Page.
	CHAPTER XV.—BOMBAY—*contd.*	
	SECTION IV.—*The Deccan*—contd.	
	(*i*).—*Local conditions ; use and value of irrigation*—	
143	Manure	62
144	Rivers in the Deccan	*ib.*
145	Extent of area protected by irrigation	63
146	Foreign States	*ib.*
	(*ii*).—*Existing State irrigation works.*	
147—148	First and second class works	*ib.*
149	Areas on second class works	64
150—152	Productive value of first class works	*ib.*
153—154	Classification of works according to their sources of supply	65
155	Class A. The Mutha canal	66
156—157	Class B. Ghat-fed storage works	*ib.*
158	Class C. Canals without storage works	67
159	Classes D and E. Rain-fed tanks	*ib.*
160	Large and small tanks	68
161	Prospective improvement in financial results of works	*ib.*
162	Financial results on second class works	69
163	Protective and productive working of canals	*ib.*
164—165	Advantages of working on productive principle	*ib.*
166	Necessity for a wide distribution of the supply	70
167	Proposed system of leases	71
168	Excessive charges for establishment	*ib.*
169	Transfer of small tanks to the second class	72
170	Small irrigation works	*ib.*
	(*iii*).—*Scope for further extensions of State irrigation works.*	
171	Irrigation works from ghat-fed rivers	*ib.*
172	Proposals which have been suggested	73
173—174	The Maladevi and Chankapur projects	74
175—176	The Gokak extension project	75
177—179	The Gajauni or Nira Right Bank canal project	76
180	The Godavari project	77
181	Bhima and Ghod rivers	*ib.*

Para.	Subject.	Page.
	CHAPTER XV.—BOMBAY—*concld.*	
	SECTION IV.—*The Deccan*—concld.	
	(*iii*).—*Scope for further extensions of State irrigation works*—concld.	
182	Krishna canal	77
183	Panna river project	*ib.*
184	Mula river project	78
185—186	her projects	*ib.*
187	Scope f the foregoing projects	*ib.*
188	Probable capital cost	*ib.*
189	Probable financial results of expenditure proposed	79
190	Increasing the storage of existing works	*ib.*
191	Rain-fed tanks	80
192	Extensions of second class irrigation works	*ib.*
	(*iv*).—*Private irrigation works.*	
193	Field embankments	81
194	Wells	*ib.*
195	Importance of extending well irrigation	*ib.*
196	Wells for sugarcane	82
197	Borings and surveys of the underground water-supply	*ib.*
	(*v*).—*Famine works and programmes.*	
198	Expenditure on relief works in 1896-97	83
199	Expenditure during recent famine to end of March 1902	*ib.*
200	Relief works in Khandesh	*ib.*
201	Relief works in Nasik	84
202—203	Relief works in Ahmadnagar	*ib.*
204	Relief works in Poona	85
205	Relief works in Sholapur	*ib.*
206	Relief works in Satara	86
207	Relief works in Bijapur	*ib.*
208	Relief works in Belgaum and Dharwar	87
209—212	Inclusion of village works in the relief programmes	*ib.*
	CHAPTER XVI.—MADRAS.	
	(*i*).—*Local conditions; use and value of irrigation.*	
213	Physical features	89

Para.	Subject.	Page.
	CHAPTER XVI.—MADRAS—*contd.*	
	(*i*).—*Local conditions ; use and value of irrigation*—concld.	
214—215	Rainfall	89
216	Soils	90
217	Total cultivable and cultivated area	*ib.*
218—219	Crops	*ib.*
220	Irrigated area	91
221	Areas irrigated in zamindari tracts	*ib.*
222—223	Secure tracts	*ib.*
224—226	Tracts liable to famine	92
	(*ii*).—*Existing State irrigation works.*	
227	Two main classes of irrigation works	93
228	Works for which Capital accounts are kept	*ib.*
229	Group divisions	94
230	Old irrigation revenue	*ib.*
231	Analysis of financial results by groups	95
232	Godavari and Kistna canals	*ib.*
233	Cauvery and Coleroon works	96
234	Kurnool-Cuddapah canal	*ib.*
235	Sub-group (*b*) of group II	97
236	Group III. The Periyar project	*ib.*
237	The Penner, Sangam, Palar, and Rushikulya projects	98
238	Smaller storage works	*ib.*
239—240	General conclusions as to financial results attained on storage works	*ib.*
241	Works for which Capital accounts are not kept	99
	(*iii*).—*Scope for further extensions of State irrigation works.*	
242	Recommendations of the Famine Commission of 1878-80	*ib.*
243	The Tungabhadra project	100
244	The Kurnool-Cuddapah canal	*ib.*
245	Further investigation of the Tungabhadra project recommended	101
246	The Cauvery delta	*ib.*
247	Storage work on the Kistna	102
248	Divi pumping project	103

Para.	Subject.	Page.
	CHAPTER XVI.—MADRAS—*contd.*	
	(*iii*).—*Scope for further extensions of State irrigation works*—concld.	
249	The Godavari	103
250	Periyar project	*ib.*
251	Kistnagiri reservoir	104
252	Other proposals for extension of major works	*ib.*
253	Provincial irrigation works for which capital accounts are kept	*ib.*
254—255	Irrigation of dry crops	105
256	Minor works for which no capital accounts are kept	107
257	Recommendations of the Commission of 1878-80	*ib.*
258	Tank restoration scheme	*ib.*
259	Time required for completing the work of restoration	108
260—261	Further outlay	*ib.*
262—264	Necessity for vigorous prosecution of the works	109
265	Maintenance of tanks	110
266	Transfer of tanks to villagers	*ib.*
267	Kudi-maramat	112
268	Distinction between channel works and tanks	*ib.*
269	Necessity for legislation	*ib.*
270	Repairs cess	113
271	Tank Inspectors	114
272	Irrigation Law in Madras	*ib.*
273—275	Liability of zamindars for the maintenance of irrigation works	*ib.*
276—277	Charges on zamindars for improvements in the means of irrigation	115
278—281	Rights and responsibilities of Government in respect of water	*ib.*
282—284	Other points on which legislation is recommended	117
285—286	Necessity for legislation	118
	(*iv*).—*Private irrigation works.*	
287	Private works other than wells	119
288	Scope for extension of private works other than wells	*ib.*
289—290	Private works in zamindari tracts	*ib.*
291—295	Wells	120
296	'Doruvu' wells	121
297—298	Supplemental wells	122
299	Takavi	123

Para.	Subject.	Page.
	CHAPTER XVI.—MADRAS—*concld.*	
	(v).—Famine works and programmes.	
300—303	Famine works	123
304 - 305	Famine programmes	124
	CHAPTER XVII.—THE CENTRAL PROVINCES.	
	(i).—Local conditions ; use and value of irrigation.	
306	Diversity of conditions	126
307	Physical features	*ib.*
308	Main geological characteristics	*ib.*
309	Annual rainfall	*ib.*
310	Total and culturable areas	127
311	Crops and area under cultivation	*ib.*
312	Irrigated area	*ib.*
313	Main classes of soils	*ib.*
	Wheat Lands.	
314	Character of the soil, and extent to which it requires irrigation .	*ib.*
315	Utility of irrigation under certain conditions	128
316	Injury from drought and rust	*ib.*
	Black cotton soils.	
317	Distribution and general character of the soils	*ib.*
318	Liability to famine	*ib.*
319	Utility of irrigation	*ib.*
	The light uplands.	
320	Distribution ; irrigation generally impossible and unnecessary .	129
321	Liability to famine	*ib.*
	Rice lands.	
322—323	Distribution and general character of the rice lands . . .	*ib.*
324	Local differences in the cultivation of rice	130
325	Rainfall	*ib.*
326	Utility of irrigation	131
	(ii).—Existing State irrigation works.	
327	Non-existence of State works	*ib.*

Para.	Subject.	Page.
	CHAPTER XVII.—The Central Provinces—*contd.*	
	(*ii*).—*Existing State irrigation works* – contd.	
328	Previous proposals for State works	132
329	Famine expenditure on works of irrigation	*ib.*
	(*iii*).—*Scope for further extensions of State irrigation works.*	
330	General principles determining field of operations	133
331	Limits of scope of operations	*ib.*
332—333	Possible field for extension of garden produce	134
334—336	Utilization of rivers	*ib.*
337	Observations of discharges and rainfall	135
338	Existing tanks	*ib.*
339	Necessity for large storage works	136
340—341	Provision against a year of drought	*ib.*
342	Projects for storage works, their cost and scope	137
343	Further scope for projects	*ib.*
344—345	Water-rate likely to be realized	*ib.*
346	Supply to existing private tanks	138
347	Experimental works recommended	*ib.*
348	Wheat tracts	139
349	The Lachera tanks	*ib.*
350	The Ramtek project	140
351	Completion of the projects	*ib.*
	(*iv*).—*Private irrigation works.*	
352	Types of works	*ib.*
	Tanks.	
353—354	Number and description of tanks	*ib.*
355—358	Repairs and improvement of tanks	141
359	State acquisition of private tanks	142
360	Scope for extension of private tanks	143
361	Special concession for the construction of large tanks . . .	*ib.*
362	Acquisition of land	*ib.*
363	Local utilization of the famine cess	144
	River channels.	
364	Present restricted use and possibilities of extension . . .	*ib.*

Para.	Subject.	Page.
	CHAPTER XVII.—The Central Provinces—*concld.*	
	(iv).—Private irrigation works—contd.	
	Wells.	
365	Number of wells and areas irrigated	144
366	Depth of subsoil water	145
367—369	Extension of wells	*ib.*
	Field embankments.	
370—373	Cost, value, and area embanked	146
374	Scope for extension	147
375	Measures for encouragement	*ib.*
376	Arrangement for construction of new embankments	*ib.*
	(v).—Famine works and programmes.	
377	Expenditure on works during the famines of 1896-97 and 1899-1900	148
378	Utility of the works	*ib.*
379	Famine programmes	149
	CHAPTER XVIII.—Bengal.	
380—381	Description	150
	Section I.—*The canals of Orissa and Midnapur.*	
382—384	The Orissa canals	*ib.*
385	The Midnapur canals	151
386	Irrigated areas	*ib.*
387	Water-rates	152
388	Navigation	*ib.*
389—390	Value of the canals	153
	Scope for further extension of irrigation.	
391	Coast districts	*ib.*
392	Angul district	154
393	Puri district	*ib.*
	Section II.—*The Damodar river works.*	
394—395	Proposed storage works on the Damodar river	*ib.*
396—397	The Eden canal	155
	Extension of works.	
398	Proposed weir across the Damodar	*ib.*

Para.	Subject.	Page.
	CHAPTER XVIII.—Bengal—*contd.*	
	Section III.—*Bihar, south of the Ganges.*	
399	General conditions	156
400—402	The Sone Canals	*ib.*
403	The *kathia*	157
404	Former system of irrigation	*ib.*
405	Leases for water	157
406—407	Water-rates	*ib.*
408	Recommendation to increase water-rates	159
409—410	Question of an owners' rate	*ib.*
411	Advantage of the lease system	161
412	Irrigation in Bhabua and Sasseram	*ib.*
413—414	Private irrigation works in Eastern Bihar	*ib.*
415—417	Need of legislation	162
	Section IV.—*Bihar, north of the Ganges.*	
418	Irrigation in Northern Bihar	163
419—420	The Tribeni Canal	164
421	The Dhaka Canal	*ib.*
422	Torrents from Nepal	*ib.*
423	Irrigation in Muzaffarpur	165
424—425	The Bagmati scheme	*ib.*
426	Irrigation in Darbhanga	166
427	The Dous project	*ib.*
428—429	The Kamla project	*ib.*
430—432	Private irrigation works	167
433	Assistance to District Boards in carrying out relief works	168
434—436	Question of an irrigation cess	169
437	The Saran district	170
438—440	The Saran Canals	*ib.*
441—443	Proposed cess, Saran Canals	171
	Section V.—*Chota Nagpur.*	
444—445	General conditions	172
446	Obstacles to extending irrigation	173

Para.	Subject.	Page.
	CHAPTER XVIII.—BENGAL—*concld.*	
	SECTION V.—*Chota Nagpur*—contd.	
447	Irrigation in estates	173
448—449	Projects in Palamau	174
450	Korarbar and Karo projects	175
451	Need for expert assistance	*ib.*
452	Relief works	*ib.*
453—454	Contrast between Chota Nagpur and Sonthal Parganas	*ib.*
	SECTION VI.—*General.*	
455	Schemes in Nadia district	176
456	Private works in Monghyr	*ib.*
457—459	Well irrigation	177
460—461	Takavi	178
462	Village tanks	179
463	Mr. Tytler's encouragement of wells	*ib.*
464	Famine relief works	*ib.*
	CHAPTER XIX.—THE UNITED PROVINCES OF AGRA AND OUDH.	
465	(*i*).—*Local conditions; use and value of irrigation*	181
466—467	The Sub-montane tract	*ib.*
468—469	The Central tract	*ib.*
470	The Ganges-Jumna Doab	182
471—475	The Southern tract	*ib.*
476	Utility of irrigation	183
	(*ii*).—*Existing State irrigation works.*	
477	Number and classification of State irrigation works	184
478	Total cost of the works and general financial results	*ib.*
479	General protective results	*ib.*
480	Injurious effect of canal irrigation, and its remedy	185
481	Dependence placed upon the winter rainfall	*ib.*
482	Increase in the protection afforded by State works	*ib.*
	Large canal systems.	
483	The four productive works	*ib.*
484	Capital cost per acre	186

Para.	Subject.	Page.
	CHAPTER XIX.—The United Provinces of Agra and Oudh—*contd.*	
	(*ii*).—*Existing State irrigation works*—contd.	
	Large canal systems—contd.	
485	Revenue, maintenance charges, and value of crops irrigated . .	186
486	Results of expenditure on improvements	*ib.*
487	The Fatehpur Branch extension	187
488	Other extensions	*ib.*
489—491	The Betwa Canal	*ib.*
492	Difference in the results in the two branches of the Betwa Canal .	188
	Minor works.	
493	Small canals	*ib.*
494	Storage works	189
495	The Tarai and Bhabar Canals	*ib.*
	(*iii*).—*Scope for further extensions of State irrigation works.*	
496	The Sub-montane tract	*ib.*
497	The Central tract	*ib.*
498—499	The Eastern Ganges and Ramganga Canals	*ib.*
500—516	The Sardah Canal	190
517	Extensions of existing works in Ganges-Jumna Doab . . .	195
518—519	Storage works and prevention of percolation	196
520—522	Possible utilization of Sardah waters outside Oudh . . .	*ib.*
523—524	The Ken Canal	197
525	The Dassan Canal	198
526	Proposed canals in Mirzapur, Benares, and Allahabad . . .	*ib.*
527	The Chandraprabha Canal	*ib.*
528	Improvement of the Betwa Canal	*ib.*
529	Establishment of a farm on the Betwa Canal	199
530	Storage tanks in Bundelkhand	*ib.*
	(*iv*).—*Private irrigation works.*	
531	Area irrigated by private works of all kinds	*ib.*
532	Wells	*ib.*
533—535	Permanent wells	*ib.*
536	Increase in the number of permanent wells	200

Para.	Subject.	Page.
	CHAPTER XIX.—The United Provinces of Agra and Oudh—*concld.*	
	(*iv*).—*Private irrigation works*—contd.	
537	Temporary wells	200
538	Famine protective value of wells	201
539—541	Scope for the extension of well-irrigation	*ib.*
542—544	Takavi advances	202
545	Improvements by tenants	203
546	Transfer of occupancy rights	*ib.*
547	Boring tools	204
548	Tanks	*ib.*
549	Canals for filling *jhils*	*ib.*
550	Other private works	205
551	Messrs. Peppé's and Holdsworth's canals in Gorakhpur	*ib.*
552	Field embankments	*ib.*
553—554	Extension of private works other than wells	*ib.*
	(*v*).—*Famine works and programmes.*	
555	Famine of 1896-97	206
556	Programmes of relief works	207
557	Works in ravines	*ib.*
	CHAPTER XX.—Upper Burma and Baluchistan.	
558	Introductory	208
	Section I.—*Upper Burma.*	
559	General conditions	*ib.*
560—561	State irrigation works	*ib.*
562—563	Scope for extension of State works	*ib.*
564	Private irrigation works	209
565	Field embankments	*ib.*
566	Programmes of relief works	*ib.*
	Section II.—*Baluchistan.*	
567	General conditions	210
568	Rainfall	*ib.*
569	State irrigation works	*ib.*

Para.	Subject.	Page.
	CHAPTER XXI.—NATIVE STATES—*contd.*	
	SECTION III.—(*Mysore including Coorg.*)	
	(*i*).—*Local conditions; use and value of irrigation.*	
622	Physical features	227
623	Soils and agriculture	*ib.*
624—625	Rainfall and famines	228
626	Value of irrigation	*ib.*
	(*ii*).—*Existing State irrigation works*	
627	Classes of works	*ib.*
628—629	Canals or river channel works	229
630	Tanks	*ib.*
631—632	Classification and size of tanks	*ib.*
633	Distribution of water	230
634—635	Restoration and repairs of tanks	*ib.*
636	Protective and financial results	231
637—639	Progress made since the famine of 1877	*ib.*
	(*iii*).—*Scope for further extensions of State irrigation works.*	
640	General remarks	232
	Works in progress.	
641—642	The Marikanave tank	233
	Proposed new works.	
643—644	River channels and ghat-fed storage works	*ib.*
645—646	Proposed new tanks	234
647	Cost of proposed new works and possible increase in the area irrigated.	*ib.*
	(*iv*).—*Private irrigation works.*	
648	Private tanks	235
649	Wells	*ib.*
650	Spring channels and private river channels	*ib.*
651	Field embankment	*ib.*
	(*v*).—*Famine works and programmes.*	
652	Famine programmes	*ib.*

Para.	Subject.	Page.
	CHAPTER XXI.—NATIVE STATES—*contd.*	
	(vi).—Coorg.	
653	Irrigation in Coorg	236
	SECTION IV.—*Hyderabad.*	
	(i).—Local conditions; use and value of irrigation.	
654	Physical features	*ib.*
655	The Telingana tract. Soils and agriculture	*ib.*
656—657	The Marathwara tract	*ib.*
658	The Carnatic districts	237
659	Extent of cultivation and irrigation	*ib.*
660	Area of cultivation per head of population	238
661	Rainfall and famines	238
662	General conclusions	*ib.*
	(ii).—Existing State irrigation works.	
663	Classes of works	*ib.*
664	Canals	*ib.*
665	Tanks	239
666—667	Restoration and up-keep of tanks	*ib.*
668—669	Method of financing the tank restoration work	*ib.*
	(iii).—Scope for further extensions of State irrigation works.	
670	Projects and surveys	240
	New works in the Carnatic districts.	
671	The Benur project	*ib.*
672	The Bhima and Kistna rivers	*ib.*
673	General scope of proposals	241
	New works in Telingana.	
674	Works in progress	*ib.*
675—676	Projects under consideration	*ib.*
	New works in Marathwara.	
677	Remarks and suggestions	*ib.*
	(iv).—Private irrigation works.	
678	Classes of works	242
679—680	Wells	*ib.*
681	Borings	243

Para.	Subject.	Page.
	CHAPTER XXI.—NATIVE STATES—*contd.*	
682	(*v*).—*Famine works and programmes* . . .	243
	SECTION V.—*Berar.*	
	(*i*).—*Local conditions; use and value of irrigation.*	
683	Main physical features	*ib.*
684—685	Soils and agriculture	*ib.*
686	Rainfall and famines	244
687	Utility of irrigation	*ib.*
688	(*ii*).—*Existing State irrigation works* . . .	*ib.*
689	(*iii*).—*Scope for further extensions of State irrigation works* .	*ib.*
	(*iv*).—*Private irrigation works.*	
690	River channels	245
691—693	Tanks and wells	*ib.*
694—695	(*v*).—*Famine works and programmes* . . .	246
	SECTION VI.—*Baroda.*	
696	Divisions of the State	*ib.*
697—698	Amreli Division	*ib.*
699—700	The Kadi Division	247
701—702	The Baroda Division	*ib.*
703—704	The Navsari Division	*ib.*
705—708	General conclusions and recommendations	248
709	SECTION VII.—*Central India*	249
	Baghelkhand.	
710	Physical features	*ib.*
711	Irrigated areas and scope for their extension	*ib.*
	Bundelkhand.	
712	Physical and agricultural conditions	250
713	Cropped and irrigated areas	251
714	Captain Ewbank's projects	*ib.*
715	Tank repairs	*ib.*
716	Field embankments	*ib.*
717	Well	*ib.*
718—720	Recommendations	*ib.*

Para.	Subject.	Page.
	CHAPTER XXI.—NATIVE STATES—*concld.*	
	SECTION VII.—*Central India*—contd.	
	Gwalior.	
721	Physical features	252
722—729	Gwalior and Isagarh Divisions	*ib.*
730	Wells	255
73	Other private works	*ib.*
732	Famine programmes	*ib.*
733—737	Malwa Division	256
	Indore and other States.	
738	General conditions	257
739	Irrigated area and scope for its extension	*ib.*
740	*General recommendations*	*ib.*
	Glossary of vernacular terms	259

सत्यमेव जयते

REPORT

OF THE

INDIAN IRRIGATION COMMISSION.

PART II.—PROVINCIAL.

CHAPTER XIV.—THE PUNJAB.

(INCLUDING THE NORTH-WEST FRONTIER PROVINCE.)

(*i*).—*Local conditions; use and value of irrigation.*

1. *The Punjab as an irrigation province.*—The first province visited by us, the Punjab or land of the five rivers, is of all Indian provinces that which is best adapted for extensive irrigation from perennial canals. Although little more than half a century has elapsed since the Punjab came under British rule, it is here that the greatest progress has been made in irrigation works of this class; and in spite of this fact it is here that there is still the greatest field for their further extension. The unfailing supplies of its snow-fed rivers, and the even surface of its arid plains, have rendered it possible to construct, at a comparatively small cost, the vast net-work of canals by which the greater part of the province is now protected from the worst effects of drought. On the other hand, the conditions of soil and climate throughout the Punjab plains are such as to ensure a constant and sustained demand for irrigation wherever it can be provided. In no other province are there greater facilities for extensive irrigation; in none is it more urgently necessary or more keenly appreciated. Thus there is no province in which, taken as a whole, the direct profits of irrigation works, as expressed in the returns realized on their capital cost, have been so high, or in which new protective works can be proposed with the same confidence in their remunerativeness as financial investments.

2. *Soil.*—It may be said generally that, wherever irrigation is practicable within the province, the soil is suitable, and the produce of the land increased by irrigation in almost all seasons. There is no black cotton soil in the Punjab. In almost all districts there are stretches of inferior soil, impregnated with salt or *reh;* and although it is beyond doubt that an extension or further deterioration of these areas has been the result of excessive irrigation, there is also evidence that such lands are not always unsuitable for irrigation, and that they have in some cases been improved or reclaimed by it. Moreover, these stretches are not so numerous or extensive as to render it unprofitable to carry canals through them for the irrigation of better soils around or beyond them. These latter are naturally the first to be brought under cultivation, but by degrees the inferior soils are also taken up. In the south and west there are very extensive tracts which are covered with sand and sand-hills, in which the conditions are not very favourable for irrigation, though it has been actually introduced in some portions of the southern tract which receive water from the Western Jumna and Sirhind Canals, and also in part of the western tract in the north of the Muzaffargarh district. It has been found that in such areas irrigation has a real protective value, and that a demand for water may be relied on; but it is much less profitable to Government than in more favourable tracts, owing to the greater cost of constructing and maintaining the distributing channels, and to the fact that the irrigation is scattered, and the percentage of high class crops low.

3. *Conditions in different tracts.*—In considering the utility of irrigation as a protection against drought it will be convenient to divide the Punjab into three tracts as shown in the following table :—

Tract A—Secure.		Tract B—Rainless.		Tract C—Insecure.	
Districts.	* Index number.	District.	* Index number.	District.	* Index number.
1. Hazara . .	85	1. Muzaffargarh . .	85	1. Gujranwala .	78
2. Kohat . .	77	2. Dehra Ismail Khan .	78	2. Gurdaspur .	77
3. Hoshiarpur .	76	3. Dehra Ghazi Khan .	77	3. Amritsar .	76
4. Jullundur . .	76	4. Multan . . .	75	4. Peshawar .	74
5. Kangra . .	69	5. Montgomery . .	65	5. Ludhiana .	72
6. Bannu . .	68	6. Shahpur . . .	64	6. Lahore .	71
7. Sialkot . .	63	7. Jhang . . .	117	7. Firozpur .	61
8. Rawalpindi . .	62			8. Delhi	61
. Simla . .	54			9. Karnal .	51
				10. Gujerat .	48
				11. Umballa .	42
				12. Gurgaon .	42
				13. Jhelum	28
				14. Rohtak .	26
				15. Hissar .	16
Tract A . .	70	Tract B . . .	85	Tract C . .	55

* *Note.*—The index numbers represent the percentages of the areas *matured* in each district during the famine year of 1899-1900 on the average areas annually matured, see paragraph 7.

4. *Tract A* includes the montane and sub-montane districts, in which the rainfall is so abundant or unfailing as to render large irrigation works unnecessary as a protection against drought. Irrigation is indeed extensively practised in many of these districts, either by the utilization of hill streams or from wells, but the works are of a simple and inexpensive character, the construction of which may be left to private enterprise. There are no Government irrigation works in this tract.

5. *Tract B* comprises the districts in the west and south-west of the province where the normal rainfall is so deficient that cultivation is almost impossible without irrigation. The unirrigated areas in these districts are practically unoccupied, so that the population is limited by the capacity of the existing irrigation works, most of which derive their supplies from snow-fed rivers, and are not liable to failure even in seasons of intense drought. The districts in this tract cannot therefore be considered as liable to famine, though they are often affected by unfavourable conditions in the river supply. The improvement of the irrigation systems, so as to render them more and more independent of fluctuations in the river supply, will make the conditions of existing cultivation more secure; but the construction of new works, or the extension of irrigation into areas at present unoccupied, is not urgently needed for the sake of protecting the districts from famine. The indirect protective value of such works cannot however be overrated. By bringing large areas of waste or desert land under cultivation, they increase the wealth and food supplies of the country and attract population from the congested districts around them. Moreover, such works are almost certain to prove highly remunerative as financial investments, so that the indirect protection against famine which they afford can be obtained not only without throwing any additional burden on the State, but also with a certainty of ultimately increasing its resources.

6. *Tract C* comprises those districts in which the area that can be cultivated without artificial irrigation, other than that from wells or other petty irrigation works, in years of normal rainfall would ordinarily be sufficient for the support of the population, but in which the crops are liable to failure in years of drought or unfavourably distributed rainfall. These are the districts which, being as a rule thickly populated, are naturally liable to the severest stress of famine, and

in which there is the most urgent necessity for protective irrigation works. Many of them are at present more or less completely protected by existing works; in others extensions of irrigation are possible which will place them in the same favourable condition; but there are others in which any considerable increase of protection does not appear to be practicable. In the case of all it may be said that the benefits of irrigation are not confined to the protection afforded against famine in years of drought. Even in years of normal rainfall the value of irrigation is appreciated as a means of increasing the profits of cultivation, and a fairly constant demand for water may be anticipated.

7. *Conditions in Tracts A and B.*—A table will be found in the Appendix to this report showing the present condition of the Punjab districts as regards population, cultivation, and irrigation. As a rough measure of the liability of each tract and its component districts to famine, we have worked out the "index number" shown for each district in the table in paragraph 3. In the case of *Tract A* it is found that in the famine year of 1899-1900, 3,981,000 acres were matured or 70 per cent. of the average area (5,654,000 acres). Of the area matured in that year only 1,506,000 acres, or 38 per cent., were irrigated, and, as there are no Government irrigation works in these nine districts, this irrigation was entirely from wells or other private works. Excluding the district of Simla, of which the small rural population is only partly dependent upon agriculture, the minimum index value is 62, for Rawalpindi. In *Tract B*, the area matured in 1899-1900 was 3,699,000 acres, against an average of 4,369,000 acres, or 85 per cent., the minimum percentage being 65, for the Shahpur district. The irrigated area in the same year amounted to 2,903,000 acres or, inclusive of cultivation from river spills and other forms of wet cultivation which are not included in the irrigated area, to 3,740,000 acres; that is, to over 100 per cent. of the area actually matured in 1899-1900. Of the artificially irrigated area, 1,849,000 acres, or over 63 per cent., were due to Government works. The high index number for the Jhang district is due to the recent expansion of cultivation on the Chenab Canal, the area actually matured in 1899-1900 having been considerably in excess of the average for the previous five years.

8. In both these tracts there may occasionally be scarcity and even local distress, but famine conditions are unknown; in Tract A, because even in the driest years the local rainfall and the existing means of irrigation, afforded by wells and other private works, are sufficient to ensure a fair crop; and in Tract B, because little dependence is ever placed on the rainfall, and the existing population and the average cultivated area depend on the extent to which assured irrigation has been provided either by private effort or by the State. In Tract A, Simla, Hazara, and Kangra, are favoured with an abundant and unfailing rainfall. Jullundur and Sialkot have over 50 per cent. of their cultivation protected by wells. In Hoshiarpur the rainfall is sometimes deficient, but there are good facilities for well irrigation of which increasing use is being made. Kohat has a small annual rainfall and few means of providing irrigation, but its wants appear to be met by a good winter rainfall that seldom fails. In Bannu the existing methods of utilizing hill-streams have hitherto proved sufficient for the requirements of the district, but with the population increasing, expert advice will now be required to improve and develop the means of irrigation. The extension of cultivation and irrigation, consequent upon our occupation of the Kurram and Tochi valleys, is said to have led to an appreciable reduction in the volume of water available for this lower-lying district. In Rawalpindi there appears to be scope for a further extension of wells, and for the more efficient utilization of hill-streams. In Tract B, there is a great field for extending irrigation in all districts, by improvement and extensions of the inundation canals, and by the development of the Chenab, Jhelum, and proposed Lower Bari Doab Canals.

9. *Conditions in Tract C.*—In the insecure *Tract C*, of the average area of matured cultivation only 55 per cent. was matured in 1899-1900, although 38 per cent. was irrigated. Of the total irrigation more than one-half was due to Government works. The index numbers, which vary from 16 to 76, show how

unequally the districts in this tract are protected. From a consideration of the effects of the recent drought, and of the index numbers of the several districts comprised in the three tracts, we infer that the minimum index of security may be taken as 60; or, in other words, that a district in the Punjab is just secured against general famine if the area of crops matured in a year of extreme drought is six-tenths of the average area matured in non-famine years. Judged by this rough standard the first six of the districts included in Tract C may be considered as adequately protected, though in some of these distri.ts there are small local areas which are still subject to distress, such as the Ajnála tahsil of Amritsar and the Sharakpur tahsil of Lahore. Firozpur and Delhi are fairly well protected, but some further protection is no doubt desirable. The Sharakpur tahsil of the Lahore district will be protected by a branch of the Chenab Canal. In Firozpur some extensions of the inundation canals are contemplated. Further protection in Delhi can only be afforded by means of wells. The remaining seven districts of this tract must be regarded as inadequately protected. For the Jhelum district two minor irrigation works have been proposed. Neither here nor in Gujerat, Karnal, and Umballa, is there any scope for large works; and the only hope of any considerable extension of protection in these districts lies in the further construction of wells and the utilization of hill-streams. Hissar, Rohtak, and Gurgaon are, in the order named, undoubtedly the most insecure districts in the province. The spring level in Hissar and Rohtak is too low to admit of any considerable extension of irrigation from wells. In the third and fourth sections of this chapter we discuss the possibility of extending other forms of irrigation, but the prospects of giving both these districts complete protection against famine are not promising. It is possible, however, by the development of wells and the construction of additional *bands* or embankments to make Gurgaon much more secure than at present.

10. *Native States.*—Before concluding this section reference must be made to the principal Native States in the Punjab. Bahawalpur may be regarded as in Tract B, and is as adequately protected against famine by its inundation canals as the British districts in that tract. Faridkot and Nabha are completely protected by the Sirhind Canal. The greater part of Patiala and Jind are also protected by the Sirhind and Western Jumna Canals. But the northern part of Patiala is as liable to distress as adjacent parts of Umballa, and the Narnaul taluka in the south-east of the State is as insecure as the adjacent British districts; the same remark applies to the Dadri taluka in the Jind State.

(*ii*).—*Existing State irrigation works.*

11. *Major and minor works in the Punjab correspond with perennial and inundation canals.*—Irrigation works constructed by the State are usually divided into two classes, major and minor works. These terms are defined in Chapter VIII, where it is shown that the classification depends entirely on the source from which funds for construction and maintenance are provided. It so happens, however, that in the Punjab these terms accidentally connote, subject to a slight exception, a more convenient and natural distinction in the irrigation works of the province: major works may be generally understood as referring to perennial canals, or canals which utilize the cold weather supply of the rivers; while the other great class of Punjab irrigation works, the inundation canals, which flow as a rule only during the hot weather months, are designated by the term minor works. The only real exception is the small Lower Sohag and Para Canal which, though classed as a major work, is a purely inundation canal. The Sidhnai Canal, which is classed as a major work, is sometimes spoken of as an inundation canal, because its supply is liable to fail in the cold weather. It differs, however, from an inundation canal in being provided with head-works, which enable it to utilize whatever supply there is in the river, however low, and it is often in flow throughout the greater part of the cold weather. It occupies, therefore, a position intermediate between a perennial and an inundation canal. All Imperial minor works in the Punjab are without exception inundation canals, while, subject to these exceptions, all major works are perennial. The canals referred to in the following remarks

on major and minor works may, therefore, for all practical purposes, be regarded, respectively, as perennial and inundation canals.

Major Irrigation Works or Perennial Canals.

12. *Major works, their productive and protective value.*—Including the recently opened Jhelum Canal, there are in the Punjab eight major works. The productive and protective results of the seven works in operation for the year ending 1900-01, and the financial results attained to the end of that year, are shown in the table below :—

Name of Canal.	Results for the year 1900-01.				Excess of net revenue to end of the year over interest charges.
	Imperial capital outlay to end of the year.	Excess of net revenue for the year over interest charges.	Percentage of net revenue on capital cost.	Area irrigated during the year.	
	Rs.	Rs.	Per cent.	Acres.	Rs.
Western Jumna . . .	1,71,35,032	9,08,127	9·16	567,125	3,65,20,379
Bari Doab . . .	1,84,48,173	16,65,129	12·86	861,301	1,42,28,870
Sirhind	2,44,70,507	13,01,809	9·11	961,927	—18,60,281
Swat River	41,38,881	2,71,088	10·41	166,031	1,42,919
Lower Sohag and Para . .	7,34,050	—8,972	2·60	86,163	74,729
Sidhnai	12,64,191	25,011	5·81	169,780	14,09,428
Chenab	2,58,85,143	26,31,421	14·01	1,830,525	43,05,843
Total .	9,20,75,977	67,93,613	11·20	4,642,852	5,48,21,887

All these works are classed as "productive" except the Swat River Canal. This was originally sanctioned as a productive work, but before completion a revised estimate became necessary, and it was then considered that the original forecast of revenue had been too sanguine, and that the canal would not fulfil the conditions of a productive work. The revised estimate was, therefore, sanctioned as a "protective" work, and all expenditure subsequent to the sanction has been met from the Famine Grant. As will be seen, however, the canal is now actually a highly productive public work. Before the change of classification, Rs. 11,14,090 had been charged against Loan Funds on account of this work, and Rs. 2,24,580 against ordinary revenue. The balance of the direct capital expenditure has been met from the Famine Grant.

13. *Financial results of major works.*—The financial results attained during the year 1900-01, which may be regarded as normal in the aggregate though not for individual works, speak for themselves. The canals yielded a return of 11·2 per cent. on their capital cost; equivalent to a contribution of nearly 68 lakhs to general revenues, after all interest charges for the year had been met. The last column in the table shows that the canals have earned, since they came into operation, a total gross revenue which exceeds the accumulated working expenses and interest charges by 548 lakhs, or by more than half the capital cost of the works.

14. *Capital cost of major works per acre irrigated, and rates for gross revenue and maintenance.*—It should be noted that the amounts shown as Imperial capital outlay for the Western Jumna and Sirhind Canals are exclusive of the contributions made by Native States who have shares in these canals. These contributions amount, respectively, to Rs. 11,38,153 and Rs. 1,40,82,160. Their exclusion does not affect the financial results exhibited, as the revenue derived by the Native States has also been excluded. But the areas shown as irrigated by these canals in 1900-01 include the areas irrigated on the Native States' branches, which amounted to 45,784 acres on the Western Jumna, and

240,076 acres on the Sirhind Canal. These areas have been included for the sake of indicating the full protective value of the works, without reference to considerations of ownership or territory. If they are deducted from the total area in the last line of the table, there will remain 4,356,992 acres irrigated during the year from works, the capital cost of which has amounted to Rs. 9,20,75,977 or Rs. 21·1 per acre, which shows at what a low rate irrigation can be provided on the perennial canals of the Punjab. The working expenses during the year amounted to Rs. 43,01,651 or nearly Rs. 0·99 per acre. Interest charges and working expenses may therefore be taken together at Rs. 1·83 per acre. The gross revenue during the year averaged Rs. 3·36 per acre, leaving Rs. 1·53 per acre as clear profit to Government. The total value of the crops, excluding the areas assessed on Native States' branches, has been estimated at Rs. 12,05,00,000, or 23½ per cent. in excess of the whole capital cost of the works; the average value per acre being about Rs. 28, or eight times the amount taken as gross revenue. The value of the crops assessed on the Native States' branches amounted to nearly 72 lakhs. These figures give a very fair indication of the productive, protective, and financial results which have been attained on major irrigation works in the Punjab.

15. *Normal area irrigated by major works and growth of irrigation.*—The total area shown in the table in paragraph 12 cannot well be compared with those of previous years owing to the annual extensions of area on the Chenab Canal where irrigation is not yet fully developed. The areas for the older canals taken collectively may, however, be regarded as fairly normal. Those shown for the Western Jumna and Sirhind Canals were considerably below the average of the previous three years, owing to favourable rainfall during the *rabi* which checked the demand for irrigation, but on all other canals the areas were above the normal. On the whole it seems that the year 1900-01 may be taken as a normal or typical year of the major works in the Punjab at their present stage of development; but an almost continuous increase may be expected, not only as the new Jhelum Canal is brought into operation, but also in consequence of extensions and improvements, now in progress or in contemplation, on the Chenab and other Canals. The following table, showing the growth of irrigation on these works since 1881, will give a good idea of the gradually increasing protective value of the works. The increase which may be expected from the construction of new works will be considered in the next section of this chapter.

Name of Canal.	Average area irrigated annually in successive five-year periods.			
	1881-82 to 1885-86.	1886-87 to 1890-91.	1891-92 to 1895-96.	1896-97 to 1900-01.
	Acres.	Acres.	Acres.	Acres.
Western Jumna	329,949	331,559	395,595 (*b*)	686,637
Bari Doab	398,919	491,259	570,580	795,169
Sirhind	152,837 (*a*)	568,397	635,749 (*c*)	1,204,284
Swat River	44,092 (*a*)	91,808	97,599	145,108
Lower Sohag and Para	17,246 (*a*)	44,462	68,991	74,901
Sidhnai	...	80,146	132,991	123,103 (*d*)
Chenab	...	37,549 (*e*)	220,484 (*f*)	1,094,346
TOTAL	943,043	1,645,180	2,121,989	4,123,548

(*a*) Irrigated area for one year only (1885-86).

(*b*) Increase due to opening of Sirsa Branch in 1895-96.

(*c*) Average during this period much affected by five successive half-years of abundant rainfall which reduced the demand. Had demand been normal, the average would probably have been about 920,000 acres.

(*d*) Average greatly affected by exceptionally low river in 1899-1900, when the canal ran for 93 days only during the year and the area irrigated did not exceed 26,265 acres.

(*e*) Average for four years only, the canal having been opened as a small inundation canal in 1887-88.

(*f*) Head-works completed and canal supply rendered perennial in 1892-93 and afterwards enlarged and extended.

16. *Expansion of irrigation from major works during the last decade.*—It is not our intention to enter into a history or description of these works; but attention may be called to the remarkable expansion of irrigation shown on all works, with the accidental exception of the Sidhnai, from about the year 1895-96. In the case of the Chenab Canal this is merely the natural growth of irrigation on a new work still under construction; but in the case of all the other works the figures, although affected in one direction or another by accidental causes such as extreme drought, low rivers, or abundant and seasonable rainfall, show a remarkable development of irrigation. This is in the main the result of a policy of extension which had been initiated a few years before; a policy which on some of the works has not yet reached its ultimate limit. In explanation of this policy it may be observed that, excepting the Swat River and Jhelum Canals, the irrigating capacity of all the perennial canals during the *rabi*, which in the Punjab has generally been the principal crop, is limited by the cold weather supply in the river. The maximum capacities of the canals were originally designed with reference to this supply. It was for many years thought that the maximum capacity should not greatly exceed the average cold weather supply, and the ratio has varied from 1 to 2. The policy of extension has been to increase the maximum carrying capacity of the canals; to arrange for a more effective and economical distribution of the limited cold weather supplies; and to extend the commanded area to the extreme limits imposed by the supply thus rendered available, or by the physical features or natural boundaries of the country. It may be stated, in greater detail, as follows:—

(*i*) To remodel gradually the main line and branches so as to increase their capacity to the utmost extent that is possible or desirable, without reference to the limits of the cold weather supply.

(*ii*) To arrange for passing the whole of the cold weather supply, when it falls below a certain limit, into one or more of the branches in rotation, so that each branch may be run full for some time and then be closed entirely. The remodelling of the branches under (*i*) is generally sufficient for this purpose.

(*iii*) To remodel the distributaries, when necessary, to permit their being worked on the same system of alternate full supplies and complete closures.

(*iv*) To shorten the length of village water-courses by the construction of minor distributaries; the general policy being to carry water through a Government channel to the boundary, at least, of every irrigating village, so that no water-course is carried through the lands of another village.

(*v*) To reduce further the waste on village water-courses by realigning, or amalgamating them whenever this can be done. (On all new canals and extensions the water-courses are now generally aligned and constructed by the Irrigation officers, the cost being subsequently recovered from the villagers.)

(*vi*) To proportion the capacity of each irrigation outlet to the area which the water-course is intended to serve.

(*vii*) To give greater and more immediate control over the distribution by the extension of canal telegraphs.

(*viii*) To restrict the supply for *rabi* irrigation in certain tracts to a first watering, for which special or reduced rates are charged.

(*ix*) To extend the commanded or protected area gradually by the construction of new distributaries.

17. *Results of expenditure against open capital accounts.*—The policy of extension has been greatly facilitated by the rules which were introduced in 1890, under which the cost of extensions and improvements of irrigation works could be charged to an open capital account, and be provided for, under certain conditions, from loan funds. The following table shows the extent to which extensions have been carried out under these rules on the six major works to which

we have just referred, and approximately the degree of additional protection which has been obtained from this expenditure: —

Name of Canal.	Year in which construction or remodelling estimate was closed.	Maximum irrigation recorded in any year up to end of third year from date of closing construction estimate.		Maximum irrigation recorded to end of year 1900-01.		Capital outlay incurred between date in col. 2 and end of 1900-01 in rupees.
		Year.	Area in acres. (Number of villages.)	Year.	Area in acres. (Number of villages.)	
1	2	3	4	5	6	7
Western Jumna . . .	1890	1877-78	507,974 (693)	1897-98	{ 199,744(*a*) 564,552(*b*) (1,167)	40,10,579(*a*) 30,00,791(*b*)
Bari Doab . . .	1890	1891-92	592,785 (1,384)	1900-01	861,301 (1,570)	20,41,697
Sirhind	1891	1891-92	910,056 (971)	1899-00	1,370,735 (980)	14,63,341
Swat River . . .	1893	1893-94	110,819 (137)	1900-01	166,031 (187)	5,26,093
Lower Sohag and Para .	1891	1893-94	71,179 (294)	1897-98	102,014 (312)	42,493
Sidhnai	1892	1893-94	151,427 (213)	1897-98	185,709 (257)	2,99,644
TOTAL . .	...	...	2,344,240 (3,692)	..	3,450,086 (4,423)	1,13,84,638

(*a*) Sirsa Branch only.
(*b*) Old canal and extensions other than Sirsa Branch.

The figures in column 4 may be assumed as representing approximately the maximum irrigating capacity of each work at the time that the construction estimate was closed, which was in all cases several years after the commencement of irrigation. Those in column 6 show the maximum irrigation recorded up to date; and the excesses over those in column 4 indicate roughly the increase in irrigating capacity which has resulted from the expenditure shown in the last column, although the full benefits of this expenditure have probably not yet been realized. According to this test it appears that as a consequence of a total expenditure of less than 114 lakhs against the open capital accounts of these works, their maximum irrigating capacity has been increased by 1,105,846 acres at a cost of a little over Rs. 10 per acre, while the number of villages protected has increased from 3,692 to 4,423. We have brought forward these figures to show how much can be done by a liberal expenditure of capital to develop irrigation on works after they have been nominally completed, and also how much has been done in the case of these works, as bearing on the question of the scope for further expansion.

18. *Chenab Canal.*—The Chenab Canal is the largest and most profitable perennial canal in India. It was designed to command an area of about $2\frac{1}{2}$ million acres, and to irrigate annually a little less than half that area. The area to be commanded consisted chiefly of crown waste lands, which at the time of the census of 1891 were populated only by the labourers employed on construction and a few nomads. The head-works of the canal, and two branches, were completed in the spring of 1892, and in that year the colonization of the crown waste began. The area irrigated in 1900-01 amounted to 1,830,525 acres. Up to the end of that year $1\frac{1}{2}$ million acres had been sold or leased to cultivators, who were drawn from almost all the districts in the Punjab. The population of the colonies according to the census of 1901 was 792,666, consisting mainly of thriving and prosperous peasants with occupancy rights in holdings of about 28 acres each. A railway, 200 miles in length, has been constructed, and traverses the centre of the canal tract; it is said to be one of the most profitable parts of the North-Western Railway system. The policy of extension is being followed also on this canal. The boundaries originally proposed for the area to be commanded have been considerably extended during construction, but further extensions are now contemplated. It was originally intended to confine irrigation to the high tracts forming the central *Bar*, in which the depth from ground surface to spring level exceeded 40 feet. It has, however, been

found here, as on other canals, that the extension of canal irrigation in this tract has, by drawing away labour, injuriously affected the proprietors in the lower lands that lie between the *Bar* and the rivers on each side, where the conditions of cultivation are always precarious. It has, therefore, been decided to extend irrigation into these tracts, where protection is much needed. Many estimates for these extensions have already been sanctioned against the open capital account, and the works are now under construction. The total additional gross area to be brought under command, by these and other extensions that may be proposed hereafter, will probably exceed 1,200,000 acres, of which about 350,000 acres will be annually irrigated. It is probable that the total area annually irrigated by this canal will ultimately average considerably over 2 million acres.

19. *Jhelum Canal.*—The Jhelum Canal was formally opened by His Honour the Lieutenant-Governor on the 30th October 1901, the head-works, main line, and two branches with their distributaries having been practically completed. The total estimated cost of the work is 125 lakhs, of which over 94 lakhs had been expended up to end of the year 1901-02. The area that can be commanded by this canal is limited on both sides by the Jhelum and Chenab rivers; and, though less than can be protected by the supply available in the river, it cannot be extended. It is estimated at 1,139,500 acres, of which about 612,000 acres will probably be irrigated annually. It will not be as profitable as the Chenab Canal, as it is a smaller work, and the proportion of crown waste is much less, but it is likely nevertheless to prove highly remunerative. In its present incomplete state, within one year from date of opening it had irrigated 90,000 acres. The Jhelum silt is noted for its fertilizing qualities, and it is anticipated that the lands will be even more productive than those on the Chenab Canal.

Minor Irrigation Works or Inundation Canals.

20. *Minor Irrigation Works.*—Most of the inundation canals in each system, with the exception of the Ghaggar Canals, existed in some form or other before they came under the control of Government. The Upper Sutlej and Shahpur Imperial Canals have, however, been almost entirely constructed or reconstructed by Government, and they have reliable capital and revenue accounts of their own. In addition to the Imperial canals, there are two provincial canals in the Shahpur district which have been constructed or purchased by the Local Government since the introduction of the system of provincial settlements, and these are now under the management of the Irrigation Department.

21. *Protective value of inundation canals.*—The great protective value of inundation canals in the irrigation system of the Punjab may be judged from the fact that in the famine year of 1899-1900, when their efficiency was at a minimum, they irrigated over 10 per cent. of the total irrigated area of the province, including that irrigated by wells. In certain areas they are being, or in time may be, superseded by canals of constant flow; while the withdrawal of constantly increasing portions of the cold weather supply of the Punjab rivers must to some extent affect the efficiency of the remaining works. But, however far these processes may be carried, it seems hardly possible that the inundation canals can ever cease to fulfil the important function of utilizing a portion of the enormous surplus body of water which pours down the rivers during the rainy season, far in excess of the capacity of such perennial canals as it now seems possible to construct. All of them, with the single exception of the Ghaggar Canals, bring the waters of snow-fed rivers to the land long before the beginning of the rains and, what is of special importance for the spring crops, they continue to supply water for some weeks after their close. The Ghaggar Canals also bring the flood-waters from tracts of copious to those of scanty rainfall, although these floods cannot be relied on in years of drought, and may sometimes fail altogether. The degree of protection afforded

by each of the minor works under the Irrigation Department, and also the growth of irrigation since 1881-82 are shown by the following table:—

Name of Canal.	Average area irrigated annually during successive five-year periods.			
	1881-82 to 1885-86.	1886-87 to 1890-91.	1891-92 to 1895-96.	1896-97 to 1900-01.
	Acres.	Acres.	Acres.	Acres.
Upper Sutlej	109,334	133,317	178,664	186,807
Lower Sutlej	181,368	176,361	177,492	(c)160,362
Chenab Inundation	166,751	156,423	149,152	158,241
Muzaffargarh	248,810	283,605	294,705	293,853
Indus	178,053	191,194	176,088	180,790
Shahpur (Imperial)	11,980	18,135	25,653	36,492
Ditto (Provincial)	...	(a)19,105	16,252	22,751
Ghaggar Canals	...	...	..	(b)30,310
TOTAL	896,296	978,133	1,018,006	1,069,606

(a) For 1890-91 only.

(b) For four years (1897-98 to 1900-01) only.

(c) Area for 1899-1900 was only 91,133 acres, the minimum on record.

It will thus be seen that the present average irrigating capacity of these works is about one million acres per annum, but the fluctuations are great. In 1899-1900 the actual area irrigated was 859,981 acres only, and in the following year it amounted to 1,357,699. These may be regarded as the minimum and maximum areas for the minor works as they now stand. In addition to these areas must be considered the area irrigated by the Kabul River Canal in the Peshawar district, which is a provincial work, and not under the Irrigation Department. It is said to have irrigated an average of 26,547 acres during the past five years.

22. *Productive value of minor works. Works with capital accounts.*—As regards the productive value of these canals, minor works must be considered in two classes: those with capital accounts, and those which have only revenue accounts. The only works which have capital accounts are the Upper Sutlej, the Shahpur (Imperial), the Indus, the Ghaggar, and the Kabul River Canals. The average net revenue on the Upper Sutlej and Shahpur (Imperial) Canals during the five years ending 1900-01, amounted to Rs. 64,016, and Rs. 46,165, respectively; amounts which represent a return of 7·64 and 21·43 per cent. on the capital cost of the respective works to the end of 1900-01. The figures for the Upper Sutlej Canals are, however, affected by large outstanding balances of revenue at the end of 1900-01. If these are allowed for, the true average return for these canals will probably be over 10 per cent. We are unable to determine the productive value of the Indus Canals, for, apart from the fluctuations in the areas irrigated, there have been changes in the method and rates of assessment, and large credits on account of arrears, which render it difficult to ascertain the true financial position of these works; but they may probably be considered productive. The Ghaggar Canals were constructed by relief labour in 1896-97, and no charges have yet been made for irrigation, but it has never been expected that the works will be remunerative, as the supply is very precarious. The Kabul River Canal is a highly remunerative work. The capital cost to end of 1900-01 stood at Rs. 4,83,282 and the net revenue in that year amounted to Rs. 1,03,696, or 21·46 per cent.

23. *Productive value of minor works for which capital accounts are not kept.*—As regards works for which revenue accounts only are kept, the accounts for the Lower Sutlej and for the Chenab Inundation Canals have hitherto been combined, and it is not necessary for our purposes to separate them, although they are to be separated in future. The following table shows the

average results of minor works for which no capital accounts are kept during the five years ending 1900-01 :—

Name of Canal.	Average gross revenue per annum.	Average working expenses per annum.	Average net revenues per annum.	Percentage of working expenses on gross revenues.
	Rs.	Rs.	Rs.	
Lower Sutlej and Chenab .	6,54,825	4,84,518	1,70,307	74
Muzaffargarh . . .	4,07,162	2,37,306	1,69,856	58
Shahpur (Provincial) . .	47,248	35,812	11,436	76
TOTAL .	11,09,235	7,57,636	3,51,599	68

The gross revenue is all fairly creditable to the works. It includes all direct receipts, all enhancements or shares of land revenue which have been declared due to canal advantages, and in the cases of the Lower Sutlej and Chenab and of the Muzaffargarh Canals, the value of the labour which the landowners have supplied for clearances under the conditions of the settlements, and the contributions towards cost of maintenance which have been made from the fine fund. The net revenue therefore represents the annual profit now derived by Government from the works which it has taken under its control. There is another small and recently constructed minor work for which no capital account is kept—the Bara River Works which are under the Deputy Commissioner of Peshawar. The expenditure on this work to the end of 1900-01 amounted to Rs. 97,847, but as in the case of the Ghaggar Canals no revenue has yet been assessed on the irrigation.

24. *Inundation canals in Firozpur and Bahawalpur.*—An account of the inundation canals in this province would not be complete without a reference to two important systems on the left bank of the Sutlej, which are not under the control of the Irrigation Department, *viz.*, the Firozpur and Bahawalpur Canals. The former are district canals, and will be considered under private works; it may merely be noted here that they have an average irrigating capacity of about 160,000 acres per annum. The latter belong to the Bahawalpur State, and do not irrigate British territory. They are said to irrigate annually an area varying from 647,000 to 994,000 acres, which is nearly as great as the total area irrigated by all the inundation canals under the Irrigation Department; and their protective and financial value to the State cannot be overrated.

25. *Stationary condition of inundation canals.*—Before leaving the subject of existing minor works we would call attention to the inconsiderable increase in the area that has been brought under irrigation by certain works during the last fifteen years, as exhibited in the table in paragraph 21. It is understood that the areas recorded during the last five or six years differ from those for former years, in that they exclude areas on which assessments have been remitted owing to the crops having failed. It is possible that a deduction of not more than 10 per cent. may be made from the figures in the first two columns on this account, for purposes of comparison with those in the other columns; but even allowing for this there has practically been no progress on any works except the Upper Sutlej and the Shahpur Imperial Canals. These are canals which have capital accounts of their own, and a system of assessment which ensures an immediate return for any extension of irrigation. The capital outlay on these two works during the decade ending with 1900-01 amounted to Rs. 2,44,001 and Rs. 1,34,226 respectively, and has resulted in a satisfactory increase in the area irrigated. The Indus Canals have a capital account, but no expenditure has been incurred against it since 1881; though the evidence

shows that there is room for extensions on these canals. The Muzaffargarh Canals were transferred from district to departmental management in 1881-82, and the increase shown during the two succeeding quinquennia is due partly to this cause, partly to expenditure which has been incurred on extensions and improvements, and partly to the completion of flood protection embankments, the whole cost of which has not been charged against the canals. The condition of these canals appears, however, to be now stationary, but the Settlement Officer, Pundit Hari Kishan Kaul, has referred in his evidence to a number of useful improvements and canal-extensions which have been worked out in more or less detail by the canal officers, and by which it is anticipated that the irrigated area may be extended by 139,000 acres at a cost of less than 7 lakhs. This may be a sanguine estimate, but it shows the opinion of the local officers as to the scope which exists for improvement. On the Lower Sutlej and Chenab Canals there has been actual retrogression. In the case of the Sutlej Canals the retrogression is more serious than the figures indicate, as the last two columns of the table in paragraph 21 include the areas irrigated by the Hajiwah Canal, which was taken over by Government in 1891. The area irrigated by this canal may be taken at 30,000 acres, and this amount should therefore be deducted from the areas in the last two columns. On the other hand, the conditions of the river were exceptionally unfavourable in 1899-1900, and this has unfavourably affected the average in the last column of the table. Retrogression is less marked on the Chenab Canals, but there are at any rate no signs of progress. At the land-revenue settlement of the Multan district in 1878 the average area irrigated by the combined Lower Sutlej and Chenab Canals, excluding the Hajiwah, was estimated at 305,963 acres; and if allowance be made on the one side for the difference between net and gross areas, and on the other for the Hajiwah, the area during the five years ending with 1900-01 may be taken at about 316,000 acres, showing an increase of only 10,000 acres in twenty-three years.

26. *Reason for slow development of irrigation on inundation canals.*—It is not of course as easy or as profitable to extend irrigation on existing inundation canals as it has been possible to do on perennial canals with a certain and assured source of supply, but a comparison of the table in paragraph 21 with that in paragraph 15, suggests the idea that inundation canals have not received their due share of attention. The real reason for this appears to be that all expenditure on minor works, whether incurred on construction, extension, or maintenance, has to be met from the minor works grant, or by the amount that can be spared from current revenue; and that the ordinary grant is sufficient for little more than the actual maintenance of existing works. On the other hand, there is, as we have shown, little difficulty in obtaining funds for the extension of major works to their utmost capacity, the outlay on which is also, as a rule, more directly and immediately remunerative. We shall return to this subject in the next section, but meanwhile state our general conclusion that the Punjab minor works, almost all of which traverse districts in which cultivation is hardly possible without irrigation, have a great protective value; they are, with hardly an exception, financially very productive or remunerative; but their irrigating capacity is not much greater now than it was 15 years ago, and the question of their development, and of devoting more money to their extension, deserves earnest consideration.

(*iii*).—*Scope for further extensions of State irrigation works.*

27. *Lower Bari Doab Canal.*—The Famine Commission of 1898 referred in paragraph 573 of their Report to three great works which had been proposed for the extension of irrigation in the Punjab: the Jhelum, the Sind Sagar, and the Montgomery Canals. Of these the first, as we have seen, is approaching completion, and has been formally opened. A general estimate for the third, under the name of the Lower Bari Doab Canal, was submitted by the Local Government to the Government of India in October 1901, a few days before the first meeting of the Commission. The project is in itself a most promising one. The proposed canal will command a total area of about 1,600,000 acres in the

Montgomery and Multan districts, of which over 800,000 acres are situated in the *Bar* and consist entirely of crown waste lands; while the balance is in the *Bet*, or riverain tract, of the Ravi and old Bias rivers. Of this area it is proposed to irrigate annually 824,000 acres, of which about 524,000 will be in the *Bar*. The total capital cost is estimated at $3\frac{1}{3}$ crores of rupees; and it is anticipated that the net revenue in the eighth year after the commencement of irrigation will amount to over 31 lakhs, or $9\frac{1}{3}$ per cent. on the capital cost. The work will not have the same productive or protective value as the Chenab Canal, for it will be more costly to construct and will irrigate a much smaller area; but its productive and protective value will nevertheless be very great. The Punjab estimates of revenue appear to have been framed with studious moderation, and in view of the results which have been attained on all the other major works in the province, we have little doubt that this work will prove highly remunerative, and have an immense protective value.

28. *Interference with the supply to the Sutlej inundation canals.*—There is, however, an objection to the scheme which must be considered. The proposed canal will draw its supply—about 4,000 cusecs—from the Sutlej, immediately below the confluence of the Bias river. The Sirhind Canal now draws off the whole of the cold weather supply of the Sutlej, at a point nearly 100 miles above the junction, and the new canal will take in almost all the cold weather supply of the Bias. It is urged that the construction of the canal will affect very prejudicially the four systems of inundation canals on the Sutlej, which are situated below the proposed head-works, *viz.*, the Upper and Lower Sutlej Canals on the right bank, and the Firozpur and Bahawalpur Canals on the left. The withdrawal of the cold weather supply of the river should not, we think, seriously affect inundation canals, because the beds of these canals are, as a rule, too high for them to utilize this supply, which passes on unused to the sea. The cultivation has adapted itself to these conditions, and the crops do not depend on a cold weather supply. It has been stated in evidence before us that, owing to the skill and energy displayed by the cultivators of Bahawalpur in deepening their canals below the level of cold weather supply, this supply is utilized to a great extent in that State; but in the absence of detailed records we are unable to say whether the cultivation depending on it is considerable. Elsewhere in the Punjab, the inundation canals would certainly not suffer by the complete withdrawal of the cold weather supply; nor would the withdrawal of the volume required for the proposed canal seriously affect the supply to the inundation canals when the river has risen to full monsoon level, or approximately from the middle of June to the end of September. The injury which is apprehended to these canals is that which may be due to the withdrawal of 4,000 cusecs during the period that the river is rising to monsoon level at the beginning of the irrigation season, or falling below it at the end.

29. *Effect of the opening of the Sirhind Canal on the Sutlej inundation canals.*—The *Wazir* of the Bahawalpur State has told us that the working of the Sirhind Canal has involved a great increase in the State's expenditure on canals, in spite of which the average area irrigated by them has fallen from 716,365 acres, the average before the canal was opened, to 693,718 acres, the present average; that the average area irrigated by river spill has been reduced from 520,467 to 324,312 acres; that the spring level in wells has fallen on an average 10 feet; and that a number of wells have been abandoned. We cannot examine these statements at length, but there is *primâ facie* no reason to suppose that the opening of the Sirhind Canal has caused a reduction in the areas irrigated by the inundation canals. There must always have been some inundation canals in the State; but we understand that the development of the existing system of State Canals was first taken in hand by the Political Agent in 1867. The irrigated area had been increased to 295,233 acres in 1872 and to 724,950 acres in 1879, when the agency ceased and the canals came under the control of the State officials. From a statement furnished by the *Wazir*, we have obtained particulars of the average areas irrigated during successive quinquennial periods, which are compared below with similar

averages for other inundation canals on the Sutlej, including the Lower Sohag and Para Canal :—

Canals.	1876-77 to 1880-81.	1881-82 to 1885-86.	1886-87 to 1890-91.	1891-92 to 1895-96.	1896-97 to 1900-01.
Upper Sutlej	96,754	109,334	133,310	178,664	186,807
Lower Sohag and Para Canal	...	17,246(a)	44,462	68,991	74,901
Lower Sutlej	157,247 (b)	211,368(c)	206,361(c)	177,492	160,362
Firozpur	73,017	104,072	139,773	122,613	159,528
Total British Canals	327,018	442,020	523,906	547,760	581,598
Bahawalpur State	708,179 (d)	741,095	661,619	888,209	743,148
TOTAL	1,035,197	1,183,115	1,185,525	1,435,969	1,324,746

(a) For one year only (1885-86).
(b) For one year only (1880-81). No record for previous years.
(c) 30,000 acres added for Hajiwah Canal. See paragraph 25.
(d) Average for three years from 1878-79.

The withdrawals by the Sirhind Canal were practically insignificant before the year 1887-88. The maximum area recorded on the Bahawalpur Canals before that year was 807,058 acres in 1884-85, but there have since been three years in succession (1892—95) in each of which the area exceeded 900,000 acres, the average for the three years being 947,842 acres, while the maximum was 994,353 acres, in 1894-95. There is no indication here of a falling off in irrigation in Bahawalpur, although the State may have had to spend more money on the maintenance and improvement of its canals than formerly. The figures for the Lower Sutlej Canals, to which we have already referred in paragraph 25, may be thought to indicate retrogression due to the opening of the Sirhind Canal ; but, in view of the increase of irrigation shown on the Upper Sutlej Canal, it is more probably due to short expenditure on improvements. As regards the reduction of the spill area and the fall of spring level, which are attributed to floods being lower than formerly, we cannot think that the withdrawal of the small quantities taken by the Sirhind Canal could have had any appreciable effect on the height or volume of the floods.

30. *Possible improvements in the inundation canals.*—Although we think it very doubtful whether the opening of the Sirhind Canal has affected the inundation canals on both banks of the Sutlej, in any other way than that of necessitating a greater expenditure on their maintenance and improvement, we do not therefore conclude that a second perennial canal can be opened without seriously affecting the efficiency of these canals. The Firozpur Canals may be left out of consideration, as it will not be difficult to arrange for supplying them from above the weir which would be built for the supply of the perennial canal ; an arrangement which would increase their efficiency, though it would probably involve a change in the method of their administration. As regards the canals on the right bank, all of which are under the Punjab Public Works Department, it appears to have been thought hitherto that they can be maintained in their present state of efficiency, in spite of the withdrawals from the river of the supplies required for the new canal, by the expenditure of a moderate sum on their improvement. The mouths of the canals would be moved higher up the river ; the head channels would be cleared to the greater depth which the withdrawal or reduction of the cold weather supply would render possible ; the canals would be shortened and straightened, and a greater command obtained by cutting off long loops ; and, above all, a great economy in distribution would be secured by the substitution of properly aligned distributaries for the present village water-courses. Evidence has been placed before us which shows, beyond doubt, that there is great scope for improvements of this kind on all the inundation canals in the Punjab ; but no definite or comprehensive schemes have yet been considered for such an improvement of the canals on the right bank of the Sutlej as will enable them to meet the altered conditions of supply which will result from the opening of the Lower Bari Doab Canal. As regards the Bahawalpur Canals, the officers of the Irrigation Department had, at the time of our inquiry, no information beyond

a map showing their position, and a statement of the total areas said to have been irrigated from them annually since 1871-72. The Superintendent of the State maintains that, since the opening of the Sirhind Canal, the State has increased the capacity of the canals, has developed their irrigating power by the construction of branches, has cleared them earlier, and by skilful draining of river-side channels has kept them flowing later. He declares that nothing that experience and skill can do has been or will be lacking, but that no efforts can meet the diminution of the Sutlej supply which would result from the construction of the proposed canal.

31. *Inadequacy of improvements proposed.*—No opinion can be formed on this point until the whole Bahawalpur system of canals has been examined by an irrigation expert. We understand that an officer has already been deputed for the purpose; but, whatever may be the result of his inquiries, we are of opinion that improvements of the kind which have been suggested can no longer be regarded as adequate, although they may suffice for the immediate object of maintaining the irrigating capacity of the canals at its present level even after the opening of the new canal. But it is not enough to prevent retrogression; an effort should be made to develop to the utmost the capacity of these fine irrigating systems. As far, at any rate, as the Sutlej is concerned, we agree in the opinion expressed by Colonel Grey, the father of both the Firozpur and the Bahawalpur systems, "that the days of inundation irrigation have passed. The rivers have been or are being tapped to a degree which much lowers the value of these works by depriving them of the early and late water which is so important to irrigation. The method was after all but a makeshift; it has had its day, and the time has come for arresting the summer floods by weirs, and for distributing them scientifically over the country to afford a duty of 200 acres to the cusec, instead of the 30 or 40 acres which is the average of inundation canals." A similar opinion has been expressed by Mr. Preston, late Chief Engineer, Punjab Irrigation Works, and now Inspector General of Irrigation in India.

32. *Proposed construction of weirs across river. The Sutlej Valley canals project.*—The project for the Lower Bari Doab includes the construction of a weir across the Sutlej immediately below the canal off-take. There should be no engineering difficulty in constructing similar weirs at suitable points lower down the river, and it is probable that one or two additional weirs would suffice for the requirements of all existing inundation canals, on both banks of the river, which would draw their supplies from feeders taking off above them. The cold weather supply in the river will not be available for these canals, but they will get the benefit, even in the cold weather, of all surplus water and freshets; and the construction of weirs will enable them to utilize, to the extent of their requirements, every drop of water in the river, from the time that the supply rises above the requirements of the perennial canals to the time that it falls below them. The irrigation season will be lengthened at both ends, and the canals will be independent of all fluctuations in the level of the river water surface throughout the season. We cannot hazard an opinion as to cost of the works required, but we think it not improbable that they would prove directly remunerative. As shown in paragraph 29 the present average irrigating capacity of all the existing British inundation canals on the Sutlej may be estimated at 580,000 acres; but the maximum capacity may be taken at 880,000 acres, and this would almost certainly become the average capacity if the works proposed were carried out, so that there would be an increase of 300,000 acres. In addition many extensions would be possible into high and dry lands that cannot be commanded by the present canals, where high rates would be readily paid for the advantages of irrigation. It is also probable that there would be eventually a considerable enhancement of the revenue derived from existing irrigation; an enhancement which would be justified in consideration partly of the greater regularity and certainty of the supply, and partly of the reduction which will almost certainly be effected in the cost of silt clearances in the village water-courses—at present a serious tax on the cultivators. But even if the new works are not likely to prove directly remunerative as financial investments, we may fairly set against any loss that may be anticipated, the

profits which will be derived from the proposed Lower Bari Doab Canal. If the two schemes are considered together, as they should be, there appears every probability that they will, as a whole, fulfil the conditions of a productive work. The scheme of weirs, or as we may call it, the Sutlej Valley Canals project, cannot of course be carried out in its entirety without the co-operation of the Bahawalpur State ; but irrigation is so essential to the prosperity of that State and its advantages are so keenly appreciated by the people, that there will probably be no greater difficulty in entering into a satisfactory arrangement with the Durbar, than was experienced with the Phulkian States in the case of the Sirhind Canal. We understand, indeed, that the Durbar has been, for some years, setting aside money for the construction of weirs and the remodelling of canals ; and we have no doubt that it will be prepared to pay its fair share of the cost of any works that may be proposed.

33. *Projects for Lower Bari Doab Canal and Sutlej Valley Canals should be prosecuted concurrently.*—To return to the Lower Bari Doab Canal. We are impressed with the great protective and productive value of that project; but we think that the construction of this canal must involve, as a necessary consequence, the prosecution, not subsequently but concurrently, of the proposed Sutlej Valley Canal project. If the necessity for the latter project is admitted, it is possible, though by no means certain, that the altered conditions may render it desirable to reconsider the question of the site proposed for the Lower Bari Doab Canal head-works, which may, of course, affect the alignment and grading of the main line. We, therefore, submitted to the Government of India, soon after we left the province, an *ad interim* recommendation that nothing should be done to commit Government to the site now proposed until the question had been considered from the new point of view. We understand that the Local Government has since submitted a report on the subject; but it will probably be unnecessary to come to an immediate decision on the point, as in the meanwhile other important proposals have been before us, the adoption of which would render it unnecessary to construct any head-works on the Sutlej at all, at any rate for some years to come.

34. *Mr. Wilson's objections to the present Lower Bari Doab Canal project.*—The first suggestion or rough outline of the proposals to which we refer is contained in two Notes—one on the Lower Bari Doab project, and the other on 'Future Irrigation Policy in the Punjab'—by the Honourable Mr. J. Wilson, C.S.I., Settlement Commissioner of the Punjab, and our colleague on the Commission during its stay in that province. Mr. Wilson objects to the proposed Lower Bari Doab project, on the ground that it will not only deprive the desert country to the south of any chance of future irrigation on a large scale, but will also leave unutilized the surplus waters of the Chenab and Jhelum, which now flow uselessly to the sea, and which might be utilized in the irrigation of the Lower Bari Doab; thereby setting free the surplus and cold weather supply of the Bias and Sutlej for diversion to the " untold millions of acres in Rajputana which it is quite feasible to irrigate from the Punjab rivers." Mr. Wilson's notes had not been considered by the Punjab Irrigation Officers when we visited that province; and we were unable then to form any definite opinion as to the feasibility or merits of his proposal, which has since been put into a more definite form and strongly advocated in a memorandum which has been forwarded to us by Colonel S. L. Jacob, C.I.E., R.E., a late Chief Engineer in the Punjab, and an officer with very long experience in Punjab irrigation works. Colonel Jacob's memorandum was written in England at a time when the writer had no opportunity of referring to maps and levels; but the question is of such undoubted importance that we have endeavoured to form an opinion of it in the light of information on the more salient points which has been supplied to us by Mr. Field, Officiating Chief Engineer, Irrigation Works, Punjab.

35. There is something very attractive in the proposal to divert eastward the ample surplus of such rivers as the Indus or the Jhelum, and thus leave the waters of the Bias and the Sutlej free for the irrigation of the country on the left bank of the latter. Leaving the Indus for the present out of the

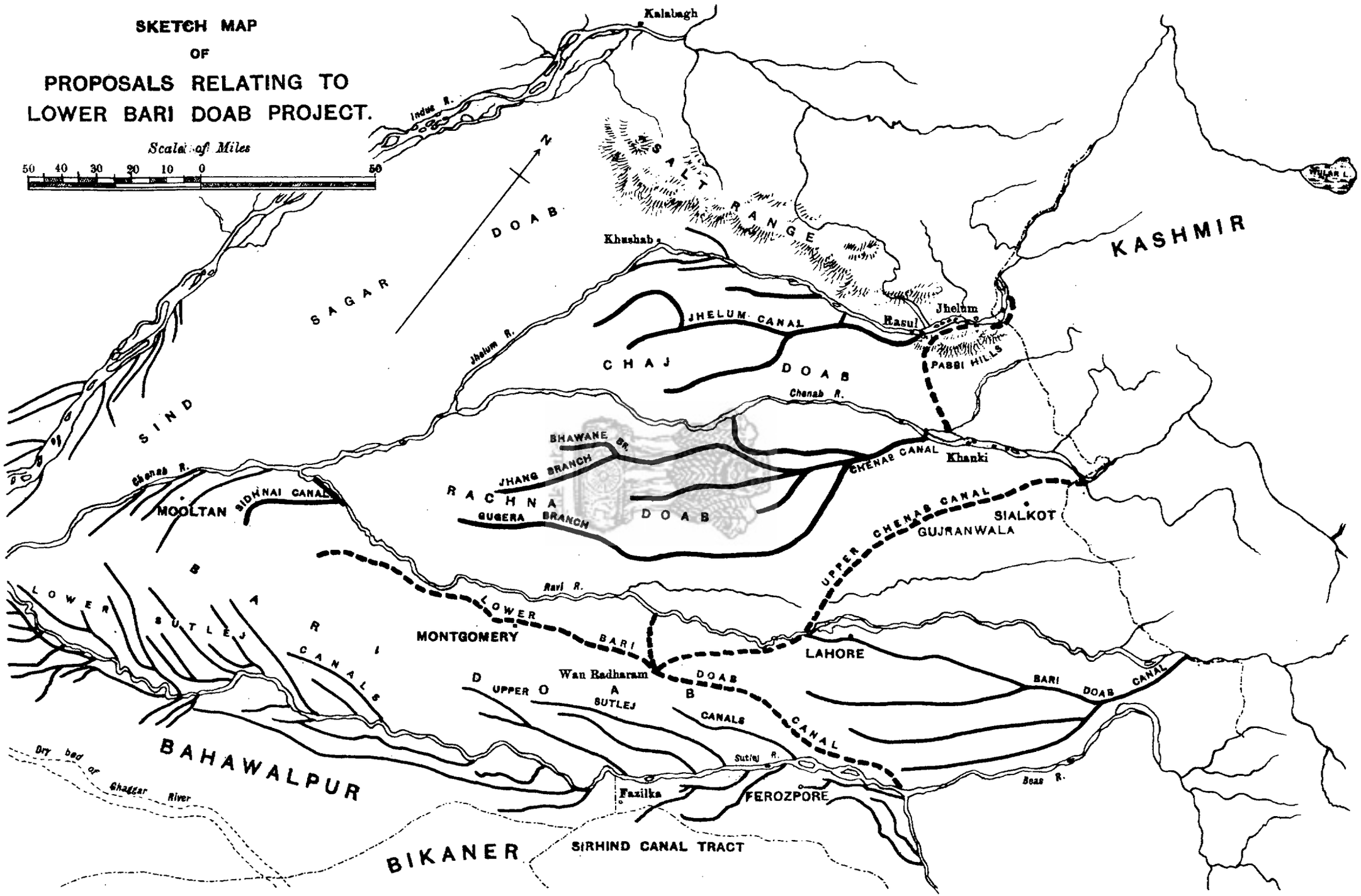


Photo. Litho, T. C. Press, Roorkee—No. 7285—

question, our information points to the conclusion that the cold weather surplus of the Jhelum alone will ordinarily be enough, although not more than enough, for the *rabi* irrigation of the area which it has been proposed to command by means of a Lower Bari Doab Canal from the Sutlej. It also appears certain that, *qua* levels, a canal taking off from the Chenab at or above Khanki could command every acre of the same area. But the proposal is open, *primâ facie*, to two serious objections. The crest of the Khanki weir on the Chenab is 14 feet higher than that of the Jhelum weir at Rasul, and, in order to deliver Jhelum water into the Chenab at or above Khanki, it would be necessary to draw it off several miles above Rasul, or even above the town of Jhelum itself, and to carry the canal either through or round the Pabbi range of hills. It may well be doubted whether this is practicable at any cost which is not virtually prohibitive; and also whether any canal taking off from the Chenab below Khanki would command an area sufficiently large for the purpose in view. In the second place, it is very doubtful whether the extent and quality of the land that could possibly be commanded by any canal taking off from the left bank of the Sutlej, are such as would justify the heavy additional expenditure which the adoption of this scheme would involve, as compared with the cost of the present Lower Bari Doab scheme. Such a canal would command a belt of land in British territory lying between the areas which are at present served by the Sirhind Canal and the Fazilka Inundation Canals; but the only portion of Rajputana which could possibly be brought under command would be the north-west corner of Bikanir. Beyond this the canal would lie entirely in the desert land of Bahawalpur, which was formerly traversed by the Ghaggar Nullah. This tract is said to be covered with sandhills, and practically uninhabited; and it appears to be as unpromising a field for the extension of irrigation as the Sind-Sagar Thal, with the further disadvantage that it belongs to a Native State, from which Government could not recover as large a share of the profits of irrigation as it is able to do when canals are carried into crown waste. Moreover, if the canal be ever made, it will be as obligatory to construct supplementary works lower down the Sutlej, for protecting the interests of the inundation canals, as it will be if a right bank canal is constructed. It may, therefore, reasonably be doubted whether a left bank canal from the Sutlej will ever be constructed, even if the present cold weather supply of the Bias is reserved for it; and this doubt must always be borne in mind when considering the extra expenditure which will be involved in the adoption of Mr. Wilson's proposal.

36. These objections have no doubt great weight, but we cannot at this stage regard them as conclusive. Even if the canal on the left bank of the Sutlej should never be made, it will be no small advantage if the waters from the western rivers can be drawn on for the Lower Bari Doab, and the supply in the Sutlej reserved for the existing inundation canals on both banks. The objections which have been raised by the owners of the Firozpur canals, and by the Bahawalpur State, to the diversion of Sutlej water to the high lands of the Doab, would fall to the ground; for existing conditions would not be interfered with at all, and it would be unnecessary to consider at present the question of additional weirs across the Sutlej for safeguarding the interests of the inundation canals. Proposals to this end could be considered at any future time on their merits, but they would not be rendered obligatory by the alienation of any part of the Sutlej supply to lands which have not hitherto been served by it. Moreover, some hesitation may well be felt before undertaking such a scheme as the present Lower Bari Doab project, which, whatever its merits, will have the effect of rendering it impossible for our successors for all time to utilize the waters of the Sutlej for extensions of irrigation on its left bank. However unpromising such extensions may now appear, a time may come, in a more or less distant future, when the pressure of population and many other causes may justify their construction. Important as these considerations are, there is of course a limit to the amount of extra expenditure which could be justified. There is, however, another argument which will affect the question of cost. If it be practicable to divert the waters of the Jhelum into the Chenab above Khanki, there would be in the Chenab river, so aided from the Jhelum, surplus sufficient to give *kharif* irrigation and at least one *rabi* watering for a

large and unprotected area in the Sialkot, Gujranwala, and Lahore districts, and its productive and protective value would be so great as to justify an expenditure on the Jhelum diversion which might otherwise appear prohibitive.

37. In view of these considerations, we addressed a communication to the Government of India in December 1902, in which, after pointing out the doubts which existed as to the practicability of Mr. Wilson's proposals, we remarked that we could not regard them as conclusive ; and we recommended that no action should be taken committing Government to the construction of the Lower Bari Doab Canal, as already designed, until the whole question had been more fully examined ; and especially until some idea could be formed of the feasibility and cost of diverting Jhelum water into the Chenab above the Khanki weir, which we regard as the *crux* of the whole problem. We have since heard with satisfaction that proposals to the same effect had been independently put forward by the Punjab Government, and that the necessary investigations have been started.

38. We have also recently seen a memorandum by Mr. L. W. Dane, the late Resident at Kashmir, and a note by the Kashmir State Engineer, in which it is stated that not less than 20,000 million cubic feet of water might, at very small cost, be stored in the Wular Lake, and be made available for supplementing the cold weather supply in the Jhelum. This scheme, which would in many ways be advantageous to the State, has an important bearing on the present proposals. If it is not feasible to divert the Jhelum into the Chenab above Khanki, the supplementary supplies which may be obtained from storage in the Wular Lake will be of little advantage to the Punjab. But if such a diversion can be made, this supply, which will be equivalent to 2,000 cusecs during four months, will be invaluable. It will not only permit a great enlargement of the scope of the proposed new canal, but it will also absolutely ensure the Chaj, the Rachna, and the Lower Bari Doabs against all possibility of failure of the *rabi* supply even in the driest years. This important scheme will doubtless be carefully examined by the Punjab officers in connection with the new proposals, to which it may give an entirely new aspect. The fact that the future extensions of irrigation in Bikanir or Bahawalpur may depend on the construction of a storage work in Kashmir, is a signal illustration of the width of view from which large irrigation projects must now be regarded, and of the extent and character of the investigations which they involve.

39. To complete our remarks on this subject it may be added that the waters of the Indus cannot be utilized to any considerable degree for extensions of irrigation in the Doabs to the east. The Indus could not be diverted unto the Jhelum at a point much higher than Khushab, except by means of a channel that would have to be carried through the Salt Range ; and the command that would be obtained from Khushab would be insufficient. The most practicable way of supplementing the cold weather supply of the Jhelum above Khushab would appear to be by storage in the Wular Lake. It is doubtful whether the diversion of Indus water into the Jhelum, at or below Khushab, would ever result in any extension of irrigation at all commensurate with the cost ; but the question can be considered with much greater advantage when the scheme for the irrigation of the Sind Sagar Doab is taken up. It may then be found advisable to make escape channels from the canal into the Chenab, which may be utilized when necessary for the diversion of surplus Indus water, to be picked up at a weir below the confluence of the Jhelum and Chenab.

40. *Sind Sagar Canal.*—The Sind Sagar Canal was first contemplated more than thirty years ago, when some preliminary surveys were made for the purpose of determining the feasibility and probable cost of drawing water from the Indus opposite Kalabagh, and delivering it into the Sind Sagar Doab—a wide expanse of desert in the Dera Ismail Khan (now Mianwali) and Muzaffargarh districts. The prospects of the scheme were not very favourable, and it has remained in abeyance in favour of the more promising schemes which have since been completed or proposed. The Famine Commission of 1878-80 stated that it had been estimated that $1\frac{3}{4}$ million acres could be irrigated annually by this

work; but the late Chief Engineer, Irrigation Works, Punjab, who had recently inspected portion of the area to be commanded, informed us that there are large tracts of the Doab which will not repay cultivation, owing to the poorness of the soil and the prevalence of sandhills. Mr. Ward, of the Punjab Irrigation Department, has since been deputed to make a thorough reconnaissance of the whole tract, and determine the area that can be brought under cultivation. He has recently submitted an interesting and valuable report, of which a copy has been supplied to us. Mr. Ward estimates that over 30 per cent. of the whole area which the canal could command is covered by sandhills; but in one large block of 3,000 square miles on the western side of the tract the sandhills cover only 20 per cent. of the area. In this block the soil between the hills is generally of a loamy nature and seems to be suited for canal irrigation, although it is inferior to the average quality of soil in the tracts watered by the Chenab and Jhelum Canals, and, certainly in the sandier parts, cultivation will be unprofitable without a good supply of manure. Between this block on the west, and the Jhelum and Chenab rivers on the east, there is another large block covering 5,000 square miles of what Mr. Ward calls "grazing lands." Here the sandhills cover, on an average, over 36 per cent. of the surface, but only 10 per cent. in one long and narrow strip of 400 square miles. Mr. Ward excludes this strip of good land from his first division, only because it lies outside of the compact area which would be irrigated by the canal. Within this large block, if canal water is introduced at all, its chief use would be to provide water for stock and the means of cultivating the narrow strips of good soil adjoining the drainage lines. It appears that the southern portion of the western block, or the Muzaffargarh *Thal*, could be brought under irrigation at a comparatively small cost by means of an inundation canal taking off from the Indus near Bhakkar; and Mr. Ward suggests that such a canal may be made in the first place, as a means of testing the capacity of the Doab for irrigation. Such a work would probably be remunerative in itself, as it would be in effect an extension of the Muzaffargarh system of inundation canals; but it would also be of great value as a means of ascertaining the profits that may be expected from cultivation in the *Thal* if irrigation can be introduced, and of obtaining much useful information on many of the doubtful points which will have to be considered before Government commits itself to the construction of such a work as the Sind Sagar Canal. For this reason we think that, if such an experimental canal can be carried out at a moderate cost, it should be undertaken as soon as may be convenient. But we cannot recommend that the Sind Sagar Canal itself should be put in hand, until the Lower Bari Doab Canal and its allied works are approaching completion. It is certain to be more costly and less remunerative than any other major work which has hitherto been constructed in the Punjab; and, although every project for the extension of irrigation into desert tracts, and for the consequent increase of the reserve food supplies of the country, is deserving of consideration, protection is not urgently required in this tract, which is very sparsely populated. Nevertheless we hope that it may be possible to undertake this work a few years hence, and so complete the great programme of perennial canals from the Punjab rivers which will not only protect the province from famine, but also render it the most important granary of India.

41. *Extensions of existing perennial canals.*—We have next to consider the possible extensions of existing perennial canals. We have shown, in the preceding section of this chapter, how much has been done during the last ten years to develop the irrigating capacity of these works; and we have no doubt that this policy of extension will be continued without interruption in future, until it has reached the utmost practicable limit. This limit will apparently have been nearly reached on the Bari Doab Canal, when the works now in progress have been completed; but some further extension may be possible on the Swat River Canal. The Sidhnai cannot effectively command a much larger area, and further extensions of irrigation in the Multan district will be effected by the proposed Lower Bari Doab Canal; while future development of the Lower Sohag and Para should be considered in connection with the Sutlej Valley scheme. There remain the Western Jumna and Sirhind Canals, which require special consideration, because any extensions which can be made on these

canals will benefit Rohtak and Hissar, which, as we have already shown, are the two most insecure districts in the Punjab.

42. *Western Jumna Canal.. Curtailment of cold weather supply in certain tracts.*—It has been shown, in the table in paragraph 17, that while the Western Jumna Canal irrigated only 693 villages in 1877-78, its waters supplied 1,167 villages in 1897-98. There would appear to be little possibility of further extension, although there is a considerable scope in the Rohtak and Hissar districts for the utilization of any water that could be made available. Various suggestions have been made for increasing the supply, none of which has, however, been carefully worked out, so that we can only refer to them in general terms. The first of these involves the curtailment of the present supply to certain areas of the Karnal and Delhi districts, which ordinarily enjoy a favourable rainfall, and in which the spring level is sufficiently near the surface to allow of wells being constructed and worked with profit; and the diversion of the water thus economized to tracts which are in more urgent need of protection.

43. Since the canal was re-aligned in 1880, the supply of water to individual villages of these two districts has already been very largely restricted by reducing the size of the village outlets, and by lengthening the intervals between the turns when the branches are opened in rotation during seasons of short supply; but the restriction has been based upon considerations connected with the welfare of the villages themselves, which had suffered from the too profuse irrigation of excessive areas. The process, if carried out with judgment, is beneficial both to those from whom the water is taken and to those to whom it is given; but indications are not wanting that it has probably approached its limit. It is now proposed to go further, and to reduce the supply, not, as hitherto, on the ground that it is advisable to do so in the interests of the people whose supply is to be restricted, but on the ground that the water is more urgently needed elsewhere. The specific proposal which was placed before us, and which has been supported not only by the Canal Officers, but by Mr. H. C. Fanshawe, late Commissioner of the Delhi Division, and by the Honourable Mr. J. Wilson, Director of Land Settlements and Records, is, following the practice already in force in the upper parts of the Bari Doab Canal, to close most of the distributaries on the Delhi Branch from the 15th October for the *rabi* months, opening them again for ten days only in November. This would probably release about 300 cusecs during the *rabi*, which might be utilized to irrigate some 45,000 acres elsewhere. It is recognized that the complete withdrawal of irrigation during the *rabi* season may affect the crops injuriously, and that it may be necessary to supplement the diminished supply from the canal by the construction of wells throughout the area affected. But it is proposed to introduce the change only upon those distributaries where the spring level is within 15 feet of the surface, and where, therefore, the construction of wells is easy; and it is urged that the water is more needed, and could be used to greater profit, in drier tracts where irrigation is more constantly and more urgently required, where there is always less rainfall, and where the spring level in wells is not within a workable distance from the ground level.

44. On the other hand, it must be remembered that the irrigation which it is proposed to restrict dates back some sixty years or more, during which period canal water has been freely supplied, and that the agricultural economy of the villages has gradually adapted itself to these conditions. The old wells have fallen in; the bullocks necessary to work them have disappeared; the density of the population has increased, and with it that subdivision of holdings which is one of the most effective obstacles to irrigation from wells; the leading staples have changed, and with them the whole course of agricultural practice. The people of the tract in question rely largely upon the cultivation of sugarcane, not only for the payment of the Government revenue, which can always be reduced, but also for their own subsistence; and if, as some contend, the withdrawal of canal water early in November would cause injury to sugarcane, the number of wells which would be required to take the place of the canal in the large area under cane would undoubtedly be very great. It is urged that it is unlikely

that the people would construct them unless Government supplied the funds, in which case the cost would be prohibitive; that they would attempt to struggle on without them until their resources had become so seriously crippled that the means of construction would no longer be forthcoming; and that, even if the wells were constructed, the fall in the spring level, which would inevitably follow so large a reduction of canal irrigation, would shortly leave them useless.

45. We fully recognize that the tracts to which it is proposed to transfer the water are far more urgently in need of that protection which canal water affords, than are those from which it is proposed to withdraw it; and if it were a question of initial distribution, we should unhesitatingly support the proposal. But if the withdrawal of the water is to inflict substantial and permanent injury upon people who have enjoyed it for two generations, it would clearly not be right to withdraw it, merely in order to take it to another tract which is more urgently in need of protection. We do not feel that the information at our disposal is sufficiently complete to justify us in expressing a final opinion on the merits of this proposal; but until it has been examined and recommended by the highest revenue authority in the Province and by the Local Government, we are unable to assume that any considerable portion of the cold-weather supply hitherto assigned to the Delhi Branch can be regarded as available for diversion to Hissar.

46. *Supplementary supplies from the Jumna.*—A second suggestion which has been made is the construction of subsidiary head-works at some suitable point on the Jumna, such as Panipat, from which a supplementary supply might be drawn during the *kharif* for the extension of irrigation into Rohtak and Hissar. The proposal appears never to have been seriously considered, but we find that the Jumna differs from all the other Punjab rivers in the short duration of its flood supply. It is doubtful whether a supplementary supply would be available for more than two months in the year, and this would be of little use. The present authorized maximum supply in the canal is 6,400 cusecs, and it has been stated that this might be increased to 7,000, but that the additional supply of only 600 cusecs would not, as a rule, be available before the 15th June or after the 25th September. If, as seems probable, the main canal can be made to carry this extra supply, it would be better to take it in at the present head of the canal. The possibility of doing this deserves consideration; but the cost of, and objections to, a subsidiary head would, as compared with the extra supply that could be obtained, be so great that the matter is not worth further examination.

47. *Reduction of the Eastern Jumna Canal's share of the supply in the river.*—A third suggestion which has been made is the reduction of the Eastern Jumna Canal's share of the cold-weather supply in the Jumna. During the last forty or fifty years, the supply has been distributed between the Western and Eastern Jumna Canals in the proportion of two to one. If the Eastern Jumna share is in excess of requirements, the surplus is passed on to the Agra Canal. This arrangement, which has been agreed to by the two Local Governments concerned, is of such long standing that we hesitate to propose any modification of it. Although it may be admitted that the necessity for irrigation in the southern districts of the Punjab is greater than in the tracts that might be served by any possible extension of the Eastern Jumna Canal, we have found that the Agra Canal depends for its cold-weather supply on the surplus not only of the Eastern Jumna but also of the Ganges Canal, which is passed into it *viâ* the Hindun. Recent extensions of the Ganges Canal, such as the Fatehpur Branch and the Mat Branch extensions, will tend to reduce in future the surplus which has hitherto been available from this source, and there have also been considerable extensions on the Agra Canal itself. We are satisfied that under present conditions no reduction of the Eastern Jumna share could be made which would be sufficient to permit any considerable extension of the branches of the Western Jumna Canal. On the whole, therefore, we are unwilling to recommend any alteration of the existing time-honoured arrangement, or to deprive the United Provinces of the incentive to economy in

distribution which is afforded by the possibility of utilizing in other parts of the province the water which may be saved.

48. In paragraph 521 we, however, make a suggestion which if carried out would render it possible to divert into the Western Jumna not merely a small fraction, but nearly two-thirds, of the cold-weather supply which is now taken into the Eastern Jumna Canal. The suggestion is that the Eastern Jumna Canal should be fed from the Ganges, the supply in which would be supplemented by water to be drawn from the Sardah river. If this scheme, which has many other points to recommend it, could be carried out, the canal irrigated area in Rohtak and Hissar could be increased by 60,000 or 80,000 acres. The value of a project by which such results may be attained in these districts, will be very inadequately represented by the direct monetary return.

49. *Storage works and puddling of canal channels.*—Two other suggestions may be noted for increasing the cold-weather supply of the Western Jumna and other canals: the construction of storage reservoirs in the hills; and the puddling of the canal channels and village water-courses. The Jumna has never, we believe, been examined for sites for storage works; but the slope in the river bed is so great that we do not think it at all probable that reservoirs of the capacity required could be constructed, except at a prohibitive cost, and there would then be great danger of their filling up with boulders and shingle. The question of channel puddling appears to us, however, to deserve careful consideration. It is well known that only a small percentage of the water entering the head of a canal is actually delivered on the fields; and many estimates have been made of the losses in main canals and branches, in distributaries, and in village water-courses. We understand that there are several sections of the Western Jumna Canal and its branches in which heavy loss by percolation or absorption is known to occur, and is evidenced by the height of the spring level and, in some cases, even by the palpable water-logging of adjacent lands. A double benefit would be gained if this could be prevented and the water now lost by percolation utilized for extensions of irrigation. The objections to channel puddling are that the process is very expensive, that it can only be carried out intermittently during closures, and that it is difficult to judge of the utility or effectiveness of such work until it has been carried out on a very extensive scale. Much might, however, be done if money and the best professional skill were made available for conclusive experiments. The first point is to ascertain by repeated observations, carefully devised *ad hoc*, the actual loss by absorption in a given length of channel, and the effect on spring levels in the vicinity. Sections in this length should then be puddled as opportunity offers, and the observations repeated as each section is completed. In this way it will be possible to obtain a quantitative idea of the value of puddling, which may justify future expenditure on a scale that may at present seem prohibitive, although it would possibly be really remunerative. The long closures of the Delhi Branch would render this an ideal channel for such purposes; and we would recommend that the reach in which loss by percolation is known to be most serious should be placed under observation and subsequently puddled as an experiment. It is indeed possible that the next great step to be taken in the development of the canals of Northern India, may be in this direction; and that their efficiency may be very largely increased by reducing the great loss that now occurs by percolation.

50. Some interesting evidence on this point has been laid before us by Mr. Kennedy, Superintending Engineer, Punjab, who has recently returned from a tour in the United States, undertaken with the object of inspecting the principal irrigation works in the Western States, where it is said that great efforts are made to minimize the loss by percolation in canals and water-courses; many miles of distributary channels being lined by their proprietors either with masonry or with a cement plaster, particularly in the case of orchard irrigation. Mr. Kennedy is of opinion that the lining of channels should begin with the water-courses or smaller distributaries; and he has adduced calculations, based on observations made by him many years ago, to show that a greater saving of loss by percolation will be effected by a given expenditure if the outlay is incurred

on a number of small channels, than if it were spent in lining a main canal. The available data are too scanty to justify any definite conclusion, but it is certain that in India the lining of private water-courses would have to be undertaken by the State, and that the subsequent maintenance of thousands of miles of village channels would be extremely costly and difficult. On this account we think that attention should first be directed to those sections of Government channels in which the loss by percolation is known or believed to be most considerable. At the same time we strongly recommend that systematic observations be made, on a considerable scale, of the loss by percolation in channels of all sizes and classes; and that, when this has been determined, money should be freely allotted for the experimental lining of many of them, for the purpose of determining the most effective and economical form of lining, and the saving of water that may be effected thereby. Such experiments may be most advantageously carried out on the Western Jumna and Sirhind Canals, on each of which there is a wide field for the utilization of whatever water may be saved. There is every reason to believe that on these canals the expenditure would be reproductive.

51. *Extensions of the Sirhind Canal.*—The Sirhind Canal area admits of extension in two directions. Distributaries from the British branches might be extended into the long belt of land in the Ludhiana and Firozpur districts, between the present boundary of irrigation and the edge of the Sutlej *khadir*; but protection is not urgently required in this tract, and the supply to these branches is not in excess of present requirements. A great part of this area would be commanded by the canal on the left bank of the Sutlej, referred to in paragraph 35, if this is ever constructed. A small portion of the Hissar district can be commanded from the Native States' branches, but the distribution on these branches, except as between State and State, is not under the control of the Punjab Irrigation Department. Mr. Farrant, who has been for five years the State Engineer in charge of the Patiala Canals, has given evidence to the effect that the Native State's share of the canal supply, to which it is entitled under the terms of the Canal Agreement, is fully utilized in the *rabi*, but has always been in excess of requirements during the *kharif*, except in the famine year of 1899 when every drop was used.

52. *Limits to possible extensions from the Western Jumna and Sirhind Canals into famine districts.*—It seems doubtful whether it will, at any rate for some years to come, be possible by any practical measures to increase the area under irrigation from the Western Jumna and Sirhind Canals in the Rohtak and Hissar districts by more than about 60,000 acres, which, however valuable, will be quite insufficient to afford complete protection against famine. In the southern parts of these districts the ground rises towards the Rajputana highlands, and cannot be commanded by any Punjab Canal. This high tract includes portions of Jind and Patiala territory to which also there is no hope of extending canal irrigation.

53. *Extensions of inundation canals.*—We have already shown how little has been done to extend or develop irrigation on these canals; and we have also had evidence to show how much could be done both by adding new canals to existing systems, and by carrying out improvements of the kind indicated in paragraph 30, if funds could be more liberally provided for the purpose. The present system of distribution is unscientific in the extreme, and wasteful both of water and of the labour of the people. The canals were for the most part made in the first instance without professional advice, and, as we have shown, want of funds has prevented any improvement save of the smallest and most unsystematic nature. Regard must, however, be paid to the extension of cultivation; the increase of population; the rise in the value of agricultural produce; and the fact that the abstraction of a constantly increasing portion of the supply for new canals, perennial and inundation, has made and will continue to make it more and more difficult to maintain the early flow which is so important to valuable crops such as indigo, and the late flow which is absolutely essential to *rabi* cultivation. All these facts imperatively call for a systematic remodelling of the machinery of distribution, which will result in economy

of water, the saving of labour, a more regular and certain supply, increased protection against flooding, the extension of cultivation and increase of revenue by the command of new areas, and the enhancement of revenue on existing cultivation which greater security will render possible. If the proposals for a Sutlej Valley Canals project are favourably entertained, the Upper and Lower Sutlej Inundation Canals would be remodelled in connection with that scheme; but if the scheme is not taken up, a great deal can be done to improve them as they stand. Improvements on the Shahpur Imperial Canals will probably take the form of connecting them with the Jhelum Canal system. As regards the other inundation canals—the Lower Chenab, the Muzaffargarh, and the Indus—all of which take off from either the Chenab or the Indus, we do not think that it will be necessary for many years, if ever, to consider the question of connecting them with weirs across these rivers. The cost and difficulties would be too great and the field for extensions too small. But we are of opinion that the efficiency of each of these systems can be immensely improved and extended, at a very moderate cost, on the lines indicated in paragraph 30.

54. *New provincial irrigation works.*—So far we have been considering possible extensions of irrigation works which under present arrangements would be classed as Imperial. There is, however, scope in many districts for smaller irrigation works, which, whether constructed by the Irrigation Department or not, would probably be managed after completion by the District Officer, and would ordinarily be undertaken as provincial works. The proposals for works of this kind which have come to our notice are not very numerous; but the scantiness of the programme appears to be due, not to the narrowness of the field for such works, but rather to the want of funds, and of a suitable and clearly-defined policy in financing works for the extension of irrigation. We understand that under the provincial settlement the whole of the direct revenue from provincial irrigation works has been assigned to the province; that it was estimated that this would exceed the cost of maintaining the works by Rs. 45,000 per annum, which would be available for the construction of new works; but that this surplus has not been available for the purpose, owing to the demands for plague and famine expenditure.

55. One of the most important schemes that have been brought to our notice is the Hazar Khani branch of the Kabul River Canal, which is estimated to irrigate 11,000 acres of land in the Peshawar district and to fulfil the conditions of a productive work. This promising scheme has been held in abeyance for the past five or six years solely for want of funds, but we learn that it has been sanctioned since our visit to the Punjab. Another project is that for a new inundation canal in Dera Ismail Khan, which, it is anticipated, would irrigate 84,000 or 54,000 acres, according to the line ultimately adopted. The cost of the preliminary surveys was estimated in 1900 at Rs. 18,000, which, under present arrangements, would be chargeable to provincial revenues. The funds could not be provided by the Provincial Government, nor by the District Board—an alternative which appears to have been considered; and eventually an application was made to the Government of India for a contribution towards the cost of the survey from Imperial revenues, on the ground of the political advantages anticipated from the construction of the canal. The application was negatived, as the Government of India did not consider that the political advantages were sufficient to justify a contribution from Imperial revenues under the existing provincial settlement. We were informed that an allotment of Rs. 18,000 was subsequently made by the Local Government in 1901-02, and that the surveys were to have been carried out last cold weather. We refer to this merely as an instance of the difficulty in preparing extensive programmes for new provincial irrigation works. It is not only that funds cannot be found for the surveys, but there is also little inducement to undertake surveys when it is realized that funds will not be available for the prosecution of the works, however promising they may be. Many other proposals for small provincial works have recently been under consideration, some of which have been abandoned under the advice of the Irrigation officers, while others are in abeyance pending further surveys or inquiries, or for want of funds. Among these may be mentioned the Kala Canal to irrigate 10,000

acres in the Jhelum district; an extension at the cost of provincial revenues of the Shah Nahr Canal to irrigate about 1,000 acres in the Hoshiarpur district; the Ujh River Canal in the Gurdaspur district, the prospects of which appear to be very uncertain; a canal from the right bank of the Indus at Pihur, which would protect about 40 villages in the Peshawar district, and a new inundation canal in the Firozpur district which would irrigate about 34,000 acres annually. The first and last of these works appear to be the most promising.

56. *The Jalalpur Canal and necessity for similar works.*—There is one other work to be mentioned—the Jalalpur Inundation Canal, to take off from the right bank of the Jhelum below the canal head-works, and irrigate annually 18,000 acres in the Pind Dadan tahsil of the Jhelum district. This canal was commenced as a famine relief work in 1900, but the value of the work done did not amount to Rs. 28,000, against an estimate of Rs. 4,68,458 as the direct capital cost of the works, including establishment. It is anticipated that the net revenue will yield a return of about three per cent. on the capital cost, and we were told that the Local Government had recommended its completion. We have since heard with satisfaction that the Government of India have recently made an assignment to the province for its completion as a provincial work, to be included in the Shahpur Provincial Canals' system. The completion of this work appears to us to be very desirable, not so much on account of the expenditure already incurred, which is small in proportion to the total cost, but because we think that the construction of small inundation canals of this class should be encouraged, even if they will not fulfil all the conditions of a productive work. We invite attention to the note by the Hon'ble Mr. Wilson on the 'Irrigation of the River Valleys in the Punjab,' in which the importance of devoting more attention to the maintenance of irrigation is very forcibly insisted on. As far as existing Government inundation canals are concerned, we have already recommended the adoption of a more active policy of extension and improvement than has been followed in the past. We have also shown that the policy of extending irrigation from the high level perennial canals into the river valleys is now being followed on the Chenab Canal; and it may be added that similar extensions are contemplated from the Jhelum and proposed Lower Bari Doab Canals. There are, however, in the river valleys, large areas which cannot receive irrigation from existing inundation canals, or from any extensions of the perennial canals. The cultivation of these areas, which has always been precarious, has depended mainly on river spills or on small private canals assisted by wells; and there is, no doubt, reason to believe that the opening of the perennial canals and the development of the larger inundation canals have directly impaired the simple means of irrigation hitherto available. The difficulties of the owners have also no doubt, in some cases, been increased by the colonization of the adjacent waste lands, which has drawn away their tenants and their labourers, and reduced the area available for pasture. We think that there must be a wide field for the extension of small inundation canals in these tracts, which has not hitherto been sufficiently examined, partly owing to want of funds and establishment, and partly because small works of this kind are likely to prove less remunerative than the more important schemes. There appears to us to be a strong case for the construction of works of this kind, even though, as in the case of the Jalalpur Canal, they may not be considered likely to prove directly remunerative. We recommend that money and establishment should be provided for them. But we do not think it necessary, in the absence of any detailed information as to what can be done, to support the proposal which has been made that ten lakhs of rupees, or some other definite sum, should be devoted to the purpose; although we have made proposals in another chapter which will facilitate the financing of protective irrigation works of all kinds.

57. *Drainage works in Umballa and Karnal districts.*—We have now dealt with all the proposals that have come before us for the extension of irrigation by means of Government works. Our attention has, however, been urgently invited to the problem afforded by the area of closed drainage which lies to the west of the watershed between the Jumna and the Sutlej. Here the waters brought down by hill-streams from the Himalayas spread themselves

in times of flood over an immense area of fertile soil, subject only to such control as can be exercised by the rude *bands* that the villagers construct. The crops are wholly dependent on inundation, which fails them in a year of drought. But indiscriminate flooding produces terrible effects upon the health of the people, and the grounds for interference are at least as much sanitary as famine-protective. We have little doubt that improvement from the former point of view is feasible. But the feasibility of any regulated system of irrigation seems more than doubtful. The water would be available only in years of copious rainfall, and any regulation would almost certainly deprive some villages of flood water upon which their crops depend, without giving them anything in its place. The problem is still further complicated by the fact that the flood water flows on into the territory of Native States who have a vested interest in it. At the same time the position which was put before us of the condition of the villagers is so deplorable that we recommend that the survey of the tract be completed, and projects prepared to remedy the evil as far as practicable. It seems improbable that the works will ever yield interest on their cost. But the Patiala State and the district of Hissar, parts of which are peculiarly exposed to famine, and in which it is difficult to find suitable relief works, lie within a reasonable distance and would furnish the requisite labour on the next occurrence of famine. We hope, however, that it may be practicable to do something for the improvement of this tract, without waiting for the recurrence of an opportunity for the employment of relief labour.

(*iv*).—*Private irrigation works.*

58. *District Irrigation Works, Firozpur Canals.*—In this section we propose to consider first District Irrigation Works, which, although not strictly private works, do not belong to Government; many of them indeed are in the nature of private works which have been taken over or financially assisted by the District Boards. The most important works of this kind in the Punjab are the Firozpur District Canals to which reference has already been made. In 1874 Colonel L. T. H. Grey, C.S.I. (now Superintendent of the Bahawalpur State), while Deputy Commissioner of Firozpur, succeeded in inducing the cultivators on the left bank of the Sutlej to combine in the construction of ten inundation canals, without any pecuniary help from Government; and later, in 1883-84, while Commissioner of the Hissar Division, he had three canals constructed in the same manner in the Fazilka tahsil. The total length of these canals is about 600 miles, and the area irrigated annually averages about 160,000 acres, but amounted to 260,000 acres in 1900-01. The canals were originally excavated by labour supplied by the owners interested; and the burden of keeping them in repair and clear of silt is laid on the cultivator, who contributes either his personal labour or a money payment in proportion to the area he irrigates; a small additional cess, of about 4 annas per acre, being levied to cover the cost of establishment or of any masonry works requiring skilled labour. The Firozpur District Board has granted liberal loans to the Canal Fund, without interest, when required for purposes of extension; but the canals are under the control of the Deputy Commissioner, and are practically administered by Rai Bahadur Maya Dass, Extra Assistant Commissioner, who has managed them with great ability for nineteen years. The system appears to be both popular and economical, while it is of value in affording to some extent an instance of local self-government. It is, however, admitted by Colonel Grey himself, and by others who appreciate the system, that it would be impossible to repeat in the present day the methods by which canals were constructed 30 years ago. Even in Firozpur it is doubtful whether the present system can be continued indefinitely, though we hope that it will not be interfered with as long as it is efficiently worked.

