GOVERNMENT OF INDIA

NATIONAL COMMISSION ON AGRICULTURE

INTERIM REPORT

ON

DESERT DEVELOPMENT

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NEW DELHI

MARCH, 1974

C O N T E N T S

continued/-

(CONTENTS CONTD.)

SUMMARY OF RECOMMENDATIONS

APPROACH TO FUTURE DEVELOPMENT

1. To check further deterioration of the desert, digging of phog (*Calligonum polygonoides*) which accelerates wind erosion and dune formation should be discouraged. The desert rehabilitation programme should generate enough fuel for local use and employment potential to absorb the labour which would be taken away from this vocation.

(Paragraph 4.3)

2. As the migratory system of rearing of cattle and sheep leads to higher mortality and low yields and comes in the way of any systematic breeding programme, conditions should be created to enable the nomadic people to lead a settled life.

(Paragraph 4.4)

3. Pasture development, regulated grazing and creation of grass reserves should constitute an important programme for the rehabilitation of the desert.

(Paragraph 4.5)

4. Since the process of desert rehabilitation would take some time, there should be a well planned programme of procurement of resources from outside the desert area and their distribution to augment local availability particularly of food, fodder and fuel.

(Paragraph 4.9)

5. Since a largescale programme of sand dune stabilisation cannot be contemplated at this stage due to limited financial resources, stabilisation of such dunes as pose a threat to large towns, roads and

railways should be taken up. All shifting dunes in the canal commanded area must be stabilised by planting over with grass and trees to prevent sand casting on arable land. Grazing of livestock on these dunes should be restricted so as not to disturb the soil, but people may be allowed to cut grass on payment of a moderate fee.

(Paragraphs 4.12 and 4.15)

6. The desert area should be self-sufficient in the matter of fuel supply to the extent possible. The main activity in tree growing will have to be in the canal commanded area so that the area becomes a major source of fuel supply in future.

(Paragraph 4.13)

7. In the canal cultivated area, suitable shelter-belts and wind-breaks should be established to minimise the desiccating effect of hot winds and reduce sand casting.

(Paragraph 4.16)

8. Advantage should be taken of spare water in the early stages of development in the commanded areas for growing trees there on a massive scale.

(Paragraph 4.17)

9. In areas outside the canal command, besides the trees which will naturally come up in the pasture enclosures or which may be planted under any limited programme of sand dune stabilisation, no attempt need be made to raise forest plantations as these are not likely to succeed in the arid conditions of the desert without irrigation which would not be justified.

(Paragraph 4.19)

10. With limited water resources and scanty rainfall and the consequent limited area for arable cropping, the economy of the desert area must be animal husbandry oriented.

(Paragraph 4.20)

11. In the canal commanded area, about 30 per cent of the irrigable area should be utilised for growing fodder crops to ensure a good supply of green fodder for high yielding dairy cattle.

(Paragraph 4.23)

12. At places of cattle concentration, farmers and cattle breeders should be encouraged to instal gobar gas plants to ease the fuel problem and to ensure availability of the residue as manure.

(Paragraph 4.25)

13. To make fuller use of the available water resources all known methods of water harvesting such as khadins, etc. should be promoted wherever suitable conditions obtain.

(Paragraphs 4.26 and 4.27)

14. A study should be made and proper instructions should be drawn up for making full use of water whenever unusually good rainfall occurs. A regional reserve of implements and equipment under the Department of Agriculture may be necessary to assist the farmers in this respect.

(Paragraph 4.28)

15. After meeting the important requirements for domestic use and industries, groundwater wherever available should be developed early for growing high value crops and orchards. Irrigated grass farms for

fodder banking would not be feasible on tubewells due to high cost of water.

(Paragraph 4.30)

16. The irrigation policy should be to cover as large an area and as many farmers as economically possible; high intensity need not be aimed at. It is necessary to spread the benefit of irrigation to certain lift areas.

(Paragraphs 4.33 and 4.34)

17. A programme of reclamation of saline lands in the 'tal' areas in the command of a channel should be put through during the first few years of irrigation development when there would be spare water.

(Paragraph 4.36)

18. Proper marketing facilities for dairy and animal products should be organised.

(Paragraphs 4.37 and 4.38)

19. Since electricity will be required for exploiting groundwater and minerals and for industries including chilling and processing plants for milk and milk products, a long-term plan for laying transmission lines should be drawn up for the area taking into consideration the likely schemes under all heads of development requiring power. Where electricity cannot be taken economically in the initial stage of development, diesel engines should be considered for running tubewells for domestic and industrial purposes.

(Paragraph 4.39)

DEVELOPMENT OF WATER RESOURCES

RAJASTHAN

20. Class VI lands, which require heavy land levelling, should be excluded from the CCA of Phase II of Rajasthan Canal Project. Instead, lift irrigation should be provided in reasonably flat good lands. Five new lift canals are recommended for a culturable commanded area of about 310,000 hectares. The saving on development costs in this case would be more than the additional construction cost.

(Paragraphs 5.21 to 5.29)

21. To provide some more irrigation in Pali district, the possibility of replacing water supplied to Jodhpur from Jawai reservoir by Rajasthan Canal water should be considered.

(Paragraph 5.32)

22. The cropping pattern for Rajasthan Canal area should be modified to provide a larger percentage of fodder crops to meet the requirements of animal husbandry in mixed farming.

(Paragraph 5.34)

23. Water rates for irrigation should be revised upwards, keeping in view the principles discussed in the Report of the Irrigation Commission on this subject.

(Paragraph 5.36)

24. The Rajasthan Canal Project should be recast to exclude unsuitable areas, bring more area under lift irrigation and alter the cropping pattern for more fodder crops. This would require some surveys and investigations for which adequate funds should be

provided immediately so that construction work may not get held up due to the change.

(Paragraph 5.37)

25. While the construction of Phase II of Rajasthan Canal should be completed in 10 years, the work of development of the canal commanded area should be completed within 15 years. This would require faster pace of development than hitherto.

(Paragraph 5.37)

26. In the Ganganagar district, the cropping pattern in the area covered by the Gang Canal and the Bhakra Canal systems should also be revised on the lines recommended for Rajasthan Canal area.

(Paragraph 5.38)

27. In $C_2D_1E_1$ zone, the productivity per unit of water should be improved by better water management practices and adoption of a fodder oriented cropping pattern.

(Paragraph 5.39)

28. Detailed studies should be made regarding the utilisation of the waters of the Ganga in its upper reaches, taking into account the available groundwater and the needs of the neighbouring arid areas.

(Paragraph 5.40)

CROPPING PATTERNS

29. In irrigated areas quality seed of all kinds of crops should be produced in large quantities.

(Paragraph 6.8)

30. In D_2E_2 zone the accent should be on development of grasslands for grazing and seed production.

(Paragraph 6.9)

31. In D_2E_2 zone where groundwater is available after meeting the domestic requirements, vegetables and orchard crops could be the best choice. Seeds of vegetables could be especially raised. Oilseeds like sunflower and safflower could also be tried.

(Paragraph 6.10)

32. In $C_2D_1E_1$ zone, it is not the change in cropping pattern but improvement in the yield level of the crops which should receive attention for which known methods of water conservation would have to be employed.

(Paragraph 6.11)

33. Research should be intensified so that definite recommendations could be made as early as possible with regard to establishing crops like bajra by transplanting than by direct seeding.

(Paragraph 6.12)

FOREST DEVELOPMENT

RAJASTHAN

34. A programme of tree growing on 16,000 hectares on the sides of main canal, branches and major distributaries should be drawn up and implemented on a priority basis. All attempts should be made to complete planting within four to five years of water becoming available in an area. Nurseries should be planned ahead, so that tall seedlings are available by the time they are needed.

(Paragraphs 8.8 and 8.9)

35. In addition to continuing the present practice of growing trees in the fields, farmers should be

encouraged to take up specially in canal commanded areas a substantial programme of planting khejri (Prosopis cineraria) and other suitable trees on bunds and boundaries of their fields to serve as wind-breaks.

(Paragraph 8.14)

36. For the successful implementation of a large programme of farm forestry, a strong extension organisation under the Forest Department should be developed with suitable and adequately trained personnel. The programme should be organised on the lines recommended in the Commission's Interim Report on Social Forestry.

(Paragraph 8.14)

37. The uprooting of phog should be gradually controlled by banning its movement outside the State. It would be necessary to have arrangements for distribution of fuelwood to big towns, defence establishments and bigger settlements. Initially, fuelwood would have to be brought from outside the desert area to augment local supply. The procurement and distribution agency for fuelwood should be the same as for food and fodder.

(Paragraph 8.15)

38. A programme of 8,000 row km of roadside plantations should be undertaken to prevent or reduce deposition of wind blown sand on the road, provide shade and for aesthetics. These should be considered as social benefits and not as commercial proposition in this region. To be effective against sand casting on the road there should be at least five rows of trees on the windward side and three rows on the leeward.

Where sufficient land is not available, only one or two rows of widely spaced trees can be planted for shade. Nurseries and supply of watering trucks should be planned ahead.

(Paragraphs 8.16, 8.17 and 8.18)

39. Shelter-belts should be established departmentally on about 80,000 hectares after careful planning. The programme should be executed in the early stages of development of the canal commanded areas, when there will be water to spare. No shelter-belts programme need to be taken up outside the canal command.

(Paragraphs 8.19, 8.20 and 8.21)

40. At least 200,000 hectares should be brought under grass reserves, each district having an adequate area under them. The entire production of hay should be collected, baled and stored in fodder banks, normally for three years. But hay should be disposed of in the fourth year, if not used up.

(Paragraphs 8.22 and 8,23)

41. A separate Wing for the implementation of the programmes of grassland development and grass reserves should be created under the State Forest Department with agrostologists, agronomists and range management specialists having sufficient knowledge and experience. Where necessary, they should be trained.

(Paragraph 8.24)

42. The areas put under grass reserves must not be converted later into forest plantations. For policy making, guidance and review of implementation there should be a coordinating body at the State headquarters consisting of the heads of departments of forest, sheep development, animal husbandry, dairy development and agriculture. Formation of a similar inter-departmental coordinating committee at the district level would be necessary.

(Paragraph 8.25)

43. Government should own and manage grass reserves to supply hay to fodder banks for storage. To augment this supply, Village Panchayats and individual farmers may be encouraged to conserve grass on cooperative basis with necessary extension assistance.

(Paragraph 8.26)

44. Scientific methods should be adopted in the improvement of grassland and grass reserves. The programme of grass seed production should be properly organised involving the local farmers. The seeds produced by the farmers should be purchased at reasonable rates for processing and distribution by well-organised agencies as recommended in the Commission's Interim Report on multiplication and distribution of quality seed.

(Paragraph 8.27)

45. Fodder banks for storing hay should be located close to the centres of consumption and near roads or railway stations to facilitate transport. The baling of hay should be done by hydraulic presses

to reduce the bulk and hence the expenditure on storage and transport. The storage should be done in the open in hay stacks (locally known as ganjis), but there should be pucca plinth and provision of fire-fighting equipment.

(Paragraphs 8.30 and 8.31)

46. Outside the command of Rajasthan Canal, surveys should be undertaken to determine the extent of works required for the stabilisation of shifting sand dunes which pose a threat to towns and railways and works taken up.

(Paragraph 8.32)

47. In the commanded areas of Rajasthan Canal, stabilisation of shifting sand dunes in compact blocks of 20 hectares and above should be taken up by the Government after enlisting the support of the Village Panchayats which should be entrusted with the task of protection. The income from the sale of grass and trees including lops should be shared equally between the Government and the Panchayats.

(Paragraph 8.33)

48. As a support to afforestation, grassland improvement and sand dune stabilisation programmes, the Forest Department should establish, on a priority basis, the base for research on different aspects of forestry in desert areas supplementing the efforts by the Central Arid Zone Research Institute in this direction. The Institute should also give adequate importance to research in

forestry along with other agricultural problems.
(Paragraph 8.35)

49. The ecological status of the desert should be studied to understand the life cycle of plants and animals of the region. An area of at least 100 sq km in Jaisalmer district should be selected, notified and maintained as a Desert National Park for continued studies under undisturbed desert conditions.
(Paragraphs 8.36 and 8.37)

HARYANA

50. At least 20,000 hectares should be afforested in compact blocks and in the gaps of the Aravalli hills in the next 15 years to serve as barrier to reduce the velocity of wind and to make available small timber, fuel and leaf fodder.
(Paragraph 8.42)

51. Plantation of 80,000 row km of strip forests on the sides of canals, roads and railway lines should be attempted in 15 years as a commercial venture on the lines recommended in the Commission's Interim Report on Social Forestry. The State Government should mobilise institutional finance for these plantations.
(Paragraph 8.43)

52. Sand dune stabilisation programme should be planned for 20,000 hectares in 15 years, the first preference being given to the smaller dunes (less than 1.5 metre high) which are the most active.
(Paragraph 8.44)

53. Under the farm forestry programme, the present scheme of planting of trees along the peripheries of cultivated lands should be encouraged. The Forest

Department should create adequate number of nurseries to supply tall plants to the farmers. The programme should be organised on the lines recommended for Rajasthan.

(Paragraph 8.45)

54. The grassland development programme should be executed by the Forest Department on the lines recommended for Rajasthan.

(Paragraph 8.46)

GUJARAT

55. Shelter-belts should be suitably located along the border of the Rann of Kutch adjoining the Santalpur and Vav tehsils. Suitable areas should also be selected in the commanded area of the Dantiwada reservoir for the purpose. The programme, 20,000 hectares in 15 years, should be organised on the lines recommended in the Commission's Interim Report on Social Forestry.