59. *Gurgaon Irrigation Works.*—The next district works to be referred to are the *bands* and tanks in the Gurgaon district, in a tract covered by offshoots from the Aravalli hills. The primary object of these works is the protection of cultivated areas from floods, although the water held up is used to a somewhat limited extent for irrigation, while the saturated soil above the *bands* is sown with *rabi* crops. The action of the *bands* in raising the level and maintaining

the supply of water in the wells below them is also of considerable value. But the works can scarcely be held to possess much protective value against drought, since, when the rains fail, the amount of water retained is very greatly diminished. Such quantity as is then available is, however, of special value, more particularly owing to its action on the adjoining wells. Much remains to be done, partly in the shape of new works of a similar nature, but perhaps still more in the shape of improvements to existing works, in order to render the protection afforded by them more certain and complete; and especially in order to allow by means of sluices and regulators more of the water held up to be utilized for direct irrigation. The Gurgaon dams were originally under the Public Works Department, but they were transferred to the management of the district authorities at the last settlement. The works fell for a time into grievous disrepair. Of late years, however, much has been done to restore them; although, as usual in the case of management by local bodies, owing to the necessary funds not being available, it has been found impossible to carry out improvements and extensions which, in some cases at least, would have proved directly profitable. The management, which is in the hands of the Deputy Commissioner assisted by the District Engineer, seems at present to be exceedingly efficient. But its efficacy depends on personal considerations; and some day or other it will almost certainly become advisable to place the works once more under the control of the Irrigation Department. We consider that this change should be made at once and without hesitation, if ever there is reason to believe that the present efficient management will no longer be maintained; lest neglect should result in injury which it will be difficult and costly to repair. But, whatever the agency that may be employed, we agree with the opinion, expressed by the late Commissioner of the Delhi Division, that it is impossible that much can be done by District Funds for works of this class; and that funds for all the new works that may be proposed should be found by Government, a certain number of works being reserved in the relief work programmes for execution in times of famine.

60. *Other District Irrigation Works.*—Other cases of District Irrigation Works have come to our notice. The Karnal District Board has constructed the Sarusti Canal, which may itself prove a profitable work; but it is one which for many reasons a District Board should not have been called on to take up. The Montgomery District Board is responsible for the upkeep of district canals which it is unable to maintain in a state of efficiency; and in other districts, money has been frittered away on immature schemes, which have had to be abandoned as soon as it was realized that they would involve a greater risk or greater expenditure than the Boards could properly incur.

61. *Connection of District Boards with irrigation works.*—We do not consider it generally desirable that District Boards in the Punjab should undertake the construction of revenue-earning irrigation works. They can seldom undertake these works in the hope of making them remunerative, because the land revenue that depends on or may be created by them is not a district asset. This is a difficulty which has been brought prominently to our notice in connection with the district expenditure on the Gurgaon *bands*. District Boards do not undertake works of this kind in other provinces; and, in the few cases in which they have done so in the Punjab, the real reason appears to have been that an energetic Deputy Commissioner had desired to carry out irrigation works for which there would be some difficulty in obtaining money from Imperial or Provincial funds. The works have been financed by the District Board, but are really managed by the Deputy Commissioner and the District Engineer, or, as in the case of the Firozpur Canals, the Superintendent of Irrigation. We think it would be better if new works of this class were sanctioned as minor works, Provincial or Imperial, as the case may be. This would not necessarily affect the management of the works when completed, as there are several instances of important minor works remaining under the management of the Deputy Commissioner. The Firozpur Canals cannot be regarded as an instance of successful district irrigation work; for, as already shown, they are not district works at all, but works, made by a combination of private individuals, which have received some financial assistance from the District Board, and over

the management of which the Deputy Commissioner exercises *ex-officio* certain powers of control. We have heard of other cases in which combinations of landowners to carry out irrigation or agricultural works have received financial assistance or encouragement from the District Board. We have no objection to urge against such a practice, which may often be very commendable so long as vested interests are not allowed to grow up to cause future embarrassment to Government But there is a great difference between occasional grants-in-aid to local associations which involve no further liabilities, and the raising of district loans for the construction of irrigation works to be worked as commercial undertakings.

62. *Private irrigation works. Inundation Canals.*—Private irrigation works in the Punjab other than wells may be divided into two classes: private inundation canals, such as are still to be found in the valleys of the great rivers; and private works for the utilization and distribution of hill-streams. Works of the former class have generally been constructed in the first instance by wealthy and influential riverain landowners, who may have received a grant of land from Government on the understanding that a canal would be made. Where the landowner has acted fairly and generously by his tenants, and where there were no engineering difficulties to be encountered, these canals have for a time worked satisfactorily. Under such conditions, we recognize that there may be distinct advantages in their control by their owners; and that the cultivators may prefer the easier or more elastic regime of one of their own nationality, to the more rigid rules of the British Government. But it has been found that the system lacks continuity: on the death of the original owner his property may become sub-divided; there is then divided control which is often further weakened by family quarrels; the land may change hands; new owners may act tyrannically towards the tenants; and frequent changes in the course of the river may necessitate the reconstruction of parts of the works. Sooner or later Government is asked to take over the work, and it eventually becomes absorbed in one of the Government systems. The only important private inundation canals which are now working effectively, are those in the Shahpur district, several of which are at present satisfactorily managed by their owners. We consider that Government should not offer any obstruction to the construction of inundation canals by private landowners in their own lands, and under suitable conditions, the main object of which would be to prevent the growth of vested interests which might seriously hamper the introduction by Government of a more extensive and efficient scheme of irrigation. Experience, however, shows that sooner or later Government will have to assume charge of such works; and we think that it will generally be better to undertake them as Government works from the beginning, on as extensive a scale as may be practicable, and as part of a well-considered scheme.

63. *Private irrigation works in hill districts.*—The case of private irrigation works in the montane and sub-montane districts, for the utilization of hill-streams, is very different. The maintenance of these works and the proper distribution of the supply is a much simpler question than on inundation canals, and the people have been thoroughly accustomed during many generations to their management. We have had interesting evidence regarding works of this class in the Peshawar and Dera Ismail Khan districts. The people are themselves very willing, and even eager, to improve and extend these works, and to take loans from Government for the purpose. Their collective protective value is considerable; and we think that Government should be prepared not only to assist with *takavi* advances, but also to give liberal grants-in-aid towards any improvement which will have the effect of increasing the protected and revenue-paying area, or to guarantee the owners for a long term against an enhancement of assessment. Departmental advice and assistance may also be required, when a work of more than ordinary importance is proposed, and should be freely given. But it should never be contemplated to bring these works under departmental management. They are essentially private works which the people can manage themselves under their simple system of self-government, any disputes or difficulties that may arise being referred to the Civil officers. In order that such disputes may be dealt with satisfactorily,

rights in wate… be as carefully recorded at settlement as rights in land. We n… told of one frontier district which has come under regular settle… which it is said that no such record exists. The works which … be most required are long low dams across the beds of the streams as they debouch from the hills, so as to form, not storage reservoirs, but distributary basins by which the flood waters can be drawn off into a radiating system of distributaries. There is apparently scope for small works of the same kind in the Umballa, Hoshiarpur, Jhelum, and Gujerat districts.

64. *Area irrigated by private irrigation works other than wells.*—The collective importance of private irrigation works, other than wells, is indicated by the fact that during the famine year of 1899-1900 they irrigated 989,000 acres, or nearly 9 per cent. of the total area of irrigation in the province from all sources, including wells. We have not found it possible to distribute this area correctly between the various classes of works, but the following distribution is approximately correct:—

	Acres.
District Irrigation works	116,000
Inundation canals	90,000
Hill streams, jhils, etc.	783,000

In the three districts, Kangra, Peshawar, and Bannu, 486,000 acres were irrigated by private canals.

65. *Royalty and legislation.*—We think that it is in principle inexpedient to levy royalty on water in any tract in which the staple crops are insecure in the absence of irrigation; and that, if such a charge is thought advisable in order to keep alive the right of Government in its water, the rate should be nominal. It is obviously to the advantage of Government and the people to have the water utilized for protective purposes. In the Punjab we understand that no charge is made except in the Shahpur and Firozpur districts, and that in both of these districts the charge is a nominal one of a few annas per acre. We may add that the construction, extension, and management of private canals is attended with many difficulties which can only be satisfactorily removed by legislation. We will not refer to them more particularly, as we understand that a Minor Canals Bill, which has been devised to meet all the requirements of the case, is now under the consideration of the Local Government.

66. *Wells.*—In the first section of this chapter (paragraph 3) we have divided the province into three distinct tracts; the importance of well-irrigation in the agricultural economy of each tract during the famine year of 1899-1900 is shown below:—

	Irrigation from all sources in 1899-1900.	Irrigation from wells, 1899-1900.	Percentage of well-irrigation.
	Acres.	Acres.	
Tract A	1,330,000	1,022,000	77
„ B	2,903,000	906,000	31
„ C	5,303,000	2,227,000	42
TOTAL .	9,536,000	4,155,000	44

The figures in Tract A do not include the Simla and Kangra districts, in which there is no well-irrigation. In the three hill districts in this tract, Kohat, Bannu, and Hazara, the well-irrigation is also inconsiderable, amounting to little over 3 per cent. of the total irrigated area; and if these are excluded, the percentage for the remaining districts, Rawalpindi, Hoshiarpur, Sialkot, and Jullundur, is 94. In the last two districts there is practically no irrigation except from wells. The figures for Tract B are affected by the

recent extensions of irrigation from the Chenab Canal into *Bar.* If this district be excluded, the percentage for Tract In Muzaffargarh only 14 per cent. of the irrigated area Well-irrigation is general throughout Tract C. In Jhelum pl... the whole, in Umballa 77 per cent., and in Hissar only 4 per cent. of the irrigated area is under wells. In Peshawar and Firozpur the percentages are 18 and 22, respectively. In all other districts from one quarter to three quarters of the irrigation is from wells.

67. *Progress in well construction during the past ten years.*—The following statement shows the progress made in the construction of wells during the last decade :—

Year.	Number of wells in use.			Area of crops matured by well-irrigation.	Average area of crops matured per well in	
	Masonry.	Temporary.	Total.		Normal year, 1891-92.	Famine year, 1899-1900.
1889-90 . .	219,940	42,660	262,600	3,959,427	...	...
1890-91 . .	222,217	40,716	262,933	3,822,323		...
1891-92 . .	232,644	40,254	272,898	3,695,883	14	...
1892-93 . .	232,768	38,156	270,924	3,428,768	...	...
1893-94 . .	243,377	35,561	278,938	3,449,672	...	...
1894-95 . .	248,385	29,478	277,863	3,072,220	...	...
1895-96 . .	253,137	34,143	287,280	3,730,789	...	...
1896-97 . .	258,852	46,697	305,549	4,006,984	...	...
1897-98 . .	262,358	39,288	301,646	3,970,518	...	...
1898-99 . .	266,519	42,357	308,876	3,956,902	...	..,
1899-1900 . .	274,851	73,859	348,710	4,154,598	...	12
Increase or decrease as compared with 1889-90.	+54,911	+31,199	+86,110	+195,171	...	...

Substantial progress has been made in the construction of masonry wells. Their number has increased from 219,940 in 1889-90 to 274,851 in 1899-1900, or at the average rate of 5,491 per annum. Temporary or unsteined wells have also increased from 42,660 to 73,859; but almost the whole of the increase of 31,199 in wells of this class occurred during the famine year of 1899-1900, the last year of the decade. The area irrigated from wells varies from three million acres in years of good winter rainfall to over four million in dry years. The four districts of Sialkot, Jullundur, Amritsar, and Gujranwala, account for nearly one-third of the whole area. Comparing the two dry years of 1889-90 and 1899-1900, it is remarkable to find that in spite of an increase of 25 per cent. in the number of masonry wells, and of the large increase in temporary wells, the well-irrigated area has only risen from 3,959,427 to 4,154,598 acres or by 5 per cent. This is due to the fact that in the eleven districts noted on the next page there has been an actual decrease of 14·0 per cent. in the total well-irrigated area, although there has been an increase of 22·0 per cent. in the number of masonry wells. If these eleven districts, only two of which (Jhelum and Gujerat) can be regarded as inadequately protected against famine, be excluded from consideration, we find that in the remaining districts of the province there has been an increase of 30,574 or 27·9 per cent. in the number of masonry wells, and of 513,538 acres or 30·5 per cent. in the well-irrigated area, so that the extension of the latter has been more than proportional to the increase in the former. The greatest increase has been in Hoshiarpur where masonry wells have increased by 57 per cent., temporary wells by 109 per cent., and the area irrigated has been doubled. It is satisfactory to note that the area irrigated by wells of all kinds in the six plains districts of the Delhi Division—the most insecure portion of the province—during the famine

year of 1899-1900, showed an increase of 57 per cent. over the area of the previous dry year. This increase is due to an increase of 9,652 or 35·9 per cent. in the number of masonry wells, and to an increase of 23,184 or 358 per cent. in the number of temporary wells. Hissar shares in the increase, showing 993 masonry wells at the end of the decade against 664 at the beginning; but there is not much scope for the construction of wells in this district, as the water is too far below the surface to make well-irrigation profitable.

68. *Temporary wells.*—Temporary or unsteined wells, though numerous in certain districts, appear to play an insignificant part in the general protection of the province. They are said to irrigate on an average not more than one acre a piece, or little more than one per cent. of the whole well area in an ordinary year, and two per cent. in a dry year. The only districts in which they are at all numerous are Gurgaon, Umballa, Hoshiarpur, Multan, and Gurdaspur, which between them account for 45,000 or 60 per cent. of the total number in use in 1899-1900. The number of temporary wells increases in a year of drought, when they are dug and used for one or two seasons, but many of them are subsequently abandoned when years of normal rainfall occur. Thus it is found that there were 42,660 wells of this class in the year 1889-90; during the succeeding wet years the number gradually decreased to 29,478 in 1894-95; and in the following dry years it gradually rose again to 42,357 in 1898-99, which was increased in the following or famine year to 73,859.

69. *Districts in which the well-irrigated area has not increased.*—The eleven districts in which an increase in the number of wells has been accompanied by an actual decrease in the well-irrigated area are given below :—

Districts.	Percentage of increase in number of wells.	Percentage of decrease in well-irrigated area.
Montgomery	24·1	1·3
Dera Ghazi Khan	30·0	2·6
Jhelum	4·1	4·0
Sialkot	17·1	5·8
Peshawar	13·0	7·3
Gujerat	19·3	8·7
Muzaffargarh	19·8	11·2
Lahore	17·0	13·6
Shahpur	12·8	14·8
Gujranwala	4·5	27·5
Jhang	22·1	28·5

All these eleven districts are traversed or bounded by one or more of the four rivers, the Indus, the Jhelum, the Chenab, and the Ravi; and it has been suggested that the decrease in the well area in many, if not in all, is attributable to the low state of the rivers, or to the absence of heavy spills, which not only reduced the spring level in the vicinity of the wells, but also rendered necessary a larger number of waterings, owing to the comparatively dry condition of the soil. This explanation is probably correct; but in the absence of separate statistics regarding the wells affected by floods, it is impossible to form any reliable conclusions on the question. It appears to us improbable that, as has also been suggested, the greater quantities of water which have been abstracted from the Ravi and Chenab, during the last few years, by the Bari Doab and Chenab Canals, can have contributed appreciably to this effect. The local officers consider that the great decrease in the well-irrigated area in Gujranwala and Jhang is attributable as much to the effect of colonizing operations in the Chenab area in attracting labourers from the riverain lands, as to diminution in the floods. It is not easy to say to what extent each cause has contributed to the decrease. With the return of the usual high floods in the rivers and of labourers to the riverain tracts,—of which there are already signs,—conditions may soon change for the better; but the fact that the well cultivation in the valleys is so much

affected by the fluctuations to which the river supply is liable, emphasizes the necessity, to which we have already referred, of improving the means of irrigation in these tracts.

70. *Extension of well-irrigation.*—In Chapter V of this report the general considerations affecting the problem of protection by well-irrigation have been stated, and we have now to consider their application to the Punjab. We do not regard the extension of well-irrigation of urgent importance as a direct protection against famine in this province. But there are not inconsiderable areas in which the need for further protection exists; and, since everything that

nue. An extension of well cultivation is very desirable in the two insecure districts of Gujerat and Jhelum. It is understood that in portions of the former district the spring level is so deep that, as in the Hissar district, wells could not be used for irrigation even in a famine year. But we observe that 465 temporary wells were made in this district in 1899-1900, and if these were of any use the owners might be assisted to make them permanent. There was an increase of nearly 15 per cent. in the number of permanent wells in this district during the decade, and further extensions may be possible, if actively encouraged. Similar encouragement may be recommended in the Jhelum district in which wells are practically the only existing means of irrigation, and in which the cultivation appears to be very insecure. Some wells in Pind Dadan Khan are said to be brackish, but it may be possible to tap sweet water at a lower level. We have already referred to the immense number of temporary wells made in the Umballa district, and in other districts of the Delhi Division, during the late famine; and there appears to be room for a considerable increase in the number of permanent wells in these districts. Finally, we consider that in districts which are notoriously insecure, such as Gurgaon, Rohtak, and Delhi, Government should be prepared to give substantial grants-in-aid towards the construction of wells in places where the spring level is not too deep for them to be worked with some small margin of profit, but where the margin is so small, and the difficulties or cost of construction so great, that private enterprise cannot be expected to come forward without such assistance. We understand that the water-supply of many wells in Hissar is precarious owing to the fact that the wells rest on an impervious stratum of hard clay, but that when this has been pierced an unfailing supply is reached. When this stratum is thick the villagers are unable to get through it with their simple appliances, and expert assistance might be usefully afforded in making borings. As a general rule, however, the construction of wells in the Punjab appears to be a simple matter, which the people are quite able to carry out without professional assistance.

73. *Character of the cultivators to be considered.*—We make these recommendations subject to the general condition that, before Government assistance is given in the construction of private irrigation works, regard must be paid to the character or class of the cultivator; to the facilities that have been held out to him in the past; and to the question whether any increase in these facilities will materially stimulate the construction of such works. The success of well cultivation, in tracts where the profits must in any case be small, depends so much on good husbandry or the capacity and industry of the cultivator, that this must always be a determining factor when State aid is proposed for private protective works.

(*v*).—*Famine works and programmes.*

74. *Relief works executed during famines of 1897 and 1899.*—The Famine Commission of 1898 reported that out of 19½ lakhs spent on relief works in the Punjab during the famine of 1896-97, over 11 lakhs were spent on irrigation works, 6 lakhs on village tanks and other miscellaneous works of very small protective value, and nearly 2½ lakhs on the construction of roads and collection of kankar for metalling. The actual value of the work done on irrigation works, which has been debited to the works concerned, was estimated at Rs. 4,41,029. The principal of these works were the Ghaggar Canals, which have been completed; and the excavation of a portion of the main line of the Jhelum Canal, which was taken up in advance of the regular commencement of that work. All other irrigation works on which relief labour was employed were also completed. During the famine of 1899-1900 relief operations were on a considerable scale only in the Jhelum, Lahore, Gurgaon, Rohtak, and Hissar districts, and there was not the same scope for the employment of labour on irrigation works. The distribution of expenditure was as below:—

	Rs.
Irrigation works	5,96,695
Village tanks	27,51,389
Roads and collection of metalling	4,42,279
Earthwork on railways	1,85,582
Miscellaneous works	45,176
TOTAL	40,21,121

The Jalalpur Inundation Canal was commenced in the Jhelum district, and gave employment to relief labourers from February to August 1900, when the works were closed. We have recommended (paragraph 56) that this canal be completed as a protective work. In the Lahore district, a small inundation canal taking off from the right bank of the Ravi was carried out by the District Board, and Rs. 20,000 were spent on excavation. The channel was completed and the canal was opened on the 29th July 1900, but a record flood occurred in the Ravi in the following month which eroded the right bank and outflanked the regulator. The work had not been properly designed, and will have to be entirely reconstructed if it is to have any protective value. The District Board are unable to risk more money on it, but the whole tract concerned should be properly surveyed by the Irrigation Department; and, if a supply can be assured to a properly aligned canal, it should be undertaken as a provincial work, or held in reserve for execution on the next occurrence of famine in this unprotected part of the Lahore district. An attempt was made to draft labour from the Hissar district to the Jhelum Canal works, over 200 miles distant. The difficulties must have been great in any case, but the outbreak of cholera on the works deprived the experiment of all chance of success. In the Hissar district itself the only irrigation work that could be proposed was a bywash channel near the head-works of the Ghaggar Canals (a work of very small protective value), and an irrigation cut from the Ghaggar which has since been completed. In this and the Rohtak district—the only districts in which relief operations were required on a large scale—the main form of work was the excavation, in drainage lines, of large tanks intended to hold water for cattle, though a certain amount of lift irrigation would be possible in the event of their filling. These tanks were of great size, with a capacity of about ten million cubic feet, and were designed to give employment for 5,000 labourers, though in some cases as many as 12,000 were employed. It is generally admitted that, as regards discipline and management of relief labour, there is no better form of work than this, but the utility of the tanks is very doubtful. The Chief Engineer has stated that before any site was finally selected six or eight trial pits from 18 to 20 feet deep were made, so as to determine the depth to which the tank should be excavated and to make sure of the water-holding conditions of the soil; but it is said that none of these tanks were holding water after the rains of 1901. They may possibly be more retentive in time as they become puddled with the silt that may be brought in during seasons of heavy rainfall, or by periodical fillings from the canals when these are possible. Some of the tanks were not completed, but it is of course unnecessary to complete them; works of this kind can be left unfinished at any stage of progress when it is no longer necessary to employ labour. In the Gurgaon district relief labour was employed mainly on raising and repairing some of the embankments referred to in paragraph 59, and on the earthwork of the proposed Delhi-Agra Chord Railway.

75. *Provincial programmes of relief works. The three south-eastern districts.*—We have examined the Punjab revised Programme of Relief Works for 1900-01—a bulky volume containing detailed programmes for 18 districts; that is, for all the districts of the province excepting Peshawar, Kohat, Simla, Sialkot, Jullundur, Ludhiana, Shahpur, Jhang, Multan, Dera Ghazi Khan, and Muzaffargarh. The following details will give an idea of the present character

impossible form of relief work, and we do not know why it was entered in the programme. Silt clearances can only be carried out when water is not running in the channels, or during intervals of 15 or 20 days at the utmost. Two other useful canal works are proposed, but they would only employ 216 people for the period assumed. The remaining five public works are road works. The large tanks are of the type already referred to, and some of them were begun during the late famine. About six have been provided in each tahsil, and they would be under the management of the Public Works Department, forming the backbone of the relief system of the district. The village works are in all cases the enlargement of village tanks. Sixteen of the public works in the Rohtak district are road works, and three of them are useful canal drainage works, on which over 2,000 relief labourers can be very usefully employed during six months. The two remaining works are of a petty character. The large tanks and village works are of the same kind as in the Hissar district. The 20 public works in the Gurgaon district comprise 12 road works and 8 works on *bands*. The latter will employ 12,660 people for six months, and, as we have already shown, are very useful protective works, however little reliance can be placed on them in a year of drought. Many more works of the same kind are being estimated for, and will no doubt be entered in due course in the programme. If carefully designed, these works will be of great value to the district. The large tanks and village works resemble those in Hissar and Rohtak.

76. *Programmes in other districts.*—The programmes of public works in all other districts consist almost entirely of road works, including collection of metal; and the village works are invariably the construction or enlargement of tanks, except in Bannu, where a few petty *bands* across torrents are proposed. The Karnal district programme includes eight large tanks of the Hissar type, three of which were commenced in the last famine. This is the only district, besides the three which have just been considered, in which works of this kind have been proposed. The programmes for the Karnal, Umballa, Firozpur, and Lahore districts, include many drainage or canal improvement works under the Irrigation Department. The Firozpur programme consists entirely of useful works, as, in addition to the works under the Irrigation Department, there is a new district canal, which will have a great protective value, and the earthwork for the Ludhiana-Firozpur Railway; but this district is not very liable to famine. In the Jhelum programme provision has been made for the proposed Kala Canal which will apparently be a useful protective work, but it has not yet been estimated for in detail. The Gurdaspur programme provides for the Ujh Canal, a project of very doubtful value, and the district is practically secure against famine. With these exceptions the programmes include no works which will be of any service as protection against famine, however useful some of them may be in other respects. The only districts in which there is any large field for the extension of protective works are those in the rainless tract; and as has already been explained these districts are not liable to famine, and are all excluded from the programme, with the exception of Dera Ismail Khan, though our evidence shows that in that district also relief works are not likely to be required. There is a wide field for extension of irrigation, but this is desirable for political reasons, and for the development of the district, rather than as a means of preventing famine.

77. *Programmes not complete.*—These programmes cannot be regarded as complete. Both public and village works have been entered in considerable numbers, but the detailed plans and estimates which are necessary before the former can be undertaken, and the local examination which is essential if there is to be any security that the labour expended in the latter will not be wasted, are still in progress. There appeared to be some conflict of evidence as to the time necessary for the completion of these processes with the ordinary staff; but it appears that an additional staff costing about Rs. 700 a month would be required in each district to complete the work in some eighteen months or two years; and we think that some such staff should be appointed, at any rate in each district that can be considered at all liable to severe famine. It seems certain that village works will in future famines

occupy a more important place in the scheme of famine relief than they have done in the past; and we think that the special staff should make such an examination of any tract which is liable to famine as will enable it not only to record all suitable sites for village tanks, but also to make suggestions for other kinds of works which may be of benefit to the community, such as the construction of field embankments. We are not sure that no other form of village work is possible than the enlargement of tanks, though, as we have pointed out, this is the only form which is contemplated in the programmes. Whatever further preparations, in the shape of levelling and estimating, may be necessary before the projects are finally ready for inclusion in the programme, might be confined to a number of works sufficient to satisfy the probable requirements of the next famine; but the opportunity of making a complete though cursory survey should not be lost, and the work will not be thrown away. There seems to be some doubt as to the precise degree in which Civil officers are responsible for the preparation and sufficiency of their programmes. We consider that they should be held primarily responsible for suggesting projects for the employment of famine labour, at any rate as regards village works and works which would ordinarily be undertaken by local bodies.

78. The programmes as prepared show the number of persons to whom each work is estimated to afford employment for six months. But there is no standard from which to form a judgment how far the number thus provided for is sufficient. The experience of the last two famines should, in most places, afford ample material for such a standard. And we recommend that the actual number of relief-work units (one person employed for one day) which were employed during whichever of these two famines was the more severe, divided by 180 (the number of days in six months) should be shown below the totals for each tahsil; and that no programme should be considered sufficient in which the numbers provided for by schemes for which plans and estimates have been sanctioned, or, in the case of village works, of which the necessary local examination has been made, falls materially short of the standard thus provided.

79. It may also be very advisable to prepare projects for relief labour in tracts which will not themselves supply the labour, when the works are in themselves very desirable and relief labour will be available from no great distance, or when there is a difficulty in providing suitable works in neighbouring insecure areas. The suggestion made in paragraph 57 illustrates our meaning. So, too, the Irrigation Department may often be able to suggest useful works or improvements, desirable but not necessarily remunerative or protective, which could be carried out in famine times by labour imported from a moderate distance. We endorse the suggestion of the Famine Commission of 1901 that all current Public Works Department schemes,—both irrigation and general—which are suitable for relief labour, should be shown in the programme; care being taken to strike them off as they are completed in the ordinary course, while new works as sanctioned should be entered when they are situated in or contiguous to areas in which relief may be required.

80. *Possible additions to programmes.*—We cannot suggest many useful additions to the programmes of those districts in which relief works are most likely to be required. We strongly recommend a full programme of *bands* in Gurgaon; and also the preparation of a complete scheme for the improvement of the Karnal and Umballa drainages, on which relief labour could very usefully be employed when occasion arises. If it is possible to contemplate extensions from the Western Jumna or Sirhind Canal into the Rohtak or Hissar district, if only for the utilization of surplus supplies in *kharif*, we think that the lines of such extensions might be laid down in advance of any arrangements that can be made for providing the supply, with a view to the necessary channels being constructed by relief labour on similar occasions. This labour might also be usefully employed in constructing channels to connect some of the new tanks, and also old village tanks with the canals, so that they may get an occasional filling when water is available. We understand that it is the practice to fill free of charge as many village tanks within the canal area as may require filling during the seasons of slack demand. It will not be easy to fill large tanks at a

. the boundary of irrigation, and many of the tanks in Hissar ... miles from the tail of the canal; but some tanks not so far off ...e partially or wholly filled occasionally if supply channels were available, ... would form useful escapes when heavy rainfall occurs in the upper reaches of the canal. Every such filling would benefit the tank, as it would leave a deposit of silt. The channels should be made as large as possible, so as to take advantage of short spates. There might be some difficulty in regard to land, but probably a right of way for a channel could be obtained without payment. We think that the programmes should include some channels of this kind, which will have to be carefully aligned and graded beforehand by the special staff employed on the completion of the programmes. We understand that there are many abandoned lengths of channel on the Western Jumna Canal, loops which have been cut off in the course of remodelling, and which have been surrendered to the villages concerned, but which are of little value in their present condition. The filling in of these channels or levelling down of their banks might sometimes be useful as village works. The Jhelum and Gujerat districts should be examined with a view to the construction of such minor irrigation works as may be feasible, and if these are not likely to be remunerative they may nevertheless be included in the programmes of famine relief works. We are conscious that these suggestions are not very far-reaching or helpful, and that in putting them forward we are indicating the narrowness rather than the width of the field for useful relief works in these districts. We may, however, point out that, if the Lower Bari Doab Canal be sanctioned, there will be for eight or ten years ample employment for relief labour on the excavation of its main line. The works will be within 100 miles by rail of the heart of the Hissar district, or less than half the distance to the Jhelum Canal; and there is no doubt that they will attract a great deal of labour even in ordinary years. If any canals are made on the left bank of the river the works will be even more accessible for the Hissar labourer. It would hardly be necessary to open relief works to be conducted on famine relief principles or to do more than reserve certain sections of the work for labourers from famine districts, who would be given work on the ordinary system of petty contract or unlimited piece work, with which the Punjab labourers are very familiar. Work on such terms would attract the greater part of the able-bodied population, and it would only be necessary to open tank works for the residue. As long as these canals are in progress the problem of relief works in Hissar will be much simplified.

CHAPTER XV.—BOMBAY.

SECTION I.—INTRODUCTORY.

81. *Divisions of the Presidency to be considered.*—The Bombay Presidency may, for the purposes of our inquiry, be divided into four parts, in each of which the irrigation problem presents itself under an entirely different aspect. These parts are geographically distinct, and are generally known by distinctive names, as below :—

(i) Sind, or the delta of the Indus,

(ii) Gujerat, comprising the districts of Ahmedabad, Kaira, Panch Mahals, Broach, and Surat;

(iii) The Deccan and Carnatic; the former comprising the six districts of Khandesh, Nasik, Ahmadnagar, Sholapur, Poona, and Satara; and the latter the districts of Bijapur, Belgaum, and Dharwar. It will be convenient, however, to consider these nine districts together under the general name of the Deccan.

(iv) The Konkan, or four Southern Coast districts, Thana, Kolaba, Ratnagiri, and parts of Kanara below the Ghats.

82. The fourth or Konkan may be very briefly dismissed. It consists of an intensely rugged strip of country lying between the Western Ghats and the sea. It is intersected by numerous creeks and tidal rivers with their tributary streams. The country between these comprises a few open valleys and flats, but is mostly cut up by rough steep hills many of them forest clad, or rudely cultivated with the inferior hill millet reserved for pasture and the growth of *rab*, the term used for the brushwood and loppings which are spread and burnt, according to the methods of tillage in vogue, upon the seed beds in which seedlings of rice are reared prior to transplantation. Over the flats and valleys, and in terraces along the beds of the streams, rice is thus cultivated with the aid of the local rainfall which varies considerably, but rarely or never totally fails. Some valuable garden cultivation is carried on by means of wells in the districts of Thana and Kolaba, but there is no other form of artificial irrigation. The abundance and regularity of the rainfall is such that measures for husbanding or storing it are wholly unnecessary. Although occasionally the fall is so deficient as to cause considerable shortage in the crops, nothing like real famine has ever occurred. In recent years of extremely short rainfall, the small amount of distress which occurred was easily coped with by the opening of a few insignificant local works, which indeed were most sparingly resorted to by the people for whose relief they were intended. We have not thought it necessary to call for any specific evidence, and none has been offered, regarding the possibility of increasing irrigation in this tract. It is possible that the damming up of the hill-streams might be useful in places for the promotion of *rabi* cultivation; the rice crops might be rendered a degree more secure by the construction of small tanks; and valuable garden cultivation might no doubt be extended by the multiplication of wells in Thana and Kolaba. But the development of these or similar measures can be safely left to private enterprise, with the aid of such encouragement on the part of the State as it may be deemed advisable to give, upon the lines suggested in Chapters V and VI of this report, to a tract which has nothing to fear from famine.

The remaining three tracts differ so much in character and are geographically so distinct that it will be convenient to consider each separately, under the five headings prescribed in our terms of reference.

SECTION II.—SIND.

(*i*).—*Local conditions; use and value of irrigation.*

83. *General conditions.*—The conditions in Sind correspond closely with those which distinguish what we have called the rainless tract in the Punjab, of

which this province is geographically a continuation. The only difference is that the rainfall is even less than in the Punjab districts, and that cultivation without irrigation is even less possible. There is population only where there are the means of irrigation, and the main source of irrigation, the river Indus, is unfailing. In such a province there is no danger of famine, although under pressure of famine, numbers may crowd in from adjacent territories—from Khelat, Rajputana, and Cutch—for employment on the annual clearances of the canals, or on the works of extension and improvement that may be in progress. The argument for such extensions is, as in the case of the rainless tract in the Punjab, that they tend to increase the wealth and annual food-supply of the country, and to attract population from more congested or less favoured districts, and also that irrigation works of the kind suited to the country are almost certain to be productive, and to yield a high return on the capital outlay. Nowhere is the utility of irrigation more marked in increasing the produce of the land; for without it cultivation is impossible, while with it excellent crops can be raised in most parts of the province.

84. *Dependence of cultivation on irrigation.*—The extent to which the cultivation in Sind depends on irrigation, and to which the irrigated area depends on the condition of the river supply, is shown by the following figures:—

Kind of cultivation.	1895-96.	1897-98.	1899-1900.
	Acres.	Acres.	Acres.
Canal irrigated	2,009,271	2,734,107	2,493,028
Twice cropped area	131,868	262,119	215,474
Irrigated from other sources	123,601	183,517	151,419
Dependent on rainfall	522,316	884,858	136,567
Total area cropped	2,787,056	4,064,601	2,996,488

1895-96 was a very unfavourable year for all kinds of cultivation, while 1897-98 was the most favourable year on record. In an average year a net area of about 3,100,000 acres is under crops, and of this about 200,000 acres are double cropped. The canal irrigated area is, as might be expected, subject to less fluctuations than that of the inundation canals in the Punjab; but the difference between a bad and good year may nevertheless exceed 800,000 acres, and if cultivation of all kinds is considered, the difference is nearly 1,300,000 acres. The net revenue earned by the canals in 1895-96 fell short of that for 1897-98 by Rs. 29,35,290, and it may be assumed that the difference in the value of the crops raised was not less than $2\frac{1}{2}$ crores of rupees.

85. *Proportion of total area of the province which is commanded by the canals.*—The total area of the province is, in round numbers, 30 million acres, of which 14 millions are returned as cultivable, if water were available. The occupied area amounts roughly to 8 million acres, of which $1\frac{1}{4}$ millions are *jagir* lands, and the remainder are Government occupied. The area annually cultivated may therefore be taken as about three-eighths of the occupied area. The canals are designed generally to irrigate about one-third of the area commanded, and many lands lie fallow for two years out of three. There are, however, some lands, especially rice lands which are regularly cultivated every year; and there appears to be no reason why a higher proportion than one-third of the area commanded should not be cultivated annually if an adequate water-supply were available. Apart from extensions of irrigation within the commanded area, there remain about 6 millions of acres of cultivable land which have not yet been brought under irrigation. We are unable to say what proportion of this area may be potentially commanded by inundation canals from the Indus; but it is said that about 1,118,000 acres will be brought under command by new works which have been recently sanctioned, and that 708,000 acres may be commanded by other works that are proposed. There will then remain

over 4,000,000 acres, an unknown portion of which may eventually be brought under command.

86. *Foreign territory.*—The canal irrigated areas given in paragraph 84 refer to British territory only. The canals also irrigate about 75,000 acres annually in the Khelat State. Outside British territory, there is also the Khairpur State on the left bank of the Indus, in which there is, however, at present no irrigation from the Government Canals.

87. *Population compared with the cultivated area.*—About one quarter of the cropped area in Sind is under rice, and half under wheat, millets and other cereals, the remainder being non-cereal crops. The total population of the province according to the census of 1901 amounted to 3,211,000, so that there is an average of 1 acre of cultivation per head. The province has a sparse population of 256 persons per square mile of occupied area, and the supply of labour has always been a difficulty in Sind. Yet there seems reason to believe that, so long as new country is not opened up too rapidly, no great difficulty will be found in colonizing it from Cutch, Gujerat, the Punjab, Rajputana, and especially from among the Biluch tribes, on whom the provision of assured cultivation may be expected to exercise the same tranquillizing effect that the construction of the Swat River Canal has exercised over their more turbulent neighbours, the Pathans.

(*ii*).—*Existing State irrigation works.*

88. *Extent and growth of irrigation from the State Canals.*—All irrigation works in Sind, with the exception of wells, have been constructed or are maintained by the State. The so-called private canals are merely private owned channels which take off from the State Canals. The following figures show the growth of the area irrigated by the Government Canals, and of the revenue assessed thereon, during the 20 years ending 1899-1900 :—

Quinquennial period.	Average areas irrigated annually.*	Average of net assessed revenue.
	Acres.	Rs.
1880-81 to 1884-85	1,618,390	36,66,700
1885-86 to 1889-90	1,978,827	44,80,817
1890-91 to 1894-95	2,358,032	55,26,598
1895-96 to 1899-1900	2,484,954	58,34,046

* Exclusive of twice cropped areas.

As the averages have been struck on periods of five years, the effects of fluctuations in the conditions of the river have been to a great extent eliminated; but so far as can be judged from the readings of the standard gauge at Bukkur, the conditions throughout the last two periods were much less favourable than in the first two, and they were especially unfavourable during the last of the four periods. Were it not for this, the growth of irrigation would have been greater than the figures indicate. There has, however, in spite of less favourable conditions, been an increase of over 50 per cent. in the irrigated area during the last fifteen years.

89. *Productive and financial results.*—Most of the canals in Sind are inundation canals which, like those in the Punjab, existed in some form or another before they passed under the control of the British Government, and have since been enlarged or extended in a piece-meal fashion as funds could be made available. Thus very few of them have capital accounts, and it is difficult to form a correct idea of the productive or financial results attained on the works as a whole. There are, however, five new canals which have been constructed from loan funds and classed as productive public works: the Desert, the Unharwah, the Begari, the Eastern Nara, and the Jamrao Canals, the total capital outlay on which to the end of 1900-01 amounted to Rs. 1,79,29,731, and the net revenue to Rs. 13,72,912, or 7·6 per cent. The

Jamrao Canal was first brought into operation during the year, and yielded a return of 3½ per cent., while the returns on the Unharwah and Begari were respectively 19 and 24 per cent. The average capital cost of these five works, per acre annually irrigable, may be taken at about Rs. 21 per acre. Four other smaller productive works are under construction. There are moreover seven old canals, which are classed as minor works, and for which capital accounts have been opened. The capital expenditure on the improvement of these canals to the end of 1900-01 amounted to 40 lakhs, and the net revenue during the year, due to improvements, or after deducting the revenue due to old irrigation, was equivalent to a return of over 16 per cent. on this outlay. As far as can be judged therefore from those canals which have capital accounts, the expenditure has been highly remunerative. Many of the canals, however, have no capital account, and these irrigate in the aggregate about one-third of the total area irrigated by the Sind Canals. The revenue credited to these works during 1899-1900 amounted to Rs. 20,89,905, and the working expenses to Rs. 10,61,970, or a little over 50 per cent. of the gross revenue. The revenue due to irrigation throughout the province averages about Rs. 2·2 per acre, while the working expenses are at the rate of Rs. 0·85 per acre. The general conclusion is that the irrigation works in Sind, whether classed as major or minor, are even more highly productive than the inundation canals in the Punjab.

90. *Revenue credited to canals.*—The revenue which is credited to the canals is nine-tenths of the land revenue assessed on the irrigated area. It fluctuates with the area irrigated and the nature of the crop sown. For the irrigation of *jagir* lands, and of land in foreign territory, a water-rate, known as *hakabo*, is levied. This varies generally from 5 annas to one rupee per acre, but an increased rate of one rupee eight annas is charged on new extensions into Khelat territory. The *hakabo* is merely a contribution towards the cost of clearing the channels, and no credit is made to the canals on account of the enhanced land revenue. Some of our witnesses have recommended that a credit should be given to the canals on this account; but there are obvious objections to crediting the canals with a revenue that is not paid to the British Government. A *pro formâ* account is, however, kept up, from which it appears that in 1899-1900, the revenue credited to the canals on account of irrigation in *jagir* and foreign State lands was Rs. 5,79,910 less than would have been received, had the irrigation been in British territory, the average shortage being about 6 lakhs a year. There appears to be on this account a disposition to avoid extending irrigation into *jagir* and foreign State lands; but, in the case of extensions at least, it would seem possible to charge higher *hakabo* rates than have hitherto been levied.

91. *Lift and flow irrigation.*—About one-fourth of the irrigation on the canals is effected by lift—a very high percentage, although it appears to be gradually diminishing. We have been much impressed by the small proportion which the differences between the rates for flow and lift irrigation bear to the greater cost to the people of the latter as compared with the former; and have been told in explanation that lift irrigation is better both for the land and the people, that the crops are larger and the supply more assured, while flooding and excessive irrigation, with their attendant insanitary results, are unknown. Yet it is admitted that the people infinitely prefer irrigation by flow to irrigation by lift, that they desert the latter for the former, and that it is difficult in many places to induce them to take up land on which the latter only is available. These facts seem to suggest that sufficient allowance may not have been made for the additional labour and expense of lifting the water. If it should hereafter ...nd advisable to increase the difference between the two sets of rates, either ...ing the one or reducing the other, the effect would be to improve the ...l prospects of proposed improvements, so far as they depend on the ...n of flow for lift irrigation.

...-Scope for further extensions of State irrigation works.

...ons of existing canals.—It has already been stated that about ...ll be brought under command by new works already sanctioned,

while other works are proposed which will increase the commanded area by 708,000 acres. The sanctioned works are the four new productive works which have been referred to as in progress, and some extensions on the Fuleli and Eastern Nara systems. The works proposed are extensions of the Sukkur, the Ghar, the Western Nara, the Fuleli, and the Central Hyderabad Canal systems. We have no doubt not only that these extensions are as feasible as they are desirable, but also that they do not represent the ultimate limits to which irrigation can be extended while the canals are worked under the present system, or as inundation canals. As in the case of the inundation canals in the Punjab, there is still much to be done in the way of remodelling the canal systems in Sind, with the object of economizing water; largely reducing the labour and expense of clearance, both of the main channels and the village water-courses; increasing the proportion of flow to lift irrigation; improving the supply and rendering it more certain; providing irrigation for a larger proportion of the area at present commanded; and extending the boundaries of that area. It has been shown that the total area of irrigation has been increased by over 800,000 acres during the last 15 or 20 years, but nearly half of this increase has occurred on the five productive works on which capital outlay has been freely incurred. On other canals progress has been limited by want of funds, as the cost of all improvements, however remunerative, has been met from general revenues. Here, as in the Punjab, what appears to be most wanted is a remodelling of the system of distribution, and the substitution of carefully aligned Government channels for long village water-courses. On some canals these water-courses are three or four miles in length. The wastefulness of the present system is recognized by all irrigation officers; but the policy has been to leave things to work on as best they can, and to spend as little money as possible on all existing canals. No doubt extensive remodelling of the system of distribution must be carried out cautiously and with great discretion. But, however jealous the people may be of interference with their long established private channels, they feel the great burden of the heavy silt clearances which the present system imposes on them; and the gradual transfer of private channels to Government indicates that, in Sind as elsewhere, the people would welcome the change, if introduced gradually and with careful regard to their interests. No doubt any extensive remodelling will impose heavy charges on Government, both in first cost and in subsequent maintenance; but it has long been recognized by irrigation officers that the further Government carries the water the greater will be the efficiency and the remunerativeness of an irrigation work. We are confident that there is a wide field for the extension of irrigation in Sind, at a comparatively moderate cost, by improving the existing canals, and, more especially, by remodelling the distributary channels.

93. *Possibility of making the canals perennial.*—The question has however been raised whether something more than this may not be done in Sind; and whether the time was not now coming for making the existing canals perennial by the construction of weirs across the Indus, similar to those which we have already recommended in the case of the Sutlej. Sir Evan James, the late Commissioner of Sind, referred to this subject, in the last review of the operations on the Sind canals which he wrote before leaving the province, and called attention to the possible effect on the canals of the opening of new perennial canals in the Punjab. We need hardly point out that the construction of weirs across the shifting bed of the Indus, in its passage through the Sind delta, is quite a different thing from putting weirs across its tributary the Sutlej. Not only would the cost and difficulties, both of first construction and of subsequent maintenance, be immeasurably greater, but the necessity is less urgent. The Indus in Sind contains the combined waters of all the Punjab rivers, and is naturally a r less uncertain source of supply for inundation canals than any of its tribu The differences between a bad and a good year are much less marke many of the most important canals in Sind—the Sukkur, the Eas systems, and the Fuleli—have moderate perennial supplies, which sufficient for present requirements, though better or more assured no doubt render further extensions of these systems possible. I of the Sind Irrigation Officers who came before us, that the supp have not been appreciably affected by the withdrawals from

The full monsoon supplies of the canals which have been opened in the Punjab during the last 20 years amount to 28,000 cusecs; but such supplies are only run when the rivers are very full, and the withdrawals would not seriously affect the levels in the Indus during the inundation season. The progressive increase in the irrigated area during the same period shows that the efficiency of the canals has not been affected. The *rabi* supplies of the new Punjab canals would amount to about 15,000 cusecs, but the present minimum cold-weather supply of the Indus at Sukkur is from 30,000 to 35,000 cusecs. During this period perennial supplies have been given to the Eastern Nara and Fuleli Canals by lowering their beds or preventing silt deposit, and these supplies may no doubt be affected by future Punjab withdrawals; but the majority of the Sind canals, like the inundation canals in the Punjab, have never had cold-weather supplies at all. As far as existing Sind cultivation is concerned heroic measures are not required, and there is as we have shown great room for extending existing cultivation by working on existing methods. These considerations, to which may be added an apprehension that cultivators would not be forthcoming for any great or rapid extension of cultivation in Sind, have hitherto had such weight that the idea of harnessing the Indus has never been seriously considered, though the advantage of having a weir at Bukkur, in the Rohri gorge, has been talked of for years. Mr. Dawson, the Secretary to the River Indus Commission, made a preliminary investigation of the Bukkur site in 1900, and subsequently in anticipation of the visit of the Commission, prepared an interesting memorandum on the subject.

94. *Advantages of the Bukkur site for a weir.*—There is no doubt that some site in the vicinity of the Rohri gorge would be most suitable for a weir across the Indus. A glance at the map shows that it is from some such site that the present irrigation system could be most conveniently connected. Above Bukkur there are the Desert, the Unharwah, the Begari, the Sind, and the Sukkur Canals, on the right bank; and the Shikarpur Canals, including the new Mahiwah, on the left bank. It is true that none of these would be benefited by the construction of a weir at Bukkur, except the Sukkur Canal and perhaps to a slight extent the Sind Canal. The others would be too far upstream to come within the influence of the weir. But it would apparently be feasible, by means of two great main canals taking off from the right and left banks above the weir, to feed all the remaining irrigation systems in Sind, with the exception of the Karachi systems which take off from the Indus below Kotri. The right bank canal would take up the whole of the irrigation on the present Sukkur, Ghar, and Western Nara systems, and could be extended even further south to whatever extent the levels and character of the country may permit. The Eastern Nara Canal, which takes off immediately above Bukkur, would draw an assured and abundant supply throughout the year and great extensions of that system, which includes the Jamrao Canal, would be rendered possible. Immediately below it would take off the new left bank canal which, after traversing and irrigating part of the Khairpur State, might be made to feed the present northern and central Hyderabad systems and also the Fuleli Canal. From no lower point in the river could such a command be obtained of the existing systems. A vast scheme of this kind appears to be feasible, but there are many practical considerations which would perhaps render it desirable to reduce its scope. For instance, the Fuleli Canal system would probably continue to work so efficiently as an inundation canal that there would be little advantage to justify the great cost of feeding it from above the weir, especially if the supply could be taken to waste lands elsewhere. Mr. Dawson himself does not appear to contemplate a new left bank canal at all, or even the connection of the Western Nara system with the right bank canal. He merely proposes to give full perennial supplies to the Sukkur, Ghar, and Eastern Nara Canals, though of course there would be room for further developments. The most economical scope for the scheme would no doubt be intermediate between these extremes.

95. *Mr. Dawson's note on the Bukkur site.*—Mr. Dawson's memorandum on the weir is printed with our selected evidence. We do not propose to criticize it at any length as it is based on data that are admittedly incomplete,

and can only be regarded as the first impressions of an officer who has but recently been called on to study the question. But it serves to show the great difficulties that will have to be encountered. The site proposed for the weir is immediately above the entrance to the Rohri gorge, and the rough borings which have been made indicate that a continuous bed of rock (limestone) may be relied on. Taking the average level of water during the cold-weather months as that of zero on the Bukkur gauge, it was found that in the central 700 feet of the line of weir (which would be 4,600 feet long) the rock was about 36 feet below the water level, or gauge-zero, the depth on the lateral portions varying from 9 to 1 feet. The foundations of the central part of the weir would therefore have to be laid in 36 feet of water; and in this situation there would of course be no possibility of diverting the river, the minimum cold-weather discharge of which is estimated at not less than 30,000 cubic feet per second. It is considered that, for the purpose of gaining the required command, it will be necessary to hold up the supply to a level of 12 feet above the gauge-zero; and Mr. Dawson provisionally proposed a permanent weir, with crest at a level of 3 feet above zero, to be surmounted by moveable gates 9 feet high. But, for reasons which he has given, he considers it impossible to block up the deep central channel with a solid weir 39 feet high, and he has come to the conclusion that very powerful undersluices will be necessary at as low a level as may be possible. The difficulties of constructing such a work in such a site are sufficiently obvious, but other alternatives may suggest themselves after further examination. A site higher up the river in a sandy bed would necessitate a very massive and costly weir, and an unknown expenditure on training works, which would have to extend many miles; while the difficulties of construction would perhaps be even greater if the weir were placed within the gorge or at its lower end. Whatever the cost may be, we think it will certainly be prohibitively high if the scheme is restricted, as Mr. Dawson proposes, so as to serve merely the Sukkur and Ghar Canals and the Eastern Nara system. The latter gets now as much water as it requires, and the possibilities of extension depend on cutting off floods from the valley, and are somewhat remote. The Civil officers estimate that an annual perennial supply to the Sukkur and Ghar Canals would not result in a greater increase of revenue than Rs. 1,50,000, to which may be added Rs. 2,20,000 as the difference between average and maximum realizations on these canals during the last ten years. But from Rs. 3,70,000 gross revenue so obtained must be deducted the increase in working expenses due to the cost of maintaining the proposed new works which will be very heavy. It seems to us therefore that if the idea of a weir across the Indus is ever seriously entertained, the scope of the scheme must be very much wider than Mr. Dawson has contemplated; and that, apart from steadying the supply in as many of the existing canal systems as possible, it should provide for something like half a million or a million acres of new irrigation. If this were done it is quite possible that an expenditure of even 4 crores might be contemplated, with some prospect of a remunerative return.

96. *General remarks on the weir proposal.*—A scheme of this kind will deserve, and will no doubt receive, serious consideration some years hence, but we are not impressed with its immediate importance. Sind is not liable to famine; it is not thickly populated; the rates that can be realized for irrigation are not high; and there is still considerable scope for the extension of irrigation on general lines without resort to more heroic measures. We think, however, that the Civil and Irrigation officers in Sind should endeavour to determine definitely what are the areas in Sind that could be irrigated either by means of extensions of existing systems, or by perennial canals taking off from the Indus. Little appears to be known about the levels, and the suitability for irrigation of the country beyond the boundaries of the present systems; and it cannot be said with any certainty what new areas could be commanded by canals drawing perennial supplies from above a weir in the Indus. We have found that the maximum area hitherto irrigated by the Sind Canals has not on the whole exceeded the average or normal area by more than 10 per cent.; and although it can hardly be doubted that the effect of perennial canals with an absolutely assured supply, would be to bring the present average area of existing cultivation up to maximum level, or, in other words, to increase

it by 10 per cent., and also to convert much lift irrigation into flow, and to permit a large extension of *rabi* cultivation, we doubt whether these advantages combined will in themselves justify the great cost of making the canals perennial, if unaccompanied by considerable extensions of irrigation into new tracts. A great many lines of levels must have been run at different times in all parts of the province; and if these were collated, verified, and supplemented by such additional levels as may be necessary, it should be possible to prepare a general plan, showing clearly the position of the six million acres of cultivable waste which are said to exist in Sind, and the possibilities of extending irrigation into these areas. The question of an Indus weir should not in the meanwhile be dropped. An attempt should be made to collect all the data and information that are necessary before a judgment can be formed by the best experts on either the feasibility of the project or its cost, and if something more is then known than at present of the areas into which proposed perennial canals may be advantageously extended, it may be possible to formulate a sound scheme which will have every prospect of success.

(*iv*).—*Private irrigation works.*

97. *Private canals in Sind.*—There are practically no private canals in Sind, drawing their supplies direct from the river. Many of the channels leading off from the Government canals are privately owned, and these are termed private canals. Most of the Government Canals existed long before Government assumed the management, and they had a vast net-work of these private channels, some of them of great length. We were told of one on the Fuleli Canal 40 miles long. They are owned either by *Jagirdars*, who maintain them and are allowed water from the Government Canal on payment of a small rate as a contribution towards the cost of maintaining the main canal, or by communities who are allowed a small reduction in rate on account of clearance. Although the maintenance and management of such channels must be a much simpler matter than the maintenance of private inundation canals in the Punjab, we find that even in Sind Government is frequently asked to take them over. The people like keeping them until there is a dispute, but canals are continually being taken over by Government on the application of the owners. Such transfers are not to be regretted, but may on the contrary be regarded with satisfaction; for the existence of these long channels, over which Government has but little control, leads to great waste of water and hampers the arrangements for distribution; and it may be hoped that all these channels will be absorbed eventually in the Government systems. Private canals taking off direct from the rivers are said to be almost unknown in Sind, but the recommendations which we have made, in paragraph 62, regarding the policy to be adopted in the Punjab in respect of proposals for new works of this kind will apply also to Sind.

98. *Wells.*—The areas recorded as irrigated by wells in Sind during the twenty years ending 1899-1900 have averaged less than 16,000 acres per annum. The total number of wells in the province is said not to exceed 14,000, and many of these are not worked every year. Well irrigation is perhaps of smaller importance in Sind than in any other part of India which has but a scanty rainfall. Not only is there very little cultivation from wells unaided by canal irrigation, but the practice, which prevails so extensively in the Punjab, of using wells to mature *rabi* crops which have been sown on lands moistened by the last of the inundation supply, seems to be pursued to a very limited extent. It appears that throughout a large portion of the province there is little or no difficulty in the construction of wells, and it may be expected that, as the pressure of population upon the land increases and as the standard of agricultural practice rises, their use will become more common. But at present it seems to be doubtful whether any increased facilities for obtaining advances will have any great effect in extending the area of irrigation from wells. Advances under the *takavi* rules are chiefly taken for the clearance of private water-courses—an object for which they will be less and less required as these channels are gradually absorbed in the Government Canal systems. These loans for clearances are granted under the Land Improvement Act; but the Commissioner of Sind is of opinion that, as the

cost of clearances is an ordinary recurring expenditure, advances would be given more appropriately under the Agriculturists' Loans Act, and with a great simplification in procedure. The difficulties which have been experienced in working the *takavi* rules are much the same in Sind as elsewhere, and are separately discussed in Chapter VI.

(*v*).—*Famine works and programmes.*

99. *Famine relief works not required.*—Famine is unknown in Sind except in the desert, and there has never been occasion for relief works or programmes. When there is famine in the desert, or in the neighbouring States of Rajputana, Cutch, or Baluchistan, there is a great influx of labourers into Sind who obtain employment on the canal works and clearances; but it has never been necessary to open relief works on Famine Code principles.

Section III.—GUJERAT.

(*i*).—*Local conditions; use and value of irrigation.*

100. *Liability to famine.*—The extent to which Gujerat is liable to famine is a matter on which it is difficult to form a trustworthy estimate. If the present inquiry had been instituted before the monsoon of 1899 the tract would probably have been considered as secure as those parts of the Punjab in which famine and extensive State irrigation works have been alike unknown, because the rainfall of even dry years, supplemented by wells and other private and petty irrigation works, have afforded all the protection required. In the past history of the tract only one severe famine has been recorded as having taken place during the first ninety-eight years of the last century. That famine, which took place in 1813, was due to locusts, and was therefore not preventable by means of irrigation. By the great famines of 1832, 1868, 1877, and 1896-97, Gujerat was scarcely affected; and the disastrous drought of 1899-1900 fell with full force on a province little prepared by previous warning or experience to withstand it. That year, in which the rain completely failed, was succeeded by two years of such short rainfall that the crops again failed extensively; and despite the low level of prices due to the abundance of harvests in other parts of the country, the continuance of relief measures on a large scale was found necessary. It is now therefore known that Gujerat can no longer be considered secure, and that the problem of its more effective protection must be considered. In no part of India, however, is a more difficult problem presented, for the very reason that occasions of severe drought have hitherto been so infrequent.

101. *Area protected by irrigation.*—The gross area of the five Gujerat districts is 6,115,000 acres, of which 4,316,000 are under cultivation. The proportion of the normal sown area (3,572,000 acres) which is actually irrigated from any source is 246,000 acres, or 6·9 per cent. only, the irrigation from Government works not exceeding 40,000 acres. And yet until 1899 the cultivation in these districts, unprotected though it was by irrigation, was regarded as almost absolutely secure. The average rainfall (excluding the dry year 1899) varies from 36 inches at Ahmedabad in the north, to 45 inches at Broach and Surat in the south. In 1899 the rainfall varied from 4·7 inches at Ahmedabad to 9·6 at Broach, and 18·5 at Surat. The stress of famine was intense in the three northern districts, but was comparatively light in Surat where the Mandvi taluka only was severely affected. These figures might be supposed to indicate that the demand for, and utility of, artificial irrigation in ordinary years is likely to be small, but such an inference would be very precarious, as may be gathered from the facts stated in the following paragraph.

102. *Soils and cultivation.*—The two principal soils in Gujerat are the yellow sandy loam known as *gorat* which is found to a limited extent in the three northern districts, and the black cotton soil which prevails in Broach and Surat. There are intermediate and other varieties, but it is unnecessary to specify them. Rice is grown in both kinds of soil when the conditions of water-supply are

favourable. The dry crops are cotton and millet in black soil, and millet and wheat in the *gorat*. In Broach, where the black soil is much heavier and more retentive of moisture than in Surat or any other district, cotton is the staple crop. It is ordinarily matured without irrigation, and thrives best in a year of light rainfall, though it fails in a season of extreme drought. In a year of heavy rainfall cotton is usually injured, and in order to insure against the injury it is the practice to grow rice in alternate rows with the cotton. Besides sugarcane and garden crops rice is the only crop which will bear irrigation in ordinary years. In the lower lands it is grown successfully on the rainfall alone, but such rice is of an inferior quality, though when it does succeed the crop is very heavy and consequently valuable. The better qualities are grown where some protection against an ill-distributed rainfall can be obtained by small storage tanks, which fill during heavy rainfall and are drawn on during the breaks or after the close of the rains. They also enable a second crop of *val* (a sort of bean) to be grown after the rice. These tanks, which are capable of protecting from one to a hundred acres each, exist in considerable numbers in Gujerat, and form an important part in the agricultural economy of Ahmedabad, Kaira, and Surat. They are the chief means of protecting the rice cultivation against irregularity of rainfall, and Mr. Mollison, now Inspector-General of Agriculture, is of opinion that when they exist they double the value of the fields in a normal cycle of years. Apart from sugarcane and garden crops, rice appears to be the most profitable crop that can be grown, if the water-supply is secure; and there is a consensus of opinion that much more rice would be grown if canal irrigation were introduced, but that water would not be taken, except in years of extreme drought, for any other staple *kharif* crop. It may be added that it is pretty certain that water could not be supplied for any considerable area of perennial or *rabi* crops, as the volumes in the rivers after November are too low to be of much value.

103. *Irrigation required for rice only.*—Irrigation, if provided on any large scale, would in all probability be utilized mainly for rice, the conditions generally not being favourable to the extensive irrigation of other crops. The crops, other than rice, obtained without irrigation in ordinary years are, as a rule, so fine that it does not pay the cultivator to lift water, or to pay for a supply of flow, except for valuable crops such as garden produce, tobacco, or the more valuable cereals; and the irrigation of these implies very high cultivation, or, in other words, plentiful manure and labour. Moreover, the lateness and shortness of the sowing time, the absorbent nature of the soil, the heat of the sun, and the greater number of waterings that are consequently required, make the "duty" of water far smaller than in Northern India; and in many parts the undulating or uneven surface of the land increases the labour of preparing the soil for cultivation, while the fact that light watering is impossible renders heavy manuring indispensable.

104. *Irrigation in black cotton soil.*—The great body of opinion laid before us, as well as long established practice, points we fear to the conclusion that deep pure black soil, such as is met with throughout by far the greater portion of the Broach district, cannot be irrigated extensively except for rice, and that, even for rice, irrigation must be most carefully restricted, both in area and supply, if it is not to do harm. The reasons are the extraordinarily absorbent nature of the soil, which yields excellent crops with a very moderate fall of rain, but absorbs enormous quantities of water if it is attempted to flood it. This is enhanced by the cracks which appear in dry weather, and render irrigation from wells, even when the water is moderately near the surface, exceedingly expensive, if not physically impossible. Even when water is available in sufficient quantity, and is given to save crops other than rice in a year of drought, there is some reason to fear that the soil is deteriorated by the quantity of water absorbed and that the crops of subsequent years suffer. Mr. Mollison is of opinion that to introduce a canal, with its copious water-supply, into black soil of this class would do more harm than good; and that even from large tanks extensive irrigation, which must be of rice, would probably be dangerous. It is true that black soil will receive a considerable rainfall without injury to other crops, that in places wheat can be grown as a *rabi* crop in a year of heavy rain, and

that Mr. Mollison, so far from objecting to, is disposed to recommend, the extension of rice irrigation from small tanks. But wheat in these soils is a poor substitute for a cotton crop lost by excessive moisture; and the difference between irrigation from canals and small tanks is not only that the former is certain to be more copious than the latter, but also that, whereas small tanks merely husband the actual local rainfall so as to effect its more equable distribution in point of time, the canal supply is derived from more distant sources and is so much added to the natural and local rainfall. Our conclusion therefore is that, before venturing to introduce a canal, with its copious supply of water, into black soil of the class described in this paragraph, the utmost caution should be exercised, lest as feared by Mr. Mollison more harm than good should result.

105. *Soils suitable for irrigation.*—At the opposite extreme are the yellow and alluvial soils which are eminently suited for irrigation, although often, as on the Hathmati Canal, too light for rice. They occupy large areas in the Ahmedabad and Kaira districts, and in the Panch Mahals, and there is a small area in Surat. As to the intermediate soils, of which there is every gradation, it appears that when black soil has a certain admixture of loam it can be profitably irrigated for garden crops with high cultivation; and that when, in addition, it is not too deep and overlies a permeable substratum such as *muram*, it admits of general irrigation without injury; but we understand that these conditions are somewhat exceptional in Gujerat.

106. *Cultivators in the Panch Mahals.*—In the Panch Mahals the character of the population appears to offer, for the present at least, an almost insuperable obstacle to any great extension of irrigation. It consists almost entirely of Bhils and Kolis, who are both too lazy and too poor to cultivate the better class of crops. It will undoubtedly require long education before they can be induced to undertake the additional labour needed for the cultivation of rice, even if water be given them free; while the chances of getting them to take up well irrigation are for the present extremely remote. Throughout the remainder of Gujerat we understand that the people are most efficient cultivators.

107. *Manure.*—The question of manure, without which irrigation is unprofitable if not harmful in Gujerat, has also to be considered. The people are evidently fully alive to its value; they are already drawing upon sources, such as oilcake, which were till lately unknown to them; and we have little doubt that in the case of any such gradual and locally limited extension of irrigation as may be looked for from the multiplication of wells or small tanks, the requisite supply will be forthcoming. The manner in which the manure set free by the failure of the dry crops was transferred to the extended area which was brought under irrigation during the recent famine, seems to have been remarkable. But whether, if a copious supply of water were brought into a tract by a large canal, the manure required to utilize it to the best effect would be forthcoming for many years, is perhaps open to doubt. There is some evidence that the soil on the Hathmati Canal is deteriorating from an insufficient supply of manure. Too much weight, however, ought not to be attached to this objection, for we have it on the evidence of Mr. Mollison that until ten per cent. of the area of Gujerat is irrigated there is little fear of manurial supplies proving insufficient. In any case, high class cultivation cannot be extended *per saltum;* and it is on that, and on rice, that the extension of irrigation in Gujerat must depend.

108. *Drainage.*—Some tracts in Gujerat suffer from water-logging, and attention has been devoted in recent years more to the construction of drainage than of irrigation works. The evil is said to be on the increase, and is attributed to several causes—the silting up of the Gulf of Cambay and the consequent rise in the bed levels of the rivers in Northern Gujerat which fall into it; the disturbance of the natural drainage of the country due to the construction of railways; the encroachment of the sea on the coast villages of Broach; the silting up of old drainage lines; and the opening of new drains in the Gaekwar's territory, which bring more water into Gujerat. The drains which have been constructed appear to have reclaimed considerable areas which have been brought under

cultivation, and we have no doubt that more works of this kind are required. But we have heard complaints that their effects have not been wholly beneficial, and that the land is often unwatered too rapidly, so that in seasons of drought water is carried away which should have been retained in the fields, while at times of heavy rainfall a valuable tilth is washed off the surface into the drains. The most effective remedy for these evils would be the construction of small field *bands* with proper arrangements for letting off the water. But it is probable that too great a run-off has been provided for in some of the drains, on which some form of regulation may be required, and the matter should receive attention.

(*ii*).—*Existing State irrigation works.*

109. *First class irrigation works.*—In Bombay, Irrigation Works are divided into two classes, first and second. The first class includes all works, whether major or minor, for which capital accounts are kept, and these are under the management of the Public Works Department. The second class includes petty works for which a revenue account only is maintained. These works are managed under the Civil authorities, the Public Works Department being responsible for their maintenance; and the lands irrigated by them are assessed at a consolidated rate. There are only two first class works in Gujerat—the Hathmati Canal and the Khari Cut—both of which are in the Ahmedabad district. Their protective value is small, the average areas recorded as irrigated by them during the ten years ending 1900-01 being 3,225 and 1,961 acres respectively. During the famine year of 1899-1900, the Hathmati Canal irrigated 110 acres only, and the Khari Cut did not irrigate a single acre, as it was dry throughout the season. Their productive value is even more unsatisfactory. The Hathmati Canal was opened in 1873, and is classed as a productive public work. The total capital expenditure to end of 1900-01 amounted to Rs. 5,17,838. The working expenses up to date have exceeded the gross revenue by Rs. 44,146, and in addition the interest charges have amounted to Rs. 5,51,572. The Khari Cut has a capital account of Rs. 4,29,980. It was opened in 1883, and its gross revenue to end of 1900-01 exceeded the working expenses by Rs. 46,279 only. The two works taken together have cost about 9½ lakhs of rupees and just pay their working expenses, the average area irrigated being about 5,200 acres, so that the capital cost has been about Rs. 200 per acre, on which there is no return. These results do not encourage the construction of irrigation works of this type, namely, channels taking off from the minor rivers in Gujerat. The Hathmati Canal takes off from above a weir 22 feet in height, the catchment area of the river above the weir being 524 square miles, but the supply is very precarious and can only be insured by the construction of a large storage reservoir, for which no suitable site has yet been found, though the question has several times been taken up. The cost of storage, even if feasible, would be very great; and if water were stored it is doubtful if there would be much demand for it except in years of drought. The only crop that takes regular irrigation is rice, and it is found that the soil in the area commanded is not very suitable for rice cultivation.

110. *Second class irrigation works.*—There are in addition 387 second class works in Gujerat. Most of these are small irrigation tanks; but an important exception are the Khari sluices which irrigate eleven villages in the Ahmedabad and Kaira districts. These are said to be very useful in ordinary years, but they, and almost all the tanks, failed entirely in the famine year. The average irrigation from these 387 works during the ten years ending 1900-01 exceeded 32,000 acres, the revenue dependent thereon amounting to nearly Rs. 1,12,000, while the expenditure on maintenance was Rs. 38,000, or about 35 per cent. of the revenue. The net revenue has been therefore about Rs. 74,000, but this does not represent profit on capital expenditure. Most of the works were originally constructed by the people and the expenditure of Rs. 38,000 on maintenance has been incurred by Government in consideration of the revenue dependent on the works. Of the 387 works no less than 289, which irrigate over 12,000 acres, are in the Surat district; and 66, irrigating nearly 11,000 acres, are in Ahmedabad.

111. *Other small irrigation tanks.*—The tanks which are classed as second class works irrigate over 20 acres each, and for these continuous revenue accounts are maintained. But there are in addition about 4,300 smaller tanks upon which over 40,000 acres are said to be dependent for their irrigation. There are 1,286 of these tanks in Ahmedabad, 2,200 in Kaira, and 700 in Surat. As in the case of the second class works, the lands under them are assessed at a consolidated rate. Apparently a large portion of the area irrigated by these works is omitted from the annual statistics of irrigated areas.

112. *Repairs of tanks.*—We understand that at the time of settlement Government undertook certain obligations in respect of the maintenance and repairs of tanks which were not however very clearly defined. Since then, in 1892, the Government recognized its duty, as a great landlord, to repair tanks from which it was reaping an enhanced revenue. The general practice has been to require the cultivators to deposit 10 per cent. of the estimated cost of repairs, and the Public Works Department is then asked to carry them out. The object of the 10 per cent. deposit is to prevent applications for unnecessary repairs. But it has not been considered obligatory in all cases, or when loss of revenue would ensue if the repairs were delayed; although it has been ruled that the contribution should generally give priority of claim for repairs to the tank concerned. It has also been ruled that, without the consent of Government, the cost of repairs should not exceed ten times the annual water revenue due to the tank. The evidence laid before us indicates that these rules have not worked very satisfactorily. No attempt appears to have been made to repair the tanks as a whole, or on any regular system. On the one hand there has been a general feeling on the part of Government officers that the people had some share in the responsibility for repairs. On the other, the people have made no attempt to keep them in order, in the expectation, probably, that Government would some day repair the tanks which in years of ordinary rainfall have served their purpose fairly well. Evidence has been given, of the value of which we find it difficult to judge, that the reductions given at revision of settlement are at any rate not commensurate with the deterioration in the supply as it now stands in many places. The neglect to repair does not seem to have been due to want of funds, for allotments have been made year by year and allowed in great part to lapse. It seems to have been due partly to a want of system, and to indifference on the part of the officers consequent on the absence of complaint by the people during a cycle of prosperous years; but very largely to the rule that preference should be given to those villages which were prepared to contribute 10 per cent. of the cost—a rule which caused grievous delays, which prevented any systematic and economical dealing with the question as a whole, and which in practice made compulsory what was intended by Government to be an optional contribution.

113. In Surat the water revenue due to private tanks is estimated at Rs. 60,000 per annum, and the expenditure at Rs. 10,000. It is said that this rate of expenditure is insufficient to maintain them in good order owing to past neglect, although it would probably suffice if repairs had been carried out regularly. We were told that in this district the wet revenue might have been pitched one-sixth higher at settlement if the tanks had been then in order. In Ahmedabad, where there are said to be 1,286 tanks irrigating on an average 26,600 acres, an annual grant of Rs. 10,000 has been allotted for repairs, but the actual expenditure is said to have been about half this or Rs. 30,000 only in seven or eight years. The Executive Engineer told us that it was now proposed to spend 5 lakhs in the next thirty years. It is not anticipated that this expenditure will result in any great increase in the revenue realized from these works, but merely that it will make the supply more secure and prevent the tanks falling altogether out of repair. The expenditure appears to be required mainly to make up for past neglect. The work to be done is principally that of repairing and raising the *bands*, and providing suitable waste weirs. In some cases, where the tanks have silted up, they will also have to be deepened. The cost of removing silt from large tanks is out of all proportion to the advantage gained, but in the case of these small tanks, which may fill several times in the season and in which silt accumulates very

slowly, clearances may sometimes be recommended, especially when it is necessary to find employment for relief labour.

114. We learn with satisfaction that Government fully recognizing their responsibilities have directed that the 10 per cent. rule, which was originally introduced as a sort of test of the urgency of any demand for repairs, should be abolished. We would recommend that all tanks should now be put into thorough order within five years, and that subsequent repairs should be conducted on a system of rotation, so that every tank may be overhauled in its turn, within a period of 20 or 30 years, or whatever length of time may be found by experience to be suitable.

115. *Liability for petty repairs.*—When once a tank has been thoroughly repaired and put into good working order at the cost of Government, we consider that the customary obligation on the cultivators to carry out ordinary petty and annual repairs, such as filling up rat-holes, clearing away vegetation, etc., should be strictly enforced. The local responsibility for such repairs does not appear to have been as clearly recognized in Gujerat, either by custom, or by express declaration as in Madras, though we cannot believe that there was no such responsibility in the old days. Be this as it may, we regard it as a matter of the first importance that these tanks should be maintained in a high state of efficiency. Government should first recognize and carry out its own obligations in this matter by putting all the works into thorough order; and when this is done, whatever obligations in the matter of petty repairs can conveniently and legitimately be imposed on the cultivators, should be systematically enforced, legislation of the kind which we have proposed for Madras being undertaken if necessary for the purpose.

116. *Relinquishment of small tanks.*—In the case of the numberless very small tanks which Government cannot possibly maintain, or of others which they are not prepared to maintain, we consider that they should be definitely relinquished, a liberal reduction being made in the assessment. We understand, however, that the catchment area must be surveyed and estimates made before it can be finally decided whether a tank should be retained on the Government list or relinquished to the cultivators. Once made, these plans and surveys will remain as a guide to the revenue officers and others of the standard to be maintained.

(*iii*).—*Scope for further extensions of State irrigation works.*

117. *Construction of large canals from the principal rivers.*—The question naturally arises whether Gujerat could not be almost absolutely protected against drought by the construction of large canals taking off from the four fine rivers which traverse it—the Sabarmati, the Mahi, the Nerbudda, and the Tapti. We have already pointed out some of the objections to canal irrigation in black soil districts, but the question has now to be looked at from other points of view. The first thing to be noted is that these rivers are all very deep, 30 feet and upwards below the natural surface of the country, and are subject to violent and enormous floods. The head-works for any canal, including a weir and head regulator, would therefore be very costly; and channels ten or more miles long, in very deep cutting, would probably be required before command of the country could be obtained. But if this expenditure be faced, it has also to be borne in mind that the supplies in these rivers from November to May, both inclusive, are so small and precarious that *rabi* and hot weather or perennial crops cannot be irrigated on any extensive scale unless storage works are also made. Assuming for the present that the construction of storage works cannot be contemplated, the result will be that the canals will supply water only for monsoon crops, that is, for rice, and for a limited and variable area of *rabi* crops. Probably sufficient water could not be reckoned on to justify the attempt to irrigate sugarcane or garden crops, or at any rate the areas under them would be insignificant. In tracts the rainfall of which averages 35 inches, it may be difficult to obtain high rates for rice irrigation. But the local officers seem to think that there would be little difficulty in getting as much as Rs. 5 or even Rs. 7 per acre; and the scale of rates obtained on the Khari Cut, and the wet

rates on rice lands deriving irrigation from tanks, justify this conclusion. In the Kistna and Godavari Deltas also, where the rainfall conditions are not dissimilar, the revenue rates are Rs. 4 and more for irrigated rice. With a rate of Rs. 5, and allowing for working expenses Rs. 2 per acre, which is probably the lowest rate for such canals as would be made in Gujerat, works of which the capital cost did not exceed Rs. 75 per acre, would be remunerative; and works costing even double that amount might be justifiable for protective purposes.

118. We consider then that for canals in Gujerat reliance will generally have to be placed, as in Madras, upon rice irrigation. Irrigation for *rabi* is, however, not altogether out of the question. But it will not be possible without storage works, which are likely to be expensive, and for which sites will be difficult to find and, perhaps, to acquire. It is unfortunate that the most likely country for such works seems to be in almost every instance outside British territory. But there is no *primâ facie* reason to suppose that there would be any insuperable difficulty in coming to terms with the Durbars of Native States for the utilization of the sites. Similar difficulties were overcome in the case of the Nira Canal and the Periyar project, the lake reservoirs of which are situated respectively in the territories of the Chief of Bhor, and of His Highness the Maharaja of Travancore. For storing the waters of the Gujerat rivers, search must be made for sites high up the valleys in hilly country, where the land likely to be submerged will not be of great value for cultivation. Prospecting for such sites has been begun by His Highness the Gaekwar of Baroda with the object of storing water for use in his own territory. We think that a thorough and scientific examination of the head waters of the Sabarmati and Mahi, and of those parts of the Satpuras and Vindhyas which feed tributaries of the Nerbudda, should be made with the object of ascertaining what the possibilities are of storing the head waters of the great rivers of Gujerat, and of utilizing them for the benefit of the whole of the country commanded, whether British territory or Native States. It is of extreme importance, in the interests of our own famine administration, that the Native States of Gujerat, from Baroda downwards, which march and are interlaced with British territory at numberless places, should be given as efficient protection from famine as circumstances will allow. We have no hesitation therefore in recommending that the cost and agency for the proposed investigation should be provided by the Government of India. What the result of the survey will be it is impossible to predict. It may turn out that the expense of storage will be prohibitive, or the difficulties of making the works, insuperable. But until the possibilities have been ascertained, the attempt to render a considerable measure of famine protection to Gujerat ought not to be abandoned in despair.

119. *The Sabarmati scheme.*—The first scheme to be considered is that of tapping the Sabarmati. Surveys for this work were first made as long ago as 1868, when it was proposed to irrigate on both sides of the river. It was subsequently decided in 1873 that, as the land on the left bank would be provided for by the Khari river works, the Sabarmati water should be used only on the right bank. The project was revised in 1893, but was not recommended by the revenue authorities. The people in the tract that would be commanded have, in consequence of the famine of 1899, been petitioning for a reconsideration of the scheme, and the old estimates have been brought forward, with some revision to indicate the probable scope and cost. The head-works would be placed near Ahmedabad, just below the pumping station for the city water-works, and water would be supplied to the fertile lands of Sanand and Dholka. A very expensive and substantial weir on a sandy bed would be required, with a head channel, 40 feet deep in the first mile, which would run out and command the country in the tenth mile. A monsoon discharge of 500 cusecs has been proposed, but this supply will not, as a rule, be available after September, and it is difficult to say what quantities may be relied on between October and July. The recorded discharge observations, prior to 1901, indicate a minimum of 378 cusecs in October, falling gradually to 100 cusecs in April, May, and June; but the record is incomplete and unreliable, as observations have only been casually and occasionally made without any attempt to secure minimum values. The average discharges during September and October

1901 were, however, no higher than 239 and 126 acres respectively, and at the time of our visit in December the discharge must have been less than the latter amount, the bed being almost dry. It is doubtful therefore whether any supply can be relied on after October in a dry year, though the safety of the monsoon crops would be assured. There appears to be some doubt as to the area that can be commanded by the scheme, which has been variously estimated at from 55,000 to 100,000 acres, but, if the latter area is available, an annual irrigation of about 33,000 acres may be reckoned as feasible. The total cost of the scheme has been roughly estimated at 24 lakhs. If it can be completed within this sum, and if 33,000 acres can be irrigated annually, a return of over three per cent. might be anticipated ; but it is impossible to form an opinion until the scheme has been worked out in greater detail by the Public Works and Revenue officers. The long reach of deep cutting in the first ten miles would be admirably suited for the employment of relief labour. This scheme, however, even if successful, makes use of but a small portion of the waters of this considerable river, and by no means obviates the necessity of searching for sites for storage works higher up the valley, both in British territory and in Native States. We recommend indeed that this examination should be undertaken before any attempt is made to work out the Sabarmati project in greater detail; as it is quite possible that investigation may show that, if suitable arrangements can be made with Native States, a scheme of a much more extensive and useful character can be proposed.

120. *Mahi river scheme.*—The idea of a canal from the right bank of the Mahi river, to irrigate the south-eastern portion of the Kaira district between Thasra and Anand, does not seem to have advanced much beyond the suggestive stage; though a site for the head-works has been proposed by the Executive Engineer, near the point where the railway from Anand to Godhra crosses the river. If a suitable site could be found a few miles higher up, beyond Rewa Kantha territory, it might perhaps also be possible to take off a left bank canal into the western Panch Mahals. The Mahi river is not perennial, and monsoon irrigation only could be provided for ; but although the river is a large one, very little seems to be known about its discharges. The wells in this part of the country appear to be very deep, and it may be inferred that irrigation would be appreciated if the soil is suitable, but we have seen no reports on this point. All these matters should be fully investigated.

121. *The Nerbudda.*—The Nerbudda has the best and most unfailing cold weather supply of all the Gujerat rivers, but there appear to have been no observations of cold or hot weather discharges. The question of a canal from the Nerbudda for irrigating any part of the Broach district, seems never to have been seriously considered. We find indeed that as long ago as 1863 a proposal was made to the Government of India by a Mr. Balston to form Joint Stock Companies for the construction of a large canal in Sind and also "of the necessary works for irrigating that part of British Gujerat which is situated between the rivers Tapti and Mahi, by means of a dam across the Nerbudda, to reserve a supply of water, and of collateral high level canals, at a cost roughly estimated at £2,500,000." The writer stated that he had made "a preliminary survey of this part of Gujerat, and collected sufficient data to satisfy Mr. Hawkshaw, the eminent engineer, that the proposed work is practicable, and would be highly beneficial to the province and profitable to its promoters." These quotations contain all the information that was given in regard to this proposal, and the correspondence ended when the receipt of the letter had been acknowledged. The question of a Nerbudda Canal does not appear to have ever been considered in the Public Works Department; probably because it was realized that all conditions were even less favourable than in the case of the Tapti which as we shall presently show has been frequently under consideration. The waters are tidal for some miles above Broach, and too brackish for irrigation. Upstream of the eastern boundary of that district the Nerbudda passes through Baroda and Central India States; and if any use is to be made of its water it must be drawn off outside British territory, and after irrigating parts of Baroda might perhaps be extended into Kaira, but the question does not appear to have been investigated in any way.

122. *The Tapti.*—A project for constructing canals from the Tapti in the Surat collectorate was made as long ago as 1857. The general idea was to construct a dam across the river above a rocky barrier near Kurroda, and to take off two canals above this, one from the north, and the other from the south bank; the former to irrigate the Olpad taluka in Surat, with a possible extension across the Kim river into the Ankleswar taluka of Broach, and the latter to irrigate part of the Bardoa taluka in Surat. Both canals, but especially that on the south bank, would have been capable of irrigating part of the Gaekwar's territory. These proposals were first submitted to the Government of India in 1868, when the Government of Bombay recommended sanction for an estimate amounting to Rs. 9,53,573 for the construction of the dam and the south bank canal as an experimental work; on the success of which would depend the construction of the north bank canal, and the completion of the scheme to the ultimate extent contemplated. The Government of India were unable to accept this estimate; and after some correspondence and delay, an estimate for a north bank canal, amounting to over 44 lakhs and expected to yield a return of nearly 16 per cent., was accepted by the Government of India, and sanctioned by the Secretary of State in January 1872. Work on the dam was actually started a few months later; but in the following January orders were given to suspend operations until the detailed estimates had been worked out and had received the approval of Government. Further correspondence ensued. Modified estimates were submitted, and eventually, in 1876, the Government decided that the state of the finances would not admit of the project being proceeded with, and that it should be postponed to a more favourable opportunity. A doubt was also expressed as to the estimates of revenue which were regarded as too sanguine. In 1883 the Bombay Government again proposed to take up the project; but after further correspondence, the Government of India expressed its inability to hold out any hope of its being sanctioned as a productive public work. Subsequently, in 1893, the Bombay Government reconsidered the project with regard to its suitability as a relief work; but the local officers consulted reported so unfavourably on the prospects of the scheme that it was again dropped. The objections were mainly on the grounds that the staple crop of the district was cotton, which not only did not require irrigation, but would be injured by it; that there would be no demand for water in the rainy season; and that the small supply available in the hot weather could not be diverted to perennial irrigation without injury to the city of Surat and its water-supply. Notwithstanding the experiences of three successive years of drought, these objections were sustained by the official witnesses who came before us; and we had no evidence of any desire on the part of the landowners or cultivators in Broach or Surat for canal irrigation.

123. It may thus be said that the idea of making canals from the Tapti has been under consideration many times during the last 45 years; but that on each revival of the question it has been viewed with less and less favour by the Government of India, and put forward with less and less confidence by the Local Government and authorities. After considering the whole history of the case, and all the evidence that was taken by us in Gujerat, we are of opinion that although the work cannot be regarded as one of extreme urgency or importance, it may nevertheless deserve favourable consideration when works of more immediate importance have been completed. The tract which would be commanded suffered less from drought than the more northern parts of Gujerat, and distress was not very severe even in 1899. In many years the crops suffer from an excess of rainfall; and in some parts, as in the Olpad taluka, drainage works have been constructed or are required to prevent serious water-logging. A large and increasing proportion of the whole area is peculiarly suitable for the cultivation of cotton, a crop which nowhere in this part of India requires irrigation. The supply in the Tapti in the hot weather months is too uncertain for the irrigation of a considerable area of perennial crops without storage works. For all these reasons the protective value to Gujerat of a canal from the Tapti would be much less than is often supposed, when regard is paid only to the magnitude of the monsoon supplies which discharge unused into the sea.

124. On the other hand, such protection as would be afforded would probably not be very costly. There is no doubt that all the earlier estimates of the

revenue which these works would yield, varying from 16 to 9 per cent., were very exaggerated. In 1885 the sanguine anticipations of earlier years had come down to a return not exceeding 4·4 per cent., to be attained only after many years; and now it is certain that an estimate of cost framed nearly thirty years ago cannot be accepted without further inquiry. There are however reasons for supposing that the net revenue on this work may within a reasonable time equal the charges for interest, or may at any rate fall so little below them, that the permanent charge on the State may be very small. We think it hardly safe to rely on much revenue from perennial or even *rabi* crops, or on the abandonment of cotton for rice cultivation. We find, however, that a right bank canal would command a cultivable area of 295,000 acres, of which about 40,000 acres are under cotton. A canal of the size which has been proposed, and without storage works, should be capable of irrigating 50,000 acres of rice, which would be less than one-fifth of the area commanded. The area which the canal would traverse has already a certain amount of rice cultivation, as shown in the margin; and, in both Olpad and Ankleswar, an appreciable number of tanks have been constructed for the assistance of that cultivation. These would not have been made if irrigation were not required to obtain a good rice crop in ordinary years; and, as already observed, Mr. Mollison has estimated that the existence of tanks doubles the value of the produce of rice during a series of years. Even when allowance is made for the expense of preparing fields for rice, and for the difficulty as regards manure, we do not think it unreasonable to suppose that in such a tract an area of 50,000 acres under constant rice cultivation might be relied on within ten years of completion; and that if no higher rate than Rs. 5 per acre can be levied, and a very moderate allowance be made for water-rates on perennial and *rabi* crops, the work would not be unremunerative even if the capital amounted to 50 lakhs. It is indeed true that no large irrigation work in the Bombay Presidency, outside Sind, has ever proved remunerative; but the only work of the kind in Gujerat is the Hathmati Canal in which the supply is very uncertain, and which commands an area in which the soil is unsuitable for rice. In the Deccan, also, both the soil and the character of the people are unfavourable to the extension of rice cultivation. We think that all conditions are much more favourable in the tract now under consideration. But we would strongly urge that even here the canal should only be taken into those parts in which an extension of rice cultivation may be relied on; and that it should avoid the lowest lying tracts in which rice can now be cultivated without the assistance of a canal, and in which there would be a danger of water-logging.

	Acres.
Mandvi taluka	12,000
Olpad taluka	3,700
Ankleswar taluka	3,000

125. Reference has been made to a proposed canal on the south-bank of the Tapti. This project has been given up in favour of the north-bank canal; partly because the area to be commanded is said to be less exposed to famine than the northern tract; and partly because the area will be much smaller, and will therefore yield a smaller revenue in proportion to the cost of the head-works. Moreover, much of it is in the Gaekwar's territory. On the other hand, the cost of the canal would be much less, and the soil appears to be better suited for rice; so that it is a question for consideration whether the south-bank canal should not be first undertaken. But, before either of the schemes is considered, detailed soil maps must be prepared, and a careful examination made of the suitability of the soils for irrigation.

126. *General recommendations.*—The total area that could be protected under the various proposals which have been hitherto made for utilizing the larger rivers in Gujerat forms, however, but a small proportion of the total area of the province, the physical characteristics of which, it is feared, may not prove favourable to very extensive irrigation schemes. The question of utilizing the waters of the Sabarmati appears to us to have the first claim to consideration, whether regard be paid to the character of the soil, or to the liability of the country to drought. But we do not think that the project which has been laid before us should be undertaken until the question of making a large storage work in one of the Native States, and of taking the canal off higher up the river, has been carefully considered; and we think that this should be investigated at once, and that there

should be concurrently a further examination of the possibilities of utilizing the Mahi river. Canals from the Nerbudda and Tapti appear to us to be less urgently required as a measure of protection from famine, and great caution must be exercised in introducing canal irrigation in the black cotton soil tracts of Gujerat. A Nerbudda Canal in black soil could not possibly pay, or be justified except for the protection of the country in seasons of extreme drought. The country to be irrigated by the Tapti is not sufficiently exposed to severe famine to justify the execution of the canal for purely protective purposes. It should be undertaken only if likely to prove remunerative, though not necessarily highly remunerative, for purposes of rice irrigation on lands not required for the growth of cotton. But, as already indicated, the proposals which have been laid before us do not cover the ground; and for the ascertainment of the possibilities of irrigation in Gujerat a comprehensive examination of the country is absolutely essential.

127. Subject, however, to the precautions which we have recommended, we think it possible that a canal from the Tapti can be made which will be beneficial to the country without imposing any permanent liability on the State, and we recommend that the matter be taken up as soon as may be convenient. We have little information as to the Nerbudda, but there appears to be a wider field for the utilization of the waters of this river in Baroda territory than in Gujerat. The possibility of extending any canal that may be made in Baroda into some portion of the Kaira district seems, however, to deserve consideration; and an examination of the country should be made by British and State Engineers working in conjunction, so as to utilize the water to the best advantage in all Provinces and States of which any portion could be commanded. It may be observed that it is hardly possible to utilize effectively the waters of any of the Gujerat rivers without reference to the interests of Native States, for even the Tapti Canal would have to traverse some parts of Baroda. We realize the difficulties which this may involve, but we do not regard them as insuperable. Every irrigation work should be designed to benefit as large an area as can be effectively served by it, without reference to territorial boundaries; and we think that if Government will assist Native States in developing irrigation within their own boundaries, and will allow them a fair share on equitable terms of the benefits of British works which traverse or derive water from their territories, it should not be impossible to secure the friendly co-operation of the Durbars, as has already been done on a notable scale in the Punjab.

128. *River gauges.*—Before leaving this part of our subject we must call attention to the want of any reliable and continuous record of the flow in the Gujerat rivers. When particular projects have been under consideration, casual observations appear to have been made of the actual discharges on particular dates; but there is nothing to show that these dates were the dates of minimum discharge, or during what periods the discharges varied within certain maximum or minimum limits. No record has been kept of river gauges with which observed discharges could be correlated. We recommend that permanent gauges be established at suitable sites on all the more important rivers, and that the gauge reading be recorded at least twice a day while the river is in flow. The many railway bridges which cross these rivers will generally form ideal sites; and when there is any establishment on or near them it should be easy to arrange for the maintenance of a gauge record at an inconsiderable expense. The Public Works Department should be made responsible for the maintenance of this record, and for the taking of a few observations of the actual discharge at each site every year between the months of October and July, and at different stages of the river, which would be correlated with the gauge readings. It is of less importance to take discharges during the flood season, as long as gauge levels are recorded, but an occasional flood discharge would also be of great value.

129. *Minor irrigation works.*—It is difficult to say what scope there is in Gujerat for the construction of minor irrigation works. The general question of improving the water-supply and affording increased facilities for irrigation, has not hitherto received much attention; and very few definite proposals

have been laid before us. Most of these relate to works which have been commenced under pressure of famine as relief works, and others are works which can only be recommended as a means of employing relief labour. The works proposed are generally fairly large tanks, though in such a flat country as Gujerat there are not many parts where these can be made with advantage. Where there are suitable sites commanding lands in which rice cultivation will certainly be practised, it seems probable that such works will have a considerable protective value; and that they will yield some, if not a full, return on the cost of construction, as the year in which water would not be in full demand for rice would be a rare exception. A thorough examination of the country with a view to the construction of such works would seem advisable. It is true that tanks which depend on local rainfall are likely to fail in a year of extreme drought, but it by no means follows that they will have no protective value. They will, like the tanks in the Central Provinces which did such great service during the famine year of 1896-97, be invaluable in years of badly distributed rainfall. One great difficulty, here as elsewhere, is the supposed necessity for taking up the submerged land. In our Chapter on the Central Provinces we make proposals for overcoming this difficulty (paragraph 362). There is said to be a considerable field in the Kaira district for repairs and improvements of existing tanks and the restoration of broken *bands;* and new tanks have been proposed also in the Ahmedabad, Panch Mahals, and Surat districts. Particular attention should be paid to the Dohad taluka of the Panch Mahals which should be thoroughly examined. It appears probable also that something might be done in the way of constructing channels to take off from the minor rivers for the purpose of feeding existing tanks. These channels would be of little use for direct irrigation, as the supply would be very fitful and precarious; but if they ran even for a few hours they would be of great service in filling tanks, although no direct return could be expected on the cost. There are also drains which draw off water from upper lands which might with advantage be connected with tanks. The construction of weirs across rivers like the Mahi, with rocky beds, has also been recommended, so as to impound a certain quantity of water which could be lifted and used for irrigation. For the present, however, the most urgent work for the Public Works Department is the repair and improvement of existing tanks, to which we have referred in the last section.

130. *Drains.*—There is still a great deal to be done in the way of drainage works, which may be regarded as really protective, as they result in an extension of cultivation, although in themselves of little service in a year of drought. We think that the construction of drains, like that of tanks, could in many cases be facilitated and, what is of even greater importance, rendered more popular, by the adoption of the policy which is suggested in paragraph 362 *infra*.

(*iv*).—*Private irrigation works.*

131. *Well irrigation.*—Wells exist in considerable numbers in Ahmedabad, Kaira, Surat, and in smaller numbers in the Panch Mahals. There are very few in Broach, for, as we have already shown, well irrigation is not suited to the rich black soil of that district, and the water in such soil is generally brackish. Elsewhere they can be worked with profit up to a depth of 40 feet, and even up to 50 feet in a year of drought. In the garden lands of Surat, water is as near as 20 feet from the surface, and even less in some localities; but in other districts it is seldom less than 30 feet, and generally more. There are large tracts in which water cannot be found; or if found it is too brackish for any but tobacco and barley cultivation, or it acts like glue upon the soil. Moreover, the nature of the supply seems to be extraordinarily capricious in Gujerat. In some cases fresh water is obtained by sinking through a salt water bearing stratum; in others a well is deepened at the risk of substituting brackish for sweet water. The water will sometimes desert a well or turn brackish without apparent cause. The first year of drought (1899) had no very great effect on the water level in wells, though in some cases, especially in black soil, the water became too salt for use; but the subsequent years of drought very greatly diminished the supply. We have already referred to the difficulties of irrigating black cotton soils from wells, owing to its absorbent nature and to the cracks which appear in dry weather; in Gujerat

the fact that the water-supply is from percolation and not from springs still further reduces the area irrigable. Ordinarily, a single *mot* will irrigate only 2 acres in black, and 4 acres in other soil; though these areas will be trebled in a year of famine by substituting fodder and cereals for garden crops, and taking two or three crops off the land. The areas in which it is possible to sink wells that can be worked with profit, are so limited that good judges estimate that if every such area in Gujerat were supplied with as many wells as it could employ, irrespective of cost, the total area irrigated from them would be at the outside one-tenth of the existing cultivation; and indeed Mr. Mollison applies this proportion to the Kaira district itself, which is the best suited to well-irrigation of all the Gujerat districts. The cost of a single-*mot* masonry well, 8 to 10 feet in diameter, and from 40 to 60 feet deep, varies from Rs. 500 to Rs. 700.

132. *Extension of well-irrigation.*—In Gujerat as elsewhere the extension of well-irrigation to be healthy must be gradual. Before 1896-97 large numbers of efficient wells are said to have stood unused. During the recent famine an immense number of wells seem to have been constructed, but many of them were unlined, and calculated to last one or two seasons only. They were made at trifling cost, and served their purpose in some cases sufficiently well. We recommend strongly, as the first thing to be done, that the people be assisted to complete as many of these wells as may be worth completing, so far at any rate as may be necessary to give them a reasonable duration. It seems undoubted that the famine has greatly stimulated the desire for well-irrigation, and that at the present moment the two great obstacles to its extension are want of cattle and want of money. We have been told that in parts of Gujerat the thoroughly solvent cultivator can get money from the lenders at 6 per cent. Where this is the case there will not be much inducement to take *takavi* from Government. But we apprehend that the class of cultivators which can borrow at this rate must be extremely limited, especially since the famine, which, with the subsequent years of drought, has resulted in the general impoverishment of the people. At any rate, if wells are to be largely extended, it is necessary to get at a class below that which can borrow easily from the *sowkar* at 6 per cent.; and there is every reason for continuing to make *takavi* available with the utmost freedom, now that it has become popular with the people owing to the pressure of famine. We have discussed the general question of *takavi* loans elsewhere, and we have now to consider how far the concessions which we recommend with the object of getting loans freely taken, should be made available in Gujerat. We think that in this province it may be advisable to encourage the sinking of wells by the grant of most of the various trial measures recommended. Owing, however, to the apparent uncertainty in the life of wells in some parts of the country, greater caution will be required than elsewhere in the grant of loans for very long terms. At the same time, having regard to the appallingly severe effects of famine in Gujerat when it does occur, it seems worth the while of Government to incur risk and make some sacrifice, with the object of inducing the people to secure for themselves the protection in years of drought which, up to the present, wells, and wells alone, have been found able to give.

133. *Necessity for a subsoil water survey.*—The soil in Gujerat seems to be free alike from the rock which in the Deccan, and from the sandy strata which in parts of the Indo-Gangetic plain, offer such obstacles to the well-sinkers; and it is so easy and cheap to sink a trial pit to the water that not much assistance in the way of boring implements is required for the purpose. We cannot, however, but think that a systematic examination of the subsoil waters would throw light upon the extraordinary variations in the nature of the supply to which we have alluded. There are also many indications that the supply to wells in Gujerat may be rendered independent of the ground water by borings of a moderate depth, and we think that this is one of the provinces in which the special investigations which we have elsewhere recommended may be undertaken with advantage.

134. *Steam pumps for irrigation.*—In connection with well-irrigation, we may refer to a modern form of enterprise which has been started in Gujerat, in

the form of irrigational steam pumps, of which at least four have been recently erected on the Sabarmati, and one on the Watrak river. In one case a landowner has erected two centrifugal pumps, of 10 and 7½ inches diameter, which lift water about 25 feet; in another a Company has erected two pumps of 15 and 12 inches with a lift of 30 feet, receiving from the cultivators, as payment in kind, one-fourth of a rice crop, and one-third of wheat or sugarcane. They appear to have experienced more difficulty from the leakage in the irrigating channels than in working the pumps. No royalty appears to have been hitherto charged. The landowner stated that if he supplied water to the owners of other lands than his own, a water-rate of one rupee per acre would be charged by Government, and that this had prevented applications. A partner in the Company stated that it had permission to irrigate up to 500 acres free of charge, but that if it extends its operations special arrangements would be made. This form of enterprise is at present in an experimental stage, but it appears to us to be deserving of every encouragement. We think that the right of Government to impose a royalty should be waived altogether for a definite and long period, or at any rate that the charge, if made, should be purely nominal; and that the conditions on which such installations are permitted should be such as to leave the capitalists free to extend their operations over as wide a field as possible.

135. *New private tanks.*—Although the most eligible sites for small tanks have probably been taken up, there must be room in Gujerat for more works of the same type, for the construction of which private enterprise must be relied on. We have discussed in Chapter V the general principles to be observed in encouraging and assisting private enterprises of this kind, and have only to say here that we consider the protective value of small tanks in Gujerat so great as to justify liberal assistance on the part of Government. Under the Bombay rule the constructors of the tanks would be exempted from liability to an enhancement of their assessments on account of improvements, and would undertake their future maintenance.

136. *Bands in Ahmedabad.*—Long lines of field *bands* or embankments, four or five feet in height, are another useful form of private irrigation work. They are found in the low lying plains of Viramgam in the Ahmedabad district and in other suitable plains where the cultivators have introduced the system. The water which is held up is used for rice irrigation below the *band*, and after it has been run off the land above is sown with wheat or gram.

137. *Importance of encouraging private works.*— We have shown how beset with difficulties is the problem of providing Gujerat with large irrigation canals. We fear indeed that, when the possibilities have been exhaustively investigated, it may be found wholly impracticable, or prohibitively expensive, to protect by means of canal irrigation such a percentage of the cultivable lands of the province as will confer on it a security in any way comparable to that of the Madras delta districts or the great canal-irrigated areas of Northern India; and it is even possible that such irrigation would, in some parts of the country, particularly in the black cotton soils, do more harm than good. We are well aware that irrigation works of any other class, excepting perhaps wells, cannot be relied on to give protection in such an exceptional succession of dry years as that which commenced with the terrible famine of 1899. Nevertheless much may be effected by the persistent development and improvement of the existing means of protection—private irrigation works and wells. The problem of extending and improving these, until recently, has hardly been studied, for the apprehension of famine has been too remote. But there appears to be room for gradual improvement on many different lines. The assistance of Government will be required, not only financially, but in organizing and advising private effort. Those who know the people best appear to be agreed that little can be expected from them when co-operation is necessary, as for instance in the construction of new irrigation tanks. Yet the long *bands* which have been constructed in the centre and west of the Ahmedabad district must have been made by the joint efforts of many landholders; and we feel certain that Civil and Public Works officers, with a conviction of the importance of small works and with a

sympathetic knowledge of the people, would be able to do a great deal in encouraging the development of wells and other private protective works. They can at least indicate where and how success is possible, and can obtain for the people whatever money aid may be needed. It may be inquired perhaps why the action of Government should be limited in general to the encouragement of private effort in small works of this description, and why such works should not be undertaken by Government itself. It must be recognized that in a *rayatwari* province, in which Government takes a portion if not the whole of the rental which would go in other provinces to the landowner, a special obligation rests upon Government to improve its estate in the same way as a prudent landowner would improve his. We have no desire that Government should evade this obligation. In the case of Government estates in *zamindari* provinces, we have not hesitated to press upon Government the duty of executing, by its own agency, improvements of the class which the zamindar might be expected to undertake in his private estate. But the case of individual, particular, and occasional Government estates, though in many respects similar, differs in important respects from that of a vast province administered on *rayatwari* principles. In the case of the latter, the part which Government can usefully play in the management and improvement of the land is necessarily general and remote. The rayat, for good or evil, has been given a far more independent status than that of a Government tenant in a *zamindari* province; and he would be the first to resent the wholesale interference and often ignorant meddling of Government officials with his little property for the purpose of improving it. The narrow limits which exist for the construction of irrigation wells by Government agency have been fully set forth in the general chapter on Private Irrigation Works, and much the same principles must we think apply to all small works which would benefit a single holding or a small group of holdings. The functions of Government must be limited to providing the capital; or to enabling the rayat to procure with the minimum difficulty the capital necessary for the execution of the required improvements, to furnishing him with the information and expert aid which he is unable to provide for himself, to suggesting the directions in which improvement may be possible, and generally to the organization of private effort. Holding these views, therefore, we do not recommend that Government should, except in rare and special cases, make wells or small tanks, or even *bands*. But we have proposed that the country should be thoroughly examined as to subsoil water-supply for wells, and for suitable sites for tanks and *bands*. The concessions proposed under the heading of *takavi* (Chapter VI) are of course designed to enable the people to procure the capital which they require, either direct from Government or on easier terms from the local capitalists, with whom the people may be able to make better bargains when they have the alternative of a resort to Government.

138. There is one measure which has long been regarded as above all others essential for the encouragement of private improvement, namely, what is usually termed the exemption of improvements from enhancement of assessment at revision of settlement. Now not only is this exemption allowed in the Presidency of Bombay, as it is throughout India, but the exemption has been made perpetual; its perpetuity has been declared by law, and by special orders of Government, which have been published with the express object of making known far and wide the policy and its motives. It might have been expected that in Bombay, if anywhere, the full effect of this extremely liberal policy would have been thoroughly appreciated and understood. To our considerable surprise, however, we find that this is not the case, and that there is a certain amount of misapprehension on the part not only of the rayats, but also in some cases of the officials, as to the intentions and practice of Government in this matter. It is of great importance that any misapprehension of this kind should be removed as soon as possible, in whatever way may appear most suitable. The question is separately discussed in Chapter V (I, 180).

(*v*).—*Famine works and programmes.*

139. ***Works constructed during the famine of 1899-1901.***—From April 1899 to the end of October 1901, 86½ lakhs had been spent on famine relief

works in Gujerat—3 lakhs on railways, 8 lakhs on roads, 50 lakhs on village and District Board tanks, and 25 lakhs on irrigation and drainage works. Only three works of any real importance were incomplete—the extension of the Khari system of canals, the Muwalia tank, and the Godari-Goraj drainage channel. They should all three be completed, unless this has already been done by the famine labour since employed. With few exceptions the works selected were, no doubt, useful works; but we think that, in some instances at any rate, the policy adopted of concentrating all the labourers in large relief camps prevented the best use being made of their labour. It apparently led to the expenditure of 4½ lakhs on the Broach tank—a work which we inspected, and of which it is difficult to see the utility. To this policy must also, we think, be attributed the fact that, although for the past three years labour has been available in abundance, and although large sums have been spent on tanks in certain localities—often more than was necessary—many of the small tanks in Gujerat still remain in a state of grievous disrepair. We cannot but feel that a great opportunity for repairing them has been lost. There are no doubt difficulties of supervision in the case of a large number of small works, which the *rayatwari* system intensifies, but we are not satisfied that they were insuperable.

140. *Possible irrigation works for future famines.*—We have no doubt that, in accordance with the recommendations of the recent Famine Commission, the tendency in future will be to attach far greater importance than formerly to village works. But, in any case, the fact that in Gujerat small irrigation works afford perhaps the only means of employing famine labour with profit to the people and to Government, tells weightily in their favour, and should ensure the first place in all future programmes of relief works to the construction and repair of small tanks, and of field embankments of the kind referred to in paragraph 136. Where nothing better can be proposed, the beds of the tanks should be cleared of silt, although the cost will generally be great in comparison with the benefit gained. Drainage works should also have a prominent place in the programme. Until a more thorough examination has been made of the country, it will be impossible to do more than indicate roughly, as we have already done (paragraphs 119 to 126), the field that exists for larger irrigation works on which famine labour might be employed.

Section IV.—THE DECCAN.

(*i*).—*Local conditions; use and value of irrigation.*

141. *Demand for irrigation in the Deccan.*—The Deccan districts resemble those in Gujerat in so far that about 95 per cent. of the cultivation is unaided by irrigation, and that in a year of good rainfall the dry crops do as well or better without irrigation than with it. But there is this great difference that, whereas a year of drought is exceptional in Gujerat, it is of very frequent occurrence in the Deccan. During recent times the Deccan districts have been visited by the severe famines of 1876-78, 1896-97, and 1899-1901, with considerable scarcity in 1901-02. There was also distress, not amounting to famine, in 1892. Excluding the Ghat areas the average rainfall is much less than in Gujerat, and in ordinary or normal years the cultivation is more precarious. Irrigation is therefore much more urgently needed as a protection against drought than in Gujerat; and it may be added that there is much less danger of injury to the country by water-logging, not only because it is not exposed to floods and can be much more easily drained owing to the natural fall in the country, but also owing to an important difference in the cultivation. We have shown how any extension of irrigation in Gujerat would be certainly followed by a great extension of rice cultivation, which is the only crop, besides sugarcane and garden crops, for which irrigation is ordinarily required. In the Deccan, however, irrigation is not another word for rice cultivation as it is in Gujerat and Madras. The Bombay Irrigation Report for 1899-1900 shows that of the total area irrigated in that year by first class irrigation works (106,000 acres), no less than 54 per cent. was under millets,

11 per cent. was sugarcane, nearly 7 per cent. ground nuts, while only 5·6 per cent. was rice, the percentage under which was exactly equalled by that under maize. In the previous year the proportion of rice cultivation did not exceed 4·3 per cent. of the total area irrigated by the works. There is no evidence of a tendency to extend the area of rice cultivation in the tracts commanded; but, except in years of very heavy rainfall, water is taken freely for wheat and millets, and there is also a marked tendency to extend the area under sugarcane and high class crops. Maximum areas are usually attained on the Government irrigation works in years of drought, in spite of the shortness of the supply, the reason being that water is taken for a much larger area of dry food crops than usual. But although the area contracts in a wet year, higher class crops are then cultivated; and the revenue earned is often greater in wet years, or years of small areas, than in years of drought when every available drop of water is keenly utilized. During the five dry years ending 1900-01, the irrigated area exceeded that of the previous five wet years by nearly 47 per cent., but the net revenues for the two periods were practically identical. Irrigation is, therefore, appreciated in the Deccan as a means of increasing the value of the produce of the land, as well as for the protection that it affords against drought. It is true that irrigation works cannot be made to pay, but this is due generally to their unavoidably great cost, rather than to the unwillingness or inability of the cultivator to pay for irrigation; the average water-rate being at the rate of Rs. 4·46 per acre which is much higher than in other provinces.

142. *Soils.*—Black soil prevails in all the Deccan districts, but in the southern or Carnatic districts a rich loam is also found. The black soil is found generally in the river valleys, but it is not so heavy or so retentive of moisture as the deeper beds which are found in Southern Gujerat, and Khandesh is the only district in which cotton is very extensively cultivated. As in Gujerat this crop does not require irrigation. Rice is extensively cultivated in Dharwar, and to a less extent in Belgaum; but it is not much cultivated in other districts. There appears to be no reason why rice should not be cultivated successfully in the black soil of the Deccan, if an adequate water-supply were available; but in those parts in which there are water advantages, the people seem to grow a large area of dry crops, which in good years yield an excellent outturn without irrigation, and a smaller area of sugarcane and other high class crops. In years of drought the latter area is curtailed or water is economized and diverted to the dry crops. This is undoubtedly the system best suited to the Deccan, and it is to be hoped that no attempt will be made to force or encourage the extension of rice cultivation.

143. *Manure.*—The extension of irrigation in the Deccan will, as in Gujerat, involve heavy manuring. We had abundant evidence that the people recognize this fact, that the value of manure is keenly appreciated, and that no one thinks of withholding it from irrigated land. Many new sources are gradually being opened. In Ahmadnagar safflower is now grown largely for oil-cake, to meet an ever-increasing demand; poudrette is prepared and sold by the Municipalities of Poona and other large towns, with great advantage to the Municipal incomes; and recently fish manure has been imported in large quantities by rail from the coast districts. We have no doubt that the supply of manure will keep pace with any possible extensions of irrigation.

144. *Rivers in the Deccan.*—The Deccan, like Gujerat, is traversed by a number of important rivers, which carry great volumes of water during the monsoons, but are dry or nearly dry for the remainder of the year. There is this great difference, however, that the Gujerat districts lie near the mouths of the rivers which traverse them, or at the end of their course towards the sea, while the Deccan districts are situated near the sources of their rivers in the Western Ghats. This fact justifies the hope that it may be more possible to provide storage works for the Deccan than for Gujerat. It may not be easy to find suitable sites, even in the Ghats, for such works, which will be both difficult and costly; but any which it may be possible to construct will be situated in a region of unfailing rainfall, and yet within a

reasonable distance of the area to be commanded. The effective protection of any considerable portion of the Deccan against famine is absolutely dependent on the construction of such works, which will in a small and humble way perform the functions of the glaciers in the distant sources of the snow-fed rivers of Northern India, and hold back some portion of the excessive rainfall of the monsoons, so as to ensure a small but perennial supply to the rivers in whose catchments they will be placed.

145. *Extent of area protected by irrigation.*—The following table will give an idea of the extent to which the nine Deccan districts are at present protected by irrigation from all sources. The areas are averages for the ten years ending 1900-01 :—

1	2	3	4	5	6
District.	Population (Census of 1901) in thousands.	Average area cropped in thousands of acres.	Average area irrigated in thousands of acres.		Percentage of column 5 on column 3.
			From wells.	From all sources including wells.	
Khandesh	1,427	2,964	42	60	2·0
Nasik	816	1,837	53	101	5·5
Ahmadnagar	838	2,589	107	122	4·7
Poona	995	1,942	79	138	7·1
Sholapur	721	1,967	112	128	6·5
Satara	1,147	1,690	76	143	8·5
Bijapur	735	2,507	16	19	·7
Belgaum	994	1,706	31	53	3·1
Dharwar	1,113	2,124	4	83	3·9
Total	8,786	19,326(*a*)	520	847	4·4

(*a*) The double cropped area is included twice over; the proportion of this to the whole varies from 0·3 per cent. in Bijapur to 4·4 per cent. in Poona.

(*b*) The areas shown under wells are based on the assumption that the double cropped area under wells bears the same proportion to the total area under wells as the double cropped area irrigated from all sources bears to the total irrigated area.

146. *Foreign States.*—The Deccan districts include Kolhapur and a number of smaller Native States, in all of which irrigation would apparently be as keenly appreciated as in the British districts. In future schemes for the extension of irrigation in the Deccan the requirements of these States should be considered as far as may be practicable. In some cases it may be necessary to construct reservoirs in, or to carry the new channels through, some of these States; but it is not thought that this will cause any difficulties which cannot be removed by mutual agreement.

(*ii*).—*Existing State irrigation works.*

147. *First and second class works.*—There are in the Deccan districts 33 first class State irrigation works, that is, works for which separate capital and revenue accounts are kept, and which are under the management of the Public Works Department. Of these, 8 are classed as Major, and 25 as Minor Works; but the distinction is rather an arbitrary one, depending merely on the source from which funds were provided. The Minor Works are of the same character as most of the Major Works, and some of the former are more important than some of the latter. Six of the Major Works have been sanctioned as productive works, but no irrigation work in the Bombay Presidency outside Sind has fulfilled the conditions of a productive work. Two only, the Nira Canal and the Mhasvad Tank, have been sanctioned as protective works, and one of these has proved more remunerative than the so-called productive works. The first class works may therefore be considered together, without regard to these arbitrary classifications which have been made merely for purposes of account. The second class works are long established works, which, although not constructed originally by Government, are now under Government control. They have no capital accounts. The Public Works Department are responsible for maintaining them in a proper state of repair,

but the revenue management is in the hands of the Collector. The following table shows the distribution and the protective value of all irrigation works maintained by the Public Works Department :—

District.	1st class irrigation works.				2nd class works.		Average for ten years ending 1900-01. 1st and 2nd class works.
	Number of works.	For ten years ending 1900-01.					
		Minimum area.	Maximum area.	Average area.	Number of works.	Average area.	
		Acres.	Acres.	Acres.		Acres.	Acres.
Khandesh	5	3,561	10,525	6,417	82	9,013	15,430
Nasik	1	2,200	3,763	2,879	271	28,254	31,133
Ahmadnagar	3	2,001	10,752	5,675	2	147	5,822
Poona	6	26,065	70,909	45,558	3	507	46,065
Sholapur	4	6,290	25,064	12,105	...	...	12,105
Satara	6	7,231	18,937	12,600	1	109	12,709
Bijapur	1	4	205	42	16	1,367	1,409
Belgaum	2	4,185	10,845	6,409	67	9,910	16,319
Dharwar	5	1,564	2,979	2,141	478	60,606	62,750
Total	33	53,101	154,979	93,829	920	109,913	203,742

The minimum and maximum areas shown in the 3rd and 4th columns are the aggregates of the minimum and maximum areas for each work without reference to the particular years of occurrence. The totals of these columns do not therefore represent the minimum and maximum areas of all the works in any one year.

148. The maximum areas on record are 119,771 and 121,229 acres in the years 1897-98 and 1900-01, respectively. The minima during the decade are 62,916 and 69,564 acres in 1892-93 and 1895-96. It will be observed, however, that generally the average area is throughout about 60 per cent., and the minimum area about 30 per cent. of the maximum recorded. It may also be noted that, as a general rule, maximum areas have occurred in years of drought, which shows that the works may be of great value in such years, and do not ordinarily fail, though failures in a year of drought have occasionally occurred. We have before observed that a year of short area may be a year of good revenue, owing to the irrigation being confined to the higher class crops, and not being required for dry food or fodder crops.

149. *Areas on second class works.*—The areas returned as irrigated by second class works are practically constant from year to year, for reasons which will be explained further on. It will be seen that although these works do not irrigate on an average more than 120 acres each, the total area under them is greater than that irrigated by first class works, so that they are collectively of considerable importance. They are most numerous in Khandesh, Nasik, Belgaum, and Dharwar. In the two former districts they take the form of *bandharas*, or weirs, built across the rocky bed of some stream, to divert the water into side channels. These channels cannot command the country at any great distance from the banks of the stream, but they nevertheless irrigate considerable areas, and are often held by several villages. The works are managed by the people with considerable skill, every drop of water in the stream being utilized by means of successive *bandharas*, and the channels are, when necessary, worked in rotation. The second class works in Belgaum and Dharwar consist mainly of tanks.

150. *Productive value of first class works.*—The productive value or financial position of the first class works has next to be considered. Taking the 33

works as a whole the results of the working during the ten years ending 1900-01 are as shown below :—

Average area irrigated annually	93,829 acres.	
	Rs.	Per acre. Rs.
Capital cost to end of 1890-91 . . .	2,39,33,422	
„ „ 1900-01 . . .	2,56,68,797	273·60
Average water-rates and land revenue . .	4,18,691	4·46
Average total revenue of all kinds . . .	5,77,802	6·16
„ working expenses	3,29,667	3·51
„ net revenue	2,48,135	2·65

151. At the beginning of the decade irrigation had been developed to nearly its full extent on almost all the works, and but little expenditure has since been incurred against their capital accounts. The average net revenue for the whole period yielded a return of just 1 per cent. on a capital of 248 lakhs, which is the mean of the capital outlay at the beginning and end of the decade. Taking the rate of interest at 4 per cent. it may be said that the irrigation of 93,829 acres per annum involves a permanent annual charge on the State of Rs. 7,44,000, or at the rate of Rs. 7·93 per acre. This result is attained after levying an average charge on the cultivator of Rs. 4·62 per acre, so that the true cost of irrigating an acre may be taken at Rs. 12·55, or a little less than one-third of the value of the crop, which, according to the detailed valuation in the Bombay Irrigation Reports, may be taken as averaging about Rs. 42 per acre.

152. In return for this expenditure the State may rely on the irrigation of from 106,000 to 120,000 acres in years of drought, which would reduce *pro tanto* the severity of distress and the cost of famine relief. There is also of course an indirect return to the State in other ways which must result from any increase in the wealth of the country. On the other hand, no account has been taken of the interest charges incurred while the works were under construction, and until they had attained their present stage of development.

153. *Classification of works according to their sources of supply.*—The great cost of irrigation in the Deccan is so striking, and has such an important bearing on all proposals for its extension, that we have thought it necessary to analyse the figures which have been quoted, in some detail. It has already been observed that the recognized classification for accounts purposes of these works does not indicate their character, but they may for the purpose of our inquiry be divided into five classes as follow :—

Class A.—The Mutha Canals.

Class B.—Canals with ghat-fed storage works, or which are in other ways favourably situated : the Nira, the Gokak, the Lower Panjhra, the Upper Man, and the Yerla River Canals.

Class C.—Canals without storage works : the Krishna, Kadva, Lakh and Ojhar, Rewari, Chikli, and Jamda Canals.

Class D.—Large rain-fed tanks, the capital cost of which is not less than Rs. 4,00,000 each. There are four of these, *viz.*, the Mhasvad, the Ekruk, the Ashti, and the Maini.

Class E.—Small rain-fed tanks, each costing less than Rs. 4,00,000.

The Mutha Canals really belong to Class B, as they are fed from Lake Fife, a fine ghat-fed storage work with a capacity of over 3,200 millions of cubic feet. But these canals must form a class by themselves. In the first place, they have been constructed as much for the purpose of the water-supply of Poona and Kirki as for irrigation, and the capital cost includes the cost of the reservoirs, mains, reserve weirs, and other works connected with the water-supply. Apart from this, the area irrigated by the water available for the purpose is very small, because the cultivation is all of the highest

class consisting mainly of sugarcane, the best and most valuable kinds of which are grown in the neighbourhood of Poona. It thus happens that the capital cost of these canals works out to the abnormal rate of Rs. 729 per acre, and as it represents more than a quarter of the total capital outlay on all works, it is absolutely necessary to consider it separately.

154. The following table gives details relating to each of these five classes of works :—

Item.	Class of work.				
	A.	B.	C.	D.	E.
(1) Number of works	1	5	7	4	16
	Rs.	Rs.	Rs.	Rs.	Rs.
(2) Capital cost (1900-01)	66,69,380	86,70,934	34,93,574	47,00,416	21,34,493
Totals for ten years ending 1900-01.					
(3) Water-rates and wet land revenue	13,04,790	14,34,037	7,29,574	3,95,958	3,22,537
(4) Gross revenue of all kinds	24,97,800	15,83,262	7,85,891	5,51,510	3,59,560
(5) Working expenses	8,29,758	9,02,161	7,85,957	5,01,154	2,77,638
(6) Net revenue	16,68,042	6,81,101	—66	50,356	81,922
Areas recorded.	Acres.	Acres.	Acres.	Acres.	Acres.
(7) Minimum, since 1890-91	6,457	27,271	7,742	7,348	4,283
(8) Maximum „ „	12,691	71,977	28,588	26,671	15,152
(9) Average, 1890-91 to 1900-01	9,146	46,133	16,662	13,254	8,634
Rates per acre as in (9).	Rs.	Rs.	Rs.	Rs.	Rs.
(10) Capital cost	729	188	210	355	247
(11) Water-rate and wet land revenue	14·27	3·11	4·38	2·99	3·74
(12) Gross revenue of all kinds	27·31	3·43	4·72	4·16	4·16
(13) Working expenses	9·07	1·96	4·72	3·78	3·22
(14) Net revenue	18·24	1·47	...	0·38	0·94
(15) Interest charges less net revenue, or net cost to State per acre	10·93	6·04	8·32	13·81	8·94
	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.
(16) Net revenue, return on capital outlay	2·5	0·79	...	0·11	0·38

155. *Class A. The Mutha Canal.*—The work in Class A is of such a special character that no explanation is required of the apparently abnormal rates shown under items (10) to (14). It will be seen that the work is more remunerative than those in any other class. It is difficult to say whether better or more financial results would have been attained if the whole of the available supply had been made available for irrigation. The capital cost could probably have been considerably reduced, and in any case the extensions of area would have resulted in a reduction of all the acreage rates, except perhaps that shown as item (11).

156. *Class B. Ghat-fed storage works.*—Of the five works included in Class B, the Nira Canal is the only one which has a large storage work. The remaining four are comparatively small, and their storage is not ghat-fed; but they have been included in this class as their supplies are more assured than those of works in Classes C to E. The Upper Man and Yerla river works

have been very costly, the capital cost per acre being Rs. 286 and Rs. 242, respectively, and neither of these two works at present pays its working expenses. The Nira Canal, which is the best type of works of this class, has cost nearly 57 lakhs which corresponds to a rate of Rs. 174 only per acre of average irrigation. Its storage work at Bhatgarh, now known as Lake Whiting, has a capacity of 5,500 millions of cubic feet. It is one of the finest works of its kind in India, and a work of which any Government might be proud.

157. On referring to the preceding table it will be seen that the cost to the State per acre irrigated (item 15) has been considerably less in this than in any other class. The reason is that the capital cost per acre (item 10) is much less, or, in other words, a much larger area can be irrigated with a given expenditure, when there is a ghat-fed storage work. It will also be seen, on comparing items (7) to (9), that both the minimum and average areas of the class bear a higher ratio to the maximum than in any other class except Class A, the circumstances in which are special. The return for the whole class is pulled down by the low average of the water-rates, which appears to be mainly due to the system adopted in working the Nira Canal to which we shall presently refer. The returns are also affected by the diversion of water from the storage work on the Gokak Canal to the Gokak Mills, which is referred to below (paragraph 176). Allowing for these accidental causes, the return for works of this class would probably exceed 1 per cent., and the permanent charge on the State for every acre of irrigation would probably be less than Rs. 6 per annum. It is only by means of works of this class that any considerable extension of irrigation in the Deccan will be possible.

158. *Class C. Canals without storage works.*—Class C includes the Krishna Canal, which receives a fairly steady supply from the Krishna river near the foot of the Ghats, though the area under irrigation could be greatly extended if a storage work, for which hitherto no suitable site has been found, could be provided. This work has cost less than 9 lakhs, and has been very successful, the average return amounting to 3·35 per cent. The small Rewari Canal has yielded a return of nearly 6 per cent. Works of this class, which are *bandharas* on a large scale, are comparatively inexpensive, as weirs can be easily and cheaply built on the rocky beds of the Deccan rivers. But they are of little protective or productive value, however small their cost, if the supply is liable to constant failure and interruption. Against the successful works just named, may be placed the Kadva, the Pravara river (Lakh and Ojhar Canals), and the Jamda Canal works, all of which are of very little value without storage works and have failed to pay even their working expenses. We do not think that there is much room for successful works of this class on a large scale in the Deccan; and the general results attained show that, although the absolute cost of such canals is comparatively low, the rates of capital cost and of working expenses per acre brought under irrigation, are likely to be very high owing to the great uncertainty of the supply.

159. *Classes D and E. Rain-fed tanks.*—We have next to consider the case of rain-fed tanks situated outside the Ghats, of which there are twenty examples constructed at a cost of over 68 lakhs of rupees. Many more works of this class have been proposed, or actually commenced, as famine relief works, so that it is of great importance to consider the results attained on them. We would, in the first place, remark that costly as these works undoubtedly are, and uncertain as their action may be in a particular year, they have nevertheless a protective value which is not to be despised. Particular tanks may fail in seasons of great drought, but they do not all do so, and in such years many of them irrigate their maximum areas. Three of the four large tanks in Class D irrigated their maximum areas in 1900-01, and the fourth irrigated its maximum in the previous year. Several of the smaller tanks attained their maximum in the famine years 1896-98. Apart, however, from their value in years of great drought, they are also of great utility in years of badly distributed rainfall, and undoubtedly strengthen the position of the cultivator. In many places they also have an indirect value in maintaining the spring level in the wells.

160. *Large and small tanks.*—We have divided these rain-fed tanks into two classes according to size. Many of our witnesses expressed the opinion that small tanks had little or no protective value, owing to their small catchment areas. The figures in the preceding table do not, however, appear to support the view that large tanks have a greater protective value, in relation to their cost, than small ones, or that they are less unremunerative works. Whether regard be paid to the areas recorded, to the ratio of the average to the minimum and maximum recorded areas, to the capital cost per acre irrigated, to the working expenses, or to the actual cost to the State of each acre irrigated, the advantage is all on the side of the smaller tanks. The advantage would have been all the greater if the dividing line had been drawn a little lower down; for the most unremunerative of all the tanks in Class E is the largest of them, the Bhatodi, which cost Rs. 3,79,707, while the working expenses exceed the gross revenue by Rs. 1,835. On the other hand, the figures for Class D have been unfavourably affected by the fact that a considerable portion of the supply of one of the largest tanks in that class, the Ekruk, is reserved for the water-supply of Sholapur. It is difficult to say what allowance should be made for this, but it appears doubtful whether any reasonable allowance would give Class D the advantage. We do not claim that the figures are conclusive in favour of the smaller tanks. The capital outlay shown against some of these may possibly have been incurred on restoration of old works, and not on original construction. One of the best of them receives a supply from the Mutha Canal; and many of the most remunerative small tanks are in the Dharwar district, in which conditions are more favourable for such works than in the northern districts. The figures, nevertheless, indicate that if Government wished to spend, say, a crore of rupees on rain-fed tanks, it would be better to make, say, fifty small tanks at some distance from each other, than five large tanks like the Mhasvad, which cost over 20 lakhs. Large tanks which can be made to hold two or three years' supply are of course less likely to fail in years of drought than other tanks of any size which irrigate annually as large an area as they can; but the cost per acre annually irrigated is very much greater. A tank with a very large catchment area is likely to receive a higher proportion of its full supply in a year of drought, than one with a catchment area one-tenth the size, but not a higher proportion than ten such small tanks would receive. We advocate the construction of storage works of the largest possible capacity, wherever suitable sites for them can be found in the zone of unfailing and torrential rains, or when they can be fed from a river or canal; but we think that the advantages of large tanks in the region of uncertain rainfall have been over-rated. We have had abundant evidence in other provinces of the collective value of numbers of small tanks, but we need not go outside the Deccan for such evidence. We have only to point to the results attained on the second class works, which irrigate annually a larger area than all the first class works put together.

161. *Prospective improvement in financial results of works.*—In our attempt to determine the true financial position of different classes of works, considered with reference to the character of the source of supply, we have taken the average results during the decade ending 1900-01; because the figures show that, in spite of an increase of nearly 47 per cent. in the area irrigated in the latter half of the period as compared with the former half, the net revenue realized in the two quinquennia were practically identical. We have little doubt, however, that the great expansion of the irrigated area, which has occurred during the last five years of drought, will result in a permanent improvement in the financial position of these works; and that, as the advantages of irrigation are more widely understood, the average area under irrigation will approach nearer and nearer to the maximum. On this account the future financial prospects are probably more favourable than is indicated by our statements of the results attained during the past ten years; but when every allowance is made for this, and for possible improvements in the administration of the canals, we do not think that they will ever prove remunerative in a financial sense, or that they can be expected as a whole to return more than 2 per cent. on the capital cost.

162. *Financial results on second class works.*—As regards second class works (paragraph 147), it is found that the average revenue credited to them amounts to Rs. 4,43,489 per annum, while the average expenditure on maintenance and collection fees amounts to Rs. 1,87,119, or 42·2 per cent. At least 99 per cent. of the revenue credited to these works is indirect, that is, it is a certain share of the fixed consolidated land revenue assessment; and it shows very little variation from year to year. It is subject to remission on account of failure of the works, but otherwise it is payable whether water is taken or not. This accounts for the small variations in the areas returned as irrigated by these works.

163. *Protective and productive working of canals.*—Several questions connected with the working of the first class irrigation works have been brought to our notice, on which we desire to offer a few remarks. The first of these is the difference in the administration of those classed as productive and protective. It is the practice in Bombay to manage the two works classed as protective —the Nira Canal and the Mhasvad tank,—on what are called protective principles; that is, less with a view to commercial profit than to the protection of as large an area as possible in the event of a drought occurring. Thus it is the custom to restrict, in the beginning of the year, the area that may be put under sugar-cane and other high class crops; in the apprehension that the rainfall may prove deficient, and that there will be a strong demand for water in the following cold weather for dry food crops which it will not be possible to meet without such restriction. If there is a normal rainfall, the area under high class crops is therefore much less than it would otherwise have been, or might have been, and a great deal of canal revenue is lost. If the rains fail there is less, if any, loss of revenue; as the water held in reserve is utilized to great advantage in protecting a large area of dry crops. On works which have been classed as productive, this system is not observed; the idea being that, as they have not been sanctioned avowedly for purposes of protection, water should be disposed of to the best advantage, or, as it is called, on commercial principles, so as to bring in as great a revenue as possible without regard to the possibility of drought. The difference is shown by the table in margin, showing the average percentages of sugar-cane and 8 months' crops on the two protective works, and on those other works which have a fairly assured supply. The rates for sugar-cane vary from Rs. 10 to Rs. 50, and for 8 months' crops from Rs. 4 to Rs. 8; while those for other crops vary from 12 annas to Rs. 3; so that the percentage of high class crops very materially affects the financial results attained.

Name of work.		Crop percentages.	
		Sugar-cane.	8 months.
Protective	Nira	8	11
	Mhasvad	4	25
Productive	Mutha	50	7
	Krishna	26	47
	Matoba	23	8
	Ekruk	16	29

164. *Advantages of working on productive principle.*—The first point that occurs to us is that, if the protective system of working has any advantages, it should be applied to all works alike, irrespective of the fund from which the cost of construction has been met. We are, however, disposed to doubt whether the system has any real advantages, even from a protective point of view. The mere extension of the area under food crops in a year of famine is, in the Deccan, no longer a matter of the first importance, as it was in 1877-78. There is no longer any difficulty in getting food grains into the province in years of drought. What is really wanted is remunerative agricultural employment for the people; and as long as this can be found for them by means of irrigation works, it is a matter of little importance whether they are employed in the cultivation of food crops, or of such a crop as cotton or sugar-cane which can be exchanged for food. If the cultivation of an acre of sugar-cane will afford employment, directly or indirectly, for ten times as many people as an acre of *juar* or *bajri*, there is no particular advantage, even in a famine year, in sacrificing the acre of cane for the sake of the ten acres of millet; and in a year of ordinary rainfall the acre of cane is lost to the country, and the profit that might be derived from irrigating it, is lost to the State. If the wealth of the community is to be increased to the full extent

which the expenditure on irrigation works may render possible, these must be worked with regard to the conditions in normal, and not in exceptional, years. Subject to one limitation to which we shall presently refer, we consider that, as a general rule, the system of working which will give the best commercial results will also be found to be the most protective. The greater the amount of the canal revenue, that is, the greater the amount which the cultivators are willing to pay for the use of canal water, the greater are the profits of cultivation and the addition to the wealth of the community; and we cannot recommend that the productive efficiency of irrigation works should be crippled in ordinary years, for the sake of meeting the supposed exigencies of a year of drought. We think that in the long run the cultivators may be trusted to know their own interests better than the authorities, who may attempt to impose restrictions on the course of cultivation; and that if left to themselves, they will extend the cultivation of food crops when the rise of prices, and other indications of approaching scarcity, encourage them to do so. Lastly, we cannot but recognize that the continued extension of protective irrigation must depend on the financial results attained on works which have been constructed. If such works could be made to pay, as the canals in Northern India pay, there would be no limit to the funds which successive Governments of India would readily devote to their multiplication. But if, in consequence of the adoption of a faulty system, each new work imposes a permanent charge on the revenues of the country out of all proportion to the protective advantages gained, a time will come when the extension of protective irrigation will be discontinued, owing to the blunders committed in its name.

165. The Executive Engineer, Poona Irrigation Division (Mr. Visvesvaraya), informed us that it would be possible to treble the net revenue on the Nira Canal if the existing restrictions on the extension of high class cultivation were removed; and other officers have also testified to the prejudicial effect of the existing system. We are not in a position either to accept or to question this estimate; but we cannot but think that if, by a relaxation of the present rules, it were possible to treble or even to double the net revenue of the canal, the increase, in successive seasons, of the wealth and prosperity of the cultivators would be a far better protection in a season of drought, than the greater extension, in that particular season, of the area under food crops which may be rendered possible by the continuance of the present system. And if the Nira Canal could be made to pay 3 per cent. on its capital cost, the greatest objection to the extension to all parts of the Deccan of as many works of the same class as it may be possible to construct—the objection based on the permanent charge that such works would impose on the State,—would practically disappear.

166. *Necessity for a wide distribution of the supply.*—There is one exception to the general principle that the system of working which will give the best commercial results, will also in the long run afford the greatest protection. We refer to the importance of a wide and fairly equal distribution of the supply. Even this does not always involve an exception, for the cost of a wide distribution is very often compensated for by the greater permanence and stability of the demand. But even when this is not the case, we consider it of the greatest importance, on both protective and sanitary grounds, to distribute the available supply as widely as possible, even when this may render the works less remunerative. This is especially the case in the Deccan, where wet cultivation can be supplemented in ordinary years by large areas of dry crops. The Mutha Canal affords an instance of the evil of concentrated irrigation; no less than 50 per cent. of the area irrigated is under sugar-cane within a radius of a few miles from Poona; and we have had evidence that very serious injury is being caused to the soil by water-logging and over-cropping. We have also been informed that water cannot be sent down to the tail of the canal, owing to the demands of the Poona cane cultivators; and a proposal has been made for a new storage work to give a supplementary supply which may be joined to the tail of the canal and to extensions beyond it. The concentration of irrigation around Poona must reduce the protective value of the canal. No doubt the cane cultivation employs directly and indirectly a great number of labourers; but there is reason to fear that, when irrigation is thus concentrated, an undue

share of the benefits of protection is appropriated by wealthy landowners or capitalists. We think that in the Deccan a canal should ordinarily be designed to command four, or at least three, times the area which it may be expected to irrigate in normal years; that the share of the total supply to be assigned to each water-course should be proportioned to the area commanded by it, the internal distribution being arranged by the cultivators in accordance with their respective shares; and that each landowner within that area should be entitled to a proportional share of the supply, so that he may irrigate a quarter or a third of his holding, which would rise to 40 or 50 per cent. in years of drought. It is not to be supposed that a Government official can carry out so fine a distribution of water. What he has to do is to fix the discharge of the village water-course, in proportion to the area it is intended to water. This area may be divided among a dozen landowners, and it may be left to them to settle among themselves for how many hours in the day each is to have the use of the water. But when the share that may be taken by each individual has been thus fixed, it seems unnecessary to impose any restriction on the crops which each may cultivate. If a man would prefer to cultivate an acre of cane, and to take his chance of being able also to raise a few acres of dry crops on the rainfall, it is surely better to allow him to do so than to refuse him water for the cane, on the ground that he may want it hereafter for his dry crops. But it is undoubtedly necessary to prevent, as far as possible, any individual from permanently appropriating more than his fair share of the supply.

167. *Proposed system of leases.*—We regard with approval a suggestion which has been made by Mr. Visvesvaraya that, when after the first few years the course of irrigation has become fairly established, the cultivators should be encouraged to form blocks with a fixed rotation of cropping and irrigation, such as has been arrived at on the *bandhara* systems; and to take out long leases (5 to 7 years) for a supply of water to these blocks, regulated with reference to the scheme of cultivation proposed, a minimum supply being guaranteed for certain periods during the currency of the lease. The conduct of the arrangements with the people would have to be entrusted to an officer of considerable tact and experience to whom as free a hand as possible should be given. At first perhaps few cultivators would combine to form blocks and take leases. But gradually the advantage of receiving an assured supply of water, without having to make annual applications, would be realized; and the number of blocks and leases would increase until almost the whole of the irrigable area of the canal had been arranged for in this way. By means of such a system, the combined advantages of the productive and of the protective methods of working would be secured; no individual owner would be able to appropriate permanently or continuously more than his fair share of the supply; and apart from the more equal distribution of water, a substantial reduction might be effected in the cost of revenue management, as the disposal of applications, and the subsequent inspection and measurement of irrigated areas, would be greatly facilitated.

168. *Excessive charges for establishment.*—We have also been informed that the working expenses on many works have been unduly exaggerated, owing to the system of distributing establishment charges which obtains in many divisions. The faultiness of the system is generally recognized; but, as it affects the distribution of charges between the Imperial and Provincial Governments, it has been allowed to remain unaltered. A proposal to alter it was made some years ago, but appears to have been dropped on the ground that the provincialization of the irrigation works, which was then contemplated, would render the change unnecessary. The works have not, however, been provincialized, and no change has been made in the system. Under it, the charges which have been made against certain works, principally those in the Ahmadnagar and Nasik districts, appear to have been extraordinarily high, and to have materially affected the revenue accounts for those works which are mostly in Class C. We doubt, however, whether the absolute amount of such charges has been such as seriously to affect the financial position of the irrigation works in the Deccan, taken as a whole; and we have not thought it necessary to examine the question. It is, however, very desirable that the account of each

work should be debited only with its fair share of establishment charges, and there appears to be no real difficulty in the way of a modification of the present system.

169. *Transfer of small tanks to the second class.*—We have already observed that water-rates are not charged on the second class works, the cultivators on which pay a consolidated dry and wet canal revenue assessment, which has been fixed with reference to the water advantages. We think that, when opportunity offers, many of the smaller tanks in the first class might, with advantage, be transferred to the second class, a suitable addition being made to the fixed assessment, and water-rates being abolished. We do not know whether it would be possible to do this before the next revision of the settlements, but there are advantages in this system, which is almost universal in Madras, where the irrigation arrangements have become as it were crystallized by long usage. We do not recommend it on the larger or newer works, where the system of water-rates must continue for many years to come, especially if improvements and extensions are proposed; but the transfer of the revenue management of these small tanks from the Public Works to the Civil Department, and the substitution of a fixed assessment for the present water-rates, would probably result in a reduction of expenditure, and would leave the people freer to manage and develop the irrigation from their tanks without official interference.

170. *Small irrigation works.*—In addition to the small works of the second class there are, as in Gujerat, a number of still smaller works for which no revenue accounts are maintained. These works irrigate annually an area of about 125,000 acres. They consist partly of small tanks and partly of *bandharas* or other works for utilizing the waters of streams. They are for the most part old works which are ordinarily repaired by the people and the area irrigated by them is not included in the returns of areas irrigated by Government works; but, as in the case of the Gujerat tanks, Government recognizes its responsibility with respect to improvements and special repairs. We gather that there is probably not much scope for the extension of very simple works of this kind, but the importance of utilizing every opportunity for increasing their number should not be lost sight of.

(*iii*).—*Scope for further extensions of State irrigation works.*

171. *Irrigation works from ghat-fed rivers.*—It has already been remarked that the first line of protection in the Deccan must be sought for in a system of canals depending for their supplies on large storage works which will be filled from rivers whose sources are in the Western Ghats, where the monsoon rainfall is unfailing even in a year of drought. In such a year it is only works of this class which can be thoroughly relied on as a means of protection, and we have shown (paragraph 157) that, although unavoidably costly, they are likely to prove in a series of years the least unremunerative of any works that can be proposed. Ghat-fed rivers are fortunately numerous in the Deccan. There are the Panjhra in West Khandesh; the Girna and its tributaries in North Nasik; the Godavari and its tributaries in South Nasik and Ahmadnagar; the Bhima with its tributaries; the Mutha, Mula, and Nira in Poona; the Krishna in Satara; the Ghatprabha with its tributaries in Belgaum; and the Malprabha in Dharwar; and canals supplied from some of these could be extended into the remoter and less favoured districts of Sholapur and Bijapur. The alignment of canals from these rivers, so as to command considerable areas which are greatly in need of protection, does not appear to present insuperable difficulties, except possibly in the case of the Krishna. The real difficulty lies in obtaining suitable sites for storage works. We find that the courses of most of these rivers have been examined for sites at different times; and that many sites have been suggested and subsequently condemned as unsuitable, or as involving works the cost of which has been regarded as prohibitive. We fully recognize the great difficulties in obtaining suitable sites for large storage

works. It is by some supposed that a certain percentage of all the rainfall that occurs over a given catchment area can, by the construction of suitable works, be utilized for irrigation; and extraordinary statements have been put forward as to the millions of acres that could be protected by the rainfall that occurs annually in the Western Ghats, and other catchment areas, as if this could all be impounded and prevented from running uselessly to the sea. The practical difficulties in impounding immense volumes of water are seldom considered. The irrigation of only 100,000 acres or, say, 150 square miles, requires a volume of from ten to twenty thousand million cubic feet, or a reservoir ten miles long, a mile wide, and fifty feet deep. We have already referred to the combination of favourable conditions which must be secured before a large storage work can be constructed in the area of the Ghats. For the necessarily lofty dam, sound foundations, and suitable materials within a reasonable distance are essential; arrangements must be made for passing off flood waters during cyclonic storms; and, in many otherwise excellent sites, this may entail an enormous expenditure; the construction of the work may involve the submergence of many thousand acres of the most fertile lands, or the removal of whole villages and towns; and, finally, a practicable alignment must be found for a channel from the reservoir to the area which it is proposed to command. Many of these difficulties could no doubt be disposed of if no regard were paid to the cost; but this at least would not be a practical policy. We believe, therefore, that there may be large catchment areas the rainfall on which cannot be impounded and utilized for protective purposes at any reasonable cost. But we do not think that there has been such a systematic and exhaustive examination of the different catchment basins in the Ghats as to preclude the possibility of constructing many irrigation works in the Deccan, the protective and productive value of which will not compare unfavourably with that of the Nira Canal. The examinations which have been made of particular sites appear to have been of a more or less spasmodic character, due to the interest or enthusiasm displayed in the matter by individual officers, rather than as part of a defined and systematic policy of exploiting to the utmost the water resources of the Ghats. The reason for this is not far to seek. It has been proved beyond all question that irrigation works in the Deccan cannot be made to pay; and the financial prospects of all projects that have been proposed have been so unpromising as to discourage both the Bombay officers and the Bombay Government from persevering in costly investigations of schemes the ultimate rejection of which appeared more than probable, at any rate as long as money was required for projects of a more promising character in other parts of the country. But we doubt not that if the protection of the Deccan be given a foremost place in the future irrigation policy of Government, subject to whatever limitation of cost may appear to be reasonable, and if money be found for the cost of surveys, future investigations will be undertaken with better heart by all concerned; and will be carried on systematically and continuously, until either a satisfactory programme of new works has been prepared, or it has been conclusively proved that such works are not practically feasible within the limits of cost proposed. Soon after leaving Bombay we forwarded to the Government of India an *ad interim* recommendation that no time should be lost in commencing a thorough and systematic hydrographic and hydrological survey of all the catchment areas in the Ghats, and an examination of all possible sites for storage works; and we desire now to state that we consider the continuous prosecution of this survey a matter of the very highest importance.

172. *Proposals which have been suggested.*—Various proposals or suggestions for canals with ghat-fed storage works have been brought to our notice, a list of which is given below. The works have been placed provisionally in the order in which it seems to us desirable that they should be taken up, having regard to the progress already made in their preparation, to the comparative urgency of the need for protection in different districts, and to the importance of distributing protection as fairly as possible between different parts of the country. The actual order of prosecution will, however, depend on the course and results of the general hydrographical survey of the Ghats

which we have proposed, and on many other considerations; and we do not desire to make any definite recommendations on this point.

No.	District to be irrigated.	Name of drainage line.	Name of Project.
1	Ahmadnagar	Pravara river	Maladevi.
2	Nasik	Girna river	Chankapur.
3	Belgaum, Bijapur	Ghatprabha	Gokak extension.
4	Satara, Sholapur	Gujawni	Right Bank Nira Canal.
5	Nasik, Ahmadnagar	Godavari river	Godavari.
6	Poona	Bhima and Ghod	...
7	Satara, Belgaum, Bijapur, Kolhapur	Krishna river	Krishna extension.
8	Poona	Panna river	Panna river.
9	Ahmadnagar	Mula river	Rahuri.
10	Poona	Dhinli and Siv river	Siv-Dhinli.
11	Bijapur	Malprabha	Malprabha.

173. *The Maladevi and Chankapur projects.*—An estimate for the Maladevi reservoir had been prepared before we visited this Presidency, and the papers and plans, which were more complete than those of other projects, were closely examined by us, as they may be regarded as a type of the class of works required in the Deccan. We proposed some modifications in the design, mainly with the object of increasing the storage; and the estimate will after revision in accordance with these proposals be submitted to the Government of India. The work will give an annual supply to two existing canals, which now irrigate between four and five thousand acres annually, but the supply of which is very precarious, and the gross revenue hardly sufficient to cover the working expenses. It will also provide for an extension of irrigation. The total area to be irrigated by the project, including present irrigation, may be estimated at 21,600 acres in ordinary years, which will probably be increased to over 30,000 acres in years of drought. The total capital cost of the entire project will probably amount to about 50 lakhs; of which, however, 11½ lakhs have already been expended on existing works, or on work which has been carried out by famine labour. The soil in the tract to be commanded appears to be very suitable for irrigation; and there can be no doubt as to the great protective value of the work in the heart of a district so liable to famine as Ahmadnagar. There is every reason to believe that the work will ultimately yield a net revenue equivalent to a return of over 2 per cent. on the total capital cost; and in view of the expenditure already incurred, and of the small protective value of the existing works owing to the uncertainty of the supply, it appears very desirable to commence and complete this work as early as possible.

174. The Chankapur project has also been estimated in full detail, and the estimate has been forwarded to the Government of India for sanction since we left the Deccan. It will protect and improve 1,750 acres of existing irrigation, and provide for 9,618 acres of new irrigation, at an estimated capital cost of Rs. 13,22,522. The project will form a useful protective work at a moderate cost, and appears likely to yield a return of over 2 per cent. on the capital outlay.

175. *The Gokak extension project.*—The Gokak extension scheme, or second section of the Gokak Canal, has much to recommend it. Government appears to be under an obligation to increase the storage capacity above the Dhupdal weir, or head of the present Gokak Canal, for the purpose of meeting the requirements of the Company owning the Gokak Mills. It is desirable, therefore, to consider the whole question of storage works on the Ghatprabha and its tributaries, so as to provide not only for the requirements of the mills, but for all possible extensions of irrigation. The plans show that a very large area could be brought under command in Belgaum, in the Mudhol and Jamkhandi States, and also in the Bagalkot Taluk of the Bijapur district, if only sufficient storage can be obtained. Three or four sites have been proposed; and though objections may be made to each, they do not appear in any case to be insuperable. In order to permit an extension of irrigation to Bijapur, which should certainly be aimed at, it is considered necessary to provide an additional storage of 8,500 million cubic feet; and after allowing for loss by evaporation and the supply to be given to the mills, there will remain 5,600 million cubic feet available for an extension of irrigation, enough perhaps for an area of 67,000 acres. The required storage can apparently be obtained; but present estimates of the cost, which place it at Rs. 83,00,000, cannot be accepted until proposals have been worked out in greater detail. Our evidence shows, however, that the cultivation throughout the whole area of the tract that may be commanded is very precarious, and that the canal will have a great protective value; while it is probable that there will be a strong and regular demand for irrigation in both seasons, so that a considerable net revenue may be anticipated. It is noteworthy that monsoon crops on the existing Gokak Canal form 32 per cent. of the total irrigated area—a percentage which is not approached by any other irrigation work in the Deccan. It is even thought by the local officers that the canal, part of which has already been constructed, might be advantageously extended for some miles and opened as a *kharif* canal only, before the completion of the proposed new storage works on which they must depend for their *rabi* supply; and that the whole scheme can thus be carried out in sections, each of which can be brought into operation as completed. On the whole, the project appears to be one of the most promising, and one of the most important as a means of protection, of all those which have been considered by the Commission; and it is recommended that detailed plans and estimates should be worked out as soon as possible.

176. The existing Gokak Canal, or as it is called the first section, is classed as a provincial work, and is the only provincial irrigation work in the Bombay Presidency. It was provincialized many years ago, in consequence of certain rather indefinite obligations which had been undertaken by the Local Government in regard to the Gokak Mills; obligations which have rendered it necessary to abandon or hold in abeyance the extension of the canal known as the second section, on which a capital expenditure of Rs. 1,90,284 has been incurred. The mills are at present entitled to a supply of 68 cusecs throughout the year, which may be increased ultimately to 136 cusecs as a maximum; but this cannot be given in certain seasons of the year until the storage has been increased. The water supplied to the mills passes through a fall of about 180 feet, and cannot thereafter be used for irrigation purposes, as command of the country is lost. This does not matter during six months in the year when there is plenty of water to spare; but we find that the obligation to supply 136 cusecs during the remainder of the year, is likely to affect the protective value of any proposed extension in a very remarkable manner, and to an extent far greater than might be supposed from the actual quantity of water to be supplied. This will not indeed be the case if new storage works can be provided, with a capacity considerably in excess of the requirements of the area that can be brought under command; but our information leads us to doubt whether this will be possible. It appears not improbable that it may eventually be advantageous to obtain a release from this obligation, by providing the Company with engine power for use during the dry season, and also paying the cost of working. The expenditure thus involved will not be balanced by the increase in irrigation revenue that will ensue; but the difference would probably be not too high a sum to pay for the sake of the larger area which will

be cultivated and protected. We have examined the position with some attention; and although we cannot go into further detail here, we think that there are good grounds for believing that the protective value of any extensions of the Gokak Canal that may be proposed, could be immensely increased at a comparatively moderate net cost to Government, if, by some arrangement of this kind, a release from or modification of the present obligations to the Company, in regard to the dry weather supply, could be obtained. The question at any rate will deserve attention when proposals for the extension are under consideration.

177. *The Gajauni or Nira Right Bank Canal project.*—Little was known at the time of our visit about the Gajauni reservoir which it had been proposed to construct north of Lake Whiting, or in the adjoining valley, and which appears to have been surveyed many years ago, although the plans could not be found. We have, however, received and considered a preliminary report by Mr. Beale on the result of surveys in connection with this project, which, in accordance with our recommendation, he has been conducting since we left the Deccan. In one respect this report is very satisfactory, as it indicates that there are greater possibilities of storage in the basin of the Nira river than we anticipated; and indeed that the capacity of any irrigation works which may be proposed, is more likely to be limited by the area that can be commanded, or that will take irrigation in any but the driest years, than by the run-off or yield of the catchment area. Mr. Beale recommends a project for storing about 8,000 million cubic feet on the Gajauni river, which it is estimated will irrigate over 60,000 acres, by means of a canal, to take off from the right bank of the Nira river, traversing the Phaltan State and entering the Malsiras taluka of Sholapur. The capital cost is estimated at about 109 lakhs, which is nearly double that of the Nira Left Bank Canal, but it will protect a larger area. If it is proposed to construct this work, we should be inclined to recommend that the storage capacity be increased from 8,000 to 10,000 or 12,000 million cubic feet. We think that, in spite of the greater capital cost, the work would be financially more successful, while its protective value would be greatly increased. The general financial results which are now anticipated, agree very closely with those set forth in paragraph 189, which were calculated long before Mr. Beale's estimate had been received.

178. If no larger or better scheme than this can be proposed, we think that, when worked out in greater detail, it will deserve favourable consideration; but we are not satisfied that it meets the requirements of the case. The proposed canal will terminate at the Kasal river, and will barely enter the Malsiras taluka, which is one of the worst famine areas in the Deccan. We are of opinion that an effort should be made to do much more for this taluka than is now proposed, if full effect is to be given to the policy of storing and utilizing the heavy rainfall in the Ghats; and that there should be, for each basin in which works are proposed, an exhaustive survey of the whole field both of supply and demand. In this case the size and length of the canal should be fixed with reference not to the storage which it may be possible to provide at any particular site, but to the total storage which may be provided within the whole basin by the construction of suitable reservoirs at all the more eligible or practicable sites. It will of course be unnecessary to provide storage in excess of what is required for the area that can be brought under command at a reasonable cost; and there are also many sites where the cost of impounding, or the engineering difficulties to be overcome, may be prohibitive. But, subject to these limitations, we should desire to see efforts made to store and to utilize as much as may be practicable of the rainfall over the whole catchment. We think, therefore, that no particular project should be sanctioned until all possible sites for storage works have been examined; and that the scope of any proposed canal should be fixed, primarily, with reference to the combined capacity of as many storage works as it may be found expedient to construct.

179. We have communicated these views in somewhat greater detail to the Government of Bombay, when returning the plans and papers connected with the project, which had been forwarded for our information. There is, however, one

feature in the scheme submitted which we may notice here, as it illustrates one of the difficulties connected with irrigation projects. Of the total area which will be commanded, about one-third will be within the boundaries of the Phaltan State. The canal is so eagerly desired that the Durbar will no doubt be willing enough to allow it to pass through its territory, if a fair share of the supply is allotted to the State; nor is there likely to be any difficulty in realizing the full water-rates which will be leviable within British Territory. But, as in most existing works in the Deccan, the net revenue on every acre irrigated is not likely to exceed Rs. 3; while the cost to Government, as represented by the interest charges on capital cost, will probably not be less than Rs. 9 per acre. In other words, one-third of the net annual cost to Government of this work would be incurred for the protection of those who are not its own subjects. This may be avoided if the Durbar can be induced to contribute towards the capital cost, in proportion to the share of the supply to be allotted to the State, making its own arrangements for the assessment and recovery of water-rates. If this cannot be arranged, we can only suggest that the area within the State for which irrigation may be provided, be restricted as much as possible, full compensation being, however, paid for the land to be actually occupied by the canal; and that a larger share of the supply be carried on into the Sholapur district.

180. *The Godavari project.*—The Godavari river project was first investigated in 1870. A favourable site for head-works was found on the Godavari river at Nundur-Madhmeshwar, 20 miles below Nasik, and canals taking off from the right and left banks would command 80,000 acres in Nasik and Ahmadnagar. The river, however, is practically dry during the first six months of the year, and the construction of these canals depends on the possibility of finding suitable sites for storage works on ghat-fed streams. The storage required is not less than 5,500 million cubic feet. It has been suggested that part of this might be given by the proposed Karanjawan tank scheme, which has not, however, yet been properly investigated; and that a second reservoir might be made on the Dharna river. The possibility of providing adequate storage works which may be relied on in all years should be examined, and if suitable works can be proposed, the Godavari Canal project should then be considered in detail.

181. *Bhima and Ghod rivers.*—Useful works taking off from tanks or weirs on the ghat-fed rivers Bhima and Ghod, appear to be possible and to deserve further investigation.

182. *Krishna Canal.*—The question of an extension of the Krishna Canal presents many difficulties. Two sites have been proposed for storage works; but both have been abandoned as unsuitable, and there are at present no suggestions for others. If an adequate supply could be made available, there is a fine field for the extension of irrigation in the Krishna valley both in the Satara and Bijapur districts; but the plans show that there will be great difficulty in obtaining the required command, and that the works are likely to be very costly. All that can be said is that the question has never been exhaustively examined; but it may be hoped that further investigation will result in the discovery of suitable sites for storage works, and of a practicable alignment for a canal which would undoubtedly have a great protective value, especially if it can be carried into Bijapur. Apart from any large schemes of this kind, it seems that there is a field for construction of *bandharas* in the upper parts of the Krishna. These would be useful works, although the tracts to be benefited are less exposed to severe famine than other parts of the district. The possibility of extending irrigation into Kolhapur State also appears to deserve consideration.

183. *Panna river project.*—The Panna river project has been proposed by Mr. Visvesvaraya, who estimates that 5,000 million cubic feet can be stored —a volume sufficient for the annual irrigation of from 14,000 to 30,000 acres according to the class of cultivation,— and that the total cost of the works would not exceed 34 lakhs. This appears to be a promising scheme, worth further

investigation, although the area to be commanded is less insecure than those to be protected by other projects.

184. *Mula river project.*—The Mula river project has not yet been very carefully examined, but enough information has been obtained to justify a more detailed investigation. A promising site for a reservoir has been found only five miles above Rahuri; it is said that a storage capacity of about 10,000 million cubic feet can be here obtained, and that an area sufficient for such a supply can be brought under command. Such a storage work should suffice for the irrigation of between 50,000 and 60,000 acres in ordinary years, and this area would be considerably increased in years of drought. The cost has been roughly estimated at about 90 lakhs, and it is said that the area to be submerged in the reservoir is chiefly waste and forest land.

185. *Other projects.*—The Siv-Dhinli Tanks have also been proposed by Mr. Visvesvaraya, who estimates that they will be capable of providing a net storage of 1,600 million cubic feet for the extension of irrigation at the lower end of the Mutha Canal, or in the western side of the Poona district, and that the cost is not likely to exceed Rs. 15,00,000. The area to be irrigated in ordinary years will vary from 5,000 to 10,000 acres, according to the percentage of higher class crops. This is not a very costly project, but its protective value will be considerable, and it is likely to yield as good a return on the capital as can be expected in works of this class.

186. The Malprabha scheme is at present little more than a suggestion. All that can be said of it is that it would provide an unfailing supply if suitable storage works could be constructed; but nothing is known of the area that can be commanded, or of the probable cost, and this information can only be obtained by further investigation.

187. *Scope of the foregoing projects.*—The foregoing list of works is not put forward as a complete programme of practicable projects. It may hereafter be found that many of the works proposed are not practicable, and, on the other hand, that many new schemes may be added to the list. Until the surveys which we have recommended have been completed, it is impossible to say what works may be practicable. Nor can we tell at present what storage may be available for all the works proposed, what areas they will command, or what areas will be irrigated on the average and in famine years. From such information as has been put before us we doubt whether all these works, if carried out, would, at any rate for many years after their completion, irrigate on the average more than 300,000 acres a year. In a year of drought the area would probably be increased to 500,000 acres, or about double the area at present irrigated by State irrigation works of all kinds. The ultimate areas to be irrigated by new protective works may be greater or less than now stated, but we put forward these figures as giving what appears to be at present a rational idea of the extensions of irrigation that may be possible, if every ghat-fed river in the Deccan is put under contribution, and as a basis for determining the cost of a given degree of protection.

188. *Probable capital cost.*—The capital cost of irrigating an acre can only be estimated on the basis of experience gained on existing works, and of detailed projects for new works. It has been shown (paragraph 154) that the average rate for existing works of Class B is Rs. 188 per acre, but of these the only really typical work is the Nira Canal, the rate for which, based on the average area for ten years, is Rs. 174 per acre. This rate is probably too high. Both the irrigated area and the net revenue have been steadily progressing on the Nira Canal of late years, and there is reason to think that the average area during the last five years (over 40,000 acres) may be maintained, in which case the capital cost of irrigating an acre on this canal may be put at Rs. 140. The rates for the Maladevi and Chankapur projects, which we have carefully examined, will apparently work out to Rs. 170 and 181, respectively, but these are estimated, and not actual, rates. On the whole, we do not think that it would be safe to reckon on the capital cost of new projects working out to less than

Rs. 200 per acre of average annual irrigation after the work is fully developed. The capital cost of providing for the average annual irrigation of 300,000 acres will at this rate amount to six crores of rupees. As to the return that may be anticipated, it has been shown that the present average return from all first class irrigation works in the Deccan, averages just 1 per cent. On works in Class B the return has averaged only 0·79 per cent., but the average on the Nira Canal during the last five years has amounted to 1·2 per cent.; and if the canal is worked so as to encourage the cultivation of a higher percentage of high class crops, the return may eventually rise to nearly 3 per cent. Such a rate may be ultimately realized on almost all new works, but some failures must be expected; and when allowance is made for the fact that irrigation on new works develops very slowly, it will not be safe to anticipate a higher average return on all new works than 1 per cent. Thus, taking the rate of interest at 4 per cent., it may be said that one-quarter only of the capital cost will be remunerative; the remainder, or Rs. 150 per acre, will yield no direct return; or, in other words, a permanent charge will be imposed on the State of Rs. 6 for every acre of crops irrigated by the works.

189. *Probable financial results of expenditure proposed.*—In order to secure a system of works capable of irrigating an average of 300,000 acres in a series of years, or a maximum of about 500,000 acres in years of drought, the State will therefore have to incur a capital expenditure of $4\frac{1}{2}$ crores which will be wholly unproductive, and impose for many years an annual charge on the tax-payer of 18 lakhs. Eventually, as irrigation on all works becomes fully developed and its advantages are more and more appreciated, the charge may be gradually reduced to about half that amount. If it is proposed to protect a larger area, the cost of protection may be relatively greater, because there must be a limit to the number of works which can be constructed at the average rate of capital cost assumed. We may, however, remark here that the protective value of any works that may be carried out in the Deccan will not be limited to that represented by the areas which may be directly irrigated from them. The annual irrigati5n of from 300,000 to 500,000 acres, by means of water which would otherwise be carried on to the sea, must, by its effect on the spring level, render existing well-cultivation more secure. It will, at the same time, render possible a considerable extension of that form of cultivation, and thus provide a most important second line of protection. Our present purpose is not, however, to justify the heavy unproductive expenditure which such a scheme as is here contemplated will involve, but merely to give a clear idea of the amount required for a given measure of protection. On this point there should be no illusion. Whatever the area which it may be possible to irrigate by storing the rainfall in the Ghats, all available experience points to the conclusion that for every acre brought under annual irrigation, a capital outlay of at least Rs. 150 must be incurred, on which Government will receive no direct financial return. And although it is not possible to say, until the surveys of the Ghats which we have recommended have been completed, what is the ultimate area which may be irrigated by works of this class, and at a cost not greatly in excess of that which has been named, we are at present inclined to doubt whether it will exceed 500,000 acres, even in a year of famine or unlimited demand.

190. *Increasing the storage of existing works.*—In connection with the extension of irrigation from existing works, we may urge the importance of increasing the storage, from that available at the present full supply, or crest of waste weir contour, to that at or near the maximum flood level, by erecting self-acting gates on the waste weir; and, if necessary, increasing the full flood discharging capacity. The Bombay Public Works officers have devoted a great deal of attention to this subject. The Bhatgarh dam at Lake Whiting, which supplies the Nira Canal, is mounted with 81 gates 8 feet in height, by means of which the available storage is increased by this depth without danger, 45 of the gates being self-acting and of an ingenious design, originated and patented by Mr. Reinhold, a retired Bombay officer. These gates have been in use for several years and have worked admirably. A variation of this design, to suit special conditions, has been devised by Mr. Visvesvaraya, and

gates of this pattern have been recently erected on the Kharakwasla dam on Lake Fife, at the head of the Mutha Canals. Mr. E. O. Mawson has invented a self-acting gate working on quite a different principle, which also promises to be very useful in certain situations. It is also proposed to erect self-acting gates on the Dhupdal dam at the head of the Gokak Canal, which will increase the depth of storage by 7 feet. Similar gates should be provided, whenever the circumstances admit, in the case of new projects. We have ourselves suggested to the Bombay officers that they should be erected on the Maladevi reservoir, the capacity of which will be thereby increased by 1,000 million cubic feet, without any increase in the height of the dam. The only objection which we have heard to these gates is that they are expensive; but in large lakes the value of every extra foot in depth above the present full supply level, is so great that the expense will generally be fully justified. We think that a similar device might with advantage be applied to such of the smaller works as are liable to overflow frequently; and that the importance of reducing to a minimum the quantity of water that must pass to escape, should be generally insisted on. It may be possible to design a cheaper form of shutter for these works which, if not self-closing, shall at least be self-opening.

191. *Rain-fed tanks.*—We do not recommend the extension of irrigation by means of large tanks, like the Mhasvad, which are not dependent on the rainfall of the Ghats, or some unfailing source of supply. Many such works have been commenced in the Deccan as famine relief works, and many others, some of great magnitude, have been proposed. We have already shown that existing works of this class have been twice as expensive, with reference to the area protected by them, as works of Class B, and at least 50 per cent. more expensive than smaller tanks. Even as relief works they are open to objection. They are much too large to be completed by relief labour even in the course of two or three years of famine; and either Government is then committed to the heavy expenditure required to complete the work, or it has to stand over until the next occurrence of famine, when much of the old work will generally have to be done all over again. In the case of high earthen dams, there is a distinct danger in continuing work commenced many years before and held in abeyance during a long period. For relief purposes smaller tanks, costing, for works only, not more than five or six lakhs, are therefore to be preferred; for if they cannot be completed by relief labour, the subsequent cost of completion will not be great. There may be special cases in which it will be desirable to increase the existing means of protection by the construction of tanks. We should, for instance, be glad if the Manad Tank, or some other work, could be made for securing and improving the supply to the existing Jamda Canals in Khandesh, which, uncertain as it is, may possibly be injuriously affected by the development of the Girna river irrigation after the construction of the Chankapur reservoir. There appears to be some doubt about the foundations for a dam at the Manad site; but if a tank of the required capacity can be constructed for the amount estimated (Rs. 11,21,000), it may with advantage be carried out, especially if it is necessary to find employment for relief labour. But, speaking generally, we think it better that the energies of the Public Works officers should be devoted, for many years to come, to the design and construction of a system of canals fed from large storage works depending on ghat-rainfall, than on the large tanks dependent on local rainfall that have been proposed in the Khandesh, Bijapur, and other districts. Projects for smaller tanks should, however, be prepared in all districts in which such works are possible, for inclusion in the programmes of relief works if they cannot be recommended on their own merits for earlier prosecution. We shall make specific recommendations later on regarding works which have already been partially carried out by relief labour.

192. *Extensions of second class irrigation works.*—We understand that most, if not all, of the second class irrigation works were constructed originally by the people, although the Public Works Department is now responsible for their maintenance. If works of this kind were now constructed by the Public Works Department, they would, under the rules, be treated as first class works, unless their cost was less than Rs. 50,000. However they may be classed, there

is apparently some scope for such works, if the people cannot be induced to carry them out themselves. We are informed that the existing weirs, or *bandharas*, in Nasik and Khandesh utilize every drop of water in the rivers after the supply has fallen, and that no more works of this kind can be constructed in these districts. But it would appear possible to construct weirs at a moderate cost in many other rivers having rocky beds; and if self-opening shutters could be added, of the kind designed by Mr. Mawson, or some other suitable pattern, a good deal of irrigation might be effected on the margins of the rivers. A series of such weirs on a river might form a single minor work. We have already said that works of this sort would be feasible on the upper part of the Krishna and on many other rivers; and although the collective value of all possible new works of this kind will not be very large, the matter seems to be deserving of attention. The permanent *bandhara* system appears to be practically confined to the Nasik and Khandesh districts. This may be due to the fact that the conditions elsewhere are not favourable; but if it is due to ignorance of the system, or to the inability of the people to combine for the purpose of constructing the works, or to their not possessing the necessary means or skill, it seems advisable that the matter should be taken up in the Public Works Department.

(*iv*).—*Private irrigation works.*

193. *Field embankments.*—Field embankments, constructed for the purpose of retaining the rainfall on the fields and preventing the tilth from being scoured away, are very numerous throughout the Deccan, and their value appears to be appreciated. During 1896-97, and subsequent years to end of 1899-1900, over 12 lakhs of rupees appear to have been advanced as *takavi* for the construction of works of this class, which, although they cannot be called irrigation works, have an undoubted protective value. We have seen instances in which the works have failed and the land has been injured by the formation of ravines, owing to defective provision for running off storm waters, and advice and assistance may sometimes be required in this respect. There appears to be great scope for the extension of these works, upon which the people can be usefully employed in seasons of famine.

194. *Wells.*—Well-irrigation is a most important factor in the protection of the Deccan. Referring again to the table in paragraph 145, it will be seen that out of 847,000 acres, the average gross area irrigated from all sources, no less than 520,000 acres, or over 60 per cent., are irrigated from wells. In 1886-87, the total number of wells available for irrigation in the nine districts under consideration, amounted to about 117,000; this had increased to 151,000 in 1896-97, and to 171,000 in 1900-01. During the five years ending with 1901-02, 10,184 wells were constructed and 11,971 repaired, by means of Government loans. Over 50 lakhs have been advanced by Government for the construction and repair of wells during the decade ending with 1899-1900. Taking 520,000 acres as the average gross area under wells during the ten years ending 1900-01, it is found that the maximum occurred in the famine year of 1896-97, when 655,000 acres were irrigated. This shows that in spite of failures of individual wells, the underground water-supply may be relied on in a single, or the first, year of famine, notwithstanding the heavier demand made on it. In 1899-1900, or after four dry years, the area fell to 507,000 acres, notwithstanding an increase of 20,000 in the number of wells. There was a further decrease of about 80,000 acres in 1900-01, after a fifth year of drought, and many wells must then have failed. But these circumstances are exceptional; and after two or three years of good rainfall the spring level will rise again to the normal level. On the whole, we have no doubt that well-irrigation is a much less precarious form of protection than any other, with the exception of canals which draw their supply from ghat-fed storage works.

195. *Importance of extending well-irrigation.*—Except in the deep black soil parts, as in Bijapur, the depth of the spring level in the Deccan, below natural surface, is less than in the well-irrigating districts in Gujerat, so that wells can be more easily worked. They have, however, often to be sunk through

rock, and the initial expenditure in proving the water-supply is greater and more risky. On the other hand, the well when made requires no steining, and is never likely to fall in like the unlined wells in Gujerat. The only masonry required is a wall on one side of the well, which is usually square or rectangular in plan, to support the gearing. The cost of a double *mot* well, to irrigate about 6 or 7 acres, varies from Rs. 300 to Rs. 400. The area in the Deccan in which well cultivation can be carried on with profit is limited. The soil in the uplands is too thin and rocky; and Mr. Mollison considers that, even in the low lands, wells can only be profitably worked when the black soil does not exceed from 2 to 4 feet in depth, and has a permeable stratum of *muram* below it. But he is of opinion that the area at present under well-irrigation can be doubled; and he strenuously recommends the extension of this form of protection in all areas in which it is suitable. We are strongly of opinion not only that such an extension is deserving of encouragement by all the means, and subject to all the precautions, which we have discussed elsewhere; but also that it should be regarded as an essential part of the scheme of protection which we have put forward for the Deccan. There is evidence that, in those parts in which canal irrigation has been introduced, there has not only been a marked rise in the spring level, but also an increase in the amount of water passing into the drainage lines; and we have already pointed out that this will be one great indirect advantage of the extension of canal irrigation. We desire now emphatically to state that the extension of canal and well-irrigation should go on side by side; and that, in order to obtain the full measure of protection which new irrigation works will afford, it is essential that supplementary measures be taken to encourage the construction of wells and *bandharas* within, or on the margin of, the areas to which canal irrigation is to be extended. The tract is one in which it would seem particularly justifiable to offer loans with long periods of repayment, and even free grants; for the life of a well is evidently far more secure in this country than, for instance, in Gujerat.

196. *Wells for sugar-cane.*—We may refer here to a suggestion which has been made by Mr. Mollison, that canal irrigation for sugar-cane or perennial crops should be withheld from any holding in which the owner had not constructed a well from which the crop could be watered during the hot weather, or from 1st April to the setting-in of the rains; the idea being that a canal supply should not be guaranteed during this period. We have been told that cane cultivation at the lower ends of the canals is now often protected by wells; and that lower water-rates are charged than on lands nearer the canal heads, which receive an annual supply during the hot weather. We are unable to say whether the universal adoption of Mr. Mollison's proposal would unduly restrict the extension of cane cultivation, or result in the long run in any material loss of revenue; but we fully recognize the advantage of avoiding any obligations in respect of the hot weather supply, and we think that the question deserves careful consideration. Mr. Mollison has been conducting a series of interesting experiments as to the quantity of water required for the successful cultivation of cane; and he seems to be in the way to demonstrate that under the existing system the total consumption of water is largely in excess of what is necessary, owing to the irregularity in the intervals at which the supply is given, and the consequent flooding of the crop by the cultivator whenever he gets the water. The results of these experiments should be carefully studied as soon as they are known, with the object of devising measures for economizing the distribution of water, of the kind which we have referred to in paragraph 167. If the Irrigation Department is able to do what may be required of it in the way of giving the smaller supplies at regular intervals, it will be justifiable to put considerable pressure upon cultivators to change their methods of irrigation for those successfully followed by the Agricultural Department.

197. *Borings and surveys of the underground water-supply.*—It has already been observed that wells in the Deccan have to be sunk into or through rock. The recommendations which we have made elsewhere (I, 176) for a systematic survey of the underground water-supply, and for the formation of a special expert establishment which would undertake borings and examination of sites, and assist the people in sinking their wells, are specially applicable to the Deccan districts.

From some borings which were made with common jumper bars, in the Sholapur district during the famine, it would appear that it may be possible to penetrate the trap rock in places and reach water-bearing strata at moderate depths. Systematic boring may prove to be of great value in determining the existence and accessibility of such strata. No time should, in our opinion, be lost in organizing a well-boring agency with suitable equipment on the lines followed in the United Provinces.

(*v*).—*Famine works and programmes.*

198. *Expenditure on relief works in 1896-97.*—The Famine Commission of 1898 reported that the expenditure on relief works in the Deccan during the famine of 1896-97 amounted to Rs. 95,77,000, distributed as follows :—

	Rs.
Roads and metalling	71,46,000
Railway work	8,40,000
New irrigation works	13,17,000
Improving old works	1,48,000
Water-supply	1,26,000

The actual or normal value of the work done on new irrigation works was estimated at about one-third of the expenditure incurred, but it was doubtful whether many of these new works would be completed. Relief labour was employed on many of them during the recent famine, so that if these works should be eventually completed, the work formerly done will not have been wholly thrown away. The completion of the most important of them all, the Shetphal Tank, has been sanctioned, and it will be a useful protective work. The Kapurvadi Tank at Ahmadnagar has also been completed, but this is intended more for water-supply than for irrigation.

199. *Expenditure during recent famine to end of March 1902.*—As relief works have not yet been closed throughout the Deccan, we have not been able to obtain final figures of the expenditure incurred on them during the late famine, but the approximate amounts to end of October 1901 are understood to be as follows :—

	Rs.
Roads and road-metalling	1,28,07,870
Irrigation works	77,09,937
Village tanks, etc.	6,45,185
Railways	2,46,933
Miscellaneous	1,191
Total Works	2,14,11,116
Establishment	4,86,546
Tools and Plant	11,16,225
GRAND TOTAL	2,31,13,887

In Bombay the system of large relief works, employing several thousands of labourers who come from great distances and are hutted on the works, has hitherto been generally followed; and the irrigation works on which relief labour has been employed, have been usually large tanks, the plans for which have been hastily prepared. We shall refer to the principal works which were thus undertaken in each district.

200. *Relief works in Khandesh.*—In Khandesh, there was at the commencement of the famine a complete scheme for the Chankapur Tank, the construction of which we have already recommended. Some work, the normal value of which is estimated at about Rs. 70,000, has been carried out by relief labour at this site; but it is understood that the greater part of this was executed in a former famine, and that very little was done during the late famine; the reason being that the locality was very unhealthy, while the

distress in this part of the district was not very severe. The Talwada Tank is a small storage work calculated to hold 177 million cubic feet and to cost Rs. 1,36,000. The dam was completed by famine labour, and we understand that the completion of the project as an ordinary work has been sanctioned. On the Purmepada Tank, work was carried out by relief labour, the normal cost of which is estimated at nearly Rs. 1,00,000. This is rather a large tank, with a capacity of 408 million cubic feet, situated on the Bori river, and estimated to cost Rs. 6,55,000. The supply will be ample except in the worst years, and the foundations of the dam are said to be excellent. It will protect nearly 6,000 acres, and will apparently have a greater protective and productive value than the average of tanks of this class. Operations have been stopped, but we think that the completion of this work should be contemplated. Relief labour was nominally employed on another large project in this district—the Raipur Tank, which has been roughly estimated to cost over 37 lakhs of rupees. The only work done, however, was the construction of a service road to the site. Other large storage works have been proposed—the Aner, Pankheda, and Karwand Tanks—and have been roughly estimated to cost 40, 26, and 16 lakhs respectively; while there are others like the Mulher for which even rough estimates have not been prepared. We have already shown that the protective value of large tanks of this kind is very small in proportion to their cost, unless they derive their supplies from unfailing rainfall in the Ghats, which none of these will do. We do not therefore recommend that these projects should be further investigated at present; and we think that they may remain in abeyance, at any rate until the more important schemes for ghat-fed irrigation works which we have proposed, have been investigated. And, for reasons already given in paragraph 191, we strongly deprecate the employment of relief labour on these large works, unless or until they have been estimated for in detail and have been formally sanctioned as desirable protective works. There is scope apparently in this district for a number of smaller tanks like the Purmepada or proposed Dahivel, schemes for which might be included in the programmes of relief works after proper investigation; but we think that works, the total cost of which, including all charges, is likely to exceed ten lakhs of rupees, should not be included, unless their construction as ordinary works has been definitely sanctioned on their own merits, and not as a means of employing famine labour. We should like to see attention directed to the preparation of projects for these small works, for inclusion in the programmes, rather than to the investigation of larger schemes, only a small portion of which could ever be carried out by the labour likely to be available in a single famine.

201. *Relief works in Nasik.*—In Nasik a small tank, the Khirdi Sathe, to hold 91 million cubic feet, has been almost completed by relief labour; but it is doubtful whether this will be used for irrigation or for the water-supply of the town of Yeola. Work to the value of about Rs. 42,000 was also carried out on the Odal Tank, which is estimated to hold 491 million cubic feet and to cost Rs. 6,30,000. The supply to this tank will apparently be very uncertain, and the quantity of work already done is not sufficient to justify its completion, except as a means of employing relief labour, for which it should be reserved. Other tanks have been proposed in this district, the Pimplad, the Karanjawan, and Waldevi. Some of these projects will have to be considered in connection with the Godavari project to which we have referred elsewhere. Our general recommendation here, as in Khandesh, is that an attempt should be made to draw up an extensive programme of works not likely to cost more than ten lakhs each, including all charges, but that larger works than this should not be entered in the programmes unless their construction as ordinary works has been sanctioned on their merits.

202. *Relief works in Ahmadnagar.*—The most important work on which relief labour was employed in the Ahmadnagar district, is the Visapur Tank, which was inspected by us. This is estimated to hold 1,061 million cubic feet, but it is not likely to fill except in years of more than average rainfall. The work was proposed as long ago as 1870, and was started as a relief work in the famine of 1897. The total value of the work done by relief labour to end of Octo-

ber 1901 is estimated at over 3½ lakhs, but the work has not yet been closed, and nearly three thousand labourers were employed on it at the time of our inspection, and also a number of prisoners. The total cost of the work is estimated at Rs. 15,19,000. Considering the expenditure already incurred on the work and the present state of progress, we think that its completion should be sanctioned; although we note that detailed plans and estimates have not been completed for the project, and at the time of our visit the arrangements for the distribution of the supply, and even the position and boundaries of the area to be protected, had not been determined. In our opinion such a work as this should not have been begun as a relief work until the project had been more thoroughly investigated, and it would have been better to have employed the labour on a number of smaller works. Nevertheless we think that proposals for its early completion should be favourably considered, provided that a complete estimate is submitted.

203. The other new irrigation works on which relief labour was employed in this district are the Ojhar Right Bank Canal and the Musalvadi Tank, the value of the work done being approximately Rs. 5,00,000. Another 5 lakhs will be required to complete these two works, but their protective value will be small unless the Maladevi project, of which they really form part, is completed. We have already recommended the early prosecution of the Maladevi reservoir, and these two works should be completed as part of that project as soon as the estimate may be sanctioned. They will not get an annual supply until the reservoir is completed, but they will be of some use. If the Maladevi project is negatived, we doubt whether it will be advisable to spend another 5 lakhs on these works for the sake of completing them, though they may be completed as far as possible by relief labour on the next occurrence of famine. The Maladevi project, if sanctioned, will afford a great deal of employment for relief labour, if famine should occur before its completion; and the same may be said of the Godavari and Mula river projects, the early investigations of which may be recommended on this account alone.

204. *Relief works in Poona.*—We have already referred to the Shetphal Tank in the Poona district, as a work on which relief labour has been largely employed since 1896-97, and the completion of which has been sanctioned. It is a tail tank on the Nira Canal, and as such will have a considerable protective value. Relief labour was also employed in this district, during the late famine, on the Khamgaon and Warwand Tanks. The former may with advantage be completed at once, but the latter may be held in reserve for the future employment of relief labour.

205. *Relief works in Sholapur.*—In the Sholapur district, relief labour was employed during the late famine on six moderately sized tanks—the Pathri, Manji, Vadshivne, Badhihal, Hotgi, and Bambhurdi—the aggregate estimated cost of which, including all charges, amounts to Rs. 37 lakhs; that of the largest, the Badhihal, being only a little over ten lakhs. The policy which we have recommended above, of employing relief labour on tanks not estimated to cost more than ten lakhs, has therefore been adopted in this district. The actual value of work done up to 1st October 1901 is reported as amounting to Rs. 12,66,000, but the works have not been closed, and more must have been spent since then. It will be advisable to complete all these tanks as ordinary works, if they were not completed when the relief works were closed; with the possible exception of the Bambhurdi, on which comparatively little has been done. There are many other proposals for tanks of the same class in other parts of the district for which detailed plans and estimates should be made out without delay, so that they may, after professional scrutiny, be included in the programme of relief works. This district is in urgent need of protection; and although a portion of it may eventually be commanded by ghat-fed canals from the right bank of the Nira (the Gajauni project) and the left bank of the Bhima, it is on rain-fed tanks that reliance must mainly be placed. We are aware that such works are liable to fail in seasons of general and prolonged drought. But they will often have a considerable protective value, besides strengthening the position of the cultivator in ordinary years; and, considering

how much of the work can be successfully carried out by relief labour, we consider that their real cost to the State will not be excessive, in comparison with the protection which they will collectively afford. In any case, it seems doubtful if anything better can be done for Sholapur.

206. *Relief works in Satara.*—In the Satara district, the only large work on which relief labour has been employed is the Goregaon Tank, the value of the work done being estimated at Rs. 1,42,000. The total estimated cost is nearly 12 lakhs, of which $3\frac{1}{2}$ are for land compensation, establishment, and indirect charges. The tank will hold 751 million cubic feet when full, but not more than 450 millions in a year of average rainfall. We are not able to recommend that anything more should be done at present to this work than may be necessary for safe-guarding the work already done, as its protective value will be small in comparison with the expenditure, and there appears to be some doubt as to the foundations of the dam; but if, on examination, these are found to be reliable at a moderate depth, work might be resumed hereafter for the purpose of employing relief labour, if no more suitable work can be found. Some other works have been proposed in this district in connection with the Yerla and Man river works, and these should be worked out in detail for inclusion in future programmes of relief works.

207. *Relief works in Bijapur.*—In Bijapur, relief labour was employed in the Sangogi and Hullur Tanks which have been roughly estimated to cost $24\frac{1}{2}$ and 6 lakhs, respectively. The value of the work done has not been reported, but we understand that the labour was employed in the excavation of the puddle trenches, and their partial refilling with puddle. At Sangogi the trench was in some parts over 50 feet deep. The Sangogi tank will be costly, but it is estimated to hold 2,845 millions of cubic feet in ordinary years, which would suffice for the irrigation of 12,500 acres. This district is so exposed to famine that we hesitate to recommend the suspension of an important work of this kind if it can be completed for the amount which has been named. We note, however, that not only has the cost not been estimated in detail, but also that the area which can be commanded has not yet been determined, and that there is some doubt whether there will be a demand in ordinary years for irrigation up to the full capacity of the tank. Moreover, although it is estimated that the tank will fill in 20 years out of 26, or with an annual rainfall of $19\frac{1}{2}$ inches against an average of $24\frac{1}{2}$ inches, we find that a rainfall of $3\frac{1}{2}$ inches only was recorded in 1876, of 12 inches in 1891 and 1899, and of little over 8 inches in 1896. In such years the tank would be liable to fail. Lastly, there is evidence that the cultivators in Bijapur are not disposed to resort to irrigation except under pressure of severe drought. A remarkable instance of this is the Muchkhandi Tank, the only first class work in the district, the water available in which has been practically unutilized. Two other second class works, the Nilgund and Inchgeri Tanks, have also been abandoned because the cultivators would not use the water. These are small works, and the disinclination of the cultivators to resort to irrigation appears to have been due to the uncertainty of the supply and other local causes, and we do not regard the facts as conclusive against a further extension of tank irrigation in Bijapur, though they indicate the necessity for caution. On the whole, we are disposed to recommend that operations on the Sangogi Tank should be confined to completing the excavation and filling in of the puddle trench, and protecting the work already done, so that work can be resumed on the dam whenever it may be again necessary to employ relief labour. The Hullur Tank is a much smaller work, and it may be advisable to complete it as an experiment; for although an extension of the Gokak Canal into a corner of this district may be possible, it is only by rain-fed tanks that the greater part of it can be given any protection whatever. But a final decision as to the expediency of completing these works can only be passed after detailed estimates and proposals have been submitted by the Local Government. The estimates which have been put before us of the cost of completion, and of the financial results anticipated, are avowedly approximate, but we think that works of this kind in Bijapur are not likely to pay more than their working expenses. Another small tank, to cost 4 lakhs only, has been proposed at Kalaskop.

It can be recommended only as a means of employing relief labour, for which it is more suitable than such a large work as the Sangogi Tank. Other projects of this smaller type should be proposed for inclusion in the programmes of relief works.

208. *Relief works in Belgaum and Dharwar.*—Relief labour was not employed in the Belgaum and Dharwar districts on new irrigation works which have not been completed. In the former, the Durdundi Tank, a tail tank on the Gokak Canal, estimated to cost $9\frac{3}{4}$ lakhs, would seem to be an excellent work for the employment of relief labour, if not previously undertaken on its own merits as part of the Gokak Canal extension scheme; for, as the supply to the tank will be assured even in the driest years, it will have a great protective value. If the proposals for the extension of the Gokak Canal are sanctioned, there will be a great scope for the employment of relief labour until the works are completed. Other small tanks have been suggested in this district, but the projects have not yet been sufficiently investigated to justify their inclusion in programmes of relief works. In Dharwar several small works have been proposed on which large numbers of relief labourers could be employed with advantage. The most promising of these are Pudkalkatti and Kardikop Tanks, each of which is estimated to cost about $6\frac{1}{4}$ lakhs. Relief labour might be concentrated on either of these without hesitation in the event of famine; and the works, especially the former, will be worth completing.

209. *Inclusion of village works in the relief programmes.*—The relief programmes for the Deccan districts which were shown to us, were those which had been sanctioned in 1901, and in accordance with which the current relief operations were being carried out. Their character is sufficiently indicated by the account which we have given of these operations and by the figures in paragraph 199. The programmes for the future were under consideration. We have already expressed an opinion that these programmes should not include any large irrigation works, the total cost of which, including land compensation, establishment, and all indirect charges, is likely to exceed Rs. 10,00,000, unless the construction of these works has been sanctioned by competent authority, on their merits as productive or protective works. It is desirable to have on the programmes of each district a few tanks of the smaller kind which we have been considering—those likely to cost from 1 to 10 lakhs—or to provide work of a normal value of from $\frac{1}{2}$ a lakh to 6 or 7 lakhs, which can be undertaken by relief labour. There must be a few large relief works of this kind to form the backbone of the district system of relief works. But we think that in the Deccan, as elsewhere, the policy of supplementing these works with small village works, which was recommended by the late Famine Commission, should be developed as far as possible. We have already shown the great importance not only of the second class works which exist in these districts, but also of the private irrigation works; and we think that in all future programmes the strengthening, repair, improvement, or extension of these useful works should find a place.

210. Mr. Beale has suggested—

> That certain tracts of country would benefit by the construction of what may be called *kachcha* tanks formed by *bands* suitably drained to avoid slips, but with no puddle trench. The function of such *bands* would be to head up the water for a period, and let it escape gradually, thus raising the surrounding subsoil water-level, and producing a small and more permanent flow in the *nala* below. The material employed for the construction of the *band* would preferably be stones and *muram* alone, or with earth if the hard materials be scarce. * * * The *kachcha* tank is recommended for districts where well-irrigation is practised, where the nature of the catchment area and rainfall would not warrant the heavy expense of an ordinary tank,.....and where the wells are liable to be brackish when the water is low.

Works of this kind are to be found in other parts of India and are well suited for famine labour. Their construction as relief works may be recommended whenever the water which may percolate through the dam can be utilized lower down.

211. It is not our duty to say by whom or in what manner the programmes for these petty works should be prepared, or what arrangements should be

made for the distribution, payment, and supervision, of the relief labourers who may be employed on them. There are no doubt difficulties in making thoroughly efficient arrangements of the kind; and these difficulties are perhaps intensified in *rayatwari* provinces, where there are few or no persons of the landlord class to command influence and secure unity and co-operation in a neighbourhood. But the more extensive employment of relief labour on small works has been distinctly recommended by the last Famine Commission, and we are unable to believe that these difficulties are insuperable. Whatever the advantages of the concentration of labour on large works, there is, in the greater portion of the Bombay Presidency at any rate, this disadvantage that the works themselves are likely to be of little utility for purposes of protection or agricultural improvement. It is better, in our opinion, to sacrifice a certain amount of efficiency in supervision, and to run the risk of admitting a certain proportion of the undeserving to relief, for the advantage of getting work done which will be useful even to a small section of the community. There is ample evidence of the collective importance of these works, and of the state of disrepair into which many of them have been allowed to fall; and we have no doubt that there is a wide field for the useful employment of relief labour on their improvement or restoration, if suitable means are adopted for collecting information as to what is required from those most interested. For the collection of the information persistent inquiry and systematic record will be indispensable. For this purpose, use can probably be made of the village and sub-divisional note-books which are now compiled in every province, and which show the results of the inspection and observations of the District Officers. Each officer should systematically inspect and record in these note-books what works of agricultural improvement or famine protection the village requires, and which of these might be executed by famine relief labour. Extracts from the note-books should be forwarded to the head of the district for use when he compiles his programme of village works. Such information should be embodied in all future programmes of relief works.

212. We do not propose that operations should be confined to small tanks for the storage of rainfall. As we have shown, there are many parts in which the system of *bandhara* irrigation can be extended, and much, if not all, of the necessary work could be carried out by relief labour. We would also call attention to the value of *tals*, or field embankments, in some districts; and to the importance of employing as much labour as possible on these useful works in seasons of famine, and generally on all well-considered schemes of agricultural improvement, however petty they may be individually, for which, after careful and wide-spread inquiry, place can be found in the programmes of famine relief works. It may be objected that these small works will benefit particular cultivators, and not the country at large. But we think it preferable that benefit should be conferred on a number of individuals, rather than that works should be undertaken which would practically be of no use whatever, either to individuals or the State.

CHAPTER XVI.—MADRAS.

(i).—*Local conditions; use and value of irrigation.*

213. *Physical features.*—The Presidency of Madras occupies the whole of the southern extremity of the Indian Peninsula, and almost surrounds the Native State of Mysore and the Province of Coorg. It is traversed by two great ranges of hills, the Eastern and Western Ghats, which extend along the opposite coasts, leaving, between them and the sea, a plain of about forty or fifty miles in breadth. These ranges divide the Presidency into three broad divisions—

(1) the long and broad belt lying between the Eastern Ghats, the southerly extension of the united Ghats, and the Bay of Bengal; and extending from the borders of the Chilka lake to Cape Comorin, along a coast line of about 1,250 miles;

(2) the shorter and narrower strip lying between the Western Ghats and the Arabian Sea, along a coast line of 450 miles; and

(3) the table-land lying between the two Ghats.

214. *Rainfall.*—As might be expected, the two hill ranges influence the rainfall materially in the different tracts. The Western Ghats arrest the greater portion of the rain brought up from the Indian Ocean by the south-west monsoon, and cause excessive rain precipitation on the narrow strip of coast line on the western side of the Peninsula, comprising the districts of South Canara and Malabar and the Native States of Cochin and Travancore. Where the range is of great height, as between Malabar and Coimbatore, the rain-bearing clouds are almost entirely diverted from the districts immediately below the Ghats on the eastern side; so that, while the annual rainfall on the western side exceeds 100 inches, under 20 inches may be registered on the eastern side immediately within the influence of the mountain ranges. In places, however, the clouds pass over the hills, where their elevation is lower, or escape through the gaps which here and there occur, and rain is then precipitated in larger amount over the tracts lying to the east of the Ghats. The Eastern Ghats act in a similar way, but only on the north-east monsoon which blows from the Bay of Bengal; and, owing to their lower elevation, their influence is not so great as that of the other range. Over the greater part of the Presidency the heaviest rainfall of the year is brought by the south-west monsoon. In June and July the rainfall is usually light, but in August and September it becomes more general and heavier. In the latter month the westerly winds die away, and, with the receding monsoon, the heavy October rains of the Coromandel Coast set in. These, known as the north-east monsoon rains, continue generally until February and occasionally bring some late rainfall to the extreme south of the Presidency. In the plateau, or table-land, lying between the Ghats, the rainfall, which is brought by the south-west monsoon, is the lightest in the Presidency, the average fall in parts of the north-western portion of this area being barely 20 inches. The greater portion of the plateau frequently suffers from unseasonable or deficient rainfall; more especially the Deccan districts, comprising Kurnool, Bellary, Anantapur, and Cuddapah, and parts of the central districts, comprising North Arcot, Salem, Coimbatore, and Trichinopoly.

215. The rains of the south-west monsoon regulate the bulk of the sowings on the lighter classes of dry land and are thus of the utmost importance to the Presidency as a whole. If they are late, the sowings on these soils will be untimely and the ordinary crops will suffer in consequence, or others of a less valuable character have to be substituted for them. Such a delay, if the rains are ample towards the end of the period, is not of much consequence on the heavier soils; for, from their nature, they are more retentive of moisture and are not usually sown till the latter end of this period or early in October. The south-west monsoon rains are also of great value to the Presidency, even when they fall beyond

its limits; for it is on them that the supplies in the great rivers which are utilized for irrigation—the Godavari, Kistna, Cauvery, and Tambraparni—mainly depend. These rise in localities where the south-west monsoon rains are usually very heavy and almost unfailing. The rains of the north-east monsoon are chiefly of importance in filling the numerous tanks which are scattered over the Presidency. Some unirrigated cultivation is also carried on under their influence; but, except in the extreme south, this is usually either on the heavy soils at the beginning of the period, or on the lighter soils, with inferior or catch crops, later on.

216. *Soils.*—The soils of the Presidency are for the most part loamy, gravelly, or sandy soils, derived from the disintegration of the local rock formations, alternated by the alluvium of the great river deltas, or by wide stretches of black cotton soil. These latter are found chiefly in the southern part of Kistna and the adjoining portion of North Nellore, in the valley of the Kundér river in Kurnool and Cuddapah, in the eastern part of Bellary and adjoining taluks of Kurnool and Anantapur, in the southern part of Coimbatore and the Palni taluk of Madura adjoining, and in the southern parts of Madura and the neighbouring taluks of Tinnevelly.

217. *Total cultivable and cultivated area.*—Excluding the Native States of Travancore and Cochin, and the smaller States of Pudukota, Sanduru, and Banaganipalli, which cover an area of about 9,900 square miles, the total area of the Presidency amounts to nearly 141,200 square miles, of which 19,200 square miles are occupied by the agency tracts of the Northern Circars, and over 29,600 square miles by *zamindari* and proprietary estates, regarding which no detailed statistical information is available. Of the remaining area, amounting to over 61·55 million acres, not more than 36·53 million acres are returned as cultivable, and the balance either as "Forests" (12·38 million) or as "not available for cultivation" (12·64 million). Of the cultivable area, about 30¼ million acres, or 83 per cent., are under occupation, of which about 24½ million acres are annually under crop. Including the area cropped more than once, the average area annually sown is about 26 million acres.

218. *Crops.*—About 80 per cent. of the area cropped is devoted to food-grains, of which rice is the most important, occupying from 6½ to 7 million acres, or about one-fourth of the total cropped area. It is grown largely in all the districts along the east and west coasts and in North Arcot and Trichinopoly. It is the crop most commonly cultivated under all the irrigation works, though, on the west coast and in parts of Ganjam and Chingleput, an inferior variety is grown on unirrigated lands as a rain-fed crop. The next most important crop is *juar* or *cholam*, of which there are several varieties grown on different soils and at different seasons. It accounts for about a sixth of the total area of crop, and is of great importance in Kistna and Nellore and in the Deccan, Coimbatore, Trichinopoly, and Madura districts. *Bajra*, or *cumbu*, is another important crop which is grown largely in Vizagapatam, Kistna, Cuddapah, South Arcot, the Central districts, and Tinnevelly, and occupies about a tenth of the total cropped area. It is chiefly dependent on the early rains. The other dry crops which deserve mention are *ragi* and *varagu* which account for 6 and 8 per cent., respectively, of the cultivated area. Amongst the industrial crops, cotton occupies about one and one-third million acres, and oil seeds one and three-quarter million, or about 5 and 6 per cent., respectively, of the total cropped area. Cotton is grown principally in the black soil tracts of the Deccan and in Kistna, Tinnevelly, and Coimbatore. Of the oil seeds, ground-nut is becoming an important crop, and its cultivation is extending largely in South Arcot and the surrounding districts. Indigo is steadily declining; it occupied over 450,000 acres in 1896-97, but has now shrunk to 250,000 acres. Tobacco occupies about 100,000 acres and sugar-cane about 58,000 acres.

219. Crop statistics are not available for *zamindari* areas and alienated villages, but there is no reason to suppose that the distribution of the different crops in these tracts is very different from that found to exist in the *rayatwari* portion of the districts in which they are situated. It may, therefore, be safely

assumed that out of an estimated area of ten million acres under cultivation in these tracts, about 25 per cent. is under rice, 16 per cent. under *juar* or *cholam*, 10 per cent. under *bajra* or *cumbu*, and 6 to 8 per cent. under *ragi* and *varagu*, respectively.

220. *Irrigated area.*—The gross area irrigated in *rayatwari* tracts, that is, the extent charged in the revenue accounts as irrigated in 1900-01, a fairly normal year, amounted to over $7\frac{3}{4}$* million acres, or nearly 28 per cent. of the total area cropped. This is inclusive of over $1\frac{1}{2}$ million acres irrigated from wells and about 71,000 acres from other private works. The balance of 6 million acres is irrigated from Government works. The bulk of this area is situated in the deltas of the Godavari, Kistna, and Cauvery rivers, which take their rise in the Western Ghats and, after traversing several hundreds of miles in their course eastward across the Peninsula, afford assured irrigation to large stretches of rich alluvial soils in the districts of Godavari, Kistna, and Tanjore. During the past decade, which included many unfavourable years, there has been a steady increase in the area irrigated by these larger works. The area irrigated by minor works averages $3\frac{1}{8}$ million acres, but the extent actually irrigated varies greatly from year to year, especially in the case of the smaller works, the supplies to which are entirely local and dependent on the seasonal rains. The variation sometimes amounts to half a million acres, and large remissions of revenue have to be granted in consequence. During the ten years ending 1900-01 these remissions averaged nearly 9 per cent. per annum, but they exceeded 10 per cent. in four years, and in one year they amounted to 21 per cent. In a favourable year, however, the area irrigated increases largely and the remissions shrink to less than 3 per cent. In the case of the larger works the remissions average about 2·6 per cent. of the total revenue, but on the three great delta works they are necessary practically only when crops are occasionally damaged by excessive floods.

221. *Areas irrigated in zamindari tracts.*—Accurate statistics are not available for the areas irrigated in *zamindari* tracts; but the Board of Revenue, in an estimate recently furnished to us, give the total cultivated area for *zamindari* and alienated villages at about ten million acres, and the irrigated area at about one-fourth of this, or $2\frac{1}{2}$ million acres. This is exclusive of the area irrigated from Government works amounting to 556,000 acres.

222. *Secure tracts.*—The districts which, as a whole, may be considered to be practically immune from famine are South Canara and Malabar on the west coast and Godavari, Kistna, and Tanjore, on the east coast. From their situation, the first two districts enjoy an almost phenomenal rainfall which has seldom been known to fail; whilst the three last are protected by magnificent irrigation works which afford an assured supply to immense areas of rice lands. In the western portion of the Godavari and Kistna districts, near the Ghats, there are some upland taluks where the cultivation is chiefly dependent on the rainfall, which averages about 30 to 35 inches; but as there is always a great demand for labour in the delta taluks, these tracts rarely suffer from any acute distress. The southern portion of the Tanjore district, outside the influence of the Cauvery system, is not properly protected; but the people find employment in the delta taluks and in towns, or in the neighbouring island of Ceylon in times of drought, and thus distress is never acute.

223. Besides the five districts mentioned above, the districts of Vizagapatam in the north and Tinnevelly in the south may also be said to be generally secure, though in a less degree. There have been periods of scarcity in both districts, but these have been few, and anything like severe famine has been unknown within the past half century and more. Vizagapatam enjoys a good rainfall which inland is seldom deficient; the soil is generally rich and fertile; hill streams are numerous, and the tanks, fed by them, irrigate a large area of double crop.

---

* *Note.*—This includes about 399,000 acres, comprising chiefly portions of survey fields left uncultivated through the rayats' neglect. As the non-cultivation is not due to any deficiency in the supply, the areas are charged as irrigated.

The great "Guntur" famine of 1833 scarcely affected this district; in 1865-66 it suffered only slightly; and in the famine of 1876-78 the distress was due more to high prices than to actual failure of the crops. In 1889 and in 1896-97 the district was practically immune, though Ganjam suffered severely. The labouring classes easily find work in the Godavari deltas, and several thousands also annually emigrate to Burma and Assam. The Tinnevelly district is situated immediately under the united Ghats, and enjoys the benefit of the early showers brought by the south-west monsoon and of the later rains of the north-east monsoon. Though the total fall is light, averaging about 27 inches, it is generally well-distributed. The Tambraparni river, which rises in the Ghats, affords perennial irrigation to a fairly large area on which two crops are generally raised, and there are several tanks and wells which irrigate some 200,000 acres in ordinary seasons. There is no record extant of the district having suffered from famine within the past century, though during a portion of the year 1876-78 a small number of people were on relief, and some distress was also felt in certain parts in 1891. The labouring population finds an easy outlet to the planting districts of Ceylon and to Travancore, where labour is usually in demand, and they consequently suffer but little in an unseasonable year. On the whole, therefore, the seven districts referred to above, which account for more than forty per cent. of the total area and population of the Presidency, may be regarded as fairly secure from famine.

224. *Tracts liable to famine.*—Excluding these seven districts, the remainder of the Presidency is more or less liable to famine, excepting such small areas as are protected by works of irrigation. The most insecure districts are those known as the Deccan districts, comprising Kurnool, Bellary, Anantapur, and Cuddapah, which have suffered several times from famine during the past century. They cover a total area of about 27,500 square miles, with a population of nearly four millions, the majority of whom depend upon agriculture for their support. The country is broken up by hills, and consists largely of soils of poor productiveness, though there is a very considerable stretch of black cotton soil on the southern and western boundaries of the Kurnool district, and in the adjoining taluks of the other three districts. Owing to the general poverty of the soil, over one-half of the cultivable area is assessed at rates not exceeding eight annas an acre; in Cuddapah the proportion rises to nearly two-thirds, and in Anantapur to over three-fourths, of the whole area. In the latter district more than one-half of the cultivable area bears a nominal assessment of two to four annas per acre, and in Bellary nearly a third of the area is similarly assessed. More than two-thirds of the landholders pay less than Rs. 10 a year to Government for their lands. The disastrous famine of 1876-78, which swept away nearly a third of the population, was followed by a succession of unfavourable years, and the districts have not yet fully recovered from their effects. A very large portion of the cultivable area is still unoccupied; and the recent census of 1901 showed that in two of these districts, Kurnool and Cuddapah, the population was still about 4½ per cent. less than it was thirty years ago; while in the remaining two, Bellary and Anantapur, the increase was not more than 4 and 6½ per cent., against an increase for the whole Presidency of 22·44 per cent. for the same period. These districts are drained by the Kistna and the Penner and their affluents; but, with the exception of the Kurnool-Cuddapah Canal, the Cumbum tank in Kurnool, and the Tungabhadra channels * in Bellary, there are no important irrigation works, and the crops are almost entirely dependent on a very precarious and scanty rainfall. The proportion of the occupied area irrigated in a normal year from all sources, including wells, amounts to only 3 per cent. in Bellary, 7 per cent. in Kurnool, and 13 per cent. in Anantapur. In Cuddapah, where the number of tanks and wells is large, it rises to over 20 per cent.; but in a year of severe famine, like that of 1876-78, the protected area, both in this district and in Anantapur, falls by almost 50 per cent.

225. The districts of Nellore, North Arcot, and Salem, have also suffered periodically from famine, the most disastrous of which was that of 1876-78. Since then considerable portions of the first two districts again suffered from

Note.—In Madras a distinction is made between artificial streams according as they are navigable or not. The former only are called canals. When the stream is not adapted for navigation, it is called a channel.

severe distress both in 1891-92 and 1896-97 ; and the increase of population, according to the census of 1901, is still greatly below the average of all other districts in the Presidency, excepting those of the Deccan. In Nellore and North Arcot, there is a very large area of *zamindari* land, in which the irrigation works are few and their supply precarious. In the Government taluks a great deal has been done to develop irrigation under the Penner river in Nellore, and the Palar, Poiny, and Cheyar, in North Arcot ; but the area irrigated by these systems does not at present exceed 85,000 and 150,000 acres, respectively. Including tanks, channels, and wells, the total irrigated area amounts to about 300,000 acres in Nellore and 350,000 acres in North Arcot, or about 20 and 35 per cent. of the average holdings. But in a year of prolonged drought hardly a fourth of this area can be effectively irrigated. In North Arcot, however, well-irrigation has largely developed and affords a considerable measure of protection.

226. The only other districts which remain to be noticed, are Chingleput, South Arcot, Trichinopoly, Coimbatore, and Madura. The Chingleput district has suffered from famine five times during the past century, and from failure of crops on many other occasions ; but, owing to its proximity to the Presidency Town, it has not felt the effects of the famine to the same extent as the districts already referred to. Over 50 per cent. of the occupied area is irrigated, but the nature of the irrigation works is such that hardly a tenth of the area is protected in a year of severe drought. The South Arcot and Trichinopoly districts are less liable to famine. In both a large area is protected by the Cauvery and Coleroon channels and other works, and it is only in the upland taluks, adjoining the North Arcot and Salem districts, that the crops are precarious. In Coimbatore, the rainfall is generally scanty and precarious, but the district possesses great natural advantages in the way of subsoil springs, which have been utilized to the fullest extent by an industrious and thrifty population, stimulated by liberal grant of State loans. The completion of the Periyar works has greatly improved the prospects in the Madura district. A very large portion of the district, however, comprises *zamindari* estates, which are more liable to famine than the Government taluks and in which the irrigation works are not at all in a satisfactory condition.

(*ii*).—*Existing State irrigation works.*

227. *Two main classes of irrigation works.*—Irrigation works in the Madras Presidency may be divided into two great classes. The first includes all the more important works which have been constructed, restored, enlarged, or extended, by the British Government within the last century, at a capital cost of over 8 crores of rupees, and which are now capable of irrigating annually from 3 to 3½ million acres. The second class includes all the smaller tanks and river channels which are scattered all over the Presidency, and many of which have existed from time immemorial. In consideration of the revenue derived from the lands irrigated from these works, Government has assumed certain responsibilities in connection with their maintenance and management, and devotes considerable sums annually to their upkeep, although very few of them were originally constructed at the cost of the State and still fewer at that of the British Government, and they cannot be regarded as State irrigation works in the same way as the works in the first class. The area annually irrigated from these works also varies from 3 to 3½ million acres, so that the total area irrigated from all the works with which Government is more or less directly connected, may be said to range from 6 to 7 million acres annually. This is a larger area than is irrigated from State works in any other province, although it will soon be exceeded in the Punjab. We shall now consider works of the first class, which includes all those classed as productive and protective, and all minor works for which capital accounts are kept.

228. *Works for which capital accounts are kept.*—These works have always been regarded as highly remunerative. Until a few years ago, the productive works in Madras yielded, as a whole, a higher return on their capital cost than was attained in any other province, and it is now second only to the

Punjab. Taking the thirty irrigation works, for which capital accounts are kept, we find that the total capital outlay to end of 1900-01 amounted to over 808 lakhs of rupees, while the average annual net revenue due to the works during the five years ending in 1900-01 amounted to nearly 63½ lakhs, and yielded a return of 8 per cent. on the capital outlay. The average area irrigated amounted to 3,292,825 acres, but much of this was old irrigation existing before the works were constructed. If we assume, as in paragraphs 230 and 231 below, that the area of new irrigation due to this capital expenditure may be taken at 2,065,000 acres, the average capital cost has been at the rate of Rs 39 per acre annually irrigated.

229. *Group divisions.*—These figures give a correct general idea of the protective and productive value of the irrigation works which have been constructed or restored by Government in this Presidency; but the works are of so diverse a character that it is necessary to analyze the figures in greater detail, in order to obtain a clear idea of the actual cost of irrigation. For this purpose the works may be divided into three main groups. The first of these comprises the great perennial canals in the deltas of the Godavari, Kistna, Cauvery, and Coleroon rivers, from which very large areas of level, alluvial lands are irrigated, without the assistance of storage works; the second group comprises all other canals which are fed directly from rivers, but which irrigate more difficult and uneven country than those comprised in the first group; while the third consists of works which depend for their supply mainly or entirely upon storage works. The first group comprises four, the second nine, and the third seventeen separate works.

230. *Old irrigation revenue.*—Before considering the results attained in each of these groups, it is necessary to point out that on all the works, with the exception of two, the Kurnool-Cuddapah Canal and the small and recently constructed Dondapad tank, there is a certain area of old irrigation which existed before capital expenditure was incurred, and is not a direct result of that expenditure. In the administrative accounts of the works, the revenue due to this old irrigation is deducted from the total revenue realized, and the balance only is credited to the canal account, and treated as the revenue due to the capital expenditure. Similarly, a deduction is made in some cases from the working expenses on account of the estimated value of old maintenance charges, the balance being regarded as the net working expenses due to the new irrigation. It is found that, taking the works as a whole, the revenue due to new irrigation, upon which the return on the recorded capital outlay is calculated, is about 63 per cent. of the gross revenue derived from the works, while about 37 per cent. is "old irrigation revenue," which it is assumed would have been realized from old works, if the capital expenditure had not been incurred. This factor of "old irrigation revenue" renders it difficult to ascertain with great accuracy the real productive and protective value of any work, as the amount of the old revenue, and also of the old maintenance charges, must be determined more or less arbitrarily, and the figures, which have been adopted, may possibly be open to criticism. The existence of this old irrigation has, however, to be recognized on almost all Madras irrigation works, and the method of accounting for it has been in force from the commencement of the new works, and has undoubtedly received very careful attention from the Madras revenue authorities. It is possible that some of the works have not been given full credit for their undoubted effect in keeping the returns from old irrigation more steady; but the substantial fairness of the present distribution of the total revenue between old and new irrigation has not been challenged by any of our witnesses, and we have no reason for believing that the share which is attributed to the construction of the new works, is, on the whole, appreciably more or less than may be properly credited to them. We therefore accept the figures which have been recorded as the most reliable that can be obtained. We may also assume, as sufficiently correct for our purposes, that the area of irrigation due to the works bears the same proportion to the total area irrigated as the revenue credited to the works bears to the whole revenue; that is, taking the works as a whole, about 63 per cent. This assumption is, no doubt, open to criticism, but we think that it may be safely adopted, at any rate when comparing the results attained in the different groups of works.

231. *Analysis of financial results by groups.*—The following is an abstract of the principal results obtained for different groups and sub-groups :—

Group.	Sub-group or section.	No. of works.	Capital outlay to end of 1900-01.	Percentages (average of 5 years ending 1900-01).		Average areas irrigated annually during the five years ending 1900-01.		Rate per acre of irrigation due to the works.		
				Net revenue on capital.	New irrigation revenue on total revenue.	Total area irrigated.	Assumed area of new irrigation.	Capital cost.	Irrigation revenue.	Working expenses.
1	2	3	4	5	6	7	8	9	10	11
			Lakhs.			Thousands of acres.	Thousands of acres.	Rs.	Rs.	Rs.
I.—Deltaic canals .	(*a*)	2	269·69	15·9	96·5	1,330	1,283	21·0	4·38	1·15
	(*b*)	2	40·25	33·6	26·1	1,083	283	14·2	4·30	0·49
II.- Other canals .	(*a*)	1	217·33	0·2	100·0	65	65	334·4	2·54	1·76
	(*b*)	8	14·18	12·8	40·3	153	62	22 9	3·45	1·27
III.—Storage works .	(*a*)	1	88·37	3·4	66·7	132	88	101·0	4·67	1·21
	(*b*)	3	128·37	3·0	55·5	316	175	73·4	3·09	0·98
	(*c*)	13	50·03	5·6	51 0	214	109	45·9	3·78	1·31
Total III .		17	266·77	3·6	56·0	662	372	72·0	3 66	1·13
GRAND TOTAL .		30	808·32	8·1	63·3	3,293	2,065	39·1	4·15	1·08

Note.—The figures for group III (*a*) in columns 5 to 11 are the figures for 1900-01 only, and not the average of five years ending with that year.

The rates in the penultimate columns have been struck on the irrigation revenue and areas due to the works, and represent the charges for water supplied to the cultivators. The total revenue creditable to the works, on which the percentages in the fifth column are based, includes miscellaneous receipts, but the amount of these receipts is very small. Out of a total revenue of over 85¾ lakhs, it amounts only to Rs. 1,94,000 for all works. Of this sum, Rs. 1,71,000 is realized on the first sub-group in Group I (the Godavari and Kistna Canals) and is mainly due to navigation.