(Paragraph 8.49)

56. The pilot scheme for farm forestry in the Fifth Plan, as recommended in the Commission's Interim Report on Social Forestry, should cover both the districts of Banaskantha and Mehsana. From the Sixth Plan period onwards, there should be an aggressive programme of farm forestry.

(Paragraph 8.50)

57. A programme of mixed forestry should be planned on 15,000 hectares in 15 years, in the vicinity of habitations on suitable waste lands, panchayat lands and village commons on the lines recommended in the

Commission's Interim Report on Social Forestry.
(Paragraph 8.51)

58. The grassland development programme should be executed by the Forest Department on the lines recommended for Rajasthan.
(Paragraph 8.52)

LIVESTOCK DEVELOPMENT

RAJASTHAN

59. Mixed farming should be adopted in the canal irrigated areas. It should include maintenance of high yielding dairy cattle and cultivation of good varieties of fodder crops including legumes.
(Paragraph 9.13)

60. The main approach to cattle development should envisage simultaneous attention to four aspects viz. (i) reducing, if not possible, containing cattle population in the area, (ii) augmentation of feeds and fodder resources in the area in order to ensure supply of adequate nutrition to the animals, (iii) prevention in a large measure of the present nomadism of cattle breeders and (iv) breed improvement through planned breeding programmes. A large proportion of improved breeds/types of cattle in the arid zone should be transferred to the canal commanded areas; induction of inferior cattle from other areas by the settlers who are allotted land in the Rajasthan Canal command should be discouraged.
(Paragraph 9.15)

61. In the areas under canal command, a programme of crossbreeding of local cattle preferably with the

Jersey breed should be taken up as the marketing of milk from these areas will be mainly product based. The level of exotic inheritance should be maintained at 50% until such time as the farmers have become fully conversant with the rearing of crossbred cattle and green fodder production has adequately increased. The cattle breeding policy in the non-commanded area should be directed mainly towards improvement through selective breeding.

(Paragraphs 9.16 and 9.17)

62. Artificial insemination should be taken up in the canal commanded areas and intensified in the milk-sheds of the existing milk schemes and around urban areas. In the non-commanded areas, it should be gradually introduced.

(Paragraph 9.18)

63. Cattle breeding farms of adequate size with superior foundation stock should be established for undertaking scientific breeding programmes preferably based on progeny testing. In each of the desert districts, a central semen station should be developed with facilities for maintaining at least 25 bulls and adequate equipment and provision for collection, processing, storage and transport of semen. In addition, in the canal commanded area, similar stations should be established at Anupgarh, Pugal, Bikrampur and Nachna. The facilities already existing at the Key Village Centres should be merged

with the proposed Artificial Insemination Centres.
(Paragraph 9.19)

64. To ensure adequate coverage of dairy development in the canal command, additional milk chilling plants and milk products factories should be set up at places recommended in the Report. The balancing dairy at Pokaran should be converted into a large milk products unit and two feed mixing plants should be established, one each in or near Jodhpur and Suratgarh.

(Paragraphs 9.21, 9.22, 9.23, 9.24 and 9.25)

65. In arid areas outside the canal command, emphasis should be placed on sheep development with simultaneous improvement of grasslands. Improved grazing should be secured by bringing additional land under pasture.

(Paragraphs 9.26 and 9.27)

66. All available grazing lands in possession of Government should be reserved as range lands and no allotment should be made of these lands to the landless for cultivation of crops. Assessment of Government land by block size should be made in each district. All blocks of land of 200 hectares and above should be taken up progressively for pasture development and controlled grazing. Small sized and scattered blocks should be consolidated. The possibility of tapping groundwater or extending drinking water supply from other sources should be explored on a priority basis to enable utilisation of large tracts

of grasslands in Barmer and Jaisalmer.
(Paragraph 9.29)

67. Large blocks of Government range lands located far away from normally inhabited villages may be developed mainly as grass reserves for hay making and storage in fodder banks. In all grasslands to be developed by Government, controlled and rotational grazing should invariably be practised.
(Paragraphs 9.30 and 9.31)

68. While grass reserves would yield a good quantity of grass seeds, seed production should also be undertaken in properly organised seed production farms in areas with good soils and having rainfall over 400 mm and in areas with good irrigation facilities.
(Paragraph 9.35)

69. Pasture demonstration plots should be established in village common grazing lands. The Village Panchayats should be encouraged to undertake grassland improvement for which adequate extension support and financial assistance should be extended. In the eastern part of the arid zone, viz., the districts of Churu, Nagaur, etc., it is necessary to encourage sheep breeders owning land to earmark some area for pasture for sheep and they should be provided financial assistance for undertaking land development, fencing, reseeding and use of fertiliser.
(Paragraphs 9.36 and 9.37)

70. At least one million hectares of grassland/ culturable waste land should be brought under protected grassland development over three five

year Plans by the Government, village panchayat agencies and sheep farmers. This should comprise 800,000 hectares to be taken up by the Government including 200,000 hectares as grass reserves for fodder banking, 100,000 hectares of village commons and 100,000 hectares of private grasslands owned by sheep farmers.

(Paragraph 9.39)

71. Chokla and Nali breeds of sheep should be chosen for crossbreeding with exotic breeds in areas with better rainfall, the exotic inheritance being limited to 50% initially. Higher exotic inheritance should be considered only after the performance of such crossbred sheep has been fully studied. Selective breeding should be resorted to in the case of carpet wool breeds like Magra, Marwari and Jaisalmeri for production of improved sheep with heavier body-weight and wool of uniform quality.

(Paragraphs 9.41, 9.42 and 9.43)

72. Wool marketing should be organised and all the recommendations made in the Commission's Interim Report on 'Poultry, Sheep & Pig Production through Small and Marginal Farmers and Agricultural Labourers for Supplementing their Income' regarding the formation of sheep breeders' cooperatives, extension of credit and marketing facilities, etc. given effect to on priority basis in the arid areas.

It will be necessary to establish an autonomous body in the form of a Wool Board or a Corporation at the State level for wool marketing. The Directorate of Sheep and Wool should concentrate and utilise its expertise on production aspects of sheep and wool.

(Paragraph 9.44)

73. The techno-economic surveys on the marketing of sheep and goats proposed by the Rajasthan Government should be taken up and completed expeditiously to collect reliable information on marketing aspects.

(Paragraph 9.46)

74. Stockyards and slaughter houses should be organised at convenient places in the arid zone to enable transport of dressed carcasses and packed meat instead of livestock to distant meat markets. The Central Food Technological Research Institute, Mysore, may undertake pilot studies on long distance transport of meat and meat products.

(Paragraph 9.47)

75. For maximising utilisation of wool through local cottage industry, a large number of shearing centres and service units for preliminary processing like scouring, carding, etc., should be started.

Special arrangements should be made for training young artisans in the villages in the latest spinning and weaving methods, making use of locally produced wool. The State Khadi and Village Industries Board should be assisted not only to expand its activities to help a large number of artisans but also to establish additional wool utilisation centres.

(Paragraphs 9.48 and 9.49)

76. The number of goats should be reduced to 25 to 30% of sheep population to ensure adequate grazing resources for sheep and cattle. The sheep owners should be educated on the advisability of improving their sheep flocks and reducing the number of goats.

(Paragraph 9.51)

77. The Camel Farm at Bikaner should be adequately expanded to enable it to take up a scientific breeding programme and make studies on genetics, reproductive physiology and nutritional and health requirements of camels. The farm should be linked with a number of camel development blocks in different districts.

(Paragraph 9.53)

HARYANA

78. For increasing cowmilk production, crossbreeding with Jersey breed should be progressively

introduced, with exotic inheritance being limited to 50% till such time as green fodder availability has adequately increased. The Intensive Cattle Development Project (ICDP) at Bhiwani should be expanded to cover additional areas in Bhiwani tehsil and adjacent areas in Dadri and Loharu tehsils. One central artificial insemination station could be started at Mahendragarh with about 50 or more artificial insemination sub-centres preferably in the milksheds of the existing dairy projects and those proposed for establishment in the near future and other areas which have irrigation facilities. The breeding programmes should be linked with the activities of the cooperatives under the dairy projects and organised on the lines indicated in the Commission's Interim Report on "Milk Production through Small and Marginal Farmers and Agricultural Labourers.
(Paragraph 9.57)

79. The milk plant at Bhiwani should be expanded to handle at least 50,000 litres of milk a day with provision for further expansion to one lakh litres capacity. Milk chilling plants should be set up in Loharu, Mahendragarh and Dadri areas. Dairy schemes should extend all incentives for increased production and marketing of cow milk

as recommended in the Commission's Report referred to in the preceding Recommendation.

(Paragraph 9.58)

80. The decreasing trend in sheep population should be checked and their quality both for wool and mutton production improved. Crossbreeding of Nali sheep should be taken up progressively to replace ultimately the existing stock by a uniform population of crossbreds having 50% exotic inheritance. For production and supply of sufficient number of rams, the size of Hissardale and Nali sheep flocks at the Government Livestock Farm should be considerably increased. Similarly, in selected areas where good type of Nali sheep exists, controlled and planned crossbreeding may be introduced through sheep breeding extension centres.

(Paragraph 9.59)

81. The Wool Grading and Disposal Centre already started should be fully established at an early date with adequate facilities. Sheep development programmes and other measures to benefit small and marginal farmers and agricultural labourers as recommended in the Commission's Interim Report concerning sheep production should be taken up on a priority basis in the tehsils of Hissar and Bhiwani districts falling in the desert area. Facilities should be created locally for utilisation

of wool produced to provide employment to sheep breeders and artisans. The State Khadi and Village Industries Board should organise centres for wool utilisation as is being done in Rajasthan.

(Paragraphs 9.60 and 9.61)

82. Programmes should be taken up in at least 20,000 hectares of village commons during the next 5 to 10 years to develop grasslands and introduce controlled grazing.

(Paragraph 9.62)

83. For production of good quality camels to meet the local needs, 10 stud centres may be started and superior he-camels for these centres may be selected from the State Camel Breeding Farm and/ or established camel breeders in Rajasthan.

(Paragraph 9.63)

<u>GUJARAT</u>

84. For improving the quality and productivity of cattle, buffaloes and sheep in the arid areas of Gujarat, the two medium sized ICDPs proposed under the Drought Prone Areas Programme should be located early at Tharad and Thara in the arid areas. The artificial breeding programme should be closely linked with the activities of the cooperatives organised under the dairy schemes. The Kankrej cattle breeding farm at Thara should be expanded for genetic improvement of the stock.

(Paragraph 9.66)

85. Three more additional chilling centres should be established at Vav, Kankrej and Deodar in Banaskantha district and two centres at Sami and Harij in Mehsana district as the arid areas are not covered by the dairies at Mehsana and Palanpur.

(Paragraph 9.67)

86. Selective breeding of sheep should be resorted to for production of increased quantity of carpet wool of uniform quality. Programmes for collection, processing, warehousing and marketing of wool should be on the same lines as recommended for the desert areas in Rajasthan. The Gujarat Sheep & Wool Development Corporation should take up similar functions in Gujarat as recommended for the Wool Board for Rajasthan. The State Government should also consider setting up of one Intensive Sheep Development Project in this region under the Fifth Five Year Plan so that all measures for improvement of stock, marketing of wool, etc., could be planned and implemented.

(Paragraph 9.68)

87. A total of about 65,000 hectares of land should be brought under grassland development on the lines indicated for Rajasthan.

(Paragraph 9.69)

88. Five Camel Stud Centres should be started for organized breeding programme. Improved he-camels for these Centres could be obtained from Rajasthan.

(Paragraph 9.70)

OUTLAYS AND PRIORITIES

89. A comprehensive time phased plan of development should be prepared with a clear idea of relative priorities and keeping in view the interdependence of programmes.

(Paragraph 10.1)

90. For each item of development, there should be a suitable organisation adequate in strength and expertise to implement the programme at the required pace. The development should be completed in a period of 15 years i.e. by the end of the Seventh Plan period.

(Paragraph 10.2)

91. Excluding the items for which institutional sources are to be tapped, the requirement of outlays over a period of three Plans to complete various programmes in Rajasthan would be about Rs.397 crores, in Haryana about Rs.16 crores and in Gujarat about Rs.10 crores. In addition, there will be other items of development under the Plan in the desert areas.

(Paragraphs 10.3 and 10.4)

92. Measures to check further deterioration of the desert should be given first priority.

(Paragraph 10.6)

93. Consolidation of holdings to form suitable blocks for regulated grazing should be done on a high priority basis.

(Paragraph 10.7)

94. Tree plantations in canal commanded area and along the roads should be taken up on a priority basis.

(Paragraph 10.8)

95. Measures to make full use of the available live-stock resources should receive higher priority than those for further development. Programmes of dairy development and marketing facilities as also shearing units for sheep and grading centres for wool should be developed on a priority basis.

(Paragraph 10.9)

96. Between the programmes of further construction of Rajasthan Canal and the development of the commanded area of the portion already constructed, the latter should have priority.

(Paragraph 10.10)

INTERIM REPORT
O N
DESERT DEVELOPMENT

SECTION I
INTRODUCTION

The Great Indian Desert which encompasses the western half of Rajasthan and extends over parts of Gujarat and Haryana covers nearly 218,100 sq km. The population there is sparse. The people are economically backward in spite of the fact that the area has developmental potentialities, particularly in the field of animal husbandry. Some of the good breeds of cattle and sheep are bred in this area. But rains, scanty even in good years, often fail and famine conditions frequently arise. During such periods, large scale migration of man and livestock takes place in search of food and fodder, great distress prevails and large numbers of livestock perish, and the Government is greatly strained both financially and administratively.

1.1 In the course of its study of the economically backward areas in the country, the Commission visited some of the desert areas of Rajasthan, Gujarat and Haryana, examined the problems in the field and held discussions with some of the inhabitants, public men, scientists and State officials. Realising that the desert area is deteriorating rapidly and needed immediate attention and recognising the possibility

of the development of the area, the Commission decided to submit this Interim Report on development of the Great Indian Desert for the urgent consideration of the Government. The Report deals with the problems of the Great Indian Desert only and does not cover the cold Ladakh area which comprises the Northern Arid Zone nor the arid zone of the Peninsula. Problems relating to these areas will be discussed in the Commission's Final Report.

1.3 The area covered by this Report comprises 11 districts of Rajasthan, viz., Bikaner, Jaisalmer, Barmer, Jodhpur, Nagaur, Churu, Pali, Jalor, Ganganagar, Jhunjhunu and Sikar of which the first 8 districts form the "Core" of the desert. Parts of the latter 3 districts are relatively better placed from the point of view of water resources, In addition, it also includes parts of Mehsana and Banaskantha districts of Gujarat and Bhiwani, Hissar and parts of Rohtak districts of Haryana.

1.4 Year after year, substantial amounts are being spent on famine relief operations in the desert areas. In the core districts of the desert in Rajasthan alone, a sum of Rs.77 crores has been spent over a period of 8 years from 1963-64 to 1971-72 to afford some relief to the population. If ways and means can, therefore, be found to develop these areas, not only much of the hardship arising out of drought and aridity can be mitigated permanently, it will also help the socio-economic development of the existing affected areas.

SECTION II

THE DESERT

2.1 The first scientific approach to an understanding of the 'Great Indian Desert' and its problems originated from a note by the Planning Commission. According to this note, topographical surveys showed the spreading of the Desert at the rate of ½ mile (0.8 km) per year for the last 50 years and its encroachment upon approximately 50 sq miles (13,000 hectares) of fertile land every year. Following this note of alarm, the National Institute of Sciences, India, arranged in 1952 a comprehensive seminar on Rajasthan desert, in which this particular situation, namely, the spreading of the desert, was specifically discussed from all possible angles such as meteorological, archaeological, geological, hydrological and historical. The principal finding of these deliberations was that in ancient times at the places now found arid and deserted, had flourished prosperous towns and civilisations. The 'Great Indian Desert' as it presents itself now is the result of meteorological, geological and hydrological changes over the centuries, for which evidences are not lacking, but the desertic condition has undoubtedly been accentuated by the activities of man. This kind of human interference is still prevalent. Some scientists are of the opinion that if the process can be reversed

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*Draft Report on First Five Year Plan, July 1951, p.134

and growth of vegetation encouraged by protecting it against human depredation, the desert may be controlled and even improved. The Rajasthan desert, unlike others, is not so intractable as is often imagined. On the basis of the Report of an ad hoc committee appointed by the Ministry of Agriculture several suggestions were put forward for the creation of shelter belts, controlled grazing, fuel and fodder reserves for the area in order to prevent further ravages by man and animal.

Aridity and Moisture indices - Parameters of desertic condition

2.2 Whenever evaporation exceeds precipitation aridity prevails. If the excess of evaporation is due to high temperature the area affected is hot arid, but if the aridity is the result of low rainfall and the temperature is very low as in high altitudes, the affected area is cold arid. In both, the lack of vegetation is caused by deficiency of water. A quantitative measure of aridity has been attempted on the basis of climatic data, namely, rainfall and potential evapotranspiration. The latter, according to Thornthwaite (1948)* who was the first to introduce quantitative factors, denotes water need. The difference between rainfall and water need represents either water surplus or water deficit. Annual surplus and deficit expressed as percentage of the annual

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*Thornthwaite, C.W.(1948). An approach towards a rational classification of climate. Geog. Rev. 38, 55-94

water need are respectively termed humidity index (I_h) and aridity index (I_a). The moisture index Im equals Ih - I_a. Climatic types have been classified on the basis of certain defined ranges of moisture index as shown in Table below:*

Table 2.1 - Climatic Types and Moisture Index Ranges

Climatic type	Moisture index range
Perhumid	100 and above
Humid (with four subtypes)	100 to 20
Moist subhumid	0 to 20
Dry subhumid	-33.3 to 0
Semiarid	-66.7 to -33.3
Arid	-100 to -66.7

There have been several improvements and modifications in the calculation of potential evapotranspiration but the basic idea of Thornthwaite has remained unaltered.

2.3 Based on improved calculations using the Penman** formulation of potential evapotranspiration the following figures of indices in respect of the meteorological stations located in the arid zones of Rajasthan, Haryana and Gujarat have been arrived at (cf. Rao et al. loc. cit.).

* Rao, K.N., George, C.J. and Ramasastri, R.S.(1972) Agro-climatic classification of India. Meteorological Monograph, Agrimet. No.4

**Penman, H.L.(1948). Natural evaporation from open water, bare soil and grass. Proc. Roy. Soc. Lond. Ser. A.193, 120-145

Table 2.2 : Humidity, Aridity and Moisture Indices in the Arid Zone

Station	I_h	I_a	I_m
Rajasthan			
Ganganagar	0.0	82.1	-82.1
Bikaner	"	82.7	-82.7
Phalodi	"	88.1	-88.1
Jodhpur	"	79.3	-79.3
Jaisalmer	"	89.4	-89.4
Barmer	"	83.2	-83.2
Sikar	"	70.6	-70.6
Haryana			
Hissar	0.0	72.3	-72.3
Gujarat			
Radhanpur	3.5	70.7	-67.2

Peculiarities of Rajasthan Desert

2.4 Rajasthan desert, because of its many peculiar problems and properties, has been studied in greater detail than other arid areas of the country. But the problems of the arid areas in general are almost alike. From a temperature-precipitation diagram, the Rajasthan desert occupies the worst position. "The monsoon air, after having lost much of its moisture elsewhere ascends here and tends to form clouds at a height of 10,000 to 12,000 ft. (3000-3600 metres), but dry winds from the north-west infuse into the system dissipating the prevailing clouds".* Rajasthan desert does not appear to have been created by any of the conditions under

*Banerji, S.K.(1952). Proc. Symp. Rajputna Desert. Bulletin, National Institute of Sciences (renamed Indian National Science Academy) No.1.

which deserts in other parts of the world have been formed. Defining desert as is often simply done, on the basis of a minimum rainfall and a diurnal range of temperature, namely, 25 cm or less and 24°F or more respectively, the desert area in Rajasthan, covers about 500,000 sq. km. For the purpose of development, however, the total area that ought to receive considerable attention is nearly half as large comprising the various districts in Rajasthan, Gujarat and Haryana mentioned later (paragraph 2.12). Rajasthan desert, however, fulfils in a large measure, though not in a rigorous sense, the general characteristics of a desert, viz., low rainfall with a large variability; large diurnal temperature variation; high evaporation; non-existence of a perennial river; scanty vegetation; practically no agriculture; dependence of man ~~and~~ on animal; sparse and nomadic population.

2.5 The soils of the western area of the Rajasthan desert are generally sandy and deficient in organic matter. Whenever water is available, the crop yield is excellent but subterranean salt constitutes a limiting factor. Rajasthan desert is not poor in flora, for as many as 507 species of plants including 46 exotics have been recorded. In fact, if one visits this area in the midmonsoon period in a year of good monsoon activity he would hesitate to call it desert.

2.6 Though rainfall in the desert area is low the relative humidity is quite high as comparative figures given in Table below show:*

Table 2.3 : Rainfall and Humidity in Arid, Semiarid and Subhumid Zones

		Arid Zone		Semiarid Zone	Subhumid Zone	
		Barmer	Jodhpur	Kotah	Indore	Bhopal
Mean relative humidity(%)	July	65	65	69	80	79
	Aug.	70	71	75	83	82
Mean vapour Pressure (Mb)	July	28.7	27.9	28.7	26.6	27.1
	Aug.	28.1	28.0	28.7	25.9	27.0
Mean annual rainfall(mm)		310	380	841	1053	1209

The differences in relative humidity as well as mean vapour pressure are not large. Moreover, the amount of precipitable water over Jodhpur in July is 5.5 g, for which the corresponding values in Delhi, Nagpur, Bombay and Trivandrum are 6.1, 5.5, 6.2 and 4.6 g. In spite of this, the rainfall is low in the arid zone because of adverse atmospheric conditions, namely, low level divergence and associated subsidence of air up to 0.8 km and also a marked divergence between 2 and 6 km over arid zone. As a result of this condition "clouds coming over the region do not grow in vertical extent and tend to dissipate. It is only when monsoon depressions reach east or west Rajasthan and recurve towards

*Krishnan, A.(1968). Distribution of arid areas in India, Symposium on Arid Zone XXI. Internat. Geog. Cong. New Delhi.

north or northeast or when they cross just through the arid zone, the region gets widespread rainfall".* It has been computed* that the frequency of such depressions is 24 in a period of seventy years beginning from 1891. If no depressions move across Rajasthan but recurve only in Madhya Pradesh or eastern fringe of east Rajasthan, droughts appear in the desert area. The presence of a large volume of dust in the upper air affecting the radiation regime has been held responsible for low rainfall in spite of good precipitable water in the air.** For reasons such as those mentioned above, the Rajasthan desert has been considered as different from a true desert, and is amenable to reclamation and development.

Sand Dunes

2.7 Sand storms and dunes are spectacular features of the desert and indicate predominant wind action. The sand particles are formed by weathering of rocks in which large temperature differences causing expansion and contraction, and salt crystallisation play a significant part. In both, the presence of moisture either in the form of dew or occasional rain is essential. The movement of sand by wind takes place by the processes of suspension, saltation and surface creep. The formation of sand ripples and ridges are caused by surface irregularities and heterogeneity of sand particles. On a much larger scale are found transverse dunes or barchan

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* Krishnan, A. (1966) Ind. Geog. Also Dutta, R.K. & George, C.C (1964), Symp. Proc. Prob. Indian Arid Zone 347-53

**Bryson, R.A. et al (1967) Bulletin, Amer. Met.Soc.48, 136-42.

and the long straight dunes or seifs. The former are formed when the wind is nearly unidirectional, and the latter are formed when strong winds blow, in addition, from another direction. The average height of barchan in Rajasthan desert is about 8 metres and a sand dune may be as high as 70 metres. On the basis of size, shape and orientation, dunes have been distinguished into parabolic, longitudinal (seif), transverse, barchan and hummock types. The parabolic dune has the two flanks extending leeward. The longitudinal and transverse dunes have respectively their ridge lines parallel and perpendicular to the wind direction. A hummock is formed around fence lines, bushes and shrubs.

2.8 The old system of dunes to which the longitudinal, transverse and parabolic forms belong are generally high and more or less established, whereas the new ones to which the barchans and hummocks belong are low and active. The stabilisation of dunes may be due to certain degree of cementation caused by kankar deposits and grass vegetation. Utilisation of dunes, for example, by afforestation should be done with caution lest the cementation should be destroyed, initiating active wind erosion. The menace of drifting sand associated with the unstable and new dunes is one of the significant problems of sand dune stabilisation. Afforestation being a much slower process than the rate of dune formation has made little impact in the matter of dune stabilisation. In fact, weakly grown shrubs or sapplings act as obstruction around which hummock types of dunes begin to form. Where the subsoil layer of moist sand is sufficiently thick a vegetal cover of perennial species may be caused for cementation of sand

particles. The available moisture is, therefore, the limiting factor. Afforestation and the growing of grasses etc. should not be started arbitrarily, but only where the water and other conditions are most favourable. Otherwise, the venture may be the cause of more harm than good. It may also be useful to investigate whether the processes causing gradual destruction of dunes when pebbles are strewn on them can be utilised,* e.g., where dunes encroach on roads and railways. The most urgent problem with the sand dunes is their fixation or stabilisation, which has been discussed in detail in Section VII.

Salinity

2.9 Salinity is another major problem of Rajasthan desert. From a study of the chemical composition of brine salt and its comparison with that of the sea and lake waters it appears that the source is neither marine, nor aeolian. The investigations on the salt basins of western Rajasthan** have strongly suggested that the origin of salt could be ascribed to the dead and buried saline depressions or playas which once formed the natural drainage channels. The confluence of prior drainage systems should be avoided for irrigation or carrying an irrigation channel for fear of salt contamination, as avoidance of salt flushing in arid zones may be rather impossible. Saline soils are most commonly formed

*Verstappen, H.Th.(1968). Bulletin Internatl. Hydrolog. Decade, 4 No.4.

**Ghose, B.(1964). Symp. Proc. prob. Indian Arid Zone, 79-82.

in the depressions or ravines of Barmer, Jaisalmer, Bikaner and Nagaur districts. Some of the soils have turned sodic and alkaline.

Soils

2.10 The soil formation in the arid zone is more a physical than a chemical process. Because of almost complete absence of illuviation and other soil forming processes, the profile shows little sign of horizon development. The scanty xerophytic vegetation has contributed almost nothing to the organic matter of the soil, and as such the soil is sandy and loose, and, therefore, susceptible to severe wind erosion. Depending on the topography and parent materials, seven classes of soil have been distinghuished and their distribution has been mapped out.* The desert soils extending over the districts of Ganganagar, Bikaner, Jaisalmer, Sikar, Churu, Jhunjhunu, Barmer, Jodhpur and Jalor are pale brown to light yellowish and greenish brown in colour, sandy to loamy sand in texture, loose and structureless, the fine sand constituting nearly 60 per cent of the soil. The soils are generally calcareous having a subsoil concretionary layer of lime and are very poor in organic matter. They are generally very deficient in plant nutrients except potash, and have pH of about 8.5. The dune soils are composed mainly of fine sand with 3-5% of clay, and small amounts of calcium carbonate throughout the surface and subsoil layers. Only

*Roy, B.B. & A Kolerkar, A.S.(1968) Symp.Arid Zone, XXI Interntl. Geog. Cong. New Delhi.

in the case of stabilised dunes covered with vegetation does the lime content show an increase.