232. *Godavari and Kistna Canals.*—The deltaic canals, forming Group I, may be considered under two sub-groups. The first comprises the Godavari and Kistna Canals. These are the only irrigation works in Madras which can be usefully compared with the great perennial canals of Northern India. They were, however, the first or pioneer works of the kind constructed in Southern India by the British Government, and are signal monuments to the genius of Sir Arthur Cotton, with whose name both, but especially the former, must always be inseparably connected. The grand results obtained by Sir Arthur Cotton on the Cauvery and Godavari Canals led to the subsequent construction of the Kistna works. It must be borne in mind, however, that the Godavari and Kistna Canals, like the great canals in Northern India, present the simplest form of the irrigation problem, excepting only that which has been met in the Cauvery works and in the inundation canals of the Punjab and Sind. The canals command level alluvial plains and draw their supplies from great rivers which are in flow all the year round, and on which large storage works, however desirable, have not been found necessary to secure the results already attained. The necessary command and control of the supply, in all seasons of the year, has been obtained by the construction of weirs or anicuts which hold up the water a few feet to the required level; and, although the construction and maintenance of these works have in almost all cases demanded great boldness and engineering skill, the cost, however great, has been small compared with the results which they rendered possible. Lastly, it may be said of all these works that the character of the climate and of the cultivation assures a practically continuous or constant demand, which is limited only by the supply, and which renders financial success almost a matter of certainty. It is only with canals of this class that the Godavari and

Kistna Canals can be fairly compared. If the figures given in the first line of the table in paragraph 231 are compared with those for the Punjab major works given in paragraphs 12 to 14, it will be found that there is a great similarity in the results brought out, whether regard be paid to the average return on the capital outlay, or to the rates of capital cost, of irrigation revenue, and of working expenses per acre irrigated. The fact that results so similar have been attained on two great systems of irrigation works, separated by nearly the whole length of India, designed and constructed by Irrigation Engineers of two different schools, and developed under two wholly independent administrations, cannot but be regarded as very remarkable; while it justifies some confidence in general conclusions as to the productive and protective value of works of this type.

233. *Cauvery and Coleroon works.*—The Cauvery and Coleroon works have been considered as a separate section of the deltaic group, as they form a special class, and cannot be compared with any other irrigation works. The main Cauvery river, on entering the delta, divides into a number of minor channels, of which the Coleroon to the north is the principal; and irrigation has been practised from these channels during the flood season from time immemorial. The distribution of the supplies entering these channels has, however, been subject to extraordinary fluctuations, depending on the vagaries of the river and the vicissitudes of the rainfall. Sir Arthur Cotton recognized, almost at the commencement of his Indian career, how much might be done by properly constructed works to control and improve the distribution; and on his initiative, an important old native work, the Grand Anicut, was strengthened and repaired, the Upper Anicut was constructed at the head of the delta or off-take of the Coleroon river, and many other works were made for improving the regulation. These, with subsequent additions, constitute the Cauvery works. There are no artificial canals or large distributaries, as the water is carried all over the delta by means of the river channels; and the efforts of the Irrigation Officers are mainly directed to controlling the distribution, so as to prevent a channel from running dry when water is most urgently needed, or to protect the cultivation on it from excessive floods at other seasons. The total revenue assessed annually on the Cauvery irrigation during the five years ending 1900-01 averaged Rs. 42,31,000, but of this, Rs. 32,91,000 has been treated as old irrigation revenue, the balance only being credited to the works. This balance represents a return of over 37 per cent. on the small capital outlay which has been incurred in improving the distribution. The lower Coleroon works are of less importance, but they are of the same class, and have therefore been grouped with the Cauvery. The average revenue realized from the lower Coleroon irrigation has amounted to Rs. 4,26,000, of which only Rs. 1,50,000 is old irrigation revenue, the new revenue representing a return of 25 per cent. on the capital outlay. The expenditure on these works has therefore been of a highly remunerative character, and has resulted not only in an increase of the irrigated area, but also in great benefits to the areas originally irrigated. The works are, however, of such an exceptional kind as to make it improbable that similar results will ever be attained elsewhere.

234. *Kurnool-Cuddapah Canal.*—The first work to be considered in the second group is the Kurnool-Cuddapah Canal, which, in comparison with the small degree of protection it affords, is one of the most costly and unremunerative irrigation works in India. It was part of a great scheme for the extension of irrigation in the Madras Presidency by the agency of a private Company. This scheme was first proposed in 1857 in consequence of the great success which had been attained on Sir Arthur Cotton's works in the deltas. The construction of the work was entrusted to the Madras Irrigation Company, by whom it was practically completed; but financial and other difficulties compelled Government to purchase and take over the works, the transaction being completed in 1882, when the Company was dissolved. We shall refer again to this work in the next section and are merely considering it separately now, because the capital outlay which has been incurred is absolutely so large, and the revenue returns have been so insignificant, that no true idea can be formed of the productive value of

irrigation works in the Madras Presidency if this canal is merged with all other works of the same class. As to the protective value of this work, it appears to have been at one time contemplated that the canal would irrigate 200,000 acres. The maximum area hitherto recorded is 90,285 acres, in the great famine year of 1876-77, when the canal was still under the management of the Madras Irrigation Company; but in years of normal rainfall, the area was not more than a third of this, the average for the four years preceding the second great famine year of 1896-97 being only 32,160 acres. In 1896-97 the area was 87,226 acres, and in other years of drought, such as 1891-92 and 1899-1900, it exceeded 73,000 acres. There has been a marked and satisfactory improvement since 1895-96, the average area for the following five years being 64,484 acres, and during this period the gross revenue has exceeded the working expense by about half a lakh. It is also worthy of note that, whilst the recent census shows a decrease in the total population in both the districts (Kurnool and Cuddapah), as compared with the population before the famine of 1876-78, the taluks which the canal traverses exhibit some increase which it may not be unreasonable to attribute to the protection afforded by the existence of assured irrigation.

235. *Sub-group (b) of Group II.*—The eight works * comprised in this section are typical of the most useful works that can be constructed in the areas outside of the three great deltas. They consist of canals of varying size, taking off from above anicuts across the beds of rivers, the flow of which is sufficiently constant during certain months in the year to permit the irrigation of considerable areas of single crop paddy, without the assistance of storage works, although storage works are valuable accessories. On these works, however, there are no storage reservoirs of any importance. The capital expenditure on the eight works has amounted to Rs. 14,17,716, and the area irrigated by them averages 153,000 acres, of which we have assumed that 62,000 acres are directly attributable to the capital expenditure incurred. The net revenue due to the works averages Rs. 1,36,000, or nearly 13 per cent. on the capital cost; so that, taken as a whole, this important class of works may be regarded as highly remunerative; and if the irrigated area assumed as due to the works may be taken as correct, the capital cost has not exceeded Rs. 23 per acre. Works of this kind are, however, so simple and so cheap that they have probably been already constructed in most of the places in which the conditions are favourable.

* Munyeru, Shatiatope, Vallur, Thadapalli, Arkonkota, Kalingaroyen, Nandiyar, Ganjam.

236. *Group III. The Periyar project.*—The works which have been placed in the third group depend for their supplies on large storage reservoirs, which have been formed by constructing dams across rivers or streams which flow irregularly during the rainy season, and are generally dry for the greater part of the year. The irrigating efficiency of any particular work depends so much on the size and nature of the catchment area, and on the rainfall over it, that comparisons with other works of the same class are difficult and misleading; but on most of these rivers a certain amount of irrigation has always been effected by means of anicuts and side channels of the kind which have been placed in Group II. The value of the storage work is indicated by the increase in revenue which has ensued on its construction, and on the improvement of the anicuts and distributary systems below them. The works differ so much in size that it is convenient to consider them in three sub-groups. The first of these is the Periyar project which must be placed by itself, not only on account of its magnitude and special character, but also because it was not completed until 1896, and its irrigation is hardly yet fully developed. For the latter reason, it is useless to consider, as in the case of other works, the average results attained during the last five years, and we have therefore shown, in the table in paragraph 231, the figures for the year 1900-01, as giving a better idea of the productive and protective value of the work. The annual return on capital outlay has been steadily rising from *nil* in 1896-97, to 3·43 per cent. in 1900-01; and it seems probable that, as irrigation develops, the average return for the future will be higher than that attained in the latter year, and that this [illegible] before long to yield a net revenue in excess of the

may eventually be reduced to less than Rs. 100. The conditions are, in many respects, very favourable for a large storage work, for the lake fills every year; and in every year but one since the opening, there has been so much surplus that the question of increasing the storage capacity appears to deserve consideration. It is satisfactory to note that there is a probability of a large storage work of this kind proving directly remunerative, but it may, at the same time, be inferred that such works cannot be expected to yield very large profits, even when the conditions of storage are unusually favourable.

237. *The Penner-Sangam, Palar, and Rushikulya projects.*—The second sub-group of this class comprises three large storage works, on each of which the capital outlay has exceeded 20 lakhs. Of these the most profitable is the Penner and Sangam project which has yielded an average return of 7·2 per cent. on a capital of 60 lakhs; but here, too, conditions are very favourable, as there is a good deal of direct irrigation from the Penner river, in addition to that effected from the reservoirs. On the other hand, the Rushikulya project, which also has some direct irrigation, has yielded a return of 0·6 per cent. only, on a capital of nearly 48 lakhs. The cost of this work appears to have been enhanced by faults in design and construction; and, as it was sanctioned as a protective work, it has been deemed advisable to withhold water at the end of the rains which might be utilized for second crop irrigation, and to reserve it for use in the following season—an arrangement which involves a certain loss of revenue. The average return for the three works in this sub-group is just 3 per cent., while the capital cost per acre of new irrigation is about Rs. 74.

238. *Smaller storage works.*—The third sub-group comprises productive works varying in cost from 15 lakhs to Rs. 44,000. These works have yielded an average return of 5·6 per cent. on the capital outlay, which amounted to about Rs. 46 per acre. They have, therefore, on the whole been distinctly remunerative; and the figures given support the general conclusion at which we arrived when considering the storage works in the Deccan, that for a given expenditure on works outside the Ghats, or region of unfailing rainfall, greater protection can be afforded by a number of small works of this class than by a few large works. This inference, however, is one that must be adopted with caution; and so much depends on the circumstances of each case that exceptions are likely to be very numerous.

239. *General conclusions as to financial results attained on storage works.*—From this analysis of the financial results attained on irrigation works in Madras for which capital accounts are kept, it will be seen that the general results for the works, as a whole, which are shown in paragraph 231, cannot be taken as an indication of those which may be anticipated for new works which may be undertaken in future. The conditions on the delta works are exceptionally favourable and will not obtain elsewhere; while, on the other hand, the abnormal cost of the Kurnool-Cuddapah and its unfavourable conditions render it necessary to exclude it from consideration. It is doubtful if there is much field for the construction of new river channels unaided by storage works; and it appears, therefore, that future extensions of irrigation must depend upon storage, and will fall under Group III. Taking this group as a whole, it is found that the capital outlay on seventeen works has amounted to 267 lakhs, on which the net revenue due to the works yields an average return of 3·6 per cent. According to the method adopted, the average area annually irrigated in consequence of this outlay may be estimated at 372,000 acres, or 56 per cent. of the area irrigated by the works, and the capital cost of the new irrigation may therefore be taken at Rs. 72 per acre. The revenue due to the works is at the rate of Rs. 3·66 per acre irrigated, while the average rate for working expenses is Rs. 1·13 per acre.

240. It must, however, be borne in mind that the capital cost per acre on new works is likely to be much greater than that incurred on existing works. The best and most eligible sites have probably been taken up, and much of the outlay of the past has been incurred on the restoration or improvement of old works. The average cost of new works is not likely to be less than Rs. 100 per acre, and the net revenue per acre would not be more than Rs. 2·5, assuming

that the present average rates for revenue and working expenses are maintained. On some works, on which great volumes can be stored with unfailing certainty, such as the proposed reservoirs on the Cauvery and Kistna, the results may be more favourable than this; but on others, such as the works in the Deccan, there will probably be a much smaller return.

241. *Works for which capital accounts are not kept.*—We have hitherto considered only works of the first of the two classes referred to in the first paragraph of this section, that is, works for which capital and revenue accounts are maintained. It has already been explained that works of the second class have not been constructed by Government; but heavy expenditure is nevertheless annually incurred by Government in respect of them, and the protective value of the works is so great that some reference must be made to them in this section. It is said that there are no less than 40,000 small irrigation works in the Presidency, consisting either of small tanks or river channels, which irrigate between them over 3 million acres, or about as much as all the works in the first class put together. Of these 3,460 of the larger works, irrigating over 200 acres each, are in the charge of the Public Works Department, and 31,376 works are in charge of the Revenue Department. The remaining works consist of very small tanks, irrigating less than 10 acres, and of a large number of 'spring' and river channels which are kept up by the rayats themselves. The areas irrigated by the works under the Public Works and Revenue Departments during the three years ending 1900-01 averaged 3,117,283 acres, on which a revenue of nearly 81 lakhs was assessed. The total expenditure annually incurred by Government during the same period, in the maintenance and improvement of the works, amounted to nearly 20 lakhs. These figures show clearly the great protective value of these works. As there is no capital account, their productive value cannot be stated; but it is sufficient to say that the charges for maintenance amount to about 25 per cent. of the revenue dependent on them. The general question of the administration of these works will be more conveniently discussed in the next section of this chapter.

(iii).—Scope for further extensions of State irrigation works.

242. *Recommendations of the Famine Commission of 1878-80.*—The Famine Commission of 1878-80 made the following recommendations as regards the irrigation systems of the Madras Presidency :—

First.—That the systems of the three great deltas might be completed.

Second.—That the proposal for storing the water of the Tungabhadra and thereby irrigating a large area in the famine-stricken district of Bellary, should be carefully examined.

That the following works should be executed :—

Third.—The Kistnagiri reservoir in Salem.

Fourth.—The Periyar project in Madura.

Fifth.—The Rushikulya project in Ganjam.

Sixth.—The Sangam project in Nellore.

Seventh.—That the Kurnool-Cuddapah Canal, the property of the Madras Irrigation Company, should be transferred to the State.

The fourth, fifth, sixth, and seventh of these recommendations have been carried out, and much has been done to improve and extend the area of irrigation in the three great deltas of the Godavari, Kistna, and Cauvery. But there still remains a good deal to be done. In the Kistna, second crop irrigation has yet to be developed, and water has to be given to 150 square miles in the island of Divi. A supplementary supply is often required in the Cauvery, and the many channels that traverse the delta are at one time used for irrigation, at another time for drainage. The irrigation outlets are so imperfect as to render economical distribution of water impossible, and vested rights have been recognized which only tend to extravagant waste of water.

243. *The Tungabhadra project.*—Careful study has been bestowed by one officer after another on the utilization of the Tungabhadra. But from the reports laid before the Commission, it would seem that these officers saw very clearly that no project could be framed which would prove directly reproductive ; and their reports have about them a sort of academical flavour, as though the authors knew quite well there was no chance of the work ever being carried out. Much cannot be done without the storage of the Tungabhadra. This must be an expensive work ; and it can only prove reproductive if the agricultural classes decide to avail themselves regularly of the water that will flow past their lands. But this is just what cannot be safely depended on. Much of the Bellary soil is of the black cotton species, similar to that on the Kurnool Canal. In a year of drought the cultivators will be ready enough to use it to water their millets ; but in ordinary years this soil retains so much of its moisture that irrigation is quite superfluous for dry crops. A steady and regular demand for irrigation is, therefore, dependent on the readiness of the cultivators to abandon the cultivation of dry crops for that of rice. We find, however, that strenuous and long sustained efforts on the part of Government to induce the cultivators on the Kurnool Canal to substitute wet for dry cultivation, have not been attended with any marked success ; and we see no reason to suppose that a different result may be anticipated in the Bellary district, or that there will be a general demand for irrigation in any but the driest years. Where holdings are large, three or more acres can be put under dry crops at a cost not exceeding that of cultivating an acre of rice, and will, in years of ordinary rainfall, yield in these rich black soil tracts a larger profit to the cultivator. We are inclined, therefore, to doubt whether it is sound policy to endeavour to force the cultivation of rice on such soils as soon as the means of irrigation have been provided, or to rely on the readiness of the people to change their whole system of agriculture. We cannot but think, however, that some arrangement may be possible under which water could be supplied to dry crops in Bellary in seasons of drought, and be utilized elsewhere in other years. It seems certain that, if a canal could be taken through the Bellary district, and across the watershed into the districts of Anantapur, Cuddapah, and Nellore, supplementing the discharge of the Penner, there are many tracts in which the water would be eagerly utilized ; and, looking simply at the great national object of protection against famine, it might be justifiable to deprive these latter tracts, in years of drought, of so much of their supply as would otherwise be stored for second crop cultivation, in order to utilize it in saving the dry crops in the black cotton soil tracts of Bellary and other districts.

244. *The Kurnool-Cuddapah Canal.*—Closely associated with this Tungabhadra project, is the question of the measures to be taken to adapt the Kurnool-Cuddapah Canal to carry the volume originally proposed for it. It seems certain that that canal can never be made into a great financial success. It must always be crushed by the weight of its capital account. But, taking it as it is, it has already proved a valuable instrument of famine protection, and we believe that its usefulness might be greatly extended by the judicious outlay of funds ; an outlay which will certainly not render the financial position of the whole capital account more unsatisfactory than it now is. The Kurnool-Cuddapah Canal, as originally designed, was to carry 3,000 cusecs. Part of this was to be employed on the irrigation of these districts, and part on maintaining a navigable connection between Kurnool and Cuddapah—a scheme which has resulted in nothing but loss of water and money, for the navigation traffic is practically *nil*, although no dues of any kind are levied. The unused balance of the water was to be passed on into the Penner and used for the extension of irrigation in the Nellore district. We have been informed that, owing to the original defects in the work, and to the neglect of necessary annual repairs and the difficulty of getting money for expenditure on a work which has proved so unremunerative, a larger volume than 2,000 cusecs cannot now be passed into the canal at the head, while the usual limit is 1,200 cusecs ; and that the supply that can be carried safely below the Tangadentza tank in the 61st mile is much less than this. We consider that, whether or not it is decided to create storage reservoirs in the upper Tungabhadra, the Kurnool-Cuddapah Canal should be placed in thorough order, its capacity should be increased, and extensions should be made into adjacent tracts which are more suited for irrigation than much of the area at present

under command. The state of inefficiency into which this work has been allowed to fall appears to be due in great measure to the existence of a rule that, inasmuch as the canal has not fulfilled the conditions of a productive public work, all further capital expenditure must be met from revenue, that is, from the grant for minor irrigation works, which are provincial works in Madras.

245. *Further investigation of the Tungabhadra project recommended.*—The construction of the Tungabhadra project, and the extension and improvement of the Kurnool-Cuddapah Canal on the lines that we now propose, would render it possible to extend protection to large areas in the Bellary, Anantapur, Kurnool, Cuddapah, and Nellore districts, all of which are more liable to severe visitations of drought than any other part of the Madras Presidency. We therefore addressed a communication to the Government of India soon after our visit to Madras, in which we explained the position and the scope of our proposals in greater detail, and strongly recommended early sanction for an exhaustive survey of the whole tract concerned. This recommendation was accepted, and survey parties have since been formed for the preliminary investigation of the proposals which have been made. The fact, however, must not be lost sight of that it will not be possible to carry out any large storage scheme on the Tungabhadra without occupying lands belonging either to His Highness the Nizam or to His Highness the Maharaja of Mysore, or perhaps to both. We are hopeful that no serious difficulties may arise if they are allowed to participate, as far as may be practicable, in the benefits of any schemes that may be devised; or if they are assisted in the development of other schemes, within their own territories, which depend on the consent or co-operation of the British Government. At any rate we think that, at this stage, both States should be invited to allow the fullest examination of those portions of their territories in which suitable sites are likely to be found for the storage of flood waters; for in such storage lies the only hope of affording protection to this part of India, whether in British territory or in Native States. If it is clearly understood that the object of the proposed investigation is to utilize such sites as may be suitable for storage to the best advantage, without reference to territorial boundaries, and that permission to examine the country will not commit the Durbars to the acceptance of any proposals which may eventually be formulated; we think that it should be possible to obtain the hearty co-operation of the States concerned in these preliminary investigations.

246. *The Cauvery delta.*—The Cauvery works, as explained in the preceding sections, consist of little more than regulators, anicuts, and escapes, which have been constructed for the purpose of controlling to some extent the distribution of the river supply between the innumerable channels with which the delta is intersected. Of late years many additional works have been constructed with the object of improving this control, and much additional work of the same kind remains to be done; but it has long been recognized that something more than this is wanted, and that measures should be taken to prevent the failure of the river supply at critical seasons. The total area irrigated by this system averages 950,000 acres, of which little more than 10 per cent. is second crop, but the single crop is also liable to fail in very dry years. There are also areas, both inside and outside the delta, to which irrigation might be extended if a fuller supply could be assured at the end of the season. The question of constructing a large storage work on the Cauvery or on one of its principal tributaries has been under discussion for many years; and a project for constructing a reservoir on the Bhavani, a tributary of the Cauvery, near Satyamangalam, with a capacity of 27,000 million cubic feet, has been recently prepared in detail. The work is estimated to cost over a crore of rupees, and to provide for an extension of irrigation of about 90,000 acres, although the main object is to give greater security to the existing irrigation. The project is, however, in abeyance, as the question has been raised whether any storage work that may be proposed should not be constructed on the main Cauvery, where it is said that a very suitable site exists for a reservoir to hold 30,000 million cubic feet. The average supply of the Bhavani is not more than one-fifth of that of the main river, and it has been contended that a reservoir constructed on it will be liable to fail in dry years at the most critical period. It appears to be admitted that a reservoir on the main river

would be more powerful and less likely to fail than one on the tributary, and would render possible a much greater extension of irrigation. But the suitability of the site for a dam, 130 feet in height, which will be required to pass the full floods of the Cauvery, has not yet been fully demonstrated; the probable cost of the work has not been estimated in detail; and an objection has been raised that it will intercept much of the silt now brought down by the Cauvery, which is said to be of such fertilizing value that the lands which are benefited by it require no other manure, and would deteriorate if deprived of it, however ample the supply of water. No final decision is likely to be arrived at until both projects have been investigated in the same degree of detail, and further information has been obtained on many points that affect the question. Both projects are of great magnitude, but it is believed that, whichever may be ultimately preferred, the expenditure is likely to prove directly remunerative. The greater part of the Tanjore district is now so well protected that the construction of this work does not appear to be of urgent importance as a protection against famine. But it will add greatly to the wealth of the district, and render the existing irrigation revenue much more secure; it will give protection to some outlying areas; and it will probably fulfil the conditions of a productive irrigation work. We may add that, although we are unable to offer an opinion on the relative merits of these alternative projects, there is one argument in favour of the reservoir on the main Cauvery which may deserve attention. Neither project provides for an extension of irrigation in the Coimbatore district. The Bhavani reservoir is not high enough up the river to give the requisite command; but if it is once built, it is very unlikely that a reservoir will ever be built higher up for the benefit of Coimbatore, as it would intercept and divert the water required for Tanjore. On the other hand, if the reservoir for Tanjore be built on the main Cauvery, there will be no objection to constructing a reservoir at any suitable point on the Bhavani for the benefit of Coimbatore. It appears possible also that some extension of irrigation might be effected in the Salem district if the reservoir is constructed on the main Cauvery. In both these districts there is great need of protection.

247. *Storage work on the Kistna.*—The question of providing a storage reservoir on the Kistna has also been frequently mooted, but until recently has not been seriously considered. The second crop cultivation on the Kistna Canal is practically *nil*, as the average area during ten years has been only 323 acres, out of a total area of over 520,000 acres, although on the Godavari over 14 per cent. of the annual irrigation is second crop. The absence of a second crop on the Kistna has been explained as due partly to the insufficiency or irregularity of the supply after December, and partly to the apathy and conservatism of the rayats; but the former is probably the truer cause. There appears also to be room for a considerable extension of first crop cultivation if a full supply at the end of the season could be assured. The present supply is sometimes not equal to the demand; and it is important to observe that, under present conditions, any extension of irrigation on the Kurnool-Cuddapah Canal, or in Hyderabad, could only be effected at the expense of the Kistna system. A storage reservoir on the Kistna would permit the development of the Kistna Canal to its fullest capacity, and would, at the same time, render it independent of the supplies now brought down by the Tungabhadra. Mr. Reid, Executive Engineer, has recently made some preliminary investigations, and has proposed to construct a storage work about 130 miles above Bezvada with a dam 150 feet high and capable of impounding between 30,000 and 40,000 million cubic feet. One advantage of the proposal is that, if carried out, it would be possible to take off a high level canal from the right bank of the Kistna above the dam, which could be maintained in flow as a monsoon canal until the level in the reservoir fell below a certain point. This canal would be carried through the uplands of the Kistna district and then on into the northern part of the Nellore district, and could be utilized for irrigation in these tracts, and for filling storage works. When the canal ceased to flow, the water still retained in the reservoir would be utilized in maintaining the supply in the Kistna at the level of requirements in the delta, where both first and second crop irrigation would be developed to the utmost. Mr. Reid is of opinion not only that the work is feasible, but that it will also be directly remunerative. No opinion can be offered

on these points until the scheme has been thoroughly investigated. The project is of such magnitude that it may not be possible to carry it out concurrently with the Tungabhadra and Cauvery projects; but it has such an important bearing on the proposals for the former, that we have recommended that further investigation should also be put in hand as soon as possible.

248. *Divi pumping project.*—An interesting project for the irrigation of 50,000 acres in the Divi Island at the mouth of the Kistna delta was laid before us by Mr. Reid. Water from the Kistna Canal can be conveyed to this island only by means of an expensive aqueduct across the river, and the present supply in the canal is not sufficient for the purpose. Estimates have, therefore, been prepared for a large steam pumping station, at which the water required for the irrigation of the island would be pumped up from the river. Pumping would begin as soon as the river comes down in flood and would be continued until the river supply falls so low that the water becomes brackish, or generally from the middle of June to end of November, the maximum lift being about 15 feet, although the average will not be more than 10 feet. It is estimated that this work will cost 12 lakhs, and that it will be directly remunerative. The scheme, which has been carefully worked out, is one that should be considered on its merits as a productive work; for we are unable to recommend heavy unproductive expenditure on the ground of the protective value of an extension of irrigation to this island. The project is, however, one of considerable importance; for, if it can be demonstrated that steam pumping on a large scale can be carried out at a profit, there must be a great many places where it can be introduced with great benefit to the people, and without imposing any permanent burden on the State. Mr. Reid has indeed proposed other sites on the Godavari and Kistna above the anicuts, where it is said that large areas could be brought under irrigation in the same way, at less cost than by the construction of storage works. It is, indeed, probable that one or two successful installations of this kind would encourage large landowners or private capitalists to undertake similar works. In Egypt many thousand acres are annually irrigated by steam pumps; but in India steam lift irrigation is almost unknown, although a few instances have come to our notice, in which, by private enterprise, efforts in this direction have recently been made on a small scale with oil engines. It appears to us that this is a matter in which Government might very usefully lead the way, and that a well-devised pumping scheme should, on this account alone, receive favourable consideration.

249. *The Godavari.*—Our evidence indicates that the supply in the Godavari is generally sufficient for the requirements of the delta; and that there is at any rate no scope for such an extension of either first or second crop cultivation within the delta as would justify the construction of expensive storage works in the Upper Godavari for the benefit of this tract, which is now completely protected against famine. No doubt many storage works might be proposed on the Upper Godavari or its affluents, for the protection of tracts in their neighbourhood. But many or most of these would be in *zamindari* lands, or in the territories of feudatory Chiefs, regarding which we have no evidence; or in scarcely populated and unhealthy forest tracts, in which the development of cultivation would be very slow. Others, to which reference is made in our chapter on the Central Provinces, are in black cotton soil tracts, into which the introduction of irrigation would be a measure of very doubtful expediency. Every scheme of this kind must be judged on its own merits as a local project. Storage works have been proposed in the uplands of the Godavari district itself, on the Sigilleru and Yerrakalva and Yelleru rivers; but such inquiries as have been made in respect of the two former, which cannot however be regarded as conclusive, indicate that the cost of the works would be very high when considered with reference to their irrigating capacity. This part of the district is in need of protection, and we recommend further investigation of projects of this class, although they cannot be regarded as promising.

250. *Periyar project.*—The possibility of extending the important Periyar project has also been suggested to us. The present full supply capacity of the lake is 6,480 million cubic feet. In 1899, which was a very dry year, there was no

surplus or discharge over the waste weir ; but we were informed that in other years the surplus has averaged over 10,000 million cubic feet, all of which passes to waste. It would be possible, by erecting shutters on the waste weir, to increase the storage in the lake by over 2,000 million cubic feet. But the present escape capacity is thought to be insufficient even under existing conditions; and if the storage or full supply level is to be increased, it will be imperatively necessary to give greater facilities for escape, either by lowering the bed of the present escape or in some other way, and also to increase the discharging capacity of the tunnel. The cost will be considerable, but it will probably not be prohibitive if an additional 8,000 million cubic feet can also be stored, at a moderate cost, in one or more tanks at the foot of the hills or downstream of the tunnel. It would thus be possible to extend the area under irrigation by 20,000 acres, and we are informed that there is plenty of room for such extension. It would seem, therefore, that the utility of this work could be greatly increased, but the cost has not yet been estimated.

251. *Kistnagiri reservoir.*—The Kistnagiri reservoir, in the basin of the Ponniar river, the construction of which was recommended by the Famine Commission of 1878-80, has not been carried out. It was at that time supposed that the reservoir would have a waterspread of from 24 to 30 square miles and be capable of irrigating from 96,000 to 120,000 acres. The project was investigated in 1884, and it was roughly estimated that an average of 15,428 millions of cubic feet would be available for storage, which would suffice for the irrigation of 50,000 acres, and that the cost would amount to 40 lakhs. It was subsequently found that a yield of 15,000 million cubic feet could not be relied on, as the *maximum* yield during five years ending 1895-96 was less than 10,000 millions, and only 483 millions would have been available in the dry year of 1891-92. Later experience has been more favourable, for although the yield in 1896-97 did not exceed 3,335 millions, it varied during the four following years from 25,000 to 61,000 millions. These figures are based on gauge readings recorded at a weir lower down the same river, and are, therefore, probably reliable. Doubts have, however, also been expressed as to the area that can be brought under irrigation near this site. It is pointed out that the land closely resembles that under the Barur tank, which is lower down the same drainage line, and on which there is a very small demand for irrigation owing to the reluctance of the people to take to wet cultivation. Various reasons have been assigned for this, such as the insufficiency of the supply during the second crop season, the unsuitability of the soil, objections to the system of compounded assessment on wet lands, and the great cost of preparing the land for rice cultivation. These reasons are not very convincing; and some effort should be made to ascertain the real obstacles to the development of irrigation on this work, before constructing another of the same class and under the same conditions. If the form of assessment is ill-adapted to the conditions of supply, it should not be difficult to alter it. Protective works are, no doubt, desirable in the Salem district, which is liable to suffer from drought; but if the Kistnagiri reservoir is to be constructed, it must be on a much smaller scale than originally contemplated. The first step is to determine by closer inquiry the area that is likely to take irrigation, and the possibility of utilizing the water in South Arcot, if not taken in Salem. But in view of the uncertainty of the yield, we doubt whether it will be found advisable in any case to provide storage for more than 4,000 or 5,000 million cubic feet, unless the extra cost due to a greater capacity should be very small.

252. *Other proposals for extension of major works.*—Other proposals for extensions or improvements of existing major works have been made, such as the construction of a new storage reservoir on one of the tributaries of the Tambraparni, for the purpose of steadying the supply of the Srivaikuntam anicut system during the south-western monsoon, and of additional storage works in connection with the Rushikulya and Penner projects. Such works will be useful, and the estimates for them can be considered on their merits when submitted.

253. *Provincial irrigation works for which capital accounts are kept.*—We have hitherto considered either new works of great magnitude, or exten-

sions of existing major works, which would, under present arrangements, be carried out from Imperial funds, either as productive or protective irrigation works. But there are in the Madras Presidency no less than 26 minor works (excluding the Buckingham Canal which is purely for navigation) for which regular capital and revenue accounts are maintained, and all expenditure on these works is classed as Provincial. These works irrigate about 500,000 acres a year ; and the capital outlay incurred on them to the end of 1900-01 amounted to about 101 lakhs, the cost of particular works varying from 21 lakhs, for the Palar anicut system, to sums of less than one lakh. The capital cost of new works of this class, and of extensions of existing works, as well as the whole cost of maintenance, are met from provincial revenues; expenditure chargeable to capital during the ten years ending 1899-1900 averaged Rs. 4,22,051, the average amount of the maintenance charges during the same period being Rs. 3,61,746 ; so that, in round numbers, the total expenditure may be stated as 8 lakhs per annum, divided in nearly equal parts between new works or extensions, and maintenance. The works as a whole are remunerative, for the net revenue yields an average return of 5 per cent. on the capital cost. There appears to be a wide field for the multiplication and extension of works of this class; but the existing rules for financing irrigation works tend to restrict the construction of those which are not individually of sufficient importance to be treated as Imperial works (productive or protective, as the case may be), or which are extensions of works at present classed as minor or Provincial. The Local Government has, indeed, power to sanction estimates up to a limit of Rs. 10,00,000, exclusive of establishment and indirect charges; but, as long as the cost of new works is chargeable to provincial revenues, the grants that can be allotted for their construction are likely to be inadequate. In another chapter we have recommended that capital outlay on irrigation works for which capital and revenue accounts are kept, should not in future be met from revenue. If this recommendation be accepted, future progress in the construction and development of works of this kind, even if classed as Provincial, will not be liable to restriction by the exigencies of provincial finance. They will be carried out as part of a general programme for the extension of irrigation works throughout India; progress in which is more likely to be limited by delays in investigating and working out sound projects, and by want of establishment for their execution, than by any difficulty in providing the necessary funds. There is undoubtedly a wide field in almost every district for the construction of isolated works, forming no part of any great project, but collectively of great importance. We have seen a list of seventy such works, situated in sixteen different districts, of which fifty-four had been so far examined as to permit an idea being formed of their irrigating capacity, which was estimated in the aggregate at over 400,000 acres. Some of these were under investigation at the time of our visit; and the work has since been continued by the Superintending Engineer on special duty, according to whose latest reports there are some, such as the Gandipalem and Mopad tanks and the Paleru project in Nellore, and the Ponneru project in Trichinopoly, which are likely to fulfil the conditions of a productive public work. We think that, if ordinary caution is shown in selecting works of this class, they are likely as a whole to prove directly remunerative; or, at the worst, to impose a burden on the State which will be inconsiderable in comparison with their protective value.

254. *Irrigation of dry crops.*—In connection with the question of new works there is one point on which we desire to make a few remarks. We have been struck with the fact that, throughout the Madras Presidency and also in Hyderabad and Mysore, the word 'irrigation' is regarded as almost synonymous with rice cultivation, and that the success of every work depends on the readiness of the people to convert their lands into rice-fields. We recognize that in the deltas and low-lying lands, no other form of cultivation is so profitable, and that in many cases no other form is possible. It is also true that in many kinds of black cotton soil, people will not take water for the cultivation of anything but rice; but some of our witnesses are of opinion that it would be freely and regularly taken in other soils in the higher lands. We have heard of cases in which the cultivators have opposed irrigation schemes, on the ground that they do not want to be brought under a wet assessment. We think that in such

places the works should be designed on a dry-cultivation basis; that is, the available water-supply should be distributed over a much wider area than would be possible for rice cultivation, and the distributary channels should be designed with reference to the requirements of dry crops, and not to those of paddy cultivation. We understand that in some places irrigation on these lines would be very acceptable to the rayats; and that if water could be supplied to a second crop, such as gram, rates could be imposed which would bring in a revenue not less than that which might be obtained from a smaller area under paddy. These proposals apply, of course, only to works in tracts in which rice cultivation is not practised, or in which there is reason to believe that the produce of dry crops would be so much increased by irrigation, even in years of normal rainfall, that the rayats would be ready to pay a fair price for it. It is hardly necessary to point out that works which irrigate a large area of dry crops would have a far greater protective value in seasons of drought than works intended solely for rice cultivation. The irrigation of dry crops in suitable localities appears to us to deserve more attention and encouragement than it has hitherto received; and it is probably capable of considerable development.

255. Another suggestion may be made in connection with the irrigation of dry crops. We have already referred, in paragraph 248, to the field which exists for irrigation by means of pumping works; and we recommend, as a very useful form of minor work, the erection of small pumping stations on the banks of streams or collections of water, from which an adequate supply can be relied on for the irrigation of dry crops. We have had evidence of the successful working of a small oil engine, which was recently set up in a missionary settlement at Chingleput; and we think that a few Government pumping works of the same kind would not only give a useful lead to private enterprise, but would also result in the acquisition of very valuable information in regard to the irrigational requirements of dry crops. If, for instance, five or six pumping engines (oil or steam as may be found more economical), each capable of irrigating from 200 to 2,000 acres of dry crops, were erected on the banks of such rivers as the Hagari, the Penner, the Chitravati, and the Hindri, in the black soil tracts in Bellary, Anantapur, and Kurnool districts, it may be found that the cultivators are more willing than is now supposed to take water for the irrigation of dry crops in such soils, and that judicious irrigation will increase the profits of cultivation even in years of normal rainfall. There appears to be no doubt that flush irrigation is unsuited to these soils, unless the people are prepared to convert their dry into wet cultivation; but it is quite possible that irrigation may be found to be very beneficial, if water is sparingly and judiciously applied, which will always be the case when it has to be lifted and the lifting has to be paid for. If arrangements were also made for charging for the water supplied according to the quantity actually used, a measure would be obtained of the effectiveness and fluctuations of the demand for irrigation of dry crops in black soils, which would be very useful when the details of the distributary arrangements are under consideration. The records of pump irrigation are of exceptional value for experimental or statistical purposes: in the first place, because the quantity of the supply admits of very accurate measurement; and, in the second, because there is the strongest incentive to economy in its application. Pumping installations of the kind proposed will probably not be remunerative; but if they are worked so as to give the best results, the loss will not be heavy, and the information that will be gained will be of the greatest value when schemes for the protection of dry cultivation by irrigation works are under consideration. The works may also be of great use in teaching the rayats the value of judicious irrigation, and so preparing the way for the successful development of irrigation on the Tungabhadra or other projects which it may be decided to carry out. We learn with satisfaction that a Government farm has recently been established near Bellary; and the experts employed there will, it is hoped, be able to demonstrate to the rayats the advantages of such irrigation even in ordinary seasons. Moreover, if the works are successful, it is but reasonable to hope that private enterprise will follow the example set by Government, and that works of this class may be multiplied. Such enterprise should be actively encouraged in the way which we have recommended elsewhere, by the offer of

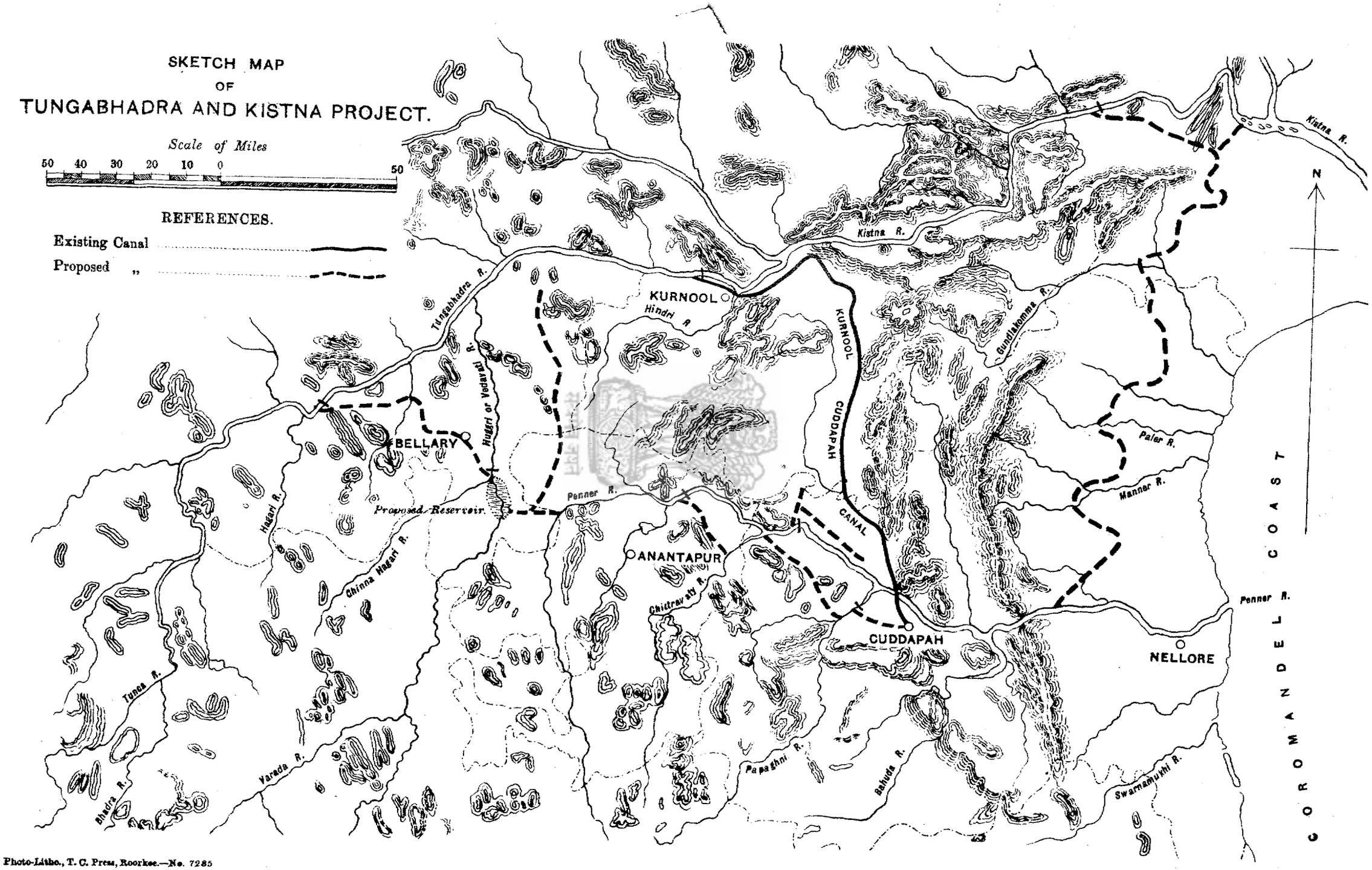


Photo-Litho., T. C. Press, Roorkee.—No. 7285

advances on liberal terms, and the waiving, for a number of years, of all charges for water lifted.

256. *Minor works for which no capital accounts are kept.*—We have next to consider the important class of minor irrigation works for which no capital accounts are maintained, and which, as we have already shown in paragraph 241, irrigate collectively as large an area as all the other State irrigation works in the Presidency put together. There does not appear to be much hope of increasing the number of these works, or of greatly extending the area already irrigated by those which are now in good order. Where large works are possible, they may be undertaken as State works for which capital accounts are kept; but almost all the most suitable sites for smaller works of the kind which we are now considering, have probably been taken up, and there is also a difficulty in making a new work which will not interfere with established interests on existing works. The revenue dependent on these tanks is, however, so considerable that Government is vitally interested in their efficiency, on the maintenance of which about 20 lakhs have been spent annually of late years. The object has been merely to prevent retrogression or to restore works to their former efficiency when deterioration has occurred; but it is the opinion of most of the local officers in both the Revenue and Public Works Departments that the grants hitherto allowed are insufficient for the purpose.

257. *Recommendations of the Commission of 1878-80.*—The Famine Commission of 1878-80 entered fully into the subject of the maintenance of the numerous small river channels and tanks, which together exceeded 40,000 in number and on which the irrigation of nearly 3 millions of acres in the Madras Presidency depended. Of these works, nearly 30,000 were tanks. The Commission recommended that a scheme should be framed for systematically putting the tanks in repair, and that afterwards only those watering above 200 acres, or possessing some other special importance, should remain in the hands of the Public Works Department; that smaller tanks, irrigating not less than 50 acres, should be brought up to standard and made over to the villagers to maintain; that tanks watering less than this area should be handed over as they were to the villagers to keep up; and lastly, that tanks irrigating less than 10 acres should be handed over to the rayats, while the lands watered "should be assessed as though irrigation did not exist."

258. *Tank Restoration Scheme.*—The first of these recommendations was adopted by the Madras Government, and the restoration of tanks has been steadily pursued since 1883, when operations were commenced in the Madura district. The system adopted, which has since been followed without material modification, may be briefly described. Survey parties were formed for the purpose of preparing a detailed record of all the works in each main drainage line. A map was prepared for each main basin, showing all the minor basins with groups and sub-groups, each work being surveyed and its catchment area worked out and recorded. Detailed maps were then prepared on a scale of 4 inches to a mile for the minor basins, showing the position of each work, with longitudinal sections of all banks, detailed sketches of masonry works, and notes indicating the work to be done to put each work and channel into repair. Statements of financial and hydraulic details were then prepared, with a descriptive memoir of each work, in which information was given as to standard levels, flood discharges, storage capacity, etc. Finally, estimates for the repairs to be executed were prepared in detail. The particulars collected for each basin, excepting the detailed estimates for works, have been printed in separate pamphlet form, so as to form a permanent record. This investigation work has, from the first, been kept distinct from the actual restoration work. The survey parties were, in the first instance, placed under a Superintending Engineer specially deputed to the duty; but the appointment was afterwards abolished, and all investigation work was placed under the control of the Chief Engineer for Irrigation, an Executive Engineer being posted at head-quarters as his assistant for the Tank Restoration Scheme. The estimates for repairs, framed by the survey parties, are, after scrutiny, passed on to the Superintending Engineers, who arrange for the execution of the works by the ordinary divisional officers to the extent of the funds available.

The number of survey parties has varied from time to time, but we find that, up to the end of March 1901, investigations had been undertaken in all districts of the Presidency, excepting Ganjam and Trichinopoly, and that about 45,000 square miles of country and 6,297 works, irrigating 750,000 acres, had been examined. The total area to be investigated is estimated at 117,000 square miles, so that the survey operations have not covered more than 40 per cent. of the total area; or, if calculated in another way, on the basis of the tank-irrigated area, which is thought to be more correct, not more than one-third. The cost of the investigations has amounted to about 16 lakhs.

259. *Time required for completing the work of restoration.*—Turning next to the actual work of restoration, we find that estimates have been passed on to Executive Engineers for the repairs of about 5,000 works, the aggregate amount being about 65 lakhs, including establishment charges. In addition, estimates have been prepared for the remaining works which have been examined, but have not been passed on by the Superintending Engineers for execution owing to insufficiency of funds. These estimates amount to about 11 lakhs.

260. *Further outlay required.*—From these figures it may be inferred that the cost of completing the Tank Restoration Scheme on the present lines will be roughly as follows:—

	Rs.
Works not yet passed on for execution	11,00,000
Future investigation work	32,00,000
Future restoration work	1,52,00,000
GRAND TOTAL	1,95,00,000

The average annual expenditure on tank investigation and restoration during the ten years, ending 31st March 1900, amounted to Rs. 4,76,000, and at this rate it will take over 40 years to complete the work of restoration.

261. The question naturally arises whether the results of the expenditure hitherto incurred can be held to justify this immense further outlay. We find it impossible to form any definite conclusion as to the increase of revenue that may be attributed to this expenditure, or the reduction of revenue that may have been prevented by it. During the years 1883-84 to 1886-87 the Government of India made special grants to the Madras Government for the work of restoration, and from 1887 onwards increased the provincial assignment by 1½ lakhs on this account. They offered in addition a special grant, not to exceed 5 lakhs annually, on which the Local Government was to be charged interest at 4½ per cent.; but it was to be allowed, on the other hand, to take the whole increase in land revenue due to the expenditure to be incurred, provided satisfactory accounts were kept showing the increase of revenue attributable to each of the works brought under restoration. An attempt was made to keep up accounts of this kind during three years—1888-89 to 1890-91—from which it appeared that a return was received on the outlay incurred of between 2 and 2½ per cent.; but of this less than 60 per cent. was attributed to increase of revenue, the balance being due to decrease in expenditure on ordinary repairs. In 1892 the terms of the provincial settlement were altered, no special assignments were made for tank restoration from Imperial funds, and the accounts of the revenue due to improvements were no longer maintained. Such accounts would only be of value if maintained during a long series of years. Even then they would not show the full loss of revenue which the work had prevented, and they would generally be very misleading unless account could also be taken of variations in the rainfall and other vicissitudes. The question may, however, be regarded from another point of view. It must not be forgotten that the outlay on tank restoration is but a small portion of the expenditure annually incurred on the maintenance of these works. We have shown that during the ten years ending 1899-1900 it averaged Rs. 4,76,000. During the same period the annual expenditure on ordinary repairs averaged over 13 lakhs, of which Rs. 2,66,000 was incurred in the Revenue, and the balance in the Public Works Department. This outlay is incurred mainly on works which have not been restored. If a work has been

'investigated,' it is thoroughly overhauled in accordance with the recommendations of the investigation party and with the estimates which have been prepared; but otherwise such emergent repairs are carried out as are necessary to prevent loss of revenue. If, therefore, tank investigation and restoration work were altogether discontinued, there would still be an annual expenditure of not less than 18 lakhs on ordinary tank repairs, but the operations would be carried on without system and the annual outlay would steadily rise. If, on the other hand, the present rate of progress and expenditure on tank restoration be increased and the works are put into thorough repair on a systematic plan, there will be a diminution in the cost of ordinary repairs, and a gradual reduction in the total annual expenditure on tank maintenance to the amount required for the upkeep of works which have once been restored or put into thorough order.

262. *Necessity for vigorous prosecution of the works.*—For these reasons we strongly recommend that the work of tank restoration should be more vigorously prosecuted, and that the grants for maintenance of minor works should be increased until it has been completed. The importance of devoting more money to the restoration and upkeep of these works appears to be fully recognized by both revenue and public works officers. The Board of Revenue has pointed out that within the last ten years, 9 to 10 per cent. of the demand on the land irrigated from these works was remitted on account of defective supply; and that a very large part of these remissions was necessitated by the fact that the works were not in a state of thorough repair and efficiency. We think that an annual expenditure on the works of not less than 26 lakhs, which is less than one-third of the net revenue derived from them, should be contemplated, of which about half would be available for investigation and restoration work, which should then be completed within 15 years.

263. Although all witnesses on the point were unanimous as to the importance of completing the tank restoration work as soon as possible and increasing the present rate of progress, some of them have complained that local officers were not sufficiently consulted, and that in some cases unnecessary repairs were executed in consequence. We think it probable that there is some foundation for such complaints, and that some modifications of the present system may be commended to the consideration of the Government of Madras. During the first three years in which tank investigations were in progress, the survey parties included at least one Engineer Officer, and all worked under the supervision of a specially appointed Superintending Engineer, who devoted his whole attention to organizing the system. Subsequently, when operations were in progress in many widely separated districts, the control was transferred to the Chief Engineer, assisted by an Executive Engineer. This central control was probably necessary at this stage, so that operations might be conducted in all districts on a uniform system; but now that one-third of the work has been done and almost every district has been partially investigated, this central control is, in our opinion, no longer necessary or even desirable. The survey parties are now composed entirely of subordinates, who are, no doubt, capable of doing the technical work of investigation on the lines which have been laid down. Their work is supervised by an Executive Engineer in the central office, who forwards estimates for restoration to the local officers for execution. We were informed that this officer spends part of his time in inspecting the survey parties in the fields, and also that he submits doubtful or difficult cases to the Chief Engineer for orders; but we think that control of this kind is likely to be too formal and mechanical, particularly if the rate of progress is more than doubled as we propose.

264. We would suggest, therefore, that the appointment of Assistant to the Chief Engineer be abolished, and that all investigation and restoration work in each circle should, in future, be placed under the control of the Superintending Engineer, who might be allowed an Assistant Engineer to supervise the work under his orders, whenever the scale of operations is sufficiently large to render this advisable. The advantages of this are obvious. The estimates would be prepared under the orders of a superior officer, who would be more in touch

with local conditions and local officers than the Assistant to the Chief Engineer can possibly be; and who would also be given a wider discretion to permit deviations from hard-and-fast rules and formulæ. He would be able to arrange the programmes for investigation and restoration within his circle, so that one should not get too far in advance of the other, and with due regard to his budget provision, and to the demands for ordinary or emergent repairs. He and his subordinate officers would take greater interest in the work as they became personally more directly responsible for it, and a much needed elasticity would be given to the procedure. We were told that the estimates which are now sent out to the local officers, are never revised or modified by them unless it is necessary to alter any of the rates. They appear to be regarded as works prescribed by an external authority, to be carried out without question. It is said that the Executive Engineers have no time to prepare these estimates themselves; and we recognize the advantage of employing a special establishment for the purpose; but when they or their Assistants have to carry out the works, they must often be in a position to propose useful modifications of the estimates, and they should be encouraged to do so. The present Assistant to the Chief Engineer informed us that the efficiency of the works could be improved if more funds were made available; but that it is rather the aim of the Tank Restoration Scheme to bring works to the normal standard of efficiency to which they were originally designed, as nearly as can be, allowing the ordinary Divisions to deal with the increase of efficiency. It may be true that the main and original object of the Restoration Scheme was to bring the works to a state of normal efficiency rather than to improve or extend them; but we think that there should be no rigid limitation of the duties of the investigation parties in this respect, and that it will be unnecessary if operations are brought under a more decentralized control. We would go further and say that it should be a distinct instruction to the survey parties to submit proposals for increasing the efficiency of a tank by raising the full supply level, whenever this can be done at a cost which will not be excessive with reference to the advantages to be gained. If the proposal will involve the submergence of cultivated land, it may still be worth while to acquire the land by payment of reasonable compensation. But there will probably be many cases in which compensation will be unnecessary, or may be given in the form of a small lump sum or annual payment, if the owner is allowed to retain his title to cultivate the land as the water recedes, and to exercise all other rights of ownership which are compatible with the use to be made of it in increasing the storage capacity. The survey parties will also have exceptional opportunities for proposing sites for new tanks, and should be encouraged to look out for them.

265. *Maintenance of tanks.*—We have next to consider the important and difficult question of the maintenance of tanks after they have once been restored. The Commission of 1878-80 recommended that "Inspectors should be appointed in each district, whose duty it should be to report annually to the Collector on every tank, besides special reports where necessary. These Inspectors should be directly under the Collectors, and their salaries should not be less than Rs. 150 per mensem." The repairs themselves, they advised, should be carried out by Statute labour, according to the old custom of the country known as *kudi-maramat*, and with this view they submitted a draft Bill to legalize the practice. We are informed that a Bill was drafted on the lines suggested, and, with the approval of the Governor-General in Council and the Secretary of State, was introduced in the Legislative Council of Madras in June 1883; but it was subsequently dropped, the abandonment of any further consideration of the Bill being announced by His Excellency the President at a meeting held on the 18th August 1884. We find also that, as a consequence of the dropping of the Bill, Tank Inspectors have never been appointed.

266. *Transfer of tanks to villagers.*—The recommendations of the Famine Commission of 1878-80, regarding the transfer to the villagers of tanks irrigating less than 200 acres, have not been carried out. Their proposals were considered by the Government of Madras early in 1880, and formed the subject of a correspondence with the Board of Revenue which extended over many years.

After some unsuccessful and experimental attempts had been made in the years 1883 to 1885 to transfer to the rayats jointly interested all small tanks in the Cuddapah and a few other selected districts, the matter was dropped pending the result of the investigations then in progress in the Madura district under the Superintending Engineer in charge of the Tank Division. It was revived again in May 1887 when orders were issued giving authority to hand over certain tanks in the Peryakulam minor basin, in the Madura district, to the rayats, on the understanding that they would be "expected under the supervision of the Collector to maintain them in a state of repair up to the standard laid down in the descriptive review relating to the basin." The Collector was to be given a lump grant of 4 annas per acre on the ultimate area of cultivation estimated by the Tank Survey Party, from which he might pay the rayats such grants-in-aid as he might deem proper, and also meet the pay of the Tank Inspector to be appointed to inspect and report on the condition of each tank and the value of the work done to it. In February 1889 experimental transfers of the same kind were ordered to be made in the basins which had been investigated in the Coimbatore district; but a month or two later, the Board of Revenue reported that the rayats in the Peryakulam basin had declined to take over the tanks on the terms offered, the reasons given by them being "the absence of union among themselves, the insufficiency of the grants-in-aid proposed, and the fact that Government declined to grant any remission." In July 1889 the Government directed that the experiment should be given up both in Madura and elsewhere, and declared that, as a result of the abandonment of the attempt to enforce the obligation of customary labour by legislation, Government must undertake, under the most economical arrangement possible, the duty of maintaining the tanks. It was, however, proposed that petty works, irrigating less than 15 acres, should be handed over to the rayats, the lands under them being assessed at reduced rates, to be fixed in each case; a proposal which has never been carried out. The orders given were communicated to the Government of India, who asked for a further report on the subject; as they considered it useless to continue to spend large sums on investigating and estimating for the requirements of works which the villagers refused to, and the Public Works Department could not, maintain. After some correspondence the Government of India suggested that the better course would be for Government to restore and maintain all tanks irrigating over 50 acres, and to transfer all the remainder to the rayats. The Board of Revenue reported strongly against this proposal. They pointed out that there were nearly 19,000 such tanks, irrigating about 300,000 acres; and that the direct financial effect of transferring them to the rayats and reducing the revenue on the area irrigated from wet to dry rates, would be a loss of revenue of about Rs. 7,70,000, which might, however, be reduced to Rs. 4,05,000 if the tanks were all abandoned and the beds brought under dry cultivation. They objected to the proposal, however, on general grounds, such as the importance of preserving the water-supply of the country; the certainty that, owing to the absence of any co-operation amongst the rayats, the tanks would be neglected; the equal certainty that the abandonment of all control by Government would lead to endless disputes and the gradual usurpation by the richer rayats of the water-rights of the poorer; and the fact that most of these works were situated in tracts where water-supply is scanty and difficult to maintain, and where they were of the greatest use, not merely for irrigation, but also in affording drinking-water for man and beast, and in improving the supply in wells. The Government of Madras entirely concurred in the conclusions of the Board, but were of opinion that tanks irrigating 50 acres and less might be made over to the rayats concerned, in cases in which the *ayakat*, or land under them, was held by a single rayat, and in which the imposition of dry assessment on the water-spread and on the *ayakat* together would involve no loss of revenue. Orders to this effect were issued by the Board of Revenue in their Resolution No. 202, dated 16th May 1894. It is not surprising that the order has proved a dead-letter, for no rayat would be likely to take over a tank, and to undertake the cost of its upkeep, unless he was given the benefit of a reduction in his assessment. The order authorizes the transfer of a tank in the few cases in which the rayat concerned desires to abandon it, and to bring the whole *ayakat* and tank bed under dry cultivation; but the main intention was that all tanks used for irrigation, even when irrigating less than 10 acres, should continue under Government control, and they have so continued up to the present time.

267. *Kudi-maramat.*—We were repeatedly assured that the maintenance of the tanks was not satisfactory, and that *kudi-maramat* was practically dead. Others regarded it only as moribund, as falling into desuetude now that Government has evinced a readiness to accept liability for important repairs and restoration; and some thought that it could and should be resuscitated. We are ourselves reluctant to admit that so valuable an institution is really dead and past restoration. We do not recommend its adoption for any repairs on a large scale. Government must,in its own interest, not only restore the tanks, but also accept a liability for any important emergent works, as well as for periodical general repairs, the avoidance of which would result in a great loss of revenue. But the frequency and cost of such emergent and periodical repairs will depend upon proper attention being paid in the intervals, to the upkeep of the works, by those interested in them. Much is not required; merely the attention that will prevent rapid deterioration,—the stitch in time that will save nine. They are all petty works, such as filling up holes and gullies, replacing stones in the bank revetments, digging up prickly pear on the *bands* or channels, clearing silt from tank sluices or from channels, renewing outlet plugs or shutters, etc., and generally keeping the work in the trim order which is the surest way of preventing deterioration. They cost the cultivator little, since the work can be done in the slack season when he would otherwise be idle. The work is done close to his village, and for his direct and immediate benefit, while the absence of cash payment protects him from the blackmailing of sometimes unscrupulous departmental subordinates. The value of the work done is indeed small, and if the question of cost only were to be considered, Government might very well afford to bear it. But the point is that the works are so petty, and so scattered, that such repairs cannot be carried out properly by any departmental agency; and that if they are to be done at all, it is by enforcing on those who derive benefit from them a responsibility which is no new thing, but in accordnce with ancient custom.

268. *Distinction between channel works and tanks.*—In considering the question of maintenance, it must be borne in mind that there are two distinct classes of works to be dealt with: river or spring irrigation channels, and tanks. The efficiency of the former depends on the channels being periodically cleared of silt and on the observation of a fair standard of maintenance. Otherwise the supply fails absolutely, and it often indeed happens that silt clearances at the heads may have to be carried out more than once during the season, in order to save the crops. On these works the customary obligation to supply labour is still fully recognized, and *kudi-maramat* cannot be said to be dead: there is indeed often a difficulty in enforcing it in the case of channels supplying several villages or a number of different estates; but this has, in practice, been met by the establishment of a voluntary cess, the proceeds of which are applied to the remuneration of whatever labour it may be necessary to employ. There is no legal sanction under which contribution to these cesses can be enforced: but it is so much to the interest of all parties to contribute their *quotas* to the general fund, that hitherto little difficulty appears to have been experienced from the want of an enactment legalizing the cess; and as far as works of this class only are concerned, we doubt if there is a strong case for enforcing by legislation the customary obligation to supply labour for their maintenance. The case of tanks is, however, very different. Here customary repairs may be neglected year after year with impunity, that is, without seriously affecting the irrigating capacity of the work, until, after years of progressive deterioration, the dam suddenly fails during an unusually heavy rainfall, and the work is then absolutely useless until Government comes forward and restores it at great expense. As we have already shown, Government undertakes such restorations in the interests not only of the rayats, but of itself; and as the only means of preventing serious loss of revenue and a diminution of the protective resources of the country. But there appears to be no doubt that the wider recognition of the State's obligations in this respect, during the last fifty years, has resulted in the cultivators losing all sense of their responsibility for the maintenance and upkeep of tanks, which custom had formerly imposed on them.

269. *Necessity for legislation.*—We do not clearly understand why the Bill of 1883 was abandoned. From the papers which we have seen, it appears that

there were differences of opinion on the part of some of the officers consulted, on points which hardly affected the main object of the Bill. It was thought by some that the responsibilities of Government for the maintenance of the works should be as clearly and fully stated as those of the cultivators which it was proposed to enforce by legislation; and by others that the provisions of the Bill should not be enforced until all works had first been put into thorough order by Government. But whatever the obligations of the State in these matters, no one seems to have disputed the contention that the petty repairs, for which it was proposed to make the cultivators responsible, are of a kind that cannot be promptly or effectively carried out by Government agency, or by any others than the men on the spot; that they are of great importance in preventing or retarding the deterioration of the works; and that the obligation to carry them out is sanctioned by ancient custom. The position may be stated thus. Formerly, the cultivators had to depend almost entirely on themselves for the maintenance of these works; if a tank failed, assistance in restoring it might or might not be afforded sooner or later by the State; but no reliance could be placed on such assistance, and the people had to rely on their own efforts, or *kudi-maramat*. But this system was not in itself sufficient to ensure the perpetual maintenance of the tanks. Sometimes repairs were required which were beyond the power of the cultivators to carry out; or the works were wrecked by disastrous floods; and in other cases even *kudi-maramat* could not wholly prevent, however much it might retard, deterioration. It thus happened that Government devoted more and more attention and money to the restoration and upkeep of these works, even before the obligation was accepted, on the recommendation of the Commission of 1880, as a part of its regular policy. But the more the State has risen to a sense of its obligation, the more have the people become unmindful of their own; so that *kudi-maramat* has almost ceased to exist, and no care is taken even to retard the progress of deterioration. We strongly recommend a liberal and systematic devotion of funds to the improvement and maintenance of tanks; but we must point out that, if the cultivators cannot be made to do their small part, we foresee no limit to the expenditure which may eventually have to be met. Government cannot, in fact, preserve the works from retrogression without the assistance and co-operation of the rayat, any more than *kudi-maramat* could by itself preserve them without assistance from Government. The one is a necessary complement of the other; and we cannot but think that, if care were taken to define clearly the respective responsibilities of Government and the cultivators in this matter—the obligations which the former will undertake, and the work expected from the latter,—it should not be impossible to revive the system of *kudi-maramat*. If it cannot be enforced without legislation, we think that legislation should be undertaken.

270. *Repairs cess.*—The question has been raised whether, instead of attempting to enforce *kudi-maramat*, power should not be taken by legislation to impose a repairing cess on the land irrigated from tanks. A cess has many advantages. It distributes the burden fairly, and the rich man cannot escape his contribution. It has already been voluntarily adopted on many of the minor canals, or river channels, which do such good service in Madras and irrigate the lands of many villages, although the system is not, we believe, in force on any tank. If, therefore, the maximum limit were moderate, and expenditure were rigorously restricted to such repairs as would usually be done by *kudi-maramat*, and to those works in respect of which the cess was levied—a point which we regard as essential,—its adoption might be possible in cases in which there was a difficulty in enforcing *kudi-maramat*, or in which the people themselves preferred it. Although very suitable for minor canals, the objection to it, as far as tanks are concerned, is that it involves the execution by Government of all those petty repairs which the people can do so much better themselves; unless, as we hope may be possible, the cess is administered and the necessary works are carried out by a village *panchayat*. We think that any Act on the subject should affirm, in its preamble, the customary and traditional liability of the people for their petty repairs, so as to afford an equitable basis for a cess, which should be proposed as an alternative to *kudi-maramat*. We should be inclined, indeed, to legalize the imposition of a cess only when the Local

Government was satisfied that the *kudi-maramat* system would not work, or when it was desired by the people concerned, instead of *kudi-maramat*. We think also that it would be a great advantage if cess funds could be administered by local *panchayats*, for each tank or group of tanks, the object being to get the people themselves to feel a proprietary interest and pride in *their* tank; and that, at any rate, legislation should provide for such arrangements.

271. *Tank Inspectors.*—Whether *kudi-maramat* can be enforced at present or not, we think that, in accordance with the recommendation of the Commission of 1878-80, Tank Inspectors of the rank of Sub-Engineer should be appointed in all districts in which there are at present no competent or sufficient establishments for the inspection, at least once a year, of all tanks for the maintenance of which Government is responsible. It appears to us unreasonable that Government should spend annually many lakhs of rupees on the restoration and repair of tanks, and that there should be no periodical inspection of them by a responsible officer, who would at least bring to the notice of the proper authority all matters requiring immediate attention, even if he were unable to induce those interested to do what was necessary. The successful working of a *Kudi-maramat* Act will depend, in a great measure, on the employment of well-trained and competent Inspectors, who will inspect all works periodically, advise the villagers as to the repairs required, and assist them in getting necessary works done which they are unable to carry out themselves. When power has been given to the Collector to enforce the provisions, an active and sympathetic Tank Inspector should be able to induce the cultivators to keep their tanks in good order, without having recourse to the penal clauses.

272. *Irrigation Law in Madras.*—We cannot conclude this portion of our report without reference to a matter which we regard as of great importance in connection with the question of extensions of irrigation in Madras. The Famine Commission of 1878-80 observed in paragraph 60, Chapter V of their Report:—

> There is a general agreement that great inconvenience is occasioned by the absence of any Irrigation Law for Madras. Act VII of 1865 empowers the Government to levy a water-rate in addition to the land revenue, wherever water is supplied for irrigation. But, with this exception, no special provision is made by law for the grant of sufficient powers to carry out the various administrative arrangements which the introduction of canal irrigation necessarily involves, and there are, in our opinion, several particulars as to which the absence of express enactment has produced evils of a very serious nature.

In accordance with the recommendation of the Commission, an Irrigation and Navigation Bill was introduced in the Madras Legislative Council on the 18th August 1884, on the very day on which the abandonment of the *Kudi-maramat* Bill was announced. The Bill was amended by a Select Committee, whose report, dated 15th March 1886, was not, however, unanimous, as two Honourable Members appended notes of dissent. It was subsequently announced in a Government Order No. 84, dated 14th December 1888, that the Right Honourable the Governor had been "pleased to direct that the Madras Irrigation and Navigation Bill, No. 1 of 1884, respecting which no motion has been made in the Council since October 1885, be removed from the list of business."

273. *Liability of zamindars for the maintenance of irrigation works.*—Among the questions on which legislation was necessary, the Famine Commission alluded to the impossibility "of enforcing on *zamindars* the obligation of maintaining their tanks and other irrigation works in proper efficiency, or even of contributing their share of expenses incurred by Government in the improvement of irrigation works by which their estates are benefited." They pointed out the fact that the land forming the bed of *zamindari* tanks had been expressly excluded from assessment when the permanent settlement was made, in order that it should remain as a means of irrigation, but that the *zamindar* had too often forgotten the object of this exemption, and put the tank bed to what purposes he pleased.

274. The Famine Commission found in 1879 that very little was known as to the state of the irrigation works in these estates; and very little is known now.

We have, however, obtained statistics of 22 *zamindaris*, ranging from Vizagapatam to Tinnevelly, and having a total area of 14,849 square miles. These reports do not vary much. Some of the estates have never been surveyed. Many keep no record of the rainfall. *Takavi* advances to assist in sinking wells are quite unknown. The tanks are often out of repair. One writer reports:—

> As a rule, most of the tanks are considerably silted up, and the *bands* have been worn out. Many of the tanks have no sluices, *calingulas* or surplus weirs. It is the practice on this estate to cut open the *bands* for taking water to the fields for irrigation purposes. This is a fruitful source of breaches in the tanks. The river channels supplying the tanks are, in many cases, much silted up; and it is only when the rivers receive heavy freshets that water can flow through them to the tanks.

There are no famine relief work programmes, and in many cases no relief seems to have been given in past famines.

275. While famine-stricken peasants flock in large numbers from the *zamindaris* to the State relief works, we consider that the Government may well insist on the *zamindars* keeping up their irrigation works, and that Inspectors should be appointed to see that they do so. But this cannot be brought about properly without legislation. We are informed that the Madras Government have recently had under consideration a new Land Bill, which provides, among other things, for enforcing the liability of *zamindars* and *inamdars* for the maintenance, in a state of proper repair, of works which have been in use for irrigation at any time within ten years before the enactment of the Bill. As long as power is taken at as early a date as possible to enforce this liability, it is a matter of indifference whether it be taken in a Land Bill or in an Irrigation Bill, but we hope that the proposal may not be allowed to drop.

276. *Charges on zamindars for improvements in the means of irrigation.*—The Commission also called attention to the benefit which *zamindars* derived from irrigation works constructed at the cost of the State.

> Lands, which, on the introduction of canal irrigation, were in the enjoyment of any means of irrigation, however inferior and precarious, are now supplied with canal water without any additional charge. The consequence is that a *zamindar* gets a continuous and unlimited supply for the whole of the area which, under the most favourable circumstances, he had ever brought under irrigation. There seems to be no reason why this benefit should be gratuitously conferred. In those cases in which the supply is enlarged or otherwise improved, a corresponding payment should be enforced, and any difficulty in doing this should be removed by legislation.

277. We cannot but think that legislation of this kind is absolutely necessary, if Government propose to embark on an extensive programme of irrigation such as we have recommended. As has already been observed, there are few irrigation projects in Madras which do not take up a certain area of old or pre-existing irrigation. The effect of the works is not only to extend irrigation into lands not previously protected, but also to render this old irrigation incomparably more valuable and secure. The water which may be stored in a new work cannot always be carried away from *zamindari* lands, even if it were desirable to debar them from any share in it. It is passed from the storage work into a river where it is picked up and diverted into the channels above existing anicuts, and when these belong to *zamindars*, the additional supply, which has been created by the new works, has to run the gauntlet of these channels before it can be utilized on lands on which a rate can be charged. We observe that legislation, with the object of enabling Government to recover a rate from *zamindars* in respect of improvements or extensions of their water-supply, which are due to works executed at the cost of the State, was regarded as undoubtedly just and proper by one of the Honourable Members of the Select Committee on the abandoned Bill of 1884, who recorded in a minute of dissent his disapproval of the Bill as a whole.

278. *Rights and responsibilities of Government in respect of water.*—There is, however, another reason for proposing an Irrigation Act for Madras, which

appears to us to be of far greater importance, *viz.*, the fact that there exists at present no definite statutory declaration of the rights and responsibilities of Government in respect of the control of the public water-supply. The Commission of 1878-80 did not refer specifically to this point, although it is certainly covered by the language of paragraph 60, Chapter V of their Report, which we have already quoted; but in the course of our inquiries we have been strongly impressed with the urgency of this question. We find that the simplest orders which may be issued by the Executive Officers responsible for the control and management of irrigation works, whether in the Civil or Public Works Department, are liable to be made the subject of suits in the Civil Courts; and these are not infrequently carried into the High Court, whose rulings may be said to constitute the only irrigation law in the Presidency. In these rulings, there is a recognition of the right of Government to regulate in the interests of the public the distribution of any portion of the water flowing in natural channels on which rights have not as yet been acquired; and also to regulate the distribution of water and to construct and repair works in *rayatwari* lands. But this right is subject to such qualification, according to the law of easements or user, that the greatest uncertainty prevails as to the extent to which controlling officers can make any alterations or improvements in the existing system of distribution, however wasteful or unequal it may be. Section 2 of the Indian Easements Act (V of 1882) provides that nothing contained therein shall derogate from "any right of the Government to regulate the collection, retention, and distribution of the water of rivers and streams flowing in natural channels, and of natural lakes and ponds, or of water flowing, collected, retained, or distributed in or by any channel or other work constructed at the public expense for irrigation;" but, in the absence of a statutory declaration of any such right of Government, this section appears to have little value in Madras.

279. As one illustration of the serious inconvenience caused by the want of such a declaration, we may refer to the case of the river Vaigay. Irrigation has been practised on this river from time immemorial by means of a number of old anicuts, channels, and sluices. The supply, however, was always precarious, until, after the completion of the Periyar project at a cost of over a crore of rupees, the waters of the Periyar river on the western slopes of the Ghâts were stored and diverted into it. The result has been to increase the supply, at the seasons when it is most in demand, by about 1,100 cusecs; and to improve to a remarkable degree all the former conditions of supply to the works on the Vaigay river. In these circumstances it has become necessary to alter the dimensions of some of these works, to lower the crests of anicuts, or to reduce the size of sluices so as to prevent their drawing off an undue share of the extra supply, and to permit its utilization elsewhere to the best advantage. We were informed that, in the case of one work which has thus been altered, a suit has been brought against Government which is now *sub lite;* and that the plaintiff claims that the work should be restored to its original condition, not solely on the ground that he has suffered injury, which, if put forward at all, is a secondary issue which it may or may not be possible to substantiate, but on the ground that Government has no right to alter the dimensions of a work which has been in existence from time immemorial, even if it can be shown that the plaintiff's interests have not been prejudicially affected. A similar contention has been made in another case which has been brought to our notice. We are not concerned with the question whether such a claim as this can be established under the law as it stands; but we think that the mere fact that it has been put forward renders it necessary to declare by Statute the power of Government in such matters.

280. Another illustration of the necessity for legislation is afforded by the case of the Cauvery. We have already referred to the proposal to construct a large reservoir, either on the main river or on one of its principal tributaries, for the purpose of reinforcing the supply to the delta when necessary. Whichever site may be eventually selected for the reservoir, it seems certain that a great portion of the supplementary supply, which it is proposed to store at great expense, will be intercepted in its passage from the reservoir to the head of the delta by the existing large canals or river channels. These channels have no head sluices, so that the supply passing into them cannot be regulated, and the owners have from

time immemorial claimed and exercised the privilege of constructing *korambas*, or temporary spurs or *bands*, when the river is low, for the purpose of diverting as much of the water as possible into their channels. If the reservoir is constructed, it will be both necessary and equitable to introduce some system of regulation at the heads of these channels, so as to prevent their drawing off more water than has hitherto been passed into them; but it is at least doubtful whether these customary rights can be interfered with in the present state of the law. Similar difficulties will be met with throughout the delta, where the distribution is of the most unsatisfactory character, and where it is most difficult in years of short supply to prevent the lands at the head of the channels from intercepting all the water, so that none arrives at the tails. We were told that some of these channels were re-sluiced some years ago in order to improve matters; but the vents were all enlarged again by the people, who claim immemorial rights whenever any attempt is made to equalize the distribution. The irrigating duty is known to be remarkably small, and, if Government spend large sums in creating a supplementary supply, it should take the necessary action to secure a greater control over the distribution.

281. It may be said that if, as in both the illustrations which have been cited, the claim of Government to interfere with existing arrangements is based on the assumption that it has itself incurred a great expenditure in increasing the supply, it is not likely to be objected to by the Courts. This may or may not be the case, but it is a matter which should not be left to the judgment of the Courts. Government has, no doubt, a stronger case for exercising its powers of control when it has itself done much to improve all the conditions of supply. But we submit that it should, in the general interest of the public, be free to exercise these powers in all cases; so that the best results may be obtained from the available water-supply of the country, without reference to the expenditure which the State may have incurred in improving it in any particular case. Thus, if a certain tract of country is irrigated from a number of independent channels taking off from above several anicuts, but can be more effectively and economically irrigated from a single channel which can command the whole, Government should not be prevented from making the change, because the channels which it may propose to abandon have existed from time immemorial. Again, if a particular owner has from time immemorial drawn a supply which is clearly excessive, when considered in relation to the area irrigated, Government should be free to make arrangements which will involve the reduction of the supply to what is sufficient for the irrigation of the area to which it is applied. The measure of any owner's or cultivator's claim should be the share of the supply which is necessary for the irrigation of the area which is entitled to irrigation, and not the supply which he has been permitted to appropriate under a system of very lax control. Distribution should be controlled in the public interest, with reference not to demands which can be justified only by prescription, but to actual and legitimate requirements.

282. *Other points on which legislation is recommended.*—The first and main object of legislation is, in our opinion, to declare the right and title of Government in Madras to the same power of control over public water-supply as is already possessed in Northern India, subject to compensation for *injury* done by diminution of supply to any existing channel or area, but not for its mere diminution, if not injurious; to penalize unauthorized interference with that control; and to affirm, as in the Northern Indian Canal Act, that no supply of water from any irrigation work constructed, maintained, or controlled by Government, can create a right to the continuance of that supply, or to anything more than compensation for its restriction or withdrawal, as provided in Parts II and IV of that Act.

283. There are other points on which we recommend legislation, but they are all of secondary importance to the main point of declaring an indisputable right of Government to use and control for public purposes the water-supply of the country. We have already referred to the necessity of legislation for the enforcement of *zamindars'* obligations in respect of irrigation works, whether this be effected by means of a Land or an Irrigation Bill; and also for enabling Government to recover in some form or another a return for capital

expended in introducing, extending, or improving, the means of irrigation in lands permanently settled, or of which the revenue has been relinquished in whole or in part. The Commission of 1878-80 pointed out (Chapter V, paragraph 65) "the great difficulty in dealing under the general criminal law with various offences which interfere materially with the proper management of a canal. Stopping up other people's channels, improperly opening one's own, tampering with banks, etc., are acts of this nature. We desire to repeat their recommendation that this difficulty should be removed by suitable legislation.

284. Besides what has been mentioned above, and the many other articles that a careful study of the irrigation laws of the other Indian provinces may suggest, we would refer to the desirability of legalizing, either under the proposed Act or by an amendment of the Land Acquisition Act, the acquisition *by the consent of the parties* of a partial usufruct in land, leaving to the owner the property in the land, and the enjoyment of it so far as may be compatible with the public purpose for which it is acquired.

285. *Necessity for legislation.*—It may be contended, as it appears to have been in some of the discussions on the Bill of 1886, that Madras has hitherto managed to get on without an Irrigation Act, and that legislation therefore is not called for. This was not the opinion of the Famine Commission of 1878-80. Our own view is that legislation is now required not less, but more urgently than it was in 1880; and that, in every year as it passes, there is a growth or extension of assumed private rights, which renders legislation more difficult and at the same time more imperatively necessary. One great disadvantage of the present uncertainty as to the powers of Government is that it encourages litigation in respect of the simplest orders that may be passed by the officers responsible for the management of irrigation works; not only is the time of the Courts taken up by such cases, but also that of the officers whose orders are disputed, and who become defendants in civil suits, which are often carried on appeal from the Munsif's to the District Judge's Court, and sometimes even to the High Court. In Northern India it is almost an unknown thing for cases connected with the control of irrigation works to be brought into a Civil Court, although such Courts have jurisdiction; and we are informed that litigation of this kind has been very infrequent in Bombay since the passing of Bombay Act V of 1879. A still greater objection to the present state of things is that, until the powers of Government have been more clearly defined, the officers responsible for the management of an irrigation work must often refrain from the exercise of any power of control, in the apprehension that they may be acting *ultra vires*, and that their orders may be reversed after a long and vexatious course of litigation. This uncertainty as to their powers tends to paralyse all efficient control, and to prevent such attention being paid to the improvement of the distribution and the increase of the irrigating duty as we have observed in other provinces. We may add that legislation of the kind which we propose has been found necessary in all other provinces of India, in Egypt, and in all European countries in which irrigation is extensively practised.

286. We recognize the great difficulties in the way of an Irrigation Act for Madras, of which the greatest is due to the fact that the measure has been so long deferred. We recognize also that many of the conditions in Madras differ so much from those in other parts of India that any Bill which may be brought in will have to be framed in some respects on lines of its own. But we consider that irrigation in Madras will never attain the great development of which it is still capable, unless or until Government assumes the full powers of control over the whole water-supply of the country which we have recommended, and which have been found so necessary in other Indian provinces and in all countries in which extensive irrigation works have been constructed or are maintained by the State. We lay stress on the consideration that future extensions of irrigation in this Presidency will depend mainly on the construction of expensive storage works, and that much greater care must be expended in the distribution of a stored supply than has sufficed for the great deltaic canals. Economy in distribution will be of paramount necessity; and wasteful arrangements based on immemorial usage must not be allowed to stand in its

way, although due care must be taken, in modifying them, to prevent real injury to the interests concerned. We have recommended a very liberal expenditure on the extension of irrigation in this Presidency; but we cannot think that Government will get a proper return for that expenditure, or that the most will ever be made of the water-supply at its disposal, until it claims for itself the extended powers of control which have now, but not for the first time, been recommended.

(*iv*).—*Private irrigation works.*

287. *Private works other than wells.*—Private works, that is, works constructed and maintained by private proprietors, may be considered under two heads: those situated in *rayatwari* tracts; and those found in *zamindari* and alienated villages. Excluding wells, the number of such works in the former area does not exceed 7,000, comprising 5,681 tanks and 1,231 channels. Most of these are petty works; nearly 48 per cent. irrigating less than 10 acres each, and barely 10 per cent. irrigating more than 50 acres each. About 42 per cent. of the works are situated in the Cuddapah district, while North Arcot, Salem, and South Arcot, account for another 26 per cent. Most of the river and spring channels are to be found in the Anantapur and Cuddapah districts, in the basins of the Penner and Chitravati rivers. The aggregate area irrigated by all the works amounts to 71,000 acres in a normal year, and to probably less than a fourth of that in a year of severe drought. Of the total area, nearly 13,300 acres are under river channels, more than 34,500 acres under tanks, and about 23,200 acres under 'other sources,' chiefly spring channels.

288. *Scope for extension of private works other than wells.*—In *rayatwari* tracts the scope for the extension of large private works is necessarily limited, as almost all the available sites are already occupied by works constructed or maintained by Government, and the construction of new works by private proprietors might seriously interfere with existing interests. It is probable, however, that, when the investigation now in progress in various parts of the Presidency, is completed, it may be found advantageous to allow some of the smaller projects which have been suggested from time to time during the past half century, to be carried out by private enterprise. The rules at present in force in Madras for the encouragement of such efforts are sufficiently liberal and do not require any change. Under these rules, lands irrigated from private works which do not interfere with the water-supply to works lower down, are permanently exempted from enhancement on account of water advantage; though the owners are liable to pay dry assessment on so much of the land covered by the water-spread as has been cultivated within the previous ten years.

289. *Private works in zamindari tracts.*—In paragraph 221, it has been explained that, on the best data available, the area irrigated by private works in *zamindaris* and alienated villages in an ordinary year, is estimated at about $2\frac{1}{2}$ million acres. Particulars of the number and description of the works are not known, but from the replies to our inquiries received from some of the *zamindaris* it may be assumed that about 200,000 acres are irrigated from wells, about 300,000 from river channels or streams, and the remainder from tanks. The general condition of the works is reported to be far from satisfactory, and the extent of protection afforded in a season of prolonged drought is consequently very limited. Excepting the *zamindaris* in Vizagapatam, almost all the estates suffered severely during the past famines, and there is apparently not much scope for the construction of any new works which would afford substantial protection to any appreciable area in these tracts. Moreover, with some few exceptions, the proprietors of the larger estates are either financially embarrassed or are involved in litigation, and they are unable to improve even the existing works. On the other hand, the position of the tenants in many of the *zamindaris* is very unsatisfactory. They appear to have practically no protection against enhancement of rents on account of improvements effected by them.

290. Within recent years four large estates have come under the management of Government, while two more have been leased to European firms for

periods varying from thirty to fifty years, towards the liquidation of debts due by the proprietors. It is probable that some improvement will be effected in the condition of the irrigation works before these estates, which account for nearly a fifth of the total *zamindari* area in the Presidency, are handed back to the proprietors. Already, in Vizianagram, a sum of five lakhs of rupees has been expended on irrigation works since the estate came under management four years ago, and there are also projects, costing over two lakhs more, which are said to be under investigation. In the Sivaganga *zamindari*, in the Madura district, the European manager under the lessees reports that about 300 tanks and many channels have been repaired during the past seven years, the repairs in many cases including the construction of new weirs and sluices. There are still 700 tanks and several channels which require to be repaired. About two-thirds of this estate, and a considerable portion of the Ramnad *zamindari*, could be irrigated by Periyar water if the supply were sufficient.

291. *Wells.*—Wells in Madras are divided into two classes: wells sunk in lands held on dry assessment; and those sunk in wet lands, or lands classed as wet, under Government sources of irrigation. The former are termed '*ayakat*' wells, because the *ayakat*, or area attached to them, is dependent for its irrigation solely upon the well supply, and not upon any other source; the latter are called 'supplemental' wells, because their main function is to supplement the irrigation from Government works whenever the supply in them fails owing to deficient rainfall or other causes. Lands irrigated by *ayakat* wells are permanently exempted from additional assessment on account of such irrigation; but, in the case of supplemental wells, the lands benefited by them are liable to pay the full wet assessment fixed upon them, except in seasons when there is no supply whatever in the Government works and the lands dependent on them are cultivated solely with the aid of well water. On such occasions only the dry assessment is charged.

292. Excluding *kachha* or temporary wells, which are few, the number of *ayakat* wells returned for 1900-01 for *rayatwari* tracts alone amounted to about 470,000, and the area irrigated, to nearly 1½ million acres, first and second crop. Compared with 1891-92, there has been an increase of over 170,500, or 57 per cent., in the number of wells, and of about 469,000 acres, or 46 per cent., in the area irrigated. During the same period, the number of supplemental wells has increased from 134,300 to 141,800, or by 9·5 per cent. Coimbatore shows the largest number of *ayakat* wells, *viz.*, 70,600, and is closely followed by North Arcot and South Arcot, with 65,193 and 68,265 wells, respectively. These three districts account for 44 per cent. of the total number of wells, and for 43 per cent. of the area, returned for the Presidency. The districts next in importance are Salem, Tinnevelly, and Cuddapah, with a total of 131,000 wells, and of 400,800 acres irrigated, or 28 and 27 per cent., respectively, of the Presidency total. There are about 30,000 wells in Trichinopoly and 33,000 in Madura, irrigating 67,700 and 117,600 acres, respectively, and about 13,000 each in Chingleput and Anantapur, irrigating 28,200 and 66,100 acres, respectively. The average area irrigated per well varies from 3 to over 4 acres in eight districts and from 2 to 3 acres in six others. Coimbatore shows the largest average (5½ acres) and Ganjam the lowest (0·9 acres). The average for the Presidency is a little over 3 acres. North Arcot and South Arcot which possess a large number of wells, between 65 and 68 thousand, exhibit a comparatively small average, 2 and 1½ acres, respectively. This is apparently due to the poorness of the subsoil supply and partly also to the small size of the holdings. The number of wells in *zamindari* tracts is not known, but for whole *inam* villages, the number is returned at 15,330, including 2,561 supplemental wells, irrigating an aggregate area of 56,526 acres.

293. In the two west coast districts, where the rainfall is always heavy, there are no irrigation wells worth mentioning. In the two northern districts, Ganjam and Vizagapatam, where the conditions are similar to those of the adjoining province of Orissa, the number of wells is exceedingly small, and the same is the case in the three great deltaic districts of Godavari, Kistna, and Tanjore. In the Deccan districts, where protection is most urgently required,

well-sinking is said to be difficult and expensive, especially in Kurnool and Bellary, and in the northern portion of Anantapur and Cuddapah. In the two former districts, the number of wells does not exceed 8,000 each, though in Kurnool the number has more than doubled during the past ten years. The wells in this district are to be found chiefly in the taluks of Cumbum and Markapur, situated to the east of the Eastern Ghâts, where water is generally found within a moderate depth. In the southern taluks of Anantapur and in the sub-division of Cuddapah, the facilities for the construction of wells have been utilized to a considerable extent.

294. The great development which well-irrigation has attained in the Madras Presidency has unquestionably been largely assisted by the liberal policy which has been pursued during more than half a century, in regard to the exemption of private improvements from additional taxation. The principle of leaving to the rayat the full benefit accruing from improvements effected by his own industry and means, was first advocated by Sir Thomas Munro at a very early period of his career; but it was not until 1852 that his recommendations bore fruit, in the determination not to assess wells so as to raise the assessment over what the general value and character of the land (apart from the well) would warrant. In that year orders were issued, giving a distinct assurance "that the rayats would be allowed the full benefit of their own improvements, that the lands thus improved would not be subject to any additional assessment so long as the general rates of the district remain unaltered; and that, on the occasion of any general revision of the district rates, the assessment of the lands so improved would be irrespective of the increased value conferred upon them by their holders." With a view, however, to guard against possible fraud by the construction of wells in close proximity to existing Government works, so as to draw away water from such sources by absorption and percolation, it was laid down that the exemption shall not extend to wells "dug within 100 yards in rear of tank *bands*, rivers, channels, and beds of tanks," nor to wells "dug in land which can be watered by any existing public work of irrigation." The first restriction was subsequently relaxed, as it was found impossible to determine the extent of the influence of percolation and absorption, so that rayats can now sink wells quite close to a tank, river, or channel, without fear of enhancement of assessment; provided the wells are sunk in lands assessed as dry, and that water from existing Government sources is not drawn into the wells by surface flow. The results of these liberal concessions have been most beneficial to the province generally; and in more than one district they have prevented scarcity from developing into famine.

295. The Famine Commission of 1878-80 recommended that all such concessions should be embodied in a legislative enactment, "so that it may be clearly known, without fear of mistake, or danger of retraction and change of view, by every landowner or tenant who executes a permanent improvement on the land, whether he is entitled to the entire profits arising from it, or to a part, for ever, or for a term of years." Considering the liberality with which the Local Government have given effect to the rule of permanent exemption, we doubt whether legislation is required in the Madras Presidency. We have no reason to suppose that the rules are misunderstood; but, with the object of securing the full observance of the spirit of the orders in future settlements, it may be advisable that the rules should be supplemented by a clear direction that the rates assessed on well lands should in no case exceed those assessed on adjacent lands enjoying similar qualities and advantages, but unprovided with wells.

296. '*Doruvu*' *wells.*—The foregoing remarks apply to wells sunk in dry lands. There are other wells sunk on the banks of rivers and streams, and known as '*doruvu*' wells, which do not enjoy the exemption referred to. These *doruvu* wells derive their supply partly from channels from the river or stream, and on that account the lands irrigated from them are usually charged wet assessment, less a deduction for lift of one rupee per acre for first, and half a rupee per acre for second crop. Up to 1878, they were liable also to be charged for second crop cultivation, except in Nellore and Cuddapah; but in that year this additional charge, which amounted to half that for first crop, was ordered to be

everywhere abolished. The exact number of these wells at present in use has not been reported, but in 1893 the number did not exceed 5,700 for the whole Presidency. We fully recognize the principle that these wells, which are fed directly from natural rivers or streams, are not entitled to the same exemption as wells sunk in dry lands; but, for the reasons given in our Punjab Chapter (paragraph 65), we consider it inexpedient to levy any royalty on such irrigation, in tracts where the staple crops are insecure in the absence of irrigation. In the Deccan, Carnatic, and Central districts, which are frequently subject to famine, there are numerous streams which probably afford great facilities for the construction of such wells all along their banks; and it is obviously to the advantage of Government and the people to have the water utilized, to the fullest possible extent, for protective purposes. Considering the expense involved in the construction and maintenance of these wells, which are often liable to be damaged by floods, we are strongly of opinion that every encouragement should be given to their extension. We observe that the number of *doruvu* wells in the four worst famine districts, comprising the Deccan, amounted to less than 1,600 in 1893, irrigating only 7,600 acres; but it is worthy of note that nearly 500 of these wells are situated in the two eastern taluks of Kurnool on the banks of the Gundlakamma river, where the charge of wet assessment has long been given up. In these districts, at any rate, there ought certainly to be no hesitation in carrying out a specially liberal policy in regard to the extension of such wells.

297. *Supplemental wells.*—As already explained, the chief function of supplemental wells, that is, private wells sunk in wet lands, is to supplement irrigation from Government works when the supply in them proves insufficient for raising or maturing a crop. They are found chiefly under very precarious sources, and are of great use in enabling the rayats to save their crops in times of deficient supply, and often to grow even a second crop when the water in the Government works is exhausted. There are in all about 141,800 of these wells, excluding those in whole *inam* villages (2,561); nearly a third of the number being found in the North Arcot district; from 25 to 23 thousand in South Arcot and Salem; about 16 thousand in Chingleput, 10 thousand in Cuddapah, and over 7,000 each in Madura and Tinnevelly.

298. The great value of these supplemental wells is forcibly brought out in an interesting memorandum furnished by Mr. Benson, Deputy Director of Land Records and Agriculture, in which he conclusively shows that in all the districts in which such wells exist in any appreciable numbers, the percentage of annual remissions under minor works is very considerably less, and the proportion of second crop cultivation very much greater, than in districts in which these wells are scarce. At a very moderate estimate, the existing number of supplemental wells in *rayatwari* villages should be able, with the assistance of the tank supply, such as it is, to afford a very fair amount of protection to more than half a million acres of crop; while, in the absence of such protection, the Government would lose even the dry assessment on this area, amounting probably to more than 10 or 12 lakhs of rupees annually, and the loss to the rayats would be at least five or six times as great. It is evident, therefore, that the extension of these wells deserves every possible encouragement, both by the grant of all the advantages and concessions proposed for other classes of wells and by all reasonable liberality in matters of assessment. But the existing rules, at any rate as they are worked and usually interpreted, are not, in our opinion, sufficiently liberal. They have certainly failed to afford any stimulus to the construction of these wells. The effect of the rules as worked is that dry assessment is levied only in cases where "the crops are irrigated solely with the aid of private wells and no supply whatever is received in the tank or other Government source of irrigation, either in the first crop or second crop season;" but the concession is not extended to the more numerous cases in which any supply, however small, is received during any portion of the time that the crops raised entirely with the aid of well-water remain on the ground. In such cases the lands become liable to the charge of full wet assessment. We think that in such cases the dry rate of assessment only should be charged on the well-lands, whenever remissions have had to be

granted for failure of the tank supply on other lands of the *ayakat* unprovided with wells.

299. *Takavi.*—As already observed, the Government of Madras has been distinguished by the vigour and liberality of its *takavi* policy. The first step forward was taken in the seasons of scarcity which occurred in the years 1890-91 and 1891-92 with sufficient severity to require the institution of relief operations, though not on any large scale, in parts of the Carnatic, central, and southern districts. The threatening of scarcity in parts of the southern districts during 1892-93 had the result of maintaining this policy in unabated activity throughout that and the following year. Two good seasons followed, and with them exertions were slackened. But in 1896-97 and 1897-98, when scarcity re-appeared in many parts of the Presidency and assumed considerable severity, vigorous measures were resumed. During the years 1898-99 and 1899-1900, the sums advanced were comparatively small, owing probably not only to the favourable character of the seasons, but also to the curtailment of allotments in consequence of the exceedingly large sums which were being advanced in other provinces where severe famine prevailed. The total sum advanced during the decade ending 1901, under the Land Improvements and Agriculturists' Loans Acts, amounted, in round numbers, to 76 lakhs; of which 47 lakhs were granted for the construction and repair of wells; 12½ for other purposes under the former Act; and 16½ lakhs for seed, cattle, etc., under the latter. It is worthy of note, that during the famine of 1896-97-98, which was, as above remarked, of appreciable severity, the total amount advanced amounted to about 17 lakhs; 10½ of which were for seed and cattle, nearly 4 for other purposes, and only 2½ for wells. Whereas, in 1891-92-93, nearly 27 lakhs were advanced, of which only 2½ were for seed and cattle, about 4½ for "other purposes," while nearly 20 were advanced for wells. Even in the fairly favourable year of 1893-94, over 6 lakhs were advanced for wells, and in the next year nearly 3 lakhs. Subsequently, however, the advances for wells were allowed to fall below 2 lakhs per annum. Now our witnesses were virtually unanimous that in every district (except Vizagapatam and Ganjam, where there are scarcely any wells used for irrigation) irrigation from wells is capable of considerable development. We regret, therefore, that the policy of advancing liberally for wells should have had to be interrupted, and we trust that it may be resumed with full vigour. During the three years ending 1893-94, nearly 12 lakhs a year were advanced for land improvement, nearly 11 lakhs being for wells alone; and we are confident that no difficulty will be found for many years to come in expending to full advantage an allotment of at least 15 lakhs. Several of the most important improvements which we have suggested in the procedure and conditions under which advances have been made, such as the lengthening of the period of repayment, the reduction of interest to 5 per cent., and the empowering of officers of the rank of Tahsildar to grant loans, are already in force in Madras, and no doubt account to a considerable extent for the success attained there, up to the present, in *takavi* administration.

(*v*).—*Famine works and programmes.*

300. *Famine relief.*—The Famine Commission of 1898 reported that out of a total expenditure of Rs. 71·32 lakhs, incurred on actual works of relief, during the famine of 1896-97, only about 8 per cent. was spent on the maintenance or construction of irrigation works, and a little over 1 per cent. on miscellaneous works; the balance, or over 90 per cent., being expended on roads which, in many cases, appear to have been taken in hand merely from the necessity of finding work of any kind for the numbers demanding employment. In the tracts which were then affected—the two northern districts of Ganjam and Vizagapatam, and the four Deccan districts—there are very few irrigation works suitable for famine labour; and relief works consequently consisted mainly of roads and the collection of road-metal. The actual value of the work done was roughly estimated by the Commission at one-third of the recorded expenditure, or, in round numbers, at Rs. 24 lakhs, of which Rs. 2 lakhs were on account of irrigation works.

301. The principal irrigation works undertaken during this famine were the extension of three distributary channels in connection with the Rushikulya project in Ganjam; the restoration of three ruined tanks in Bellary; and the construction of certain sections of the Chopad and Peddapasupala projects in connection with the Kurnool-Cuddapah Canal, and of two new tanks in the Cuddapah district. The sums expended on these new works amounted to Rs. 43,600, Rs. 69,000, and Rs. 1,48,800, respectively, in the three districts. In addition to this sum, nearly two lakhs were spent on the repair of 25 tanks, and of some river and spring channels, and about half a lakh in improving several village ponds and wells used for drinking purposes.

302. In 1900-01 the Deccan districts were again affected, and also portions of the adjoining upland taluks of Kistna and Nellore; but the distress was not severe, and it was found possible to meet the demand for labour by providing employment on various test-works, chiefly irrigation works. Thus, out of about Rs. 1,66,000 expended on relief in that year, including about half a lakh for general charges for supervision, tools and plant, etc., nearly Rs. 91,000 were spent on irrigation works, including those which were left incomplete in the previous famine in the Deccan districts. Owing to the adoption of the intermediate system of tasking, and to the small numbers that had to be relieved, the actual value of the work turned out on this occasion was very satisfactory; it being, in almost all cases, in excess of the normal rates.

303. With the exception of the two projects in Cuddapah, and of one or two tanks, all the irrigation works undertaken during the two famines referred to above have been completed and are likely to prove very useful. We understand that arrangements have been made by the Local Government for completing the other works as soon as possible.

304. *Famine programmes.*—A detailed list of works suitable for famine relief is maintained by the Board of Revenue for every taluk in the Presidency, except the deltaic taluks of Godavari, Kistna, Tanjore, and Madura, the two west coast districts, and the Nilgiris. The programmes for 1902 provide relief for six months for over 4 million units, or about 15·7 per cent. of the population of the districts, or portions of districts, to which the lists relate. Out of the total number, road works provide for over two million units, irrigation works for 1·32 millions, and village tanks and water-supply and other miscellaneous works for the remainder. The total cost of the works provided in the programmes is estimated at over 6 crores; of which 3·6 crores relate to what are classed as 'large works,' that is, works which are calculated to provide simultaneous employment for three months for at least 1,000 persons. The number of works of each class, for which estimates have been prepared, is not known; but the statements which have been furnished to us by the Board show that estimates for 'larger works,' costing in the aggregate over 1·85 crores, have been sanctioned, while similar estimates are said to be ready for 'smaller works' costing about 1½ crores.

305. We are of opinion that the provision made for irrigation works in the relief programmes might be greatly increased; especially in districts in which these works exist in any considerable numbers. In the previous famines very large sums appear to have been expended on the construction of roads which it was subsequently found impossible to maintain from want of funds. We accordingly recommend that all works on the tank restoration programmes should find a place in the famine relief programmes until they have been carried out; and that the first care of the authorities, when famine is imminent, should be to get on to the programmes all works of repairs that can usefully be carried out on tanks. When nothing better can be done, the opportunity may be taken to remove silt from the beds, as less unprofitable than constructing roads which cannot be maintained, or collecting road-metal that is not likely to be required within any reasonable period. It is true that the difficulty of supervising a number of scattered irrigation works would be great; probably much greater than in the case of labour employed on road works. But we do not think that the difficulties are insuperable. In most cases the execution of the repairs might advantageously be entrusted to the local headmen, or other respectable rayats

who own large extents of land under the works; and if care is taken by the overseer, or other officer employed for the purpose, to select the persons for whom employment should be provided, and to prescribe the tasks for different descriptions of work, there can be no danger of the relief being misapplied, or of the money being wasted. In this connection we would invite attention to the remarks contained in paragraph 209 of the Bombay Chapter, which apply generally with even greater force to the Presidency of Madras, where the minor irrigation works are much more numerous and are collectively much more important. In addition to the minor works referred to above, it is necessary also to have on the programmes of each district a few larger works which may be found suitable for the employment of relief labour in large camps. When any of these works are carried out in the regular course, before the occurrence of a famine, others should be inserted in their place until all the possible projects in each district are exhausted.



Chapter XVII.—THE CENTRAL PROVINCES.

(*i*).—*Local conditions; use and value of irrigation.*

306. *Diversity of conditions.*—Differences in the configuration of the country, in its geological structure, in the quality of the soil, in the rainfall, and in the agricultural habits of the numerous races comprised in the population, render it impossible to divide the Central Provinces into any reasonable number of well-defined tracts, each of which would present a fairly uniform aspect. In considering the question of the utility of irrigation it will be convenient, therefore, to deal separately with each of the main classes into which the agricultural lands of the province are naturally divided. But before doing so it will be necessary to give a very brief description of its main physical and geological features, and to show the extent to which its cultivation is already protected by irrigation works.

307. *Physical features.*—The great range of the Satpuras, stretching across the province from the western corner, and extending along the greater portion of its north-eastern boundary line, forms the leading feature in the physical configuration of the country. On these extensive high lands are situated the Satpura or plateau districts of Mandla, Seoni, Chindwara, Betul, and portions of Nimar and Balaghat. In the extreme northern corner of the province, on a portion of the Vindhyan range of hills, are situated the districts of Saugor and Damoh and a portion of Jubbulpore. Between these two hilly tracts lies the deep and narrow valley of the Nerbudda, comprising the greater part of Jubbulpore, the districts of Narsinghpur and Hoshangabad, and that portion of Nimar which lies outside the basin of the Tapti river. To the south and east of the Satpuras are the two great plains of the province, separated from each other by the watershed of the Wainganga and Mahanadi rivers. The western or Nagpur plain contains the districts of Wardha and Nagpur and the three Wainganga districts of Bhandara, Chanda, and Balaghat. The eastern or Chhattisgarh plain includes the districts of Raipur, Bilaspur, and Sambalpur. Though commonly designated 'plains' these two large tracts of undulating uplands bear no resemblance to the flat alluvial plains of Northern India.

308. *Main geological characteristics.*—With regard to the very complicated geological structure of the province, it will be sufficient to note that the districts of the Vindhyan and Satpura plateaux with the whole of the Nerbudda valley, the districts of Wardha and the greater part of Nagpur are situated almost entirely within the area of the Deccan trap formation; the only exceptions being the district of Balaghat and portions of Seoni and Chindwara. The trap as a rule overlies crystalline rocks or sandstone. The latter predominates, and frequently shows on the surface, in Damoh, in the northern part of Saugor and Jubbulpore, and in a tract surrounding the boundary line between Hoshangabad and Chindwara. Outside the region of the trap the province lies generally on the crystalline formation, but the northern and greater part of Raipur, the southern third of Bilaspur, and portions of Sambalpur are formed on rocks belonging mainly to the lower Vindhyan sandstone series.

309. *Annual rainfall.*—The average annual rainfall varies from 32 inches in the extreme west (Nimar) to 47½ inches in the north (Jubbulpore), 53 inches in the east (Sambalpur), and upwards of 60 inches in the central district of Balaghat. The mean for the province is 47½ inches, and compared with most other provinces the rainfall is remarkably steady, the annual amount varying but little from year to year. Since 1869, there have only been two years in which it varied from the normal by more than 25 per cent.—the wet year of 1884, and the dry year of 1899. But the amount is often very unevenly distributed throughout the season, and the fall is particularly liable to prove deficient during the later months of the rainy season, the critical time for the rice and *rabi* crops. To ensure a full outturn from these crops not less than the average rainfall is required in September and October, while an examination

of the records shows that nineteen times during the last 33 years the rainfall in one or other of these months has fallen short of the average by more than 25 per cent.

310. *Total and cultivable areas.*—Out of a total area of 115,898 square miles included in the Central Provinces, 29,435 are occupied by Feudatory States; the balance of 86,463 square miles, or just over 55 million acres, is in British Territory. Of the latter area, 19¼ million acres are under cultivation; over 15 million consist of forest and uncultivable waste; 6 million lie in unsurveyed *zamindari* estates for which no statistics are available; while nearly 14¾ million acres are classed as waste lands available for cultivation, although only in a small portion of this is the soil said to be of a kind that would make cultivation profitable.

311. *Crops and area under cultivation.*—Out of the 19¼ million acres shown as under cultivation, about 16 million acres are actually under crop in a year of normal rainfall, or allowing for double cropping, which is chiefly confined to rice lands, about 17½ million acres; giving an average of 1¾ acres per head of a population of nearly 10 millions. The proportion varies from about one acre per head in the rice districts of Sambalpur and Chanda, which are mainly peopled by the irrigating Telinga and Uriya races, to about 2 acres in the wheat districts of the Nerbudda valley, and 2·3 acres in the cotton-growing district of Wardha, and in the plateau district of Betul where hill millets are largely grown. Of the gross area annually under crop, in round numbers, 5 million acres consist of rice; 3½ million of wheat; 4½ million of *juar*, the lighter millets and oilseeds; 3 million of cotton, gram, and *rabi* pulses; and there are 1½ million acres of *kharif* pulses and other miscellaneous crops. Rice is grown entirely as an autumn or early winter crop; a second or spring crop is never grown.

312. *Irrigated area.*—In a normal year the gross irrigated area is about 700,000 acres, or only 4 per cent. of the area under crop. To this, however, should be added about 500,000 acres of crops grown in lands saturated by means of field embankments. Including this area, 7½ per cent. of the normal cropped area may be said to be ordinarily protected by irrigation works. Rice, irrigated mainly from private tanks, accounts for 70 per cent. of the actually irrigated area; the balance consisting mainly of wheat and other *rabi* crops, gardens, and sugarcane, which are irrigated chiefly from wells. In 1899-1900, after a succession of dry years, the irrigated area fell to 255,000 acres or 1½ per cent. of the normally cropped area. The area under tanks varies from 200,000 acres in a very dry year to 700,000 acres in a very favourable year; that under wells, from 64,000 to 99,000; and that under river channels and other sources, from 15,000 to 60,000 acres.