Delineation of Arid Areas

2.11 The exact delineation of arid areas demands a large number of meteorological observations than are available at present. However, from the trend of variation of rainfall and temperature amongst the meteorological stations, the moisture index parameters and observable arid region characteristics, a reasonable delineation, howsoever approximate, has been made.

2.12 The areas so delineated in Rajasthan and neighbouring Haryana, Punjab and Gujarat States possess, to a greater or lesser extent, the desertic features described in the foregoing paragraphs. For the purpose of development, however, additional factors have to be taken into consideration, e.g. contiguity, geographical boundary, which would facilitate administration and execution of programmes. Keeping these points in view eleven districts of Rajasthan lying to the west of the Aravalli range, and some districts and tehsils of Haryana and Gujarat have been taken into consideration. The names of the districts and tehsils together with their areas are given below (Table 2.4). There is not only a great deal of similarity of conditions in the region covered by these districts and tehsils, but they also constitute a more or less contiguous area. Consequently, the programmes for development are expected to have similar approach and strategy.

(Table on page 14)

Table 2.4 : Statewise District/Tehsil and Area Delineated for Development Programme

RAJASTHAN State/District	Area (sq km)
1. Ganganagar	20,6[illegible]
2. Bikaner	27,3[illegible]
3. Jaisalmer	38,[illegible]
4. Barmer	28,[illegible]
5. Nagaur	17,[illegible]
6. Churu	16,[illegible]
7. Jhunjhunu	5,9[illegible]
8. Jodhpur	22,[illegible]
9. Sikar	7,749
10. Jalor	10,564
11. Pali	12,224
Total	208,626

HARYANA State/District Tehsil	Area (sq km)
Hissar	
1. Dabwali	1,446
2. Sirsa	2,825
3. Fatehabad	2,385
4. Hissar incl. Tohana	2,648
5. Hansi*	2,089
	11,393
Bhiwani	
1. Bhiwani	1,982
2. Loharu	581
3. Dadri	1,448
	4,011
Rohtak	
1. Jhajjar	2,107
Total	17,511

GUJARAT State/District Tehsil	Area (sq km)
Banaskantha	
1. Vav	1,701
2. Tharad	1,358
3. Deodar	1,012
4. Kankrej	822
5. Radhanpur	596
6. Santalpur	1,352
	6,841
Mehsana	
1. Sami	1,510
2. Harij	407
	1,917
Total	8,758

* Includes Bawani Khera tehsil now forming a part of Bhiwani district.

Rajasthan	: 208,626
Haryana	: 17,511
Gujarat	: 8,758
GRAND TOTAL	234,895

2.13 According to the criterion of moisture index several other arid areas could be distinguished in the country, namely, in Saurashtra and Kutch, Andhra Pradesh, Karnataka and Tamil Nadu. Except the areas in Saurashtra and Kutch which are somewhat contiguous with the region mentioned above, the rest are scattered and deserve local attention. Moreover, ~~each of~~ these areas, though arid, have their peculiar problems, which are quite unlike those of the region delineated above. Thus, in the mainland of Kutch, the problem is, no doubt, one of aridity, but in the Rann the problems of both salinity and alkalinity predominate, which require large scale reclamation measures. On the coastal tracts of Gujarat and Saurashtra, the problem is similar, namely, a large scale reclamation of saline soils. Ferozepur district (Punjab), especially its southern part, falls legitimately into the arid desert area but since already under irrigation, the question of its consideration in this Report does not arise. Again, Bellary and its neighbourhood constituting an arid area of Karnataka has the problem of a deep, impervious, alkaline and bad structured black soil. It does not, however, possess any of the desertic conditions attributed to the Rajasthan and neighbouring arid areas. The development of these areas is equally important, but for reasons stated above, they have not been included in this Report.

SECTION III

DESERT DEVELOPMENT PROGRAMMES

- A REVIEW -

3.1 Apart from the sporadic attempts made by some of the former rulers of Princely States to find ad hoc solutions to the pressing problems in isolated areas, there is no evidence of any organised and systematic attempts having been made before Independence to tackle the problems of the desert in a comprehensive way.

3.2 In 1951-52, the need to conserve and improve the resources of the desert region of Rajasthan was recognised and an ad hoc Committee of Experts was appointed by the Union Government to investigate and report on this problem. A Desert Afforestation Centre was set up at Jodhpur in pursuance of the recommendations of this Committee. Subsequently, the scope of works at the station was enlarged by the inclusion of soil conservation programmes and it was named in 1957 as the Desert Afforestation and Soil Conservation Station. The Station was required to conduct research, basic as well as applied, in land use relating to forestry, crop husbandry and grassland development so that the problem of wind erosion and resulting increase in desert conditions could be controlled.

3.3 About this time, an Arid Zone Project was started under the auspices of the UNESCO to initiate and intensify research on problems of arid zones in different parts of the world. Under this project a UNESCO adviser, an expert from Australia, was invited to render advice on the ways

and means of identifying and overcoming the problems of desert areas in this country. The Expert suggested a broad based programme of research and surveys covering basic resources, fundamental problems of soil-water-plant-atmosphere relationships, control of pests, regulated grazing of pastures, development of animal husbandry and arable crop raising and socio-economic problems. In pursuance of these suggestions, the Desert Afforestation and Soil Conservation Station was reorganised in 1959 as the Central Arid Zone Research Institute.

3.4 The Central Arid Zone Research Institute (CAZRI) comprises 6 Divisions with 4 experimental research farms and 12 Range Management and Soil Conservation Centres. The main function of this Institute is to conduct basic and applied research on different problems of the desert regions of the country with a view to finding out the most appropriate and relevant solutions. The researches include integrated basic resource surveys which indicate possibilities of exploitation, analysis of rainfall pattern and distribution, determination of evapotranspiration and soil moistures, techniques of stabilising sand dunes and raising of shelter belts, study of improved grasses etc. Studies have also been made in improved farming practices, cropping pattern and application of fertilisers, water harvesting techniques, development of grasslands and pastures and afforestation.

3.5 In 1960, the State Land Utilisation Committee appointed by the Government of Rajasthan made its recommendations on the development of desert and semi-desert areas of Rajasthan. In 1964, Government of India set up a Working Group under the Chairmanship of Shri M.K. Kidwai which examined

the problems of desert development and recommended a number of pilot projects for improvement of selected desert areas. This Committee felt that ultimately it would probably be necessary to set up a Desert Development Board to keep a watch over the formulation and implementation of schemes for the development of desert areas. In June, 1966, the Desert Development Board was accordingly constituted with the Secretary, Ministry of Agriculture as its Chairman to ensure a more rapid development of arid region. Nominees of the States of Rajasthan, Gujarat and Haryana and representatives of the Planning Commission and Ministries of Finance, Agriculture, Irrigation and Power, Health and Family Planning, Communications, Education and Social Welfare and four non-officials were made members of the Board. However, the emphasis in the programme of the Board was mainly restricted to agricultural development only.

3.6 The Board was reconstituted in October, 1971, with the Minister of State in the Ministry of Agriculture as its Chairman and the Secretary, Department of Agriculture as its Vice-Chairman, thus, raising the status of the Board. The representatives of the Ministries of Health and Family Planning, Irrigation and Power, Communications, Education and Social Welfare were excluded as the programmes covered only agricultural development. In the reconstituted Board, representatives of the Planning Commission, Ministry of Finance, Department of Agriculture and State Governments of Rajasthan, Haryana and Gujarat were included. In addition, four non-official members

including two Members of Parliament and two representatives of the local Panchayats were also included in the Board.

3.7 On the basis of the recommendations of the Board, an integrated programme of pilot projects for desert development involving a total outlay of Rs.10 crores was proposed for inclusion in the Fourth Five Year Plan. This programme covered items like pasture development, minor irrigation and soil conservation. As against this, a very limited programme costing a total of Rs.2 crores could actually be provided for in the Fourth Plan, allocated among the three States as under:

Rajasthan	...	Rs.120 lakhs
Haryana	...	Rs. 40 lakhs
Gujarat	...	Rs. 40 lakhs

With these resources naturally only a few Centrally Sponsored Pilot Projects could be undertaken in compact areas.

3.8 The desert development work was initiated in 1969-70, with pilot projects in the fields of soil conservation, minor irrigation and forestry in the States of Haryana and Gujarat. In 1970-71 similar schemes were taken up in Rajasthan but were confined to Barmer and Jaisalmer. The idea in taking up small areas was that it was expected that when development activities were concentrated in small areas, it would be possible to create a real impact in these areas and also to demonstrate that given the necessary resources even the arid areas could become prosperous.

3.9 The expenditure incurred by the three States against the funds sanctioned upto 31st March, 1973 is shown in Table below:

Table 3.1 : Desert Development Programmes - Progress of Expenditure

State	Sanctioned funds (Rs.lakhs)	Expenditure incurred upto 31.3.73 since inception (Rs.lakhs)	% of expenditure to sanctioned funds
Rajasthan	115.51	87.44	75.7
Haryana	40.63	39.66	97.6
Gujarat	39.44	30.37	77.0

A provision of Rs.30 lakhs has been made in the Central Budget for the Desert Development Schemes in these three States during 1973-74.

Programmes in Rajasthan

3.10 The arid region of western Rajasthan covering nearly three-fifths of the State, by and large, does not possess the conditions favourable to crop farming. To stabilise the agricultural economy and initiate its growth, the following schemes were sanctioned in May, 1970, for execution in Barmer district:-

(Table 3.2 on page 21)

Table 3.2 : Desert Development Schemes in Rajasthan

Scheme	Physical targets	Allocation (Rs. lakhs)
Rehabilitation of forests on hills	12,500 hectares	31.25
Grassland development for fodder banks	2,000 "	2.50
Development of pastures	6,000 "	24.00
Reclamation of saline soils	3,000 "	15.00
Wind-break plantations	500 row km	5.00

3.11 These physical targets have subsequently undergone certain changes. Moreover, an additional sum of Rs.21.65 lakhs has also been sanctioned for these programmes.

3.12 The scheme for rehabilitation of forests on hills is to cover a considerable area in Barmer district with kumat (Acacia senegal), dhoora (Anogeissus pendula) and bushes to protect the area for about 8 to 10 years against grazing and browsing so that the trees are re-established and the ground is covered with grasses and bushes. The resulting scrub forest is expected to provide fuelwood from dead and dry fallen wood for about ten years in addition to grass and grazing facilities. On a rotation of 40 years, each hectare will yield 200 quintals of fuelwood. In addition, two quintals of grass will be available annually from the fifth year.

3.13 Extensive stretches of sewan (Lasiurus sindicus) grasslands exist in the Barmer district. A portion of such areas is sought to be preserved by fencing so that in years of good rain, grass may be cut and stored in a fodder bank to be utilised during scarcity years. While providing work to the local people on collection and baling of grass, the scheme is expected to make available hay locally in scarcity years and save long haulage from outside the State.

3.14 Under the scheme for development of pastures it is intended to introduce controlled and rotational grazing in the gochar areas (village commons) of Barmer district. A few of these areas are to be reseeded with suitable perennial and nutritive grasses viz. dhaman (Cenchrus ciliaris), kala dhaman (Cenchrus setigerus), karad Dichanthium annulatum) and sewan. Moreover, in some of the pastures, various top feed species have been planted. It is understood that the pasture lands treated under this scheme have on the whole responded well. The implementation of this scheme has already provided work to about two thousand needy labourers and 160 local literate people upto March 1971.

3.15 There are extensive patches of saline soils devoid of vegetation along the Luni river. The programme for reclamation of saline soil is intended to convert these lands into productive land for cultivation by planting salt resisting plants. Vilayeti babul (Prosopis juliflora) and babul (Acacia nilotica) are now fairly well established from sowing and farash (Tamarix articulata)

from cuttings. Salinity on the whole has gone down with these measures and natural vegetation has come up. It is understood that there is a growing demand for releasing a large part of agricultural area covered by the scheme which has become fit for productive use.

3.16 Wind breaks in multiple rows of suitable tree species of vilayeti babul, Israeli babul (Acacia tortilis), farash, neem (Azadirachta indica) and siris (Albizzia lebbek) are proposed to be planted along all important roads and railway lines and around tubewells. The wind breaks will protect roads and railway lines from being covered with sand and check wind erosion in adjoining leeward lands. The trees will also provide shelter to livestock and travellers. There has been considerable damage to plantations by gerbils. Measures to eradicate this rodent species have not yet met with complete success.

3.17 The programme sanctioned in Jaisalmer was more modest. The schemes included cultivation of green fodder in 200 hectares, pasture development over 3,000 hectares and raising of 100 wood lots and two nurseries. The estimated cost of these schemes is Rs.16.11 lakhs. It is reported that upto March, 1973, no significant progress has been achieved in respect of these schemes, the State Government having spent a sum of Rs.3.34 lakhs only.

3.18 Investigations have shown the existence of acquifers in the Lathi Series of Jaisalmer district, with potential of installing several tubewells with an average discharge of about 150,000 litres per hour. The

exploitation of this groundwater is expected to help green fodder cultivation in this area. The tubewells can act as watering points for cattle and these very locations could become milk collection centres. The Government of Rajasthan has undertaken a pilot project during 1973-74 around five tubewells. The targets are to undertake fodder production in 300 hectares, pasture development in 750 hectares, organisation of milk producers' cooperatives in 25 villages and installation of a chilling plant at Pokaran. An expenditure of Rs.28 lakhs - Rs.14 lakhs from Drought Prone Areas Programme and Rs.14 lakhs from Desert Development Programme is anticipated.

Programmes in Haryana

3.19 In Haryana, the programme of desert development was initiated during 1969-70 on a pilot basis. The problems of Haryana desert are similar to those in the desert of Rajasthan, sand-blowing, westerly hot winds and saline ground water. An outlay of Rs.40.63 lakhs was sanctioned for various programmes in Mahendragarh district:

Agriculture	Rs. 14.50 lakhs
Minor Irrigation	Rs. 18.13 lakhs
Forestry	Rs. 8.00 lakhs

3.20 Contour bunding being a well recognised programme for increasing agricultural production through conservation of rain water was taken up in two blocks of Mahendragarh district during 1969-70. Besides enabling better penetration of

rain water and replenishment of groundwater, the programme is expected to provide the much needed employment to the idle manpower.

3.21 The loose friable texture of the soil and the undulating pattern of land make the task of carrying irrigation water to the fields difficult besides causing heavy transmission losses due to percolation in kacha channels. With a view to making optimum use of water resources, installation of underground pipeline conveyance system around five tubewells was taken up for the benefit of the areas under their command. This work was completed by 1971-72 and extension of the programme to 22 new deep Government tubewells was planned during 1972-73.

3.22 Demonstration of sprinkler irrigation was undertaken on a small scale during 1970-71. The impact of the programme on the areas covered is reported to be encouraging. Besides the 42 sprinkler sets purchased in 1971-72, the purchase of 40 additional sprinklers was envisaged for 1972-73.

3.23 To meet the acute shortage of water for drinking and irrigation purposes, three schemes for percolation bunds have been approved by the Desert Development Board for Mahendragarh district under minor irrigation programme. As a result of construction of these bunds, the land below the bund has been reclaimed for cultivation and water level in the wells in an area of 39 to 52 sq km has risen. The water in the wells which was highly saline before has improved in quality and it is now fit for irrigation purposes though even now it is slightly saline. The areas enclosed by the bundes could grow a crop of wheat with the stored moisture.

3.24 Forestry schemes have also been sanctioned in two blocks of Mahendragarh district. This programme covers afforestation on hills and non-arable areas in the plains, fixation of sand dunes, setting up of wind breaks in agricultural lands and pasture development.

Programmes in Gujarat

3.25 In Gujarat one tehsil of Banaskantha district has been selected for implementation of the pilot projects during the Fourth Five Year Plan under the Desert Development Programme. This area lies adjacent to the Rann of Kutch. The sub-soil is saline and winds blow sand across the fields. The rainfall is scanty and irregular. The following programmes with a total provision of Rs.39.44 lakhs have been sanctioned:

Table 3.3 : Desert Development Schemes in Gujarat

Scheme	Physical targets	Amount sanctioned (Rs. lakhs)
Minor Irrigation		
a) Check dams (Adbandhis)	5 Nos.	6.02
b) Tubewells	14 Nos.	24.55
Soil Conservation	2,532 hectares	4.98
Afforestation	600 hectares	3.89

3.26 The programme for minor irrigation includes construction of check dams (adbandhi) and tubewells. The check dams conserve water and moisture by inundating the area enclosed which helps to leach the salts. These are expected to benefit an area

of 766 hectares. Under the tubewell scheme 16 sites were explored of which 13 have proved successful. When completed they are likely to benefit 1,040 hectares of culturable command area. Under the soil conservation programme, contour bunding has been done in 3,232 hectares till November, 1973.

3.27 Under the afforestation programme a new technique of afforestation suggested by the Central Arid Zone Research Institute is now under trial. This consists of deep ploughing, contour bunding and planting of seedlings. This technique is reported to have increased the survival percentage of plantations to 60 on an average. It has been reported that the plants have come up well on the higher slopes but they have stunted growth in the valleys where salts are accumulated. The problem of keeping the salt away during the initial period of plant growth has to be solved. Plantation has been completed on 375 hectares by November, 1973.

3.28 The pilot projects described above are only in the nature of experiments. They only demonstrate the extent to which various methods would be effective. But by themselves these schemes would hardly make any dent in the vast problems of the desert areas. The main task of the desert rehabilitation and development has yet to be faced.

SECTION IV

APPROACH TO FUTURE DEVELOPMENT

4.1 In spite of the inhospitable environments in the desert area of Rajasthan, the human population there has been increasing. Conditions being unfavourable for unirrigated arable crop production, the principal vocation of the people has been animal husbandry. Inevitably, the rise in human population led to an increase in the livestock population to support it. This created increasing pressure on the vegetal resources of the desert leading to their rapid depletion. This first slowed down the rate of growth of animal population and then more recently resulted in an actual decrease, the decrease being sharper in the more arid western part of the desert. As stated in the draft Fifth-Five Year Plan of Rajasthan, during the period 1951-61 the increase in livestock was at the rate of 2.5 per cent per annum. This came down to 1.5 per cent during 1961-66. Then, during the period 1966-71, due to repeated droughts, the livestock population declined by 5 per cent. The overexploited vegetal cover was no longer able to sustain the large number. The main reduction was in cattle and sheep. Goats held on and in fact increased, as they could eat almost anything and survive.

Early Rehabilitation of Desert Area Necessary

4.2 The deterioration in the area has reached a stage, when unless it is effectively and expeditiously checked, there will be further deterioration at an accelerated pace. The area has potentialities not only for rehabilitation but also for becoming more prosperous than ever before. But, the longer the delay in its rehabilitation, the more difficult, expensive and uncertain will the development become.

Forage and Fuel Resources

4.3 Nature has endowed the desert areas with hardy grasses and shrubs which are able to survive arid conditions. These have developed deep root systems. Grasses like anjan (Cenchrus setigerus), dhaman (Cenchrus ciliaris), sewan (Lasiurus sindicus), etc., which grow in these areas have fairly high protein content and are relished by the stock. The shrubs give various berries which provide food material. A few tree species, notably khejri (Prosopis cineraria), provide top feed for camels, sheep and goats. These are heavily lopped for fodder and fuel. The phog (Calligonum polygonoides) is a valuable bush in the desert. The portion of it above ground provides fodder and the roots below are dug out for fuel. Digging of phog has become a regular vocation and provides employment to a large number of people and use of their camels when not otherwise occupied. There is a regular trade in

phog roots which are supplied as fuel not only to towns within the State but also in the neighbouring States. The digging up of phog roots loosens the soil held compact by them and therefore accelerates wind erosion and dune formation. To check the large scale root digging, alternative source of employment and livelihood has to be found for the people engaged in this activity, as also the means to meet the fuel demand. The harmful practice of digging phog roots can be further discouraged a good deal by prohibiting their movement out of the State. The desert rehabilitation programme should generate enough fuel for local use and employment potential to absorb the labour which would be taken away from this vocation.

Migration

4.4 Because of the incapacity of the desert area to sustain the large animal population throughout the year, a system of annual migration has developed in the area. In normal years, cattle and sheep graze in the desert area from July to November, first on government and uncropped lands and then on private cropped land after harvest sheep following cattle for stubble grazing. The migration starts usually after Diwali festival. This migratory system even during the best of the years operates harshly. During this annual migration, considerable animal mortality occurs, the toll being heavy in drought years. Cattle and sheep lose weight, milk, wool and mutton yields drop. As under these conditions of migration any

organised system of marketing is not feasible, the cattle and sheep owners get low prices for their products. Nor can the livestock, because of migrations, be improved through any systematic breeding programme. As wool is disposed of in areas of migration, the families staying back are deprived of raw material for cottage industries which could give them some additional income. The nomadic life which the migrating cattle and sheep owners and herdsmen lead deprives their children of the benefit of education. They, therefore, continue to remain backward. It is thus of great importance that conditions should be created to enable these nomadic people to lead a settled life.

Pastures and Grass Resources

4.5 The most important programme for the rehabilitation of the desert would be pasture development by regulated grazing and creation of grass reserves. At present, the grasses and shrubs have not got a chance to grow due to over-grazing. If areas are properly fenced and grazing is regulated as suggested in paragraph 9.33, the grazing capacity of the area can be increased manifold. The rotational grazing and grass reserves have to be planned in fairly large blocks, each of a minimum of 200 hectares. It would also enable concentrated grass collection from grass reserves. Large blocks are relatively easy to supervise and manage. Also, the larger

the block size, the less expensive is the fencing. Wire fencing should invariably be resorted to as it offers no obstruction to sand storms and does not facilitate longitudinal sandbank formation, which any other type of fencing would encourage.

4.6 In the grass reserves, no grazing can be allowed; otherwise sufficient stocks of grass cannot be built up to tide over scarcity years. There should be sufficient number of grass reserves in each district. Grass is to be collected, baled and then stored in fodder banks. Collected grass in any year should not be held in fodder banks for more than three years, including the year of collection, after which it should be disposed of, unless consumed in the meantime to relieve scarcity conditions. Normally, the current year's collection would replenish the 3 year old stock disposed of in any year. At any time, the fodder banks will, thus, have grass stock of full 3 years' production to meet the requirements during periods of scarcity.

4.7 Both the programmes of regulated grazing and grass reserves can best be done on government owned land. The Commission was given to understand that there is a fair amount of government owned land in Bikaner, Barmer and Jaisalmer districts and a lesser proportion in other desert districts. But not much of this land is in large blocks which can be economically and conveniently fenced. It is a matter of considerable importance, therefore, that the government land scattered all over

in bits of various sizes should be consolidated in blocks of suitable sizes. Towards the same end, groups of landowners should be encouraged to collectively use their land for regulated grazing and formation of grass reserves. It is emphasised that pasture development through regulated grazing and grass reserves is the cornerstone of the programme of desert rehabilitation and consolidation of land holding an essential step in it.

4.8 It is an accepted policy that surplus land wherever available, as a result of enforcement of land ceilings or otherwise, should be distributed to landless agriculturists, farmers with uneconomic holdings and other defined categories. This would be a suitable arrangement where the land so distributed would give at least one assured crop in a year, but not so under the desert conditions where in most years nothing worthwhile can be cropped. In desert area unirrigated land is best put to use for pastures for which large blocks have to be enclosed. It is, therefore, recommended that in the desert area unirrigated land should not be parcelled out in small bits to the landless but should be consolidated in large blocks for pasture development.

Induction of Resources from outside

4.9 Inevitably, the process of desert rehabilitation would take some time. A rehabilitation programme based only on local resources is not likely to gather enough momentum to overtake the pressure of demand created by the rising population in an over-exploited area. Initially, therefore, resources will have to be inducted from outside the desert area to augment local availability, particularly of food, fodder and fuel. This would require a well planned programme of procurement and distribution.

Sand Dunes

4.10 The desert may not be advancing north and north-eastwards as suspected at one time, but the sands in the desert certainly move with strong winds. Over millennia the desert sands have formed sand dunes. Most of these are stable though their stability is now being threatened by the overexploitation of the vegetal cover. Regulated grazing, as proposed earlier, would go a long way to improve the condition of these dunes. The more recent sand dunes are unstable and are composed of freshly deposited loose sand which is easily blown over by the wind. These pose a threat to habitations, roads and arable lands within their reach.

4.11 The Forest Department of Rajasthan and the Central Arid Zone Research Institute have undertaken some pilot schemes to evolve techniques for sand dune stabilisation. Results so far are reported

to be good for the short period the experiments have been underway. Treatment of an area is estimated to cost around Rs.680 per hectare over a period of 5 years. Half the cost is for fencing and mulching. As the young plants have to be watered 5 to 6 times in a year, each time with about 18 litres of water per plant, that also is a major item of cost. It is reported that the treated area is expected to bring economic return in a period of about 15 to 20 years.

4.12 It would require an enormous sum of money to stabilise the shifting dunes in the vast desert area. With more pressing claims on the limited financial resources, a large scale programme of sand dune stabilisation cannot be contemplated at this stage. But stabilisation of such dunes as pose a threat to large towns, roads and railways should be taken up. An assessment of the requirement of funds for the purpose should be made so that priorities may be considered. Of course, all shifting dunes in the canal commanded area shall have to be stabilised to prevent sand casting on arable land there.

Plantation in Canal Area

4.13 The desert area should be self-sufficient in the matter of fuel supply to the extent possible. Large demands from towns and requirements of defence personnel have reduced the fuel

resources of the desert, particularly the western part of it, to near exhaustion. These have to be revamped. Growing trees in this area with very meagre rainfall and high temperatures require watering of the saplings for the initial three to five years before the roots go down deep enough for the plants to sustain themselves. The main activity in tree growing will have to be in the canal commanded areas because of the availability of water there. That area would, therefore, be a major source of fuel supply in future when the programme of tree growing there is mostly through.

4.14 Canalside land is admirably suitable for tree plantation. Along the Rajasthan Canal, land of varying width upto 300 metres is available for plantation on either side of the canal. Likewise land is available along branch canals for at least 3 rows on either side. The State authorities also propose to plant trees in single rows on either side of offtaking channels. The feasibility and desirability of the latter are in doubt. Also tending of a single line of trees may be expensive and its success uncertain. Trees in this area unless properly protected and guarded have poor chance of survival.