313. *Main classes of soils.*—The varieties of soil to be found scattered throughout a province of such diverse physical and geological characteristics, are naturally very numerous. They pass one into another by almost insensible gradations, but for our purposes it will be sufficient to recognize the following four main varieties of agricultural lands: alluvial black soils or wheat lands; black cotton soils; light sandy or stony uplands; and the light and heavy rice lands. In discussing the question of the utility of irrigation in the province, we shall deal separately with each of these classes of land.

Wheat Lands.

314. *Character of the soil, and extent to which it requires irrigation.*—The cultivation of wheat is confined, as a rule, to the alluvial black soils which are found in the central valley of the Nerbudda, on the open and level portions of the Vindhyan and Satpura plateaux, in the eastern portions of Nagpur and Wardha, and in the river-valleys of the Chhattisgarh and Wainganga districts. The crops on these lands suffer if anything more frequently from excessive rainfall than from drought, especially those grown on uneven ground or where the soil is of the deep and friable alluvial kind overlying an impervious substratum.

In the latter case, irrigation would be useful in a dry year as a preliminary to sowing; but if subsequently applied to the standing crop, it would render it more liable to rust, and in the end might do more harm than good. In the higher valleys and plains of the trap area, where the black soil is generally of less depth and of a stiffer and less friable nature, and where it frequently overlies a porous substratum of either sandstone or disintegrated trap, rust is less frequent and irrigation would no doubt often be beneficial; but the field embankments, constructed for the purpose of holding up water on the fields, which are commonly found in such tracts, and to which we shall again refer, probably afford the best means of securing the required degree of moisture in this soil.

315. *Utility of irrigation under certain conditions.*—Before the late series of dry years had set in, out of 4 million acres under wheat, only about 10,000 acres were irrigated; and of these over 7,000 acres were in the single district of Nimar, 20 per cent. of the wheat cultivated area in that district being then under irrigation. Since then the total area under wheat throughout the province has fallen to slightly over two million acres, while the area irrigated has risen to 30,000 acres, of which more than a third is in Nimar. In this district the rainfall is the lightest in the province, and the black soil overlies a stratum of porous trap. In such conditions wheat benefits by irrigation in almost all years, and often indeed without it will yield no crop; while the increase in outturn due to irrigation in normal years is estimated at 260 lbs. of grain or 40 per cent. In a dry year the increase due to an assured water-supply would of course be very much greater.

316. *Injury from drought and rust.*—The northern districts, in which wheat is most extensively cultivated, suffered severely from the effects of drought in 1833, 1868, 1896, and again in 1899; and less severely in 1878, 1881, 1889, and 1895. The wheat crop was almost completely destroyed by excessive rain and rust in 1854 and 1894, and was less seriously injured from the same causes in 1871 and 1874, during each of the four years from 1884 to 1887, and again in 1891 and 1893. Thus, in a period of under 70 years, the crop suffered eight times from drought and ten times from excessive rainfall.

Black Cotton Soils.

317. *Distribution and general character of the soils.*—Lands which are specially suitable for the growth of cotton, and of autumn crops other than rice, predominate in the districts of Nimar and Wardha, in the western half of Nagpur, and in the southern portion of Chhindwara. Within this tract the rainfall varies from 32 inches on the west, to 36 inches on the east; the underlying rock is generally trap; the stony uplands consist of trap rock but partially disintegrated, yet with good rainfall the poorest plateaus and slopes produce fair crops of *juar* and cotton, and the lighter millets are seldom grown. In the valleys, cotton and *juar* flourish in ordinary years, the cotton doing better in dry, and *juar* in wet years. Wheat is less successful; and in all but the wettest years it requires irrigation to ensure a full crop.

318. *Liability to famine.*—The western cotton districts suffered from drought in 1825, and again in 1899; but they passed almost unscathed through the dry years of 1868 and 1896, and even in 1899 they fared better than most parts of the province, and they are making a quicker recovery. The crops in these districts suffer more, on the whole, from an excess of moisture than from any lack of it, while cotton suffers less than any other crop from an early cessation of the rains.

319. *Utility of irrigation.*—The hardiness of cotton in years of drought, and the retentiveness of moisture, characteristic of black soil, which enables all classes of crops grown on it to mature with the aid of comparatively little rain, enable this tract to escape in years of minor scarcity, although in a year of extreme drought, such as 1899-1900, it is likely to suffer severely. It is doubtful, however, whether irrigation would prove much more useful here than in other areas of black cotton soil where it has been tried and failed. The cotton crop

in all ordinary years is so profitable that the cultivators are not likely to abandon it in favour of other crops for which irrigation might be suitable. At the same time the results obtained by the *Kachhi* tenants at the Nagpur farm show that irrigation may be introduced with advantage in the areas in which the superficial layer of black soil is of moderate depth and rests upon a porous subsoil providing good drainage, especially if a good supply of manure may be relied on. In such tracts, works constructed at a moderate cost might in time prove to be actually remunerative. Schemes for such works should be considered on their merits; but speaking generally we are unable to recommend the construction of irrigation works in these soils, at any rate until tracts in which they will be more useful have been provided for. The cultivators of the cotton districts are the most intelligent, and, in spite of the absence of irrigation, the most prosperous in the province; and, unless there is a considerable change in the present comparative prices of produce, we think it very unlikely that, where the soil is really suitable for the cultivation of cotton and of the better classes of autumn millets, the cultivators will be induced to change their present agricultural practices to any appreciable extent, even if every possible facility for irrigation be afforded.

The Light Uplands.

320. *Distribution; irrigation generally impossible and unnecessary.*—The hilly and stony uplands, the poorest lands of the province, are devoted chiefly to the lighter millets (*kodo* and *kutki*) and inferior oilseeds. The former, which constitute the main food-grain of the aboriginal cultivators, are entirely dependent on the rainfall of August and September. The hilly and jungly tracts of the Vindhyan and Satpura plateaux, and the higher slopes of the rolling plains of Chhattisgarh, contribute most largely to this class of land. Even if water could be led on to the high slopes, where these lands are usually situated, the soil is too poor and porous, and the ground too uneven, to make irrigation profitable; while the crops to which the soil is best suited are liable to suffer from any excess of moisture. There are, however, in the valleys and on the flatter slopes of the Satpura districts, many fairly level stretches in which the coarser millets could be replaced gradually by rice, if water were made available and the cultivators, who are mostly aboriginal, were taught its use.

321. *Liability to famine.*—Until the last few years famine appears to have been unknown in those parts of the plateau districts in which the coarser millets form the staple crop. In 1868 a timely fall of rain in September saved the situation, and "the hilly districts, in which the aboriginal population is the largest, gathered fair crops and were indeed in a position to export grain."* The records show no serious failure of the crops in these tracts until 1895; this was followed by another failure in 1896, and a still more serious failure in 1899. Again in 1902, many of the rice districts received barely half their normal rainfall, and in these the rice crop, except where protected by tanks, has failed almost completely. It has been necessary to remit nearly the whole of the land revenue in Bhandara, Balaghat, and part of Chanda, and in Raipur there are now (March 1903) 35,000 people on relief.

Rice Lands.

322. *Distribution and general character of the rice lands.*—Although rice is grown to some extent in every district, on the rich black soils as well as on the light and sandy loams, the great rice tract of the province lies on the crystalline and sandstone formation, in the plains drained by the Wainganga and Mahanadi rivers. It includes a portion of Seoni, South Balaghat, Bhandara, Chanda, and the three districts of Chhattisgarh, where as a rule the black soils are found only in the low parts of the river valleys. On ascending the slopes of the higher ground which separates one valley from another, the soil changes in colour and gradually loses its clayey nature, until at the top of the ridge an almost pure sand or gravel is found, from which a crop of any kind is seldom taken. In Sambalpur there is but little black soil even in the valleys. The sandy soil

* Paragraph 228 of the "Report on the Famine in the Central Provinces in 1896-97."

of that district is somewhat similar to that found so extensively in the valleys of the Vindhyan and Satpura plateaux, in the former of which, especially, a considerable area of rice is annually sown. As already noted, many of the level valleys in the Satpura districts, where the soil seems suitable for rice cultivation, are now devoted to the coarser millets.

323. In 1895-96, the first of a series of dry years, and one favourable for irrigation, the total area under rice was distributed as follows:—

Area under rice in 1895-96.

Tract.	Transplanted rice.			Broad-cast rice.			Total.		
	Irrigated.	Unirrigated.	Total.	Irrigated.	Unirrigated.	Total.	Irrigated.	Unirrigated.	Total.
The Northern Districts . .	208	11,575	11,783	150	528,863	529,013	358	540,438	540,796
Wainganga rice districts in Nagpur Division, including Seoni	477,994	375,540	853,534	33,482	278,848	312,330	511,476	654,388	1,165,864
Chhattisgarh	8,527	47,340	56,427	144,900	3,092,255	3,237,155	153,487	3,140,095	3,293,582
Total .	486,789	434,955	921,744	178,532	3,899,966	4,078,493	665,321	4,334,921	5,000,242

According to the figures given, the irrigated area in Chhattisgarh in a very favourable year is only about 5 per cent. of the whole rice area; but it should be noted that this does not include all the areas benefited by percolation from the tank, which is the main purpose for which tanks are made in that part of the province. Including this form of irrigation, the area irrigated in Chhattisgarh, in a favourable year, is about 9 per cent. of the total rice area.

324. *Local differences in the cultivation of rice.*—The differences in practice which this table exhibits are very remarkable. The northern districts attempt practically no irrigation; Chhattisgarh irrigates 5 to 9 per cent., and the Wainganga districts about 44 per cent. of their whole rice area. In the northern districts and Chhattisgarh, all except 2 per cent. of the rice is sown broad-cast; in the Wainganga districts, 75 per cent. is transplanted. More than one explanation of this curious difference has been suggested. The Hon'ble Mr. Fuller, when Commissioner of the Jubbulpore Division, drew attention to the fact that the practice of transplanting rice is practically confined to tracts in which the soil is underlain by crystalline rocks; while the broad-cast varieties are chiefly grown in soils overlying the more porous sandstone formation. Others have suggested that the difference may be due to the fact that the tracts in which the later ripening or transplanted rice is grown receive, as a rule, a slightly more abundant rainfall in the later months of the season; while others again have pointed out that where rice is grown broad-cast the conditions are generally more suitable for the growth of a subsequent *rabi* crop, which is rendered possible by the earlier reaping of the broad-cast varieties. These differences in the conditions of soil and climate no doubt affect the practice in each tract; but a further explanation may be found in the character of the people, to which we refer below.

325. *Rainfall.*—The rainfall of the rice districts varies from an annual average of about 50 inches in Chanda, Raipur, and Bilaspur, to 54 inches in Bhandara, and about 60 inches in Sambalpur and Balaghat. It is, on the whole, remarkably steady, but it failed almost completely in 1868, and again in 1899; and, although the total amount is usually sufficient, it is seldom satisfactorily distributed throughout the season. It is particularly liable to fail or be deficient in the all-important months of September and October; as a rule indeed the rainfall during the latter month is insufficient for the better qualities of rice. In 1886, and again in 1895 and 1896, although there was ample rain in the earlier months of the year, the rice crop, where unprotected by tanks, suffered severely from a deficient supply in September and October; and in many other years it suffered, though with less severity, from the same cause.

326. *Utility of irrigation.*—Thus it will be gathered that the first and chief value of irrigation will be to correct irregularities in the distribution of the rainfall, and more especially to supplement deficiencies of the late rain. Opinion, however, is unanimous that irrigation, besides being of inestimable value in this respect, would largely increase the quantity and quality of the rice crop. According to evidence based on crop experiments in Chhattisgarh, where the average yield from an unirrigated field is 850 to 1,000 lbs. of unhusked grain, irrigation increases the yield 75 per cent. in a normal year, and fourfold or more in a year of drought. Similarly, in the Wainganga districts, in a normal year an irrigated field will yield 1,700 lbs., or 600 lbs. more than one which is unirrigated; and during the last famine the irrigated fields produced from 1,000 to 1,200 lbs. per acre, against a yield of about 150 lbs. from fields which were dependent solely upon the rainfall. Again, irrigation renders it possible to grow the better and transplanted kinds of rice, instead of the inferior and broad-cast varieties; and, another important advantage, a second crop can often be raised on irrigated land, when it could not in the absence of irrigation. As evidence of the cultivator's desire to avail himself of the opportunity for securing a second crop, we have the fact that in the wet year of 1894-95 the double-cropped area was nearly $1\frac{3}{4}$ million acres, against 565,000 acres in 1896-97 and 164,000 acres in 1899-1900. We do not know the proportion of years in which a second crop cannot be secured without irrigation, but it seems probable that, even in an ordinary year, the extension of irrigation would lead to a corresponding increase in the double-cropped area. In proof, moreover, of the readiness of the cultivator to grow the better qualities of rice, we have the fact that the opening up of the country, and the stimulus given to trade, by the construction of the Bengal-Nagpur Railway, induced the cultivator of Chhattisgarh to grow the heavier and later-ripening varieties of rice on the higher lands which used to be devoted almost entirely to the lighter and earlier-ripening varieties. The heavier rice soils would no doubt only benefit by irrigation in occasional dry years; but the rice crop in the lighter and more sandy varieties of soil—the class of soil most common to the rice tracts of the Central Provinces—is extremely liable to injury from drought or from an uneven distribution of the rainfall. Where irrigation is available such lands now take water in almost all years; and, of all classes of land in the province, these light rice lands stand most in need of further protection by means of irrigation works. It may be asked, however, why, if irrigation be so valuable as supposed in Chhattisgarh, there is at present so little of it, as compared with the Wainganga districts. The question is not very easy to answer; neither the soil, nor the rainfall, nor the pressure of population, appear to account fully for the difference of practice. The first most probable reason is the character of the population, which in the Wainganga districts consists largely of the more energetic Telugu and Marhatta castes, whereas that of Chhattisgarh is made up of a peculiar race of Chamars and aborigines whose style of cultivation is remarkably slack. The second cause is the minute sub-division and scattered nature of the holdings, resulting from the fortunately decaying practice of *lakha bhata*, according to which all land used to be redistributed at the end of every year among the numerous shareholders; thus of course removing all incentive to improve any particular plot. The evil remains of this practice will take long to eradicate; and in the meantime few landholders possess, in any one part of the village, sufficient land to make it worth their while to spend considerable sums of money on its improvement.

(*ii*).—*Existing State irrigation works.*

327. *Non-existence of State works.*—There are no State irrigation works in the Central Provinces—a fact which it is not difficult to explain. In the first place, when the province was formed in 1862, it was in a very backward state of development and the question which presented itself was rather how to increase the population and bring waste land into cultivation, than to increase the produce of the soil and protect it from the vicissitudes of season. In the next place, the need of irrigation for protective purposes was never forced upon the notice of Government. Between 1862 and the recent succession of dry years, such an occurrence as an almost complete failure of the rains was practically

unknown. Wheat, cotton and *juar*, the lighter millets, and the *rabi* crops, which taken together comprise considerably more than half the total cropped area, had, we have shown, suffered on the whole as much if not more from excessive than from deficient rainfall. The rice crop had, no doubt, suffered in more than one year; but the numerous private tanks already in existence provided for that crop a fair amount of protection against the ordinary vicissitudes of the seasons, and the losses suffered had always been local and partial. How secure from any widespread calamity the province appeared to be, even to the most mature experience, is evident from the Report of the Famine Commission of 1880, in which it is stated (Part II, Chapter I, paragraph 12) that "in the greater part of the country the rain has never been known to fail, and no part of India is freer from the apprehension of the calamity of drought than are the Central Provinces and Berar." Between 1880 and 1896 nothing occurred to suggest any doubt as to the accuracy of this view. On the contrary, within that period, a long cycle of wet years caused serious injury to the crops in many parts of the province. In these circumstances, and with so much to be done in other parts of the country where irrigation was vital to the well-being of the cultivator, it is scarcely a matter for surprise that Government refrained from devoting funds to the construction of irrigation works which would certainly be very unremunerative, and the necessity for which was regarded as more than doubtful.

328. *Previous proposals for State works.*—The question of developing the irrigation of the province by means of State irrigation works had more than once been considered. In 1866, from some preliminary investigations which had been made, the late Sir Richard Temple was induced to take a very sanguine view as to the possibility of irrigating large areas in the Nagpur plain by storing the waters of the Wainganga, and of its affluents, the Pench and Kanhan. When his proposals were examined in detail, it was found that the facilities for storage had been greatly exaggerated, and that the cost of the works generally would be very much more than he had been led to expect. Three separate projects for utilizing the waters of the Pench and Kanhan rivers were, however, prepared, and the plans and estimates worked out in detail. After much consideration the project finally selected by the Local Administration was that known as the Kanhan river scheme. The estimate for this work, amounting to over 102 lakhs, was submitted in 1871 for the sanction of the Government of India. As there were serious doubts regarding the returns to be derived from the work, the Government of India stated that the cost was more than they were then prepared to accept. Colonel Rundall, then Inspector General of Irrigation, visited the sites of the proposed works, and as the result of his visit another set of three projects was prepared. One of these, known as the Ramtek project, was finally selected and submitted for sanction, at an estimated cost of Rs. 9,61,058. As it was not anticipated that the work would return a net revenue sufficient to cover the interest charges, the Government of India declined to sanction the estimate, and suggested the advisability of making a commencement with a work on a still smaller scale. Subsequently, on receipt of a note from the Inspector General of Irrigation, showing the wants of the various provinces in the matters of irrigation and famine protection, the Local Administration decided to devote for the present all available funds to the improvement of communications. In the discussions on the projects the fact that the areas to be commanded consisted chiefly of black cotton soils may have influenced the final decision; but in the records of the case that have been laid before us, we can find no reference to this important factor. In 1887 the question of developing irrigation was reopened and again dropped after discussion amongst the local officers. The differences in the local conditions from those of other parts of India where State irrigation works had proved successful, and the necessity for the exercise of caution in any attempt to develop irrigation in black cotton soils, were now fully recognized.

329. *Famine expenditure on works of irrigation.*—Thus the amount of Rs. 48,36,000, which was spent during the two recent famines on the construction and repairs of tanks and wells, represents practically all the expenditure which has been incurred by the State in connection with irrigation works in

the Central Provinces. During the last famine, eleven new large tanks were partially constructed by the Public Works Department at a cost of 5 lakhs; and in both famines new small tanks were made, and old private tanks repaired, at a cost of over 43 lakhs. This latter expenditure has, it is stated, led to a considerable increase in the area annually irrigated by the tanks. In Chhattisgarh the new small tanks are recorded as Government tanks, but it is proposed to hand them over to the *malguzars* under certain conditions with regard to their maintenance and repair; in fact this has already been done in many cases. In the rest of the province no condition has been made, but the *malguzars* have been given to understand that the tanks are to irrigate the tenants' lands as well as their own. There may be an increase in the rent of the lands protected by these works, amounting to about eight annas per acre in Chhattisgarh, and one rupee elsewhere; but Government will receive no share of the increase until the expiry of the settlement which was in force when the tank was made.

(*iii*).—*Scope for further extensions of State irrigation works.*

330. *General principles determining field of operations.*—In discussing the utility of irrigation in the Central Provinces, we have indicated generally the classes of lands which may reasonably be considered to stand in need of protection by means of irrigation works. From this category we have excluded those lands which, owing to the nature of the soil or to the classes of crops grown upon them, would rarely require irrigation. There are, doubtless, certain tracts in which the introduction of irrigation would effect a change in agricultural practice and lead to the substitution of irrigated for unirrigated crops. Lands are not invariably devoted to the class of crop best suited to the soil. Difficulties in procuring water, the absence of a neighbouring market and of the means of communication with more distant commercial centres, and social or local custom, are factors which cannot be ignored. We have already indicated instances in which one or more of these conditions appear to have had a determining influence: thus black soils, eminently suitable for wheat, are often devoted to rice in Chhattisgarh, while rice is neglected for hill millets in many parts of the plateau districts; and cotton and *juar* are sometimes grown on lands which would perhaps be more suitable for wheat or rice if a supply of water were available. But, considering the question in its broad aspect, we have no doubt that throughout the province each class of land is, as a general rule, devoted to the crop most suited to it. Thus the trap country, with its light rainfall and well-drained black soil, is best devoted to cotton and *juar;* the heavy soils of the Nerbudda valley are best suited to wheat; and the light yellow and red soils of the Wainganga districts and Chhattisgarh must always look to rice as their principal product. There may be other exceptions similar to those which we have noted; but in considering the field which exists for the construction of State irrigation works in this province, we are reluctant to recommend the construction of expensive works in any tract where its utility cannot be justified by existing agricultural practice in that tract, or in a tract with fairly similar conditions as regards soil, subsoil, and rainfall. Even then in many cases, before irrigation can be developed, local prejudices will have to be overcome, and the cultivator taught how to grow and how to irrigate new classes of crops. But though the process may be a slow one, and involve expenditure which will yield no return for some years to come, we believe that in the end it will result in benefit both to the State and to the cultivator; provided—and this is an important proviso—the area in which the change is made be limited to that for which the available supply of water is sufficient to afford real and substantial protection. A change from dry to wet cultivation does not always involve an increase of protection. It would, for instance, be foolish from a protective point of view, to substitute, over any considerable area, a rice crop that would be liable to fail in a year of even partial failure of the rains, for a crop of cotton or millet which would only succumb in an occasional year of exceptional drought.

331. *Limits of scope of operations.*—Working, then, on this general principle, and deferring for the moment the question of supply, the most promising field for the extension of irrigation by Government works, may be said to comprise the rice

tracts of the Wainganga and Chhattisgarh districts, of Seoni and Nagpur, and of the Vindhyan and plateau districts; a narrow strip at the foot of the Satpuras running through the districts of Jubbulpore, Narsinghpur, and Hoshangabad; and the better drained and higher lying wheat lands which are found chiefly in the northern and western districts. The light uplands of the Vindhyan and Satpura districts, the deep alluvial and friable soils of the Nerbudda valley, and the true black cotton soils of the western districts, must be regarded as affording the least promising field of operations. In the valleys of the Satpura and Vindhyan ranges, there are, however, some comparatively level tracts of light soil suitable for rice, where facilities for irrigation might be afforded.

332. *Possible field for extension of garden produce.*—There is of course in all districts a possible field for the extension of garden crops. Vegetables and other produce grown for local consumption do not from their nature admit of any large extension; but spices, fruits, and other products which are capable of export, might, we think, be cultivated more extensively. Thus in the year 1900, chillies, to the value of over 5 lakhs, were imported into the province; and there is no reason apparent why they should not have been grown locally. The recent history of sugar-cane does not hold out much hope for the extension of that crop. The area has steadily fallen during the past eleven years from 45,000 to 15,000 acres. Various causes have been assigned for this notable decrease, among which are the failure of the water-supply during the recent succession of dry years, and the extension of railways leading to the import of refined sugar from Bombay, and of cheap coarse sugar from Northern India, where the conditions for its production are more favourable. A distinct decrease appears to have set in before the series of dry years had commenced; but under the influence of recent legislation and of a more assured supply of water, the prospects of the crop may possibly revive. Cane up to the present has been almost wholly cultivated from wells. It is quite possible that, wherever perennial canal irrigation can be given, the area under cane will largely increase.

333. Having thus roughly indicated the possible field for the general development of irrigation, we have now to consider the sources from which supplies of water are likely to be available in sufficient volumes for State irrigation works, and the general results of the investigations for utilizing those supplies, which were in progress at the time of our visit to the province.

334. *Utilization of rivers.*—Of large rivers there are three which might be depended upon to afford a fair supply to tracts in need of irrigation—the Nerbudda, the Mahanadi, and the Wainganga. Neither systematic gauge readings of these rivers nor records of their discharges have been maintained; but all three are said to carry large volumes throughout the period for which rice would require water. Observations which were made at our request showed a flow of 219 cusecs in the Nerbudda river on the 11th March 1902, although there had been no rain over the catchment since the preceding September. A second observation made on the 21st October of the same year gave a discharge of 1,538 cusecs. Any useful canal taken out from this river would have to run roughly parallel to the line of railway, and close to the foot of the Satpura range so as to command the strip of light soil lying between the hills and the deep alluvial soil of the river valley. It would follow a very broken alignment, crossed in many places by drainage from the hills. The local officers are not hopeful as to the possibility of utilizing this supply, and the question has not been investigated; but we think that at least a preliminary survey should be made, and a rough estimate prepared of the probable cost of carrying a canal along the alignment suggested. In all probability the difficulties will be no greater than those which have been successfully overcome in the case of the Dun canals in the United Provinces, though no doubt the works will be on a larger scale. In the absence of surveys we cannot form a definite opinion; but it seems to us quite possible that in spite of the difficulties connected with its construction, a canal may be found to afford cheaper protection to the lighter soils of the Nerbudda valley, than the alternative which has been proposed, of a series of reservoirs on the small streams which issue from the Satpura hills.

335. The Mahanadi is reported to carry in a normal year from 500 to 1,000 cusecs throughout October, and from 100 to 150 cusecs throughout the *rabi* season, but in 1899 the supply in October was only one-third of the normal. The Wainganga carries a large volume throughout the rains, and an observation of its flow at a point in the Chanda district showed a discharge of 530 cusecs on the 5th February 1902. Many of the larger tributaries of both rivers are said to carry ordinarily considerable volumes from the commencement of the rains until the end of October; but in 1899 all save the largest had dried up completely by the end of November, and the supply during September and October was not more than one-fourth of the normal. Here also, however, there have been no detailed observations of the flow. Three projects are under preparation for small canals from the Mahanadi and its tributaries, to irrigate rice in the Chhattisgarh districts; but the attention of the officers employed upon the investigations has hitherto been devoted mainly to projects for tanks, which, in addition to being more suitable for inclusion in the famine programmes, are no doubt the form of irrigation work upon which the rice districts must chiefly rely for their protection.

336. The general conformation of the country may not lend itself to the construction of large canals, or to the conveyance of even small supplies to any considerable distance from the river bank; still from experience elsewhere, and from the results attained on the few small channels which were constructed in the Raipur district during the recent famine, there is every reason to believe that small canals taking off from streams and rivers will afford a much cheaper form of protection, for such areas as they can be made to command, than any other form of irrigation works. Mr. Blenkinsop, Famine and Settlement Officer in Raipur, has stated that many of the works constructed during the famine irrigated areas out of all proportion to the expenditure incurred. Three small works mentioned by him, costing only Rs. 10,000, have irrigated 1,300 acres in a year. Moreover, from the few projects which have been laid before us for small canals from the Mahanadi, it would appear that the cost per acre protected will be less than one-third that of works depending entirely upon storage. We think therefore that works of this class should be the first to receive attention, storage works being provided for them hereafter when found necessary. The valleys of the main rivers, and of all their principal tributaries, should be systematically inspected by a specially qualified officer, who should note the tracts in which the available supply might be most profitably utilized; select sites for connected storage works, where these are likely to be required; have the necessary lines of levels taken; and, generally, collect all the information required for the rough or preliminary projects which he should then prepare. Where the conditions appear to be exceptionally favourable, a detailed project might be prepared at once and submitted for sanction.

337. *Observations of discharges and rainfall.*—Before any work is put in hand, it would no doubt be advantageous to have observations made for some years, of the flow in the river, more especially of the minimum discharges during the cultivating seasons, and to have gauge readings recorded daily throughout the period of flow. Measures should now be taken to have these observations recorded; but we do not consider it necessary to postpone construction until the records for a number of years are available. The records of dry years would be most valuable, but it may be many years before another very dry year is experienced. For the present the designers of the works must be content with such observations as are available, and with the data afforded by the records of rainfall, special regard being paid to those of dry years. Observations should also be made of the flow at the sites of all existing and proposed large storage works, and of the rainfall over the catchments; and for these it will be necessary to increase considerably the present number of stations for recording rainfall, at least in those districts in which any extensive construction of tanks is contemplated.

338. *Existing tanks.*—The area which it will be possible to protect by the direct utilization of the river supplies, will at best comprise only a small

proportion of the total area for which protection is required; and for the extensive areas that cannot be commanded in this way, reliance will have to be placed on a system of storage tanks. Laying aside for the present all questions of the subsequent demand for water and of the probable financial results, the conditions, especially in the rice districts, are exceptionally favourable for the construction of these works. The general configuration of the surface lends itself to the storage of water; and the rainfall is, as we have shown, usually abundant, and but little liable to severe fluctuation in total annual amount. In the Wainganga districts, where 44 per cent. of the rice area is irrigated, these advantages have already been largely utilized. In Chhattisgarh the work of storage has not proceeded so far, but, as already stated, 9 per cent. of the rice area depends on tank irrigation, direct or by percolation. The tanks, being private works, will be referred to in detail later on, but as their existence will have, in many cases, an important influence on the design and working of any Government tanks that may hereafter be constructed, it is necessary to make a brief reference to them here. They are generally small tanks irrigating on an average, according to the statistics supplied to us, 10 to 15 acres each. But this average has been obtained by including a large number of mere ponds; and the embanked tanks are, as a rule, much larger than this average would seem to imply, many of them protecting some hundreds of acres each. Their function is to store the rainfall and protect the rice crop from failure when the rain ceases prematurely, or when its fall is badly distributed. But, being small and shallow, they are liable to fail in very dry years; and, even in years when the rains fail only partially, many fields which are returned as irrigated receive a very insufficient supply of water. Nevertheless, these tanks were of great protective value during the famine of 1896-97, when the early rains were copious but the later rains failed. The use of wells to supplement the tanks' supply is unknown, except in the Sambalpur district where they are used to a very small extent.

339. *Necessity for large storage works.*—For the full protection of the rice districts it will be necessary not only to provide tanks in greater numbers, but also to ensure them a supply of water in the driest year. To arrive at anything approaching this latter condition, much larger tanks than those hitherto made will be required, and in nearly all cases it will be necessary for the State to undertake their construction. The only large tanks at present in existence were made many years ago by the farmers of the land revenue, who had a free hand and were not hampered by the rights of their neighbours or tenants.

340. *Provision against a year of drought.*—Even the largest tank unless river-fed will, however, be dependent on the local rainfall; and in most parts of India all purely rain-fed tanks, however large, are liable to failure in a dry year. But in this respect the conditions in the Central Provinces are exceptionally favourable, more so perhaps than in any other tract outside the limited areas of really assured rainfall. The rainfall is usually abundant, and in most years only one or two waterings are required for the autumn crop; there is no winter crop of rice; and the moisture remaining in the soil after the autumn rice has been harvested is sufficient to bring to maturity the second crop of *rabi*, which is usually sown only on low-lying lands. Moreover, it has to be remembered that famine in the Central Provinces may result not merely from very short rains, as in 1899-1900, but from an abundant, or even excessive, rainfall which ceases prematurely, as in 1896-97. In such a year as this all tanks will be full to repletion, and will be of the utmost value in saving the cultivation supplied from them. Such droughts as 1899-1900 are not likely to occur more than once or twice in the century. Nevertheless in the projects which have been prepared for new storage works, the object of affording protection throughout a period of drought as prolonged and severe as any on record, has been steadily kept in view. Whether that object is likely to be fully attained is a question which, as the conditions are peculiar, can only be settled satisfactorily by actual trial. The estimates of the Engineers as to the area that each work will protect have, however, been framed with caution, after a careful examination of the records of rainfall for the past,

33 years; and we see no reason to think that they will prove unduly sanguine. The tanks, we may note, are designed generally to hold 25 per cent. more than the estimated run-off in a year of average rainfall. This probably allows as large a margin as can reasonably be afforded.

341. In the detailed projects which have been laid before us the area proposed to be irrigated in an ordinary year is generally but little in excess of that for which, according to the calculations, water would be available in a year of drought. This arrangement has been the subject of a good deal of discussion. The objection has been raised that it will not admit of the water being used to the best advantage in years of sufficient but badly distributed rainfall, such as occur so frequently in the Central Provinces. This is no doubt the case; but, on the other hand, it is contended that no one can foretell at any moment how the rest of a season will turn out, and that it is necessary to limit the area watered at any time to that which could be matured by the volume of water available in the tank in the event of a subsequent failure of the rains. It will undoubtedly be necessary sooner or later to fix some limit to the area entitled to water from any work; and we have no objection to urge to the provisional limits on which the estimates are based. But we think that they should be regarded as provisional only, and be subject to modification hereafter as experience is gained of the real irrigating capacity of the works, and of the best methods of management.

342. *Projects for storage works, their cost and scope.*—At the time of our visit nearly 200 projects were in various stages of preparation, for storage works in the rice-growing districts; the capacities of the works varying in size from a small tank to hold under 10 million cubic feet and irrigate 70 acres, to the large Ramtek reservoir designed to contain 4,564 million cubic feet and protect over 50,000 acres. Their average capacity is about 300 million cubic feet. For 42 of the projects the plans and estimates had been worked out in full detail, while the remainder had been investigated in sufficient detail to give an approximate idea of their protective capacity and cost. Many of these projects are in their present form too expensive in relation to the area to be protected, to justify their construction as ordinary works; but in the event of a famine they would provide an excellent programme of works for the employment of relief labour. Taking all the projects which have been brought forward, as a whole, it is estimated that they would protect 450,000 acres of rice at a cost of about 3 crores of rupees, or at the rate of about Rs. 67 per acre. This exceptionally low rate for storage works is only rendered at all possible by unusually favourable conditions of rainfall, and by the small number of waterings likely to be required. At present, out of 5,000,000 acres under rice, about 550,000 acres are returned as irrigated in ordinary years, and about half that area in years of severe drought. The construction of the proposed works would increase the area irrigated in an ordinary year to 1,000,000 acres, or to 20 per cent. of the whole rice area; and, if the calculations are correct on which the areas that can be fully protected are based, the area irrigated in a year of drought would be increased to 685,000 acres, of which 400,000 acres would be irrigated by the new works.

343. *Further scope for projects.*—This programme is far from being exhaustive. Many tracts have not yet been examined, and it is said that in all the rice-growing districts there is a large field for the extension of tank irrigation outside the scope of the projects which have so far been examined. There are no doubt some places where storage works would involve the permanent submergence of large areas of valuable low-lying lands which seldom fail to produce a crop. From a protective point of view the benefit to be derived from the work in such cases may sometimes fail to counter-balance the damage done. But, speaking generally, the only limit to the percentage of rice cultivation that can be protected in a year of drought would appear to be that imposed by considerations of cost.

344. *Water-rate likely to be realized.*—The works themselves, compared with similar works in other provinces, will not be costly to construct, but they

can scarcely be given to the province as a free gift, and their maintenance will entail a large annual expenditure. There is no doubt as to the utility of the works, nor as to their comparative cheapness of construction, even though it may not be found possible in practice to work to such a low rate per acre as the estimates indicate. The only question is, will the people be willing to pay a fair amount for the use of the water, so that its provision may not throw an unreasonable burden on the shoulders of the general tax-payer of the country? On this question we have heard various opinions; but the evidence of Mr. Sly, and of other competent witnesses, points to the conclusion that the people may be willing, eventually, to pay for effective protection an annual rate averaging Rs. 2 per acre on the whole area protected. This is the rate upon which the estimates of the financial returns of the projects have been based, although it is admitted that such a rate cannot be realized for some years to come, except perhaps in the Wainganga districts where the value of irrigation is already fully appreciated.

345. Water rates similar to the occupiers' or owners' rates which are leviable under the Northern India Canal and Drainage Act (VIII of 1873) would not be suitable, except as a purely provisional arrangement, for the works which we now propose, as these rates can be levied only on the areas actually irrigated. On these works, however, it may be anticipated that the cultivators will in favourable years abstain from taking water at all. In the case of a number of existing private tanks there are many seasons in which water is not drawn off, but is carefully husbanded for use in the next season or period of severe drought. The practice is one to be encouraged; but it is incompatible with a permanent system of water rates which would only be paid in years of active demand. The most suitable form of irrigation revenue would be afforded by an enhancement of the land revenue assessment over the whole area protected by the works, irrespective of the area actually irrigated in particular seasons. This enhancement would follow, or be based on, the increase in rents of the protected lands, which may be expected as a result of the construction of the works. Such enhancement, however, can only be made at settlement, and after some experience has been gained of the value of the water advantages afforded by the works and their effect in raising rents. In the meanwhile some revenue may be realized by imposing an occupiers' or an owners' rate under the Northern India Canal and Drainage Act, which applies to the Central Provinces; although such a rate can only be charged for any particular crop on the lands actually taking water. In the Wainganga districts a reasonably high rate might probably be charged as soon as water has been made available. But elsewhere the people will certainly require some education in the value of irrigation before they can be induced to pay even a low water rate; and we think that it will be advisable in such cases to give the water free of charge for two or three years, subsequently levying a small occupier's rate on the area actually irrigated. Eventually, when the irrigating capacity of the work and the value of the protection afforded have been tested by experience, it may be advisable to allow the land-owners to compound for this rate by an annual payment, to be made for a convenient number of years or until the next settlement; but it is doubtful if the full value of the water will ever be realized until the first or second revision of settlement following the completion of works. Water rates would of course always be charged when water is supplied to lands outside the protected area. A scale of charges may also be required for filling private tanks.

346. *Supply to existing private tanks.*—In certain cases it may be possible, in years of scanty rainfall, to supply private tanks with water from Government works, if the owners agree to pay a suitable annual contribution. In fact, in some cases, where a considerable portion of the area commanded is already irrigated from small private tanks, this must be the chief function of any Government work; and whenever the Government tank prevents water reaching tanks lower down in the catchment area, the supply to such tanks may have to be given gratis.

347. *Experimental works recommended.*—It is necessary to insist on the fact that, although a considerable extension of tank irrigation is practicable in many parts of the Central Provinces at a comparatively moderate cost, the great

obstacle is the unwillingness or inability of the people to pay for insurance or protection against famine. The land revenue rate of assessment is so low that even a moderate water rate must seem high in proportion, and the cultivator may be expected to try to do without water altogether, except in years of extreme drought; and these fortunately are of such infrequent occurrence that the irrigation revenue must at first be very precarious. Even when, in course of time, the advantages of protection are fully recognized and paid for, it is doubtful whether the net revenue derived from the works will yield a return of much more than 1 per cent. of their capital cost; because protection itself is so seldom needed. The justification for any expenditure that may be proposed will not be found in any prospect that it will prove remunerative, but in the fact that it will afford material protection against the cost and misery of famine. We do not think that the net cost of this protection will be unreasonably high if the present estimates of the areas to be protected by the works, and of the returns to be derived from them, are fairly correct. Their correctness, however, can only be determined by actual experience; and in order that this may be obtained with as little delay as possible, on the completion of our inquiries in the Central Provinces, we addressed the Government of India recommending that immediate steps should be taken to ensure the early completion of certain works, some of which had been partly constructed as relief works during the recent famine, so that experience might be acquired on a sufficiently large scale in both the transplanted and broad-cast rice districts. We have heard with satisfaction that estimates for six of these works, aggregating over 18½ lakhs, have since been sanctioned, and that funds have been provided for their execution. But we strongly recommend that more works be put in hand as these approach completion. In addition to the questions of the extent of area that can be protected by each work, and of the water rates which the cultivators will be willing to pay, there are many other important matters connected with the design and management of the works, and with the distribution and control of the water, which can only be settled by actual trial. One of these has already been referred to in paragraph 341. It is impossible to reason from the analogy of similar experience elsewhere; in no other province are the conditions at all similar. These experiments should be carried out boldly, continuously, and systematically, on an extensive scale in different districts and under varying conditions, even although it is certain that the expenditure will not be remunerative. Until they have been made, it can never be said with confidence either that adequate protection of these tracts at any reasonable cost is impracticable, or, on the other hand, that Government would be justified in embarking on any more extensive programme of tank construction in the Central Provinces. It is difficult to propose a limit to tentative expenditure of this kind; but we think that no final conclusion on the value of such works in such a country can be arrived at until at least fifty lakhs have been devoted to their construction.

348. *Wheat tracts.*—The experiments should not be confined to the rice districts for which most of the projects have so far been prepared. There are possible projects for tanks in the northern districts which, if constructed, would either irrigate existing rice or enable rice to be cultivated; and both in the northern and western districts there are possible tanks to irrigate wheat on the lighter varieties of wheat land. Experiments in these tracts will be useful as showing to what extent the construction of Government works would be justified; they may at the same time afford an object lesson as to the advantages to be derived from such improvements, and encourage the more enterprising landowners to carry out similar works at their own expense. There is probably some scope for the construction of tanks outside of the Wainganga and Chhattisgarh districts; but no individual will be willing to lay out capital on such works until he has some means of judging of their utility. The risk of making the experiment is, we think, one which the State should incur.

349. *The Lachera tank.*—There s one existing storage work in the Nimar district from which it may be possible to gain some experience as to the value of such works in the wheat-growing tracts. The Lachera tank is an old work which was repaired in 1845 by famine labour, and subsequently handed over to the District Board. The work has been allowed to fall into disrepair during

a series of wet years, and we understand that the high rates charged for water have discouraged its use for irrigation. The tank is situated in a tract of which the soil resembles that of the Nerbudda valley, so that it is perhaps not very favourably situated for experimental purposes. But we learn that since our visit to the province the tank has been taken over and repaired by Government, that 120 acres are being irrigated, and that the people are paying water rates of Rs. 4 for wheat lands and Rs. 6 for sugar-cane, in addition to the rent which they pay to the landlord.

350. *The Ramtek project.*—Of the schemes which have been laid before us, the most important is that for the utilization of the water of the Pench and Kanhan rivers and the construction of a large reservoir on the Pench river, opposite the town of Ramtek. In paragraph 328 we have already referred to the various projects which were prepared many years ago in connection with this scheme; and we have shown how the first ambitious proposals gradually dwindled down to the small Ramtek project. Enthusiasts for irrigation have sometimes referred in sanguine terms to the great potentialities of these abandoned schemes; but the distrust with which they have been regarded in the past appears to be still entertained by those who are most competent to give an opinion. We have been struck by the fact that the local authorities, keen as they are, after the experience of the last few years, on the extension of irrigation in other tracts, are doubtful as to the advisability of carrying out the Ramtek project, which in its present form is estimated to cost not more than about 12 lakhs, and to protect some 32,000 acres, one-half of which is under rice cultivation. They admit that in addition to the rice land there is a considerable area under garden cultivation, that much of the black soil which is commanded is probably more suited for rice than for wheat, and that some of the villages did suffer a good deal during the famine. But they think that it is of far greater importance, as a matter of protection against famine, to construct storage works within the rice-growing districts, than to extend irrigation to a tract which, as a whole, was not severely distressed in the late famine, while doubts are still entertained as to whether water will be taken outside the rice area. We do not desire to recommend the construction of this work in preference to others, which, in the opinion of the revenue and local authorities, are more urgently needed for purposes of protection, but we hope nevertheless that it may be possible to take it up at no distant date. In spite of the doubts as to the suitability of the black cotton soil for irrigation, the project appears to us to involve less financial risk, in proportion to its cost, than any other that has been laid before us; and it would, if carried out, afford important and probably conclusive evidence as to the value of irrigation in certain varieties of black soil. It may be added that, if its execution should be justified either as a productive or protective work, it may be possible to proceed with some confidence with the larger and more important Pench scheme, of which the Ramtek project is but a part, but which it is impossible to recommend until experience has been gained, on a smaller but conclusive scale, as to the value of irrigation in this portion of the Nagpur plain.

351. *Completion of the projects.*—The question whether the projects should be actually carried out as ordinary public works or reserved for famine labour, can only be determined with reference to the results of the experimental works which we have recommended. But there can be no doubt as to the advisability of completing the investigations now in hand, to the extent necessary to provide a suitable programme of relief works for each district; and for this purpose it will be necessary to retain for some time the special establishment employed on the preparation of projects.

(*iv*).—*Private irrigation works.*

352. *Types of works.*—The private works upon which, as we have shown, the Central Provinces are now entirely dependent for irrigation, consist of tanks, river channels, wells, and field embankments.

Tanks.

353. *Number and description of tanks.*—The annual statistics do not show the total number of tanks in a district; but only the actual number used for

irrigation in each year. Taking the maximum number returned for each district during the past eleven years as representing approximately the total number of tanks in the district, there are in all about 47,500 tanks in the British districts of the province. Of these, 28,500 are to be found in the Wainganga districts, including portions of Seoni and Nagpur, and 18,500 in Chhattisgarh. The remaining 500 lie for the most part in Damoh and Saugor. Of the Wainganga tanks over one-half are in the single district of Bhandara; and of those in Chhattisgarh, one-half are in Sambalpur. Even in a favourable year the tanks of the Wainganga tract irrigate on an average under 20 acres each, and those of Chhattisgarh only about 10 acres. Thus they are generally very small in size, and, as they are in nearly all cases dependent on the surface drainage from their catchments, their supplies fail in years of scanty rainfall. In a favourable year they irrigate upwards of 650,000 acres; but in 1899 all failed except some of the largest, and the area fell to 176,000 acres of which a large proportion received only a very insufficient supply. Generally the arrangements for disposing of flood waters are deficient, and the banks are often too weak to stand a high flood. Thus, in 1896-97, heavy rain in the earlier part of the year breached many of the tanks, and the result was a great loss of water which would have been invaluable when the later rains failed.

354. In the Wainganga districts some of the larger tanks are provided with masonry sluices for regulating the distribution of the water, but more frequently the water is let into the field by cutting the bank in one or more places. In Chhattisgarh, where the tanks appear to have been made primarily for domestic purposes, only a few have masonry sluices, and the bank is seldom cut before September. In years of good rainfall, and even of ordinary rainfall if the tank is in black soil, it is not cut at all; and in all years the rice crop is said to derive its chief benefit from the water which percolates through the porous embankment. In the case of some of the larger tanks as much as 400 or 500 acres are benefited in this way.

355. *Repairs and improvement of tanks.*—Theoretically the owner of the tank is bound to keep it in a state of repair. As a rule he does so if he himself cultivates land under the tank, is on good terms with his tenants, and has the necessary means. But many of the tanks are in a bad state, particularly where the owner is not a man of means, or is a non-resident possessing a number of other villages. In the latter case he will often prevent his tenants from carrying out the repairs, lest by doing so they might acquire some right in the tank. The clause in the village record of rights which requires the owner to keep the tank in a state of repair, is seldom if ever enforced. This is, no doubt, mainly due to the fact that, until recently, the defective condition of the tanks has not led to much inconvenience. Now, when the necessity for some action in the matter is felt and recognized, but little can be done; for, owing to neglect in the past, many of the tanks would cost much more to repair than the owners can afford, and more than could be recovered by any fines which, under existing rules, may be recoverable on account of past neglect. We were informed that such fines if recovered could not, under the rules as they stand, be applied to the repair of the tanks. To fine the owners for their neglect, in such circumstances, would only have the effect of rendering them still less able to incur the necessary outlay.

356. Again, if the most is to be made of the tanks, and if they are to be made of any real protective value, many of them will require more than ordinary repairs. They must be improved and provided with proper outlets and escapes. For this the present rules make no provision; and even if they did, the owner would often not be equal to the task, or could not afford it. If in the future any substantial progress is to be made in improving the tanks, we have no doubt that Government will have to render assistance, and to contribute liberally in many cases towards the works which are now required. Arguments are scarcely needed to justify their doing so. The State derives revenue from the lands protected by the tanks and, in our opinion, lies under something like a moral obligation to contribute something towards their repair. The contribution might take the shape of a grant-in-aid or of a loan on liberal terms. In cases of

improvement Government will eventually receive at least half of any increase in the rental of the land, and might not unreasonably assist in the improvement of the tanks by contributing half the total cost. In such cases the improvement would, of course, not be exempt from enhancement. If the owner wished to bear the whole cost of the improvement, so as to secure exemption for the increased area of irrigation, Government might allow him free of charge, in consideration of the extra protection afforded, such professional aid as might be required. Once a tank has been placed in efficient repair by means of Government aid, the obligation of the landlord for future repairs should be strictly enforced.

357. This leads us to the question of the agency by which the tanks are to be inspected and improved. It is needless to say that for any inspection to be efficient it must be systematic; and that something more is required than the occasional and haphazard visit of a revenue officer. The inspecting officer must be able to take up the tanks in regular rotation; and he must have such qualifications as will enable him to state clearly what works are required when a tank is found in disrepair, and to estimate roughly the amount of expenditure involved. A small staff of Inspectors should, we think, be employed specially for the inspection of tanks. They need not be very highly trained or highly paid. An Upper Subordinate of the Public Works Department should possess all the qualifications required for the work. Whether he should work directly under the Deputy Commissioner of the district, or be attached to the Public Works Department, is a detail which may be left to the local authorities to decide; but no doubt, in all important cases, the Collector will require advice either from the District or Divisional Engineer, or from a special Irrigation Officer. For the improvement of the tanks, higher professional skill will be required to prepare the designs and to exercise general supervision over the works. This will have to be supplied by the Public Works Department; and for the present at least, the work should be carried out under the general direction of the Engineer employed on the preparation of projects for Government tanks. No time should be lost in completing the necessary surveys so as to have them ready in advance, and allow of the works being taken up in rotation, with the help of *takavi* or grants-in-aid, in ordinary seasons or in times of famine.

358. The general insufficiency of the protection afforded by these small private tanks in a dry year, may be considered a ground for objecting to the expenditure of State funds in connection with their repair or improvement. No doubt most of them will still be liable, although in a less degree, to fail in a year of severe drought like that of 1899, but their protective value in a year like 1896, which is of more frequent occurrence, will be very greatly enhanced. And where, as we trust will often be the case, their supplies can be supplemented from storage in large Government tanks, there will no longer be the same likelihood of failure in a dry year. In such cases it is essential that the tanks should first be put into good repair, and be provided with proper arrangements for controlling and distributing the water. But, irrespective of any extra supply that the small tanks may obtain from Government works, we think that money spent on them by the State, in the way we propose, is likely to yield in the aggregate as good, if not better, protective results than an equal sum spent on the construction of new works. We cannot but regard with apprehension the consequences of the continued neglect and deterioration of these useful works, and the fact that the incentives, which in former times induced proprietors to construct, improve, and maintain them, appear now to be almost inoperative.

359. *State acquisition of private tanks.*—It has been suggested that, when the owner of a tank under obligation to repair it refuses to do so, even with the help of a loan or grant-in-aid for the purpose, Government should be empowered by a legislative enactment to take over the management of the work for a time, and to receive fiducially the rentals of the proprietor from irrigated lands, from which the cost of repairs and maintenance could be met; and also that the same power could be usefully exercised in cases where the water is used wastefully or distributed unfairly, as for instance, when the owner refuses in time

of drought to give water to those who are entitled to it. Our evidence leads us to believe that the hands of Deputy Commissioners urgently require strengthening in these matters, and that the necessary powers should be given them by legislation. The mere existence and occasional exercise of such powers will probably be sufficient to induce the owners to take action when called on. We should hesitate to recommend the extreme measure suggested to us, of actually acquiring the tank and rentals dependent on it, until the less drastic measure of merely taking over the management for a time has been tried and failed. The proposed measure would, of course, not be applied to any tanks which are declared in the record-of-rights to be the private property of the *malguzar*, and for the irrigation of his private lands only.

360. *Scope for extension of private tanks.*—There appear to be many obstacles in the way of any considerable extension of private tanks, some of which, we fear, no action on the part of Government is likely to remove. Few of the landowners seem to have the necessary enterprise, even if after such a succession of bad years they have the necessary means, to undertake the construction of a tank. They may desire that Government should make tanks for them; but they show no desire to make them out of their own resources, or to take loans on easy terms for the purpose. It is disappointing to note that the grant of a fixed tenure appears to have given no incentive to improvements. On the contrary, it has removed the incentive which existed under the old Maratha rule, when improvements appear to have been made more frequently than is now the case, in the hope that a renewal of the lease might be obtained on the strength of them. Security of possession has, in fact, led to an indifference which has been intensified by the easy terms on which the lands are held. A landowner, or even a tenant, might still be willing to make a tank if he had a sufficiently large area of his own land in one block, and within command of a tank. But such cases are rare, especially in Chhattisgarh, where, owing to the *lakha bhata* system already alluded to, the holdings consist of fields of almost infinitesimal size, situated in different parts of the village. Hitherto the landowners have certainly shown but little desire to construct tanks for the irrigation of lands held by their tenants, although it is thought by some that, under the influence of recent experience, the tendency to make such improvements is increasing. When a private person does wish to construct a tank in an approved site, we think that Government might render him such assistance as we have recommended in the case of tank improvements, and that on the completion of the tank an immediate remission should be made of the revenue of the lands it submerges.

361. *Special concession for the construction of large tanks.*—As an additional inducement, Mr. Sly, Commissioner of Land Settlements, has proposed that, in the case of any large work, an immediate remission should be made of one-eighth of the assessment on the land benefited. This remission should be given for a fixed term of years, the length of which would vary with the amount of the capital expended. During this period no enhancement should be made on the existing assessment. At the end of the period one-eighth of the revenue then assessable on the land should be given as a perpetual exemption. Mr. Low, Deputy Commissioner of Hoshangabad, proposes that the concession should take the form of a revenue-free grant of a proportion of the area improved; the grant to be either perpetual or for a certain number of lives. The local authorities are the best judges of the form which the grant should take, but we think that some concession of the kind is desirable; and it would, we understand, be in keeping with an ancient custom of the province. The cost to the State would be comparatively small, while the concession would have a sentimental value in the eyes of the grantee and of his family, and would raise him in the estimation of his neighbours. It should continue only so long as the tank was kept in repair; and should not be transferable, but be personal to the grantee and his heirs.

362. *Acquisition of land.*—In order to remove one serious obstacle to the construction of private tanks, powers should be given, with such safeguards as may be necessary, for the acquisition, on behalf of the person constructing the tank, of way-leaves, or a right of occupying land required for a private tank

or for its distributary channels This power might be conveniently given by an addition to the Land Acquisition Act, or to the Northern India Canal and Drainage Act. In some cases it may be advisable that the land should be acquired outright. But for such works as these it will generally be preferable to acquire only a right of occupation for the purpose of the work, subject to the payment of compensation; the owner of the land retaining the title, and the right to revenue in the event of the land being no longer required for the purpose of the work. Such an arrangement will usually be less costly, and, at the same time, far less unpopular than expropriation.

363. *Local utilization of the famine cess.*—Before leaving the subject of tanks, we may refer briefly to a proposal which Mr. Craddock has brought forward with the object of providing the funds required for their improvement, and for assisting in the general development of the private irrigation works of the province. At present an additional famine cess of 2 per cent. is charged on the land revenue by which about $1\frac{3}{4}$ lakhs are realized annually. Mr. Craddock proposes that this cess should be ear-marked for the improvement and development of private protective works, on the general grounds that it will ensure the allotment of a definite annual sum for this purpose, and, at the same time, fulfil the avowed object for which the cess was imposed; while the allotment of this local cess for a local object would render it more popular than it is at present. We realize the objection which may be urged, on general grounds, to ear-marking any portion of the public revenues for a particular purpose; and, provided that adequate funds are made available for the development and improvement of private irrigation works, we do not deem it necessary to express an opinion as to the form in which the requisite assignment should be made.

River Channels.

364. *Present restricted use and possibilities of extension.*—Channels for the conveyance of water from rivers or streams appear to be used to a fairly considerable extent in some districts; but, considering the facilities which exist in many parts of the province for the construction of small river-fed channels for direct irrigation, the area irrigated in this way is remarkably small. According to the annual returns of the areas irrigated from different sources, such channels would appear to be confined to the district of Raipur; but we gather that they are also to be found in smaller number in Bilaspur, Nimar, Damoh, and other districts. Even in Raipur, where they seem to be more popular than elsewhere, and where in 1896-97 they accounted for nearly 9,000 acres of irrigation, they are apparently used very spasmodically. Many old channels are now not used at all, owing, it is said, to the apathy of the cultivators and the weakening of corporate feeling in the village community. The granting of facilities for the acquisition of land, personal encouragement on the part of the revenue officers, the professional assistance of the Public Works Department, and the concessions recommended in the matter of loans and exemptions (Chapters V and VI) should lead to a considerable extension of this useful class of work.

Wells.

365. *Number of wells and areas irrigated.*—There is singularly little well irrigation in the Central Provinces. In 1900-01, within the eighteen British districts, there were in actual use only 55,851 irrigation wells, and they irrigated an area of only 74,851 acres, or less than $1\frac{1}{2}$ acres per well. Sixty per cent. of the well-irrigated area lies in the five districts of Nimar, Nagpur, Chhindwara, Betul, and Saugor. Roughly, rather more than one-half of the area consists of wheat and other field crops, and the balance of sugar-cane and garden crops. Eighty per cent. of the wells are small temporary wells, many of which are mere holes in the beds of streams. In the last eleven years the number of durable wells is said to have increased from 7,688 to 14,004, or to have been nearly doubled. But it is doubtful how much satisfaction can be derived from this fact; for during the same period there has occurred a decided decrease in the total area irrigated from wells of all kinds, in contrast with the neighbouring provinces of Bombay and the United Provinces, where the area has been increasing. The districts of Saugor, Nimar, Balaghat, and Betul account for

nearly half the increase. The area irrigated per durable well is not easy to estimate. In Nimar it is put at 6 acres. In Saugor at 4 acres. The statistics give no help, as there are no separate figures of area for durable and temporary wells. Probably as in Bombay the area irrigable by a single *mot* does not exceed 3 acres on the average.

366. *Depth of subsoil water.*—There is no reliable information as to the depth of the subsoil water in different parts of the province, but in tracts where wells are in use the average depth appears to be under 30 feet; while over limited areas in the district of Nagpur and elsewhere, water is found at a depth of 10 or 12 feet. During the dry year of 1899-1900, the supply failed in many of the wells in the districts of Nimar, Betul, and Raipur; elsewhere the areas irrigated per well in that year appear to have been fairly normal.

367. *Extension of wells.*—The exact reasons why well-irrigation has been so little resorted to in the past are not easy to determine. But the most probable are the abundance of the rainfall in ordinary years; the former backward state of the country; the sparsity of the population; and, at least as regards the eastern districts, which in some respects resemble Bengal, the unsuitability of well cultivation for rice, which is their principal crop. There can be no doubt, however, that, at any rate in the western districts, there is some scope for the extension of well-irrigation. Up to the present time the people have been left very much to themselves in this matter. Until the famine year, when 11½ lakhs were given out, much of it for irrigational purposes, the grants of *takavi* for land improvements of all kinds were very small. We cannot affirm that, were loans freely offered to assist in constructing wells, landowners would readily take advantage of them; but the extension of well-irrigation in these Provinces is, we consider, of such importance that it should receive all the encouragement which can be afforded by liberal grants of *takavi*, and, where good cause is shown, even by grants-in-aid or similar concessions. We agree with Mr. Craddock in thinking that if the matter be taken up energetically and prudently by the District Officers, on whose initiative the successful working of *takavi* everywhere depends, there is a considerable field for the extension of land improvement loans; and that in the near future not less than four or five lakhs per annum might be distributed with advantage, instead of the meagre sum of Rs. 30,000, which is all that has been spent in ordinary years up to the present. It is essential, too, that the annual allotments should be continuous and assured for a number of years. If this policy, and the measures recommended in our general Chapters (V and VI) on private irrigation works and *takavi*, are put into vigorous execution, only then, and not before, would we recognize that there must be difficulties connected with well cultivation which no liberality on the part of Government can overcome. In no circumstances, we fear, can irrigation from wells in the Central Provinces be so widely extended as to afford any efficient protection against famine. At the best, it will in all probability still be confined almost entirely to wheat, sugar-cane, and garden crops; and in some of the most suitable wheat tracts water is only found at an impracticable depth.

368. In the rice tracts especially, there seems to be but little hope of any considerable increase. Masonry wells for the irrigation of sugar-cane appear to be on the increase in Sambalpur; but in the rice districts generally, wells would as a rule only be required to supplement other forms of irrigation. But such supplemental wells are, so far as we have seen, confined almost entirely to tracts in which winter rice can be grown. In the rice tracts of Madras and Hyderabad wells under tanks are used extensively, but chiefly for the irrigation of the winter rice crop; though they are sometimes called upon to supplement the supply of the autumn crop when the rain or tank fails. In the Central Provinces wheat and other *rabi* crops take the place of the winter rice crop of more southern parts, and these but seldom require irrigation. Although supplemental wells would be invaluable in a dry year, we fear that the cultivator—certainly the cultivator of Chhattisgarh—is but little likely to go to the expense of providing a masonry well, and the appliances necessary for well-irrigation to which he would only have to resort in an occasional year. Even temporary wells, which it should often be possible to construct in a few days in

the vicinity of a tank, appear to have been dug in very small numbers to save the rice crop during the recent famine. But there are no doubt many tracts, where there is at present no well-irrigation, and in which masonry wells would be made if their advantages were better known; and even in Chhattisgarh it may be possible to do something towards developing the construction of supplemental wells under tanks where the subsoil does not admit of the construction of temporary wells. In all such tracts we think that Government might assist in introducing the use of wells, by giving very liberal grants-in-aid to the first cultivators who are willing to construct them, and even, in some special cases, by bearing the whole cost of construction.

369. For the increase of irrigation from temporary wells what is required is energetic encouragement in years of drought and short rainfall. In such years District Officers should have liberal grants placed at their disposal early in the *rabi* season; they should tour among the people and distribute the money on the spot to persons of respectability and sufficient resource to pay back the trifling sum advanced; and in order that there may be no delay, the tracts in which such advances are likely to be useful should be mapped out beforehand, and clear instructions issued regarding the measures to be adopted.

Field Embankments.

370. *Cost, value, and area embanked.*—Field embankments are not usually classed as irrigation works, nor are the areas protected by them included in the annual returns of areas irrigated. But, practically, they are next to tanks the most important form of irrigation works in the Central Provinces; and they certainly afford substantial protection to one description of wheat lands, in a cheaper form than would seem to be possible by any of the recognized classes of irrigation works.

371. At a rough estimate there are about 600,000 acres of embanked fields in the province, of which about two-thirds are in the district of Jubbulpore, and the remainder chiefly in Narsinghpur and Damoh. Rice fields, which are generally surrounded by small ridges, a foot or a foot-and-a-half high, are not included in this area. The regular embankments, three feet or more in height, are confined almost entirely to the wheat lands; their chief function being to hold up water on the field, and thereby ensure a sufficient supply of moisture in the soil for the germination and sustenance of the *rabi* crop. But, in addition, the soil is fertilized by deposits of silt, and, provided the water is held up to a sufficient depth, *kans* grass and weeds are eradicated; while the thorough saturation of the fields reduces considerably the cost of cultivation, and often indeed even renders ploughing unnecessary. Occasionally, in the more level lands, a catch crop of rice is taken before the *rabi* crop is sown. Embanked fields are said to be more liable to suffer from rust than those which are not embanked; but there is a general consensus of opinion that over a series of years the gains from the system of embanking are greater than the loss. More than one of our witnesses has stated that, on an average, embanking doubles the outturn.

372. The protective value of these works was fully established during the recent famine, when the embanked tracts fared, on the whole, better than any others in the province. The wheat lands of the Jubbulpore *haveli*—a large tract which is almost completely embanked—yielded in 1896-97 a full crop, and even in 1899 a very fair outturn. Again, two large embankments made in 1897 by Seth Nathu Ram, a *malguzar* in the Saugor district, protected his village so effectively that he not only kept his tenants on the land, but paid all his revenue in the year 1900, when his neighbours both lost many of their tenants and failed to pay their assessment. In those districts which are specially addicted to the rapid spread of *kans*, embankments have a very special value if made either during or immediately after famine. There are indeed parts of the famine-stricken areas in which, without the aid of embankments, recovery from the effects of recent famines may be indefinitely postponed. For an immediate consequence of famine is the

enormous spread of *kans* ; and the famine-stricken and decimated population, with their starving cattle, are quite unable to carry on the necessary campaign against the weed by means of thorough and persistent cultivation. The only resource for its extirpation is flooding through the agency of these embankments.

373. The height and cost of the embankment depend on the slope of the ground. In the more level lands of Jubbulpore and Narsinghpur, the usual height is from 3 to 5 feet, and the cost of embanking is estimated at Rs. 10 per acre submerged. In the uneven lands of Saugor and Damoh, where water is often held up to a depth of over 10 feet, an embankment is a more serious undertaking. Some of the larger embankments, like those to which we have just referred, submerge as much as 150 acres each, and practically form small tanks, from which, during the rainy season, the water is let out to irrigate rice or to saturate the fields below. But the banks are not provided with waste-weirs or with proper outlets, and in heavy rain they frequently burst and the water runs to waste. The cost of these embankments in uneven lands varies generally from about Rs. 20 to Rs. 30 per acre submerged, but for some of the larger works it reaches Rs. 50 or more.

374. *Scope for extension.*—It seems very doubtful if the more friable black soils, such as are found in portions of the Nerbudda Valley and elsewhere, are suitable for embanking, but it is worth while to make experiments in them. There are, however, still to be found in the districts of Saugor, Damoh, Narsinghpur, Hoshangabad, Nagpur, and parts of Wardha, and possibly also in Raipur and Bilaspur, large unembanked areas of the stiffer soils in which alone up to the present embankments have been made. The practice of embanking fields has received a considerable impetus during the recent years of drought ; and we have no doubt that, if immediate advantage be taken of the present feeling in its favour, a great deal of valuable protection can be afforded to the province at a very small cost.

375. *Measures for encouragement.*—Generally the State's contribution might take the form of a grant-in-aid, equal to not more than half the total cost. The increased rental on embanked fields averages, we understand, about Re. 1-4-0 per acre. The share of this which the State would eventually receive would cover the interest charges on at least Rs. 16. But in many cases the landowner will be too poor to contribute even half the cost ; and his estate may already be so heavily mortgaged that it would be unadvisable to grant him a loan for the purpose. In such cases, and especially where lands have been thrown out of cultivation by the growth of *kans*, we think that Government might bear the whole of the cost, if the constructors of the embankment would agree to pay a small annual charge on the acreage benefited, the charge to come into force three or four years after the completion of the work. Similarly in tracts where embankments are at present entirely unknown, but in which the conditions appear to be favourable for their construction, it will be necessary for Government to bear the whole cost of a few experimental works. But, in addition to encouraging the construction of new embankments, something should also be done towards restoring those which are breached and abandoned. In the Saugor district at least, these exist in considerable number, and many of them could be repaired at a moderate cost. Abandoned works of the kind are generally to be found in tracts where the advantages of embankments are already fully recognized, and, on principle, the people should be made to contribute something towards the cost of their repair.

376. *Arrangement for construction of new embankments.*—In the design and construction of new embankments in uneven lands, the assistance of the Public Works Department will, no doubt, be necessary ; and, in view of the importance of such works as possible famine relief works, it is very desirable that the attention of the Department should be directed to them. But we think that, even in the case of the larger embankments, a considerable share of the work may safely be left to the people. At first, and until the Public Works officials have had more opportunity for gaining the necessary experience, it will be best,

in locating the works, to depend on the advice of the local experts who have gained some reputation in that way. A few smart and keen men of this kind might indeed be employed as temporary subordinates in the Department. When the general location of the work has been settled, the necessary levels should be taken, and the estimates prepared by the Public Works Department; but the actual execution of the work could generally be entrusted to the *malguzar*, to whom periodical payments would be made according to the quantities executed. Where the catchment area is large compared with the size of the bank, it will be necessary to provide proper waste-weirs and outlets, and as a general rule these should be constructed under professional supervision. The failure of existing embankments has been due, in almost all cases, to the absence of a waste-weir or to the want of a properly constructed outlet. We think that in the case of the large embankments which have already been made, Government might suitably recognize the enterprise displayed in their construction, by providing waste-weirs and outlets free of charge.

(*v*).—*Famine works and programmes.*

377. *Expenditure on works during the famines of 1896-97 and 1899-1900.*—The expenditure incurred during the recent famines on works of all kinds was as follows:—

	1896-97.	1899-1900.
	Rs.	Rs.
Railways	17,144	9,62,000
Roads	80,53,541	1,12,84,000
Constructing large irrigation tanks	...	5,28,000
Constructing small ditto	...	6,45,000
Repairing and improving old irrigation tanks		11,50,000
Village tanks and water-supply	5,29,148	14,07,000
Miscellaneous	...	5,89,000
TOTAL	85,99,833	1,65,65,000

The amounts shown include only the expenditure incurred on wages, and about 9¾ lakhs given in gratuitous relief to the dependents on works under the Public Works Department.

378. *Utility of the works.*—With the exception of some doubtful roads, on which 12¼ lakhs were spent, the works which were carried out in 1899-1900 appear to have been generally useful. Compared with the figures for the previous famine, the most noticeable feature is the increase in expenditure on irrigation works. In 1896-97, the total expenditure incurred by the Public Works Department in connection with works of irrigation was under half a lakh; while under the direct agency of the Civil Department, only 101 small tanks were constructed or improved. In that famine the bulk of the work of tank improvement was carried out by private persons by means of special famine loans, which were granted free of interest, with, in most cases, a remission of one-fourth or one-fifth of the principal. By means of these loans, which were given out to the extent of over 11⅓ lakhs, a great deal of useful work was done in repairing tanks in the rice districts, and in constructing field embankments in the wheat tracts. But on the whole the expenditure on irrigation works was insignificant. In the recent famine every endeavour was made to substitute tank for road work. In the absence, however, of a detailed programme of irrigation works, road work, in spite of every effort, still remained the chief resource. Nevertheless, compared with the previous famine, a considerable advance was made in the expenditure on irrigation works. As already noted, over 5¼ lakhs were spent on the construction, or partial construction, of 10 large tanks in the Chhattisgarh division; and over 18 lakhs, on the construction, improvement, or repair, of about 3,250 smaller tanks. These smaller works have already resulted in very considerable benefit to the areas commanded by them. None of the large tanks were finished before the close of the famine. We have already recommended that a few of the most promising should now be completed as experimental works.

379. *Famine programmes.*—The famine programmes for 1901, which were laid before us, provide relief for 874 million units against 100 millions actually relieved in 1899-1900. Out of this total number of units, irrigation projects provide for 355 millions; railways for 275 millions; roads for 235 millions; and village tanks, which remained over after the recent famine, for 9 millions. The detailed programme for each district is accompanied by a small plan showing clearly the position of each work. The programmes, which had been prepared in the Public Works Department, were, however, still incomplete as regards village works, the selection of which is left to the civil authorities, from whom lists were shortly expected. They are also incomplete as regards forest works, which in more than one district formed an important feature in the late relief operations. The inclusion of these classes of works, and of a complete scheme of irrigation works, will make the programmes very complete, and will provide employment on really useful works for larger numbers than are likely to require relief in any single famine. For the reasons specified in paragraph 372, we consider it of importance that field embankments should form a prominent feature of any famine programmes for the districts, such as Saugor, in which they are likely to be of value. Even the smaller embankments are likely to form a useful class of village work; while the larger, for which apparently there is considerable scope, are as good a form of employment as a tank *band*. It may be objected that embankments, although constructed by the State, will benefit the landholder in whose estate they are situated. But this consideration ought not to stand in the way. The chance of getting some increase of rent will probably induce the landholder to give up the land required for the work, free of charge; and, at the next settlement, Government will obtain some return for its outlay in the shape of increased revenue.

सत्यमेव जयते

CHAPTER XVIII.—BENGAL.

380. *Description.*—The vast territory which is comprised in the Government of Bengal, with its 73 millions of inhabitants, presents very different conditions of agriculture. Chiefly consisting of a great plain raised little, if at all, above the sea in the east, it slopes gently towards the north-west to a level of about 200 ft. in a distance of 450 miles. In the north it skirts the foot of the Nepal Mountains, east of which it ascends 7,000 ft. to Darjiling. In the south the large province of Chota Nagpur and the *Hinterland* of Orissa contain much broken and hilly country, covered with forest and very thinly peopled. Through the heart of Bengal flows the Ganges, fed by the Gogra, the Gandak, and many minor rivers, till it mingles with the Brahmaputra from the north; and the two rivers together traverse and form the great Gangetic Delta. Throughout almost the whole country, rice is the food of the people, and the chief crop sown. It is liable to failure when there is a long break in the monsoon. Were it not for this, and for the density of the population, Bengal would require little or no famine protection. Where rice is grown throughout India it is usually benefited by regulated irrigation; but it may be said generally for Bengal, that east of the longitude of Calcutta there is no need whatever for artificial irrigation. In this part of Bengal the average rainfall is nowhere less than 54 inches, and it rises to 65 inches and 75 inches as one proceeds eastward, till at Chittagong it exceeds 100 inches. In Orissa the rainfall is about 60 inches, and until the disastrous year 1866 that province was considered immune from famine. The western portion of Bengal, forming the Commissionership of Patna and generally known as Bihar, bears a much closer resemblance to the districts of the United Provinces on the west, than to those of Bengal on the east. Here serious droughts have frequently occurred; especially in the districts bordering on Nepal in a zone of about 50 miles in width, extending from the Gandak to the Kosi, a distance of about 220 miles.

381. The irrigation fields of Bengal may be conveniently divided into five sections—

(i) Orissa and Midnapur.
(ii) The Damodar river works.
(iii) Bihar, south of the Ganges.
(iv) Bihar, north of the Ganges.
(v) Chota Nagpur.

SECTION I.—THE CANALS OF ORISSA AND MIDNAPUR.

382. *The Orissa Canals.*—It lies beyond our terms of reference to enter on the history of these canals further than is necessary to point a moral for future guidance. The first proposal to employ the waters of Orissa and Midnapur for irrigation came from the fertile brain of the late General Sir Arthur Cotton, who was deputed to visit the province in 1858, with the object of giving advice as to controlling the flood waters of the Mahanadi. He recommended the construction of a complete system of irrigation and navigation canals, following the principles then being carried out in the deltas of the Godavari and Kistna. He estimated that an area of 2¼ millions of acres might thus be irrigated, and that navigation might be opened up between Orissa, Midnapur, and Calcutta, for the sum of £1,300,000. Here as elsewhere, Sir A. Cotton attached special importance to making the canals navigable; and considering how completely Orissa was cut off from the rest of India—without roads, rail roads, or harbours, and traversed by a succession of formidable and unbridged rivers,—and seeing the success that had attended the navigation works of the Godavari Delta, one cannot wonder at the importance Sir Arthur attached to making these canals navigable.

383. In 1860, the East India Irrigation and Canal Company was formed for the purpose of carrying out the works in Orissa, and water was first supplied for irrigation in 1865; but the works were not sufficiently advanced to be of any

real use in the terrible famine of 1866, beyond furnishing an excellent form of relief labour in the distressed districts. Before this it had become evident that the original estimate would be largely exceeded; and, as the Company found difficulty in raising further funds, the Government of India purchased the whole of the works for the sum of £1,089,550, and in 1869 the Company ceased to exist.

384. From the first, irrigation in Orissa made very slow progress. Those who had enthusiastically quoted the successes of the Madras deltas seem to have forgotten that in the deltas the rainfall does not exceed 40 inches; while, as already said, in Orissa it amounts to 60 inches per annum. The works, however, proceeded; and in 1873 it was decided to provide for an irrigable area of 1,140,000 acres in Orissa (exclusive of Midnapur), at an estimated cost of 440·88 lakhs of rupees. This area was to include 500,000 acres in the Balasore and Puri sections of the scheme, which had not then been put in hand and were soon after abandoned. The works completed up to date are said to command an area of 576,264 acres, the maximum discharge of the canals being 6,058 cusecs. The average area irrigated during the five years ending 1900-01 has been 195,973 acres, all practically contained in the Cuttack district. The maximum (in 1900-01) has been 203,540 acres. The total capital cost, exclusive of interest charges, has been Rs. 2,64,46,617. The average annual working expenses for the last five years are Rs. 4,91,830. The average gross revenue from all sources for the same period has been Rs. 4,67,913, so that the working expenses have not been fully covered. Of the revenue Rs. 2,77,756, or 59 per cent., has been on account of water rate, Rs. 1,63,240 or 35 per cent. on account of navigation dues, and the rest on account of minor receipts. The maximum water rate in any one year has been Rs. 2,87,812. The annual charges for interest now exceed 10⅓ lakhs.

385. *The Midnapur Canals*, drawn from the Kasai river, were at an early stage separated from those of Orissa and treated as a distinct project. The first estimate for these works, that of November 1869, amounted to Rs. 23,65,593, inclusive of all charges, for which sum it was calculated that 173,165 acres per annum would be commanded. The maximum discharge of the canal is 1,500 cusecs. These estimates have been repeatedly revised. The capital cost, exclusive of interest, now stands at Rs. 84,73,427, and the annual working expenses, on the average of the last five years, at Rs. 2,40,259. The average area annually irrigated for the same period has been 73,280 acres, and the maximum 91,217 acres (in 1892-93). The average gross revenue has been Rs. 2,50,530, of which Rs. 1,15,530 or 46 per cent. are on account of navigation dues.

386. *Irrigated areas.*—We do not propose to consider here, at any length, the reasons why these canals have fallen so short of the expectations which were general when the Company was constituted, although even at that time many warnings were given that the undertaking could not possibly be directly remunerative. There are, however, two points, regarding the Orissa Canals, on which some remarks may be offered—the smallness of the area for which water is taken, and the lowness of the rates which are charged for irrigation. As already stated, Sir Arthur Cotton originally estimated that 2¼ millions of acres might be irrigated; but the average area is less than 200,000 acres. His estimate was doubtless a very rough one; and it probably included every acre of land within the Mahanadi Delta, and in the tract to be commanded by the Midnapur Canals, without reference to the question whether it was cultivable or would take water. The areas shown in the revised project of 1873 were estimated on the assumption, for which there was little warrant, that 500 acres in every square mile would be irrigated, so that the gross area commanded by the whole project was approximately 1,460,000 acres, or 820,000 acres excluding the Balasore and Puri sections. The area actually commanded by the present system of distributaries is estimated at 524,000 acres, of which only 264,000 acres, or about 320 acres per square mile commanded, are irrigable. The balance is either uncultivable or lies too low to take irrigation or too high to be irrigated otherwise than by lift; and lift irrigation is hardly practised at all. It is doubtful therefore whether the average area that can be irrigated by the present canals can ever exceed 250,000 acres. There is, we understand, no difficulty in regard to the

supply, which is generally sufficient for all the land that is ever likely to take irrigation.

387. *Water-rates.*—The question of the rates to be charged for water does not appear to have been considered at the time that the Company was formed; and the Directors were prepared to leave the matter to be settled while the works were in progress. After the works were taken over by Government in 1868, a scale of rates was notified which in practice proved to be prohibitive, *viz.*, Rs. 6 per acre for sugar-cane, Rs. 5 for certain other crops, and Rs. 3 for any single crop not remaining more than six months in the ground. In 1872 a system of annual block leases was introduced; the rate charged for every acre comprised in the block being Re. 1 or Re. 1-8, according as the lease was entered into before or after the 1st May. This system has been gradually modified to that which is now in force. The present practice is to give long term block leases, which often extend to 10 years, but to discriminate between the various classes of land forming a block. Thus lands lying so low that they never require irrigation, although water may often flow into them, are excluded from assessment; while a special rate of 8 annas per acre is charged on those lands which derive benefit from irrigation only in exceptionally dry years. The rate charged for other land, or the ruling rate, was until recently Re. 1-8 per acre, but it has been raised to Re. 1-12 in 1902-03. Higher rates are charged for single season leases, or for water taken between 1st April and 16th June; but the average or all round rate is about 3 annas less than the ruling rate, and it amounted to Re. 1-5 only during the three years ending 1901-02. The long lease system is well suited to these canals, as it tends to prevent loss of revenue in seasons in which irrigation is not required, and it appears to be popular with the cultivators. The fact nevertheless remains that after many years' nursing of the lease system, it has not been possible to induce the Uriya cultivator to pay an average rate of more than Re. 1-5 per acre for all the advantages of irrigation and protection from floods which the canals confer on him; and that, even after a revision of settlement, Government has not been able to propose a greater enhancement of this rate than 4 annas. On the Godavari and Kistna Canals in the Madras Presidency, the average rate varies from Rs. 4 to Rs. 4-12 per acre irrigated. The rates on the Midnapur Canals are at about the same pitch as those on the Orissa Canals; but there are no special rates for lands which derive material benefit from irrigation only in years of short rainfall; the all-round or average rate is therefore somewhat higher, and it amounted to Rs. 1-9-6 per acre during the three years ending 1901-02. There is little prospect of any early increase in these rates; although a gradual enhancement may be justified now that the country has been opened up by railways, and the backward Uriya been brought under influences which will encourage a higher class of cultivation. But even if it were possible to raise the average water rate to Rs. 2-8 per acre, to increase the irrigated area to 250,000 acres and to reduce the annual maintenance charges by 20 per cent., the return on the capital expended would be less than 1 per cent.

388. *Navigation.*—It is not probable that by the exercise of any economies in the construction of the canals of Orissa, they could ever have been made to pay to the State a profitable return on the capital spent on them. But we think it right here to call attention to one very large item of expenditure which, with the light of the experience of late years, we believe might have been greatly lessened, if not avoided altogether. We have said above that it was not unnatural that Sir Arthur Cotton should have attached much importance to the canals being made navigable. Thirty years ago this opinion was probably shared by all the most capable irrigation officers in India. Now, it may be said that excepting the deltas of the Godavari and the Kistna, there are no irrigation systems in the country in which canal navigation has yielded any financial return on the capital employed on it, or—a matter of more importance—in which it has really proved a boon to the people of the districts traversed. It might have been expected that if navigation could be a success anywhere, it would be in Orissa. But from the evidence we obtained on the spot, it is clear that, after 30 years of a very fine system of navigable canals, the people have not taken to navigation. "They send their

grain by carts" said one witness. "The chief means of transport in Orissa are pack bullocks" said another. "Even when they can get canal water to put boats on they very seldom use the boats. This is a province in which boats are very little used."* Since the opening of the railway through Orissa, the navigation receipts of these canals have diminished from Rs. 1,94,100 in 1897-98 to Rs. 78,153 in 1901-02, and there is no likelihood of nav gation ever proving of much value. The navigation establishment costs about Rs. 16,000 per annum. The rate of tolls is about 2 pies per ton per mile.

389. *Value of the canals.*—A fair test of the value of irrigation to a district is to be found in the increase of the rent obtained for the land. On this subject we have fortunately very detailed information in the able report of Mr. S. L. Maddox, I.C.S., who surveyed and settled the province of Orissa between 1890 and 1900. Mr. Maddox states—

> There is little, if any, evidence of general enhancement of rents on the ground of irrigation or of higher rates in irrigated than in unirrigated villages, though there is evidence that rent-rates have risen more in the protected and irrigated tracts than in the unprotected and unirrigated. There is, however, some reason to think that irrigation causes the lowest rents to rise and in fact has a tendency to equalize rents through an irrigated area * * * * It will be seen that the increase of cultivation is certainly no greater in the protected and irrigated group, and all the inquiries made have failed to elicit any evidence of a substantial extension of cultivation to lands which but for the canal water were not likely to have been reclaimed.* * * Amidst the mass of conflicting information on the subject of the increase of rent-rates one fact alone can be held to be abundantly proved, and that is that the cases in which a zamindar has openly enhanced rents on the ground of the accessibility of canal water or has imposed an irrigation cess of his own are very rare.

Elsewhere in India the rents of irrigated are sometimes two or three times those of unirrigated land. Here in Orissa, despite the increased crop and the assurance against drought, the tenant declines to pay a higher rent, and will only pay a very small water rate for the privilege of irrigation; nor has it been possible to increase this rate at settlement by more than four annas. It must be inferred then that the profit due to irrigation has been very small.

390. It must not, however, be assumed that these canals are of no value to Orissa. The value of the protection from floods afforded by the embankments is even greater than that of the protection from drought which is afforded by the canals. Were so terrible a calamity to befall Orissa again as that of 1865, the province would be in a far better position to withstand it. It is true that the irrigation is almost entirely confined to the Cuttack district. It hardly extends to Balasore in the north, and not at all to Puri in the south. But it is certain that the assured produce of 250,000 acres in the heart of the province, would largely influence the grain markets right and left. Cuttack is now connected by two navigable canals with False Point, one of the very few good anchorages on the whole coast of India. It is connected with Calcutta by another canal which touches also the seaport of Chandballi; while the railway places Calcutta within a few hours' reach of Balasore, Cuttack, and Puri.

Scope for further extension of irrigation.

391. *Coast districts.*—Considering these facts we are of opinion that there is no urgent need for further famine protection to the plains of Orissa; and indeed that there are few parts of India more secure, or in which the value of irrigation bears so small a proportion to its cost. We think that good might be effected by multiplying the number of irrigation sluices in the great flood embankments that line the rivers, in order that the land protected from destructive inundation may not be deprived of the beneficial inundation. Should it be considered necessary still further to protect Orissa, the volume of its rivers has not been exhausted, and irrigation might be carried into Puri and extended in Balasore for probably a not unreasonable sum. But we do not recommend these extensions in the face of the far more important projects on which capital may be better expended.

---

* Evidence of Babu Jamini Mohun Das, Deputy Collector.

392. *Angul district.*—What has been said in the preceding paragraphs applies only to the alluvial plains of Orissa and Midnapur, forming the deltas of the Mahanadi, the Kasai, and other large rivers. But, inland of the Orissa deltas, is a very large tract of country, generally hilly or undulating, containing much forest with a scattered and backward aboriginal population. The greater part of this is included in the Government lands of Angul, which cover about 1,700 square miles, and are administered by a Deputy Commissioner. The people of this district are not so dependent on cereal harvests as those in the plains, the products of the forest going far to help them in times of drought. But when, as in 1899-1900, there is not only a failure of the rains, but also of the mango and *mahua* crop, the distress is severe. The average rainfall in Angul is 55 inches. Further south in the Khondmal Hills it is as high as 67 inches. A certain amount of irrigation is effected in Angul by placing dams across streams and valleys and storing rain water. It is said that there are 503 private tanks, the largest of which waters about 100 acres and that 16,200 acres of cultivation depend on them. An annual grant of Rs. 4,000 is given for making and repairing the dams, which in the opinion of the Commissioner and Deputy Commissioner is a sum quite inadequate to the wants of the district. Angul is 64 miles from the nearest railway station, and in this distance two large unbridged rivers have to be crossed. The country is very badly supplied with roads, and they are considered of more importance than irrigation works. There is no District Engineer in Angul, and we think it might be an instruction to one of the Executive Engineers at Cuttack to visit it periodically, and to render assistance in designing and carrying out such roads and irrigation works as are required. They would probably be of a very cheap and simple nature. The annual revenue of Angul is Rs. 86,000. In the year 1889-90, Rs. 36,000 were spent on famine relief, and in the year 1899-1900, Rs. 21,000.

393. *Puri district.*—A considerable portion of the Puri district lies above the reach of any delta irrigation, and of this an area computed to exceed 56,000 acres is irrigated from tanks and *bands*. In this part of the district lies the Government Estate of Khurda, which has an occupied area of 254,000 acres. The irrigation works are said to be in need of repair, and, in our opinion, loans should be offered to the landowners to enable them to repair existing works and make improvements ; while an example should be set upon the Government Estates, the requirements of which should be investigated under professional advice, and money should be allotted to execute such works as are likely to be beneficial.

Section II.—THE DAMODAR RIVER WORKS.

394. *Proposed storage works on the Damodar river.*—The Damodar river rises in the Ranchi District of Chota Nagpur, and flows through that province and through the districts of Burdwan, Hughli, and Howrah, joining the river Hughli some distance below Calcutta. The rainfall of its catchment basin varies from 55 to 65 inches per annum. The flood discharge of the river is as high as 470,000 cusecs flowing for 3 days. In March it diminishes to less than 100 cusecs. The first proposal for dealing with the waters of the Damodar river was made in 1866, and its object was not irrigation, but the construction of a Navigation Canal to connect Calcutta with the coal fields of Raniganj. This led to the idea of irrigating from the canal, and thence to that of storing and controlling the enormous floods which occasionally cause very great damage. The Navigation Canal from Raniganj to Calcutta, and the storage reservoirs on the Upper Damodar, have never yet been made, and since the development of railways it is unlikely that the former ever will be made. The control of the flood waters of the Damodar by storage reservoirs may well be worthy of consideration, but it is beyond the scope of our inquiry.

395. It may be observed, however, that the irrigating capacity of reservoirs constructed mainly for the purpose of counteracting floods must always be very small in comparison with the storage provided. The capacity required for effectively controlling the floods of the Damodar has been variously estimated as from 50,000

to 100,000 million cubic feet, but the lower amount is probably the most that would ever be seriously contemplated. It is an almost necessary condition of such a reservoir that as much as possible of the stored water should be run off as soon as a great flood has passed, so as to leave room for the interception of as much as possible of the succeeding flood. Allowing for this, and for the amount that would have to be reserved for maintaining navigation both on the proposed canal and on the Damodar itself, the volume available for irrigation would be small and uncertain when compared with the capacity of the reservoirs. These would be situated in the rocky, hilly country of Chota Nagpur, and it cannot be inferred that suitable land would be available for irrigation in every valley in which a reservoir was constructed; for the sites would be selected more with reference to the facilities which they offered for impounding flood waters, than with a view to the probable demand for irrigation. Lastly, the value of irrigation in this part of Bengal, as measured by the amount which the people are willing to pay for it, is so small that the irrigation revenue derivable from the costly works proposed would not by itself go very far to justify their construction. If now, or at any future time, the construction of these reservoirs should be proposed as part of a scheme for extending or improving water communications in Bengal, and for moderating the floods of the Damodar, account would no doubt be taken of any irrigation that can be effected from them, and of the revenue thereon that may be anticipated; but this must be regarded as a subsidiary matter. We are unable, on the whole, to recommend the construction of these works on the ground of their value as a protection against famine.

396. *The Eden Canal.*—The employment of the Damodar waters for irrigation has come about in quite an indirect way. The districts of Burdwan and Hughli had been suffering for some years from a very severe epidemic of fever, attributed to the stagnant and insanitary condition of old river-beds and minor drainage lines. It was believed that this state of affairs might be improved if a supply of fresh water for drinking and other purposes could be thrown in from the Damodar; and this ultimately led to the construction of sluices on the left bank of the river at Jujoti, 8 miles above Burdwan, by which water was admitted into a *nala*, whence by further sluices and a weir it was passed on into the Eden Canal—a work opened by the late Sir Ashley Eden in 1881. Twenty miles further on the water is discharged into two natural drainage streams. It must be remembered then that the Eden Canal was not intended for irrigation but for sanitary purposes. Nevertheless during the last 10 years it has been largely used for irrigation.

397. The cost of the Eden Canal up to date has been Rs. 7,82,161. The average annual charges for maintenance, establishment, etc., in the last five years have been Rs. 57,453. The area irrigated per annum is on an average 25,975 acres. It was as high as 71,333 acres in 1892-93, and the year following as low as 11,739 acres. The average gross revenue from water rates amounts to Rs. 30,656. We were assured in evidence that there was a great demand for irrigation on the Eden Canal, but we had no evidence that the irrigators would be willing to pay more for their water than they now do, that is, about a rupee per acre.

Extension of works.

398. *Proposed weir across the Damodar.*—There is no weir across the Damodar at the head of the Eden Canal. This is evidently a great want, for without a weir there can never be any certainty of securing the supply required for the canal. Mr. Maconchy notes that in 1902 while there was a volume of 4,000 cusecs passing down the river, the supply entering the canal was only 80 cusecs, about one-tenth of what it should have been. The cost of a weir at Jujoti would not be less than 8 lakhs of rupees. Mr. Horn, the Chief Engineer, is of opinion that it would be better to make the Damodar weir at Raniganj (a much cheaper site than Jujoti) and to take the head of the Eden Canal up to this point, a distance of about 46 miles. He adds—"There is much more likelihood of water being in demand for irrigation between Raniganj and Burdwan as the country is much drier, and the land

would derive much more benefit from the fertilizing Damodar silt than lower down." We are of opinion that the irrigation system of the Eden Canal can never be satisfactory until there is a weir across the river at its head sluices. But this canal is not required for protection against famine, and until the irrigators are ready to pay for the water a rate sufficient to ensure a fair return on the capital cost, we cannot recommend Government to incur this outlay.

SECTION III.—BIHAR, SOUTH OF THE GANGES.

399. *General conditions.*—The province of Bihar, forming the Patna Division, is under very different climatic conditions from those prevailing in the catchment basins of the Mahanadi, Kasai, or Damodar. Here the rainfall varies from 43 to 50 inches, only exceeding this amount in the narrow zone under the Himalayas. South of the Ganges it does not exceed 45 inches. The three districts now to be considered are Shahabad, Patna, and Gaya. They have an area of 11,160 square miles and a population of 5,647,614; and in these three districts lies the most important irrigation system of Bengal, that of the Sone Canals. Judging from the extent of relief operations in 1873-74 and in 1896-97, famine has never been severe in modern times throughout this tract. No persons were employed on relief works in Patna in 1873-74, nor in Gaya in 1896-97, and in the latter year only 12,000 people were employed in the rest of the tract.

400. *The Sone Canals.*—The idea of using the waters of the river Sone for irrigation originated about 50 years ago with the late Colonel C. H. Dickens, R.A., and for many years the subject was under discussion. The project was undertaken by the East India Irrigation and Canal Company, but was handed back to Government in 1868, and work was not actually commenced until the following year. Sufficient progress had been made to allow of water being supplied through breaches in the banks of the Arrah Canal to the parched fields in the drought of 1873, and the canals were completed a few years after. They carry a maximum volume of 6,350 cusecs. About 80 per cent. of the irrigation lies in the Shahabad district, 11 per cent. in Gaya, and 9 per cent. in Patna. Here, as in the case of the Orissa Canals, the early forecasts of outlay and revenue soon proved fallacious. By curtailing the scope of the project Colonel Dickens' estimate of cost of 1861 has not been exceeded. But, whereas in October 1875 the Government of India anticipated a yearly irrigated area of 1,043,680 acres, the average of the five years ending 1900-01 was only 463,181 acres, and the maximum ever attained was 555,156 acres, in 1896-97. The cultivated area commanded by the canals is 1,354,302 acres; so that about one-third of this is watered every year.

401. The total capital cost of the Sone Canals up to 31st March 1902 has been Rs. 2,67,62,426. The annual charges for maintenance, revenue management, etc., amount to Rs. 6,04,804, taken on the average of the three years ending 31st March 1902. The total annual revenue calculated for the same period is Rs. 11,12,278, leaving a net revenue of Rs. 5,07,474 equivalent to an interest of 1·89 per cent. on the capital outlay. Here, as in Orissa, a very large sum was sacrificed to making the canals first class navigation lines. The Chief Engineer estimates this sum at one-quarter the whole capital outlay or Rs. 66,85,606. The Buxar and the Patna Canals radiate from one point (Dehri), and reach the Ganges about 80 miles apart. The Arrah Canal starting from the same point flows between the two. It is difficult to see how navigation on this intermediate line, requiring a lockage of 160 feet, could ever have been expected to pay. The navigation receipts have been seriously affected by the opening of the Moghul Serai-Gya Railway. During the four years ending 1899-1900 they averaged Rs. 87,600; but they fell to Rs. 36,507 in 1900-01, and to Rs. 23,595 in the following year. The average cost of navigation establishment only is Rs. 15,000 per annum. There are 218 miles open to navigation; and the average rate of tollage is about 2·2 pies per ton mile.

402. Before the completion of the canals, it was anticipated that the chief demand for water would be for the *rabi* or cold weather irrigation, as had been

found to be the case on the irrigation works of the Punjab and United Provinces. But it was soon found to be otherwise; and now nearly 70 per cent. of the whole irrigation is for the *kharif* or autumn crop which practically consists of rice, the average area of which in the last five years has been 334,565 acres, while that of the *rabi* crop has been only 128,616 acres. It is, at first sight, astonishing that the *kharif* irrigation is not more extensive, for only once since the canals have been opened, has the water in the river not been sufficient to supply the full discharge of 6,000 cusecs, enough to irrigate 516,000 acres of rice. But this is easily explained.

403. *The hathia.*—The universal practice in this part of Bengal is to run the water off the rice fields (*nigar*) in September; and after this the crop must get at least one watering during a period of 14 days, called the *hathia*,—generally from the 26th September to the 10th of October. If there is a good rainfall during this period the rice will mature unaided by irrigation. Otherwise it must receive water. The capacity of the canals is thus measured by the maximum area which they can irrigate during these 14 days. It is of no avail irrigating to their full capacity, say 516,000 acres, during July and August if they cannot water that area in 14 days in October. Should there be a good rainfall during this period, the 516,000 acres may mature. But if the *hathia* is a dry one, some of the crop will fail to obtain water and must perish.

404. *Former system of irrigation.*—Previous to the opening of the Sone Canals, the country was watered by a system still largely prevailing beyond the area of canal irrigation and in the neighbouring districts. The soil is that of the old alluvial system, and the surface of the country is slightly undulating; a condition which lends itself to the formation of *bands* across the depressions, intercepting the rainfall and forming a series of reservoirs, locally known as *aharas*. These are sometimes further supplied by ditches or canals, termed *pains*, leading water from the nearest drainage stream. When the Sone Canals were first opened, water was allowed to fill up the *aharas*, and to be drawn thence on to the fields. But when it came to claiming water rates, the rayats maintained that they had only used rain and not canal water, and it was impossible for the irrigation officer to disprove it. It became necessary then steadily to discountenance the filling of *aharas*.

405. *Leases for water.*—It was generally calculated that water would be given for 50 per cent. of the whole area of a village; and this irrigated portion was marked off into one or more well-defined blocks, for the irrigation of which a charge was made at a reduced rate per acre. The cultivator is supplied with water enough for his block, but he may not use it for irrigation beyond its limits. Conditions are laid down in each case, and among others it is now required that there shall be a well-defined village channel, and that the water shall not be allowed to escape into an *ahara*. These contracts have become very popular and are eagerly renewed, so that now 75 per cent. of the irrigated area receives water on long lease.

406. *Water-rates.*—The present charges per acre irrigated for water on the Sone Canals are as follows:—

	Rs.	A.
Seven years' leases for block areas, all crops between the 25th June and the 25th of the next March	2	8
Kharif season leases between 25th June and 25th October . .	3	8
Rabi season leases between 15th October and 25th March . .	2	0
Hot weather leases between 25th March and 25th June . .	4	8
Ditto ditto ditto per watering .	2	0

The last two rates were each increased by 8 annas in 1902. In ordinary circumstances we can well understand the policy of preventing canal water from escaping into *aharas*. It is a more wasteful system than carrying it direct to the field, and may easily lead to disputes as to rates. But we think

it might be possible to utilize the *aharas* during the month of September, when there is abundance of water in the river, so that they may assist in meeting the great demand in the *hathia*. It seems to us that when water is plentiful it would be wiser to encourage than to prohibit the filling of as many of these reservoirs as exist within the blocks; and that no extra charge should be made, as the effect will be to reduce the intensity of the demand when the critical time comes. As regards *aharas* outside the blocks, we observe that there is a sanctioned rate for water supplied by volume between 1st November and 15th March, *viz.*, one anna for every sixteenth of a cusec running for 12 hours, which is equivalent to a charge of Re. 1 per 43,200 cubic feet, approximately the volume necessary to flood an acre one foot deep. The rate from 1st September to 31st October is four times as high. It is said that water is never taken for *aharas* under this rule. The system of charging is rather complicated; but it seems possible that it might be popularized if owners of *aharas* were allowed to apply to have them filled between certain dates, on payment of a fixed charge for each, according to size. The applications might be for one year, or for a suitable number of years, or until further notice; and the canal establishment would arrange to fill the *aharas* before the latest date fixed. We found that a similar system was in force on some of the Punjab canals for filling village tanks for watering cattle, etc., during the period of slack demand in April and May. In this case no charge is made, but there is a regular system of registering the tanks and arranging for their being filled systematically when water can be spared. We cannot say how far the irrigated area can be extended by utilizing *aharas* as storage works before the *hathia* sets in; but we think that the practice should lead to a considerable increase in the irrigated area and in the canal revenue. It is right to add that neither Mr. Horn, the Chief Engineer, nor his predecessor, Mr. Buckley, is in favour of this proposal. Apart from this, there are only two ways, by which the *kharif* irrigation on these canals could be increased: 1st, by constructing storage works in the Upper Sone and increasing the discharging capacity of the canals when necessary; and, 2nd, by enforcing an extension of the *hathia* period from 14 to 21 days by restricting the supplies to the blocks, so far as this can be done without injury to the crops. We have no information to show what the cost of the former plan would be, as the question does not appear to have ever been seriously considered; but we do not regard it as in any way urgent, at any rate so long as water rates on these canals remain as low as they are at present.

407. Mr. Horn thinks that the water-rates on the Sone Canals might be raised, and Mr. Hare, the Commissioner of Patna, would approve of the measure, provided it were carried out "very gradually up to the real value of the water." There appear to be strong reasons for believing that this limit has not yet been approached. The area commanded by these canals is under permanent settlement; and in the present state of the law the only means by which Government can obtain any share in the agricultural profits due to irrigation, is by means of an occupier's rate, or charge for water supplied. From the first, special precautions have been taken to avoid the slightest resemblance of compulsion in respect of this rate. A cultivator is as free to take water at the prescribed rates, or to refuse it, as he is to purchase or refrain from purchasing manure. Elsewhere in India the fact that a field has been irrigated is in itself sufficient to justify the charge of a water rate; but there is a special rule under the Bengal Irrigation Act which declares that no charge can be made for irrigation unless a formal application has been received for water. A penal charge may be imposed in case of illicit or concealed irrigation; but no charge can be made for what is known as involuntary irrigation. Owing to the fact that irrigation is not indispensable in years of ordinary rainfall, and to the original backwardness of the cultivators in resorting to it, the rates fixed have been very low, and the present system of long leases has been developed; the holders of these leases having preferential claims to water during periods of high demand, such as occur in very dry seasons. These measures were wise and judicious; but it appears to be no longer necessary to charge very low rates in order to educate the cultivators as to the value of irrigation. The area under long leases has been steadily expanding. During the three years ending in March 1896 it

averaged 271,552 acres; but in 1901-02 it amounted to 317,318 acres, although the rate was increased from Rs. 2 to Rs 2-8 from the 1st April 1897. The increase of revenue has been gradual but continuous. It is now approaching its limit, as these leases are only given for the areas for which protection can be assured even in the driest years. The demands for such leases cannot in fact be fully met. During the three years ending 1901-02, applications were made for long leases for 252,393 acres; but the area for which applications were refused amounted to 112,648 acres, or to 44 per cent. of the area applied for. The Executive Engineer, Arrah Division, has reported that in that Division the canals are now practically leased up to their limit, and that any new lease can only be taken if it is very favourably situated. The demand for season leases is equally well maintained, and is equally near to the limit of the irrigating capacity of the works. In short, the demand on these canals is in a thoroughly healthy condition; and it cannot be said that the failure of the project as a financial investment is now in any way due, as in Orissa, to a slack demand, or to the inability of the cultivators to appreciate the value of irrigation. In such circumstances it is difficult to justify the low rates which are now charged.

408. *Recommendation to increase water-rates.*—The question may be considered from another point of view. Experiments on the outturn of irrigated and unirrigated crops of rice and wheat have been made for many years in all the divisions of these canals. The general results of these experiments, after valuing the outturn at the average rates received by the cultivators, are as shown below:—

Three years ending	AVERAGE VALUE OF ANNUAL OUTTURN (GRAIN AND STRAW) PER ACRE.					
	RICE.			WHEAT.		
	Irrigated.	Unirrigated.	Difference.	Irrigated.	Unirrigated.	Difference.
	Rs.	Rs.	Rs.	Rs.	Rs.	Rs.
March 1896 . .	33	not observed		36	not observed	
,, 1899 . .	38	24	14	43	38	5
,, 1902 . .	34	23	11	42	32	10

The results in the last line are based on 989 separate experiments, of which 409 were on irrigated, and 268 on unirrigated rice. Of the wheat experiments 170 were on irrigated, and 142 on unirrigated lands. Details of experiments of this kind are of course always open to criticism, but there is no reason to suppose that the differences in favour of irrigation are on the side of excess; and, if it is true that irrigation increases the value of an acre of rice by Rs. 12, and that of an acre of wheat by Rs. 7, there is room for a considerable enhancement of the water rates which are now charged.

409. *Question of an owners' rate.*—We think it right to consider here the question whether on the Sone system, in addition or as an alternative to the increase of the water-rates, which generally fall exclusively on the occupier, an owners' rate ought not to be imposed. We are aware that such a rate cannot be imposed without legislation, as the Northern India Canal and Drainage Act is not applicable to Bengal. The question of imposing such a rate in the Orissa system has, we understand, been already under discussion between the Governments of India and Bengal; and the conclusion has been reached that in view of the fact that the greater part of the tract is under temporary settlement, and that at the last revision large enhancements were taken, it would not be expedient, at any rate for the present, to pursue further the question of levying an owners' rate in that tract. Whether the question will ever be revived in Orissa is perhaps doubtful, since, in all provinces and tracts under temporary settlement, the State can, sooner or later, obtain from the landowners in the form of

an enhancement of the land-revenue their proper share of return for irrigation supplied to their lands. But the case of permanently settled tracts, like the Sone area, is altogether different. The land-revenue is immutable; and, the irrigation revenue being derived solely from water rates falling wholly on the occupier, the landowner pays nothing to the State for any benefit which he may have received from works which have been constructed at great expense by Government. Now, we find incontestable evidence that the landowner frequently, if not always, receives immense benefit from the irrigation provided on the Sone system. Mr. Oldham cites a case in which an owner admitted that a village, which at one time brought him in only Rs. 3,000, since the introduction of canal irrigation returns him Rs. 18,000 per annum. He knew of lands of which the rents had risen from Rs. 3 to Rs. 5 and Rs. 7 per *bigha*, from the same cause. A Patna landowner admitted that the income of an estate, of which he was a shareholder, had risen from Rs. 8,000 to Rs. 23,000 in a good year. The Executive Engineer, Buxar Division, knew of cases in which rents had risen from 4 annas to as many rupees; and the Superintending Engineer instanced cases in which the rents had been quadrupled. Of course, in the case of non-occupancy tenants, the landowner has no difficulty in getting the enhancement; but our witnesses were of opinion that in spite of the provisions of the Tenancy Act, he contrived generally to levy enhancement from the occupancy tenant as well. Enhancements, by contract with the landowner, are admissible in the case of such tenants; and the position of the landowner in valuable irrigated land is so strong that he can, no doubt with ease, obtain the consent of his tenant to any reasonable enhancement. Of course, where the custom prevails of paying rent in kind, the landowner obtains automatically, with the increase in the produce due to irrigation, an increase in the quantity which falls to his share. Unless the evidence is altogether incorrect and misleading, the landowners of the Sone area are enjoying immense advantages, for which they are paying the State little or nothing; and we think that in justice to the general tax-payer, a serious endeavour ought to be made to get something substantial from them. If it be alleged that to levy an owners' rate would be an infringement of the permanent settlement of land-revenue, the reply seems to be that there is no ground for considering the owners' rate, any more than the occupiers' rate, to be land-revenue. Both are payments for water supplied by the State. There is another difficulty which has been brought to our notice, namely, that any rate or charge imposed on the owner is certain to be passed on by him to his tenant. This objection ought to be met so far as possible by strengthening the law for the protection of the tenant. But if, notwithstanding all endeavours to strengthen it, the law still remains wholly or partially ineffective for such protection, we think that the principle should be recognized that an owners' rate is legally and equitably leviable from the landowner; and that, unless serious administrative inconvenience would result, the rate should be actually imposed, and levied from him, whether he succeeds in passing on the charge or any portion of it to the tenant, or not.

410. There appears to us to be a very strong case for taking a larger irrigation revenue from the Sone Canals, either from the owner or the occupier, or from both. The interest charges on the Sone Canals to the end of 1901-02 have exceeded the net revenue by Rs. 2,15,44,697. During the three years ending March 1902, the average annual excess of interest charges over net revenue amounted to Rs. 5,26,024; so that, until measures are taken for increasing the net revenue, these works are likely to impose a constant annual charge of about 5 lakhs on the State. The average annual amount of the water rates during the same period has been Rs. 10,26,459, on an area of 481,333 acres, or an average of Rs. 2·15 per acre. If this average rate could be increased by 50 per cent. or to Rs. 3-4-0 per acre, or if an owners' rate of about Re. 1-1-0 per acre could be imposed, the charges for interest would be fully covered in future. It may not be possible to make such an increase all at once. But we think that the question of making some progressive advance on the present rates deserves early consideration; and that an even higher average rate than Rs. 3-4 may be eventually contemplated and will be paid without difficulty. The canals have done a great deal for this tract. They have afforded it absolute protection against famine; and they have greatly increased the profits

of cultivation, and the material resources of the community. Although the work has been so far unproductive, we think that its construction has been fully justified by its great protective value. Were it possible to find two unirrigated districts in precisely similar conditions as Orissa and Southern Bihar, we should hesitate before recommending such an outlay as has been incurred in the former for the purpose of protecting it from famine; but we should have no hesitation in respect of the latter. This is no reason, however, why this work should continue to impose a permanent charge on the tax-payer, if the people who derive such great benefits from it are now in a position to pay the full cost of providing them.

411. *Advantage of the lease system.*—One valuable lesson is to be learned from the history of the Sone Canal system, namely, that even in areas in which the rainfall is considerable and the existing means of irrigation tolerably well developed, and where therefore the likelihood of a keen demand for water in ordinary years is a matter of uncertainty, there is good ground for believing that ultimately, though not perhaps for many years, the people may learn to set a high value on the water, and take up at remunerative rates all that can be supplied to them. In such cases the system of leases is excellent, teaching the people the value of water as an insurance, and protecting the revenue from excessive fluctuation.

412. *Irrigation in Bhabua and Sasseram.*—The whole area of the Shahabad district is 4,368 square miles, of which much the larger portion is sufficiently protected by the Sone Canals. There remains to the west an important Sub-division (Bhabua) and a part of Sasseram, containing about 600 square miles in the plains, besides some hill country, beyond the reach of the Sone waters. This tract, although 281,000 acres are said to be irrigated from private works, is still much exposed to drought; and the barrenness of the fields is all the more striking from its contrast to the fertile plains in the neighbourhood. This Sub-division is traversed by several minor streams coming from the Kaimur Hills in the south, and the subject of drawing on them for water has been fully discussed. Six years ago, Mr. Buckley, then Superintending Engineer, wrote an important note on the subject and concluded that the supply in these rivers was so precarious that he could not recommend the outlay of Government money on the project. The principal river here is the Karamnassa, which separates Shahabad from the Mirzapur district of the United Provinces. The supply of this river is not reliable; but the need of irrigation is so great that, in October 1902, we thought it worth while to urge on the Bengal Government the importance of surveying the upper portion of its course where it passes through hills. Here, the late Mr. Levinge, formerly Chief Engineer of Irrigation Works in Bengal, left it on record that in "his confident opinion" there was a magnificent site for a reservoir to contain 40,500 million cubic feet of water. The survey is now in progress, and it seems clear that an effective reservoir can be made. But whether it will be at a reasonable cost we cannot yet say; and we cannot admit that the liability of this Sub-division to famine is so great as to justify a large unremunerative outlay. If the Bengal Government sees fit to proceed with this project, it will of course be necessary to consult with the authorities of the United Provinces, who have an equally strong claim to the use of the Karamnassa for the dry plains of Mirzapur.

413. *Private irrigation works in Eastern Bihar.*—East of the Sone Canals in the Patna, Gaya, and Monghyr districts, there are no State irrigation works, but a great deal of very important irrigation is effected by private means. The system adopted is that of *pains* and *aharas* described in paragraph 403. This system seems to have attained its highest development in Gaya, where 1,670,000 acres—more than half the area of the district—are said to be watered in this way. In the upper lands, where *pains* are not practicable, *aharas* only are made. In lower lands there are both *pains* and *aharas*, working in conjunction or separately. The former are sometimes really canals, more than one of which irrigates many thousands of acres in from 100 to 200 villages. Sometimes these works are supplied with masonry sluices, but this is exceptional.

414. These works are essentially private—the property of the landowners. The custom in these districts, except where there is canal irrigation, is for the tenant to pay his rent in kind sharing the produce of the soil with his landowner. Theoretically the landowner and the tenant should share the produce equally, but generally the former claims at least $\frac{9}{16}$ths of the whole. Where this system prevails, the customary obligation to repair *pains* and *aharas* rests on the landowners; and the maintenance of the *pains* depends wholly on the proper observance of this obligation. Unless therefore the system of payment in kind (*baoli*) is also maintained, the obligation, and such inducement as the landowner now has to observe it, will disappear together. Mr. Oldham, Collector of Gaya, who has devoted much attention to the question of how the maintenance of these private irrigation works, which he regards as essential to the protection and prosperity of the country, should be secured, would prefer to see the *baoli* system everywhere abolished in favour of the cash system of rents. In this opinion, however, he is not supported by other officers; and as regards the maintenance of these works, it is not apparent what advantage would be gained by the change, which would result in the transfer of the obligation from the shoulders of the landowner to those of the tenant. It is true, however, that, owing to the sub-division of land, the landowner now rarely does his duty in keeping the *pain* silt-cleared and the *ahara* in repair; but he would do it still less were it not that he shares in the produce of the land. Owing to the sub-division of the land in recent years, and to the total want of any power of combination on the part of the landowners, these simple but valuable irrigation works are falling year by year into disrepair. There is no law to compel a person to carry out repairs, so they are not done; and, unless some means can be found to stop the resulting deterioration, it would appear as if the Government would have to step in and take over the works, or at least the *pains*, altogether. There is, however, no urgency at present for so sweeping a measure.

415. *Need of legislation.*—Mr. Oldham, the Collector, with the full concurrence of Mr. Hare, the Commissioner, recommends that an Act be passed, enabling the Collector to compel the landowners to carry out repairs, when he is satisfied on competent advice that they are absolutely required to keep up the irrigation. In the event of the landowner refusing to bear his share of the work, Mr. Oldham recommends that the Collector should have power to execute it and charge the cost to him.

416. In connection with these private irrigation works, another matter is said to require legislation. The water is diverted from a river into the *pain* by means of temporary dams; and if one of the owners of the *pain* is energetic and wishes to take in more water than his share, he can easily enlarge the channel at the head, which is not provided with a masonry sluice, or he can increase the height of the dam across the river. In the same way a landowner may put a *band* in the *pain* below his own fields in order to increase his supply. Or, if he is a new-comer, he may make a new *pain* and carry water off the river, to the detriment of the owners further downstream. It is easily to be seen what a fertile source of dispute this might be, there being no record-of-rights in the water. As a matter of fact, it leads to much litigation, as well as to rioting and local disturbances.

417. Mr. Hare recommends legislation to the following effect:—

To give the Collector power to interfere in cases of the construction of *bands* in rivers, in order—

(1) to prevent disputes and rioting;

(2) to prevent unreasonable waste of water to the detriment of those who live lower down the river;

(3) to prevent grave and material alterations in, and diversions of, the rivers, which may seriously affect the country.

Mr. Hare does not consider it would be judicious to allow the Collector to make a full record-of-rights in water, such as is prepared for land. He apprehends that the record would be too complicated. But he considers that

a record should be prepared which would show the facts ; and that, when disputes arise, the Collector should have power, on application of the parties, to give an *ad interim* order which should remain in force until set aside by a decree of the Civil Courts. On the other hand, Mr. Oldham, and other officers of considerable authority, such as the Hon'ble Mr. Bourdillon, Mr. Macpherson, Mr. Finucane, Mr. Maddox, and our local member Mr. Allen, consider that it would be decidedly advantageous to have prepared a record-of-rights in water, no less full than the record-of-rights in land. There is said to be no legal obstacle to the preparation of such a record; and the chief reason why it has not been done seems to be, that the work of preparing the record for land alone has been as much as the existing staff and establishments entertained for the purpose could cope with. The landowners, no less than the officials whom we questioned on the subject, agreed that, if the power of deciding disputes, with reference to the exercise of or encroachment on rights in water, were exercised by the Collector instead of by the Civil Courts, nothing but good would result. We think, then, that at least in all districts, or parts of districts, in which the maintenance of private works of irrigation is neglected owing to the non-observance of customary obligations, or where disputes frequently arise owing to the misuse or misappropriation of water, full records-of-rights in water should be prepared with the least practicable delay; and that the Collector should be given, for the enforcement of the rights so recorded, not less authority than he has for the enforcement of rights in land. We consider also that power should be given to the Collector to compel the owners of a *pain* to build a proper masonry sluice at its head, wherever there was reason to believe that more water was entering the *pain* than was its just share; and, in the same way, that the Collector should have power to force any landowner to build a masonry outlet in the banks of the *pain* for his irrigation channel, when he was evidently taking more than his just share of the water. Another point brought to our notice is the difficulty experienced by any one in taking a water channel through the land of another owner who may object to give a right of way. We think that some power of compulsorily acquiring a right of occupation, similar to the provisions relating to the construction of water-courses in the Northern Indian Canal and Drainage Act VIII of 1873, should be conferred upon the proper authority.

Section IV.—BIHAR, NORTH OF THE GANGES.

418. *Irrigation in Northern Bihar.*—The four districts of the Patna Division north of the Ganges are Champaran, Saran, Muzaffarpur, and Darbhanga. They consist of 12,168 square miles and have a population of 9,867,373, or 800 to the square mile. This tract is, as we have already observed, liable to frequent and serious drought. Between the years 1873-74 and 1899-1900, it suffered from two famines, and from two scarcities sufficiently severe to require an appreciable expenditure on relief operations. In 1896-97 the famine expenditure amounted to 85 lakhs. The scarcity of 1888-89 cost $4\frac{3}{4}$ lakhs ; and that of 1891-92, nearly $2\frac{3}{4}$. The severity with which the effects of drought are felt is attributable largely no doubt to the density of the population, a considerable proportion of which subsist from hand to mouth, and suffer accordingly whenever the crops fail seriously and prices rise high. The occurrence of three droughts within the last fourteen years demonstrates the variability of the seasons in a most striking manner, and suggests the inference that irrigation works are likely to be of considerable value as a means of protection. In this tract the only State irrigation work actually in operation is the small Madhuban Canal, in the Champaran district, drawn from the Teur river over which a weir is built. It is $6\frac{3}{4}$ miles long, and, on an average, irrigates annually 4,126 acres. It has cost up to date Rs. 78,546, of which Government has paid only Rs. 6,881, the balance having been subscribed by the landowners who benefit by it. The annual cost of maintenance is Rs. 7,495, but the Collector reports that the arrangements for irrigation are very unsatisfactory. Water is given free of charge to the rayats. This small work requires no further notice.

419. *The Tribeni Canal.*—Although the rainfall of Tirhut, north of the Gandak, is rather heavier than that in the lands further south, it is in the former that the effects of drought have been most severely felt; owing, we were told, to the fact that rice is more exclusively cultivated in the northern part, while further south other produce is raised requiring less water. Attention then has been chiefly turned to the irrigation of Northern Tirhut. We take first the district of Champaran, which is divided into two distinct parts by the river Sikrana, flowing from the north-west corner in a south-easterly direction. To the north of this river the slope of the country is from north to south, and the soil is clayey and well adapted to rice cultivation. A considerable proportion of the northern part is already irrigated. To the south of the Sikrana the general slope of the country is parallel to that of the river. The soil consists of fine light sand and clay, and is often impregnated with saline matter. The cultivators in this tract object to irrigate their land, on the ground that once irrigated it always requires irrigation. They seldom even irrigate from wells, although in the dry season the water surface is only 12 feet below the surface. This seems to indicate that this tract does not often suffer from drought. On its north-western border the district of Champaran is bounded for some miles by the Gandak, one of the few great rivers of Bihar which, like the Ganges and Gogra, are fed from the snows, and the volume of which is therefore absolutely reliable. A very large project, embracing canals from the right and left banks of the Gandak, which were intended to irrigate over 2 million acres, was seriously considered thirty years ago, and attention was called to it again in the report of the Famine Commission of 1880. The much smaller project known as the Tribeni Canal may be regarded as part of the original left bank canal. Earthwork was begun upon it as a famine relief work in 1897, and it was finally sanctioned on the 7th March 1901. The works are now being constructed.

420. The canal is to be taken from the left bank of the Gandak near the frontier of Nepal, and to run parallel to the foot of the hills in a south-easterly direction, irrigating from its right bank the country lying between it and the Sikrana river, and commanding an area of 427 square miles. It is designed for a discharge of 2,170 cusecs, and the area to be irrigated each year is estimated at 114,000 acres. The sanctioned estimate is Rs. 37,91,789. As it will directly cut across all the numerous torrents which flow from the Nepal Hills south to the Sikrana, the canal must be an expensive one. Its gross revenue is estimated at Rs. 2,45,000, in addition to Rs. 42,750 on account of enhanced value of land revenue. If these figures prove accurate, the capital cost per acre irrigated will be Rs. 33, that of the Sone Canals being Rs. 58. The economy in this case is due to no provision being made for navigation, and to the simple character of the head-works, as a weir across the Gandak is thought to be unnecessary. The canal could be extended by dropping it into the Thatharia river and taking it off again lower down, so as to water 115 square miles lying to the west of the Tilari river. We recommend that this extension should take place, and at our suggestion the Government have approved of the masonry works now under construction being enlarged, so as to allow of an increased volume being passed down the canal whenever it may be necessary. We do not doubt that in time the cultivators will learn to appreciate this canal as much as they do those of the Sone, and that it will prove in every respect a most valuable protective, perhaps even a productive, work.

421. *The Dhaka Canal.*—The only other State irrigation work now under construction in Tirhut is a small one known as the Dhaka Canal; the water of which is to be drawn from the Lal Bakhiya river, of which the minimum discharge in October is stated to be 300 cusecs. The estimated cost of this canal is Rs. 2,93,145, the area to be irrigated in the Dhaka Sub-division, 13,500 acres, and the revenue ultimately to be gained, Rs. 34,250. It is proposed to begin by charging a water rate of Re. 1-8-0 for rice and Re. 1 for the *rabi* crop. The canal was sanctioned in 1901, as a famine protective work.

422. *Torrents from Nepal.*—The torrent streams that issue from the lower Nepal Hills are subject to the disadvantage that the Nepalese have

it always in their power to dam up the channels and use the water for their own purposes. Nor can they be blamed for so doing, provided they do not waste water. But this being the case, it is only the larger streams, which they cannot entirely stop, that are worth examining for irrigation purposes. Of these there are three in Champaran—the Tilari, the Pussa, and the Bakhiya rivers—projects for the utilization of which are now under consideration. These streams were said to have a minimum discharge in October of 200, 150, and 200 cusecs respectively. But gauge observations taken for our information in 1901 and 1902 show that throughout September in the first of these years the discharges were so low as to be practicably valueless, and that they were little better in the following years. Here, as on the Sone Canals, the crucial time for irrigation is the *hathia* in October; and if a certain supply cannot be guaranteed at this period, it is no use proceeding with these projects. Mr. Bernard, the Collector, bears testimony to the value that these irrigation schemes would be to the district; to the urgent need of artificial irrigation owing to the irregularity of the rainfall in October; and to the eagerness of the rayats to obtain water. But in view of the liability of the supply to fail utterly when it is most wanted, we cannot regard these projects as sound. It is, however, possible that relief labour might be usefully employed in excavating channels or *pains* taking off from these rivers, similar to the work referred to in paragraph 430 *infra*.

423. *Irrigation in Muzaffarpur.*—The district of Muzaffarpur is an alluvial tract of the greatest fertility, but subject to the drawback that, in parts, the rice cultivation is so highly developed that the failure of that one crop results in a heavy calamity over a considerable tract of country. The district is well watered; it has large expanses of swamp and *jhil*, and is crossed by numerous streams running diagonally from north-west to south-east, and connecting with the great boundary rivers,—the Ganges, Gandak, and Bagmati. From these streams a good deal of irrigation is carried on, and in the rains they flood the country far and wide.

424. *The Bagmati scheme.*—In this district a more considerable scheme than those dealt with in paragraphs 421 and 422 has been under consideration. The Bagmati is a much larger river than the Bakhiya; and in 1876 it was proposed to throw a weir across it, and to construct a canal calculated to irrigate 152,000 acres of *kharif* and 50,000 acres of *rabi*, at a cost of 41 lakhs. This scheme was rejected by the Government of India, but was revived on a smaller and less ambitious scale after the famine of 1896-97, and work was proceeded with for famine relief. A detailed project was then prepared for a canal to cost 9 lakhs omitting the weir over the river. This was condemned by Mr. Buckley, the Chief Engineer, who considered, as his predecessor Colonel Haig had done twenty years before, that a weir and proper regulating head sluices were quite indispensable; and this brought the question back to the estimate of 41 lakhs which had been rejected in 1876. For any project of a smaller scope the construction of a weir could not be justified. It seemed evident, however, that the larger work could never be remunerative; while, in the opinion of the Lieutenant-Governor, the arguments which had been advanced in its favour as a purely protective work were not sufficiently strong to warrant its execution.

425. This opinion we are inclined to accept, but with some reservation. The papers indicate that the project is likely to cost between 40 and 50 lakhs, but that the average gross revenue will amount to 1½ lakhs only, of which 1 lakh will be required for working expenses. Taking interest charges at 5 per cent., a rate which allows for interest during construction, the work is likely to impose a permanent charge on the State of between 1½ and 2 lakhs per annum. A Collector of long experience in this district considers that the probable cost of providing famine relief, within the tract which the canal would protect, is equivalent to an annual charge of Rs. 25,000. Such an estimate must be necessarily speculative; but if the cost of relief is no greater than this, we cannot but agree that it is not worth while for the sake of avoiding it to incur a permanent charge of 1½ or 2 lakhs. We are unwilling, however, to believe that it is hopeless to anticipate a higher average gross revenue than 1½ lakhs

from a work which is capable of irrigating 200,000 acres, or an all round rate of only 12 annas per acre. It may not be possible to realize a higher rate than this in a district which can do so well without irrigation in years of ordinary rainfall, or in three years out of four. But after the experience gained on the Sone and Orissa Canals, we think that it should be possible to educate the people in the value of protective irrigation; and to induce them, within a reasonable period, to take long leases at rates not lower than those which are now realized on the latter canals, where irrigation is certainly not more valuable than it would be in Muzaffarpur. If the canal can be relied on to give unfailing protection to 200,000 acres in a year of drought at a capital cost of 50 lakhs, it cannot be regarded as very expensive; and if it were possible to increase the gross revenue within a reasonable time to 2½ lakhs, involving an all round rate of only Re. 1-4-0 per acre on the whole area that can be irrigated, we think that the construction of the work would be justified on account of its protective value. We recommend, therefore, that detailed estimates should be prepared, although it may be advisable to defer its execution pending completion of the Tribeni Canal, and of the smaller experimental project in Darbhanga referred to in paragraph 429 below, when a better idea may be formed of the revenue which may be expected from works of this class. If this be done, and the estimate is generally approved, the work will be available for the employment of relief labour. We are not satisfied, however, that the smaller scheme of 1896 should be wholly condemned; and we think there may perhaps be a good case for completing it as a district work as proposed by Mr. Disney, the District Engineer, either at once or whenever it may be necessary to employ relief labour.

426. *Irrigation in Darbhanga.*—The physical characteristics of the Darbhanga district resemble in many respects those of Muzaffarpur. Numerous streams flow into the district from the Nepal hills, and south of the boundary stretches a broad belt of rice land. The whole of the district north of the Bagmati river was severely affected in the famine of 1896-97. There were, however, four tracts which escaped the effects of the drought, and in three of these the escape was due to irrigation from the rivers running through it. The fourth was a *rabi* tract. In this district two projects have been brought before us—the Dous and the Kamla irrigation schemes.

427. *The Dous project.*—The Dous is a minor river that flows from Nepal into the north-west corner of the district—a tract which was severely affected by the famine of 1897. There are no records of the discharge of this river, but it is known that it is dammed up by the Nepalese after November. If a volume of from 125 to 250 cusecs could be counted on during the *hathia*, an area of from 6,000 to 12,000 acres of rice might be watered. The evidence before us was, however, to the effect that although in ordinary years the rayats might take the water, they would certainly object to paying for it. There is no more to be said of this project, except that here, as elsewhere, measures should be taken to learn exactly what volume can be counted on in the rivers at all seasons.

428. *The Kamla project.*—We shall have occasion to refer below to the excellent work done on the river Kamla, by Mr. R. S. King, a sub-manager on the Darbhanga State. We have had to consider whether operations should not be entered on here, on a scale more extensive and more permanent than can possibly be secured by works of this kind, the success of which depends so much on the personality of a single individual. In 1877 a scheme was drawn up for providing irrigation from this river by a main canal 12½ miles long, with three distributaries, to command an area of 460 square miles. The cost of the project, which was carefully worked out, was estimated at Rs. 10,41,000 and the area likely to be irrigated at 52,500 acres. From the actual results obtained by Mr. King, it is safe to count upon this estimate of area being realized, at least in years of deficient rainfall. In the matter of supply, requirements will be satisfied if water can be obtained up to the 15th October; and the estimate made by the Chief Engineer when the project was prepared, was that up to that date 600 cusecs would be obtainable in the driest years, and 900 cusecs in ordinary years. It is also established

that the river is too large to be dammed up in Nepal before that date. There seems, therefore, to be no reason to apprehend that the supplies will ever fall short of requirements. As regards the demand for the water, there is no doubt that it would all be taken up in a year of drought. Such years occurred in 1888-89, 1891-92, 1896-97, and 1901-02. In the last two years the willingness of the people to take the water was fully demonstrated. It may be concluded that they would be certain to take it at least once every four years. How far they would take it in other years is a more difficult question. Mr. King and the District Officers entertain serious doubts whether they would take the water at all.

429. The arguments for and against the execution of this work are very similar to those which we have considered in the case of the Bagmati. In both there appears to be a water-supply that can be relied on—a point which, however, should be further established by a systematic record in future of September and October river discharges; and in both the estimated capital cost in relation to the acre to be protected is very low, or little over Rs. 20 per acre. Both works will have a considerable value, but both will entail a heavy permanent charge on the State, unless a higher revenue can eventually be obtained than that which the local officers now anticipate. But there is this difference, that the Kamla is only about a quarter of the size of the Bagmati, and its construction will, therefore, involve a much smaller financial risk. For this and other reasons, we recommend that a detailed estimate of the Kamla scheme should now be prepared; and that if the cost per acre is not much greater than now anticipated, or not more than Rs. 25 per acre, it should be sanctioned, and put in hand as soon as funds can be made available. We may observe that Mr. King has recommended that the western channel should be located three miles further to the west, where it will be less liable to injury from floods, and will command a greater area. In view of the severe distress to which these densely populated districts of Northern Bihar are subjected whenever there is a failure of the autumn rains, and of the means of reliable protection that are available, we are unwilling to admit that the cost of protection will exceed its value until the matter has been put to a crucial test. Such a test the construction of the Kamla project will afford at a moderate cost.

430. *Private irrigation works.*—In these districts, as in those south of the Ganges, a good deal of irrigation is carried on from *pains*, the property of the landowners. One satisfactory instance was brought to our notice of a *pain* made from the river Musan, in the north-western corner of Champaran. It was dug as a famine relief work in 1897, and since then has been under the charge of Mr. Sealy, the District Engineer. It irrigates an area exceeding 10,000 acres, in a strip of land about 15 miles long, and 3 or 4 miles in width. The necessary silt clearance and other minor repairs are done entirely at the cost of the cultivators who pay a cess on the area irrigated. Mr. Sealy makes a yearly budget of his requirements, and divides it proportionately among the cultivators, who pay in their money to the Collector. The amount is about 2 or 3 annas an acre; and at the end of the year the Collector has generally a surplus to be carried on to the next. Mr. Sealy says the system works without any trouble, and he would not hesitate to apply it to masonry works, were it found desirable to construct them.

431. Under the enlightened orders of His Highness the Maharaja of Darbhanga private irrigation works on a much larger scale have been carried out with great success by Mr. R. S. King, who has skilfully utilized the water of the Kamla river. In May 1897, Mr. King spent about Rs. 10,000 in channels and temporary dams, diverting the Kamla water to the east into old channels of the river, from which it could be carried by *pains*, or village channels, into adjacent rice lands. In this way he saved 22,000 acres of rice. Again in May 1901, he added a fresh channel 1½ miles long, and in the scanty rains of that year he secured the rice crop of 35,200 acres situated in 42 villages. In the November following he made a temporary dam across the river, turning its whole supply into the dry bed of the Jibach river, and secured a good *rabi* crop at an outlay of Rs 4,000.

432. The excellent results attained by Mr. Scaly and Mr. King, and by the managers of other estates and factories, show how much can be done, by active and energetic officers of long local experience, to utilize the available water-supply in seasons of drought by temporary and comparatively inexpensive expedients adapted to the exigencies of the moment. Work of this kind cannot, however, be carried out conveniently through the agency of the Public Works Department. A manager of private estates has a much freer hand in undertaking measures for the benefit of his tenants than can be given to a Public Works officer. If Government make a canal it is expected to pay high compensation for all the land occupied, to provide crossings at all village roads, and to incur charges and liabilities which are really prohibitive in the case of works required to meet temporary emergencies. Above all a direct return of some kind is expected on the outlay, which involves the introduction of a scale of charges, and consequent inquisitorial measures which are certain to be unpopular and also costly. We think it almost certain that a great deal could be done for the protection of these districts at a comparatively small expense, and at a cost that would fall far below the net cost to the State of any ambitious system of permanent works, if in seasons of drought prompt measures could be taken for throwing earthen dams across the principal streams at the earliest possible moment, and for diverting the water through the network of channels already existing, connecting or closing these channels where necessary.

433. *Assistance to District Boards in carrying out relief works.*—In these districts there are able and highly qualified District Engineers, who have held their appointments for years and know almost every square mile of their charges, and on the District Boards there are many European gentlemen of great ability and resource, who have an equally intimate experience of the requirements of the district. With such an agency available, it should be possible to keep up programmes of useful works which should be undertaken at the first warning of a failure of the rains or whenever expedient, and to modify them when necessary according to the exigencies of the moment. We think that a comprehensive survey of the country should be made under the supervision of the District Boards and their District Engineers, with the object of ascertaining the most suitable sites for temporary dams and head-works, and of determining the cuts and channels which should be made for the purpose of leading water on to the lands in years of drought and short rainfall. The Boards, which are at present prohibited by law from undertaking or incurring expenditure on works of irrigation, should be duly empowered to execute such works, whenever, in the opinion of the Local Government, the emergency has arisen, or threatens to arise, which would render such action desirable. We have it in evidence that a certain amount of money could, if necessary, be made available by the Boards for these purposes. As it is, they are not infrequently under the necessity of setting aside, in years of scarcity or threatened scarcity, considerable sums for the provision, in threatened areas, of employment on works which are not always of unquestionable utility. In the year 1901-02, no less than Rs. 71,000 was reserved for this purpose in the district of Darbhanga, in expectation of famine which fortunately did not occur. Had this money been expended in the way which we have advocated, and with the same happy results as have been attained by Mr. King, irrigation might have been provided for between 150,000 and 200,000 acres of winter rice. Such sums as may be allotted by the Boards should be promptly and liberally supplemented by loans or grants-in-aid from Government. And whenever it was shown that the money had been wisely spent, the sanction of Government should not be withheld, even though an immediate and direct return should not be expected. By these measures considerable areas might be protected in addition to those which may be commanded by large works made by Government agency, such as the Bagmati and Kamla schemes; and the cost would, in many cases, impose a smaller burden on the State than would be involved by the construction of permanent works, which, in all probability, can never be made remunerative in districts where irrigation is comparatively seldom required. The help of the District Board and its officers might be utilized in the preparation of a comprehensive programme, for famine relief purposes, of similar works such as *pains*, cuts

connecting rivers and streams for improving the distribution of the rainfall, and for the filling, by means of channels from sluices in the river embankments, of any tanks which can be used for irrigation, and of the depressions and swamps, known as *chaurs*, which hold water essential for the rice crop in the low-lying parts of the country. For this purpose it would be necessary to give the District Engineer the help of a special staff and establishment.

434. *Question of an irrigation cess.*—But although we consider that in granting money Government should not insist, as a *sine quâ non*, on an immediate return, we are strongly of opinion that efforts ought to be made to obtain, both from owners and occupiers, some equitable payment for the undoubted benefits which they will derive from the proposed works. As regards the occupiers, we have it in evidence that in years of scarcity and short rainfall they might pay as much as Re. 1-8-0 or Rs. 2 per acre irrigated. Such a return would go far to cover the actual outlay on works as successful as Mr. King's. But if the cautious views of the Local Officers are accepted, there would be little return in ordinary years; and when the expenses of collection, which might be heavy, are deducted, there would remain little to cover the cost of maintenance, which, despite the more or less temporary character of the proposed works, it would be necessary to incur. Nor should the proprietors of estates benefited be exempted from contributing a fair percentage on the cost of the works, or an adequate guarantee for its repayment. The mode of obtaining such a return or guarantee from proprietors has been much discussed by us in the course of our inquiries, and unfortunately presents many difficulties.

435. These difficulties were recognized by some of the representatives of the planters who came before us; and it was suggested that they might be met by the imposition of an irrigation cess on the whole district from which a fund might be formed for the maintenance of protective works, and the payment of a moderate rate of interest on the capital provided by Government. It was contended that the district as a whole benefited by works which reduced distress in seasons of famine; and that the cost of assessing and collecting a water rate on the particular lands to which water might be supplied in each season, would form a very high proportion of the amount collected, and would be very unpopular. Mr. Hare, the Commissioner, recognizes the objection to a water rate in districts in which the demand for water is so intermittent, and proposes a small annual cess, which, however, would be limited in its application to the areas actually protected by the works. He writes—

> I would recommend definite recognition and acceptance of the principle that, in the case of schemes in which the demand for water is intermittent and consequently the receipts for the sale of water are irregular and uncertain, a cess should be levied on the lands protected by the scheme—
>
> (*a*) The benefits are so great as to recover ample return to the cess-payers.
>
> (*b*) The payment is in the nature of an insurance against failure of crops and famine which should be borne by the areas protected.

The proposal to levy a cess over a whole district or portion of a district, in consideration of benefits conferred on a limited number of owners, is, in our opinion, quite inadmissible; but we think that there is a great deal to be said for Mr. Hare's proposal. The advantages of such a system, in the particular circumstances under consideration, are so obvious that it is unnecessary to dwell on them. We apprehend that a cess could not be introduced without legislation, but we think that there may be a sufficient strength of public opinion in favour of the proposal to justify legislation. The rate of the percentage to be paid on the capital advanced will be a matter for consideration; but inasmuch as protective works in these districts are never likely to be directly remunerative, we think that Government may well be contented with a percentage less than the market rate of interest, or no higher than that which would be deemed sufficient to justify the construction of ordinary departmental protective works in the districts standing in equal need of protection. The agreement would ensure to Government a certain and regular revenue in return for the outlay incurred; but it would have an even greater value in preventing expenditure on speculative and ill-considered schemes, which may

otherwise be put forward without any sense of personal responsibility on the part of their advocates. It is of course true that, in the case of a failure or abandonment of the works, the cess could no longer be enforced ; but the risk of such failure must always be run in the case of protective works. The cesses would be credited to the district funds, and the management and maintenance of the works would be under the control of the District Boards. The Board would also be responsible for the payment to Government of whatever interest charges may be imposed.

436. These proposals would be equally applicable to the case of permanent irrigation works, such as the Kamla Canal, which it may hereafter be decided to undertake, if the proposed system of management is likely to be more suitable than departmental administration. We make them with some diffidence, and without any attempt to discuss all the details, but we think that they are likely to afford the most satisfactory solution of the problem of famine protection in these districts. It may be added that, if they are once successfully established, very useful proposals are likely to be formulated for works to be included in the programmes of famine relief works. We do not recommend, however, that any cess should be levied in respect of expenditure on such works, when undertaken *bonâ fide* for the purpose of affording employment during famine.

437. *The Saran district.*—There remains to consider the Saran district, covering an area of 2,650 square miles, with a dense population of 2,409,509 or 947 to the square mile. Like other districts of Northern Bihar, Saran has a large community of English planters from whom we received much valuable information. The rainfall in Saran is about 45 inches. The cultivators are said to be the best in all Bihar. There is practically no waste land, nor do they confine their attention entirely to rice cultivation. Indigo and poppy are extensively grown, and a large area is under well-irrigation. The district has never supported itself, and in the best of years there is a large importation of grain. The inhabitants migrate annually in large numbers to seek employment, and send or bring home very large sums saved from their earnings. At first sight then, it is not evident why there should be any great need for famine protection in Saran. Yet in 1874 there was a famine expenditure here of Rs. 24,40,552, and in 1896-97, of Rs. 9,26,107. Figures so large as these claim earnest attention.

438. *The Saran Canals.*—Saran lies in the *doab* of the Gogra and Gandak. The latter river forms its boundary for the whole length of the district. Its tendency in flood is to spill over its right bank southwards ; and, were it not for a massive embankment on this side, Saran would be subject to devastating floods. This embankment was made many years ago and was taken over by Government at the end of the 18th century. While it protects Saran from floods, it deprives it of any advantage it might have from employing the Gandak for irrigation. To meet this difficulty it was agreed, between 1877 and 1880, to make five sluices in the Gandak embankment, and to connect them with four existing drainage courses flowing through the district, so as to allow of the Gandak water flowing freely down these channels from which it might be lifted on to the fields. The estimated cost was Rs. 4,63,805 ; and Government agreed to advance this sum provided those concerned agreed to pay interest at the rate of 4½ per cent. The actual capital cost, direct and indirect, has amounted to Rs. 7,06,560. A guarantee for Rs. 21,750 was given and for some years was paid ; the guarantors being chiefly indigo-planters, who thus obtained an insurance against the loss of their crop from drought. In 1884-85 the works were said to have irrigated as much as 21,000 acres. The contract with the indigo planters terminated in 1890, and Government demanded a higher guarantee which the planters refused to give. After that various plans were tried, but none gave any satisfaction ; and since January 1898 the sluices have remained closed. It is evident that the irrigation was never on a satisfactory footing. From the evidence that was laid before us we think there is a strong general desire among the agriculturists of Saran to have irrigation both for *kharif* and *rabi*. This is probably due in some measure to the large number of English landowners in the district. The conditions have no doubt altered considerably owing to the serious falling off in

indigo cultivation, but the members of this class still recognize, more fully than the native landowners, the great value of an insurance against drought.

439. Before Government can come to any conclusion on the subject there are two points to be determined:—

First.—What would it cost to ensure to the Saran district a water supply of, say, 2,000 cusecs in the *kharif* and 1,000 cusecs in the *rabi*?

Second.—What financial arrangement could be made for recovering at least some return for the outlay?

440. The supply through the sluices of the Gandak embankment does not proceed directly from that river itself, but from a bye-channel, which, if the main stream of the river were to go over to the left bank, might be left high and dry. The certainty of being able to get water when it is wanted should be put beyond all doubt. Elsewhere it has been generally found wasteful to fill natural drainage lines, and draw from them on to the fields. It should be considered whether it would not be better to abandon these old channels, and form a regular system of new distributaries, connecting with the sluices in the embankment, just as the old *pains* in Shahabad have been displaced by the distributaries of the Sone Canal. Before proceeding further we think that Government should have before them a detailed project embracing these and other points.

441. *Proposed cess, Saran Canals.*—The second question, how a return can be obtained for the money spent, is a more difficult one than the first. The Saran district is but a short way removed from Shahabad, and we have seen how there the cultivator takes his water from the Sone Canals year after year, be it wet or dry, and pays his water rate without difficulty. We are not persuaded that the same might not occur in Saran; but unfortunately our evidence is to the effect that, perhaps once in four years, the cultivator may be glad to have water and to pay a rate for every acre he waters, but that in other years he will not take it. On this evidence, speculative as it is, and considering that the irrigational requirements of Saran are not of the first urgency, we cannot recommendthat Government should embark on a larger capital outlay in that district, on the security of being recouped by water-rates alone.

442. The alternative proposed by the planters is the levy of a small cess over the whole district. We have already referred to this as a general proposal for North Bihar; but special arguments have been brought forward in favour of its adoption in Saran, and it has in fact been strongly supported by Mr. Growse, the late Collector of the district. The landowners of Saran already pay a cess under the Bengal Embankments Act for the maintenance of the river embankments. And it is contended that, however beneficial these embankments may be in protecting the districts from floods, their construction has involved a reduction in the water-supply formerly drawn from the Gandak, and also a fall in the spring level of wells over the greater part of the district; and that the cost of the necessary remedial measures is as fair a charge on the whole of the district as the cost of maintaining the embankments. It is claimed that almost the whole district would benefit by the works proposed, either directly from irrigation, or indirectly by the rise in the spring leve land by the greater protection that would be afforded against famine. Stress was also laid on the economy with which such a cess would be collected; while the cost of assessing and collecting a water rate would form a high proportion of the amount collected, and be a very unpopular tax. We consider that here the proposal for a general cess must be regarded as inadmissible; and that the most that can be proposed is a cess limited, as suggested by Mr. Hare, to the lands protected by any scheme that may be proposed. We may add that the Honourable Mr. Bourdillon, Mr. Slacke, and Mr. W. C. Macpherson, all officers intimately acquainted with Saran, pronounced most decidedly against any proposal for placing a cess on the whole district; and that indeed the two first of these questioned the benefit to be derived from giving any irrigation at all to so flourishing a district as Saran. We are unable to record any definite opinion on this point until we know what the cost would be of supplying the irrigation.

443. It may be said that the failure of the arrangement described in paragraph 438 shows that a voluntary cess, such as we have recommended, may be expected to break down in practice. Apart from the fact that the original agreement expired after ten years and that its renewal could not be enforced, there were special reasons for the failure. The works, as actually constructed, appear to have been of little real benefit; and it is doubtful whether the protection afforded was equivalent to the charge made for it, except in the year 1884. Those who were most interested had little or no voice in the management, which was entirely under the Public Works Department, although a work of this kind was one for which departmental management was very unsuitable. The guarantors complained that many of the provisions of the agreement had not been duly observed by Government, and that they were asked to renew on terms much less favourable than those of the original agreement. The evidence and papers on this subject indicate that there were faults and mistakes on both sides; but we do not think that the arrangement was in principle unsuitable, or that either a water rate assessed on the area irrigated in each season, or a compulsory cess on the whole district, would have been a more workable or appropriate arrangement.

Section V.—CHOTA NAGPUR.

444. *General conditions.*—This province is of a totally different character from that of the Bengal plains. Geologically it is of gneiss formation, and consists of broken hilly country, much of it at an elevation exceeding 2,000 feet. The British portion of Chota Nagpur consists of five districts enclosing an area of 27,000 square miles with a population of 4,900,429 or 180 to the square mile. The population, chiefly aboriginal Kols, are poor cultivators, backward and scattered. Much of the province is under forests, and, as in the neighbouring parts of Orissa, *mahua* and other forest produce form a very important part of the food of the poorer classes in ordinary times, and go far to help them when the rice crop fails. The Tributary Native States, which in general lie to the south and west of the British districts, are still more backward and thinly peopled. They cover an area of 16,027 square miles with a population of only 890,834, and consist of a confused mass of hills, ravines, and plateaux. A large area is covered with valuable *sál* forests, and they contain much mineral wealth still undeveloped. The annual rainfall of Chota Nagpur generally exceeds 50 inches, and even in the driest year, only in one district has less than 35 inches ever been recorded. Failure of crops then can hardly be attributed to want of rainfall, but to its not falling at the required season; especially when it ceases as early as the middle of September, the October rainfall being of exceptional value. The assurance given by artificial irrigation to the success of the rice crop is highly appreciated; while the District Officers estimate that even in ordinary years the produce of irrigated rice lands is 25 per cent. more than that of unirrigated.

445. Chota Nagpur is not a province in which great irrigation projects could ever be carried out. There exists everywhere a system of damming up valleys by a succession of *bands* from 8 to 10 feet high, thus forming small tanks or *aharas*. These are not generally supplied with masonry sluices, but the water soaking through them serves to irrigate rice patches on the downstream side; while, in the bed of the tank itself, as the water is drawn off, wheat or gram are sown in the moist ground, and a good *rabi* crop is obtained. There are many thousands of these *bands* and *aharas* throughout the province, and we had universal testimony that they are everywhere neglected. The beds of the *aharas* are silted up. The *bands* are worn down and out of repair. In the repair of these *bands* and the increase of their numbers lies the advancement of irrigation in Chota Nagpur. In this undulating tract, with its copious if irregular rainfall, there must be numberless small streams the waters of which could be dammed and diverted into tanks, and utilized in saving the crop at critical seasons. Our evidence indicates that the construction of smaller works of this kind has led to an increase in the value of produce, and to a rise in rents which has rendered the expenditure highly remunerative; and we have no doubt that this will generally be the case where the works receive the personal attention of a capable manager.

446. *Obstacles to extending irrigation.*—An initial difficulty connected with the construction of protective works by the State is that Government will not be able to secure any return on its expenditure in the form of an occupiers' rate, such as is levied on large irrigation works but is quite unsuitable for works of the class proposed. This is of little importance in the case of lands of which Government is the proprietor, as it can derive, at any rate at the next revision of settlement, a return on its expenditure in the form of an enhancement of rents proportioned to the benefit which the lands will receive from the works. But in the case of permanently settled lands Government will get no return at all, and for improvements in these lands reliance must be placed on the efforts of either the landowners or the tenants; and it is on their efforts that the extension of irrigation in Chota Nagpur must to a very considerable extent depend. The chief obstacles are the impecunious and improvident character of the landowners, and the unprotected conditions under which the tenant holds his land. To deal first with the tenantry. There is as yet no tenancy law in Chota Nagpur, and every tenant is virtually a tenant-at-will, his rent being liable to enhancement at the caprice of his landowner. The introduction of some kind of tenancy law appears to be eminently desirable. The Commissioner, Mr. Slacke, is, however, not prepared to recommend that the precedent of Bengal should be exactly followed; and he considers that a temporary exemption from enhancement of rent on account of improvements executed by the tenants would, in the circumstances of the province, be sufficient for the present. The point is not one on which we need offer an opinion. But exemption for a period sufficiently long to make it worth while for the tenant to improve ought to be given. Mr. Slacke has little hope of inducing the landowners to execute improvements. But Mr. Lyall, the Deputy Commissioner of Palamau, takes a more hopeful view as regards his district, and believes that he could advance quite a lakh of rupees in it at present, and more hereafter. Mr. Slacke also admits there are a few well-to-do and prudent landowners who might be induced to make improvements if they were supplied with funds by means of *takavi*, and believes that in his division he could distribute fully four lakhs a year. Advances should, we think, be freely made, and on liberal terms.

447. *Irrigation in Estates.*—One peculiar feature of the division is that two-thirds of it is under Government, either as proprietor in the case of Government Estates, or as Manager in the case of Encumbered Estates or of Estates under the Court of Wards. In all three classes of estates, much more might apparently be spent than at present on useful works of irrigation. In the case of Government Estates the tenants have been granted a settlement, and it has been thought undesirable to enhance rents prior to its expiry. Apparently there is no legal obstacle to such enhancement in consideration of increased value imparted to the holding by an improvement executed otherwise than by the tenant; and the propriety of such enhancement has been affirmed in all Indian tenancy laws with which we are acquainted. Moreover, according to Mr. Lyall, the tenants would be perfectly willing to pay the enhanced rent for the sake of irrigation. In these circumstances there would seem to be no impropriety in the levy of an enhanced rent on so much of a tenant's holding as is found to have received benefit from an irrigation work made or improved by Government on any of its estates. Care would of course be taken not to levy the enhanced rent until the beneficial character of the improvement had been demonstrated beyond doubt. And careful distinction would have to be made between real improvements and those repairs which are required in order to maintain the efficiency of existing works. Scrupulous care ought, in our opinion, to be taken to see that Government does not on its own estates incur, even partially, the reproach of neglecting those repairs of irrigation works for which landlords are liable according to the custom of the country. In the case of Wards and Encumbered Estates, Government is in a position to enhance rents on the tenants with the same freedom as private landowners; and in the former, as on its own estates, Government should execute without hesitation or delay such improvements as a solvent and prudent landlord would be willing to undertake. On Encumbered Estates the assets are, according to our evidence, at present administered with the sole object of clearing off the liabilities within the shortest possible period, and any scheme which does not provide for

clearing them within fifteen years is generally rejected by superior authority. According, however, to the provisions of the Encumbered Estates Law regarding appropriation of the assets, full equality, if not actual priority, is given to the execution of improvements over the clearing of the liabilities; and this provision would seem to justify a liberal expenditure by Government on the execution of improvements out of the revenues of Encumbered Estates while they are under management. If these principles are accepted, it is clear that there is a considerable field for the improvement of irrigation in Chota Nagpur by Government in its capacities of landlord and manager. And if our views of the duties of Government are accepted, we think that a comprehensive investigation should be made, under competent professional advice, into the requirements of the three classes of estates which we have specified; and that funds should be liberally allotted for such works and improvements as may be approved.

448. *Projects in Palamau.*—Among minor irrigation works our attention has been drawn to five small projects for utilizing the waters of certain streams in Palamau—the driest and probably the poorest district in the province. Two of these projects consist of building a weir across the rivers Nadaura and Piri, tributaries of the Amnat, itself a tributary of the Koil, and of constructing distributary channels. The third is for a weir across the Suddaban, a tributary of the Koil, with a distributary channel. The other two projects are for the construction of two small reservoirs at Pakraha and Dhawadih. Particulars are given below, but it must be observed that the information regarding the discharge of the rivers is very meagre and uncertain :—

Name of project.	Catchment basin.	Discharge available.	Area to be watered.	Total estimated cost.
			Acres.	Rs.
Nadaura . .	8 square miles.	100 cusecs in September; dry in November.	2,700	77,400
Piri . . .	20 „ „	240 cusecs in *kharif* .	12,000	1,77,000
Suddaban .	22 „ „	200 cusecs in December	12,500	1,58,000
Pakraha . .	600 acres.	13½ million cubic feet to be stored.	1,000	39,000
Dhawadih . .	125 „	9·5 ditto . .	108	...

It cannot be pretended that much reliance can be placed on these figures, especially on the discharge of the rivers. The reservoir schemes hardly need further consideration; and all five have such small catchment basins that a failure of rain in the field to be watered must imply a like failure in the gathering ground. It is, however, desirable to see what can be done by diverting flood water by means of cheap weirs, into a succession of *aharas* where it can be stored up for future use. We agree then with Messrs. Slacke and Lyall in recommending that a trial should be made of one of the three weir projects.

449. Of the 2,700 acres to be protected by the Nadaura project only 1,000 acres are Government land; and it has been proposed that the works should be restricted to what is necessary for the irrigation of this land, in which case the cost is estimated at Rs. 37,000. The larger scheme is of course to be preferred if the landowners will contribute a fair share of the cost, failing which the smaller scheme must be considered on its merits with the Piri and Suddaban projects. We should add that the Public Works Officers are less sanguine of the success of these schemes than the Civil Officers, and think that they will often fail to protect the crops at a critical period. This apprehension appears to be based rather on the results of experience on the Sone Canal, and other works in Bihar, than on actual practice in Chota Nagpur, in which there are no departmental irrigation works. The real question is whether the works will increase the security and the profits of cultivation to such an extent as to justify an enhancement of the rents. On this point we attach weight

to the opinion of the Civil officers, and recommend the construction of one work tentatively, or as an experiment which at the worst is not likely to prove very costly.

450. *Korarbar and Karo projects.*—Two other irrigation projects were brought to our notice in Chota Nagpur, the Korarbar and the Karo. The former scheme is to irrigate a gross area of between 40 and 50 square miles on the left bank of the Korarbar, a tributary of the Sone. From the statistics given it is clear that this project is only practicable if combined with water storage, and we have no information before us as to whether this is possible. The information about the Karo is a little fuller. It is proposed to build a weir across the river, about 30 miles south-west of Ranchi (a tract which suffered severely from famine both in 1897 and 1900), and from its right end to construct a canal commanding a gross area of over 200 square miles. From discharges taken it seems probable that 200 cusecs could be relied on in the month of October. We recommend that this project be carefully worked out.

451. *Need for expert assistance.*—It is evident that the irrigational resources of Chota Nagpur have not yet been thoroughly explored. As already stated, this is not a province for large works. We would recommend that for five years an intelligent Engineer should be attached to the Commissioner. His duty would be to put himself in communication with all the district officers and others acquainted with the country, and to submit from time to time projects for improving the irrigation. A budget provision, not exceeding one lakh per annum, might be reserved for the execution of these works, which, if they failed to afford full protection against famine, would at least place the inhabitants in a much better position to combat it.

452. *Relief works.*—The silt clearance of *aharas* and the repair of *bands* afford an excellent form of famine relief labour. It may be objected that this is expending public money on the improvement of private property. Were it a question of repairing a few large reservoirs situated far apart this argument would have force. But where nearly every village has its *aharas*, it is not only their owners that derive benefit from them, for it is the interest of all that they should be in good order. If a contribution can be obtained from the owner it should be taken, but the work should not be allowed to perish owing to his indifference or impecuniosity.

453. *Contrast between Chota Nagpur and Sonthal Parganas.*—In contrast to the unsatisfactory state of affairs in Chota Nagpur it is a pleasure to call attention to the good work going on in the neighbouring district of Sonthal Parganas, regarding which we have received a most interesting note from Mr. H. Macpherson, the Settlement Officer. The progress is due to the energy and power of co-operation of the rayats, and to the judicious course of legislation. Here, as in the neighbouring districts of Chota Nagpur, the landowner does nothing to assist his rayats in improving their lands. But here, at least, he is powerless to interfere. The result of an agrarian agitation in 1873, against the uncontrolled enhancement of rents by the proprietors, was the enactment of a law under which the rentals of the whole district were settled by Government officers for 15 years. At the end of this period they were made subject to alteration, only by the order of the Settlement Officer, and they have practically remained unchanged for 25 years, during which the area of cultivation has risen from 208,178 to 332,832 acres. To quote the words of Mr. Macpherson—

> The land system of the Sonthal Parganas is one which lends itself with peculiar advantage to co-operation amongst the cultivators of the soil. The unit is the village. At the head of almost every village there is a headman. The headman is the representative of the village through whom the villagers as a body deal with the proprietor. The proprietor is merely the rent receiver, and has no part in the management or internal economy of the village.
>
> His interference, if he is at all disposed to interfere, which few landlords in the Sonthal Parganas are, is liable to be checked at every turn by appeal to the local officer, who, besides being the Court of Civil and Criminal Justice to the people, is their active and sympathetic

safeguard against every form of oppression that may be practised by headman or proprietor. The headman is appointed by, and is liable to be dismissed by, the District Officer. Hence it is that in the Sonthal Parganas the village communes, with its headman and elders, flourished with a very strong and vigorous life. The faculty of association and co-operation has been fostered and developed to a degree that is impossible in the ordinary district. It is this facility of co-operation, to which, I think, is chiefly due the very extraordinary utilization that has occurred of the natural irrigational advantages of the district. Works that have been beyond the means and enterprise of the individual cultivator have been successfully carried through by the united efforts of the community, each member of which has shared in the general resultant good; and co-operation has told not only on the work of construction but also on the work of maintenance and repair. By a special provision of the village record-of-rights and duties, which was framed 25 years ago and has now been renewed, it is the duty of the headman and rayats of a village to maintain and repair all the village *bands*, tanks, and other works of irrigation. While speaking of the record-of-rights, I may note another of its special provisions, namely, that without reference to the proprietor any rayat may construct embankments and like works for purposes of reclamation and irrigation, provided he does not thereby cause injury or loss to others. This clause removes the proprietor from interference with the work of improvement, and leaves the individual rayats and the community free to think out and execute their own ideas of improvement.

454. The Sonthal is an active irrigator. As he reclaims land from the jungle he terraces the slopes, throws embankments across the depressions, and dams the streams, thereby diverting the water on to his fields. But Mr. Macpherson seems to think that there is reasonable hope of constructing larger irrigation works than these in this district; and he advises that a qualified Engineer be sent for a year to make a careful study of the ground, decide on the sites for irrigation works, and prepare rough estimates of their cost. When an officer can be spared this would no doubt be a useful measure. The Sonthal Parganas are not in need of much famine protection. In 1896-97 there were on an average 1,790 people a day on relief works. The mean annual rainfall for the last 10 years has been 52·7 inches; the maximum in 1893 was 71·27inches; the minimum in 1895 was 38·96 inches.

Section VI.—GENERAL.

455. *Schemes in Nadia district.*—In the previous five sections we have described those parts of Bengal which we visited, and where there were either existing works of State irrigation, or proposals had been made or cause had been shown for the execution of such works. We have had evidence, however, that in other parts of Bengal there have been occasionally seasons of great scarcity and distress. Perhaps this is most marked in a portion of the district of Nadia with an area of 1,182 square miles and a population of 630,558. Here, in the famine of 1896-97, there were 28,000 people on relief works, and 83,000 receiving gratuitous relief. Regarding this distress Mr. Finucane, the Commissioner of the Division, testifies from his own personal knowledge "that the distress in parts of Nadia, and the failure of the crops there, was far greater than in Saran, and that the people there were quite as impoverished." He called our attention to two irrigation schemes proposed by Rai Bahadur Dwarkanath Sircar, who was for many years Engineer of this district. The first of these schemes is to irrigate the *doab* lying between the Bhagirathi and the Jelungi, by means of a canal about 80 miles long taken from the Ganges. This, it is estimated, would cost about 10 lakhs. It would require masonry head-works, and the people would, it is said, be willing to pay 6 annas per acre watered, per annum. No information, however, is given as to the size of the proposed canal, or the area to be irrigated. The Rai Bahadur's other scheme is for the canalization of the river Bhairub. We would suggest that these projects should be worked out sufficiently to enable Government to decide on their feasibility. They might prove a valuable form of famine relief works: on the other hand, it is right to add that Mr. O. S. Smith, Executive Engineer of the Nadia Rivers Division, pronounces against the practicability of any irrigation works in this district.

456. *Private works in Monghyr.*—Our attention was called by Mr. Williams, Commissioner of Bhagalpur, to an excellent private irrigation scheme in the Monghyr district known as the Gorakhpur Irrigation Work, which was executed in 1875-76 by Colonel Money, then Manager of the Darbhanga Estate, and which

has been of great benefit to a number of villages. We have no information as to the details of the work, beyond the fact that the water is stored in a large reservoir.

457. *Well-irrigation.*—Owing to the absence of statistics it has been impossible to procure any precise information as to the extent of well-irrigation in Bengal. But, from a statement which has been furnished to us by the Director of Land Records, giving an estimate of the probable extent of well-irrigation in the various districts of the Province, we find that, out of a total area of 662,000 acres irrigated annually from wells, 538,000 acres lie in the seven districts of Bihar, and that the three districts of Monghyr, Bhagalpur, and Palamau, account for practically the whole of the balance of 124,000 acres. Even in Bihar the area under well-irrigation amounts to under 0·5 per cent. of the whole cultivated area, against 21 per cent. in the adjoining districts of Ballia, Ghazipur, and Gorakhpur, of the United Provinces. In fact, roughly speaking, at the Gandak river well-irrigation stops. The reason is perhaps not far to seek. Out of the thirty-eight districts of Bengal only eight have a rainfall of less than fifty inches in the year, and of these six are in Bihar. There is not a single district in which the average monthly rainfall does not amount to half an inch or more for eight months of the year; and only four in which it does not do so for nine months out of the twelve. With this abundant and evenly distributed rainfall, there is generally left, in the flat alluvial soils, ample moisture for the growth not only of rice, which is the principal staple crop, but also of large areas of second crops, principally pulses. Moreover, when the rain is not sufficient for the maturing of the rice crop, wells do not provide sufficient water to save it over any large area. On the other hand, the *aharas* and *pains*, where constructed, seem to be fairly effective for this purpose, even in the worst years. The Bengal cultivator accordingly prefers these means of irrigation to wells which, generally speaking, are only used for garden produce, sugar-cane, poppy, and similar valuable crops. Wells are, however, used for the raising of *rabi* cereals in a few localities, particularly in the Sasseram Sub-division of Shahabad, and portions of the Saran district.

458. The usual method of raising water is by means of the weighted lever worked by manual labour. Cattle do not seem to be employed anywhere except in the Sonthal Parganas, where Mr. Macpherson tells us that a few wells are worked by them. As a consequence the areas irrigated by each well are generally very small. Five acres seem to be a large area to be irrigated from a permanent well, and temporary wells sometimes water as little as a twentieth of an acre. Mr. Hare told us of wells in the Saran district which supplied considerably larger areas. But these we gather are the exception. In the market gardening tracts around the large towns, such as Patna, numerous lever wells are dotted about, and in combination irrigate considerable plots of potatoes and other vegetable and garden produce. In the hilly tracts, such as the south of the Gaya district, Chota Nagpur, and the Sonthal Parganas, wells have to be sunk into the rock. But nowhere do they seem to be expensive, or the water to lie very deep. In many parts it lies so close to the surface that temporary wells can be dug for very small sums. Attempts were made in North Bihar, during the famine of 1896-97, to induce the people to dig these wells, but with poor success. In many places apparently the soil is so loose and sandy that wells will not stand without a lining of some sort. For the supply of wells, reliance seems to be generally placed upon percolation from the upper porous strata, and no general attempt seems to be made, as in the United Provinces, to reach the porous subsoil underlying the clay beds, which are no doubt to be found at varying depths beneath the superficial strata of sandy soil. That copious supplies could be obtained in this way is shown by the success attained with tube wells made by the railway company when seeking for a supply in the vicinity of Patna Railway Station.

459. It is not easy to say what scope exists for the extension of well-irrigation in Bengal. Probably little can be done outside Bihar. But, here at least, we have it on the authority of Messrs. Bourdillon, Hare, Macpherson, and other witnesses, that there are many places in which the soil, water-level, and other conditions are suitable for profitable well-cultivation, and to which it has not been extended. The operations of the Opium Department, and in particular those

of Mr. Tytler to which allusion will be found in paragraph 463 *infra*, show that something might be done by the judicious advance of money to small landowners and substantial tenants for the construction of permanent wells. We think that systematic inquiry should be made throughout Bihar, and especially in the western and central portions, with the object of determining the places best suited to irrigation from permanent wells; the possibility of reaching for that purpose the subsoil spring supplies, by penetration of the clay beds; and the feasibility of extending further the practice of irrigation from temporary wells, which has proved in famine years so valuable a resource in the eastern districts of the United Provinces. It would be worth while to depute an intelligent officer of the Agricultural Department to those districts to acquaint himself with the practices there, and to ascertain whether the obstacles to their extension into Bihar are surmountable or not. Experiments based on the information thus obtained might be tried on estates under Government management, where cultivators from the well tracts of Saran or the United Provinces might be given leases of lands, and *takavi* for the construction of wells. It is impossible, on the vague and imperfect information now available, to say what the result of these measures would be. But if it were found possible to teach the Bihar rayats to cultivate *rabi* with profit by means of permanent wells, and by means of temporary wells to save or sow a *rabi* crop in a bad year, a valuable resource would have been found for many of them in times of drought.

460. *Takavi.*—A matter which has hardly been brought to the test of experience in Bengal, is the extent to which the execution of private improvements can be stimulated by advances of *takavi*. The total sums advanced during the last ten years amount to only 10½ lakhs, or about one lakh per annum. Of this total sum Rs. 6,65,000 were allotted for works of irrigation, mostly tanks and *aharas;* and of this Rs. 3,32,000 were distributed during the famine year of 1896-97, and only 3,33,000, or less than 40,000 per annum, during the remaining years. The single district of Gaya accounts for Rs. 2,83,000, of which Rs. 1,04,000 were advanced in the famine year. These sums are extraordinarily small for such a large and populous province as Bengal. The reasons stated are those usually given, such as the unpopularity and cumbrousness of the system, the absence of demand, and the like. We were also told that appreciable discouragement had resulted from refusal by the Imperial Government of allotments applied for by the Local Government. But we fear that a more potent cause than any of these is the usually faint interest taken in the matter, except on the occurrence of exceptional calamities, when large sums are advanced under the Agriculturists' Loans Acts. We have it on the evidence of most competent officers, including our local colleague, Mr. Allen, that much larger sums might be advanced for the construction, repair, and improvement, of wells, *aharas*, and *pains;* and we recommend the general adoption of a more vigorous policy. For remedy of defects in the system we have not many suggestions to make, beyond those put forward in the general chapter on the subject. But we think that powers of granting *takavi* should be conferred as a matter of course on all officers in charge of sub-divisions of districts, and on selected officers subordinate to them. The aid of the more intelligent European planters and landowners might perhaps be enlisted in the distribution of advances. Officers should take money with them on tour, make inquiries and distribute the money on the spot. Where there was reason to believe that large sums could be distributed with advantage, and that the work would be too much for the officer in charge of the sub-division, special officers should be entrusted with the duty. Some use might perhaps be made of the officers of the Opium Department, who have considerable experience in the business of distributing advances and selecting proper recipients.

461. The bulk of advances for the wells and smaller works will be made to the smaller landowners and substantial occupancy tenants. In the case of the former the question of security offers no difficulty. The latter also are protected in perpetuity against enhancement of rent in respect of improvements executed by them. But as, in general, they do not enjoy the power of transferring their land without the consent of the landlord, it cannot as a rule be taken as security for the advance. There will probably be the same reluctance in Bengal as we have found in the United Provinces, to making the tenant's interest

in his holding transferable for purposes of recovery of *takavi*. We know of no circumstances special to Bengal to render inapplicable to it the recommendation which we have made on the subject (I, 181)—that the precedent set by the Central Provinces in this matter should be followed.

462. *Village tanks.*—Throughout Bengal and the eastern districts of the United Provinces, village tanks are formed not, as elsewhere in India, by damming up valleys and holding up water, but by excavation out of the soil, the rain water from the neighbouring ground surface being turned into them. These tanks are no doubt of great value for watering cattle and other domestic purposes; but they are also used for irrigation, and in the climate of Bengal they may be counted on to fill two or three times in the year. The area they command must be very limited, and in drought they are the first to fail. Nevertheless tanks are popular. In the course of years they get silted up, and, except to supply relief labour, it is far too costly an undertaking to clear them out. But silt clearance of such tanks is excellent for purposes of organization in the employment of relief labour.

463. *Mr. Tytler's encouragement of wells.*—We have received a very interesting note from Mr. A. Tytler, C.I.E., who for thirty years was in the Opium Department in North Bihar. He divides irrigation water into three classes according to its merit—

1st.—*Jhil* and tank water.
2nd.—Well water.
3rd.—Canal water.

He places *jhil* water first, on account of the decaying vegetation which it contains and which forms a good manure. Tank water he thinks good "because it receives surface drainage." Well water he thinks good "because it contains in solution fertilizing saline substances" and also "because it is, when used as is usual during the cold weather, warmer than the atmosphere." Canal water is placed last because it contains no fertilizing properties, and is colder than the atmosphere; also because the native cultivator obtains it without personal labour, and therefore pours it recklessly over his crops to their detriment. Mr. Tytler considers canal irrigation in Saran not only superfluous but harmful. He thinks it is only wanted for rice irrigation about once in five years, and he remarks "if used for cereals it is apparently suited for the first year, though each succeeding year the crops become worse, the yield lighter, the soil deteriorating." He adds that irrigation raised the naturally high spring level to near the surface of the ground, which brought on a most fatal fever which disappeared when the irrigation ceased. The mortality of the cattle also, he says, was excessive. Mr. Tytler recommends, then, the multiplication of tanks and wells, the latter in the higher lands at the rate of a good well for every 10 or 15 acres. His personal influence in North Bihar was very exceptional, and he succeeded in persuading the cultivators to take advances *collectively* for masonry wells, that is, "the number of men who would use the well or be benefited by it agreed to repay the loan proportionally according to the area of their poppy fields." By proceeding in this way, in 25 years Mr. Tytler increased the number of masonry wells in his district by 3,705, besides repairing 845 old wells. The amount advanced was Rs. 1,86,695, and, he writes, although "this large sum of money has been advanced to poor cultivators, in nearly every case so poor that no single man could afford to singly take the money, but required to have numerous partners in the undertaking, yet there never has been a single rupee repaid in arrears, nor have I ever had occasion to distrain security." Mr. Tytler attributes this success simply to getting the cultivators to act collectively; and we think the success worthy of record and capable of imitation. The sum advanced by him never exceeded Rs. 60 for a well, the cost of which was from Rs. 100 to Rs. 150, and the wells that were made proved of great benefit to the cultivators for the growth not of the poppy only, but also of other valuable crops.

464. *Famine relief works.*—The Bengal Government have favoured us with statistics concerning the thirty-seven districts or parts of districts which they

consider liable to famine. They embrace an area of 83,459 square miles with a population of 33,567,821, or about 400 per square mile. In twenty-five of these districts the average rainfall of the year exceeds 50 inches, so that in these there is no very urgent need for providing relief works. Provision has been made, however, in each district for the employment for three months of, on an average, 9·3 per cent. of the population of the area affected. The works on the programme are—

(*a*) Railway embankments.

(*b*) District and village roads.

(*c*) Tanks for irrigation and drinking purposes and irrigation channels.

(*d*) Embankments against floods.

Railway embankments could only be helpful to the people in the immediate vicinity of any line proposed, and quite possibly there might be no distress just in that area. Usually the preference is for roads over irrigation works, perhaps, as the Commissioner of Patna remarked, because "the Collector knows roads and not canals." We think this preference often unfortunate, leading to making roads where they are not wanted, and where District funds cannot afford to maintain them. The tanks for irrigation and drinking purposes are merely village tanks, but some of them are of great size, and many were constructed in the famine of 1897. They are of use for watering cattle, and sometimes small plots of land are irrigated on their margins, but they cannot be regarded as irrigation works. We earnestly recommend then that, where irrigation is practised at all, the opportunity of a demand for famine labour should not be lost; but that *pains, aharas*, the embankment and terracing of fields, and every other sort of irrigation or drainage work, should be put thoroughly in repair. Expert knowledge is hardly required for the silt clearance of a tank or an irrigation channel, or for the building of a village *band*. New works of course require more technical knowledge; but no form of famine labour is better, when expert supervision is possible, than the excavation of a new canal like the Tribeni.

सत्यमेव जयते

CHAPTER XIX.—THE UNITED PROVINCES OF AGRA AND OUDH.

(*i*).—*Local conditions; use and value of irrigation.*

465. In considering the value of irrigation in the United Provinces it will be convenient to regard them as divided into four nearly parallel strips, as follows :—

(1) *The sub-montane tract or zone;* a narrow strip, 30 to 50 miles in breadth, extending under the Himalayas, along the whole length of the Provinces.

(2) *The central tract;* lying between the sub-montane tract and the Ganges.

(3) *The Ganges-Jumna Doab;* extending from the foot of the Siwaliks to the Junction of the Ganges and Jumna rivers at Allahabad.

(4) *The southern tract;* lying south of the Jumna river.

Each of these tracts has special characteristics, and requires separate consideration.

466. *The sub-montane tract.*—All the districts in the immediate vicinity of the hills, from Dehra Dun on the west to Gorakhpur on the east, lie wholly or partly within the sub-montane tract, but in most of them the conditions in their southern portions approach those of the second tract. From its situation this zone has naturally an abundant rainfall, and its surface is intersected by innumerable streams. A great part of it is devoted to forests and grazing lands. The population is in most places sparse, and agriculture is in a very backward condition, the progress of the tract being much impeded by its malarial climate. The average annual rainfall varies from under 50 inches along the southern border, to upwards of 70 inches at the foot of the hills. The winter rainfall gradually decreases from 7 inches on the west to about 2 inches in the eastern districts. Rice and wheat are the principal crops. The former is freely irrigated from streams and canals, but the water being near the surface the moisture of the soil is sufficient for wheat and other *rabi* crops, except in the peculiar *Bhabar* tract in the Naini Tal district, where, at the foot of the steeper slopes of the hills, there is a broad talus of boulders and gravel through which the subsoil water flows at a great depth.

467. The chief value of irrigation in this sub-montane tract is the benefit which it affords to the rice crop. Without it the better qualities of rice cannot be grown; and even the coarser kinds are improved by it in almost all years. Serious deficiency of the rainfall is a rare occurrence, but the northern portions of Gorakhpur and Basti suffered severely from this cause in 1873; and both those districts, with Bijnor and Bareilly, are said to have lost all their rice crops in the drought of 1877. The average area sown, in the districts lying wholly or partly within this tract, is about 10 million acres, of which rather less than one-fifth is irrigated in a dry year. One-half of the irrigated area is due to wells, the remaining half being divided fairly equally between Government canals, tanks, and 'other sources.'

468. *The central tract.*—The zone between the sub-montane tract and the river Ganges is the largest of the four tracts into which we divide the Provinces, and it comprises more than a third of the total cropped area. It is composed of Rohilkhand, Oudh, and the Gorakhpur Division, excepting the relatively small portions of their areas which lie in the sub-montane tract, and of the Benares Division, except the portion south of the Ganges. Within this tract the average annual rainfall varies from about 35 inches along the course of the Ganges river, to nearly 50 inches along the southern border of the sub-montane tract. The average winter rainfall (December to April) is approximately 2 inches over the whole tract, varying from $2\frac{1}{2}$ inches in the western to $1\frac{3}{4}$ inches in the southern and eastern districts. Like the sub-montane tract this large area is liable to suffer only occasionally from deficiency of the monsoon rainfall, but the scanty winter

rainfall is generally insufficient to ensure a full outturn of the *rabi* crop without aid from irrigation. Since the end of the eighteenth century there has been no widespread famine affecting severely the whole tract, but the western districts of Hardoi, Moradabad, and Budaun, with the southern portions of the adjoining sub-montane districts, suffered severely in 1837, 1860, 1869, and (excepting Moradabad) again in 1877, when Lucknow, Rae Bareli, Bara Banki, and Azamgarh also suffered severely. In 1896-97 there was famine in Hardoi, severe distress in Sitapur, Lucknow, Bara Banki, Unao, Rae Bareli, Jaunpur, and Azamgarh, with slight distress in every other district except Ghazipur and Ballia.

469. Irrigation is extensively practised from wells, and *jhils*, or natural depressions, which occupy considerable areas in almost every district; rice, wheat and barley, sugar-cane, poppy and indigo, all of which are more or less dependent upon irrigation, occupy about 54 per cent. of the total cropped area; and of an average area of 14 million acres annually under crop in a year favourable for irrigation, 3 million are irrigated from wells, $1\frac{1}{4}$ million from tanks or natural depressions, and over $\frac{1}{4}$ million from other sources; making a total irrigated area of over $4\frac{1}{2}$ million acres, or more than one-third of the sown area. The area irrigated from tanks falls to about half a million acres in a year of severe drought, and of that area a large proportion is insufficiently watered. There are no Government works within this tract, with the conditions of a large portion of which we shall have to deal more in detail, when considering the question of introducing canal irrigation from the Sardah river.

470. *The Ganges-Jumna Doab.*—This tract comprises 13 districts, few of which are not now fully protected against famine by means of irrigation works. As will be evident from a glance at the map of the canal systems of the United Provinces which accompanies this report, almost the whole Doab is intersected by the numerous distributary channels of the Upper and Lower Ganges, and Eastern Jumna Canals; and in addition there are in most districts good facilities for well irrigation, more especially for *kachcha* or temporary wells, for the construction of which the subsoil is, in many parts of the Doab, peculiarly favourable. The average annual rainfall is about 30 inches, and the average winter rainfall about $4\frac{1}{4}$ inches in the north-west at Saharanpur, decreasing to 2 inches at Aligarh, and to $1\frac{3}{4}$ inches east of that station. Out of an average area of about $11\frac{1}{2}$ million acres which are annually sown, over 5 million acres, or nearly 45 per cent., are irrigated in a dry year; and of this roughly one-half is from Government canals, nearly one-half from wells, and a small balance from tanks and other sources. Before the introduction of canal irrigation, the districts composing this tract were among the most insecure in Northern India; and the construction of the Ganges Canal was largely due to the impressions produced by the sufferings of the famine of 1837, one of the most terrible in Indian history. Again in 1860-61 famine was severely felt in the upper portion of the Doab. Since then the country has been protected by irrigation, and although the droughts of 1868 and 1877 were severely felt, there has been no actual famine.

471. *The southern tract.*—The fourth, or southern tract differs entirely, in its geological formation and agricultural conditions, from the three tracts which lie on the northern slope of the Gangetic valley. Those tracts are alluvial formations consisting of layers of loam and sand of varying thicknesses, extending to an unknown depth. This lies for the most part on the rock formations of Central India, and even where its soils are alluvial they are generally of a different character from those on the north of the Jumna. It is naturally divided into two sections, the western section comprising the Bundelkhand districts of Jhansi, Hamirpur, Banda, and Jalaun; and the eastern section, those portions of Mirzapur, Benares, and Ghazipur, which lie south of the Ganges river.

472. Of all portions of the Provinces, Bundelkhand is most affected by the vicissitudes of the rainfall. The annual average is from 30 to 40 inches, but it ranges between the extremes of one-third and twice the normal, and, owing chiefly to the prevalence of black cotton soils, either excess or deficiency may lead to scarcity or famine. The districts of Bundelkhand suffered severely in the famines of 1837, 1869, and 1896-97, and, though with less severity, in 1873 and 1877. Their present condition is thus described by the Hon'ble Mr. Hooper

in his speech at a meeting of the Legislative Council of the United Provinces (19th January 1903) :—

> The crops suffer in years of heavy or unseasonable rainfall as well as in drought, and agriculture is liable to a special form of injury in the spread of *kans*, a grass that periodically overruns the richest soils and renders them for the time uncultivable. The effects of great calamities, such as famine, are far more serious and lasting than in more stable tracts, and recovery is more slow. Bundelkhand is now beginning to recover from one of these disasters, the famine of 1896-97. In that year the cultivated areas were nearly a million acres below the maximum reached in 1882-83, which is a variation of nearly one-third (1882-83, 3,327,842 acres; 1896-97, 2,269,444 acres) ; and this is an example, though perhaps an extreme example, of the great fluctuations to which the cultivation is subject. In some of the years that followed, the seasons were not propitious and it is only recently that improvement has begun. The agricultural loss during a series of bad years has been enormous, and it fell upon a people already deeply involved.

473. The expenditure incurred by Government, including remissions of land revenue and of advances, during the famine of 1896-97 in the four districts of Bundelkhand amounted to over a crore of rupees. One-half of this sum was spent in the single district of Banda, of which at one time over 42 per cent. of the people were receiving relief.

474. The most productive soil in Bundelkhand is the variety of black cotton soil, which is locally known as *mar*. In this, *juar* and wheat are extensively grown, but the soil is so retentive of moisture, and the crops grown on it are so liable to be injured by any excess of moisture, that artificial watering is applied to it only when the rains fail, or as a preliminary to *rabi* sowings when the rainfall is seriously deficient in the later months of the monsoon. Another black soil, known as *kabar*, closely resembles *mar*, but it is of a stiffer consistency and in the *rabi* it is utilized more for the growth of gram and mixed crops than for wheat alone. Water is applied to it somewhat more freely than to *mar*, but in all ordinary years the rainfall of the monsoon provides it with sufficient moisture even for the *rabi* crops. A yellowish red loam called *parwa*, which is found extensively in many parts, is less suited than the black soil to dry crop cultivation, but with the aid of irrigation it produces excellent crops of wheat and barley. There is no question as to the benefits of irrigation in this and similar soils. The crops grown in them benefit by irrigation even in ordinary years, and without it they fail in years of scanty rainfall. The Bundela cultivator has the reputation of being apathetic and wanting in enterprise. He does not take readily to irrigation from wells, or even to the labour involved in lifting canal water a few feet on to his fields ; but, where canal water can be flushed on to the yellow or red soils, he is ready to use it, and to pay for it ; and even in black soil tracts, where the natural apathy of the cultivator is intensified by the ease with which a crop can be raised in a dry year, he is slowly learning to make the best use of the water which the Betwa Canal has placed at his disposal.

475. The second, or eastern, section of this southern tract does not appear to have been visited by actual famine until 1896, and then it suffered with much less severity than the least affected of the Bundelkhand districts. It is however said to suffer from scarcity or distress about once in 20 years. Black soils prevail in the southern portion of the alluvial plain which extends from the foot of the hills to the Ganges river. North of this portion there is a stretch of soil eminently suitable for irrigation and rice cultivation ; and north of this again, is a strip of good alluvial soil which is flooded yearly by the Ganges, and grows excellent crops without irrigation.

476. *Utility of irrigation.*—With regard to the value of irrigation in increasing the produce of land in the United Provinces, it may be said that the millets and pulses, which form the staple *kharif* crops of the western districts and which are largely grown in almost all parts of the province, would derive no benefit from irrigation except in an unusually dry year; rice, the principal crop of the sub-montane and central tracts, yields under irrigation an increased outturn of about 20 per cent. in the former, and 40 per cent. in the latter tract ; the valuable sugar-cane and poppy crops are, in all years, dependent upon irrigation, as is indigo, the growth of which leads to an increased outturn of the subsequent *rabi* crop. Under irrigation, also, cotton can be grown to a sufficient height to enable it to escape injury from the first heavy burst of the monsoon. Of the staple *rabi* crops, gram does not require any artificial watering in ordinary years ; but in the case of wheat and barley irrigation increases the

outturn by 50 to 100 per cent. As to the protective value of irrigation, it may safely be said that, excepting the hill districts and a portion of the sub-montane tract, there is no part of the United Provinces which can be considered even fairly secure, unless at least one-third of its cultivated area is protected by irrigation from a source which will not fail in a year of drought.

(*ii*).—*Existing State irrigation works.*

477. *Number and classification of State irrigation works.*—In the United Provinces the State irrigation works under the control of the Irrigation Department comprise five large and eleven smaller canals, and twelve small storage works. The canals are all of the perennial as opposed to the inundation type; that is, their supplies are taken in by means of permanent, or in some cases temporary, dams constructed across the rivers from which they are drawn. Of the five large canals, four, the Upper and Lower Ganges, Agra, and Eastern Jumna, are classed as productive; and one, the Betwa Canal, as protective. The remaining works are all classed as minor works, and for convenience of administration and accounts they are grouped into separate systems known respectively as the Dun, Bijnor, and Rohilkhand Canals, and the Jhansi and Hamirpur Lakes; the names of the latter indicating the districts in which the storage works are situated. To this list of Government works should also be added the numerous small canals which have been constructed in the Government estates of the Naini Tal district, and which are known collectively as the Tarai and Bhabar Canals. These works are managed by an Engineer of the Irrigation Department whose services have been lent to the Estates, but the expenditure on them is not shown in the departmental accounts.

478. *Total cost of the works and general financial results.*—Up to the 31st March 1901 the capital expenditure which had been incurred on all works under the charge of the Public Works Department amounted to 907 lakhs. Taking the mean of the results for the preceding six years, so as to include both wet, dry, and normal years, the annual revenue derived from the works which were in operation at the commencement of the period amounts on an average to 88¾ lakhs, the working expenses to 29¾ lakhs, and the net revenue to 59 lakhs, representing a return of 6·9 per cent. on the capital cost of the works, which may be put at 853 lakhs. Taken as a whole, therefore, the works yield a substantial profit to the State.

479. *General protective results.*—In a year of average rainfall the works irrigate about 2½ million acres, but the area varies greatly from year to year according to the nature of the seasons. In 1894-95 with a good monsoon followed by good winter rains, the total area barely exceeded a million acres. On the other hand, in 1896-97, when over the whole canal tract there was practically no rain after the end of August, the area rose to well over 3 million acres. In that year the real protective value of the works was fully demonstrated. Under conditions very similar to those which led to such widespread famine or distress throughout the greater part of the Provinces, the cultivators in the canal-irrigated tracts not only secured their crops, but, owing to the high prices prevailing, they were exceptionally prosperous. As soon as their spring crop was assured, they were able to export grain, and thus out of their plenty to contribute to the wants of less fortunate tracts. The value of the crops raised by the works in that year was estimated at 13 crores of rupees, a sum which exceeded by 50 per cent. their total capital cost, while one and a half million tons of edible produce were rendered available as food for the people. But perhaps the best testimony to the protective value of the canals is afforded by the following extract from Sir Antony MacDonnell's review of the Chief Engineer's report for the year. Referring to the financial results of the year's operations the Lieutenant-Governor wrote:—

> These very satisfactory figures show the results of the year's operations as gauged by the departmental system of accounts; but, taken alone, they fail to represent the true value of the canals during a year of drought. In a year such as that through which we have just passed it is in the effective protection against famine and scarcity afforded to almost the whole of the canal irrigated tract, in the suitable employment provided for some millions of the people, in the exceptional prosperity of large numbers of the cultivating classes, and in the land revenue secured to Government, that the most important and most beneficial results of the canals are to be found. In these respects the benefits derived from the canal works during the past year of drought can hardly be exaggerated.

480. *Injurious effect of canal irrigation, and its remedy.*—It cannot however be said that the canals in the United Provinces have always conferred unmixed benefit upon every tract which they command. In many places their introduction led to a gradual but steady rise in the level of the subsoil water, and resulted eventually in water-logging of the soil, the increase of malaria, and the further deterioration of *usar* or *reh* covered tracts. To remedy these evils and to prevent further injury, it was found necessary to incur a considerable outlay on the re-alignment of some of the older channels, and on the construction of a large system of drainage channels, the aggregate length of which now amounts to 3,327 miles, or to more than one-third of the total length of the canals and their distributary channels. On the construction of the drains an expenditure of about 43 lakhs has been incurred. These measures have gone far to remedy, if they have not entirely removed, the evils of which there were such serious complaints in past years.

481. *Dependence placed upon the winter rainfall.*—The canals have all been designed with carrying capacities largely in excess of the supplies in the river during the later months of the cold weather. Thus, if the later monsoon rains fail, the large supplies carried by the canals irrigate an area in excess of that to which the full number of waterings can be given if the winter rains also fail. We have had objections raised to this system, but there can be no question that it ensures protection to the widest possible area. It enables a larger area to be sown with *rabi* crops than would be possible without aid from canals, and if the usual winter rains fall the whole area is matured. If they fail, a full crop cannot be ensured over the whole area; but a much larger area will yield a full or substantial crop than would be the case if the supply were limited in the first instance to the area to which water could be guaranteed towards the end of the season; and with the high prices of produce which usually prevail when there is a failure of the winter rains, the cultivators can have no cause for complaint, provided that remissions of water-rate are given as liberally as the rules provide, on the small number of fields which fail to yield a fair crop.

482. *Increase in the protection afforded by State works.*—The area irrigated fluctuates with the rainfall to such an extent that figures based upon averages do not afford a good indication of the gradual growth of the protection afforded by means of Government works. Of dry years even, no two years are alike, and a year in which there is a steady and continuous demand, taxing the canals to their utmost throughout the whole of both irrigating seasons, is unknown in these provinces. In 1877 a good fall of rain in December put a stop to all demand for water, and in 1896 the rainfall up to the end of August was normal or in excess of the normal. But taking the areas irrigated during those two famine years as a measure of the then irrigating and protective capacities of the works, we find that during the past twenty-five years the area has been more than doubled, having risen from under $1\frac{1}{2}$ million to over 3 million acres.

Large Canal Systems.

483. *The four productive works.*—The following tabular statement shows the financial results of the four large canals of the productive class, based on an average of the six years ending 1900-01. The figures given for the Lower Ganges Canal do not include those for the recently opened Fatehpur Branch.

Name of Canal.	Canal opened in	Average of 6 years 1895-96 to 1900-01.				Excess of net revenue over interest charges to end of 1900-01.
		Total capital outlay to end of year.	Excess of annual net revenue over interest charges.	Percentage of net revenue on capital.	Area irrigated.	
	Year.	Rs.	Rs.		Acres.	Rs.
Upper Ganges Canal . .	1854	2,98,87,861	17,05,245	9·47	948,977	1,27,58,990
Lower Ganges Canal . .	1878	3,53,24,044	91,084	3·97	774,137	—26,21,950
Agra Canal . . .	1874	95,40,173	1,80,500	5·60	228,739	—14,09,353
Eastern Jumna Canal . .	1850	38,64,233	8,82,186	26·55	285,987	2,20,92,711
Total .	...	7,86,16,311	28,59,015	7·37	2,237,840	3,08,20,398

These results may be regarded as fairly normal for all and each of the works. The canals irrigate on an average about 2¼ million acres, or 22¼ per cent. of the gross area of 10 million acres which they command. They yield an annual net revenue of about 58 lakhs, equivalent to a return of 7·37 per cent. on their capital cost; and after meeting interest charges which amount to Rs. 29,32,375 there is left a clear profit to the State of Rs. 28,59,015 per annum. The extraordinarily high percentage earned by the Eastern Jumna, as compared with the three other canals, is due partly to the inexpensive nature of the works, more especially of the head-works, and partly to the fact that sugar-cane and rice, which pay the maximum water-rate, form 38 per cent. of the total area of crops irrigated by the canal. On the Lower Ganges Canal, on the other hand, the capital cost has been swollen by heavy expenditure incurred on the construction of the head-works and of a large aqueduct on the Kali Nadi, while less than 9 per cent. of the crops consists of sugar-cane and rice. The net revenues earned by all four canals, from the dates of their opening up to the 31st March 1901, are 308 lakhs in excess of the interest charges to the same date. On the Eastern Jumna Canal the deficit was not cleared off until 33 years, and on the Upper Ganges Canal until 38 years from the date of opening. There are still balances of 26 lakhs against the Lower Ganges Canal, and 14 lakhs against the Agra Canal, but these are now annually diminishing.

484. *Capital cost per acre.*—Calculating on the average area irrigated, the capital cost of the four productive works amounts to Rs. 35 per acre. This is much higher than the corresponding figure for the Punjab, where, as we have shown, it amounts to only Rs. 21·1 per acre. The high rate in the United Provinces, compared with the Punjab, is due chiefly to the greater average rainfall, to the consequent less steady demand for canal water, and to the fact that in the United Provinces, where canal water is in general required merely to supplement the rainfall, the supply of water is distributed, and the protection which it affords extended, over relatively a much wider area than in the Punjab. In the latter province not only is the supply available for the canals larger in proportion to the area commanded, but there are also large tracts in which, owing to the scanty rainfall, cultivation without irrigation is impossible. Thus, with less contraction of the irrigated area in years of good rainfall, there has not been the same necessity for, or incentive to, a very wide distribution of the supply. The difference is also in part accounted for by the relatively larger expenditure incurred in the United Provinces on works connected with navigation, on escape channels rendered necessary by the more fitful nature of the demand, and on drainage works required to carry off the more abundant rainfall.

485. *Revenue, maintenance charges, and value of crops irrigated.*—The gross revenue annually earned by the four canals, including the share of the land revenue which is credited to them, amounts to over 84¾ lakhs, or to Rs. 3·80 per acre. The working expenses average Re. 1·20 per acre, or, with interest added, Rs. 2·59 per acre, leaving Re. 1·21 per acre as clear profit to Government. The value of the crops irrigated in an average year is estimated at 800 lakhs, or rather more than the total cost of the canals.

486. *Results of expenditure on improvements.*—In discussing the growth of irrigation on the perennial canals of the Punjab, we have called attention to the remarkable expansion of irrigation which has taken place during the past ten years, owing mainly to the adoption of measures for extending irrigation up to the extreme limits imposed by the supply of water available, or by the physical features of the country, and for ensuring a more economical use of the water. The policy of extending irrigation up to the farthest limits of the Doab was carried into practical effect in the United Provinces many years ago, and, with one important exception at the tail of the Ganges-Jumna Doab, all the large branch canals required to carry water along the watersheds of the main drainage lines, were completed before 1880. There were no doubt large tracts within command of the canals to which water had not been taken; but, with the one exception which we have noted and to which we shall again refer, these were all areas from which canal water had been purposely excluded owing to the unsuitability of the soil, or to the existing facilities for irrigation from wells and other sources. There has been, therefore, of recent years practically no scope for the expansion of irrigation, except by extending and improving the systems of small

distributary channels, and by economizing water so as to ensure its distribution over the widest possible area. The measures, with this end in view, which have been introduced independently on the canals of the United Provinces, are very similar to those adopted in the Punjab (paragraph 16); but, in addition, the bed slopes of many of the distributary channels have been reduced with the object of causing a deposit of fine silt on the bed and side slopes, and of thus reducing loss by percolation. As in the Punjab, these measures have been greatly facilitated by the rules introduced in 1890, which rendered it more easy to obtain funds for works of extension and improvement than it had been before the construction estimates of the works were closed, and also by the liberal grants for minor improvements which have been charged against the revenue account of the canal. In the case of the four canals which we are now considering the estimates were closed on the 31st March 1891. Taking, as we did in the case of the Punjab canals, the aggregate of the maximum areas irrigated before 1894-95, as representing the irrigating capacity of the works when the estimates were closed, and the aggregate of the subsequent maximum areas as their present capacity, we find that there has been an increase of 744,613 acres. Since 1891 an expenditure of $57\frac{3}{4}$ lakhs has been incurred against capital, and of 21 lakhs against revenue for works of extension and improvement, making a total of $78\frac{3}{4}$ lakhs, or an average of Rs. 11 per acre of extension, most of which is due to this expenditure. This result agrees very closely with the corresponding rate for the Punjab, and affords further evidence of the profits to be derived from a liberal expenditure of funds in developing irrigation on works which have been nominally completed.

487. *The Fatehpur Branch Extension.*—For the area at the extremity of the Doab, referred to in the preceding paragraph as being still outside the canal irrigated tract, it was for some years doubted if a sufficient supply of water would be available. The early results of the measures for economizing water which were adopted extensively after 1891, showed, however, that there need be no serious apprehension on this point; and, with a view to extending canal irrigation into this tract, the construction of the Fatehpur Branch of the Lower Ganges Canal was commenced in 1895. The works have now been practically completed at an outlay of 34 lakhs. The branch was opened for irrigation in 1898, and in 1901-02 it irrigated 34,451 acres. When irrigation is fully developed it is expected to irrigate annually 120,000 acres, or about one-fifth of the cultivable area commanded.

488. *Other extensions.*—There are only two other works of individual importance remaining to complete the main distributing systems of the Ganges Canals. These are the extensions, which are now in hand, of the existing Mat Branch and Kalda distributary, to irrigate 83,000 acres in the northern part of Muttra and in the Aligarh district, at an estimated cost of 11 lakhs. On the Agra Canal the Nandgaon distributary is being extended to irrigate 46,000 acres in the northern half of the Muttra district at a cost of $2\frac{1}{2}$ lakhs.

489. *The Betwa Canal.*—This is the only work in the United Provinces of the 'protective' class. It was constructed at a cost of 42 lakhs for the protection of the Jalaun district. It also irrigates small tracts in the Jhansi and Hamirpur districts, and in a few Native States, but the total area irrigated in these tracts does not ordinarily exceed a thousand acres. The canal receives its supply from the Betwa river which rises in Bhopal, on the northern slopes of the Vindhyan range. The river is dammed up by a masonry weir, about a mile in length from end to end, and with its crest level 50 feet above the lowest point in the river-bed. The area drained by the river above the dam is so large (10,000 square miles), and the rainfall in the upper reaches of the catchment so assured, that during the monsoon months there is always an ample supply. The flood discharge may rise to about $\frac{3}{4}$ million cusecs; but on the cessation of the monsoon the volume rapidly falls, and in a dry year, before the end of December, it dwindles to a few cusecs. The dam, on the crest of which iron shutters 6 feet high have recently been erected, forms a reservoir 16 miles long with an average width of about $\frac{1}{4}$ mile. It stores 2,750 million cubic feet of water with which the canal's supply is supplemented when the discharge in the river falls

below requirements. The narrow width of the channel above the dam, and the high velocity of the floods, prevent any perceptible deposit of silt in the reservoir. The canal was designed to take in 1,000, but is capable of carrying 1,200 cusecs. It was estimated to irrigate 120,000 acres in a year of full demand for water, and to yield an average return of 1·69 per cent. on the capital cost.

490. A mean of the financial results for the six years ending with 1900-01 may be taken as fairly typical of the average returns now derived from the canal. It shows that the average gross annual revenue of Rs. 85,000 falls short of the maintenance charges by Rs. 17,000; including interest charge there is an annual loss from the canal of Rs. 1,81,000. Expressed in acreage rates, the working expenses and interest charges amounted to Rs. 5·68 per acre irrigated, and the gross revenue to Rs. 1·81, leaving a net annual loss of Rs. 3·87 on a capital expenditure of Rs. 93 per acre. Calculated on the area protected against drought in the famine year of 1896-97, the capital expenditure is Rs. 50, and the net annual loss Rs. 3 per acre.

491. The canal was opened in 1885, and in the fourth year from its opening the irrigated area rose to over 32,000 acres. That area was seldom, and only by a small amount, exceeded until the famine year of 1896-97, when 87,306 acres were recorded. In years of ordinary rainfall the irrigated area still falls short of 40,000 acres. The work, it will be seen, has not fulfilled, either in its financial or protective effects, the expectations that were formed when the estimates were framed; but, though the protection afforded to the Jalaun district during the famine was incomplete, the canal led to sufficient reduction of distress, and of expenditure on relief, to justify its construction. In the words of Sir Antony MacDonnell, it was the salvation of the Jalaun district.

492. *Difference in the results in the two branches of the Betwa Canal.*—It is instructive to notice that the financial results shown in paragraph 490 are the mean of those obtained by two separate branches—one, the Kathaund Branch, running through a country in which *parwa* or yellow soil predominates; and the other, the Hamirpur Branch, commanding a tract consisting almost entirely of black cotton soil. Taking the average results of the past five years, during which the conditions have been on the whole more than ordinarily favourable to the irrigation of black cotton soil, we find that the Kathaund Branch has irrigated annually 33,000 acres, returning a gross revenue of Rs. 2 per acre; while the Hamirpur, which is the larger of the two, has irrigated on the average only 16,500 acres, returning a gross revenue of Rs. 1·5 per acre. The net annual loss to the State, assuming the capital cost and working expenses to be divided equally between the two branches, comes to Rs. 6½ per acre for the Hamirpur, against Rs. 2 per acre for the Kathaund Branch. The former figure affords a good indication of the probable cost of providing irrigation, by a canal like the Betwa, in the purely black cotton soil tracts of the United Provinces, where rice and perennial crops are not grown, or are grown only on an insignificant area.

Minor Works.

493. *Small Canals.*—The three systems of minor canals all irrigate in the sub-montane tract, and are fed by streams which rise in or near the lowest ranges of the Himalayas. Two of them, the Dun and Bijnor Canals, are highly remunerative works, returning 7¾ and 12¾ per cent. respectively on their capital cost. The Rohilkhand Canals, which command a country generally less fertile and requiring less artificial irrigation, return about 4 per cent. now that the water-rates have lately been increased. Collectively the small canals yield a net revenue of over 1½ lakhs, or 5½ per cent. on a capital outlay of 27 lakhs. On an average they irrigate 140,000 acres annually. In the famine of 1896-97 by their aid the crops on 163,000 acres were brought to maturity, against 64,000 acres in the famine of 1877-78. This large increase is to be attributed chiefly to liberal expenditure on improvements during the past 15 years.

494. *Storage works.*—The twelve tanks in the Jhansi and Hamirpur districts are the only works in the Provinces under the charge of the Public Works Department which are entirely dependent upon storage. They are all old works which were in existence before the district came under British Government, and appear to have been made more for ornament than for use. About Rs. 80,000 have been spent on improvements which have about doubled the irrigated area, but even now they only irrigate from three to five thousand acres annually. The revenue, in the shape of water rate and enhanced land revenue, barely suffices to cover the annual working expenses.

495. *The Tarai and Bhabar Canals.*—In this system are comprised about 20 small canals which have been constructed in the Government estates in the Naini Tal district, chiefly with the object of opening out jungle tracts to cultivation. They irrigate annually 125,000 acres consisting mainly of rice. There are no separate accounts showing the cost of the works and the revenue derived from them.

(*iii*).—*Scope for further extensions of State irrigation works.*

496. *The sub-montane tract.*—No proposals have been laid before us for the construction of new works in the sub-montane tract. In the western districts of Dehra Dun, Bijnor, and Bareilly, all the available water-supplies of any consequence are said to be already fully utilized. East of the Naini Tal *Tarai* there are no Government irrigation works, and there is said to be but little scope for their construction; but the question of utilizing hill streams for the protection of the rice areas, and for the general extension of irrigation in these more eastern districts should, we consider, be investigated as soon as the services of a qualified officer can be spared for the purpose.

497. *The central tract.*—Three works have been proposed for the irrigation of this tract: the Eastern Ganges, the Ramganga Canal, and the Sardah Canal.

498. *The Eastern Ganges and Ramganga Canals.*—Projects for both of these works were prepared more than thirty years ago for the irrigation of the tract lying between the Ganges and Ramganga rivers, in the districts of Bijnor, Moradabad, and Budaon. The high level of the subsoil water in the tract to be irrigated, the contention that water would be but seldom required for the *rabi* and still more seldom for the *kharif* crops, the consequent improbability of securing any adequate return on the required expenditure, and the facility with which temporary wells can be constructed, led to the abandonment of both schemes. Moreover the Ramganga, though it carries an enormous volume when the river is in flood, runs practically dry soon after the rainy season; and, with the existing canals on the right bank utilizing all the available cold weather supply of the Ganges, there is at present no surplus available for the supply of a canal taking off from the left or eastern bank of that river. It may be quite impossible to procure a perennial supply for the irrigation of this tract, and even if a supply could be procured, one or other of the obstacles owing to which the previous projects were condemned, may prove insuperable; but we do not think that the possibility of affording future protection to the tract by means of canal irrigation should be finally abandoned on the basis of information collected over thirty years ago. In spite of the high spring level in certain parts, and of the facilities for constructing temporary wells, there can be no question as to the insufficiency of the protection afforded by the existing means of irrigation. Distress from the failure of the rainfall appears to be as frequent in Rohilkhand as in any part of the Provinces. It is no doubt as a rule less intense, but in the district of Budaon the rainfall has been seriously deficient in no less than ten years out of the fifty-two for which records are available, and at least three of those years were years of famine, and two of more or less severe distress. In Moradabad only 19·17 per cent., and in Budaon only 24·4 per cent. of the normal cropped area is at present protected by irrigation.

499. We recommend, therefore, that the question of introducing canal irrigation into these districts should again be examined and considered on the more

detailed information that can now be collected with regard to the requirements and conditions of every village in the tract. It seems most unlikely that a canal from the Ramganga would afford a sufficient supply for the *rabi* season, and it would probably be too costly to construct. But it may be possible to provide a fair amount of protection at a reasonable cost by means of a *kharif* or inundation canal taking off from the left bank of the Ganges above or near the head-works of the Ganges Canal. Such a canal would at least afford a supply for a considerable area of rice and other *kharif* crops, and for the sowing of the *rabi* crop should the later rains fail. Eventually, when every possible means have been adopted for economizing water on the Ganges and Eastern Jumna Canal, or if any of the Sardah water can be carried into the Ganges—a proposal to which we shall presently refer—it may be found possible to divert some of the cold weather supply of the Jumna river for the irrigation of *rabi* and perennial crops in parts of these districts where the spring level is not prohibitively high.

500. *The Sardah Canal.*—There is probably no scheme for the introduction of canal irrigation into any part of India which has formed the subject of so much discussion as that for a canal from the Sardah river for the irrigation of Oudh. Nor has any more difficult problem been laid before us during the course of our inquiries than that of deciding whether the numerous objections which have been raised against the scheme are sufficient to prevent the utilization, in the Ganges-Gogra Doab, of the enormous volume of water which now runs to waste in the Sardah river.

501. The first project for a canal from the Sardah was prepared by Captain Forbes, R.E., in 1870, and provided for the irrigation of 2,380,000 acres in the country lying between the Gogra and Ganges rivers, at an estimated cost of over 6 crores of rupees, inclusive of outlay on navigation works. It was however foreseen that water might not be required for the whole tract, and in 1871 Captain Forbes prepared a revised scheme restricting irrigation to the north-west of a line passing through Lucknow and Fyzabad. This modified project was estimated to irrigate 600,000 acres, and to cost 3 crores. It was however held in abeyance for some years owing to the opposition of the principal landowners. In the Report of the Famine Commission of 1878 the scheme was referred to as one which "ought not to be any longer rejected unless grave and substantial objections to it can be established."

502. In the following year, 1879, Major Forbes drew up yet another modified scheme for irrigating the districts of Kheri, Sitapur, Hardoi, Lucknow, Barabanki, and Fyzabad, with possible extensions to Azamgarh and Jaunpur. The opinions recorded by the District Officers upon this scheme were generally unfavourable to the construction of the canal; and Sir George Couper, who was then and had been for many years Chief Commissioner of Oudh, stated his unwillingness to proceed with the elaboration of the scheme until driven to do so by the necessity of putting it in hand as a famine relief work. He assigned as his reasons: the degree of protection already afforded by existing means of irrigation; the possibility of their further development; and the injurious effect of the canals in the Ganges-Jumna Doab on the health of the people. In the following year, after a deficient *kharif* harvest, Colonel Brownlow, Chief Engineer for irrigation, having regard to the low supply in the wells and to the emptiness of the *jhils* and tanks in Oudh, recommended the completion of the surveys and the preparation of a project for a canal to command the Gogra-Gumti Doab. Sir George Couper accepted the recommendation with evident reluctance, in view of the necessity of providing relief labour in the event of a failure of the winter rains. The project which was subsequently prepared by Captain Clibborn and Mr. (now Sir William) Garstin provided for the irrigation of 720,000 acres, or about one-fourth of the unirrigated and cultivable area of the Gogra-Gumti Doab. The canal was designed to carry 3,800 cusecs, and was estimated to yield a return of $6\frac{1}{4}$ per cent. on a capital outlay of about $3\frac{1}{4}$ crores. This project seems to have been held in abeyance mainly from financial considerations, the Local Government being unwilling to guarantee interest on the expenditure, though evidently desirous of seeing the canal constructed for the protection of the country.

503. The matter is again referred to in the following terms in the Resolution of the Local Government on the administration of famine relief in 1896-97 :—

In October last the failure of the crops threatened to be greater in Oudh than elsewhere, and the question of undertaking the Sardah Canal as a relief work came again under discussion. The magnitude of the work, however, was so great, while the injury to the country, if a mistake were made, would be so far-reaching, that the Lieutenant-Governor decided not to enter on this great undertaking as a famine relief work without careful preliminary inquiry. But in view of the possibility that the famine might continue for longer than a year, Sir Antony MacDonnell considered it desirable to come to some decision on the question whether a canal could be advantageously made or not. Accordingly Mr. King, Superintending Engineer, was deputed to inquire into the merits of the project, and he spent four months of the cold weather in doing so. Mr. King's report has not yet been finally considered; but it may here be said that, in his opinion, Sitapur, Hardoi, Lucknow, and Barabanki are the only districts of Oudh into which canal irrigation could be profitably introduced. The facts to be deduced from Mr. King's report are, on the one hand, that the water-supply from the proposed canal would be for these four districts practically unlimited, that a canal could be made for about 4¼ crores, which would possibly return 5 per cent. on the outlay,* and that these districts would be protected from the effects of drought, their wealth greatly increased, and about 265 square miles of shallow tanks reclaimed for *rabi* cultivation.

* The question of return is very uncertain.

On the other hand, the report shows that there are serious though probably not insuperable difficulties attaching to the project, arising from the high spring level of the subsoil water, and the nature of the subsoil and drainage. The construction of the canal continues to be viewed with disfavour by a large though a decreased proportion of landowners and cultivators, and there is some doubt whether adequate water-rates could be realized.

The matter is still under the Lieutenant-Governor's consideration: but the facts which have been established by Mr. King's inquiries show the prudence of the decision which rejected the work as a famine relief measure.

Subsequently in May 1899, the Lieutenant-Governor, when forwarding Mr. King's report to the Government of India, wrote as follows :—

On a review of the case Sir Antony MacDonnell considers that the canal is not required as a famine protective work, while he is satisfied that its construction would so raise the water-level, already high, of the tracts through which it would pass as to produce the most injurious consequences to the agriculture of the tracts and to the health of the inhabitants. The opposition of the landowners, though it may have been justified by unsubstantial reasons, had thus a solid foundation on which to rest. The opposition is as strong to-day as it was in Colonel Forbes' time; although some few Taluqdars wavered in 1897 in their opposition, the great body are united in opposing the construction of the canal.

The Lieutenant-Governor does not think that interest on its capital could possibly be recovered consistently with moderate assessments of water-rates and popular contentment.

The Lieutenant-Governor and Chief Commissioner is therefore unwilling to support the scheme, which should, in his judgment, be finally abandoned while the physical conditions and popular feeling remain as they are.

504. From this brief history of the project it is evident that the Local Administration has never at any time been so fully convinced of the necessity for the work as to press very strongly for its construction. In fact, on two of the three occasions on which the construction of the canal was seriously considered, the proposal was condemned by the responsible local authorities; and, in both these cases, there had recently been ample opportunity for noting the possible effects of drought in the tract concerned. In each case, however, the condemnation was accompanied with a reservation. Sir George Couper admitted the possible necessity of carrying out the project as a famine relief work. Sir Antony MacDonnell recommended that the scheme be abandoned "while the physical conditions and popular feeling remain as they are now." The immediate question for our consideration is, whether there is sufficient evidence to justify us in recommending the final abandonment of all proposals for constructing a canal from the Sardah for the irrigation of the whole or any portion of the large tract that could be commanded by it.

505. The objections which have been raised against the introduction of canal irrigation into the Ganges-Gogra Doab are that the canal is not needed as a protective work, the country being already fairly well protected by its rainfall, by the existing means of irrigation, and by the facilities for their extension; that it would cause serious injury by raising the water-level; and that it would not be

a productive or remunerative work. On the other hand, it is contended that the general agricultural and climatic conditions are in the main similar to those in the Ganges-Jumna Doab, where canals have not only afforded valuable protection to the tracts they command, but have yielded, in addition, a handsome return on their capital cost.

506. There is certainly, so far as we can see, nothing in the climatic conditions, or in the conditions of cropping, which would lead one to suppose that canal water would be taken any less freely in this tract than in the Doab. All over the western and southern districts of the Ganges-Gogra or central tract, the monsoon rainfall is much the same as in the districts across the Ganges, and if anything it is more liable to serious deficiency from the normal; while the winter rainfall over the whole tract is both less in quantity and more uncertain than in the Doab. The main difference in the cropping of the two tracts is that rice is more extensively grown in the central tract, especially in the northern and eastern districts where it constitutes nearly one-third of the whole cropped area. But on the canals of the Agra Province, wherever rice is grown, the cultivators have always been ready to pay for its irrigation, even in tracts where the rainfall is usually quite as abundant as in any part of the central tract. The conditions of rainfall and cropping do not, therefore, lead us to suppose that if canal irrigation could be afforded to this tract at the same capital cost per acre as in the Doab, it would yield results appreciably less remunerative to the State or less beneficial to the cultivator.

507. In considering the extent of protection afforded by the existing means of irrigation it will be desirable to divide the districts commanded by one or other of the proposed Sardah canal schemes into two separate sections, as shown in the following statement:—

		Population per sq. mile, 1891.	Percentage of increase of population, 1901, compared with 1891.	Monsoon rainfall of 1896; percentage in defect of normal.	Percentage of rice on normal sown area.	Percentage of the normal sown area irrigated from						Total cost of famine of 1896-97 (including remission of revenue) in lakhs of rupees.
						Tanks.		Wells.		All sources, including tanks, wells, streams, etc.		
						99-00.	96-97.	99-00.	96-97.	99-00.	96-97.	
	1	2	3	4	5	6	7	8	9	10	11	12
Western districts.	1. Shahjahanpur	526	+3·0	34	28	...	...	13	13	28	28	1·12
	2. Sitapur	487	+8·6	31	19	7	2	8	7	15	9½	4·29
	3. Hardoi	487	—1·8	52	10	6	13	19	8	27	22	22·81
	4. Barabanki	664	+4·1	40	25	11½	4½	12½	17	24½	22	2·60
	5. Lucknow	792	—2·4	43	17	9	3	23	25	33	28	9·72
	6. Unao	549	—2·4	51	14	12	3	21	25	35	30	6·81
Eastern districts.	7. Rai Bareli	592	—0·2	62	24	18	3	29	44	48	43	9·30
	8. Sultanpur	632	—0·8	44	33	15	10	20	25	36	36	2·05
	9. Partabgarh	625	—0·2	41	22	19	6	29	40	49	47	2·15
	10. Jaunpur	816	—5·1	40	22	8	1	42	45	49	46	4·62
	11. Fyzabad	713	—0·7	25	31	16	6	22	32	39	39	1·81
	12. Azamgarh	805	—13·0	58	28	15	3	30	43	54	47	5·02

The statement shows *inter alia* the percentages of the normal sown area which are irrigated in a year favourable for irrigation, like that of 1899-1900, when excessive early autumn rains filled the tanks, and when subsequent scanty rainfall and the lateness of the winter rains caused full use to be made of all existing means of irrigation. With these are compared the percentages irrigated in 1896-97, when the autumn rains were seriously deficient and ceased at an unusually early date, leaving the tanks nearly empty.

508. Of the districts in the western section, Shahjahanpur is apparently almost fully protected by its wells and streams. Unao and Lucknow have each 25 per cent. of their cultivation irrigated from wells; but the protection thus afforded was not sufficient to prevent distress and the necessity for relief in a year of severe drought. The three remaining districts are insufficiently protected, more especially Hardoi, having regard to its conditions of rainfall and to the small area which is efficiently protected by irrigation in a year of drought. In the eastern districts, excepting Jaunpur, there is a considerable area irrigated from tanks in a year of favourable rainfall; and in all districts there is a high percentage of well-irrigation. The tanks, however, fail in a year of drought, and though the general deficiency is made up by a large increase in the area irrigated from wells, this is evidently not sufficient to counterbalance the failure of the rainfall and of the tanks. During the *kharif* season in Northern India irrigation from wells is practically confined to limited areas of sugar-cane and other high class crops, and even if the rains fail there is no extensive use made of wells for watering the ordinary *kharif* crops. The excessive heat tells alike on the work that can be done by men and cattle; in any case wells could not be made to supply the volume of water necessary to mature any considerable area of rice; and, rather than attempt to save his millets and other dry *kharif* crops, the cultivator prefers to devote all his energies to watering and preparing his fields for the more valuable *rabi* crops, hoping for assistance from the winter rains in bringing them to maturity. Thus in no part of the provinces are wells of any real avail in saving the *kharif* crops. But, apparently, at least throughout Oudh and the eastern districts of the Province of Agra, the *kharif* crops must be saved if distress is to be avoided. The drought of 1896-97 affords sufficient evidence that in this tract even very extensive well-irrigation during the subsequent *rabi*, assisted by timely and sufficient winter rains, will not prevent distress when there has been a severe failure of the *kharif*. Thus in Rai Bareli, Jaunpur, and Azamgarh, the distress was so severe as to be officially recognized as famine, although over 40 per cent. of the total cropped area of each district is irrigable from wells. Had the winter rains also failed or been seriously deficient, it seems certain that the distress among the cultivating classes would have been greatly intensified. It is evident therefore that the wells do not at present provide complete protection; nor can we think that they will do so in the future even though their number be largely increased.