4.15 There are large government owned shifting dune areas in the canal command which will not be brought under irrigated crops. These have to be planted over with grass and trees, both for their stability to prevent sandcasting on adjoining cropped areas and to provide fodder for livestock and trees for fuel, fodder and shade.

Grazing of cattle there should be restricted so as not to disturb the soil. People may be allowed to cut grass for feeding their stock on payment of a moderate fee. The trees should also be protected and lopping should be allowed under supervision. The village Panchayat may be allowed a share of the income from these trees when felled on maturity or otherwise.

4.16 In the canal cultivated area, it is important to establish suitable shelter belts and wind breaks to minimise the desiccating effect of hot winds and reduce sand casting. Wherever such protective plantation has been raised, crop yields have shown marked increase. These also provide a valuable source of fuel and small timber. With the proper choice of tree species no undesirable shade effect need be apprehended. Nor do these trees with their deeper root systems compete with crops for soil moisture and nutrients.

4.17 In the early stages of development of commanded areas, there will be water to spare, which can be utilised most advantageously for raising trees on canal lands, intercommand sand dunes, and for shelter belts and wind breaks. This opportunity must be fully availed of as later when irrigation has developed, water may not be spared for such purposes. A programme of tree growing on a massive scale in the commanded area should, therefore, be drawn up and implemented on a priority basis. Tree planting should be completed within a period of five years of water becoming available in an

area. Suitable nurseries will need to be planned ahead and saplings should be made available to people of the area at a nominal price.

Roadside Plantation

4.18 Tree plantations are necessary along all important roads, partly to prevent sand accumulation on them which obstructs traffic and partly to provide shade for the road users and the livestock which browse in the vicinity. To be effective, at least five rows of trees should be grown on the windward side without break. On the leeward side a smaller number of tree rows up to three can be planted. Both from consideration of aesthetics and requirement of shade the tree species for roadside plantation have to be such as would give good shade and have a long useful life.

Plantation in Other Desert Areas

4.19 In areas outside canal command, besides the trees which will naturally come up in the pasture enclosures or which may be planted under any limited programme of sand dune stabilisation, no attempt need be made to raise forest plantations as these are not likely to succeed in the arid conditions of the desert without irrigation which would not be justified.

Animal Husbandry

4.20 With the total water resources currently at the disposal of Rajasthan for use in the eleven arid districts covering about 208,626 sq km, only about a tenth can be served with irrigation

facilities. In the remaining area, with its scanty rainfall, there cannot be much of arable cropping. The economy of the desert area must, therefore, be animal husbandry oriented.

4.21 In 1966, according to livestock census of that year, there were, in the eleven desert districts of Rajasthan, 5.54 million sheep, 4.26 million goats and 5.82 million cattle and buffaloes besides other animals like camels, horses etc. By 1972, the number of sheep had come down to 5.11 million and that of cattle and buffaloes to 4.59 million. Goats on the other hand increased from 4.26 million to 5.82 million. The goat has been in competition with sheep for the grazing resources of the desert. The desert area, even on rehabilitation, would not be able to support the present sheep and goat population. Of sheep and goat, the latter is the more destructive animal. It is, therefore, obvious that for proper sheep raising, the number of goats must be drastically reduced. It is suggested that this may be progressively reduced to 25 to 30% of the sheep population. The number of sheep need not be increased and improvement can be sought through better breeding.

4.22 The home tracts of some of the important cattle breeds lie in the western districts of Rajasthan, such as Rathi breed which has some potentialities for milk production, the Nagori breed which is a specialised draught breed and Tharparkar

and Kankrej which are useful dual purpose animals. Breeders of these cattle derive sizeable income from the sale of cows and bullocks of these breeds. Therefore, these breeds should be developed with special emphasis both on draught quality and milk production.

4.23 For any programme of improvement in livestock, adequate supply of feeds and fodder is a pre-requisite. It is important to have a good supply of green fodder for high yielding dairy cattle. For ensuring this, under the desert conditions, it becomes necessary to make irrigation supplies available for the purpose. Rajasthan Canal would be the main source of such supplies and the cropping pattern on this canal system should include fodder crops. It is recommended that in view of the importance of animal husbandry in the desert area it should be aimed to utilise about 30 per cent of the irrigable area for growing fodder crops.

4.24 There are two alternatives to meet the fodder requirements of cattle. One could be concentration of dairy cattle in the canal commanded area by moving cattle from different parts of the desert to the canal area. The other could be to take irrigation supplies for growing fodder to areas where superior types of cattle, particularly dairy cattle, are being bred. Neither alternative alone would meet the situation. The answer would seem to lie in measures both for encouraging dairy cattle keeping in the flow commanded area and taking canal water by lift channels to the existing cattle areas to the extent feasible.

This matter is further discussed in the Section on Development of Water Resources. Cattle population of existing good breeds cannot be completely uprooted and moved to entirely new distant areas. However, movement within reasonably short distances to green fodder producing areas would be feasible and desirable. Further, green fodder can be transported to cattle centres in unirrigated areas which may lie within easy reach.

Gobar Gas Plants

4.25 In the canal commanded area and in other cattle breeding tracts, there will be a large number of cattle. At these places of cattle concentration, dung will be available in large quantities. With shortage of fuelwood, much of the dung will be used as fuel and to that extent will not be available for manuring fields. Extraction of gas for fuel purposes from dung does not detract from its manurial qualities. Therefore, if sizeable gobar gas plants are installed by farmers or cattle breeders owning sizeable herds, it would solve to a significant extent the local fuel problem and also bring them subsidiary income through sale of gas and residual gobar. The gas can be supplied to users in cheap containers or directly through pipe line. Larger gobar gas plants would be more economical than the smaller units operated

with gobar from only half a dozen cattle. Initially some promotional subsidy may be necessary to popularise the use of these plants. In considering the economics of installing a gobar gas plant the manurial value of the residual gobar would be an important consideration as in the absence of the plant that much gobar would not be available for manuring fields, it having been used up as fuel.

Water Resources Khadins

4.26 Much of the prosperity of the desert area would depend on the judicious use of the available water resources. These comprise rainwater, groundwater and surfacewater flows. Most of the desert area has to make do with only rainwater. The rainfall is scanty and erratic with wide variations and frequent failures. It ranges between an average of 178 mm in Jaisalmer and 366 mm in Jodhpur. In general there is only one good year in three and even in this pattern there is no regularity. Rainfall is therefore an exceedingly precarious source particularly in the western half of the desert area. Fighting for survival in the desert area, the Paliwal settlers in Jaisalmer developed a water conservation technique known as 'khadin'. There are areas in the desert where the surface is stony and gravelly and generally impervious to water percolation. Even a little rainfall in these areas flows down

in appreciable streams to sandy or loamy terrains. By constructing suitable guide banks or channels, such surface water is led into selected valleys where in course of time groundwater accumulates and the area becomes fit for agriculture. In one such valley near Jaisalmer town, the then ruler had developed a garden on more than a thousand acres. After Independence such 'khadins' have been developed in parts of Jodhpur, Nagaur, Jaisalmer, Barmer etc. This method of water harvesting should be promoted wherever suitable conditions obtain. The Rajasthan Soil Conservation Department has undertaken in these areas a subsidised relief works programme of constructing smaller 'khadins' for the joint benefit of five or more cultivators' families. The smaller 'khadins' need to be evaluated for performance and economics.

4.27 In the rain-served areas of the desert, all known techniques of water and moisture conservation will have to be employed to improve production where such techniques are workable. In the undulating desert terrains of Haryana and Gujarat, a system of 'bandhis' and 'adbandhis' has proved of immense value in soil and moisture conservation and groundwater improvement in the valleys. The technique is to put an earthen embankement across a converging watershed so as to hold up the rainwater flow from the catchment. The accumulated water gives some protective irrigation to the area below the bund.

At the end of the rainy season, the tank is usually dry and a rabi crop can be grown on the retained moisture in the water spread areas. Advantage should be taken of this technique on a much larger scale than at present. In the eastern part of the arid zone towards the Aravalli range where the rainfall in normal years is sufficient for raising a low-water-requiring short duration crop, contour bunding as a measure for water conservation, would be useful and should be promoted.

4.28 Water in the desert area is the most precious commodity and has to be made use of to the fullest extent whenever and wherever it becomes available. Good rainfall occurs there only once in ~~there~~ three or four years and in the more arid parts of the desert even at longer intervals. For instance, in Jaisalmer district an unusually good rainfall occurred in 1973 after a practically rainless decade. Khadins, tanks and depressions got filled to the brim. But this unexpected gift of abundant water found people unprepared for making the fullest use of it. They could have utilised this water for irrigating more area lower down if water could be conveyed there. It is reported that suitable areas exist near a number of khadins which can be irrigated in a year of good rainfall if channels are constructed in time for the purpose. For this it is necessary to investigate the likely schemes, identify the worthwhile ones and keep plans ready for implementation as soon as an

occasion arises. The feasibility of growing irrigated crops on higher peripheral lands of khadins by lifting water by pumps should also be examined. Such utilisation of surplus waters in a khadin would vacate more of tank area for timely sowing of a crop than would otherwise become available. It is recommended that a study should be made and proper instructions drawn up for making full use of water whenever an unusually good rainfall occurs. It may not be necessary to store up implements and equipment like pumps in each desert district for such a contingency. It should suffice if it is clearly laid down what is to be done and by whom and what equipment and implements are to be arranged and from where. Perhaps a regional reserves under the Department of Agriculture may be necessary for some of the items to assist the farmers.

Groundwater

4.29 Groundwater exploration has revealed usable groundwater of varying salinity level in several areas of the desert. The underground reservoirs which the groundwater investigations have revealed, formed long ago when the areas possibly had good rainfall and living streams flowing across them. Those underground sources have limited supplies of water. At present, the recharge of the aquifers is negligible, there being very little rainfall in the area and

very little flow of water from other catchments.

4.30 The first claim on the groundwater resource is for domestic use. The State Government has a comprehensive plan for providing piped water supply to various towns and villages based on exploitation of groundwater. Industries, including agro-industries, use a relatively small quantity of water for the economic benefit they give. Their requirement, therefore, should also be met on a priority basis. After meeting these important requirements, the groundwater available for growing high value crops and orchards would be quite limited. But wherever groundwater is available for these purposes, it should be developed early. Irrigated grass farms for fodder banking would not be feasible on tubewells due to high cost of water.

4.31 There is practically no useable groundwater in Rajasthan Canal command area; but after some years of irrigation, water percolating from irrigated fields will build up good groundwater as has happened in Gang Canal area. That water can then be used conjunctively with canal water for increasing crop intensities.

Canal Irrigation

4.32 While further development of the Ghaggar and the Luni would enable some more area to be cropped, the real impact of development would come from the Rajasthan Canal Project. The Canal is designed to utilise 9868 Mcum (4 million acre feet) of

water irrigating 1.26 million hectares (31.24 lakh acres) annually besides improving intensities on the Gang Canal and Bikaner Canal. Except for the Lunkaransar- Bikaner Lift Canal designed for an annual utilisation of 310 Mcum (0.25 million acre feet), the entire supply has been proposed to be utilised for flow irrigation. The slope of the desert region being from east west, the main canal has been designed as a contour canal to irrigate a long strip along the western border of the State.

Irrigation Policy in Desert Area

4.33 In spelling out irrigation policy for low rainfall areas, the Irrigation Commission recommended* that "the policy should be to benefit as large a section of the community as possible and at the same time enable farmers to obtain reasonable yields. Surface irrigation systems should be designed to irrigate compact blocks, the blocks being dispersed over a large area to benefit large number of farmers. The number of irrigations can be fewer than are required for maximum yields". We are in agreement with this policy and recommend that this should be applied to the desert area within limits of economic viability. It is pointed out that introduction of irrigation facility in an area brings prosperity not only to the irrigators

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* Paragrpah 6.19 of the Report of the Irrigation Commission 1972.

but all round to the people of the area in various forms. Keeping this policy in view and because of insufficient suitable flow areas in the Rajasthan Canal command as proposed in the Project Report, it is necessary to spread the benefit of irrigation to certain lift areas. This has been dealt with further in the Section on Development of Water Resources.

4.34 There should be a uniform water allowance on the entire Rajasthan Canal system, including the lift canals. High intensities need not be aimed at. An intensity which would give a reasonable coverage of irrigation to as large a flow and lift area as can be economically commanded should be adopted. This intensity is likely to be over 100 per cent.

Cropping Pattern

4.35 The cropping pattern on Rajasthan Canal should ultimately bring as much area under fodder as may be required for a prosperous cattle husbandry. This may be about 30 per cent of the irrigable area. As the water on this canal system is very valuable, in the rest of the area high value crops should predominate. The aridity of the area is a favourable factor for producing quality seed in the canal command as pests and diseases cannot thrive there and the very low rainfall makes it possible to apply irrigation with precision in respect of time and quantity

for best results. The seed production in the country at present is only a small fraction of the requirements. There is thus an excellent scope on this canal for producing quality seeds of all kinds in a big way and that should be very remunerative to the farmer.

Reclamation of Saline Lands.

4.36 In the commanded area of Rajasthan Canal there are some reclaimable saline lands in the 'tal' areas. These would require abundant supply of water for reclamation. As there would be spare water in a channel only in the first few years till irrigation develops, the programme of reclamation should be put through during that period. The process of reclamation would involve growing of crops like rice requiring copious irrigation. It must be made clear to all concerned that growing of such a crop on this canal can be permitted only for reclamation purposes and can be no part of the normal cropping pattern as that would be an uneconomic use of the precious irrigation supplies.