509. It cannot, however, be said that these eastern districts are, compared with many other parts of India, urgently in need of protection by State irrigation works. The decrease in the population of Azamgarh and Jaunpur, and its stationary condition in the remaining districts, are attributed more to the effects of the excessive rainfall of 1894 than to the drought of 1896; and, even in Rai Bareli, where the expenditure was greatest, the cost of relief in the latter year amounts to only about ten annas per head of the population, compared with seven rupees per head in Banda, and the much larger sums spent in some districts of the Central Provinces and Bombay. We cannot, therefore, recommend that any considerable financial or other risk should be run in order to protect this eastern portion of the central tract; and any work designed for its protection must take a low place in the order of urgency of protective works. The chances of a canal being made for the irrigation of this tract, on the ground that it would prove remunerative, are also very remote. It would hardly be proposed to construct it, merely or mainly for purposes of profit, in opposition to the wishes of the people. But its construction would necessarily involve the drainage of the *jhils*, and to this the people would apparently only consent, if they consented at all, on the understanding that lands which are now watered from the *jhils* were given canal water free or at greatly reduced rates.

510. We think, however, that the question of constructing a canal for the protection of the western district of Hardoi is deserving of serious consideration; and if a canal is to be constructed, it would be advisable to consider also the question of utilizing it for the further protection of other and adjoining districts. The main obstacles to the introduction of canal irrigation into this insecure tract are the high level of the subsoil water, the prevalence of sand in the subsoil, the small thickness of the overlying loam, and the consequent danger of water-logging the soil and of losing a large portion of the supply by percolation.

If the conditions of the subsoil water-level, and the nature of the soil and subsoil as stated by Mr. King, are general, the injury that might be caused by the introduction of canal irrigation on any extensive scale is unquestionable. It could no doubt be mitigated, and even to a very large extent be prevented, by drainage, by rendering the channels water-tight, by limiting irrigation to a small percentage of the area commanded, and, if necessary, by closing certain channels throughout the *rabi* season; but these measures might raise the cost of the work to a prohibitive figure compared with the area to be irrigated. The records which have been laid before us are not, however, in our opinion, sufficiently detailed to justify the final abandonment of the scheme on the ground of danger from water-logging.

511. These records show that along the alignment proposed for the main channels the depth to water-level varies from a minimum of 11 feet in Hardoi to a maximum of 33 feet in Lucknow; and that in certain parts of some districts pure sand is found at a depth of 6 to 12 feet below the surface of the ground. But much more detailed information than this will be necessary before it can be said that the conditions with regard to water-level and subsoil offer insuperable obstacles to the construction of a canal. The areas must first be demarcated into which it seems desirable to carry canal water, having regard solely to their irrigational needs, the extent to which they must depend upon canal water for their protection, and the suitability of their soils for canal irrigation; the subsoil water-level within these areas, and outside them up to the limits of their main drainage outfalls, and the depth of overlying loam, must be observed and shown on a plan or cross sections of the country; and all matters bearing on the necessity for and possibility of completely draining the tract likely to be influenced by the canal, must be thoroughly investigated before any decision will be possible on this important question. The projects for the canal contain a good deal of general information on these points; but, though complete in all engineering details, they were prepared at a time when the necessity for very detailed observations of the kind which we have noticed had not yet been fully realized.

512. A survey party is now engaged in investigating the possibility of taking out a canal from a point high up on the Sardah river, for the protection of the Hardoi district by affording a supply of water to fill the natural depressions in years of short rainfall. It will, no doubt, collect all the information that is necessary for the immediate object in view; but we would recommend that the investigations be extended so as to include all the detailed information necessary for the purpose of deciding on the practicability of constructing a canal for direct irrigation in Hardoi, and in those portions of Lucknow and Barabanki which lie south of the Gumti river. It may also be found desirable to include portions of Shahjahanpur, Unao, and perhaps Rai Bareli, within the scope of the investigation. The proposal to construct a canal to replenish the natural tanks in Hardoi is a very recent one, and the investigations relating to it have only lately been put in hand. We are therefore unable to form any opinion regarding it. But we see no reason for limiting the scope of the scheme in the manner proposed, until such detailed information has been collected as may justify the final rejection of all idea of affording really efficient protection to the most insecure tract in Oudh by means of direct canal irrigation. Although a canal for the irrigation of this comparatively small tract would probably not be fully remunerative, its protective value would be great; and it would afford a practical means of ascertaining the actual productive value of canal water, under the agricultural conditions and revenue systems of Oudh. We therefore recommend that a detailed project should be prepared with full provision for the prevention of water-logging, and that the question of carrying canal irrigation into these districts should again be considered.

513. The eastern districts stand less in need of protection. But, as we have shown, there is a limit to the protection which wells will afford to these tank-irrigating and rice-growing districts; and a time may come when increased pressure of population will render it imperative to provide some more effective form of protection.

514. With regard to the alleged opposition of the people to the Sardah canal scheme, we can only say that the opposition of the Taluqdars is apparently as strong as ever it has been; and that it is to some extent based upon exaggerated views regarding the effects of canal irrigation in causing an extension of *reh* efflorescence and in water-logging the soil in the Ganges-Jumna Doab. The injury formerly caused by water-logging in certain districts of that Doab was undoubtedly serious. But we have it on reliable evidence that the cultivators' complaints as to the extension of *reh* efflorescence were much exaggerated; and that the system of drainage, which was not introduced until many years after the older canals had been constructed, has put an end to all complaints of extensive water-logging. These drains, it may be noted, carry away water from many *jhils*, or natural depressions, which were in former days used for irrigation; and yet they appear to have been generally welcomed by the people, who preferred assured 'flow' irrigation from canals to the precarious and more difficult 'lift' irrigation from *jhils*. Nor have we reason to think that drains carrying off the water of natural depressions would, if judiciously designed, have any appreciable effect in increasing the magnitude of the floods; on the contrary, if they kept the depressions dry in the intervals of rainfall, they would render them more effective in storing surface drainage and preventing its too rapid flow to the rivers.

515. We cannot say to what degree the feelings of the Taluqdars against the construction of a canal are shared by the cultivators; but in the face of the evidence laid before us at Lucknow, and of the strong opinions expressed by the district officers, we cannot at present recommend the introduction of canal irrigation into Oudh outside the districts mentioned in paragraph 512. Having said so much, we must add that we are not convinced that there are really any grave and conclusive objections to the introduction of canal irrigation into other parts of Oudh. Many of the objections which have been laid before us might have been applied with equal force to more than one large tract where canals have, as a matter of fact, proved of great benefit to the people.

516. Nevertheless we do not think that it would be a wise policy to introduce canal irrigation wholesale into this large tract, even if the more detailed inquiries which we consider necessary should show that the drainage difficulty can be surmounted at a reasonable cost. There are many other reasons which render it desirable to proceed tentatively, or as tentatively as may be possible in dealing with a large river from which a supply can be drawn, and delivered where it is required, only at a considerable outlay. But there is one consideration which, in our opinion, is of itself sufficient to justify this course. Hardoi and portions of the adjoining districts stand far more urgently in need of protection than the remainder of the tract; and we cannot recommend that the measures necessary for their protection should be postponed until the general question of protecting the whole tract by carrying out the main Sardah Canal scheme has been investigated and settled, until all local prejudices have been overcome, and until all protective works which are considered more urgent than this general scheme have been completed. Whatever the results of the investigation may be, that scheme, as a whole, must take a much lower place in the order of urgency of protective works than can be assigned to any fairly promising scheme for the protection of Hardoi and the adjoining districts.

517. *Extensions of existing works in Ganges-Jumna Doab.*—The supplies available from the Ganges and Jumna rivers for the irrigation of this Doab are, as we have already stated, barely sufficient for existing works and for the extensions which are now under construction; and into every large tract of the Doab where canal irrigation is required it has been or is in process of being introduced. There is still scope for a number of small extensions, which would in the aggregate require a considerable volume; but, in the absence of any other source of supply, these can only be rendered possible by improvements in the methods of distribution and by other measures for economizing water. On the Eastern Jumna Canal especially, there appear to be some small tracts which are not now commanded by any distributary channel and in which the subsoil water is said to lie at a great depth. These tracts will, no doubt, receive attention when the necessary supply of water is found to be available.

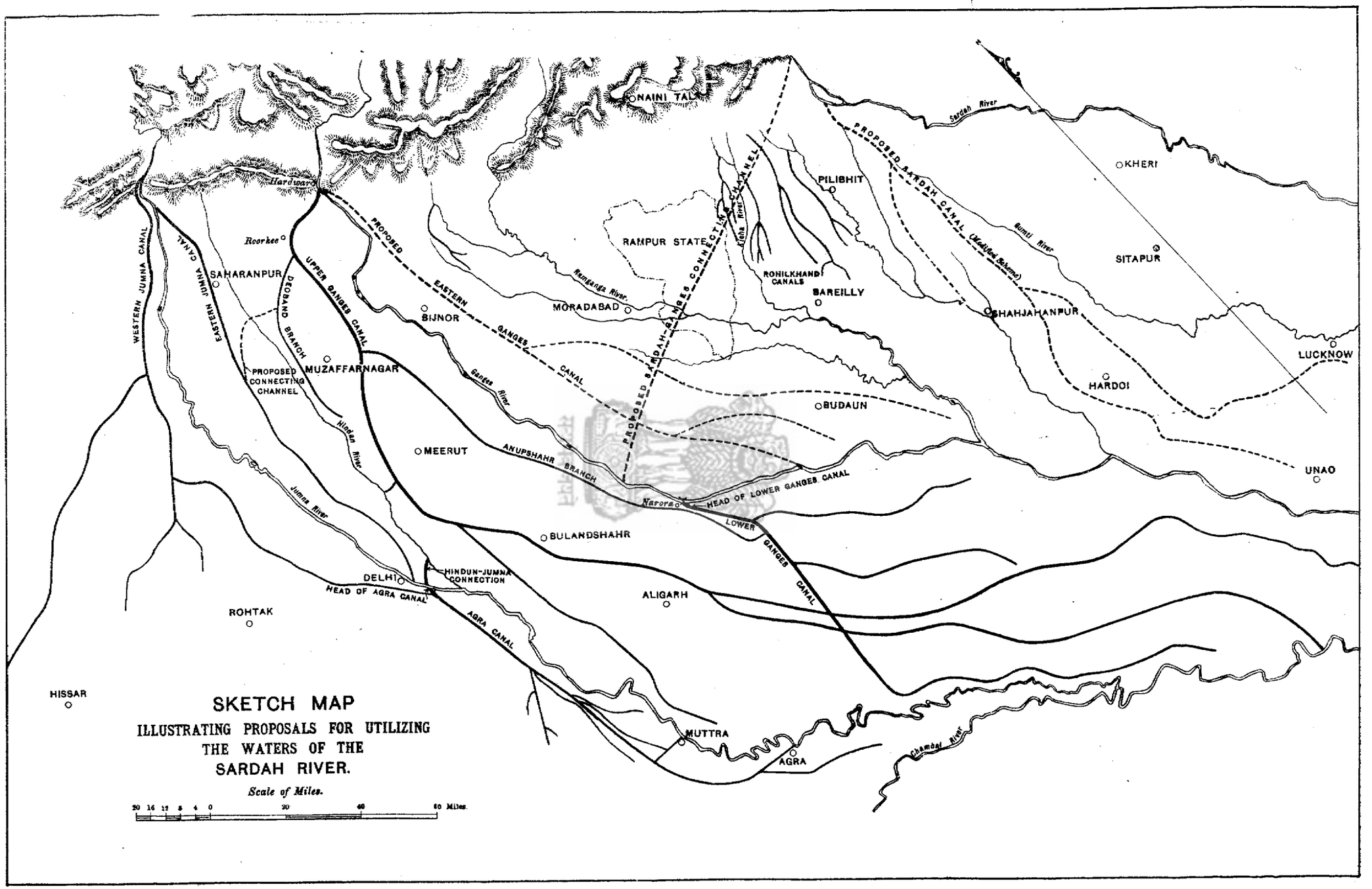


Photo-Litho., T. C. Press, Roorkee.—No. 7283.

518. *Storage works and prevention of percolation.*—The remarks which we have made in the Punjab Chapter (paragraphs 49 and 50) regarding storage works and measures for the prevention of percolation from canal channels, may be held as applying generally to the canals of the United Provinces. Observations on the lines recommended for the Punjab, should be made for the purpose of determining the loss by percolation from channels of all sizes; and, subsequently, money should be freely allotted with the object of ascertaining the best means of rendering the channels water-tight, and the volume of water that can be saved thereby. The effect on the spring level in the adjoining tracts should also be carefully noted. It is perhaps unnecessary for us to draw attention to the additional value which such observations and experiments will have in the United Provinces, in connection with the objections raised against the proposed Sardah Canal.

519. Unless, however, these and other measures for economizing water yield better results than seem to be anticipated by the canal officers, there will be but little water available for developing irrigation in villages which are now insufficiently irrigated, or for extending irrigation into other villages at the tails of the distributary channels, when the Fatehpur Branch and the extensions now under construction on the Agra and Ganges Canals have been given their full share of water. Even without any further extensions than are now in progress, the Doab is no doubt generally protected against serious or widespread distress; but if a serious failure of the monsoon were followed by a very scanty winter rainfall, the supplies likely to be available in the canals late in the *rabi* season would be quite insufficient to ensure anything like a full outturn from the large area of *rabi* crops that would have been sown with the aid of canal water. Even in years of less severe drought the supply at present does not always suffice for that purpose. Any measures, therefore, which may promise to make up the deficiency seem deserving of investigation.

520. *Possible utilization of Sardah waters outside Oudh.*—If, as seems most probable, no suitable site can be found for storing water in the upper catchment of the Ganges and Jumna, the only possible source of supplementing their supplies would appear to lie in the Ramganga and Sardah rivers. The connection of these streams with the Ganges has more than once been suggested, but the proposal has never been seriously considered. At the season when extra water is required for the Doab, the Ramganga carries only an insignificant volume; and on the Sardah river the Ganges-Gogra Doab seemed naturally to have the first claim. If, however, it should be decided to introduce canal irrigation only into those districts mentioned in paragraph 512, there would be available a considerable surplus of the Sardah's supply for utilization elsewhere, and the possibility of diverting the surplus to the Ganges river might be investigated more fully than it has hitherto been.

521. So far as the levels of the country are concerned there would appear to be no difficulty in carrying a supply into the Ganges above the head-works of the Lower Ganges Canal from a point on the Sardah where it debouches on to the plains. The connecting channel would no doubt have to cross numerous drainage lines and more than one large river, and the cost of the work would be very great; but, on the other hand, the advantages that could be derived from its construction seem to be sufficiently numerous and substantial to justify a considerable expenditure in securing them. A share of the supply which the Upper Ganges has now to pass on to the Lower Ganges Canal could be diverted to the Agra Canal through the Hindun Cut, without affecting the supply of the Upper Ganges Canal in the way that it is now affected when in times of tight supply it is called upon to assist the Agra Canal. Nor would it any longer be necessary to pass on to the Agra Canal any portion of the Eastern Jumna Canal's share of the Jumna supply. Moreover, were a sufficient volume made available from the Sardah, there would no longer be any difficulty in diverting a portion of the Ganges' supply into the proposed Eastern Ganges Canal; and the connecting channel might also be utilized for supplementing the often insufficient supplies of the Rohilkhand Canals and for irrigating Moradabad and Budaon. It might even be found possible to take a supply from the Deoband Branch of the Ganges

Canal into the lower portion of the Jumna-Hindun Doab, thus setting free a share of the Eastern Jumna Canal's supply for the protection of the Hissar and Rohtak districts at the tail of the Western Jumna Canal in the Punjab. We fully realize that this proposal is beset with many engineering difficulties, and that perhaps the cost would prove prohibitive. We think it right, however, to refer to it as a proposal which, in view of its wide-reaching potentialities, should not be lost sight of if it be eventually decided that the Sardah supply cannot be fully utilized in the Ganges-Gogra Doab.

522. We recognize the objections which may be raised to any proposal for diverting the waters of the Sardah so as permanently to deprive the tract, which by its geographical position has the prior claim, of the opportunities of utilizing them. It may be urged that at some future time the experience of a few years of drought, or the increasing pressure of population, or many other causes, may render the Taluqdars as keenly desirous of irrigation as they are now strenuously opposed to it. We cannot attach much weight to this argument, or recommend in consideration of it that all proposals to utilize the Sardah water to the greatest advantage should be held in abeyance for an indefinite period. We would observe, however, that even if the proposal which we are considering were actually carried out, it would not necessarily follow that Oudh would be finally and irretrievably excluded from canal irrigation. There would still be a surplus available from the Sardah, and it appears possible that if necessary this might be supplemented by the waters of the Gogra for the extension of canal irrigation in Oudh.

523. *The Ken Canal.*—Of the proposals which have been laid before us for the protection of the southern or *trans*-Jumna districts by the construction of State irrigation works, the most important is that for a canal from the Ken river to irrigate the district of Banda in Bundelkhand. The first project for this work was prepared in 1876 when it was proposed to take out a canal from above a dam, 68 feet high, at a point on the river some 40 miles above Banda. The estimate for the work, amounting to 46 lakhs, was held in abeyance until some experience had been gained of the working of the Betwa Canal, which was about to be constructed in a somewhat similar tract of country. The event has shown the wisdom of the postponement; for the project left out of command a large tract containing the very class of soil which the experience of the Betwa Canal has shown to be the most suitable of all the soils of Bundelkhand for irrigation by canal water. The canal as now designed will have its head-works at a point some 30 miles higher up the river than that originally proposed, and will thus be able to command all the good light soils of the district which may be expected to take water every year, as well as the heavier soils commanded by the original project, which only require water in a year of scanty rainfall or when the rains cease at an unusually early date. The project affords a good instance of the necessity for gaining experience as to the suitability of the soils for irrigation before any large expenditure is incurred on the construction of irrigation works in black cotton soil tracts.

524. The revised project is estimated to cost $36\frac{3}{4}$ lakhs and to irrigate 58,000 acres on an average, and 97,500 acres in a year of drought. It is expected to yield annually an average net revenue of Rs. 63,500, or 1·7 per cent. on the capital cost. Expressed in acreage rates the capital cost amounts to Rs. 63·5 per acre of average irrigation, the net revenue to Rs. 1·1, and, allowing for interest charges, the annual loss to Rs. 1·2 per acre. This is only about a third of the annual cost of providing irrigation to each acre watered by the Betwa Canal. The more favourable results anticipated for the Ken Canal are due chiefly to the fact that it commands a tract of country which contains a far larger proportion of the soils which take water in ordinary years than is to be found in the Betwa Canal tract. We have no reason to believe that the estimate is at all over-sanguine. On the contrary, from our evidence we have grounds for hoping that the water will be taken for the irrigation of rice more freely than has been estimated. The *rabi* area should not fall short of the estimate, provided that the supplies anticipated are always available; but we doubt if sufficient allowance has been made for the possibility of shortness of supply during the *rabi* season in a year

of severe drought; and we think that it may be found necessary hereafter, as it has been in the case of the Betwa Canal, to supplement the supply by storage. We would certainly recommend that the weir across the river be constructed so as to store the largest volume of water possible at a reasonable cost, and that with a view to selecting other suitable sites for reservoirs, a detailed examination should be made of the river upstream of the head-works. We understand that some suitable sites have already been discovered. These works will add to the cost; but the need for the canal is so great that its cost, even with such additions as may be necessary for storage, should not be greater than can reasonably be incurred in view of the protection which it will afford to the Banda district. We have no hesitation, therefore, in recommending its early construction.

525. *The Dassan Canal.*—A project for a canal from the Dassan river was prepared many years ago for the irrigation of a portion of the Hamirpur district; but the low supplies in the river and the great height and cost of the weir caused the scheme to be abandoned. A detailed reconnaissance for the purpose of determining the conditions of supply, and the probable utility and cost of the work in the light of more recent experience, will be put in hand as soon as the necessary establishment is available. The information at our disposal is not sufficient to admit of our forming any opinion on the project.

526. *Proposed canals in Mirzapur, Benares, and Allahabad.*—Preliminary surveys have been made for a number of small canals in Mirzapur, and in the southern portions of Benares and Allahabad. The most important of these is for a canal from the Tons river to irrigate a tract in the south of Allahabad. The scheme does not appear to be a promising one. The soil is mostly if not all black cotton soil; and the works would be costly in proportion to the area commanded. Rough projects have also been prepared for small canals from the Belan, Karamnassa, and other rivers. The projects are not in sufficient detail to enable us to form an opinion of their financial prospects; but, as rice is the principal crop that will be irrigated, they promise to be of considerable protective value, and there appears to be no reason why the water should not be fully utilized even in years of average rainfall. One or two of the most promising schemes should now be worked up in detail and carried out, so as to ascertain to what extent the cultivators will use the water and pay for it in ordinary years. The proposed Karamnassa reservoir and canal referred to in the Bengal Chapter (paragraph 412) should, if it fulfils the expectations of its projectors, protect a considerable area in the Benares district.

527. *The Chandraprabha Canal.*—During the course of our tour we inspected a canal from the Chandraprabha river in the private demesnes of His Highness the Maharaja of Benares. The canal, which was constructed about eighty years ago, is now a deep ravine, and it no longer commands the country except at its head and tail. It has cut away a good deal of valuable land and will continue to do so unless its supply is controlled. Nevertheless, the canal irrigates annually about 10,000 acres of rice. Plans and estimates for re-aligning the channel, and providing it with head sluices and other works for the control and distribution of the water, might be laid before His Highness and the advantages of carrying out the work explained to him.

528. *Improvement of the Betwa Canal.*—From the evidence which has been laid before us, we have no doubt that the financial and protective value of the Betwa Canal would be considerably increased by the provision of additional storage, and by the remodelling of the channels to enable them to carry larger supplies. The valley of the river above the head-works has been examined, and some suitable sites have been found for storage works. One or two of the best of these should be selected, and detailed plans and estimates prepared, with a view to the early provision of at least 1,000 million cubic feet of extra storage. This should suffice for the present, but eventually, as irrigation is further developed, it will be necessary to add another 1,500 or 2,000 million cubic feet. The branches of the canal should be remodelled so as to carry between them with safety the largest volume that can be run in the main canal.

529. *Establishment of a farm on the Betwa Canal.*—The chief reason, however, why the canal has failed to yield a return sufficient to cover its working expenses is the fact of its being almost entirely a *rabi* canal. In the early *kharif* season there is very little water in the river; and from June to October, when there is an abundant supply, the canal remains closed. Even increased storage will not add largely to the *kharif* area irrigated, unless the people can be induced to utilize the water for early sowings of rice, of which a large area could be matured during the rainy season. It may be that the soil is unsuited to rice; on this point our evidence is somewhat conflicting. But the question of introducing rice cultivation has such an important bearing on the effective working of the canal that we recommend the establishment by the Agricultural Department of a small farm in the vicinity of one of the distributary channels, for the purpose of experiments in utilizing the water for rice cultivation. We would also recommend a considerable reduction in the water rates charged for rice, so as to induce the cultivators to make experiments for themselves. Some selected cultivators might even be given water free for a few years.

530. *Storage tanks in Bundelkhand.*—The twelve small tanks in the Jhansi and Hamirpur districts which are managed by the Engineer in charge of the Betwa Canal are scattered over a large area, and are situated at a considerable distance from the head-quarters of the canal. We recommend that they be made a separate sub-division; and that for the next few years they be placed in charge of a specially qualified assistant or subordinate who would devote his whole time to their improvement, and to the preparation of projects for new tanks and for field embankments, to be carried out either at once or by relief labour in a year of famine.

(*iv*).—*Private irrigation works.*

531. *Area irrigated by private works of all kinds.*—There is no part of British India to which irrigation from private works is of greater importance than the United Provinces. For the irrigation from State canals, considerable as it is, is mainly confined to the thirteen districts of the Ganges-Jumna Doab; and thus nearly three-fourths of the Provinces depends entirely for its irrigation on wells and other private works. Out of a total area of 11 million acres under irrigation in an ordinary year, $8\frac{1}{2}$ million acres are irrigated by works of this kind, $5\frac{3}{4}$ million from wells, 2 million from tanks, and the balance of $\frac{3}{4}$ million acres from other sources.

532. *Wells.*—The area irrigated from wells varies very greatly with the nature of the season. In a wet year like 1894-95 it may fall to three million acres; on the other hand, in a year of drought it rises to over 7 millions. The wells are divided into three classes: masonry, half-masonry, and earthen or temporary. The distinction between masonry and half-masonry wells is, however, very indefinite. A cylinder lined with brickwork, laid in lime mortar, is the criterion of a masonry well; but many of the finest wells are made of bricks laid dry, or of brickwork in mortar rising to only a few feet above the subsoil water-level. No doubt in many places the half-masonry wells are less durable than those lined throughout with solid brick work, but the attempt to distinguish between the two classes appears to have led to complications which makes it doubtful if the distinction is worth retaining. It will certainly be more convenient for our purpose to class them all as permanent wells, merely noting that out of 500,000 wells thus classed about 170,000 are of the so-called half-masonry type.

533. *Permanent wells.*—There are, broadly, two descriptions of permanent wells: spring wells, and percolation wells. In the great alluvial tract north of the Jumna a permanent well usually consists of a brick-work cylinder sunk through the upper strata of alternate clay or loam and sand, down to an impervious stratum of stiff clay, known as the *mota*, through which a hole is made into the sandy stratum below. Through this hole a plentiful supply of water rises into the cylinder, sometimes to a height above that of the general level of

the subsoil water table outside the wells. These wells are therefore designated spring wells. When the hole is first made through the stiff clay stratum or *mota*, as it is usually called, a certain quantity of sand is forced up into the well with the water. After a short time the emission of sand ceases, and if the *mota* is a good one (3 to 5 feet of hard clay) no further sinking of the well takes place. The emission of the sand ceases only when the hollow inverted cone, which forms below the *mota*, presents a large enough surface to admit of the required volume of water being discharged through it at a velocity which will not disturb the grains of sand.* The cost of a well of this description depends chiefly on the depth to the *mota*, which may be great even though the subsoil water is high. The average cost to the cultivator of a well of two buckets may be put at Rs. 200 to Rs. 300, and the average area which each well will irrigate during the *rabi* season at 8 or 9 acres. The most effective spring wells are to be found in the Ganges-Jumna Doab, but they are found in largest numbers in the southern and eastern portions of the central or Ganges-Gogra tract.

534. When the *mota* is at a great depth or does not exist, water can only enter the well slowly by percolation through its sides or through the sand on which the well must rest. The well has then to be of much larger diameter than is necessary in the case of a spring well; otherwise the sand would be drawn with the water into the well and the masonry cylinder would gradually sink. Wells of this description are common in the sub-montane tract, and in the low-lying lands of the river valleys. Although of larger diameter, they are usually of less depth than the spring wells. They are cheaper to construct, but irrigate a smaller area.

535. In many parts of the districts south of the Jumna the wells are of the percolation type. Outside the black soils, in which hardly any wells are or can be made, rock is usually met with below the surface; the lining of the cylinder generally consists of rough stone masonry, and this frequently, as in the Deccan, is limited to the staging required for the lifting gear. The rock is excavated to form a reservoir for the water which issues from the porous soil or through fissures in the rock.

536. *Increase in the number of permanent wells.*—During the past decade the number of masonry wells in use for irrigation has increased by 51,000 or by about 12 per cent. This increase though substantial is proportionately much less than those shown in the provinces of Madras, Bombay, and the Punjab. The fact, however, of a very large increase during the past 30 years, in the districts which have recently come under revision of settlement, is unhesitatingly affirmed by all Settlement Officers, and may be accepted. In the eleven districts of Oudh the number recorded at settlement has risen from 50,835 to 119,942, an increase of 136 per cent. In some parts of these districts the number of wells is now so great that there scarcely seems to be room for any further large increase without affecting the supply of water in existing wells in dry years. For instance, in the Haidargarh pargana of Barabanki, covering an area of over 100 square miles, there are 27 wells to the square mile of total area, or one well to every 14 acres of cultivation, and more than two-thirds of the wells are permanent. But the principal cause of the small increase during the past decade in the number of masonry wells, in these as compared with other provinces, is no doubt to be found in the reliance which is placed on temporary wells.

537. *Temporary wells.*—In no province in India are the general facilities for the construction of small temporary wells at all comparable with those of these provinces. There are no doubt large numbers of such wells in the Punjab, but even in that province there are four masonry to one temporary well, and the total number of temporary wells does not exceed 75,000. Whereas in the United Provinces in a dry year nearly a million temporary wells are in use for irrigation, that is, for each permanent well there are two temporary wells. They differ from the permanent wells in being lined with a cylinder of wood, wicker-work,

* This theory of the action which takes place in a well was first advanced by Mr. J. S. Beresford of the United Provinces, Irrigation Department.

or brushwood, instead of masonry. The lining, as a rule, is carried up to only a few feet above the water surface. The temporary well may, like the permanent well, receive its supply either from a spring or from percolation. Where the supply is wholly by percolation the temporary well is a mere hole in the ground from which water is drawn by manual labour with the aid of a wheel or a weighted lever. Such a well seldom irrigates more than two acres, and often only a mere fraction of an acre. A good spring well of the temporary kind, such as are found extensively in the Ganges-Jumna Doab, will irrigate four or more acres in the season. They are worked by bullock power and occasionally carry more than one water-bag. The cost of a temporary well may be anything from Rs. 2 to Rs. 50 according to its depth and the nature of the lining.

538. *Famine protective value of wells.*—We have already (paragraph 508) drawn attention to the fact that in these provinces the use of wells for irrigation, other than that of sugar-cane and garden crops, is confined almost entirely to the *rabi* season, and that they are of little value in affording protection to the *kharif* crop. But there can be no doubt that in 1896-97 it was the wells, and the wells alone, which saved the greater part of the Ganges-Gogra Doab from a famine which would have rivalled in intensity that of Bundelkhand. They made possible the sowing of the *rabi*, and the replacing over a large area of the failed *kharif* by *rabi* crops. Largely owing to the prompt and timely action taken by the Local Government in granting liberal advances under the Loans Act, over 550,000 temporary wells were made in that year, the construction of some thousands of masonry wells was put in hand, and many others were repaired and improved. Probably not less than half the extra number of temporary wells were made with the aid of the money advanced. But in addition to this, as was observed by the Local Government at the time, the value of the policy consisted not merely in the amounts advanced and the number of wells which the cultivators were thereby enabled to construct, but in the stimulus which was given to private effort and the confidence inspired in the Government. It is difficult to conceive a more striking instance of the success of the policy, which we have strongly recommended elsewhere, of making, at the earliest possible stage of a threatened famine, large and liberal advances for the construction of temporary wells, as well as for seed, cattle, and lifting gear.

539. *Scope for the extension of well-irrigation.*—After careful consideration, we have come to the conclusion that, notwithstanding the large extent to which well-irrigation is already practised in the United Provinces, there is wide room for its extension. In Bundelkhand, the tract most exposed to famine, nothing can be done in the black soil tracts for which well-irrigation is altogether unsuitable. But in the south of the Jhansi district, and in a few other parts of Bundelkhand, there are red and mixed soils perfectly suited to irrigation, and water is available at moderate depths. Particularly favourable conditions exist near the so-called 'lakes' of Hamirpur and the smaller tanks elsewhere, in the proximity of which the water level is raised. By the embanking and terracing of other parts of the country the water level for purposes of well-irrigation may be raised materially. The wells also are for the most part permanent and durable. In these tracts, therefore, as in the Deccan, all the concessions and methods which we have advocated in the general chapters on private irrigation works and loans for improvements, may appropriately be offered and tried. Of the great alluvial tracts north of the Jumna the only parts in which well-irrigation is impracticable are those, mostly in the neighbourhood of the high banks of the great rivers, in which the subsoil water is found at prohibitive depths. Elsewhere distinctive treatment must be adopted according to the requirements of districts and parts of districts.

540. In the districts of the Ganges-Jumna Doab, which are liberally provided with canal irrigation, no special measures will be required, except possibly in those few localities which cannot be reached by canals or their extensions. In such localities, which are generally favourable for the construction of permanent wells, advances should be given freely. But, so far as we can judge, free grants-in-aid will not be required.

541. In parts at least of the Ganges-Gogra Doab a greater measure of liberality will be justified. The districts of the Lucknow Division which are situated in the centre of this tract suffered severely in the famines of 1896-97 and 1877-78, and in parts of them all there is considerable scope for the extended construction of permanent wells. Here grants might be allowed in addition to advances. The western portion of the tract, comprised in the Rohilkhand Division, suffered considerably in 1877-78, but escaped easily in 1896-97. It is also doubtful whether, except perhaps in the district of Budaon, conditions are favourable to the construction of permanent wells. The matter should be carefully inquired into, and wherever permanent wells can be made with advantage their construction should be sedulously encouraged by advances; but grants need not be made until the wants of other tracts, where the necessities are greater, have been satisfied. In the Fyzabad Division of Oudh, in the district of Jaunpur, and in parts of Allahabad and Benares in the south-eastern angle of this Doab, well construction has advanced so far that special measures of encouragement are not urgently required. The same also may, perhaps, be said of the districts of the Gogra-Gandak Doab, in many parts of which, also, tank-irrigation is generally very efficient.

542. *Takavi advances.*—There is, however, probably no district in which *takavi* might not be granted for permanent wells on a materially larger scale than at present. The majority of our witnesses are not enthusiastic as to the amount which can be done in this way, and the Hon'ble Mr. Roberts, the Local Member of the Commission, has rightly drawn attention to the difficulties which are certain to be encountered owing to the sub-division of holdings, the want of co-operation, peculiarities of tenure and other causes; and he does not, like most other local members, press for large increases in the *takavi* allotments, or express any hope that the progress of well construction can be materially accelerated by anything which Government can do. We agree that here, as in other parts of India, the progress in the construction of permanent wells to be healthy must be gradual. But we are not satisfied that the possibilities have been exhausted. Individual officers have occasionally been very successful in the distribution of *takavi* in ordinary years; for instance, Colonel Pitcher, who in one season distributed over half a lakh of rupees in a small district. Over the Provinces as a whole, the amounts advanced in ordinary years have been very small; and it is clear that, generally speaking, no strenuous or sustained endeavour has been made to stimulate the execution of private improvement by means of *takavi*. Until an endeavour of the kind has been made and failed, the attempt ought not to be abandoned.

543. As in other provinces, the procedure is capable of substantial improvement on the lines indicated in Chapter VI. In particular, subordinate district officers should be everywhere empowered to make advances without reference to the head of the district, and the necessary inquiries should be made by them and money advanced on the spot. Borrowers should also be allowed free option of long terms of repayment, fixed solely with reference to the durability of the work. In the Doabs, however, some caution may be necessary in this matter, as the life of wells is uncertain. But it should be within the discretion of the officer granting the loan to allow a period up to at least twenty-five years.

544. With regard to difficulties of tenure and the like, we first observe that the people who are likely to take the advances are the smaller zamindars and permanent tenants. With regard to the former no difficulties arise. Their land is freely available as security for advances, and under existing rules long periods of exemption from taxation are allowed. In Bundelkhand there should be no objection to making the exemption perpetual. The resulting loss of revenue should be trifling, and the need of wells as a protection against famine is so great, that no measure of liberality allowed elsewhere ought perhaps to be denied here. It may be doubted, however, whether the grant of perpetual exemption will have much practical effect. Elsewhere in the United Provinces it is quite unnecessary, for the mere purpose of encouraging the construction of permanent wells, to make this concession.

545. *Improvements by tenants.*—As regards tenants, however, it is impossible to say that under the existing law they enjoy everywhere a fair measure of protection against the enhancement of their rents after they have constructed wells. In Oudh the law grants no protection beyond fixing rents for seven years, —a period obviously insufficient to exhaust the value of such an improvement as a permanent well. But there is no part of the United Provinces in which the construction of permanent wells has made more regular and consistent progress than in Oudh; and the best informed settlement and revenue officers seem to think that those landowners, who are least disposed to encourage tenants in such construction, do not succeed in preventing it by enhancement of rent. This is due to the fact that in Oudh there is little or no difference between the rates of rent on irrigated and unirrigated land (hereafter referred to as the wet and dry rates), and that neither kind of rate is excessive. It would probably, therefore, not be worth while to make any serious alteration in the Oudh rent laws, with the object of protecting the tenant from the trifling enhancement to which he is at present liable on construction of a well. In the Province of Agra, however, the excess of wet over dry rates is frequently considerable, and the case is therefore different. Here tenants with a permanent right of occupancy are protected against enhancement of rent for a period of ten years, and the law also provides that their rents shall not be enhanced on the ground that the productive powers of the land held by the tenant have been increased by an improvement effected by his agency or at his expense. By another provision, however, the landowner is allowed to claim an enhancement of rent on the ground that the rate paid by the tenant is below the prevailing rate paid by occupancy tenants for land of similar quality and enjoying similar advantages. The consequence is that a tenant, who for the first time introduces well-irrigation into a tract previously unirrigated, is not exempt from enhancement of his rent up to the rate prevailing on land in the same neighbourhood, in which similar facilities for irrigation exist. Hence if a tenant make a temporary well he will be called upon to pay the wet rent rate on land irrigable from it; and apparently if he replaces an inferior earthen well by a permanent masonry well, and so contrives to irrigate a larger area than before, he will be liable to pay the wet rate on the additional area. It is worthy of consideration whether the law ought not to be made more liberal for the tenant. The existing provisions are defended on the ground that the difference between the dry and the wet rate is the equivalent of a royalty on the subsoil water, to which the landowner is fairly entitled. Admitting this, however, it must be remembered that Government is entitled to take a similar royalty from landowners when they make irrigational improvements, and that Government foregoes its share of this royalty for at least a whole thirty years' period of settlement. Tenants who make similar improvements would seem to be entitled to receive from their landowners not less liberal treatment than improving landowners receive from the State. We submit, therefore, for consideration the suggestion that when a tenant constructs a permanent well, the land commanded by which was previously unirrigated and assessed only at dry rates at the time of the construction of the well, the land should be exempt from wet rates until the expiry of ten years after the period for which the tenant is entitled to hold the land at the existing rental. Thus, if a tenant constructs the well at the commencement of the ten years' period for which his rent cannot be enhanced, he will secure exemption from wet rates for a period of twenty years. Such a measure as we propose would, we believe, prove an effective inducement to tenants to make permanent masonry wells. It may be opposed by the landowners, but if it results in the extended improvement of their land it will tend to their permanent benefit. It cannot be considered unjust to them, since the additional period of exemption suggested for the tenant's improvement is only one-third of that which the landowner receives from Government for his own improvement.

546. *Transfer of occupancy rights.*—Another difficulty in getting money advanced to tenants which has been brought to our notice is this: the land of tenants not being legally transferable except to a very limited extent to co-sharers in the tenancy, and by sublease, cannot be received as security for the advance. As a remedy it has been proposed by one competent witness that the interest of occupancy tenants in their land should be

made transferable for purposes of recovery of *takavi* advanced to them, and that a special law, of which he has furnished a draft, should be passed for this purpose. The great majority, however, of local officers seem to be strongly averse from such a measure, which would no doubt be opposed by the landowners. We accordingly hesitate to recommend it. But as pointed out in the general chapter on *takavi*, legislation of the kind has been passed in the Central Provinces. Its effect there might, we think, be watched with advantage; and if the result is to facilitate the advance of *takavi* to tenants, without causing substantial injury to either landowners or tenants, the advisability of undertaking further legislation in the United Provinces might be seriously considered.

547. *Boring tools.*—We have had frequent occasion to mention the clay beds from below which the supply of what are termed spring-wells, whether permanent or temporary, is drawn. The distribution of these beds and their depth below the surface are extremely variable, and on these factors depends largely the suitability of any tract for the construction of the different kinds of well as well as the success of individual wells. The people are said to be wonderfully well-informed as to the distribution of the beds. Nevertheless, instances are very frequent in which wells fail owing to failure to strike them, or to finding them of insufficient thickness; and with the object of ensuring more uniform success the Agricultural Department has recently employed a small establishment equipped with boring tools, and men and tools are lent for a small fee to landowners and cultivators who desire their services. We think that this system deserves extended trial, and have made similar recommendations for other provinces.

548. *Tanks.*—There are practically no embanked private tanks of any considerable size in the United Provinces. Close to almost every village there is a pond, the excavation of which afforded materials for the construction of the dwelling houses; and occasionally in some parts of the country, especially in Mirzapur and the Bundelkhand districts, water is held up by small embankments across depressions or drainage lines. But, except in Mirzapur and the adjoining *trans*-Jumna districts, where the tanks are often fed by diverting natural streams, these two classes of tanks are used chiefly for watering cattle and bathing purposes; and the *jhils* or natural depressions which are found in large numbers, more especially in the eastern districts of the sub-montane and central tracts, account for nearly the whole of the irrigation classed under tanks. In a favourable year over $2\frac{1}{4}$ million acres are irrigated from this source; but in a year of drought the supply of the tanks fails and the area falls to under a million acres. In many districts, in a year of severe drought, it may even be reduced to one-fourth of the area of a normal year. But though the tanks fail when they are most required, their protective value is very considerable. They ensure a good crop to a large area in all ordinary years; and occupying as they do a considerable portion of the ground surface, their effect in maintaining the level of the subsoil water must be very great.

549. *Canals for filling jhils.*—It has been suggested that some of the large snow-fed rivers, all of whose waters are not required for direct irrigation from canals, might be utilized to fill the tanks in a year of drought. We have no doubt that the supply of many tanks could be assured by this means, and the proposal has the great advantage of interfering to the least possible extent in the vested rights of the cultivators to the waters of the natural *jhils*. But the cost would probably be great in proportion to the advantages conferred, and we are doubtful as to the ultimate benefit to the country. The water would no doubt have to be lifted before it was delivered on to the field, and thus the loss of water from the village channels would be reduced to a minimum. But, on the other hand, the larger area of ground which the water would cover, both in the *jhils* themselves and in the channels constructed for conveying water to them, and the extra volume of water which would undoubtedly be poured on the fields, would lead to increased percolation into the subsoil. This would mean an addition to the subsoil water and a counteraction of the effect which dry years now have in retarding the rise of the subsoil water level. The addition would be immaterial if it

were certain that the canal would only be used in years of really serious drought. But when a canal had once been made, we think it very unlikely that its use would be rigidly confined to such years. It would in all probability be opened and used when there was any hope of its water affording real and immediate benefit to the cultivator. If this were the case the effect which dry years undoubtedly have in preventing a rise in the subsoil water level and in maintaining its present equilibrium, would be considerably diminished; and the result would infallibly be a gradual rise of the subsoil water table. Once the present equilibrium had been upset, sooner or later, the rise would become serious; and we should not then have, as in the case of a canal for direct irrigation, the counteracting effect of an efficient drainage system. Efficient drainage means the emptying of the *jhils*, and keeping them empty for as long as possible; a result which would obviously be incompatible with any arrangements for keeping them filled or even partially filled. On these considerations we are doubtful of the advisability of constructing *jhil*-filling canals extensively in any part of the country in which the spring level is already high. At the same time we recognize the danger of generalizing on any question of the kind. The probable advantages and disadvantages of a canal for filling *jhils* in any tract can only be determined by detailed local observations and inquiries, and by careful observation of the effects of a rise or fall in the level of the *jhils* on the water surface of the wells in their vicinity.

550. *Other private works.*—Irrigation by lifting water from streams and rivers, or by diverting it into small private canals or river channels, accounts for most of the three-quarter million acres irrigated from 'other sources.' Nearly half of the area shown under this head is comprised in the three districts of Shahjahanpur, Gorakhpur, and Basti.

551. *Messrs. Peppé's and Holdsworth's canals in Gorakhpur.*—Of individual works the canals which have been constructed by Messrs. Peppé and Holdsworth in their estates in the Gorakhpur district are remarkable instances of what can be done by private enterprise for the development of irrigation; and also of the great benefit of water to rice cultivation even where the average rainfall exceeds 60 inches, if it is liable to be deficient or unfavourably distributed throughout the season. In Mr. Peppé's estates an area of about 40,000 acres has been brought under irrigation by constructing earthen embankments, provided with sluices for passing flood waters, across those streams which, rising in Nepal, flow through the estates. By this means the water is held up and diverted into more than 100 miles of irrigating channels. The embankments form reservoirs from which the upper 5 or 6 feet can be drawn when the volumes in the rivers fall below requirements. A portion of the flood water is also diverted and stored in a neighbouring depression. Mr. Peppé's works, it is satisfactory to note, have been imitated on a smaller scale by the native owner of an adjoining estate; and the good example which he set might apparently be followed with considerable advantage in other estates if the owners could be persuaded to combine. Of the possibility of this Mr. Peppé is, however, by no means hopeful. We should note that the water supplied by these works is used chiefly for rice. It is also taken for a small area of *rabi* crops, but for these, with a view to the prevention of water-logging, the cultivators are made to lift the water on to their fields. The works in Mr. Holdsworth's estates consist of a number of small reservoirs in which the local rainfall is collected for the irrigation of about 15,000 acres of rice and *rabi* lands.

552. *Field embankments.*—There are no records showing the area of embanked fields in the United Provinces; but in the *trans*-Jumna districts, small embankments, 3 or 4 feet high, similar to those of the adjoining districts of the Central Provinces, afford valuable protection to a considerable area.

553. *Extension of private works other than wells.*—In most of the submontane districts there appears to be still room for the construction of small canals and other private works for utilizing the waters of hill and local streams; but for these no special measures appear to be necessary. In the case of larger works, which would irrigate in more than one village or estate, it would be better

for Government to undertake their construction as State works. The only classes of private works, other than wells, in connection with which the assistance of Government is urgently required are the tanks and field embankments of Bundelkhand. By the construction of the Betwa Canal a large portion of the Jalaun district has been rendered fairly secure. The Ken and Dassan projects will, it is to be hoped, afford similar protection to large areas in Banda and Hamirpur; but in all these districts, more especially in Jhansi and Hamirpur, there will still remain large areas, which will have to depend for their protection on the utilization of the local rainfall. The area that can thus be provided for will be small; the works themselves will be small and scattered; and, at the best, the protection afforded will be incomplete. But, excepting perhaps the Ken and Dassan canal projects, there are no possible irrigation works in the United Provinces, which are of more pressing necessity than these, or to which the attention of the Irrigation Department can be more usefully directed. Here, as elsewhere, these small works will be liable to fail in a year of drought. There is no doubt, however, that the villages which suffered most during the recent dry years were those which had no tanks; and we have had ample evidence, from Mr. Silberrad, the Sub-divisional Officer of Lalitpur, and others, of the general benefits derived from the tanks and embankments, and of the good results of the repairs and improvements carried out during the famine of 1896-97 and the drought of 1899-1901. When an Engineer has been appointed, as recommended in paragraph 530, and provided with the required staff, the first measure necessary will be a systematic reconnaissance of each separate catchment, and a survey of the tanks at present existing and of any suitable sites for new tanks. The tanks which seem worth repairing should then be selected; and in each case a rough estimate should be made of the cost of placing the work in a thorough state of repair, and of providing it with a proper outlet and an escape for flood waters. Rough estimates should also be made of the cost of possible new tanks, including large field embankments, and in each case an estimate should be made of the area likely to be benefited. With these estimates available, the extent to which the cultivators are willing to meet the cost can be ascertained, and the assistance which Government can reasonably be expected to render in carrying out the work can be considered. It can then be decided whether a detailed project and estimate is worth preparing, with the object either of having the work carried out at once as a State or private work, or of having it brought on to the programme of relief works.

554. In respect of the extent to which Government assistance will be required our information is not sufficiently detailed to enable us to form any definite opinion. But we have no hesitation in saying that, generally speaking, very much more liberal assistance will be needed, and may reasonably be rendered, than that which we have recommended for similar works in the Central Provinces (paragraphs 356, 361, 362, 375, and 376). With this reservation our recommendation regarding those works may be read as being generally applicable to these. The recommendation made in paragraph 375, that in certain cases Government should bear the whole cost of the work if the tenants agreed to pay a small annual charge on the acreage benefited, would appear to be specially suitable to the small tanks and field embankments of Bundelkhand. No work either of improvement or construction should be undertaken until the land-owners concerned have agreed to be responsible for the annual petty repairs. The recommendations regarding acquisition of land (paragraph 362) may be taken as applicable to all districts of these Provinces in which there are private canals, or in which there appears to be any scope for their useful extension.

(*v*).—*Famine works and programmes.*

555. *Famine of 1896-97.*—There have been no works of famine relief carried out in the United Provinces since 1896-97; and as the works carried out in that year have been dealt with in the Report of the Famine Commission of 1898, it is unnecessary for us to refer to them beyond noting that, out of a total expenditure of 121 lakhs incurred on works of relief, Rs. 20,000 only were spent on actual works of irrigation. This small sum was spent by employing relief labour on the Fatehpur Branch of the Lower Ganges Canal, which was then under

construction as an ordinary work. Over 55 lakhs were indeed spent in improving and deepening tanks, and in constructing a few new tanks in the Banda district, and we have had evidence as to the real utility of some of these works in extending irrigation and rendering the water-supply more secure. But the vast majority consisted of mere deepening of village tanks, which are used almost entirely for domestic purposes and supplying water to cattle. These works have their own use; but we have no doubt that, at least in the districts south of the Jumna where the famine was most felt, many of much greater and more permanent utility than those which were actually carried out, could have been provided if projects had been in readiness for the improvement and repair of existing irrigation tanks, and for the construction of new tanks and field embankments.

556. *Programmes of relief works.*—The latest programmes which were laid before us certainly provide ample work for any number of people who are likely to require employment; and village works occupy a prominent place in the programme of almost every district. The great bulk of the work, however, still consists of raising roads, collecting road metal, and deepening village tanks; and in most part of the Provinces this must continue to be the case. But, in the south-Jumna districts at least, where famine is most frequent, we have no doubt that, if the proposals made in the previous section are accepted, it will be possible to substitute for some doubtful works now on the programme a number of really useful irrigation works, including field embankments.

557. *Works in ravines.*—While in Bundelkhand we had an opportunity of inspecting some small tank works at Raksha, which were constructed 14 years ago by Mr. G. E. Ward, at that time Commissioner of Jhansi. The object of these works was to check scouring and ravining, caused by the too rapid off-flow of the rainfall, by throwing across the minor drainage lines a series of low banks, so that after heavy rain there should be a succession of shallow ponds, the water in which would by degrees soak into the subsoil and tend to raise the spring level in the neighbouring wells. The banks would at the same time check the denudation o soil which would be deposited in the ponds and form a bed of good soil which could be sown with a *rabi* crop as the water disappeared. A similar system has been practised largely by the French Forest Department in the valleys of the Alps. We found that the deposits above the banks at Raksha were not very extensive, and that no attempt had been made to cultivate above the banks; but the banks have been useful in increasing the cold weather supply of the stream, and in maintaining the water level of the wells in the immediate vicinity where there was a large area under cultivation. Any measures for checking denudation and retaining water in Bundelkhand are desirable; but a number of years must necessarily elapse before any tangible results can be obtained such as would justify considerable expenditure on them by the State, more especially where the people cannot be relied on to do their part in keeping them in repair. Nevertheless we think that they are works on which, in the absence of anything better, relief labour may with advantage be employed, if suitable sites have been carefully selected beforehand.

CHAPTER XX.—UPPER BURMA AND BALUCHISTAN.

558. *Introductory.*—The provinces of Upper Burma and Baluchistan were both excluded from our tour of inquiry; but for statistical purposes we have included them in the area dealt with in this report, and we shall now give a brief abstract of the information which has been furnished to us regarding irrigation works, both State and private, in each of the two provinces, and the possibility of their further development.

SECTION I.—UPPER BURMA.

559. *General conditions.*—Irrigation in Upper Burma is for the most part confined to the 'dry zone,' a tract from which the Arakan hills divert the rain of the south-west monsoon. It extends from Minbu and Magwe in the south to Shwebo in the north. Within this tract the rainfall varies locally from only 15 to 30 inches, and it is liable to great annual fluctuations. In many places the local rainfall affords the only source of irrigation, and when this fails and there is no hope of securing a crop, the people migrate in search of employment into Lower Burma. In the seventeen British districts comprised in Upper Burma, about $4\frac{3}{8}$ million acres were cropped in 1900-01; and of this 828,000 acres or about 18 per cent. were irrigated. Rice constituted about one-half, and the millets, about one-fourth of the total cropped area.

560. *State irrigation works.*—The State irrigation works of Upper Burma may be classed under two heads: major works and minor works. There are only two major works—the Mandalay and Shwebo Canals, both of which are still under construction. The former will utilize the waters of the Madaya river for the annual irrigation of about 90,000 acres in a portion of the Mandalay district which has suffered frequently from drought. It is estimated to cost $47\frac{1}{4}$ lakhs and to yield a net return of $6\frac{3}{4}$ per cent. The canal was opened in 1902, but the system of distributing channels is still incomplete. The Shwebo Canal, from the Mu river, is estimated to cost 48 lakhs and to yield a return of over 8 per cent. on capital. It will irrigate 150,000 acres in the Shwebo and Sagaing districts where, owing to the uncertainty of the rainfall, cultivation is very precarious. The canal is not expected to come into operation until 1905.

561. The minor works consist of about 200 works for which revenue accounts only are kept, and some smaller works which yield no revenue. The works for which revenue accounts are kept comprise 14 canals, 4 large storage works, and a number of smaller canals and tanks. Most of them are old works which were in existence at the time of annexation; but many of them had fallen into disuse owing to the want of arrangements for controlling floods, and, in the case of canals, to faulty alignment and the absence of permanent weirs, regulators, and falls. The works had been greatly neglected in the later years of Burmese rule, and since annexation an outlay of about 50 lakhs has been incurred on their improvement and on the construction of additional works. In 1900-01 the receipts, including the share of land revenue credited to the works, exceeded the total charges by 4 lakhs. On the completion of the works of extension and improvement the annual net revenue will probably exceed twice that sum. As already stated, the works irrigate annually about 350,000 acres.

562. *Scope for extension of State works.*—In addition to the two major works, one of which is nearly completed and the other still under construction, only two works of any considerable size have been proposed—the Mon and Yenatha Canals. The former consists of canals on the north and south sides of the Mon river, taking out from above a weir common to both systems. These canals will effectively protect a portion of the Minbu district which is now subject to frequently recurring scarcity. The estimate for the works, amounting to 44 lakhs, has recently been sanctioned. The canal will irrigate annually about

79,000 acres or 93 per cent. of the irrigable area, and is expected to yield a net return of 6·7 per cent. on its capital cost. The Yenatha Canal is a smaller and less promising work, for the utilization of the surplus supply of the Madaya river. It is estimated to cost about 10 lakhs, to irrigate annually 16,000 acres, and to yield a net return of over 5 per cent. on capital cost. These are the only large irrigation schemes likely to be carried out in Upper Burma, as there is said to be no prospect of utilizing the waters of the Irrawaddy, Myitnge, and Chindwin rivers.

563. Nor does there appear to be much prospect for the further construction of minor irrigation works, past operations having exhausted most of the favourable sites. In the Kyaukse district, however, which is traversed by two rivers and irrigated by thirteen canals, there is still room for extending irrigation by improving the smaller distributary channels. A considerable expenditure has been incurred on constructing permanent weirs for nine of the canals, and on enlarging and remodelling the larger channels. A continuance for a few years of the present policy of granting liberal allotments for these works of improvement will admit of the minor distributary channels receiving attention, and should result in a considerable extension of the irrigated area. The same remark applies to the distributary system of the Nyaungyan-Minhla storage works in the Meiktila district. There appears to be also some possibility of utilizing, for the extension of irrigation in the eastern districts of the dry zone, the more assured and abundant rainfall of the Southern Shan States plateau, and of the range of hills which divide Yamethin from Magwe, and Meiktila from Myingyan. Elsewhere there is apparently but little if any possibility of constructing works for the irrigation of any portion of the dry zone, excepting such as would be entirely dependent upon a scanty and uncertain local rainfall; and the advisability of constructing works which would certainly fail in a dry year, and which might attract a population that could be better located elsewhere, is extremely doubtful. Certainly the execution of works for which the water-supply is not assured should be postponed until daily registration of the flow, throughout a number of rainy seasons, shows conclusively what supply will be available.

564. *Private irrigation works.*—We have but little information regarding the private irrigation works of Upper Burma. By far the most important are the private canals which irrigate annually about 300,000 acres. Two-thirds of this area lies in the single district of Magwe, in which every stream flowing from the hills towards the Irrawaddy has a series of sand or brushwood *bands* with a channel to each. These temporary works are constructed by the villagers who combine either to construct them themselves or to hire a contractor. In this district nearly the whole area that it is possible to bring under irrigation is occupied by these small canals and many of the streams are taxed almost beyond their capacity. In addition to the area irrigated by private canals in Upper Burma, about 75,000 acres are irrigated from small private tanks and 100,000 from 'other sources.' In a favourable year about 7,000 acres, or less than one per cent. of the whole irrigated area, are watered from wells. With regard to well-irrigation, the Honourable Mr. Norton, to whom we are indebted for much of the information contained in this section, writes—

> Well-irrigation has not been mentioned by any of the district officers, but the little experience that has been obtained tends to show that the Burman cultivator finds it too expensive and the labour involved too heavy. There is no demand for loans to construct wells, and the only irrigation at present practised is by means of temporary shallow wells with rudely constructed bucket lifts for betel, vine, or onion cultivation. There does not appear any immediate prospect of extension in this mode of irrigation.

565. *Field embankments.*—Embankments known locally as *kazins* for retaining the rain water in the fields are to be found wherever rice is grown.

566. *Programmes of relief works.*—Programmes have been prepared for all districts which are at all liable to famine. For the Meiktila, Yamethin, and Myingyan districts, they are incomplete, and an Engineer is specially engaged in preparing a programme of irrigation works for these districts, chiefly with the object of providing a sufficient number of test-works. The Mon and

Yenatha Canals will, it is said, suffice for all the relief labour likely to be required in the next 11 years. And with a people so well accustomed to migration there would appear to be no objection to drafting relief labourers on to these works. When the necessary observations have been made of the supplies likely to be available for contemplated works, the programmes should be extended so as to include not only a sufficient number of test-works, but also all schemes which promise to have any real protective value.

Section II.—BALUCHISTAN.

567. *General conditions.*—The information which is available with regard to irrigation in Baluchistan is necessarily incomplete. Only a small portion of the province is under British rule, and it is only about 25 years since the British Government has been in any way connected with the administration of the country. The population, especially in the districts of Thal Chotiali and Zhob, is scanty, and in many parts the inhabitants are accustomed to retire with their flocks across the border when forced to do so by unfavourable seasons. The people are shepherds rather than agriculturists. The extension of irrigation works, giving a fairly permanent supply of water, would induce the people to settle down and take to cultivation. Unfortunately, in many parts of the province, the only sources of supply for irrigation purposes are the floods which come down from the hills with great velocity; they last only for a short time, and the water is heavily laden with silt.

568. *Rainfall.*—In the plains and lower valleys the annual rainfall varies from 3 to 7 inches, and is received chiefly during the summer months. The higher portions of the province (3,000 to 7,000 feet) receive 5 to 11 inches chiefly during the winter season.

569. *State irrigation works.*—There are only two State irrigation works in Baluchistan—the Khushdil Khan reservoir and the Shebo Canal, both in the Quetta-Pishin district. These two works, constructed at a cost of about 16 lakhs, irrigate annually an area varying, according to the nature of the season, from 4,000 to 8,000 acres; and they yield a return of only 1 or 2 per cent. on their capital cost. Improvements which are now being carried out, with the object of increasing the catchment area, will render the Khushdil Khan reservoir a more useful and profitable work; and it is possible that closer professional supervision may increase the utility of the Shebo Canal.

570. *Extensions of State irrigation works.*—The possibilities of constructing new works, both State and private, have recently been investigated by Mr. Mellor, of the Punjab Irrigation Department, who has submitted a list of thirteen proposed State works. Their sites all lie in the two British districts of Quetta-Pishin and Thal Chotiali, and in the districts of Zhob and Chagai which are directly under British administration. They are small works, costing from five thousand to four lakhs of rupees, and are chiefly for the utilization of flood waters. It is evident from Mr. Mellor's reports that there is not much scope for the extension of State irrigation works for the utilization of surface water, all permanent supplies of surface water being at present almost fully utilized. We have referred in the previous section to the risk of constructing, in thinly populated tracts, works which would be dependent upon a scanty local rainfall, as they would probably have the effect of bringing in settlers for whom it would be difficult to provide in a bad season.

571. *Private irrigation works.*—The private irrigation works consist largely of works for drawing off the flood waters of hill torrents or the waters of perennial streams. But the great feature of cultivation in Baluchistan is the *karez*. Field embankments are also extensively made. These classes of works are thus referred to by Major MacMahon, Revenue Commissioner, in his Report on Irrigation Works in Baluchistan:—

> The *karez* is an underground tunnel which taps a supply of water in high ground and leads it on to the surface of lower lying country. The system is greatly resorted to, and to it

are due most of the fertile spots in Baluchistan. The *karez* requires skilled labour in its construction, and is not a work on which famine labour can be employed. The country, however, lends itself to such works, and very large areas can be brought under cultivation by their means. *Karez* construction is extending gradually. It must remain a purely *zamindari* work, helped by *takavi* advances. Such help should be generously given, as the *karez* is the great stand-by of the country. After inspection of a large portion of Baluchistan, one is convinced that the *karez* must be depended on to do most towards furthering cultivation.

The only other permanent cultivation depends upon the small permanent supplies of water which are to be found in several streams where they debouch on to the extensive level valleys which lie between the main ranges of hills. The two rivers of the country are the Zhob and the Nari. The permanent supply of these rivers is made full use of.

Cultivation depending on rainfall is as follows : crops sown and matured by rainfall in the area cultivated ; crops sown in plots which are flooded to a depth of 2 or 3 feet by means of *bands*, the drainage being held up on the lower slopes at the foot of hills ; and, thirdly, crops sown in land on to which flood water has been diverted from the neighbouring large drainage channel.

The only means of extending cultivation lies in—

(*a*) *Karezes.*

(*b*) In making use of small permanent supplies in nullahs by bringing down in pipes water which would otherwise be lost in the shingle beds before cultivable land is reached.

(*c*) In making better use of the violent floods which run in most drainages after heavy rain.

(*d*) In the neighbourhood of Quetta there are several artesian wells and other parts of Baluchistan probably offer sites, and it is hoped to push work vigorously in this direction as most of the water from the rainfall soaks down deep into the porous soil, and can only be brought to the surface for irrigation purposes by this means.

572. *Artesian wells.*—With reference to (*d*), we may add that experimental borings in Baluchistan would appear to offer more hope of securing artesian supplies at a moderate depth than in any other part of India. The wells which have already been made in the Quetta valley are all confined to a very small portion of the province, but there is no reason to suppose that artesian waters at the same moderate depths do not exist in other parts. On the contrary, in Mr. Vredenburg's report already referred to (I, 217), it is stated that the structure of the alluvial deposits in the valley-plain of Quetta is by no means special to that locality, but is common in a greater or less degree to all the talus deposits that fringe the high mountains of Baluchistan.

Chapter XXI.—NATIVE STATES.

(Including Ajmer-Merwara, Berar, and Coorg.)

Section 1.—RAJPUTANA.

(*i*).—*Local conditions; use and value of irrigation.*

573. *Physical and agricultural conditions.*—Rajputana, with an area of about 130,000 square miles, embraces 20 separate States together with the British districts of Ajmer and Merwara. In its physical and agricultural aspects it presents an extraordinary diversity, including every gradation from the sandy and almost rainless plains of Jodhpur and Bikaner with their semi-nomad population and ever-shifting cultivation, to the smiling wheat valleys of Kotah, where the crops are more liable to suffer from excessive than from deficient rainfall, or to the black soils of Partabgarh, where even opium can be grown without irrigation, and where, until 1899, famine is said to have been unknown. Almost the whole north-western half of the province, comprising the greater portion of Jodhpur and Jaisalmer, the Shekhawati district of Jaipur, and all except a small corner of Bikaner, is one immense sandy plain traversed by long lines of sand-hills. Within this area the rainfall varies in annual amount from a few inches in the north and west to about 14 inches along the south-eastern border of the desert. It is seldom sufficient to cause any surface flow, and any storage of water for irrigation purposes is out of the question. The subsoil water lies at a depth varying from about 100 or 150 feet in the south-west and north-east to upwards of 300 feet along the borders of Sind and Bahawalpur, so that irrigation from wells is also impracticable except at a prohibitive cost. Thus within this extensive tract there is practically no irrigation except in the extreme north of Bikaner, where the sand gives place to loam and a small area is irrigated from the Ghaggar Canals and from any surplus water that may be passed on from the Punjab through the Sirhind and Western Jumna Canals. The scanty population support themselves chiefly by their vast herds of camels, cattle, and sheep. Such cultivation as there is—mostly millets, pulses, and melons—is dependent entirely upon the rainfall, all of which sinks into the sandy soil, so that a very small fall is sufficient to bring the crops to maturity. But they are not always blessed with even that small modicum, and partial or total failure of the crops is a common occurrence.

574. The country generally slopes upward from the Rann of Cutch and the valleys of the Indus and Sutlej rivers until it meets the abrupt northern slopes of the Aravalli range between Abu and Ajmer, or the succession of isolated hills which mark the continuation of the range from Ajmer to the borders of the Gurgaon district. South-west of Ajmer, along the line of the Luni river and immediately under the northern slopes of the Aravallis, there are good breadths of permanent cultivation; but, speaking generally, the Aravallis may be said to form a broad dividing line between the sandy desert on the north-west and the hilly and more fertile south-eastern portion of Rajputana. South-east of the range, instead of a uniform and desolate waste of sand, there are extensive ranges of hills, wide river-valleys, open plateaux, deep ravines, and broad stretches of rich alluvial soil—a country generally of good cultivation and with fair facilities for irrigation. Here maize, *juár* and cotton, wheat, barley, gram, opium, and sugar-cane are freely grown. The rainfall, however, is precarious and partial, varying much from year to year, and in the same year from place to place. The average annual fall gradually increases from a minimum of less than 20 inches on the central watershed (Ajmer and Merwara), to about 30 inches in the extreme east (Dholpur), and to nearly 40 inches in the extreme south (Partabgarh and Banswara). The two British districts

of Ajmer and Merwara, the northern half of Mewar, and the southern half of Jaipur, the States of Kishengarh and Shahpura, and a portion of Tonk, lie on or near the limits of the two monsoon currents—one from the Bay of Bengal and the other from the south-west. This tract receives in some years an ample share of both monsoons, and in others only the fitful remnants of one. Thus the annual rainfall is extremely variable. It is sometimes more than double the average; on the other hand, it has been only about half the average in no less than six years since 1860. All these years, and others in which the rainfall, though sufficient in amount, was badly distributed throughout the season, were years either of scarcity or of famine. But the liability to famine is not confined to this tract. All the States to the north and east—Alwar, Bhartpur, Dholpur, Karauli, and Bundi—suffer periodically from deficient rainfall. Those to the south—the hilly part of Mewar and the States of Kotah, Jhalawar, Sirohi, Dangarpur, Partabgarh, and Banswara—are favoured with a more abundant and somewhat steadier rainfall; but recent experience has shown that their position also is by no means secure.

575. Looking to the records of the past it may be said that Rajputana is liable to suffer once in every 40 or 50 years from an almost complete and general failure of the monsoon rainfall, leading to widespread and severe famine; and that, in addition, all parts of the province, except the more favoured southern and eastern States, are subject to distress and scarcity, arising from a more or less local and partial failure of the rains, once in every six or seven years. Of the winter rainfall of Northern India, the province generally receives only an insignificant share.

576. *Value of irrigation.*—In a province in which the rainfall is so precarious and the cultivation dependent upon it so insecure, there can scarcely be any question as to the utility of irrigation. We have had ample evidence laid before us to show that where cultivation is possible, the soil, even when falling under the generic designation of black cotton soil, is suited to and repays irrigation; that, where water has been provided, the demand for it is practically constant and unlimited; and that, however great the extent to which it may be found possible to multiply irrigation works in the cultivable parts of Rajputana, there need be no apprehension lest the water should remain unused.

(*ii*).—*Existing State irrigation works.*

577. *Sources and extent of irrigation.*—Excepting the Ghaggar, the Mahi, and the Chambal with some of its tributaries, all the rivers of Rajputana have their sources within the province and are dependent for their supplies upon the local rainfall. With one or two exceptions they all run dry, or practically dry, soon after the rainy season. They are therefore but ill-suited for the direct supply of canals; while the Chambal—the one river which affords a perennial supply—traverses that part of the province which has hitherto been least in want of water. Thus Rajputana depends for its irrigation almost entirely upon wells and storage tanks. South and east of the Aravalli range, water is generally found fairly close to the surface, and there are numerous wells in every State; besides numberless old tanks scattered over the face of the country, many of them only large enough to provide water for domestic purposes. But even the smallest of these are not to be despised. They provide drinking water for men and cattle; the moist bed, fertilized by alluvial deposits, is cultivated as the water recedes; and many of them influence the wells by raising and maintaining the level of the subsoil water for a considerable distance around them—an effect which is perceptible even in years of drought when the bed of the tank is empty. Nearly all the tanks which are used for purposes of direct irrigation have been made of recent years, through professional agency and at the cost of the Durbars, though some of the largest and best were made many hundreds of years ago. The States which have been foremost of late years in providing funds for irrigation works are shown in the following statement. We have not been able to procure complete and accurate statistics of the extent of cultivation and irrigation in all the various States, but the figures given below, relating to

certain States and to the British districts of Ajmer and Merwara, may be taken as fairly correct :—

Name of State or Territory.	Area irrigated in a normal year.				Total number of State irrigation works.	Irrigation works constructed by the States during the past 30 years.	
	From wells.	From tanks, etc.	Total.	Percentage on normal area annually cropped.		Number of works.	Cost.
	Acres.	Acres.	Acres.			No.	Lakhs.
Ajmer-Merwara	106,000	36,000	142,000	36	889	...	...
Jaipur*	240,000	40,000	280,000	37	199	199	45
Jodhpur	244,000	123,000	367,000	6	32	32	29
Bhartpur	110,000	90,000	200,000	24	178	45	10
Kotah	48,000	17,000	65,000	10	44	44	8
Kishengarh	26,000	22,000	48,000	16	161	65	7
Alwar	129,000	64,000	193,000	11	103	22	6¾
Shahpura	14,000	5,000	19,000	32	170	...	5

* Excluding *jagir* or alienated lands.

578. *Ajmer-Merwara.*—Almost every available catchment in the districts of Ajmer and Merwara is utilized to its full extent for the storage of water by the numerous tanks, which, with few exceptions, were all made more than half a century ago under the directions of Colonels Hall and Dixon. Lying, as these districts do, on one of the main watersheds of India, both the tanks and the wells are dependent for their supplies entirely upon the local rainfall. There are no large rivers to feed the tanks, nor permanent currents of underground percolation to feed the wells. The extent to which the irrigated areas fluctuate with the rainfall is well exemplified by the following figures for very recent years :—

Year.	Rainfall.	Acres irrigated.		
		From tanks.	From wells.	Total acres.
		Acres.	Acres.	Acres.
1897-98	22·7	38,321	107,677	145,998
1898-99	12·35	25,592	93,486	119,078
1899-1900	6·64	13,421	43,776	57,197

There are four classes of tanks. On class I the area irrigated is assessed each year at certain rates which vary with the crop grown. The lands irrigated from class II pay at rates which vary in proportion to the area irrigated and, when the supply for the spring crop runs short, in proportion to the number of waterings. This variable system of assessment is said to work very satisfactorily. Tanks of class III pay an assessment fixed for a number of years. These three classes of tanks are maintained by Government. Those in class IV pay a fixed assessment, but are repaired by the villagers. The tanks are credited also with a share of the revenue assessed on wells whose supply they assist in maintaining. After special inquiry the share of the well-revenue creditable to the tanks was fixed at Rs. 35,799. Except in years of drought, when the receipts sometimes fail to cover the working expenses, the works return over 3 per cent. on their capital cost of about 25 lakhs. The revenue assessment upon which the credit to the tanks depends is, however, very light.

579. *Jaipur.*—During the past 30 years the enlightened rulers of the Jaipur State have steadily devoted a considerable annual sum to the construction of irrigation works. Carried out under the able supervision of Colonel Sir

Swinton Jacob, these works have proved of the greatest benefit both to the rulers and the people. The accounts of the works show only the revenue and expenditure for each year; there are no separate capital accounts. The expenditure shown includes the capital outlay and the cost of annual repairs, but it does not include the cost of the supervising establishment or the whole cost of collecting the revenue. We have, however, been furnished with figures from which we have been able to determine approximately the net revenue for each of the past ten years, and the capital outlay to the end of each year, in the case of 142 works which were completed before 1896. We find that the works have cost on the average Rs. 124 per acre irrigated. The rate of gross revenue averages Rs. 7·93 per acre, and the average working expenses Rs. 1·83 per acre; leaving a net return of Rs. 6·1 per acre or 4·92 per cent. on the capital cost. The revenue credited to the works consists of a water-rate levied on all lands irrigated, and of the State's share of the produce from all lands newly brought under cultivation by the works. It is understood that, beyond the water-rate, no credit is given to the works for the increased outturn on old cultivation or for the benefit derived from them by the adjoining wells; on the other hand, no deduction is made for any increase in cultivation that might have taken place in the absence of the tank. In addition to providing funds for the construction of large irrigation works, the Durbar have been liberal in advancing money to private persons for the construction of wells. During the recent famine advances to the amount of three lakhs were given free of interest, of which about one-fourth was for wells.

580. *Jodhpur.*—There are but few tanks in Jodhpur and but few sites suitable for making them. The six tanks made within the last 20 years, at a cost of 15 lakhs, irrigate 15,000 acres in a favourable year. They receive no water at all in a dry year, but their effect in raising the level and sweetening the water of the wells is said to extend for many miles. Along the base of the Aravallis and in the vicinity of the Luni river and its branches, wells are extensively used. There are 54,000 wells in the State and, wherever water is found at a reasonable depth, there are said to be now a sufficient number. In the sandy plain to the north of the Luni the subsoil water is at a depth of 300 feet, and in all this extensive tract there is practically no irrigation. The State employs a competent Engineer, and the Durbar and the people seem to have spared no efforts in making the best use of such scanty facilities for irrigation as their country affords.

581. *Kishengarh.*—More than half the total cultivated area of Kishengarh is said to be irrigated in a year of normal rainfall, but in the recent prolonged drought the tanks and wells appear to have failed to a greater extent even than in the adjoining district of Ajmer. Two-thirds of the whole catchment area of the State is already provided with tanks. Territorial difficulties have been the chief obstacle to the utilization of the remainder. In view of the extent to which the manufacture of salt from the Sambhar lake depends upon a sufficient supply of water, the Government of India have prohibited the construction of new or the extension of existing storage works on any of the feeder streams of the lake, whether in British territory or in Native States. One of the most important of these feeders is the Rupnagar river, which, rising in the hills near Ajmer, traverses and drains the northern and hilly portion of Kishengarh. At present there is a difference of opinion as to the extent to which the supply of water in the lake is likely to be interfered with by the works which the State proposes to construct; and it is difficult to form a definite opinion in the absence of careful observations, extending over a number of years, of the rainfall on the catchment and of the resulting flow at various points along the course of the river. Observations of this kind are now being made, but the records extend back only to July 1901. Mr. Manners-Smith, Superintending Engineer, stated before us that one filling of the four tanks proposed in the Rupnagar valley, three of which are in Kishengarh, would raise the surface of the lake by only $1\frac{3}{4}$ inches, the area of the lake being 90 square miles; but pending the investigation now in progress, we have not thought it necessary to go into the details of his calculations. For the same reason we have also refrained from considering whether any deficiency in the salt supply that

might be caused by the construction of the proposed works, could not be met by improved arrangements for utilizing, more effectively and scientifically than is done at present, the water which is allowed to spread over the whole surface of the lake.

582. *Bhartpur.*—In Bhartpur, out of one million acres available for cultivation 75 per cent. is cultivated, and of the cultivated area 24 per cent. is irrigated annually. The State is therefore fairly well protected by irrigation. During the past five or six years, a great deal of good work has been done in constructing new and repairing old irrigation works. By an expenditure of slightly over 10 lakhs, the area annually irrigated by the State's works has been increased by over 50,000 acres. The works, besides being of great benefit to the cultivator, are a source of considerable profit to the State; for they yield annually Rs. 40,000 in water-rates, and are said to have increased the annual land revenue by $2\frac{1}{2}$ lakhs during the past six years. The country affords unusual facilities for irrigation, and the works are of a simple and inexpensive character. They consist chiefly of embankments or *bands* carried along a contour or across a shallow depression, with the object either of impounding and distributing spill waters from neighbouring torrents, or of impounding the surface flow from local catchments. The country is too flat to admit of any prolonged storage of the water. There is in fact only one tank in the State in which water is kept in store after the sowing of the winter crops. The main object of the *bands* is to submerge the land above them, so as to fertilize the soil by the deposited silt and saturate it for the autumn sowings. The land being flat a low bank floods a large area. The Ajan Bund, an earthen bank 12 miles long, intercepts the spills of the Banganga river and submerges about 14 square miles of country, the depth of water being nowhere more than 10 feet. When there is water to spare during the rains, or when after the rains it is being drawn off to prepare the land for sowing, it is utilized to saturate the lands below the embankment. Indirectly the works are of great utility in sweetening the often brackish subsoil water and in maintaining the supply of the wells.

583. In *Shahpura* out of 60,000 acres under crops, about 20,000 acres are irrigated in an ordinary year—half from wells and half from tanks. But in a dry year the tanks fail completely; while, if the drought be prolonged over a series of years, the wells water only about one-fourth of their usual area. The tanks nevertheless are said to yield a substantial return on their cost, in years of ordinary rainfall.

584. *Alwar.*—In addition to the expenditure of five lakhs in constructing 22 new tanks, the Alwar Durbar have also spent over $2\frac{3}{4}$ lakhs within recent years in re-constructing and enlarging 40 old tanks. Irrigation has not been developed on many of the tanks, the people preferring to use their wells. The good the tanks do is mainly indirect, by sustaining the subsoil water-level. In many parts the configuration of the country is not suitable for storage—especially near the hills where the steep slopes would necessitate high and expensive dams. The valleys are for the most part already occupied by wells, the revenue from which is said to be far higher than that obtainable from tanks.

585. *Kotah.*—A rainfall that seldom fails, a fertile black soil, and, until recently, a supposed immunity from famine, form a combination little likely to lead to the construction of irrigation works. Such are the conditions in Kotah. Nevertheless there are signs that the need for irrigation had been felt in that State, from time to time, even before the recent famine—the first of which there is any record in this favoured country. Small tanks, about 400 in number, are scattered over the land. These are said to have been made in the first instance for irrigation, though they are not now used for that purpose, their beds only being cultivated. During the past 20 years the State has advanced 13 lakhs for the construction of wells and field embankments. The number of wells now in existence is sufficient to irrigate over 36,000 acres in a dry year; and there are besides six fairly large works which have been constructed by the

Durbar during the past 23 years at a cost of about five lakhs. These irrigate 9,000 acres and are said to bring in a substantial profit to the State.

586. *Bikaner.*—In constructing the Ghaggar Canals and a few smaller works the Bikaner Durbar have done almost all that it was possible for them to do towards developing irrigation in this ill-watered State. On the Ghaggar Canals which were made during the famine of 1896-97 in co-operation with the Punjab Government, the State incurred an expenditure of over 2¾ lakhs. The canals depend for their supply on heavy rainfall in the hills, and in almost every year since the works were made, the climatic conditions have been unfavourable. According to a statement supplied by the Dewan of the State the works have led to a total increase in revenue of Rs. 20,000 per annum.

587. *Other States.*—In the remaining States the irrigation is almost entirely from wells, and the proportion which the irrigated bears to the cultivated area varies from about 23 per cent. in *Dholpur*, to 18 in *Sirohi*, 13 in *Tonk* and *Bundi*, and 9 in *Partabgarh*. *Jaisalmer* is, for the most part, a desert in which there is no irrigation. No statistics are available to show the extent of cultivation and irrigation in the 14,220 square miles which are comprised in the State of *Mewar*. There are in this State numberless tanks varying in size from the Jai Samand, one of the largest artificial lakes in the world, to the small tank at which the cattle of the village are watered. They are, however, but little used for irrigation; even the great Jai Samand, with a waterspread of 21 square miles, does not protect more than a few thousand acres.

588. While this report has been going through the press we have received some interesting notes on proposed irrigation works in Dholpur by Sir Swinton Jacob who has carefully inspected this State. He writes—

> Nature could not have arranged better for the interests of Dholpur. If only good use is made of the opportunities afforded, enough water falls at the highest part to irrigate the greater part of the State and make it absolutely safe against famine.

Sir Swinton has examined four sites selected by Mr. Thorpe, the State Engineer, where it is estimated that water might be stored sufficient for the irrigation of about 75,000 acres. He recommends that the most promising of these schemes should be carried out at once.

(*iii*).—*Scope for further extensions of State irrigation works.*

589. *Irrigation cannot afford complete protection.*—To protect Rajputana —or any large portion of it—absolutely against famine, by means of irrigation works, is an impossibility; for there is no unfailing source of supply such as the glaciers of the Himalayas or the *ghâts* of Western India afford. It has indeed been suggested that the waters of the Sutlej and Bias could be diverted from the Punjab to Rajputana; but according to the levels which have been laid before us, to which reference has been made in the Punjab Chapter, the only portion of the province that could be commanded from below the junction of those two rivers is a comparatively small tract in the extreme north-western corner of the Bikaner desert. And even if the Punjab could spare the water and the soil of the desert were found to be suitable for irrigation, the introduction of a canal into this outlying tract, though of great benefit to a portion of Bikaner, would afford no protection to the rest of Rajputana from which it is divided by 200 miles of desert. This relatively insignificant area in the extreme north-west, and another small tract where the Chambal river traverses the opposite corner of the province, are no doubt within reach of perennial sources of supply; but, speaking generally, Rajputana is dependent for its irrigation upon local rainfall. All available means of irrigation therefore fail under such conditions as have prevailed of late years; wells for the most part yield less than half their usual supplies; many dry up altogether; and all works of surface storage, save the very largest, fail almost completely.

590. But though the conditions render it impossible for irrigation to afford full and complete protection to Rajputana, much can be done in the way of partial protection. In most years a good deal, and in ordinary years an

immense deal, of water now runs to waste. It is not always possible to utilize it at any point in each State through which it passes; for the rivers and streams sometimes run through impassably deep ravines or through uncultivable jungle. But in the main, wherever the rainfall is sufficient to cause surface flow, the configuration of the country lends itself to the storage of water; and with quite insignificant exceptions the soil, when cultivable, is suitable for irrigation. The main problem to be solved then is to utilize to the utmost possible extent the water that annually falls within the province; and the example which has been set in Jaipur shows how much can be done in this direction.

591. *Scope for extensions and improvements. Territorial difficulties.*—In the districts of Ajmer and Merwara the catchments are, as we have said, already almost fully occupied, and, in some of the States also, there is not much room for new works. But both in British territory and the States, the existing works were, with some recent exceptions, built without expert assistance or any proper surveys, and much money might be spent in improving them. Colonel Jacob's experience in Jaipur shows what can be done even in the case of existing tanks to improve and extend the irrigation by properly surveying and reconstructing them on sound principles, and by aligning and regrading the irrigation channels. In some of the States, however, no attempt has been made to utilize the water that now flows useless to the sea, and in perhaps most of them there are sites where new large works could be constructed with advantage. As yet, although projects have been prepared from time to time, no practical attempt has been made to utilize the water of some of the principal rivers of Rajputana. In the case of many of the larger projects more than one State is concerned. Sometimes the water-rights of the States lower down the stream have to be provided for. Sometimes a tank that will irrigate the lands of one State will, if constructed on the most suitable site, submerge the lands of another. In some of these cases the difficulties may be found insuperable, and for the best possible scheme some less suitable one will have to be substituted. But in many cases the friendly and disinterested arbitrament of Government, and the engineering skill necessary to effect a proper division of the water, should avail to procure settlements such as have already been arrived at, in a few cases, by friendly agreements between the States concerned; and, at least, no scheme should be abandoned for a less advantageous one until strenuous efforts have been made, and until the persuasive influence of the paramount power has been exercised to the full.

592. *Necessity for a more detailed and systematic survey.*—At present, however, we are ignorant of the exact capabilities of the country for the storage of the surface water or of the manner in which they can best be made use of; and the first thing needed is to collect and record this information. A good deal has already been done during the past few years. Where the State employs a competent Engineer useful projects have been prepared, some of which have already been carried out or are in progress. In other States an Engineer, lent and paid by the Supreme Government, was employed in a similar manner for some months previous to our arrival in Rajputana, and on our recommendation the Government of India sanctioned the retention of his services until he had completed his investigations. The lists of projects which were laid before us—most of them in the rough or preliminary stage—include 276 separate works, estimated to cost in the aggregate 139 lakhs and to irrigate over 300,000 acres.

593. These projects, or as many of them as have been drawn up under expert advice, will be invaluable for relief purposes should famine recur. We recommended that those which had been proposed by the Government Engineer should be completed at once. They consist generally of those schemes which appeared, upon a cursory examination of the country, to be the most promising. But as we pointed out in a letter addressed to the Government of India on the completion of our investigations in Rajputana "if the maxim that it is wrong to allow a drop of water to run to waste in Rajputana is to be acted on to the fullest possible extent something more than this is wanted. What has been done already has been done in a somewhat spasmodic manner and often more or less

hurriedly. What is now wanted is the *systematic* examination of Rajputana *as a whole*, based upon its physical features rather than upon its political divisions, to which latter regard would be paid only so far as is necessary to secure the rights in water of the several States. Each catchment should be taken up in turn and an irrigation reconnaissance made of it from its head downwards. Such a reconnaissance would enable the Engineers to say where dams can best be placed or water stored. The more detailed surveys upon which plans and estimates are to be based should follow in due course, though all of them need not necessarily be undertaken at once. It will be sufficient to keep always in readiness such detailed schemes as will afford an ample programme for relief should famine again occur." We may add that, in designing storage reservoirs for Rajputana as well as for other parts of India, we think it preferable to err on the side of making them too large, rather than too small. We believe that in general the capacity of reservoirs has been calculated with regard to the mean rainfall of the catchment basin. In exceptionally heavy rain storms, therefore, a large volume of water passes over the waste-weir which might have proved of great value had it been retained in the reservoir. It may be said that money is merely wasted if the tank is made so large as only to fill once in ten years, but the water stored up in that year may well be worth the money spent in storing it.

594. *Surveys, plans, and estimates should invariably be printed.*—And here we think it necessary to say that surveys, plans, and papers connected with such projects should invariably be put into print. We have had evidence, only in too many instances, both in Rajputana and elsewhere, of the loss of valuable plans and estimates. The labour and money wasted in one such case would pay for the printing of many sets.

595. *Consulting Engineer for Irrigation in Rajputana.*—Where the State already entertains a competent Engineer, he can conduct the reconnaissance and detailed survey. To meet the case of the other, and for the most part smaller States, we recommended, in the letter from which we have just quoted, that the Government Engineer already employed in completing the preliminary projects should be retained for the purpose. "But," we added, "to secure success some supervising agency is required; otherwise the Engineers of the different States may plan to utilize the same water. Moreover, some of the schemes—not many, but mostly large ones—will require the co-operation of several States, and finally some of the State Engineers will be glad of supervision and assistance." On these considerations we suggested the appointment of a Consulting Engineer for Irrigation in Rajputana, and that the States should be asked to allow their Engineers to consult him. He would then practically direct the whole survey. We suggested that the Government of India should pay the Consulting Engineer and also the Engineers for the smaller States. We learn with satisfaction that action has already been taken to give effect to these recommendations, and that the direction of the surveys is now in the competent hands of Sir Swinton Jacob.

596. *Assistance required by the States.*—Many of the States are just now in financial difficulties and may not have money to spare immediately, even for irrigation projects however promising. But the general survey and even the preparation of the plans and estimates commits them to nothing. As their finances improve they will probably be glad to take up some of the most promising schemes as productive works. Some of them, it is understood, are even now ready to borrow for this purpose, if the Government of India will lend the money; and we strongly recommend that all reasonable encouragement may be afforded in this direction. In any case, when the next famine comes, the existence of the projects in question will ensure relief labour being employed to the best advantage. All that is possible will have been done to help the States and they will know exactly what is feasible and advisable. But it will not be enough to get the schemes drawn up and placed on record. Constant encouragement and stimulation will be needed by some of the States at least, if any real progress is to be made. And to lead them on to renewed efforts, a very careful selection should be made of the schemes to be

first taken in hand, so as to ensure a fair return while not committing the State to too large an expenditure.

597. *Difficulties in dealing with Jagirs.*—The existence of very large *jagir* areas in most of the Rajputana States constitutes a very real obstacle to the extension of irrigation. In some of the States water is given to *jagir* lands, which happen to fall within the *khalsa* area commanded by a tank, on payment of an enhanced—often double—water-rate. But in the case of continuous *jagir* tracts, which form a large proportion of the area of some of the States, the only way in which the Durbar can obtain a return for a work that it may wish to construct is by special agreement with the *jagirdars;* and the latter are usually jealous of State interference in their domains. On the other hand, they are not sufficiently enterprising and often not sufficiently wealthy to construct such works themselves. Signs are not wholly wanting that the pressure of the recent famine has operated to diminish this difficulty, but as a rule the first advance will have to be made in the *khalsa* areas. As the protective and remunerative nature of irrigation works becomes more apparent, it may be hoped that in time they will be extended to *jagir* areas also; but meanwhile cases will doubtless arise in which a Durbar will hesitate to undertake an important and promising work, merely because the *jagir* portion of the irrigable area is so considerable that if no return is to be received from it the work will no longer be productive. We hope, however, that when serious difficulties of the kind occur, it may often be possible for the Political Officers to bring about such an arrangement as will remove them.

(*iv*).—*Private irrigation works.*

598. *Well irrigation.*—From the figures given in paragraphs 577 and 587, it is evident that in some of the States irrigation from wells has attained large dimensions, while, in almost every State, it exceeds that from all other sources. As the cycle of scanty rainfall through which Rajputana has recently passed has been of unprecedented duration, so has the effect upon the subsoil water exceeded all previous experience. In 51 villages of Tonk, out of 645 wells examined in 1901, 402 were absolutely dry, while the rest were barely working. Generally speaking, the water level throughout the province sank from 10 to 20 feet, while the irrigated area diminished to about one-third of the normal. But the process was a gradual one; during the first year of drought the wells were scarcely affected, and on the whole they proved a real and valuable protection. In parts of Dholpur, it is interesting to note, there appears to be an underground supply of an artesian nature; in one well a strong spring of water was found at a depth of 120 to 150 feet which rose to within 60 feet of the surface.

599. *Small tanks.*—We have already referred to the numerous small tanks which exist in so many of the States, and have shown that even the smallest of these is not to be despised; at the least it stops water that would otherwise flow to waste, and allows it to percolate into the subsoil. In almost every State, but especially in those of the central plateau, there are large numbers of such tanks. In Mewar they were made, it is said, in by-gone days from pious or charitable motives, to afford a supply of drinking water for men and cattle; and there is now a prejudice against using the water for irrigation, or in any way that would result in pecuniary advantage. But whether used for irrigation or not, these tanks are now for the most part neglected and out of repair. It is curious to note how in this respect they have been affected by the substitution of a fixed cash assessment for revenue taken in kind. In one State at least it was the custom, when the produce of a crop was being divided, to set apart a small share for the upkeep of the tank. Now that a cash assessment has been substituted, the burden falls upon the village *malbah* and the tank is accordingly neglected. In Tonk, where the substitution has been made in the *khalsa* area only, we were told that the tanks in the *jagir* areas are in markedly better repair than in the *khalsa*. It is clear that the system of payment in kind secures to the improver a substantial share of the profits of his improvement, and gives the owner of the tank a direct interest in so regulating the distribution of water as to secure the greatest possible economy.

600. *Field embankments, etc.*—There are many subsidiary forms of irrigation works, the construction of which should be encouraged. In Bhartpur the larger *bands* which have been so successful in protecting the country can be imitated by the cultivators on a small scale. In Dholpur small banks across minor drainage lines have been successful in holding up moisture, in collecting silt and in preventing erosion; and in Kishengarh the embanking of fields has been found a valuable means of protection. In parts of Tonk small irrigation cuts from streams are largely made use of. In the systematic survey which we recommend, these minor works should not be neglected, and the importance of prosecuting them as widely as possible wherever famine labour is available should be impressed upon the States.

601. *Measures for stimulating the construction of private irrigation works.*—Advances for well sinking have been given liberally and taken freely in some of the States, and in most further large sums could probably be given out with advantage. The rate of interest charged is generally 6 per cent, while in some States (Alwar and Bhartpur) the loans are advanced free of interest. But probably the most serious defect in the encouragement afforded to private enterprise in Rajputana is the absence of any system of exemption from wet assessment, beyond that afforded in many States by a settlement for a fixed term. So far as we have information, the period of exemption is short—from five to seven years; but, as might be expected, recovery is more elastic and less rigid than in British territory. In Kishengarh, the State's share of the produce of a field irrigated by a new irrigation work is reduced, one-tenth only being taken in the first year, one-ninth in the second, and so on until the normal one-third is reached after 8 years. This is not much more liberal than a total exemption for six or seven years, and may be less liberal than the exemption afforded in British territory; but, when coupled with liberal rules for *takavi* advances, it appears to have been an attractive inducement to private enterprise. We are of opinion that the introduction of such a system, or of a fixed period of exemption, would lead in many of the States to a substantial increase of the area protected by irrigation. In some States the difficulties attending the construction of wells are considerable, and help from trial borings would be advisable.

सत्यमेव जयते

(*v*).—*Famine works and programmes.*

602. *Ajmer-Merwara.*—In the recent famine, the expenditure of 29 lakhs on relief works in Ajmer-Merwara was chiefly incurred on the construction and repair of roads and the collection of road-metal. Eleven lakhs were, however, spent on works for the storage of water—chiefly on constructing 16 new tanks, of which 11 were completed and 5 left unfinished. Work on the Outra tank was stopped, as it was feared that it might interfere with the supply of water to the Sambhar Salt Works. Three of the other uncompleted works will now be completed, and one held over until the recurrence of famine.

603. *Native States.*—Out of a total of 69 lakhs spent on relief works in the Native States, 41 lakhs were spent on irrigation works, 20 lakhs on railways, and the balance on roads and miscellaneous works. The expenditure on irrigation works was incurred on a number of new works—many of which have been or are now being completed—and on repairing and improving existing tanks. The works selected appear to have been all of real utility; but, except in a few States, there were no lists of suitable schemes ready, and in many cases there were no officials on the spot with the training or experience which would enable them to select the most suitable projects, to prepare detailed plans and estimates of the works, and to see that the works were properly constructed. The want of a programme of suitable works and of a trained establishment led, no doubt, to a considerable waste of money in many of the States. If effect be given to our recommendations (paragraph 593), the Durbars should be much better prepared, as regards their programmes of irrigation works, to meet the contingencies of another famine. Suitable employment, near their homes, will be made available for the people, who will thus be saved the trouble and

expense of moving into British territory where, as in Ajmer-Merwara, there is often very great difficulty in finding work even for the resident population.

Section II.—KATHIAWAR.

(*i*).—*Local conditions; use and value of irrigation.*

604. *Political Divisions.*—Out of 23,500 square miles comprised in the peninsula of Kathiawar, 1,320 square miles are included in the British district of Ahmedabad; another portion of the same size is in the State of Baroda; a few square miles in the south are in the possession of the Portuguese; and the remaining area is distributed among nearly 200 more or less independent chiefs and landowners.

605. *Physical features.*—Geologically Kathiawar is an outlying island of the Deccan trap series which has been joined to the main land by the silt deposits of rivers flowing into the gulfs of Cutch and Cambay. The surface of the country is generally undulating, but it is broken by numerous hills which form two very irregular ranges crossing the country from west to east in nearly parallel lines. The highest eminences are in the southern range where the summits are sometimes over 2,000 feet above the sea; one outlying hill, the Girnar, rises to 3,666 feet. These two ranges, and a high narrow table-land connecting them, form the main watershed from which numerous rivers flow to every side in almost direct courses to the sea. The largest, the Bhádar, has a total length of little more than 120 miles. But though none of the rivers is of great length, many of them attain a considerable size in the rainy season. Some of them are said to be perennial, but their supplies in the dry season are insignificant. The Bhádar in favourable years carries a considerable volume—averaging about 200 cusecs—throughout the cold weather, but in years of scanty rainfall its supply entirely fails; in 1900 it was dry before the end of November. In all the numerous valleys and everywhere in proximity to the coast, the subsoil water is found fairly close to the surface. The water is generally sweet, but it is brackish in places, especially near the sea. Inland the supply fails partially or entirely in years of scanty rainfall.

606. *Soils and agriculture.*—The soil for the most part consists of the numerous varieties of black soil common to the trap formation. It overlies generally a porous substratum, and in depth varies from five to ten feet or more in the fertile valleys, to a few inches in the hills where the trap shows on the surface over large areas. It is well suited for irrigation, but for irrigation to be fully effective, an exceptionally large number of waterings appears to be necessary. *Juar*—which is grown in all seasons of the year—*bajri*, cotton, and *til* are the principal rain crops; and wheat, hot-weather *juar*, cane, rice, and vegetables the principal irrigated crops.

607. *Rainfall.*—Round the coast the average annual rainfall varies from 19 or 20 inches on the north and west, to 25 inches in the extreme south, and 28 inches along the east coast. Inland it averages about 27 inches, excluding the higher portion of the southern hills where it is said to reach 80 inches, and the alluvial plains to the north-east where the average is about 20 inches. From year to year the amount varies between wide limits; in 1878 the province received nearly three times, and in 1899 about one-fourth, the normal amount. The rainfall is practically confined to the period of the south-west monsoon, that is, from June to early in October.

608. *Famines.*—More than one of our witnesses assured us that, until recently, famine in Kathiawar was almost unknown. But this evidence is hardly borne out by the long record of famines given in the Gazetteer of the Province. In the eighteenth century three very severe famines are recorded: the first due to drought, and the second to excessive rainfall; of the third the cause is not stated. In addition there were seven years of distress and scarcity. Within the last century there are said to have been at least 14 years in which

the rainfall was so deficient as to lead to more or less severe distress. Of these, three were years of very severe famine. The famines of 1813 and 1877 were aggravated in each case by a subsequent year of excessive rainfall.

609. *Utility of irrigation.*—From this brief description of the province it is evident that, from our point of view, the conditions in Kathiawar resemble in many respects those in Rajputana. There are the same difficulties arising from the conflicting interests of various States; there is the same liability to severe drought, and, though no doubt in a less degree, the same liability to suffer from a partial failure of the rains. There is the same absence of large perennial rivers; the same, if not a greater, liability of the wells to fail in a year of scanty rainfall; and generally the same need for irrigation, and the same dependence upon local rainfall for all means of supplying it. The general prevalence in Kathiawar of moisture-retaining black soils renders irrigation unnecessary for the monsoon crops even in years of light rainfall, if the rain is favourably distributed throughout the season; and for the *rabi* crops in some parts of the province if the later rains are abundant. In all other respects the necessity for saving every drop of water that can be stored at a reasonable cost appears to be no less urgent in Kathiawar than it is in Rajputana. In years of ample rainfall the water can be utilized for the cultivation of spring and hot-weather crops; and when the rainfall, though sufficient in amount, is badly distributed throughout the season, it will nearly always be beneficial to the monsoon crops. In years of very scanty rainfall no doubt, here, as in Rajputana, all but the largest tanks will fail.

(*ii*).—*Existing State irrigation works.*

610. *Works constructed before the recent famine.*—Irrigation works of any considerable size were practically unknown in Kathiawar before the failure of the rains in 1899. Numerous wells were in existence, of which a large number had been constructed by the Chiefs and cultivators in 1877. But in the State of Porbandar alone does any attempt appear to have been made to construct an irrigation work on a fairly large scale. In 1895 that State undertook the construction of a weir and regulator across the Bhádar river. The works were completed during the famine at a total cost of over three lakhs. They supply water, for irrigation by lift, to about 12,000 acres of existing cultivation and will, it is hoped, bring under the plough about 30,000 acres of low lands now lying waste. The State officials appear to have no doubt as to the remunerative nature of the works.

611. *State wells.*—The wells which in many cases have been constructed at the cost of the States are said to yield a handsome return on their cost. Our evidence as to the average cost of a well is very conflicting, but an ordinary masonry well, 30 to 40 feet deep, from which four or five acres are irrigated annually, is said to cost from Rs. 300 to Rs. 600. In some of the States the cost is recovered by the increase in the State's share of the produce, which is taken in kind. In others the State advances the cost of the well by instalments as the work proceeds, and the cultivator, after he has made the well, which is the property of the State, pays annually Rs. 5 an acre on the area which it is capable of irrigating, whether the land is irrigated or not; or a lump sum of Rs. 20; or in some cases an annual payment equal to 10 per cent. of the advance. In Junagadh 15,000 wells constructed by the State are said to yield an annual return of 5 per cent. on their cost, and in other States an even larger return is claimed.

612. *Storage works constructed during the famine.*—During the recent famine, relief labour was largely employed in most of the States on the construction of irrigation works. Over 33 lakhs were spent on 64 storage works, of which 38 were completed; and about $18\frac{3}{4}$ lakhs in constructing 8,158 wells. Of the new storage tanks the more important were designed by and constructed under the able supervision of Mr. Mawson, Executive Engineer, whose services were lent to a number of the States. The information laid before us does not enable us to show, with any approach to accuracy, the extent by which the

irrigated area of the country will be increased by all these works, but, at a rough estimate, if they are fully utilized, they will perhaps irrigate 50,000 acres annually. It is too early to say what return may be expected from the new tanks. Few, if any of them, are yet in proper working order and the people have not yet learned to make the best use of the water. But judging from the rates paid for water lifted from wells and from those paid on a few existing tanks, we see no reason why storage works in Kathiawar should not be at least as profitable as those in Rajputana. On the Lalpuri tank near Rajkot the rates vary from Rs. 2 for ordinary monsoon crops to Rs. 6 for wheat and Rs. 25 for sugar-cane. This tank is, no doubt, situated close to an exceptionally good market, but in other States Rs. 6 for wheat appears to be the usual charge, and the State secures in addition its share of the increased produce. When the time comes for considering the results derived from the works recently constructed, it will be necessary to make allowance for the conditions under which they were designed and carried out. In most cases the designs were of necessity hurriedly prepared; the site was often selected more with a view to its convenience as a famine work than to its being the best for a storage work; and the work was constructed by famine labour and cost at least 30 to 40 per cent. in excess of what it would have cost if carried out by ordinary labour.

(iii).—Scope for further extensions of State irrigation works.

613. *Necessity for storage works.*—The sole source of supply being a local rainfall which is practically confined to a few months of the year, an extensive system of storage works is the only means of increasing the irrigated area of Kathiawar to anything like the extent required for protection against famine. With few exceptions the rivers are in flow only during the monsoon months, when water is least required, so that any extensive system of canals is out of the question. There may be scope on one or two of the larger rivers for constructing works similar to those recently made on the Bhádar in Porbandar; and the monsoon supplies of even the smaller rivers might perhaps be utilized for *kharif* cultivation, especially where the soil is suited to rice. No doubt also there is still room for a considerable increase in the utilization by wells of that portion of the supply which percolates into the subsoil; but at the best the area that can be irrigated in this way will fall far short of the protective requirements of the province. On the whole, it seems probable that, as in Rajputana, the total amount of protection that can be afforded by all possible forms of irrigation works will still be inadequate. Mr. Mawson estimates that in no case would it be possible to protect more than one-fifth of the cultivation by means of irrigation works. On the information at present available it would be impossible to check this estimate, but we have no doubt that in the storage of water lies the only means of making any considerable addition to the present insufficient means of irrigation in many parts of the province.

614. *Facilities for storage works.*—The general formation of the country is well adapted to the construction of tanks, consisting as it does of hills that attract a heavy monsoon rainfall and of fertile valleys or plains whose soils are on the whole well suited for irrigation. But the catchments are often so small that in a year of drought the tanks may not fill and even where the catchments are large, it may often be difficult to find suitable sites for tanks on a large scale. The population also is scanty and unaccustomed to wet cultivation; and, though in many parts *rabi* crops are seldom possible without irrigation, a light rainfall if fairly well distributed secures a fine autumn harvest. Thus, though the people are at present keen for the extension of irrigation, we do not feel at all certain that on the return of more favourable seasons, they will not revert to their former less laborious practice.

615. *Political difficulties.*—The main obstacles to the extension of tank irrigation are, however, political. All the difficulties that exist in Rajputana are here greatly intensified by the extreme smallness of most of the States, and by the manner in which their territories are intermingled. In many parts, where the physical conditions are favourable, it is almost impossible to find sites for tanks of which both the submerged and the irrigated areas would

lie in the same State. The borders of many of the streams are fringed with wells, the water level in which would be injuriously affected by holding up the cold-weather supply higher up the stream, and distribution of the water among the various States interested is often hardly possible. Again, the feudal tenure-holders, who correspond with the *jagirdars* of Rajputana, have been invested with an even greater degree of independence than they have attained in that province; while large assignments of land revenue, generally in the form of shares of villages to the *Girásiás* or descendants of old free-booters, hamper all revenue administration, since the consent of all the sharers has to be obtained to any measure that may affect the value of their shares. Broadly speaking, nothing in the way of an irrigation work on anything like a considerable scale, is possible without the co-operation of many of the States, while even the smallest works are likely to be objected to by the States lower down the catchment.

616. But the very conditions that make co-operation difficult will justify the exercise of such political pressure as may be necessary to ensure the utilization of the available water-supply to the best advantage of all. Whatever objections may be raised during the progress of the negotiations the Chiefs will, we have no doubt, be glad in the end to have been persuaded to their benefit. The Porbandar State affords two conspicuous instances of the necessity for some such control. It lies at the mouth of the Bhádar river, the water of which, as already noted, has been utilized with great success and at considerable expense. But that success depends wholly upon the cold-weather flow of the river not being interfered with since the flatness of the country renders the storage of a *rabi* supply impossible. At present there is nothing to prevent such interference. Again, some 40 years ago, the State of Jamnagar threw a weir across the Vartu river which runs through Porbandar. Only a small portion of the supply was thus held up and utilized; the remainder has been diverted from its natural channel so that it passes uselessly to the sea. We were informed that the matter had been in dispute for many years, but that no final adjudication had yet been made.

617. *Completion of unfinished famine tanks.*—Many of the tanks which were undertaken by famine labour during the recent famine are still unfinished. Others are so far completed that the people are irrigating from them; but they have been finished in a hurry, and upon most of them more or less further expenditure is desirable in order to secure the best returns for the money which has already been spent upon them. The first thing to be done is to arrange for this further expenditure and to complete such of the works as are worth completing. The amounts required are not likely to be large, but in many of the States, owing to the loss of revenue and the expenditure incurred during the recent famine, the exchequer is now empty. We think that in such cases the Government of India should, when necessary, assist the States in completing the works with loans upon moderate terms.

618. *Systematic survey of the country.*—No programme of new works can be proposed until a systematic survey of the country has been made similar to that recommended for Rajputana. For this work it will be necessary to depute a specially qualified officer for the investigation of projects in those States which have no engineers of their own. His salary and the cost of his subordinate establishment might, we think, be met from Imperial funds. It would be his duty to make, in conjunction with the State engineers, a general survey of the irrigational possibilities of the entire province; to propose as many self-contained works for each State as may be possible, but at the same time to consider other schemes which may affect more than one State; and to propose the best means of utilizing the available supply of water with reference only to physical considerations, and not to territorial boundaries, due regard, however, being paid to the rights in the water of the several States concerned. To enable many of the States to undertake the works it may be necessary for Government to advance loans on liberal terms. But except when relief works are necessary we do not think that the States should be pressed to spend, at any rate borrowed money, upon extensive new works until they have seen whether the demand

for water on existing tanks stands the test of a cycle of normal years. It may be that the possibility of *rabi* cultivation will be sufficient to produce a constant demand; but in view of the character of the people we think it would be unwise to assume too readily that this will be the case. If the demand persists, tanks should be very remunerative at the water-rates now charged; but there is of course a possibility that it may be found necessary to reduce some of these rates when favourable seasons again become the rule.

(*iv*).—*Private irrigation works.*

619. *Private wells.*—A few small irrigation channels have been constructed by the cultivators in some of the States; with these exceptions the private irrigation works in Kathiawar consist solely of wells; and even of these, as we have said, a large proportion have been constructed by and are the property of the States. The facilities for the construction of wells vary greatly in different parts of the province, the subsoil water being only eight to ten feet deep in many places near the coast, and 30 feet to 35 feet over a great portion of the area. Their construction offers no special difficulties and the sites are usually selected by local water-diviners whose judgment is said to be unerring. But as usual in black cotton soil the water-supply is uncertain both in quality and quantity, and in many States only a very limited area can be protected in this manner. When wells are constructed by the State, the agency of the cultivator and his home labour are largely employed. The practice seems to be to advance material and capital and to leave to the cultivator, under supervision of the local officers, the execution of all work which does not involve the employment of highly skilled labour. In return for State aid the cultivator pays either in kind by the usual share of the produce, which is of course increased considerably in consequence of the irrigation, or by an addition to his cash assessment usually calculated to correspond with this increase. We are unable to judge how far this system has succeeded, but it has better chances of success in those States which are small, and in which therefore the authorities are able to get in close touch with the cultivators, whom they can influence in many ways not open to the officials of the large Government Departments of British India. We have not been able to procure statistics showing the extent of the area irrigated from wells in the various States, but the number of wells in the coast districts is large; there are 14,725 in Junagadh, 13,794 in Bhavnagar, and 4,340 in Porbandar. Considering the character of the people, who are for the most part averse from the additional labour involved, any extension of well-irrigation must probably be slow, but there is no reason why it should not eventually be very considerable. There are undoubtedly extensive tracts suited to well-irrigation, and it rests with the States to stimulate the construction of wells in them by advances or the system of State aid and construction already prevalent. When any State is desirous of advancing money for wells or wishes to construct them out of its own resources, financial aid, in the shape of loans at moderate rates, might be granted by the Imperial Government under such safeguards as may be required to ensure the expenditure of the money lent on the objects for which it is borrowed. A considerable number of wells were begun in the famine, but in many cases they were never finished, work being discontinued as soon as rock or hard soil was reached. As in the case of other famine works the States should be urged to complete, or to advance further money for the completion of such of them as involve slight additional expenditure and have a fair certainty of being used. Where necessary the States might be assisted financially for the purpose. We gather that the wells in Kathiawar failed more materially in the first year of drought than was the case either in Rajputana or in Gujerat; and, as tank construction extends, well construction should be pressed on hand in hand with it, the former greatly increasing the security afforded by the latter.

(*v*).—*Famine works and programmes.*

620. *Employment of famine labour.*—The works on which famine labour was employed during the recent famine consisted mainly of the irrigation works to which we have already referred, recommending their completion in certain cases; and, with regard to providing suitable works for any future famine, the

recommendations which we have made in paragraph 618 should result in the preparation of a programme of really useful works. Our recommendation to proceed tentatively in the construction of new works in ordinary years does not apply to a year of famine, when the works should be pushed on to the utmost extent necessary for the employment of famine labour; and at the end of the famine, those works should be finished which will repay the cost of their completion, irrespective of the expenditure already incurred.

621. *Prevention of emigration.*—Severe distress in Kathiawar leads to wholesale immigration of starving people into the adjoining British districts of Gujerat, and if simultaneously there is famine in those districts, the immigration gives rise to most serious complications and difficulties. On this ground alone we think that Government would be justified in assisting the States in the preparation of a complete programme of relief works and in urging that the works be put in hand on the first occurrence of a famine; dealing liberally, at the same time, in the matter of advances to the less wealthy States. We would observe also that there appears to be a much wider field for the useful employment of emigrants from Kathiawar on canal extensions and clearances in Sind than in Gujerat where their presence causes so much embarrassment. Immigration into Sind would be much facilitated by the construction of the proposed railway for connecting Kathiawar with Lower Sind which appears to us, on this account, to be a project deserving favourable consideration.

Section III.—MYSORE (and Coorg).

(*i*).—*Local conditions; use and value of irrigation.*

622. *Physical features.*—The State of Mysore, with a population numbering 5,449,923, covers an area of 29,417 square miles, of which about one-third, known as the 'Malnad,' lies on the eastern slopes of the Western Ghats; the remainder, known as the 'Maidan,' is a rolling plateau lying in the angle formed by the Eastern and Western Ghats which meet in the Nilgiri hills in the southern corner of the province. The general elevation of the plateau varies from about 2,000 feet above sea-level in the north and south, to about 3,000 feet along the central watershed which, running roughly east and west, separates the basins of the Tungabhadra and Penner rivers on the north from those of the Cauvery, Ponniar, and Palar on the south. The surface of the country is generally undulating, but it is broken by numerous hills which form irregular ranges running roughly from north to south, and it is scored in many parts by deep ravines.

623. *Soils and agriculture.*—The prevailing soil is a red loam, formed chiefly of decomposed gneiss. Irrigation suits this soil and the cultivators readily take water for it, but here and there, especially in the district of Chitaldrug, there are tracts of black soil which they are very slow to irrigate even when water is available. Out of a total area of nearly 17½ million acres for which records are available, nearly one-half is uncultivable or under forest, seven million acres are cultivated, and the balance, about 1¾ million acres, is cultivable waste. The gross area under crops in a normal year may be taken as 6,143,000 acres or rather more than 1·1 acres per head of population. Of this area 945,000 are irrigated, 105,000 from State canals, 540,000 from tanks, 70,000 from wells, and 230,000 from other sources. The staple crop is *ragi* (*Eleusine corocana*), the *marua* of Northern India, which forms more than half the total area of dry crop cultivation. It is sown soon after the commencement of the rains and reaped in November and December. From dry cultivation there is but one crop in the year, and there is practically no rotation of crops. Rice, gram, sugar-cane, and garden produce are the principal irrigated crops. Rice sown on the break of the rains is known as *Kartika*; that sown in December or January and reaped in May is known as *Vaishaka*. Both crops require constant waterings for five or six months at intervals of four or five days. Sugar-cane, of which about 30,000 acres are grown annually, requires water, at intervals of 15 or 20 days, for 10 or 11 months of the year. To prepare land for irrigation it has generally to be levelled

off and terraced at a cost to the landowner of Rs. 10 to Rs. 25 per acre. In the extreme east of the province the people prefer wet to dry cultivation. In the central portions, where the population is sparse and less enterprising, dry cultivation is preferred.

624. *Rainfall and famines.*—The province is so situated that it receives the rainfall of both monsoons. That from the south-west brings rain from the middle of May to about the middle of September and that from the north-east from September to about the middle of November. The amount received varies enormously according to the locality. At one point on the Western Ghats the annual average is said to exceed 350 inches, while at two of the recording stations in the Chitaldrug district it is barely 17½ inches. For the recording stations situated in the Ghats close to the western border, the average is over 140 inches; but the rainfall rapidly decreases as the clouds drift eastward, and at a distance of 30 miles from the border the average is only 31½ inches, while at 50 miles off it is only 25 inches. Eastward of this the average is about 28 inches in the south-eastern portion of the province, and about 22 inches in the north-eastern portion which, as a rule, receives only a scanty share of either monsoon.

625. Previous to 1876-77, there is no record in the history of the province of any considerable famine caused by drought alone. Famines had followed on the devastations of hostile armies, and partial failures of the rains had led to severe scarcities in 1824, 1833, and 1866; but these latter were of short duration, and until the failure of the rains of 1875, and the still more deficient rainfall of 1876, the province was looked upon as practically immune from very prolonged drought. In these two successive years it received only about half its average rainfall. The result was a famine which fell with appalling severity on the districts of Chitaldrug, Tumkur, Bangalore, and Kolar, and in fact on the whole two-thirds of the State lying east of a line drawn through the town of Mysore parallel to the Western Ghats. The province lost about one-fifth of its population; the treasury a year's revenue or over a million sterling; while the loss to the people in produce, cattle, and other property, was estimated at nearly 9¾ million sterling. Since then there has been no serious failure of the rains, but the rainfall has often been deficient or unfavourably distributed throughout the season.

626. *Value of irrigation.*—Experience, then, has shown that everywhere throughout the province save in a narrow strip of assured rainfall along the western border, irrigation is necessary as a protection against occasional famine and the vicissitudes of ordinary seasons; while throughout the whole province it is useful in affording employment to the agricultural classes in the interval between the reaping of the dry crops in December and the setting in of the rains in May. None of the more valuable crops, such as sugar-cane, garden produce, and the best qualities of rice, can be grown profitably without irrigation; and on an average the value of the produce of a single crop is said to be nearly quadrupled in ordinary years by an assured supply of river water, and increased thirty-fold in a year of drought. But perhaps the best index to the value of irrigation in Mysore will be found in the fact that though the irrigated lands comprise only about 15 per cent. of the whole occupied area, they pay about 40 per cent. of the total land revenue of the State.

(*ii*).—*Existing State irrigation works.*

627. *Classes of works.*—The conformation of the country, eminently adapted as it is for the construction of tanks, has been almost fully utilized for this purpose from time immemorial. Some new tanks have no doubt been constructed within recent years, but the majority are old works, the original cost of which is now not known. They are all classed as State irrigation works, with the exception of a small number situated in *inam* or alienated lands. There are in addition numerous canals or river channel works. Many of these have been improved or constructed by the State and nearly all are under State management. The State irrigation works may therefore be divided into two main classes: canals or river channels, and tanks.

628. *Canals or river channel works.*—The canals are small irrigating channels taking off from above rough stone or masonry dams thrown across one or other of the principal rivers. They run generally parallel to and at a short distance from the river's bank and irrigate only the intervening strip of land. They are fed either directly from the river or from tanks in which the water of the river is stored. The total length of channels is about 1,000 miles, and they irrigate annually upwards of 100,000 acres. They do not flow continuously throughout the year; they are shut off in December or January, and from that time until the commencement of the rains they are opened in rotation, for 7 or 8 days only in each month, for the irrigation of sugar-cane. But they receive a sufficient supply in all years for the crops protected by them, and the areas they commanded were unaffected even by the severe drought of 1876-77. All works of repair are carried out by Government except the clearance of weeds which is left to the cultivators. During the regular irrigating season the channels are worked and the distribution of the water is supervised by the revenue officials. But for half the year, during the dry weather while the annual repairs and silt clearances are in progress, most of the channels are controlled and their waters distributed by the Public Works Department.

629. The original cost of many of the channels is not known and there are no capital accounts of the works; but besides being of great protective value they are also undoubtedly remunerative, so far as the known expenditure incurred by the State is concerned. Since 1863-64 just over 40 lakhs, or say Rs. 40 per acre irrigated, have been spent on constructing new or improving old works. The total revenue dependent upon all the works is $6\frac{1}{3}$ lakhs or, say, Rs. 6 per acre; while they cost less than a lakh, or Re. 1 per acre, to maintain.

630. *Tanks.*—In the whole province of Mysore there are said to be 39,000 tanks, or one tank to every three-fourths of a square mile. Of these roughly 27,000 are State tanks, which irrigate in a normal year about 500,000 acres; 2,000 are private tanks irrigating about 40,000 acres; and the remaining 10,000 are mere ponds yielding no revenue. Many of the tanks, especially those in the Shimoga and Kadur districts, are fed by channels taking off above dams constructed in the beds of adjoining streams or rivers; but the majority are constructed across drainage depressions or streams and are fed directly by the rainfall over the catchment above. In almost every valley there is a chain or series of such tanks, one below the other and all discharging into a terminal tank. The embankments forming the tanks are, in nearly all cases, faced with a rough stone revetment having a slope of 1 to 1 or $1\frac{1}{2}$. Most of those from which there is direct irrigation are provided with masonry outlets, sluices, and escapes. Many however are not used for direct irrigation, but merely to maintain the water level of the wells in the valley below and these have no sluices.

631. *Classification and size of tanks.*—The tanks are classed according to the amount of land revenue dependent on them. All irrigated lands are assessed at a consolidated rate which includes the ordinary dry rate of about 8 annas to Re. 1 per acre, and a wet or water advantage rate which is said to vary from Rs. 2 to Rs. 4 for ordinary crops, to Rs. 9 and more for gardens. A tank is classed as a major tank if the lands under it, assessed as irrigated, yield over Rs. 300 in annual revenue; and as a minor tank if they yield Rs. 300 or less. Roughly major tanks are tanks which irrigate 80 acres or more.

632. There are in all 2,318 major tanks. The largest of those which have been completed is the Sulikere tank, in the Shimoga district, with a capacity of 3,118 million cubic feet. This work has proved a failure owing to its commanding black cotton soils which the people are reluctant to irrigate. The list supplied to us of the more important tanks contains only one other tank with a capacity of over 1,000 million cubic feet, and only 10 tanks in all with capacities of over 270 million cubic feet. This is not a fact to be regretted, for most of the tanks are dependent upon a local and uncertain rainfall and the remarks which we have already made (paragraph 160) with reference to the comparative advantages, under such conditions, of large and small tanks, are, we think, as applicable generally to Mysore as to the Deccan districts of Bombay; although in

Mysore, especially in the eastern parts, a tank of moderate size has no doubt this advantage over a number of small tanks of collectively the same capacity, that in years of good or ordinary rainfall it admits of a supply being held over for the cultivation of the *Vaishaka* crop. Besides securing a more valuable crop the cultivator is thereby enabled to grow his dry and wet crops at different seasons of the year, and can give to each his undivided attention.

633. *Distribution of water.*—The distribution of water is done by *nirgantis*, or hereditary watchmen, who are paid in kind by the cultivators. They open the sluices and let out the water under the orders of the village headmen. The system is said to work well in the case of small tanks, but to be the cause of many complaints and much waste of water in the case of larger tanks. Here, as elsewhere, the substitution of money payments for rent paid in kind has been to the detriment of irrigation. Formerly, when a portion of the produce went to Government and a portion to the rayats, it was to the interests of both, in a year of short rainfall, to see that the cultivation under a tank was limited to the volume of water available. Under the present system of assessment the State has not the same interest in limiting the extent of cultivation, and, in consequence, the sowings are said to be now often much larger than the supply in the tank can mature. On the other hand, one of our witnesses assured us that he knew of cases in which the tank being only half-full and the water not sufficient for all, no use had been made of it, as the cultivators could not agree amongst themselves regarding its distribution. We gathered that such cases are not numerous, but we have heard of similar instances in at least one British district.

634. *Restoration and repairs of tanks.*—The question of the repair and maintenance of tanks has evidently been the cause of as much trouble and anxiety to the Mysore Durbar as it has been for many years to the authorities in the adjoining Presidencies; and in this case also, judged by practical results, no satisfactory solution of the difficulty has yet been found. Under rules which were issued by the Chief Commissioner of Mysore in 1873, the village authorities were held responsible for the maintenance and upkeep of any tanks that were handed over to the rayats on or after that time. If afterwards it was found that a tank had not been kept up to the standard to which it had been brought when handed over, the rules directed that the work should be carried out by the district authorities and the cost recovered from the defaulters as a revenue demand. These rules are, it is said, still valid, but as a matter of fact they are seldom enforced. In 1885-86, a few years after the rendition of the province, what is called the minor tank system was introduced. Under that system minor tanks are restored and brought up to standard by the rayats working under the revenue authorities, the stone and masonry work being done by the Public Works Department. In the case of major tanks the whole work of restoration is carried out by the Public Works Department. As each tank, whether major or minor, is restored, it is handed over to the revenue authorities, who are expected to see that the rayats obey the rules of 1873. We do not know how many tanks have been repaired under this system; but since 1870-71 the total number restored, both major and minor, is said to be only 2,881, or at the rate of about 96 tanks per annum. Of these 1,305 are major tanks. In the case of minor tanks the initiative is apparently taken by the rayats. When they come forward and do the earthwork, the State repairs the masonry works. The number of tanks of this class which are annually restored appears to have increased considerably during recent years. In 1899 as many as 1,137 were dealt with. There are, however, still many thousands requiring restoration. But even after a tank has been restored the rayats, we are told, seldom make any effort to keep it up to standard, and there appear to be doubts on the part of some of the revenue officers as to the legality of enforcing the rules of 1873. Thus many even of the restored tanks are now gradually deteriorating.

635. We understand that a trial is being made of a new system under which all repairs are carried out by the State, the rayats' share being recovered in the form of an additional cess. There would, no doubt, be certain advantages in the introduction of such a system, if it is really impossible to enforce the

present rules. We are informed, however, that the whole question of the maintenance of the tanks is being fully considered by the responsible authorities, who recognize its enormous importance; and it may be hoped that, whatever rules are finally adopted, measures will be taken to give them practical effect. The only recommendation which we think it necessary to make is that arrangements should be made for the more frequent periodical overhauling of the minor tanks under professional supervision. These as well as the major tanks should be taken up in regular rotation and brought up to standard once in every 20 or 30 years, the rayats if necessary being compelled to do their share of the work or to pay for it if it is done by the State. For tanks in a series, and in red soil, thirty years is named as the period after which, owing to the deposit of silt, it becomes necessary to raise the weir and embankment by about a foot, so as to maintain the capacity of the tank. The period is said to be distinctly shorter in the black cotton soil tracts.

636. *Protective and financial results.*—Except in the case of a few works which have been recently constructed, there are no capital accounts for any of the tanks, nor has it been found possible to determine even roughly their capital cost. During the twenty years that have elapsed since the rendition of the State in 1881, the Durbar have spent 207 lakhs on irrigation works, of which apparently about 160 lakhs were devoted to tanks, but this includes all the outlay incurred on annual repairs and on the improvement of old works. There is a difficulty also in ascertaining the amount of revenue directly due to the works, as a separate water-rate is only assessed on lands irrigated from a new work, and then only until the expiry of the current settlement. In all other cases, the water-rate is consolidated with the dry rate, and, as the extent of area assessed to irrigation is based on the average of good and bad years, the assessment is paid whether the land is irrigated or not, and even when no water is available for irrigation. It is therefore impossible to form any estimate of the returns yielded by the tanks, as a whole, compared with their capital cost. The few new tanks for which capital accounts are maintained, and which barely pay their working expenses, cannot be taken as typical examples, for all the best sites had already been occupied by the older works. More than half of the whole irrigated area, and about a fifth of the whole land revenue of the State, are, however, directly dependent on the tanks, and there can at least be no question of their value as protective works. In a dry year no doubt many, and in a very dry year almost all, fail; but the good they do in ordinary years is of very material assistance to the cultivator in tiding over a bad year; and even in the driest year they assist in maintaining the level of the subsoil water. Three-fourths of the wells in the State are directly or indirectly dependent upon them. It is, in fact, no exaggeration to say, as one of our witnesses has said, that the tanks in Mysore are the very life of the people.

637. *Progress made since the famine of 1877.*—Before passing to the question of the scope which exists for the further extension of irrigation works, it is desirable to consider briefly in what respects Mysore is now better fitted than it was in 1875 to withstand a serious famine. The most important advantage gained lies no doubt in the improvement of the means of communication. During the famine there was but one short line of rail in the whole province—the branch line from Jalarpet terminating at Bangalore; its total length within the province being little more than 40 miles; and "upon the traffic carried along this single iron thread, throughout 1877, hung the lives of a million of souls."* Every district in the province is now either traversed by or has its main town connected with a railway, and the total length of line within the province has been increased to over 450 miles. In addition to the extension of railways, more than 1,000 miles of new roads have been opened out and a number of large rivers bridged at a total cost of over 60 lakhs. The opening out of the Kolar gold field has also created a new and important source of industry, which is said to afford employment to about 40,000 people in a district unusually liable to drought.

---

* Report on the History of the Mysore Famine of 1876-78 by Mr. Charles Elliot, C.S.I., Famine Commissioner.

638. These improvements are a substantial addition to the general wealth and well-being of the province, while the increased means of communication will enormously facilitate relief operations in the contingency of another famine. But with regard to the amount of protection afforded by irrigation, a matter with which we are more immediately concerned, it cannot be said that any very distinct advance has been made. Writing in 1877 the Famine Commissioner estimated that before the famine there was more than one acre of cultivation to each head of the population, and that about 15 per cent. of the cultivated area was under irrigation. So far as we can gather from the data which have been supplied to us, the conditions now are much the same as they were then. The proportion which the irrigated area bears to the whole area of cultivation certainly does not appear to have increased by more than one per cent.

639. Under river channels, which are described as the most valuable form of irrigation in Mysore, a distinct advance has no doubt been made, and the area irrigated by these works has been nearly doubled within the past 25 years. But this means an increase of only 5 per cent. to the whole irrigated area of the province, and the increase is confined for the most part to the districts which are least liable to famine. Large sums have also been liberally spent in improving the tanks, but most of this expenditure seems to have been necessary to prevent retrogression, and it is not said to have led to any considerable increase in the tank irrigated area. On the whole, however, the extension of irrigation has fully kept pace with the increases in population and cultivation; and all things considered the State is now, no doubt, much better equipped to meet famine than it was in 1875. The position, as regards the district most liable to be affected by drought, will be still more improved when the great Marikanave tank is completed.

(iii).—Scope for further extensions of State irrigation works.

640. *General remarks.*—Outside of the area covered by the Western Ghats nearly every suitable site has been already occupied by a storage work. The only means of providing any considerable extension of irrigation in Mysore must therefore, as in the case of the Deccan districts of Bombay, be sought for in a system of canals depending for their supplies on large storage works in the western region of assured rainfall. Unfortunately, the main rivers of Mysore, having their sources in the Western Ghats, do not traverse the districts most liable to famine. Their courses lie close to the Ghats in deep valleys which separate the secure tracts on the west from the precarious plateau districts on the east. The Tungabhadra flows almost due north through the districts of Kadur and Shimoga, while the Cauvery and its main tributaries flow to the south-east through the districts of Hassan and Mysore. Storage works in the basins of both these rivers would be useful—on the Tungabhadra they would be invaluable—to the districts of Madras which they subsequently traverse, but they would be of little use to Mysore. The only portions of the State that could be commanded by them lie in the tract that least requires protection. All the difficulties that we have referred to in connection with the utilization of the rainfall of the Ghats in the Deccan districts of Bombay are here intensified. The courses taken by the rivers, the general level of the country, and the broken nature of its surface, would all be serious obstacles against any attempt to carry the abundant rainfall of the Ghats on to the main plateau of the province. These difficulties might no doubt be overcome, but in all probability the cost would be quite prohibitive. Nevertheless, the question is, we think, one of such vital importance to the State that no opinion on this point should be accepted as final, until a thorough and systematic reconnaissance has been made by a specially qualified Engineer. Should no possible means be discovered for utilizing rainfall stored in the Ghats, Mysore will have to rely, for any extension of its irrigation by means of State works in the tracts liable to famine, upon the improvement of its existing tanks and channels, and upon the construction of new works for the storage of local rainfall in the comparatively few catchments which are not already fully occupied.

Works in progress.

641. *The Marikanave tank.*—At the time of our visit to the State two new irrigation works were under construction—the Borakanave tank to store 2,354 million cubic feet and irrigate 9,000 acres in the Tumkur district, and the Marikanave reservoir. The latter is a colossal work. The reservoir is being formed by damming up the waters of the Vedavati river in the Chitaldrug district. The crest of the masonry dam will be 142 feet above the river bed; and, with the reservoir full, the water surface will have an area of over 40 square miles, while the volume of water impounded will exceed 30,000 million cubic feet. This is much more than the capacity of any existing reservoir in India, and but little less than that of the great Nile reservoir at Assuan. The natural advantages of the site are so great that the project, which had been long under consideration, has always been a favourite one with engineers. On the other hand, although the catchment area is no less than 2,075 square miles, the supply will be liable to great fluctuations. The annual rainfall is 25 inches on an average, but it has been as low as 8 inches, and the run-off from the catchment is greatly reduced by a large number of existing tanks. The run-off corresponding to an annual rainfall of 30, 25, and 15 inches has been calculated at 19,000, 10,000, and 3,000 million cubic feet, respectively; and with a fall of 8 inches there would practically be no run-off at all. It is not considered that the tank will fill more than once in 30 years; but, owing to difficulties connected with the escape or waste weir, it has been found less costly to construct the dam to impound 30,000 million cubic feet than 20,000, the volume originally proposed. Provision is made for an overflow of 60,000 cusecs. The work is estimated to cost 39 lakhs, exclusive of establishment and indirect charges, and is a remarkably cheap one if regard be paid to its maximum storage capacity. But the area which it is proposed to irrigate in ordinary years is fixed at only 30,000 acres for which, according to the Mysore standard of 0·26 million cubic feet per acre, 7,841 million cubic feet should suffice. It is even considered doubtful if this area will be worked up to for many years to come, for the tract commanded consists mainly of black cotton soil and is sparsely populated by cultivators who are reluctant in changing dry for wet cultivation.

642. On this subject Colonel Grant, who has been for so many years connected with the Revenue Survey of Mysore, and than whom there can be no better authority, writes as follows:—

> There are considerable stretches of black soil in the Devangere, Chitaldrug, and Hiruyur taluks. If black soil is unsuitable to irrigation, important works of irrigation, contemplated or in hand, will be defeated in their main object, and will certainly not be remunerative; the Marikanave project for instance. * * * We know that the rayats who occupy black soil, rightly or wrongly, have some prejudice against using irrigation. They have hardly ever made the experiment, the real truth being that the dry cultivation of black soil is very easy, and a bumper year makes up for several years of bad yield. Moreover, the rayats of these black cotton soils are quite unaccustomed to irrigation. Could the Pagavada and more eastern rayats be imported to Hiruyur, I have no doubt they could make something of the opportunities offered. My own opinion is that the black soil does not admit of regular irrigation, and that, the means of irrigation provided, water would go little further than saving the crops by moderate waterings. I speak here of irrigation for ordinary dry crops. If black soil be converted into what is known as wet land, I believe that it will take several years before good crops are obtained, and then only because sand and other earth has gradually been intermixed, and the whole has become friable.

Even if the full area of 30,000 acres of wet crops is brought under cultivation, the work is not likely to return more than 2 per cent. on its capital cost. But it has been sanctioned chiefly on account of its protective value, which in a year of drought should be considerable, even if the tank has been only half filled by the rainfall of previous years.

Proposed new works.

643. *River channels and ghat-fed storage works.*—The existing dams are sufficient to draw off all the supply generally available in the rivers during the dry weather; and even if this were not the case, the Madras Government would object to any interference with the surplus, or the construction of any work likely to reduce the present dry weather supply of the canals in that Presidency.

Hence, for the supply of any new canals in Mysore, or to increase the dry weather supply of existing canals, it will be necessary to construct large storage reservoirs on the main rivers or their tributaries, and within the region of assured rainfall. We understand that sites for such works are now being systematically investigated, and that the discovery of suitable sites on the Cauvery or its branches will lead to a very large increase in the area under river channels; though, as we have already stated, it will probably be impossible to extend this form of irrigation to the tracts which are most in need of protection. The works, however, are, as we have shown, very remunerative, and the extension of these channels, even within the limits of the western districts, will be of very great benefit both to the cultivators and to the State. The investigations previously made, apparently in no very systematic way, have resulted in the discovery of only one possible site in the valley of the Cauvery; and even this has not proved practicable, for the construction of a reservoir would submerge the town of Fraserpet. A more thorough investigation, which should include those portions of Coorg and of the Madras Presidency lying within the upper valley of the river, may, however, lead to the discovery of other and more practicable sites. In the valley of the Tungabhadra some excellent sites have been found at Lakvalli and Mudaba; but, as we have said, reservoirs at these sites, though of great value to Madras, would apparently be of little use to Mysore. The site at Lakvalli has a catchment of 776 square miles, with an average rainfall of 150 inches. It is situated in an unhealthy tract and in the midst of valuable forests of teak; but in all other respects it is said to be one of the finest sites for a reservoir in the whole of India.

644. But, even if the investigations should result in the discovery of but few suitable sites for new storage works, our evidence leads us to think that the area irrigated by river channels could be largely extended by improving the existing works. The Chief Engineer estimates that to provide proper masonry dams and to improve and extend the channels would cost about 25 lakhs. We think that the results would justify the expenditure, but this could easily be tested by remodelling a few selected works.

645. *Proposed new tanks.*—The list of proposed works contains 30 new tanks, most of which would receive no supply in a year of drought, though many, if not all, would be useful in a year of average rainfall. It is proposed to prepare the projects for these works in detail and to construct, as funds are available, any that promise to be remunerative; those which have a purely protective value being left for the employment of labour in a year of scarcity.

646. It is evident that there is not much scope for the extension of irrigation by means of new tanks constructed outside the region of the Ghats; but, as in the case of river channels, there is reason to think that the area matured under existing works could be largely increased, not only by improving the existing tanks, but also by thoroughly remodelling their channels and providing them with proper masonry or pipe outlets for the distribution of the supply; and also, in years of short rainfall, by restricting the area irrigated in proportion to the available supply.

647. *Cost of proposed new works and possible increase in the area irrigated.*—Excluding the two works under construction, the list of proposed new works contains 48 works estimated to cost 107½ lakhs, and to irrigate 107,000 acres in a year of ordinary rainfall and 56,000 acres in a year of drought. Of the latter area only one-fifth lies in the precarious eastern districts. These figures are not based on detailed surveys or estimates. They are admittedly only a rough approximation, and they do not include all the extensions that may be rendered possible by the construction of ghat-fed storage works, and by minor improvements which collectively should have an important effect. But we fear that they indicate generally, and, at least as regards the tracts most liable to famine, with sufficient accuracy, the limited field that exists for the extension of irrigation in Mysore by means of new State works. Such possibilities as there are will, we have no doubt, be fully utilized in the near future by a Durbar which has proved itself so liberal in the past in providing funds for the general improvement of the province.

(*iv*).—*Private irrigation works.*

648. *Private tanks.*—The private irrigation works in Mysore consist of tanks, wells, spring channels (called *talpargis*) and channels from hill streams. There are in all about 2,000 private tanks irrigating an area of 47,000 acres. Half of these are situated in alienated lands. Of the remainder many are old State tanks which were repaired by private individuals in consideration of a remission of one-fourth of the revenue. When a private individual constructs a new tank, we understand that no charge is made until the next revision of settlement, when the usual wet rates are assessed.

649. *Wells.*—Wells are extensively used to supplement the irrigation of garden and other lands situated under tanks. There are no separate statistics of the area irrigated in this way. The wells in such cases are usually mere shallow holes from which the water is lifted by means of a *pakota*. The areas irrigated exclusively from wells are practically confined to the four eastern or 'Maidan' districts, in which there are said to be 41,000 wells, irrigating in an ordinary year about 70,000 acres. In a year of drought the supply of these wells is, on the average, diminished by about a half; in but few cases does it fail entirely. Except in the vicinity of the tanks, upon which 75 per cent. of the wells of the province depend for their supply, the depth to the water surface, in localities where wells are made, is about 30 to 40 feet. The well near a tank in which a *pakota* is worked by manual labour costs only a few rupees, while the well, 26 or 30 feet square and revetted with stone work, in which a leather bucket is worked by bullocks, costs three or four hundred rupees. Under rules issued in 1891 the State grants advances for the construction of wells, charging 3 per cent. interest and recovering the advance in 30 years. Since the issue of the rules 1,316 wells have been constructed by means of these advances. But for the further sinking of wells there is said to be very little suitable ground. The rules regarding the revision of assessment on well-irrigated lands, which appear to be very liberal, are printed in the appendix volume of this report.

650. *Spring channels and private river-channels.*—In the north-eastern part of the province springs are tapped in the sandy soils, and the water is conducted to the fields by channels which are sometimes of considerable length. These channels irrigate in all about 5,000 acres. We have no information as to the area under private channels from hill streams, but it is said to be considerable.

651. *Field embankment.*—In the black cotton soils of the Chitaldrug district, the practice is common of constructing small embankments, not so much to hold water as to collect silt and soil. Above these embankments, even in bad seasons when the crops fail elsewhere, gram, wheat, and cotton, are raised successfully.

(*v*).—*Famine works and programmes.*

652. *Famine programmes.*—Since the severe famine of 1877 there has been no need for works of famine relief in Mysore. Fortunately, there is not likely to be any difficulty in finding a sufficiency of suitable works for any future famine. The numerous tanks, which are in need of restoration and repair, the many miles—over 6,000—of roads, most of them metalled or gravelled, and four proposed new lines of railway, on which from the nature of the country there will be a large amount of cutting and embanking, should afford ample employment on earthwork and on the collection of road metal, for the maximum number of people likely to come upon relief. There are, in addition, the proposed new tanks to which we have referred, few of which are likely to be so large as to render it unadvisable to employ relief labour for their construction, under proper supervision. In future, reliance is to be placed mainly on these works for the employment of relief labour, the collection of metal being held in the background to supplement any deficiency in the programme of tank works. The village relief works will consist of filling objectionable pits and ditches, clearing prickly pear, deepening ponds and wells, and

constructing new wells, etc., supplemented by as many minor irrigation works as can be properly supervised. The importance of having a carefully considered programme prepared well in advance of a famine appears to be fully realized, and a detailed programme for each district is, we understand, now under preparation.

(*vi*).—*Coorg.*

653. *Irrigation in Coorg.*—In Coorg the average area annually under crop as 204,000 acres, or 1·13 acres per head of population. Of this nearly one half is under rice, 40 per cent. under coffee, and the balance chiefly *ragi*. The rainfall, which varies in average annual amount from upwards of 150 inches on the wrest to 40 inches on the east, is usually abundant; but about one-tenth of the area of the district, lying in a narrow strip along the eastern border, is affected occasionally by drought. Within this strip there are 27 irrigation works—tanks and small canals—which have been constructed at a cost of Rs. 75,000 and are said to be capable of irrigating over 5,000 acres, but there are no accurate accords of the areas annually irrigated. One-third of the expenditure has been rincurred on the Chikle Holé channels which apparently do not work successfully. We recommend that an officer with experience of irrigation works should be deputed to prepare projects for new works for the further protection of the tract liable to drought, and to advise generally regarding the improvements required in existing works.

Section IV.—HYDERABAD.

(*i*).—*Local conditions; use and value of irrigation.*

654. *Physical features.*—Excluding Berar, or the Assigned Districts, the territories of His Highness the Nizam embrace an area of 82,698 square miles, and contain a population of 11,141,142. They lie on an elevated plateau in the centre of the peninsula, and are traversed or bordered by four large rivers, whose sources lie within the region of assured rainfall in the Western Ghats. The Godavari flows through the centre of the northern half of the State, and subsequently forms the greater part of its eastern boundary. The Kistna, after traversing the south-eastern corner, and receiving on its way the waters of the Bhima, is joined by the Tungabhadra and takes the place of that river in forming the southern boundary. The plateau lies generally at an elevation of about 1,500 feet above sea level. The main watershed, separating the basins of the Godavari and Kistna rivers, crosses the State from the north-west to the south-east at a general altitude of about 2,000 feet, and divides it into two fairly equal parts. There are numerous ranges of hills, the most important of which run from east to west, but few of their summits rise to a height of more than 500 feet above the surrounding country.

655. *The Telingana tract. Soils and agriculture.*—The civil districts into which the State is divided are classed in one or other of two main divisions. The seven districts forming the eastern half of the province are known as Telingana; and the nine western districts as Marathwara. The line of demarcation is an irregular one, but its general direction may be found by connecting the point of junction of the Kistna and Bhima rivers with that of the Manjira and Godavari. There is a marked diversity in the characteristics of these two tracts, whether they be viewed from a geological, an ethnographical, or an agricultural standpoint; and in each aspect the distinction has a more or less important bearing upon the subject of our inquiries. The Telingana tract lies in the granitic and crystalline formation which covers a large portion of the Peninsula, and to the red and sandy soils of which irrigation is in general so freely applied. It is peopled, as its name implies, chiefly by Telugu-speaking races who, as a rule, are ready to make full use of all available facilities for irrigation. Within this tract rice is freely cultivated, the winter crop being known as *abi* and the summer crop as *tabi*. Both crops are irrigated from tanks, river channels, and to some extent even from wells.

656. *The Marathwara tract.*—The Marathwara tract lies, on the other hand, within the area of the Deccan trap series, and the prevailing soil is the usual

black cotton soil of that formation, in which as a rule excellent crops of wheat, cotton, and millet can be grown without artificial waterings. But, even when irrigation suits the soil, the cultivators in this tract, chiefly Marathas, are said to be averse from wet cultivation. Here, therefore, there are practically no tanks; and irrigation, which is chiefly from wells, is confined generally to the cultivation of garden crops.

657. This diversity of conditions has led to a distinction in the systems of land revenue in force in the two tracts. In the Marathwara districts the assessment, which is determined upon the Bombay Settlement system, both on wet and dry lands, is fixed for a period of 15 or 30 years, and ordinarily no remissions are given for damage to crops or for fields lying fallow. In the Telingana districts this rule applies to dry lands only; the assessment on rice lands being made subject to full remissions for any year in which the land may be uncultivated from a failure of the water-supply.

658. *The Carnatic districts.*—Of the nine Marathwara districts there are three in the south-east corner of the State—Lingsugur, Raichur, and Gulbarga—in which the conditions in some respects resemble those of the Telingana districts. The subsoil water is, as a rule, much farther from the surface; but the soil is for the most part of the same nature, and the inhabitants, being largely Canarese, understand and practise irrigation. These are sometimes known as the Carnatic districts, and for our purposes it will be convenient to retain this distinction.

659. *Extent of cultivation and irrigation.*—Out of a total of nearly 53 million acres comprised in the State, statistics are available only for the cultivable and forest areas of *khalsa* lands, or in all for about 23 million acres, of which 2½ million are under forest. About 3 million acres are returned as cultivable waste, and of this 90 per cent. lies in the Telingana districts. Out of about 17½ million acres under occupation in the year 1900, one million acres or under 6 per cent. were assessed as irrigable. The occupied and actually irrigated areas are distributed as follows:—

Tract.	Area of dry cultivation.	Area assessed as irrigable.	Probable net areas actually irrigated.	
			In a year of normal rainfall.	In a dry year, 1899-1900.
	Acres.	Acres.	Acres.	Acres.
Marathwara	8,581,165	238,572	235,447	232,409
Carnatic	4,496,725	61,440	58,430	43,887
Telingana	4,350,438	706,868	479,049	96,294
Total .	17,428,328	1,006,880	772,926	372,590

The figures of areas actually irrigated have been derived by deducting the areas on which remissions were granted from the total assessed areas. This is said to give fairly correct results for the Telingana tracts, at least for an ordinary year, and also for the Carnatic where the irrigation is chiefly from river channels with assured supplies. For the Marathwara districts, in which remissions are given only in very exceptional cases, the figures thus obtained may perhaps exaggerate the area irrigated in a dry year; for in these districts, though many more wells than usual were used in 1899-1900, many failed completely, and others yielded only half their usual supply. The figures are, however, sufficient to indicate that in the Marathwara districts less than 3 per cent. and in the Carnatic less than 1½ per cent. of the normal area under cultivation is protected by irrigation. For the Telingana tract the proportion in a year of ordinary rainfall is about 9½ per cent., and this falls to under 2 per cent. in a year of severe drought. A better indication of the value of irrigation is, however, afforded by the fact that in an ordinary year, with less than 10 per cent. of the cultivation under irrigation, over 55 per cent. of the whole land revenue of the Telingana districts is derived from the irrigated area, the average rates of assessment being under Re. 1 for dry lands and about Rs. 12 for irrigated lands.

660. *Area of cultivation per head of population.*—There are no accurate statistics of the area annually under crop, but adding the net area irrigated in a normal year to the dry area, the total works out to 2 acres per head of the population of 8,178,952, comprised in the *khalsa* area. For the Telingana tract the proportion is about 1 acre, and for Marathwara about 3 acres per head.

661. *Rainfall and famines.*—In Marathwara the annual rainfall varies from an average of 30 inches on the east, to 40 inches on the west side. This tract suffered from famine in 1877, and again in 1899 when the northern districts received only 12 inches and the southern 15 inches of rain. The Carnatic tract, for which the average is only 26 inches, is specially liable to be affected by drought. It suffered severely in 1877, in 1897, and again in 1900. In the Lingsugur district, which closely resembles the neighbouring district of Sholapur in the Bombay Presidency, scarcity is said to be almost chronic, and famine or severe distress is expected once in every twelve years. In Telingana the average rainfall varies from 31 inches in the south to 41 inches in the north; but in every district the fluctuations from year to year are considerable, the limits being from about half the normal, as in 1899, to 50 per cent. above the normal, as in 1893. Even, however, with half the normal rainfall a considerable area of dry crops can generally be matured in the more sandy soils of this tract; and in 1899, though there was severe distress, there was no actual famine. The large number of ordinary works then in hand afforded sufficient employment to the people, and it was not found necessary to open special works of relief.

662. *General conclusions.*—With reference, then, to the general question of the utility of irrigation in Hyderabad, it may be said that in the Telingana and certain portions of the Carnatic tracts, which comprise more than half the total area of Hyderabad, irrigation is vitally essential to the well-being of the people and to the general prosperity of the State; and that the soil is suited to it and the people eager for it. No stronger evidence of this could be given than is afforded by the great difference between the average rates of revenue assessment on wet and dry lands, which, if the areas are correct from which the rates are calculated, appears to amount to not less than Rs. 10 or Rs. 11 over the whole of the Telingana and Carnatic districts. This is very much higher than the average charge for water advantages, whether taken in the form of a water-rate or of an enhancement of the land-revenue rates, that is obtained in any British province or in any other Native State, although there is no reason for believing that the rates in them are unduly low. The fact that such a charge can be realized not only indicates the great utility of irrigation in these tracts, but also renders all expenditure in extending irrigation highly remunerative. In the remaining, or Marathwara districts, irrigation in ordinary years is employed almost solely for the cultivation of garden crops: the benefits that the staple field-crops would derive from irrigation in such years are, to say the least, extremely doubtful; while the cultivators themselves, in spite of recent adverse seasons, have shown no desire to change their present extensive dry cultivation for the more laborious cultivation of rice and other wet crops.

(*ii*).—*Existing State irrigation works.*

663. *Classes of works.*—The State irrigation works in Hyderabad consist of tanks and small canals, and are practically confined to the Telingana and Carnatic districts. Most of them are old works of which the original cost is not known; and we have not been furnished with statistics showing separately the areas irrigated by wells and by the various classes of State works. It is therefore impossible to show, with any degree of exactness, their value as productive works, and of their protective value only a general indication can be given.

664. *Canals.*—The principal canals take off from the Tungabhadra river and irrigate a total area of 3,732 acres, yielding a yearly revenue of Rs. 51,962, or Rs. 14 per acre, of which Rs. 1-8 per acre is spent in annual maintenance. The supply from the river is unfailing, and the works are therefore, so far as they go, useful protective works, besides being undoubtedly highly remunerative. There are also two old channels, each about 70 miles in length, taking off from the Musi river and ending in a large tank near the town of Nalgonda. The channels were constructed many centuries ago, but they have fallen into disrepair and are not now used for irrigation. There are besides a number of minor channels

taking off from above weirs constructed across the smaller streams. Unfortunately in Telingana, where water is most required, these streams dry up soon after the cessation of the rains, and no water is available for the late or, as it is here called, the *tabi* crop. The retentive black soil of Marathwara parts with its water more slowly, and the streams supplied by it carry water long after those of the Telingana districts have ceased to flow. It is, indeed, asserted that the greater part of the hot weather flow of the Kistna and Godavari consists of drainage from the trap formation within the Nizam's territories.

665. *Tanks.*—While the few canals of the State irrigate chiefly in the Carnatic districts, its 18,000 tanks are situated almost entirely in the Telingana tract, where nearly every suitable site is said to be occupied by a tank. They are all either small or of moderate size, the largest having a capacity of under 300 million cubic feet. Many of them—and these are the most successful—are fed by channels taking off from a stream or river. To be really efficient such channels should, it is said, be capable of filling the tank within a period of 35 days. All tanks, except the largest, that are not fed in this way fail in a year of extreme drought such as 1899-1900, but not necessarily in a year like 1896-97, in which drought followed an abundant early rainfall.

666. *Restoration and upkeep of tanks.*—The majority of the tanks are said to be breached or otherwise in a state of disrepair. But a great deal has been done to improve matters in this respect since 1893, when, under the advice of Mr. A. J. Dunlop, Revenue Secretary to His Highness' Government, practical steps were taken to revive the old system of *dastband*. Under this system a certain share, generally 8 or 10 per cent., of the revenue dependent on a tank, is paid in cash, or its equivalent is granted in *inam* lands or in a reduction of assessment, to a lessee who undertakes the maintenance and repair of the tank. The lessee, or *dastbandar* as he is called, is invariably an influential man, who either himself owns land under the tank or has a personal interest in its upkeep. In many cases he is a descendant of the original constructor of the tank, and he probably holds some hereditary local or village office, such as that of *Desai* or *Deshmukh*. In return for his share of the revenue he is required at his own expense to repair all breaches within a reasonable time, to keep the banks and sluices in good order, and the main distributary channels clear of silt.

667. The larger tanks, however, were often found to require not only extensive repairs but actual restoration, for the satisfactory execution of which skilled supervision was essential. For this purpose, among others, there was formed in 1896 a separate Irrigation Department under a Chief Engineer (Mr. Roscoe Allen) whose services were lent to the State by the Government of India. Under his supervision plans and estimates are now prepared, and the work of restoration is carried out, before a tank is handed over to the lessee. During the past eight years, 5,487 tanks have been leased out on the *dastband* system, the revenue on the 276,000 acres irrigated by them amounting to over 29 lakhs. The *dastband* system appears to give general satisfaction, and to have led to excellent results; but in working it two points are essential, namely, the selection of the lessees from among local or village hereditary officers of influence, and a proper system of periodical inspection. As a rule, it is the smaller tanks only which are leased out for repair. The larger tanks and irrigation systems are maintained by the Irrigation Department, on annual grants which are limited to 10 per cent. of the revenue dependent on the work.

668. *Method of financing the tank restoration work.*—When the plans and estimates for the restoration of a tank have been prepared and sanctioned, if there is any difficulty in obtaining an early allotment of the necessary funds, the work is carried out under a system of deferred payments. A contractor carries out the work under departmental supervision, but at his own expense, receiving 5 per cent. on his outlay and all the revenue realized from the tank until the debt is paid off. Often the contractor holds land under, and has an interest in the tank, and subsequently he becomes the *dastbandar*.

669. Under this system 1,472 tanks have been repaired at an estimated cost of 42 lakhs. A large tank at Kamaredipet, which we inspected, had recently

been restored under this scheme, at a cost of Rs. 35,000, and now brings in an annual revenue of Rs. 17,000. There are many other similar instances; and, though there may possibly be doubts as to the return to be derived from the construction of new storage works in Hyderabad, there can be no question as to the highly profitable nature of these works of restoration. The great value of these schemes, both for the restoration and the maintenance of the tanks, has lain in their adaptability to the special circumstances of the case. A considerable expenditure was required which was certain to be highly remunerative, but for which, owing to the pressure of famine and other circumstances, funds were not readily available from the State Exchequer. The certainty that large revenues would accrue made it possible for the State to pledge those revenues, or a share of them, beforehand, with a perfect assurance that persons would be found willing to take up the work in return for the pledge. The local influence of these persons, and their interest in the efficiency of the tanks, also made it probable that the work would be as well done as their resources and abilities would admit. Thus, without straining its exchequer in any way, the State has been able to finance a large amount of highly remunerative irrigation work, while the expenditure on its Irrigation Department has actually declined.

(iii).—Scope for further extensions of State irrigation works.

670. *Projects and surveys.*—Since the formation of an Irrigation Department in 1896, in addition to the restoration of about 500 of the larger existing works at an actual cost of 34 lakhs, and of many smaller works at a cost of 4 lakhs, a large number of projects have been prepared for the construction of new tanks and for the restoration of other works. Including the works already constructed, or now in course of execution, estimates amounting to 80 lakhs, and affecting an area of 226,000 acres, have been sanctioned by Government; additional projects for 120 works, estimated to cost 24 lakhs and to irrigate upwards of 60,000 acres, are now under consideration; while surveys are being made for a number of other projects which, it is roughly estimated, will afford protection to 130,000 acres.

NEW WORKS IN THE CARNATIC DISTRICTS.

671. *The Benur project.*—The most important of the projects which have been prepared for the protection of the Carnatic districts, is one for the restoration of an old dam or anicut on the Tungabhadra river, and the construction of a canal, at a cost of 8 lakhs, for the irrigation of 10,000 acres in the Lingsugur district. The Madras Government raised objections to the construction of the work on the ground that it would interfere with the full utilization of existing canal works in that Presidency, but this objection has now been waived. This work should materially assist in the protection of a district which is singularly liable to suffer from deficient rainfall. Unfortunately, there does not seem to be any scope for further works of a similar nature, as only a very limited area on the Hyderabad side of the river can be commanded from the Tungabhadra. Even if a large reservoir above Hospet were constructed, as has been proposed in Madras, the only benefit to Hyderabad would lie, it is said, in a possible increase of 8,000 acres to the area irrigated by the Benur and existing channels.

672. *The Bhima and Kistna rivers.*—The investigations in progress in the valley of the Bhima river had not so far resulted in the discovery of any feasible project, owing to the small slope in the bed of the river and to the unfavourable conformation of the country. From the Kistna, however, it is thought possible to take out a canal on the left bank, which would irrigate a very large area lying between that river and the Bhima. No detailed surveys have yet been made, and beyond ascertaining the possibility of the project nothing has been done. The area which the canal would command is estimated at 200,000 acres. The withdrawal from the Kistna of a volume sufficient for the irrigation of anything like that extent of country, would interfere seriously with the supply of existing canals in Madras. This difficulty might be met by the construction of storage works, if a sufficient number of suitable sites could be found; but this would add enormously to the cost of the project which, even without storage, is estimated at a crore of rupees. It might, perhaps, also be satisfactorily met by the construction by the Indian Government of the great storage work on the lower Kistna to which reference is made in the chapter on Madras, and this may be a

weighty argument in favour of that project. With so much to be done in the restoration of existing works, and in the construction of small but highly remunerative new canals, it seems improbable that His Highness's Public Works Department will be in a position to undertake such a large scheme for some years to come.

673. *General scope of proposals.*—For the further protection of these districts the only remaining project of any importance is one for the construction of a large reservoir on the Muski river, to irrigate 6,000 acres in the Lingsugur district. The restoration and repair of existing tanks is estimated to add another 10,000 acres to the present irrigated area. Adding these to the areas that may be irrigated by the proposed Benur Canal, and by possible extensions of existing canals, we obtain an area of 34,000 acres as the total increase that it seems possible to effect in the protected area within a reasonable time. This will not afford anything like adequate protection to the Carnatic districts, but it will mean an addition of 50 per cent. to their present irrigated area.

New works in Telingana.

674. *Works in progress.*—In the Telingana districts, of the new works under construction the most important are a canal, costing 10 lakhs, taking off from the Manjira—a large tributary of the Godavari—to fill a number of tanks and irrigate in all about 20,000 acres; and the restoration of the channels from the Musi river, to cost 2¼ lakhs and irrigate 24,400 acres. A number of tank restoration works are also in progress.

675. *Projects under consideration.*—The field for further extensions has not yet been thoroughly investigated; but, in addition to restoring a large number of derelict works, there is apparently some scope for the construction of new storage works, and a very large scope for the construction of channels, not so much for the purpose of direct irrigation as to connect the tanks with the rivers and ensure them a supply in years of deficient rainfall. The proposed dam across the Kistna may render it possible to command a considerable area in the Warangal district by a canal from the left bank, but it is doubtful if the land is suitable for irrigation. The question is one which will deserve investigation when the general project is under preparation. The most important projects now under consideration are those for a second canal from the Manjira river, to irrigate 12,000 acres and feed a large number of tanks in the district of Indur; a canal from the Godavari to irrigate 45,000 acres in the Elgandal district; the restoration of the large Parkal tank, and the construction of a new tank for the irrigation of about 25,000 acres, in the Warangal district; and the construction, at Sangam, in the Mahbubnagar district, of a large tank which would irrigate about 10,000 acres. Many of these works are likely to be very remunerative, and even the new storage works are estimated to return 4 or 5 per cent. on their cost. In restoring some of the larger tanks we would recommend the adoption of self-acting gates for the waste-weirs, such as are now in use in Bombay.

676. If all the works now contemplated, exclusive of the Kistna reservoirs, are carried out, the area under irrigation in the Telingana district will be increased by nearly 400,000 acres. Even this addition may not afford complete protection; but it should at least prevent a recurrence of anything like the severe distress that has been recently felt in many parts of Telingana.

New works in Marathwara.

677. *Remarks and suggestions.*—The operations of the Public Works Department have hitherto been practically confined to the Carnatic and Telingana districts, though some expenditure has been incurred in a small Telingana-like tract in the Nander district. Excluding this small area, the conditions in Marathwara are anything but favourable for the development of irrigation. Irrigation is not necessary save in exceptional years of drought. In ordinary years it is not only unnecessary but it would often do harm; for irrigation during a break in the rains,

followed by an unexpected downpour, would inevitably result in serious injury to the crops. As is the case almost everywhere in the black soil tract, irrigation can be usefully applied to limited areas of garden crops, but, unless the prevailing system of agriculture is to be changed with very doubtful advantage to the people, anything like extensive irrigation is hardly to be hoped for; and, at best, the process of extending irrigation will be a very gradual one. There appear, however, to be in most districts considerable areas of soils that are suitable for irrigation; and in many districts there was, during recent famines, a scarcity even of drinking water. We think, therefore, that the construction of reservoirs, with catchment areas large enough to ensure a supply of water in all years, would probably afford the most useful employment that could be found for relief labour in Marathwara; and that it would be advisable to have the country examined with a view to the preparation of projects of this nature, and to their inclusion in a programme of relief works. It is even possible that this examination may disclose sites for tanks or other works, which are worth taking up before the occurrence of another famine. There are also a certain number of existing irrigation works which probably command lands that are suitable for irrigation, and examination may show that it would be advantageous to have many of them repaired as ordinary public works. And, where the land is suitable for irrigation, small irrigating channels might be taken out from above weirs constructed across some of the numerous streams which are said to afford a supply of water throughout, and for some time after, the rainy season.

(*iv*).—*Private irrigation works.*

678. *Classes of works.*—The private irrigation works in Hyderabad consist of wells and tanks. In many cases the latter are small Government tanks which have been repaired by the cultivators at their own expense. There are also a number of irrigation works, some of them apparently irrigating considerable areas in *jagirs* or private estates; but with regard to these we have no information.

679. *Wells.*—In the *khalsa* lands there are in all 96,589 wells used for irrigation; of these about 40,000 are in the Telingana districts where a well for two buckets, and about 20 feet square, sunk to a depth of 30 feet, costs on an average about Rs. 300. The small temporary well in the immediate vicinity of a tank costs Rs. 15 or Rs. 20. In dry years these are made in large numbers to supplement the supply from the tank; two acres per bucket are assessed at well rates, but one bucket is said to irrigate annually two acres of cane, or three of rice, or four of other crops. In these districts, cultivators who convert dry into wet lands at their own expense are granted a lease for 30 years; during the first-half of that period they pay the ordinary dry rate on the lands irrigated, and this is doubled during the latter half; on the expiry of the lease the lands are assessed at the usual wet rates. Under this system there is said to have been a considerable increase in the number of wells, but most of our witnesses considered that it would be advisable to charge nothing exceeding the ordinary dry rates for the full period of the lease. For lands outside the *ayakat* of a tank, the ordinary well rate is about Rs. 10 per acre. Within the *ayakat* all lands are assessed at the full tank rate of Rs. 12 to Rs. 15, but a lower rate is fixed if a well is used annually to supplement the tank supply. If it is only used occasionally, the cultivator has to claim a remission for that year.

680. In the Marathwara and Carnatic districts, where the Bombay system of settlement has been followed, at revision of settlement no increase is made in the assessment on account of improvements effected at the expense of the tenant. This concession, however, has not, it is stated, led to any considerable increase in the number of wells, owing to the poverty and indebtedness of the tenants, to the high rate of interest (18 to 24 per cent.) charged by the sowcar, and perhaps to there being no allotment of funds by the State for *takavi* loans in ordinary years. Without reliable figures of the numbers of wells made since settlement we are unable to criticize the accuracy of this statement. During the famine the State granted loans at 6 per cent. and they were freely taken; but a well in these districts costs from Rs. 300 to Rs. 600, and the witnesses express doubts whether in ordinary years advances would be taken readily even if funds were

made available. We think, however, that a fair trial should be made, for in the extension of wells lies, probably, the best hope of affording any appreciable measure of protection to the Marathwara districts.

681. *Borings.*—No serious difficulties appear to be experienced in the Telingana districts in selecting a suitable site for a well, as trial pits are dug by the cultivators at small cost. But for Marathwara and the Carnatic we would suggest a systematic survey of the underground supply, such as we have recommended for similar tracts in British territory.

(*v*).—*Famine works and programmes.*

682. We have no information as to the expenditure incurred on relief works in Hyderabad during the recent famine. The works were confined to the Marathwara districts where there is no irrigation establishment; and the labour was employed chiefly on the earthwork of roads and railways, and in deepening village tanks. Neither were we informed as to the extent to which programmes of works had been or were being prepared against the contingency of another famine. We consider it of great importance that a full and adequate programme should be prepared without delay, if it has not been already prepared, particularly for such portions of His Highness' territory as adjoin the frontier of British India. It is of the greatest importance that work should be ready on both sides of the frontier, for the simultaneous employment of His Highness's and British subjects, in the unhappy event of famine afflicting the territories of both Governments at the same time. As regards the future, there appear to be no definite programmes of relief works. In the Telingana and Carnatic districts there would be a considerable field for the employment of relief labour on the construction or restoration of irrigation works which have been sanctioned or proposed; but famine is less likely to occur in the former of these tracts than in the Marathwara. We have already suggested an examination of this tract with a view to finding sites for tanks which might be included in a programme of relief works. But, whether such sites can be found or not, we consider it of the highest importance that a suitable programme of relief works should be prepared and maintained for this portion of His Highness's territories, so that work may be ready on both sides.

Section V.—BERAR.

(*i*).—*Local conditions; use and value of irrigation.*

683. *Main physical features.*—Berar, although lying almost entirely within the area of the Deccan trap formation, is divided into three tracts of markedly different physical characteristics. In the north, where the southernmost range of the Satpuras cover an area of about 2,000 square miles, the surface of the country is broken into a succession of hills and deep ravines. In the south, over nearly one-half of the total area of the province, the conformation is that which is so commonly found in the plateau regions of the Deccan—an undulating surface broken here and there by low and generally barren hills. The rugged country to the north is known as the Melghat, and the more gently undulating country to the south as the Balaghat. Between these two tracts lies a fertile and comparatively level valley, through which the Purna flows from east to west in its course towards the Tapti river. The Purna and the Wardha, the latter of which forms the eastern boundary of the district, are the only rivers of any importance. The total area of the province is 17,710 square miles.

684. *Soils and agriculture.*—In the southern plateau tract, in the valleys of the Melghat, and for a width of 8 or 10 miles from the base of the hills on either side of the central valley, the soil generally is either a brownish loam, or one of the light varieties of black soil to which irrigation is suitable. In many parts of the eastern half of the central valley, that is in the upper basin of the Purna, the black soil overlies *muram*, and its depth apparently is not so great as to preclude the possibility of irrigation; but towards the west and centre of the

valley the black soil becomes of the deep and rich alluvial variety to which irrigation would be quite unsuited, even if, over large areas of it, there were not already distinct signs of salt efflorescence.

685. In a normal year, the total area of crops sown is 6,820,000 acres, or 2·48 acres per head of a population of $2\frac{3}{4}$ millions. Of this area 38 per cent. is *juár*, 34 per cent. cotton, and about 9 per cent. wheat. Unirrigated rice is grown on 45,000 acres. The irrigated area varies from 43,000 to 80,000 acres, and forms, on an average, less than one per cent. of the whole area under crops. Wheat, garden crops, and sugar-cane, are the principal crops irrigated in an ordinary year.

686. *Rainfall and famines.*—The average annual rainfall varies, in the Melghat tract, from 28 inches at the foot of the hills to upwards of 66 inches at Chikalda, which lies at a height of 3,664 feet above sea level; and, in the remainder of the province, from 29 inches on the west to 35 inches in the north-east, and 45 inches in the south-east. In 1899, when the rainfall was the smallest on record, the general average over the whole province was about one-third of the normal, but many of the recording stations in the three south-western districts received less than a quarter of the usual amount. In that year the area from which crops were harvested was only 30 per cent. of the area sown in a normal year, and there was an almost complete failure of the crops in the western half of the province. As a general rule, however, the rainfall of June to September is abundant and certain; while that of October is variable and often insufficient, and the province receives usually but a very small share of the retreating monsoon of November and December. In 1896 there was ample rain in the earlier months of the rainy season, but the later rains failed and led to a partial failure of the *kharif*, and an almost total failure of the *rabi* crops. But the effect of the failure in 1896 was only very partial distress, nowhere sufficient to necessitate relief operations on any large scale, or seriously to increase mortality. In 1899, on the other hand, there occurred severe famine resulting in extensive relief and a considerable mortality. Such a calamity as this must be regarded as extremely rare in Berar, which is traditionally regarded by the people of the Deccan as their refuge in times of scarcity.

687. *Utility of irrigation.*—For the ordinary staple crops—*juár* and cotton, which form over 70 per cent. of the total cultivation—in all ordinary years irrigation is unnecessary; and, although Berar can no longer be regarded as immune from famine, there are no means of providing irrigation to an extent at all sufficient for the adequate protection of these crops in a year of severe drought. The utmost that can be done is to afford a certain amount of protection to the *kharif* crops and to the *rabi* sowings, against a failure of the late rains; and to provide means for extending the cultivation of wheat, rice, vegetables, and sugar-cane, where the soil and other conditions are suitable for the cultivation of those crops. With cultivators so conservative in their agricultural habits as those of Berar appear to be, and in general so prosperous and free from fear of serious drought, a change from dry to wet cultivation, even in the most suitable tracts, will at the best be a slow and gradual process.

(*ii*).—*Existing State irrigation works.*

688. With the exception of a few small tanks which have been practically dry of recent years, and which even in favourable years irrigate quite insignificant areas, there are no State irrigation works in Berar.

(*iii*).—*Scope for further extensions of State irrigation works.*

689. The Purna, the only perennial river in Berar, flows at a very slight slope, between banks which are 50 to 70 feet above the bed, and through soil which appears to be, for the most part, quite unsuited to irrigation. Thus the Melghat and Balaghat tracts, and the narrow strips immediately adjoining them and bordering the central valley on either side appear to offer the only field for

the construction of State irrigation works. In both these tracts it should be possible to construct a considerable number of storage tanks, and of small canals taking out of the numerous rivers and streams which carry the drainage of the high lands into the Purna and Wardha rivers. Any tanks constructed in the Balaghat tract will be liable to fail in a year of severe drought; but in the higher hills of the Melghat the rainfall is more certain, and it may be possible to find here some suitable sites for large tanks such as will afford an assured supply of water in all years. No proper reconnaissance of the country has, however, yet been made. We cannot, therefore, at present do more than indicate, in this general way, the tracts in which it may be possible to extend irrigation by means of Government works, and the classes of works that appear to be most suitable to them; and recommend that the necessary surveys and preparation of projects be put in hand as soon as possible. The more promising schemes might be carried out as experimental works and the remainder brought on to the programme of famine works. The small canals will probably prove fairly remunerative, and their protective value, especially in the Melghat, will be considerably enhanced if their supplies can be supplemented from storage works constructed in the valleys above. The other class of works,—those which will have to depend on storage for their whole supply,—are much less likely to prove remunerative, and it may be doubted if they will ever yield a revenue sufficient to cover the annual interest charges and working expenses.

(*iv*).—*Private irrigation works.*

690. *River channels.*—There are a few small private channels taking off above temporary dams constructed across streams and irrigating, in all, about 1,000 acres. The cultivators pay to Government for the use of the water an increased assessment which varies from Rs. 1½ to Rs. 5 per acre, according as the water lasts till the end of January or the end of May. In many of these works it may be advisable to substitute for the present temporary structures either permanent masonry dams or self-acting flood gates, to be erected and maintained at the expense of Government; the maintenance of the channels and the distribution of the water being left as at present in the hands of the cultivators.

691. *Tanks and wells.*—There are no private irrigation tanks in Berar. The holdings generally are too small to admit of tanks being constructed by private persons, even if they had the necessary means. Thus, practically, the whole of the irrigation is from wells. The depth to water surface varies considerably according to the locality; but, excluding the high lands of the hilly and plateau tracts, the average depth appears to be about 30 feet. The supply generally is from percolation, but in many places good springs have been found. During the past seven years the water level has sunk considerably, and in 1900 a large number of wells ran dry; but many of these were deepened and are said to have then yielded an ample supply. In many parts of the Purna valley the water is brackish; elsewhere it is of good quality. A well costs on the average from Rs. 300 to Rs. 500, and is said to irrigate about 4 acres annually; but for the Buldana district, in which lies more than half the whole irrigated area of the province, the number of irrigation wells is shown as 5,714, and the area irrigated from them in 1897-98 as 54,669, giving an average of 9⅗ acres per well—a result which suggests some doubt as to the accuracy of the statistics for that year.

692. Loans for the construction of wells are advanced by Government, bearing interest at 6¼ per cent. During the past five years 2 lakhs have been advanced for new wells, and over a lakh for the improvement of wells and fields. The loans, however, are not taken freely except in years of drought, owing partly to the high cost of a well and partly to the uncertainty of finding water. Lands irrigated from wells constructed before the original settlement are assessed at the maximum dry crop rates; and those from wells constructed since the settlement, at ordinary dry crop rates. We gather that improvements are perpetually exempted from enhancement as in Bombay. But there seems to be in Berar similar uncertainty as to the exact effect of the law. No pains should be spared to get the people perfectly informed on the subject.

693. The portions of Berar which are suitable for well irrigation resemble in many respects those of the adjoining Deccan districts of Bombay; and the recommendations made in the Bombay Chapter regarding the encouragement of wells and surveys of the underground water-supply in those districts may be read as applying also to Berar. Except that Berar being so much less liable to drought, the special measures recommended in our general chapter for districts exposed to famine, and in particular free grants-in-aid, are less required than in the Deccan.

(*v*).—*Famine works and programmes.*

694. During the famine of 1899-1900 an expenditure of over 90 lakhs was incurred by the Public Works Department on works of famine relief—54¾ lakhs on roads, 14½ lakhs on railways, 9¾ lakhs on tanks for the water-supply of towns and villages, and the balance on establishment, etc. No expenditure was incurred on purely irrigation works; but a large tank in the Amraoti district, which supplies water to the town of Karinja and is said to irrigate a considerable area, was improved and enlarged at a cost of Rs. 1,08,391. The work has been practically finished with the exception of the enlargement of the catchment area which will admit of an extension of the irrigated area. We recommend the completion of this work which is estimated to cost Rs. 8,000.

695. The programme of future relief works provides employment for six months for 25 per cent. of the total population, but the works are somewhat unevenly distributed. For instance, in Akola and Buldana, two districts of the precarious western tract, provision is made for 9½ and 12½ per cent., respectively, of the population; while in the eastern district of Wun, where there was very little distress during the last famine, the programme provides for 38 per cent. The collection of road-metal, though a useful form of work, occupies too prominent a place in the programme. The expenditure under this head forms 80 per cent. of the total cost of the works, and would, it is said, provide all the road-metal likely to be required for ten years. When the survey recommended in paragraph 689 has been carried out, it should be possible to reduce this item to reasonable dimensions, and to include in the programme a fair number of really useful irrigation works. Special arrangements will have to be made beforehand to provide a supply of drinking water at the sites of many of the works. Where this is necessary, the arrangements should be made as soon as the work has been brought on to the programme.

Section VI.—BARODA.

696. *Divisions of the State.*—The State of Baroda, with an area of over 8,000 square miles, consists of four separate divisions. The Amreli Division (1,245 square miles), which is situated in the peninsula of Kathiawar; the Kadi Division (3,000 square miles), which lies north-east of the Neamgam Taluka of Ahmedabad district; the Baroda Division (1,887 square miles), which adjoins the districts of Kaira, Broach, and the Panch Mahals; and the Navsari Division (1,952 square miles), which consists of several detached portions lying mostly to the east of the centre of the Surat district. The physical and other characters of these four divisions may be taken to be approximately the same as those of the Native States and British Territory adjoining them; and the treatment for purposes of irrigation will be found generally to correspond in both cases.

697. *Amreli Division.*—The Amreli Division consists of two portions separated by the Gir hills of Kathiawar; and in these hills lie the head-waters of two minor rivers of that province. It is possible that storage works of moderate size might usefully be constructed here, and the examination of the country, which we have recommended for Kathiawar, should be extended to the Amreli Division. There are four projects of irrigation from small reservoirs in this division at an estimated cost of about 11 lakhs; but we have not information sufficient to enable us to pronounce on the merits of any of them. If anticipations formed by the Durbar are correct, one of them, the Shingoda, may prove remunerative and

irrigate 3,000 acres; and the other, the Pichvi, which would irrigate 5,600 acres, will be a useful protective work. As regards the other two, there may arise, with the State of Bhavnagar, territorial difficulties of the kind adverted to in the section on Kathiawar.

698. In this division there are about 5,500 wells, of which 1,800 are permanent. The area irrigated from them is estimated at 16,500 acres. The water-level nowhere exceeds 40 feet, and wells are not difficult to dig. Extension seems to be feasible on the same lines and to the same degree as in Kathiawar. Here, during the late famine, 129 wells were made by the State at a cost of nearly Rs. 96,000, or about Rs. 750 per well. The Baroda Durbar and the neighbouring States of Kathiawar evidently adopt the same policy in this respect.

699. *The Kadi Division.*—The soil of the Kadi Division is a sandy variety of the *gorat* soil of Gujerat. The notable feature of the division is that a considerable portion of the Sabarmati river forms the eastern boundary separating the division from the Idar State. The State officials informed us that close beyond the boundary they have discovered a fine site for the storage of the waters of that river. The prospects of this scheme, of which the scope may prove to be very large, and the mode in which the water should be utilized, require investigation. There are several other smaller schemes on the merits of which we are equally unable to pronounce.

700. This division contains 43,000 out of a total number of 56,000 wells in the State. The area irrigated is estimated at about $2\frac{3}{4}$ acres per well, and amounts therefore to about 118,000 acres. There is, very probably, room for a material extension of well-irrigation in this division.

701. *The Baroda Division.*—The Baroda Division, like the district of Broach, consists mostly of black cotton soil in which irrigation is not likely to be very highly appreciated. A project, however, for damming the river Orsang, a tributary of the Nerbudda in the north-east of the division, has been partly executed. The general scheme received the approval of Mr. Whiting, a retired Public Works Officer of great knowledge and experience. The dam has been completed and the subsidiary works and canal are well in hand. The flow in the river during the recent drought has, however, been much less than was anticipated, and storage will be required to supplement the flow in dry years. We have no information as to the volume of additional storage that will be required or as to the cost of providing it; but the canal, including one storage work, is estimated to irrigate 12,500 acres at a cost of 10 lakhs, or Rs. 80 per acre. This is a cheap rate for works in this kind of country, if, as represented, the soil commanded is generally suited for irrigation. The prospects of the work would therefore appear to be sufficiently promising to justify a considerable expenditure on securing an assured supply. The other works, already constructed or now proposed, are small and of comparatively little importance.

702. The division contains only a small area of well-irrigation which is probably incapable of great extension in the black soil areas.

703. *The Navsari Division.*—The Navsari Division, like the Surat district which it adjoins, is comparatively little exposed to famine. But there are at least two large projects for utilizing the waters of the Jankri and Purna rivers for purposes of rice irrigation. There is probably no urgent need for irrigation in the tract to be commanded, which adjoins the Bardah and Jelalpur sub-divisions of Surat, where there was but little famine. But the waters of these two rivers, like those of the proposed Tapti left bank Canal, might prove valuable for purposes of rice irrigation, and the Government of His Highness may well be advised to complete the examination of both projects.

704. Except in a portion adjoining the coast, where fine garden cultivation is practised in splendid loam soils similar to those of the adjacent portions of the Surat district, there is little well-irrigation in the Navsari Division, which is

probably not one of the areas in which very special encouragement of this form of irrigation is required.

705. *General conclusions and recommendations.*—Generally it may be said that the conditions of the Baroda State, excepting the Amreli Division, resemble those of British Gujerat. That the country felt the full force of the famine of 1899-1900 was shown at the census of 1901, when the population was found to have diminished by 19 per cent., a loss even greater than that of British Gujerat or Kathiawar. The need of protection from famine is fully as great in Baroda as in those provinces, and the existing areas under irrigation are very small. In the parts most exposed to famine, the obstacles to the extension of irrigation are no less formidable than in Gujerat. But it is urgently necessary that such possibilities as there are of extending irrigation should be definitely ascertained and developed. It is satisfactory that a beginning has been made in the investigation of projects. We understand that His Highness's Government contemplates allotting a sum of 5 lakhs annually to irrigation. We trust that the resources of the country may be fully investigated, and that, if the results are sufficiently promising, it may be found possible to increase this allotment by a considerable amount. Some useful preliminary investigation has already been made into the capacities of the head-waters of the Sabarmati, Tapti, and one tributary of the Nerbudda; and those inquiries confirm the conclusion stated in the chapter on Bombay that the possibilities of the higher reaches of the principal rivers of Gujerat and the neighbouring States merit exhaustive and scientific investigation by Government, in co-operation with Baroda and the other States concerned.

706. The investigations made by His Highness's Government are limited, to a great extent, by the desire to find sites in or as close as possible to Baroda territory, and to prepare projects which will secure the maximum of benefit to that territory without consideration of the requirements of British territory or of other States. We have already recommended (paragraph 127) that an examination should be made by British and State Engineers working in conjunction, with the object of utilizing the waters of the rivers so as to secure the maximum benefit to the country at large, with little or no reference to territorial considerations excepting in so far as they may affect the expense of the resulting irrigation to the territory benefited. As in British Gujerat, the first object of the works will be rice irrigation; the secondary object *rabi* irrigation requiring storage sufficient to provide water far on into the cold or hot weather. It is possible that schemes may be found to serve the first object without storage and at comparatively slight expense. Great caution should be exercised in approving schemes for the second object alone. The preference will be given to schemes avoiding black soils. Such schemes are most likely to be found in the head-waters of the Sabarmati and Mahi situated in the Kadi and northern half of the Baroda Divisions of His Highness's territories. As regards the Nerbudda, it is impossible to say what can be done until the country has been prospected. But the hope of making effective use of the waters of this river has not been heightened by the information which the Durbar has given us. It seems only too probable that levels are unfavourable, and that it will be impossible to secure command of country in which irrigation will be of use. What is required is a project for giving an assured supply, not to the black cotton soils, which are probably less difficult to command, but to the *gorat* and mixed soils, in which rice is at present irrigated from tanks, wherever these can be made.

707. During the last twelve years the Durbar has granted, for the construction of wells, *takavi* advances aggregating 12 lakhs of rupees, of which about 7½ lakhs were given in the famine years 1899 to 1902. Nearly half of this sum was allotted to the Kadi Division. During the famine, as in British territory, the ordinary precautions as regards security were considerably relaxed, and interest was foregone, or largely lowered, periods of repayment were lengthened, and other special concessions were allowed. In ordinary years advances are given on two systems. Under one, known as the "old" system, no interest is taken on advances up to Rs. 500, only 3 per cent. on advances between Rs. 500 and Rs. 2,000, and on sums above that 6¼ per cent.; sums up to Rs. 50 are made recoverable in two annual instalments, those between Rs. 50 and Rs. 500 in five,

and larger sums in ten instalments. More recently in some parts of the State the cultivator has been allowed the option of taking loans on the Madras system with long periods of repayment. We were not told which system the cultivator prefers. The State has also constructed a certain number of wells. The only figures given us are those quoted above for the Kadi Division. But the system of State construction seems to answer so well in Baroda that His Highness the Gaikwar proposes to extend it, if necessary, to all holdings which can be irrigated with advantage, and for which water is easily procurable at a moderate depth from the surface. It will be interesting and useful to observe the results of this policy, which is followed in other Native States, but the general adoption of which in British territory we are unable to recommend for reasons already given (I, 169). We trust, at any rate, that the policy of State construction will not induce His Highness to limit the sums given as *takavi* advances. Prior to the famine a tendency in this direction was observable, the sums advanced during the four years ending 1894-95 having averaged over Rs. 80,000, against Rs. 20,000 in each of the following five years. It is exceedingly probable that the State will have to rely for protection on wells more than on any other class of work.

708. We observed, with considerable satisfaction, a general disposition on the part of His Highness's Government to appreciate the usefulness of irrigation and the desirability of taking vigorous measures for its development on all lines which inquiry may show to be practicable; and we trust that this disposition will bear fruit in the provision of sorely needed protection from the effects of drought, to a substantial portion of His Highness's dominions.

Section VII.—CENTRAL INDIA.

709. The Native States comprised in the tract of country, known as Central India, occupy several very distinct regions, namely, Baghelkhand; Bundelkhand; part of the Gwalior State; Malwa, which includes a part of the large State of Indore, and several detached portions of Gwalior; and, lastly, the hilly regions south and south-west of Malwa, and small portions of the Nerbudda valley, south of these hills.

Baghelkhand.

710. *Physical features.*—The Baghelkhand States, of which the principal is Rewa, occupy a triangle the base of which consists of low hills which stretch from east to west, and form the northern boundary of the States, dividing them from the districts of Banda, Allahabad, and Mirzapur of the United Provinces. The southern two-thirds of the triangle, down to the apex, consist of hilly and broken country, much like the Mandla district of the Central Provinces and the more jungly portions of Chota Nagpur on the south-east. The remainder or northern portion of the triangle is a well watered and open country, containing considerable areas of black soil (*már*). There are also other soils similar in character and designation to the lighter and mixed soils of the Bundelkhand districts of the United Provinces, and no doubt equally well suited to irrigation.

711. *Irrigated areas and scope for their extension.*—The area of the Baghelkhand States is about 14,000 square miles, of which nearly 13,000 are in Rewa, to which belongs the southern forest and hill tract mentioned above. In this tract there is very little cultivation and irrigation, and the population is backward and sparse. The only useful irrigation works for such a tract are likely to be small works for the protection of rice cultivation round the village. The important river Sone rises here, but it does not emerge from the hills until long after it has left the boundary of the State. Any examination which may be made of this river for storage purposes is not, therefore, likely to extend into this tract. In the open northern tract of country the returns furnished to us show an irrigated area amounting in 1899-1900 to about 13,700 acres, of which 4,200 was from wells and 7,600 from "other sources," that is to say, presumably, small river-channels or *pains*. In the year 1900-01, the area under this latter class of

irrigation had increased by 40,000 acres. We have not been informed how this increase, most of which took place in the small State of Maihar, has been brought about. But we observe that this State has spent Rs. 3,25, 00 on its irrigation works and advanced Rs. 58,000 in *takavi* as compared with Rs. 94,000 and Rs. 1,400 in the far larger State of Rewa. We trust that this extension of the irrigated area indicates a good return for the money spent or advanced by the Durbar. There can be no doubt that, except in the deep black soil, the whole of the northern open parts of these States presents opportunities for irrigation. Apparently there is much undulating country which, for want of terracing and embankment, has gone out of cultivation. We understand that, in the famine of 1896-97, a considerable amount was spent on this class of work, as well as a certain amount on tanks and dams for irrigation purposes. If the possibilities of the open parts of Baghelkhand were examined by a competent engineer, he would probably be able to discover considerable scope for small works. The upper waters of the river Tons also lie in Rewa, and the country should be examined with the object of ascertaining whether any use could be made of them, either in the State itself or in connection with the project (which we have referred to in our chapter on the United Provinces) for irrigation from this river in the southern portion of the Allahabad district.

Bundelkhand.

712. *Physical and agricultural conditions.*—Included in the tract of Bundelkhand are twenty-two small States, covering an area of 9,800 square miles, with a population of about 1,275,000, or 130 to the square mile. The rainfall in most of these States averages between 30 and 40 inches, and though subject to considerable fluctuations, it is generally sufficient to fill the tanks and wells. But it is probable that the cold-weather discharge of the rivers would seldom be sufficient for irrigation on any large scale without storage. The physical and geological formation are generally favourable for irrigation. The southern boundary of the States consists of a considerable range of hills, known as the Bander, rising out of a plateau about 1,700 feet above the sea. About 15 miles to the north-west is the Panna range of hills, below which lies the main portion of the States, a plain country much broken by hills and spurs, especially towards the west and south-west. In these States also are included considerable lengths of the rivers Ken, Dassan, and Betwa. The last named river has already been utilized, and there are projects for utilizing the other two in British territory. The soils are the same as those of British Bundelkhand; namely, *már*, or black soil; and, as the hills are approached, mixed soils such as *kabar*, *parwa*, and *dumat*, and red soil (disintegrated sandstone). Pure *már* is unsuited to irrigation, but the proportion of this variety is said to be not very large. The red soil, except when accumulated in bottoms or behind embankments, is frequently too poor for irrigation; but the mixed soils, on the other hand, are in every way suited to it, and the undulating surface of the country and numerous small drainages and streams offer good facilities for terracing and embankments. Although rock is not far from the surface, wells seem to be easy to make, and are inexpensive and durable. They are usually made by digging through the surface soil and blasting out a portion of the rock, to serve as a reservoir for the water and afford material for a rough masonry superstructure, which is often limited as in British Bundelkhand to the staging required for the lifting gear.

713. *Cropped and irrigated areas.*—Excluding the State of Panna, for which no information is available, the area of these States under crop in a normal year is returned at 1,519,000 acres, or about 1⅓ acres per head of population; and of this 218,000 acres, or 17 per cent., are returned as irrigated, almost entirely from tanks and wells. The tank irrigation is, however, almost wholly confined to the single State of Orchha. In this State about 130,000 acres are irrigated from private and State tanks, but the total area irrigated by these means in all the remaining States does not exceed 10,000 acres. Out of the 41,000 wells, which are used in all the States for irrigation purposes, no less than 17,000 are in Orchha and they probably irrigate at least 50,000 acres. In this State itself the irrigated area is about 39 per cent. of its normal sown area,

714. *Captain Ewbank's projects.*—The States are all liable to famine, and in 1896-97 they suffered in much the same way and to the same extent as the adjoining portions of British territory. At that time advantage was taken to examine the ground for the purpose of devising relief works useful for protective purposes. A British Engineer Officer, Captain Ewbank, was employed on this duty and drew up a number of projects for small works, in Orchha and other States, such as tanks and field embankments, which were estimated to cost, in the aggregate, about four lakhs, and to protect 18,000 acres. The estimated cost of these works is under Rs. 22 per acre, and if the outlay and areas have been correctly estimated, this rate is so moderate as to afford a fair prospect of a remunerative return. The Political Agent, however, seems to be of opinion that Captain Ewbank's estimates were rather sanguine; and the Durbars, except those of States temporarily under Government administration, seem disinclined to take up the projects, either as ordinary works or for the employment of relief labour. The proportion of masonry required for many of these works certainly diminishes their value for relief purposes. Small works of this kind may, however, be very useful in seasons of badly distributed rainfall, even if of little value in a year of severe and prolonged drought. That a considerable amount can be achieved, without any direct loss and with possible profit to the State, seems to be shown by what has been accomplished in the State of Orchha, the ruler of which takes great interest in irrigation and has spent considerable sums in the restoration of old and the construction of new tanks and embankments.

715. *Tank repairs.*—Of even greater importance than the construction of new works would appear to be the restoration, repair, and improvement of existing tanks; of which there are at least one hundred and fifty, but all more or less inefficient owing to the neglect of essential works of maintenance and repair. The examination of these and other existing works would probably show that the areas irrigated from them are capable of considerable extension.

716. *Field embankments.*—During the famine we understand that relief labour was largely employed on field embankments, generally in the form of *bándhs*, that is to say, earthen dams thrown across the streams and small drainages with the chief object of checking erosion, accumulating soil and silt, and holding up water behind the *bándhs*, and, finally, of cultivating in the submerged area after the water had been let out. It is also anticipated that, in some instances, irrigation will be given to the lands immediately below the *bándhs*; and it is believed that the holding up of water will raise the level of the subsoil supply, and render the construction of wells in the vicinity easier and more profitable. We understand that in a considerable number of instances these works have proved useful; and the Political Agent considers that small *bándhs* are the form of work best suited to the country and the resources of the smaller States, where, in his opinion, the need of encouragement and assistance is most urgent.

717. *Wells.*—It is evident that in several of the States conditions are favourable also to the construction of wells. Apparently substantial sums are advanced in some of the States for this purpose, and many of the Durbars consider that wells are the best form of protective work for their States.

718. *Recommendations.*—Our general conclusion is that, with sufficient funds and proper investigation and management, the possibilities of irrigation in the Bundelkhand States admit of considerable development. In the first place, the head-waters of the larger rivers, the Betwa, Ken, and Dassan, ought to be surveyed with the object of determining whether any large storage project could be carried out with advantage to any or all of the States, as well as to the portions of British Bundelkhand which are traversed by the lower reaches of the rivers in question. In the next place, the existing tanks should be examined with the view of deciding what measures, if any, should be taken for their restoration, repair, or improvement. At the same time the country should be surveyed with the object of selecting sites for additional storage works, suitable either as ordinary works or for relief purposes, and for the smaller *bándhs*, which may be entered in the programmes of relief works.

719. A great deal may also be effected by a policy of liberal advances to land-holders and tenants for the construction of irrigational works of improvement, including wells, *bándhs*, and embankments of all kinds.

720. A single well-qualified Executive Engineer, with subordinate staff and establishment, would probably suffice for the supervision of the preliminary investigations and executive work in all the States. It has been suggested to us that no special measure of assistance or encouragement is required for the Orchha State, where the Maharaja has shown so much discernment and energy in the development of irrigation works. We should deprecate any measure which would check the initiative of the Maharaja, but we have no doubt that His Highness will himself often be glad to receive professional advice and assistance in connection with important existing or proposed works within his territory.

GWALIOR.

721. *Physical features.*—The State of Gwalior, the largest and most important of the States of Central India, has a total area of 29,047 square miles and a population of 2,933,001 or of 101 to the square mile. It consists of three divisions—Gwalior, Isagarh, and Malwa. The first two form a compact but irregular oblong, and are bounded on the north by the British districts of Agra and Etawah, on the east by British Bundelkhand and the Saugor district of the Central Provinces, on the south by the State of Bhopal, and on the west by some of the Rajputana States. The south-west corner of Isagarh Division forms part of the Malwa plateau, and the north-east corner of Gwalior Division is a low-lying open plain, about 3,400 square miles in area, in physical characteristics not unlike the adjacent parts of the districts of Jalaun and Jhansi. The Indian Midland branch of the Great Indian Peninsula Railway forms the eastern boundary of this open country. West of this the land rises rapidly and the country becomes undulating and broken, till a confused mass of hills, plateaux, small valleys, and ravines is reached, which occupies most of the central and western portions of these two divisions. On both banks of the Chambal also the country is cut up into a labyrinth of innumerable precipitous ravines, the character and appearance of which can hardly be realized until actually seen.

722. *Gwalior and Isagarh Divisions.*—The two principal rivers are the Chambal and the Sind, both tributaries of the Jumna; the former pursuing a curvilinear course skirts the northern and western boundaries; and the latter flows in a north-easterly direction, first through the hilly and then through the open country, joining the Jumna two or three miles below its junction with the Chambal. Both these rivers have numerous small tributaries. The total cultivated area of the Gwalior and Isagarh Divisions amounts to 2,311,404 acres, or 1·1 acre per head of population. The two divisions together contain about an equal area of cultivable but uncultivated land. The Isagarh Division also contains large areas of forest. The present tendency of the land-holders seems to be to utilize the forest and waste land for grazing purposes and the rearing of cattle, rather than to extend cultivation. Throughout this part of the States, but especially in the Isagarh Division, where the population is only 90 to the square mile, there is evidently considerable difficulty in getting labour on to the land. From the accounts given by Fry and other travellers, and from the numerous oil and sugar mills made of stone, which are found scattered all over the country, or grouped in different localities, it is believed that in former years cultivation was far more advanced than at present. There are also numerous remains of ancient irrigation works, principally dams, earthen or masonry, which are now ruined and neglected. The comparatively backward state of the country is probably due to its having been the scene of constant warfare by the ravages of the Pindaris. It has also been suggested that the failure to maintain the dams and irrigation works in this part has resulted in increased aridity and in erosion of the valuable surface soil.

723. The exact proportion of the cultivated area, which is irrigated from all sources, is not easy to estimate. In the following table we give the figures supplied by the Durbar for the year ending June 1902 :—

—	Gwalior.	Isagarh.	Total.
	No.	No.	No.
Total number of *pacca* wells	9,808	12,555	22,363
Total number of *kachcha* wells	5,506	7,041	12,547
Total number of tanks or *bands* holding water . .	1,439	431	1,870
Total number of tanks and *bands* out of repair . .	146	370	516
	Acres.	Acres.	Acres.
Areas irrigated by *pacca* wells	30,539	42,926	73,665
Areas irrigated by *kachcha* wells	8,971	17,536	26,507
Areas irrigated by tanks	40,507	15,776	56,283
Areas irrigated by flood spills	10,375	1,769	12,144
Total area . . .	90,392	78,007	168,399

According to this return the total area irrigated amounts to 168,399 acres, or over 7 per cent. of the cultivated area.

724. It will be observed that tank irrigation (including cultivation in the water-spread) accounts for 45 per cent. of the total in Gwalior, and only 20 per cent. in Isagarh, where there is a decided preponderance of well-irrigation. The figures, while indicating the existence of very material resources in the way of irrigation, are also suggestive of the policy to be pursued in this portion of the State. Its first object would appear to be the restoration and improvement of the existing works, then the extension of irrigation by means of new works and the embankment, terracing, and levelling of the extensive, irregular, and undulating tracts which are found throughout the State. Judicious measures of the kind would eventually result in a steady increase of the population, and a substantial development both of the revenues of the State and of the considerable agricultural resources which the country enjoys.

725. The Gwalior and Isagarh Divisions felt with full force the effects of the famine of 1896-97. Advantage was taken of the demand for employment to make a considerable beginning in the development of the policy which we have indicated, and a large number of projects were investigated, many of which were put in hand and completed. Most of these were small works, some of them masonry storage dams, others earthen dams for the same purpose, or for the purpose of preventing erosion and causing a deposit of soil and silt in the area of the water-spread. The total number of such works amounted to 353, and their cost to nearly three lakhs of rupees. The policy was steadily maintained until the end of 1900, when scarcity again occurred in the divisions of Gwalior and Isagarh. The total number of works executed up to the date of our visit to Gwalior amounted to 894 and the expenditure on them to nearly 16½ lakhs of rupees. These figures are for the whole State, but we understand that the greater part of the expenditure was incurred in these two divisions.

726. We have no details of the areas irrigated, and revenue obtained, as compared with the cost of these works. But the following are instances of success attained. At Bahadarpur, on the Morar, a tributary of the Chambal,

a masonry dam has been constructed at a cost of Rs. 34,500, protecting 500 acres of rice, but additional works have been proposed to bring another 1,000 acres under command. We inspected this work and consider that, with additions and improvements which have been proposed, it should prove both useful and remunerative. We also saw several instances of success in the 'bunding' up of *nalas* on the catchment of the same stream, whereby considerable areas have been reclaimed from jungle. In one instance, cited by Colonel Pitcher, the result of this reclamation, costing Rs. 3,000, has been the creation of a new village paying a revenue of Rs. 300 per annum. Two instances of the successful employment of famine labour on irrigation work are given by the same officer: the Dobini tank which cost Rs. 50,000 and supplies irrigation to 1,000 acres; and the Tonga tank which cost Rs. 42,000 and supplies water to about 1,000 acres. When the waste weir, which was breached by a flood in 1902, is properly repaired and the channels are extended, the Tonga tank is expected to irrigate 2,500 acres. There were other works which we saw in the neighbourhood of Gwalior in which the 'bunding' up of drainage areas and depressions, and the flooding of the land behind the *bándhs*, appeared to have resulted in the partial reclamation of considerable areas, formerly barren from salt efflorescence.

727. Besides the works mentioned above, we were shown a partially completed masonry dam at Tikampur. The site had been well chosen, and a considerable area of fertile land, suitable for irrigation, was commanded by it. Owing, however, to serious defects in construction, the dam did not hold water. We were able, after examination of the plans, to suggest how these defects could be rectified, but the necessary measures will add considerably to the cost. The work is of such a character that operations should not be resumed until they can be carried out under the constant and close supervision of an expert irrigation officer.

728. There appears to be great scope for the extension of irrigation in these two divisions. As far as we could ascertain, there is a fair demand at all times for water from existing storage works, all of which appear to have been effective during the recent droughts. The largest areas irrigated from the Tonga tank were in the driest years, and in no case has the failure of a work been attributed to any deficiency in the supply. It is probable, therefore, that many new works may be proposed which are likely to prove directly remunerative. But direct remunerativeness is not the only object to be sought. One result of the policy followed during recent famines of finding employment for the people on works, many of which cannot prove directly remunerative, has been to keep the people on the land; so that at the census of 1901 the population in these two divisions showed an appreciable increase, in contrast to the decrease which occurred in the Malwa Division. The Durbar has already prepared for these two divisions a very complete programme of famine works, all of which are expected to prove useful as irrigation works. There are 840 works already in the programme, for 149 of which plans and estimates have been prepared by the Divisional Engineer. The remainder are under investigation. It is estimated that the works for which estimates have been prepared, will irrigate about 43,500 acres. If these programmes are completed, they will probably represent all that can be done in the way of small irrigation works for many years to come. All of the works are small, only one of them costing as much as two lakhs of rupees.

729. It is understood that the works in these programmes will be reserved as a means of employing distressed labour during famine. They are all admirably adapted for this purpose; but we hope that, if funds are available, it may be possible to carry out some of the larger and more promising of them in the ordinary way. We think that sites could also be found for works of more considerable size if the country were examined by an experienced irrigation officer with a trained subordinate staff, and that much might be done for the better protection of these two divisions if funds could be allotted for the systematic prosecution of a programme of such work. We are afraid that there is little prospect of being able to utilize the water in the river Chambal owing to the depth of its bed below the surrounding country; and we are informed that a project which has been framed for a work on the Sind river, to cost as much as

10 lakhs, has been set aside as it was not considered satisfactory. We think, however, that as soon as competent advice can be obtained, the possibilities of constructing irrigation works on this river should be more thoroughly investigated.

730. *Wells.*—From the table in paragraph 723 above, it will be seen that about 100,000 acres in these two divisions are irrigated from wells, of which 12,547 are classed as temporary and 22,363 as permanent. Thus over 4 per cent. of the cultivated area is under this class of irrigation. Of the permanent wells, an unspecified number are semi-permanent. A considerable number of wells has been sunk by the State not only for irrigation, but for drinking purposes, and with the object of starting new hamlets, and thus encouraging a higher class of cultivation in outlying tracts. There is no lack of soil suitable for well-irrigation, and in many places water lies within easy reach of the surface, and the construction of a well involves no special difficulties or expense. The cattle, however, are small and weak, and the area irrigated from each well is consequently small. The State has advanced money liberally for the construction of wells during the last 6 years. Interest is charged at 4 per cent. during the first year of the construction and 6 per cent. for subsequent years, and land irrigated during the currency of one settlement is assessed at dry rates up to the end of the next. There is great room for the extension of well-irrigation, which will be best encouraged by a continuance of the present liberal policy in regard to loans.

731. *Other private works.*—No details have been furnished us showing the number of privately-owned tanks and *bándhs*. But that there are some of these is apparent from the fact mentioned by Colonel Pitcher, that a *jagirdar* had recently constructed a *bándh* at a cost of Rs. 15,000, and that, notwithstanding injury from a heavy flood, it had paid him a fair percentage on the outlay. No doubt the State is ready to encourage the execution of this class of improvement, such as tanks, dams, and field embankments, by means of liberal advances on the same lines as for wells. But in their present condition the resources of the ordinary landowners are probably insufficient for the multiplication of works of this description.

732. *Famine programmes.*—We have already referred to the excellent programmes of famine works which have been prepared for these two divisions, the majority of the works consisting of small tanks and *bándhs*—the most useful class of village works. The works are enumerated for each pargana or subdivision, and the following particulars are shown on the programmes :—

(1) Whether plans and estimates have been prepared.
(2) The name of the officer who has suggested the work.
(3) The catchment area.
(4) Estimated capacity of tank.
(5) Minimum quantity of water likely to be available in a season of drought.
(6) Area commanded by the project.
(7) Area likely to be irrigated in ordinary years.
(8) Area likely to be irrigated in a year of drought.
(9) Data of rainfall, run-off, and duty on which the irrigated areas are estimated.
(10) Return, if any, expected on capital cost.
(11) Approximate cost.
(12) Extent to which work can be carried out by famine labour, and other essential particulars.

This record is one which might, in many respects, form a model for British districts. It lacks a column showing the number of people for whom employment could be provided on each work, although the information can generally be derived from the entries in column 12.

733. *Malwa Division.*—The Malwa Division of this State consists, as has been already stated, of several detached portions of territory situated in the plateau of that name. The two districts of Agar and Shahjehanpur (Shajapur), which are the most easterly, lie in north-west of Bhopal. Agar is hilly, and Shahjehanpur more or less open country. This tract contains the head-waters of the Kali Sind, a tributary of the Chambal, which flows almost due north and joins that river in the Kotah State of Rajputana. The general elevation of the country is about 1,400 feet above sea level. The district of Ujjain is a little further west in the centre of the upper portion of the plateau, at an elevation of 1,700 feet, and is a well-known centre of the opium trade. The country to the north of the principal town is broken and undulating, and the rest is a black soil plain. To the south-west is the district of Amjhera, an extremely broken and hilly tract. On the north-west lies the open district of Mandasaur, and to the north of this again Nimach, which adjoins the State of Udaipur, and the southern portion of which is open country, with occasional hills, the northern being broken and hilly. The Chambal river in its higher reaches flows northwards through Ujjain, and forms the eastern and south-eastern boundaries of Mandasaur and Nimach. The total area of the division is 7,751 square miles, and the population only 111 to the square mile. Not much more than a half of the total area is cultivable; and of this, again, not much more than a moiety is actually cultivated, the remainder being cultivable waste. The division was severely affected by the famine of 1899-1900, when the rainfall fell from between 30 and 40 to from 15 to 6 inches. Large areas went out of cultivation, and at the census of 1901 the population was found to have diminished by 20 per cent.

734. The total area irrigated amounts to 63,600 acres, or about 5 per cent. of the cultivated area. Of this 4,600 acres are irrigated from tanks, and almost the whole of the remainder, that is, about 59,000 acres, from wells and water-lifts in the banks of streams. A great deal of the water is used for the irrigation of the poppy crop. A large proportion of the soil is of the black cotton variety, but much of it is evidently well-drained and of moderate depth, and accordingly not ill-suited to irrigation. The tank irrigation is conducted from 444 small tanks and ponds, and there are 95 others specified in the returns as out of repair and not holding water. Much of the so-called irrigation consists of cultivation in the tank water-spread; judging from the list of proposed works in the famine programme and from the character of the country, there are a good many sites for additional works of the kind. The policy of promoting irrigation has, however, been less highly developed in this division than in the other two. Across a tributary of the Chambal at Singoli, in the extreme north of the Nimach district, a permanent dam has been constructed, from which, if a canal were made, a substantial area might be irrigated. At present irrigation is carried on by lift from the banks. The numerous streams present great facilities for the construction of temporary dams, which could be utilized with great advantage for the storage of water in years of short rainfall. The division as a whole, there can be little doubt, has valuable possibilities for the development of tank irrigation, and the country ought to be fully examined with the object of discovering projects for the extension of irrigation. Severely, however, as it suffered in 1899-1900, the division is not so liable to drought as the two north-eastern divisions, and until recently it has been considered immune.

735. The programme of famine irrigation works is, however, slighter than in Gwalior and Isagarh, and to make it complete it should be placed in charge of a special Irrigation Officer. By careful prospecting of the country it should be comparatively easy to prepare a programme of irrigation works and field embankments, sufficient to provide employment for the great bulk of the population who are likely to require work in a severe famine.

736. The area irrigated from wells and water-lifts is undoubtedly capable of considerable extension, which should be encouraged with the same liberality as His Highness the Maharaja has extended to other portions of his territory.

737. In conclusion we have the pleasure of observing that His Highness takes an altogether exceptional interest in irrigation. He has toured through

parts of the country, examining and selecting sites for works, and ascertaining the circumstances and requirements of the people. There is no Native State in India in which there is a more favourable chance of excellent opportunities for irrigation being turned to full advantage by the intelligence of its ruler, who, up to the present, has set a valuable example in this matter to the Chiefs of Central India.

Indore and other States.

738. *General conditions.*—The remaining States of Central India, comprising the large State of Indore, which forms the dominions of the Maharaja Holkar, 9,500 square miles in area, and a number of smaller States, occupy a total area of 27,000 square miles in the south-western corner of the province. The total population amounts to $2\frac{1}{2}$ millions, or about 93 to the square mile. The hilly portions of the Vindhyas and Satpuras, in which lies nearly half the area of this tract, are inhabited mostly by a backward and extremely sparse population of Bhils and kindred aboriginal tribes. Cultivation is also exceedingly scanty except in the open parts of the Malwa plateau. In Indore not more than half, and in the other States a far smaller proportion, generally not exceeding one-fourth of the total area, is under cultivation. The tract lies almost entirely within the area of the trap formation, black cotton soil being found in the open country of the Malwa plateau and Nerbudda valley. In and adjoining the hilly country are lighter and well-drained soils frequently well-suited to irrigation, the backwardness of which must be attributed largely to the sparseness and primitiveness of the people. The whole of this country was severely affected by the famine of 1899-1900. The Indore State was found in 1901 to have lost 22 per cent. of its population, and the minor States, especially those in the hills, were found to have suffered still more severely. But the greater part of the country escaped easily in 1896-97, and there can be no doubt that it seldom suffers from acute famine.

739. *Irrigated area and scope for its extension.*—Excluding the State of Bhopal and a few very small States, for which no information is available, an area of $2\frac{3}{4}$ million acres is under crop in a normal year. Of this only 110,000 acres are irrigated, chiefly from wells. At the same time, according to the figures given to us, these States have expended no less than 40 lakhs on irrigation works, of which $27\frac{3}{4}$ lakhs were spent in Indore. The greater part of this has probably been spent on famine relief works. How much of this expenditure has proved of real value for irrigation purposes we have no means of stating. But we gather from the statements of the Durbar Officers of Indore and many other States that there are numerous tanks and *bándhs* out of repair, which, if restored, could be made useful for irrigation purposes, and that in most States there is considerable room for the extension of well-irrigation. There is no information as to the possibility of executing any large project. But, as suggested in paragraph 724 above, the headwaters of the Chambal may repay examination; and we think there can be no doubt that a systematic survey of the country would demonstrate the feasibility of executing numerous small works, such as tanks, *bándhs*, and field embankments. It may be doubted, however, whether, in such an extraordinarily severe drought as that of 1899-1900, when the rainfall in many places fell to less than a half and even to one-sixth of the normal, the works would hold water unless designed to store more than a year's supply for the area intended to be protected by them. In the Bhil country operations would have to be very gradual and tentative until the people had shown by more settled habits that they were ready to appreciate the value of irrigation. In order that anything effectual may be done, in these as in other States, competent Engineer Officers for Irrigation are required. Two possibly would suffice: one for Indore, and one for the smaller States. These officers would investigate the possibilities of the various States and prepare a series of projects and a programme of famine relief works useful for irrigation.

General recommendations.

740. Our recommendations for the States of Central India amount, then, to this: the appointment—for the examination of the country and for the preparation

of projects and relief-work programmes—of Irrigation Engineer Officers; one or more for each of the larger States, and one for each group of minor States. We would also recommend that these officers should work under the supervision of a Superintending or Consulting Engineer, who should be appointed for the whole Agency; and we think that, as in Rajputana, Government should be prepared to pay the Consulting Engineer and the Engineer for the smaller States. Effect should first be given to these recommendations in Northern Gwalior, Bundelkhand, and Baghelkhand, as being the tracts most liable to drought. But there would, we think, be no great objection to postponing active operations until the completion of the programme of protective works in Rajputana. The experience there gained should prove of great value in preparing the programme for Central India.

COLIN SCOTT-MONCRIEFF.

T. HIGHAM.

J. MUIR-MACKENZIE.

P. RAJARATNA MUDALIYAR.

Lucknow, April 11th, 1903.



GLOSSARY OF VERNACULAR TERMS.

Áhar, Áhara.—A small pond or reservoir; an embankment.—*Bengal.*

Ánicut.—A dam, generally of masonry, to retain or divert running water for irrigational purposes.—*Madras.*

Áyakat.—The *áyakat* of an irrigation work is the land irrigable by the work.—*Madras.*

Bájrá, Bájri.—A small variety of the bulrush millet.

Band.—An earthen embankment.

Bándh.—A bank for retaining water on a field.

Bandhárá.—A dam across a stream to divert water into a canal. The term sometimes includes both the canal and the dam.—*Bombay.*

Bár.—Grazing ground.—*Punjab.*

Bet.—Low-lying lands adjoining a river.—*Punjab.*

Báráni.—Lands cultivated on rainfall; crops produced by rain; unirrigated land.—*Northern India.*

Baoli.—A well with steps giving access to the water.—*Northern* and *Central India.*

Dastband.—Abatement of one-tenth or other portion of the revenue on account of compensation for a public work, such as the construction or repair of a tank. *Dastbandár*, the person to whom the abatement is given.—*Hyderabad.*

Doáb.—The tract of country between two rivers above their junction.—*Northern India.*

Doruvu.—A well on the bank of a stream or river.—*Madras.*

Dúmat.—A soft loam; a mixture of clay and sand.—*Northern India.*

Fasl.—Crop; season.

Gorát.—A fertile sandy soil of a light brown colour.—*Bombay.*

Hakábo.—A rate levied for water supplied for the irrigation of lands in foreign territory or in *jágír* lands.—*Sind.*

Hathia.—A rain commencing between 24th September and 7th October (more correctly *Hasta*).—*Bengal.*

Haveli.—Tract of country adjacent to a capital town.—*Central Provinces.*

Inám.—A gift; a grant of land or money.

Inámdar.—The holder of a rent-free grant.

Jágír.—An estate held free of Government revenue.

Jágírdár.—Holder of a revenue-free grant.

Jamabandi.—Rent roll.—*Northern India.* The annual settlement made under the *ráyatwári* system.—*Madras* and *Bombay.*

Juár.—Great millet (*sorghum vulgare*).

Kábar.—A species of black soil.—*Central India* and *United Provinces.*

Kachcha.—Raw, immature; incomplete, rough. A *kachcha* building is one built of earth as opposed to brick or stone.

Káchhí.—A caste of industrious cultivators.—*Northern India.*

Káns.—A species of grass very destructive to cultivation.—*Northern* and *Central India.*

Khálsa.—Pertaining to the State; used to signify those villages which are under the direct management of Government as opposed to the *jágír* or alienated villages which are under the management of their owners.

Kharif.—Autumn harvest or crops; autumn season.

Kodo.—An inferior millet (*Paspalum frumentaceum*).—*Northern* and *Central India.*

Kudi-maramat.—Repairs of irrigation works carried out by the cultivators.—*Madras.*

Mahua.—A fruit-bearing tree (*Bassia latifolia*).

Malbáh.—Village expenses.—*Northern India.*

Málguzár.—The person responsible to Government for the payment of the revenues assessed on a village.

Már.—Black cotton soil.—*Central India* and *United Provinces.*

Mot.—A large bucket for drawing water out of a well for purposes of irrigation.

Mota.—The hard stratum of soil met with in well-sinking.—*Northern India.*

Muram.—Disintegrated trap or other rock.

Nála.—A stream or ravine.

Pain.—A canal or water-course.—*Bengal.*

Pakka.—Ripe, complete; built of masonry.

Pakota.—A lever for raising water.

Panchayat.—A native court of arbitration.

Parwa.—A yellow or red soil.—*Bundelkhand.*

Rabi.—The spring harvest or crop; the winter-spring season.

Rági.—A kind of grain (*Eleusine coracana*). The *marua* of Northern India.—*Southern India.*

Ráyatwári.—A term applied to tracts in which the revenue settlement is made by Government officers with each actual cultivator without the intervention of a third party.

Reh.—A saline efflorescence.

Sowkár.—A banker.

Takávi.—Advances of money made by Government to landowners or cultivators for the improvement of their land; or to poor cultivators to assist them in carrying on their cultivation.

Tarái.—Low moist land lying along the banks of rivers or at the foot of the Himalayas.

Usar.—Land infested with *reh* or saline efflorescence.

Varágu.—The common millet (*Panicum Miliaceum*).—*Southern India.*

Zamindár.—A landowner.

Zamindári.—A term applied to tract in which the land is held by *zamindárs.*