Marketing Facilities

4.37 The need for organising proper marketing facilities for dairy and animal products cannot be overemphasised. At present the surplus milk is converted into ghee which fetches a price equivalent to 40 to 50 paise per litre of milk against 70 to 80 paise which

sale of fluid milk can give. Organised marketing of milk through milk producers' cooperative societies would be a major stimulus in dairy development. Marketing of milk products, though easier, would also need to be properly organised to ensure good prices to the producers. Milk collection centres in the milkshed areas and chilling plants in suitable locations should be set up, if necessary even as a promotional measure rather than strictly on the basis of adequacy of returns at all centres.

4.38 As for milk and milk products, marketing has to be organised for wool and mutton. The setting up of wool collection, grading and carding centres would enable the shepherds to secure better prices for their products than at present. This along with development of pastures would go a long way in settling the migratory herds. The wool and mutton marketing should also be organised through cooperative societies.

Electrification

4.39 We have recommended the construction of some lift canals in a later Section of this Report. These will require electricity for the pumps. Electricity will also be required for exploiting groundwater and minerals. Also, chilling plants and processing plants for milk and milk products will come up as milk production gets organised. These and other industries will require electricity. It is, therefore, important that a long term plan

for laying transmission lines should be drawn up for the area taking into consideration the likely schemes under all heads of development requiring power. The route of these lines will be governed by major load centres, such as pumping stations on canals, clusters of tubewells, the larger towns, etc. Location of important industries including milk chilling and processing plants and other load centres should be pinpointed as best as is possible under the circumstances, so that the State Electricity Board may draw up the long term plan of powerlines for the area. The taking of electricity to the rural areas in the desert will in itself engender development in those areas. But in areas to which electricity cannot be taken economically in the initial stage of development, diesel engines should be considered as an alternative source of energy, though more expensive, for running tubewells for domestic and industrial purposes.

Desert National Park

4.40 In the vast Rajasthan desert, there is no area which can be considered representative of the natural conditions in the desert. Every part has been disturbed either by over-use or neglect. For understanding the life-cycle of plants and animals of the region, it is necessary to study the ecological status of the desert.

There is, therefore, need to locate a suitable area, which can be preserved for continued studies under undisturbed desert conditions. The preservation of the geomorphological features, flora and fauna for better understanding of the environment can best be done by selecting, notifying and maintaining a reasonably large area as a Desert National Park.

4.41 The approach to the development of the desert area in Rajasthan indicated in this Section also broadly applies to the part of the desert situated in Haryana and Gujarat.

SECTION V

DEVELOPMENT OF WATER RESOURCES

RAJASTHAN

Rainfall Zones

5.1 From consideration of rainfall, the area of Rajasthan lying to the west of the Aravalli hills and covering eleven districts, can be divided into two zones. The western zone, to be called the $D_2E_2^*$ zone, receives on an average a rainfall of 10 to 5 cm per month for two months (D_2), namely, July and August and less than 5 cm per month for another two months (E_2), namely June and September. The zone covers the districts of Ganganagar, Bikaner, Jaisalmer, Barmer and parts of Jodhpur (Phalodi and Shergarh tehsils) and Churu (Dungargarh and Sardarshahar tehsils). The remaining area nearer the Aravallis is in a somewhat better rainfall zone and is designated $C_2D_1E_1$, rainfall being between 20 to 10 cm per month in two months, namely, July and August, 10 to 5 cm in September and less than 5 cm in June. The requirement and availability of water for these two zones need to be considered separately. While in $C_2D_1E_1$ zone, some unirrigated low-water-requiring and short duration crops like Bajra and sesamum in kharif and gram in rabi can be grown in a normal year, in $D_2^*E_2$ zone a satisfactory crop cannot be raised without irrigation.

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* These and other symbols used to designate rainfall zones are explained in Section VI.

Water Resources

5.2 The water resources of the desert area can be divided into three categories, namely,

(i) Rainfall and surface runoff in the area;

(ii) groundwater; and

(iii) surface water brought in from outside the area.

These sources are unevenly distributed and in their totality are quite inadequate to meet the requirements of the area.

5.3 The rainfall in the entire desert area is very low but it progressively decreases from about 50 cm at the foot of the Aravalli Range to less than 20 cm along the western border. The variation in the annual rainfall is large and goes up to 80 per cent. Also lower the rainfall, the greater is the variation, which accentuates the adverse conditions. In the desert area the meagre rainfall has to be exploited to the maximum extent by constructing khadins, bandhis and adbandhis as earlier described in Section IV, and by adopting latest scientific moisture conservation techniques.

5.4 The indigenous surface water resources in the desert area of Rajasthan are the seasonal flows in the Luni which drains the western slopes of the Sourthern Aravalli and ends in the Rann of Kutch, traversing Pali, Jalor and Sirohi districts and parts of Jodhpur and Barmer districts; and the Ghaggar in the north which

entering from Haryana disappears in its own sandy bed in Ganganagar district. These rivers irrigate some lands by inundation during floods and also contribute to the annual groundwater recharge along their course.

Groundwater

5.5 The Rajasthan Ground Water Board has been making extensive hydrogeological investigations in the desert area and has located a number of areas which have usable groundwater (see map Appendix-XI). The Board has given a districtwise assessment of annual recharge or the quantity which can be economically mined, the present pumpage and the balance exploitable potential. This is shown in Appendix I. These investigations have shown that there are large tracts where there is no usable groundwater, as for instance, the entire Rajasthan Canal Commanded Area. In most areas the yield of tubewells is relatively low, being about 40,000 to 75,000 litres per hour. The water is mostly brackish, with salinity varying from place to place. The best groundwater source is in the Lathi series formation in Jaisalmer district. This sandstone formation with trapped water extends over an area of 7,500 sq km and can support some fifty

tubewells of a discharge of more than 136,000 litres per hour, the depth of tubewells ranging between 175 and 200 metres and pumping head being of the order of 50 metres. Not all the groundwater discovered is in convenient locations. For instance the groundwater belt in the north-western corner of Jaisalmer district is in an area which is practically uninhabited and more than 80 per cent of which is covered by sand dunes. This water has not much use at present, but would be most valuable if and when natural gas is exploited in the area.

5.6 The first claim on the groundwater resources of the area would be for domestic use. The State Government has already drawn up a comprehensive plan for giving piped water from groundwater supplies to most of the habitations. The water requirement for industries would be relatively small. Whatever is left over after meeting these requirements would be available for irrigation and would be most valuable for local development. This however would not irrigate even one per cent of the desert area.

5.7 Development of groundwater for irrigation would be practicable only if electricity is available for energising the tubewells. Diesel driven tubewells are too expensive to operate in this area with groundwater at considerable depth. Already in the Luthi area some tubewells with good yield leased out for cultivation of cash crops are going out of use as water from these diesel driven tubewells is too expensive for the purpose.

It is, therefore, recommended that development of groundwater for irrigation should be coordinated to the extent possible with the programme of laying transmission lines.

Rajasthan Canal Project

5.8 The source of extraterritorial waters for the desert area in Rajasthan is the Indus river system. The Gang Canal constructed in the 1920s takes off from the Sutlej and serves a culturable commanded area (CCA) of 380,000 hectares in the western part of Ganganagar district. Another 290,000 hectares of CCA are being benefited in this district from the Bhakra Irrigation Project. But the largest benefit will accrue from the Rajasthan Canal Project.

5.9 The Rajasthan Canal Project, sanctioned in 1957, envisaged the construction of a large canal, with a capacity of 524 cumecs (18,500 cusecs) taking off from the Harike Barrage at the confluence of the Sutlej and Beas rivers. Water was to be carried to Rajasthan Canal through a 214 km long Feeder Canal, the first 177 km of which lay in Punjab and the rest in Rajasthan. Only the portion of the Feeder Canal lying in Punjab was to be lined. The rest of the canal system in Rajasthan territory was proposed to be kept unlined. This project was intended to provide irrigation in the northwestern portion of the desert along the international border, in a culturable commanded area of about 1.35 million hectares, out of which 0.36 million hectares was to receive perennial

irrigation. An intensity of irrigation of 78 per cent in the perennial tract and 40 per cent in the nonperennial tract was stipulated. No lift canal was included.

5.10 The project was revised in 1963 and again in 1970 and it now provides for the lining of all the channels including distributaries and minors and the raising of the intensity of irrigation to 110 per cent with water thus saved and storage provided by Pong dam on the Beas river. It also provides for a lift canal for the Lunkaransar and Bikaner areas. The revised project now covers a gross commanded area of 2.0 million hectares, of which 1.14 million hectares is the culturable command. With an intensity of 110 per cent, gross annual irrigation of 1.254 million hectares is envisaged. Of the above areas, the Lunkaransar-Bikaner Lift Canal would serve a culturable commanded area of 51,000 hectares, with a gross annual irrigation of 56,000 hectares with an intensity of 110 per cent as on the rest of the canal system. The Lift Canal with a discharge of 16 cumecs would be 160 km long with 185 km of off-taking channels. Water would be lifted in four stages to a total lift of 58 metres, the discharge getting progressively reduced from head to tail.

5.11 The Rajasthan Canal Project is planned for execution in two phases. The main Rajasthan Canal, with its head regulator at the tail of the 214 km long Rajasthan Feeder will be 470 km long. A large branch canal, the Lilua Branch, with a head discharge of 112 cumecs will carry on from the tail of the main Rajasthan

Canal. The 37 km portion of the Feeder Canal in Rajasthan and the first 196 km of the main Rajasthan Canal, together with the offtaking branches and distributaries and including the Lunkaransar-Bikaner lift Canal, fall in Phase I, the rest comprises Phase II.

5.12 The latest estimated cost of the irrigation project is as under:

1.	Share cost of Harike Barrage Pong dam and Madhopur-Beas Link	Rs.99.00 crores
2.	Rajasthan Feeder up to km 177	Rs.23.22 crores
3.	Phase I	Rs.107.78 crores
4.	Phase II	Rs.108.00 crores
		Rs.338.00 crores

In addition, an investment of nearly twice this amount would be necessary on various development programmes in the project area, in order to derive the maximum economic benefit from it. The itemwise break up of the amount is shown in Appendix II.

5.13 The arid zone west of the Aravalli hills consists of eleven districts and has a geographical area of 20 million hectares. Of this, 6.5 million hectares or nearly a third of the geographical area is cropped. Only 11 per cent of the cropped area was irrigated in 1969-70 for which figures are readily available. It is would increase to 30 per cent after the Rajasthan Canal Project is completed.

5.14 An intensity of irrigation of 110 per cent has been envisaged on the Rajasthan Canal, the highest on any canal system in north India. The reason for providing intensive irrigation was that originally only gravity irrigation was contemplated. The land slopes from east to west and a contour canal had to be constructed. As only a limited area was available for gravity irrigation, a high intensity had to be adopted. The Lunkaransar-Bikaner Lift Canal was introduced in the scheme at a later stage.

5.15 The Harike Barrage and the Feeder Canal are already completed and are functioning. The consutruction of Phase I of the Project will be mostly over by the end of 1973-74. This will provide irrigation in a culturable commanded area of 540,000 hectares (13.40 lakh acres). Phase II, which is to be taken up in continuation of Phase I, is planned to cater for 600,000 hectares of CCA.

The Commanded Area of Rajasthan Canal

5.16 The entire project area is a part of the 'Great Indian Desert'. The land is covered with sand dunes of varying heights upto 60 metres with inter-spersed stretches of fairly flat land. Detailed and semi-detailed surveys of the soils of the commanded area, carried out under the UNDP Project, have revealed that low dunes will need to be levelled in about 400,000 hectares out of the total CCA of 1.14 million hectares. It has been estimated that about Rs.100 crores would be

required for land levelling in the total CCA of 1.14 million hectares. The cost of the Irrigation Project below the Feeder Canal is Rs.211 crores. Thus an additional 47 per cent cost has to be incurred on the project for land levelling to make it fit for receiving irrigation. It is obvious that greater the intensity of dunes in any part of the commanded area, the greater would be the cost of providing irrigation there, partly due to longer length of channels that would be required and partly due to more land levelling and land shaping necessary per unit area. Further, in high dune intensity area, the maintenance of channels would be more difficult and expensive, as sand blowing from the dunes will tend to choke up the channels.

5.17 In Phase I area of the project the intensity of sand dunes progressively increases from less than 20 per cent on Surtagarh Branch to 60 to 80 per cent on Pugal Branch. Phase II starts with a bad area of 60 to 80 per cent dune intensity which improves below Charanwala Branch at km 312 of the Main Canal to 40 to 60 per cent intensity. The upper reach of Lilua Branch has relatively better terrain to serve, but lower down it runs into bad area with a sand dune intensity exceeding 80 per cent. These conditions are depicted in the Agricultural Atlas of Rajasthan ICAR(1972).

5.18 In carrying out the soil survey of the Phase II area, the FAO acting as executing agency for the UNDP adopted the following classification of land in respect of irrigability:

Economically Irrigable Land

Class I	Very good irrigable land
Class II	Good irrigable land
Class III	Moderately good irrigable land
Class IV	Marginal irrigable land

Economically Nonirrigable Land

Class V	Land not suitable for irrigation under existing conditions
Class VI	Land not suitable for irrigation due to severe limitation of topography, shallowness or extreme droughtiness.

This classification, which closely follows that of the United States Bureau of Reclamation, is fully explained in the report on the soil survey mentioned above.

5.19 Of the total area of 11,57,000 hectares surveyed under the UNDP Project in Phase II, the categorywise break-up came out as under:

Class II	1,380 ha
Class III	366,240 ha
Class IV	22,690 ha
Class VI	766,790 ha
Total	1157,100 ha

Thus about two-thirds of the area falls under the category of nonirrigable land

5.20 In its Project Report on Development of the Rajasthan Canal Command Area, the State Government has pointed out that the UNDP Survey did not cover the following culturable commanded areas of Phase II:-

South of Lilua Branch	73,200 ha
Left Bank of Main Canal	46,000 ha
Interdunal areas of less than 20 hectares	20,000 ha
Total	139,200 ha

According to the State Government, therefore, the total irrigable land in Phase II is 600,000 hectares as under:

(i)	Surveyed by UNDP	
	Class II	1,200 ha
	Class III	362,000 ha
	Class IV	22,400 ha
		385,600 ha
(ii)	10 per cent of Class VI lands surveyed by UNDP	75,600 ha
(iii)	Area not surveyed by UNDP	139,200 ha
		600,400 ha

5.21 It appears to us that it may not be advisable to include some of the above areas in the CCA. Class II and III areas are suitable for irrigation. But even here, there are some relatively small isolated patches of land hemmed in by high sand dunes. It may not be economically feasible to

extend irrigation channels to such areas, as these would be both expensive and vulnerable to blowing sand from the surrounding dunes. Therefore, the full area under these classes may not be available. Class IV is marginally suitable for irrigation but may be included in the CCA excluding such patches as are surrounded by extensive dunes and which may be difficult of access. As regards the 10 per cent of Class VI area, amounting to 75,600 hectares, it would not appear justifiable to include it in the CCA. This class, according to the classification, has high dunes of over 5 metres that cannot be economically levelled. Whereas the earth work involved in levelling a hectare of Class IIIt land is 700 cubic metres and for Class IVt 1,000 cubic metres, that for Class VIt is about 1,900 cubic metres which is more than two and a half times that for Class IIIt. One would look for these 10 per cent patches only in desperation if no better lands were available for irrigation. We suggest that no part of Class VI should be included in the CCA.

5.22 The State Government's proposal to include in the CCA 139, 200 hectares which has not been surveyed under the UNDP Project requires reconsideration. This comprises 73,200 hectares south of Lilua Branch, 20,000 hectares of small bits of land each less than 20 hectares, and 46,000 hectares on the left bank of the Main Canal. The Lilua Branch in the lower reaches runs through a predominantly Class VIt land where 80 per cent or more of the land is under high dunes.

Further south the terrain is similar. This is not the type of land which one would consider for bringing under irrigation except when there is no alternative to it. It may be pointed out that this area is practically uninhabited and the developmental cost which is more than the cost of the irrigation channels on this project would be particularly high in such an area. The advisability of extending irrigation to such an area is, therefore, in serious doubt. As regards inclusion of isolated bits of land less than 20 hectares each in the CCA the economics of taking channels to these bits and the difficulty of their maintenance does not make the proposal attractive. These areas also need to be considered only if better lands elsewhere are not available. The left bank area of 46,000 hectares would be irrigable only by lift and has not been considered in the Rajasthan Canal Project Report of 1970. It thus appears that in Phase II of the Project a culturable commanded area of about 390,000 hectares would only be available for gravity irrigation.

Lift Canals

5.23 The Rajasthan Canal Project Report-1970 provides for gravity irrigation in a CCA of 600,000 hectares in Phase II with an irrigation intensity of 110 per cent. If the supply of water which is available for Phase II is utilised only for flow irrigation in a CCA of 390,000 hectares then it would give a very high intensity of 170 per cent

in an area which is very sparsely populated. In the alternative if more water is allowed for Phase I to give a uniform intensity over the entire project, as it should have, the intensity would be 134 per cent. In Section IV of this Report we have already referred to the advisability of spreading benefits of irrigation in arid regions to as large an area as is economically and technically feasible, in order to protect the maximum number of people against the ravages of recurring droughts. Social justice also demands that the water resources available in an arid region should be widely shared and their use should not be concentrated for the benefit of a privileged few. The State Government seems to have recognised the need to extend irrigation facilities to some lift area also. In Phase I, the Lunkaransar-Bikaner Lift Canal was included to provide lift irrigation in a CCA of 51,000 hectares. We suggest that in view of insufficient flow area in Phase II, extension of irrigation facilities to more lift areas should be considered.

5.24 The alignment of Rajasthan Canal lies in dune lands. The general slope of the desert area is from east to west. For gravity irrigation the canal had to be designed as a contour canal and this determined the alignment. Except for patches here and there, the area on the east of the canal can be irrigated only by lift. Some kilometres to the east of the canal beyond the dune lands, there is a fairly extensive belt of reasonably flat good land which is suitable

for lift irrigation. On the basis of a preliminary study of available maps, a gross-commanded area (GCA) of over 620,000 hectares suitable for lift irrigation has been identified for Phase II. In broad terms about 50 per cent of this area would be the CCA, of which 250,000 hectares could be irrigated with lifts up to 60 metres, 42,000 hectares with lifts up to 90 metres and the remaining 18,000 hectares with lift of about 150 metres. Five lift canals can suitably serve this area of 310,000 hectares. This area includes the lift area on the left bank of the canal referred to in the State Government's Report on Development of Rajasthan Canal Command area - 1971. These five channels along with the areas which they might command by different lifts are shown in Table 5.1 below, as also on the map.

(Table 5.1 on page 68)

Table 5.1

Proposed Lift Areas in Phase II

(Culturable commanded area in '000 ha.)

Lift involved (metres)	Churu Lift Canal	Nagaur Lift Canal	Kolayat Lift Canal	Phalodi Lift Canal	Pokaran-Barmer Lift Canal	Total
1	2	3	4	5	6	7
0 to 15	10.0*	2.0	6.0	10.0	Nil	28.0
15 to 30	30.0**	6.0	18.0	18.0	16.0	88.0
30 to 45	10.0***	8.0	16.0	24.0	10.0	68.0
45 to 60	18.0@	8.0	10.0	16.0	14.0	66.0
Total upto 60	68.0	24.0	50.0	68.0	40.0	250.0
60 to 75	12.0	Nil	Nil	Nil	6.0	18.0
75 to 90	Nil	Nil	Nil	Nil	24.0@@@	24.0
90 to150	Nil	18.0@@	Nil	Nil	Nil	18.0
Total 60 to 150	12.0	18.0	Nil	Nil	30.0	60.0
TOTAL	80.0	42.0	50.0	68.0	70.0	310.0

*Nimla-Jabrasar-Ranisar-Dhansia Tract.

**Sidhmukh project area minus Nohar feeder areas up to RL 225 M.

***Meghasar-Taranagar areas.

@Simlia, Billu, Buchas, Togawas, Rajas area.

@@Nagaur area

@@@ Bhiniana and Barmer areas.

The above figures must be regarded merely as indicative. The actual scope of the lift canals will have to be determined after detailed surveys and investigations.

5.25 Ordinarily lift canal irrigation is provided only to such areas as can be served with lifts for which there is economic justification. But there can be socio-economic compulsions due to which a deviation from the normal practice becomes necessary. The area to the north and north-east of Nagaur town has neither any surface water resources nor any significant exploitable groundwater. This area is a part of the breeding tract of the famous Nagori cattle and the cattle breeders have to migrate long distances in search of water and feed. This area needs relief and requires to be developed. If water can be taken to this area, it will greatly help in stabilising the economy of the cattle breeders. It is for these considerations that some area has been proposed for irrigation in Nagaur district despite the fact that water will have to be taken from Rajasthan Canal over a distance of 160 kilometres and lifted to a height of about 150 metres. In order to cover a large area, the irrigation system there should be designed to provide water to a large number of dispersed blocks instead of to a single large lumpy block. This would afford relief to a large number of people and facilitate provision of sweet drinking water to many habitations. In fact, there should be a combined water supply and irrigation scheme for the area. Water here being expensive, it will need to be used in a most economical manner by

adopting the latest scientific techniques of irrigation. High value crops should be raised along with fodder and high yields secured through a full package of scientific cultural practices. Seed production and horticulture would be profitable, the latter being particularly suitable for drip irrigation. To encourage economy in the use of water, it should be examined if volumetric supply can be introduced there in some form possibly on a cooperative basis.

5.26 The share of Rajasthan in the waters of the Ravi and Beas rivers is 9900 ~~MCM~~ Mcum in an average year. Of this, 500 ~~MCM~~ Mcum is intended to be utilised for raising water allowance in the existing Gang Canal and Bhakra Canal systems in the State. With the construction of the five lift canals in Phase II as envisaged in this Report, the distribution of the balance 9400 ~~MCM~~ Mcum would be as shown in Table below:

Table 5.2

Distribution of Water
Existing and Proposed

	Existing distribution		Now proposed	
	CCA '000 ha	Water ~~MCM~~ Mcum	CCA '000 ha	Water Mcum ~~MCM~~
Stage I (including Lunkaransar-Bikaner Lift Canal)	540	4400	540	4100
Stage II (Flow Channels	600	5000	390	2950
Lift Canals)			310	2350
Total:	1140	9400	1240	9400

The irrigation of a larger area with the same quantity of water would mean some reduction in the intensity of irrigation, which as is shown later in paragraph 5.34 would still be above 100 per cent and still higher than on any other canal in north India.

Project Cost

5.27 The Project at present envisages gravity irrigation in a CCA of 600,000 hectares in Phase II at an estimated cost of Rs.108 crores. In the new proposals the CCA is increased to 700,000 hectares, 390,000 hectares by gravity and 310,000 hectares by lift. Because of lift and larger area the cost of construction would be more. The 210,000 hectare gravity area which is being taken out of the present project has very high density of dunes where unit construction cost would be considerably higher than in the rest of the area. But even on prorata basis there would be a saving of about Rs.37 crores on account of exclusion of this area. As regards the proposed lift area, the cost can be roughly figured out on the basis of the latest cost estimate of the Lunkaransar-Bikaner Lift Canal now under construction. As shown in Appendix III, this comes to Rs.62 crores excluding the cost of lined water courses. Thus the new proposal of commanding a larger area and having lift irrigation involves an additional construction cost of Rs.25 crores only. The cost of lined water courses is shown by the State under Command

Area Development estimates.

5.28 The increased cost of construction in Phase II has to be considered in conjunction with the development cost of the area. In the area which is proposed to be deleted from the present CCA, the population is very sparse, dune density is very high, communication facilities are practically nonexistent and there are no nearby markets. Development of such an area would involve moving large number of people into the area, settling them and providing them with the necessary facilities. The cost of land levelling and land shaping in this Class VIt land would be heavy as also that of the maintenance of channels. In spite of the wind breaks and shelter belts which might be raised there, crops would be affected by sands blowing from the surrounding high dunes and it may not be possible to prevent sand casting altogether. In contrast the proposed lift areas are mostly Class III lands, have greater population density, are well served by rail and road communication, are close to towns such as Nohar, Taranagar, Nagaur, Kolayat, Pokaran, Phalodi, Jaisalmer and Barmer and, therefore, near markets and mandis. The lift channels are well located in respect of existing cattle centres. In the lift areas, therefore, the problem of settling people and the unit cost of development would be considerably less.

5.29 Amongst the items of development in the commanded area, the single item requiring the largest amount is land levelling. For the entire project, both Phases

I and II, it is around Rs.100 crores. We have suggested exclusion of 210,000 hectares of Class VIt lands from the CCA of Phase II and addition of 310,000 hectares of good Class III land under lift canals. This change would give a very substantial saving of Rs.22 crores in the land levelling cost. In fact this figure would be substantially higher in view of the recent rise in oil prices. As described in Appendix II there are savings in some other items of development also. There would, however, be a significant increase of Rs.10 crores on lined water courses to increase in the CCA, but in spite of this, there would be an overall saving of Rs.33 crores in the development cost of Phase II. This more than offsets the additional cost of Rs.25 crores on the construction of Phase II.

5.30 Jodhpur town which has a population of 317,600 (1971 census) gets its supply of water from the Jawai reservoir in Pali district besides the local catchment. The supply is supplemented to the extent of 0.24 to 0.30 cumec (8 to 10 cusecs) from tubewells located in and around Ramoura several kilometres out on the Phalodi road. The Hemawas reservoir, also in Pali district, used to be another source, though a precarious one. Water is supplied from the Jawai reservoir through a 160 kilometre long channel which is lined for most of its length. However, in a length of about 65 kilometres, the old lining is in lime concrete. The water loss on this channel, despite lining, is quite high. It has been reported that on releasing 1.8 cumecs (60 cusecs) from Jawai reservoir only 0.66 cumec

(22 cusecs) reach Jodhpur. Some water is used enroute for domestic purposes.

5.31 The Table below shows the quantity of water stored in Jawai and Hemawas reservoirs and that supplied to Jodhpur town from 1967-68 to 1973-74:-

Table 5.3

Water stored in Jawai and Hemawas Reservoirs and supplied to Jodhpur

Mcum

Year	Jawai Reservoir	Hemawas Reservoir	Supplied to Jodhpur		Available for irrigation.
			Jawai	Hemawas	
1967-68	166	40	9	11	186
1968-69	112	24	42	5	89
1969-70	17	2	23	1	(-) 5*
1970-71	112	40	9	6	137
1971-72	48	6	13	1	40
1972-73	24	8	37	6	(-) 11*
1973-74	190	40	-	2	228

Dead storage of Jawai reservoir - 14 Mcum
Live storage of Jawai reservoir - 184 Mcum
Live storage of Hemawas reservoir - 40 Mcum

* Drawn from dead storage.

It will be observed that during these seven years there was no irrigation from the two reservoirs in 1969-70 and 1972-73 as all available water had to be supplied to Jodhpur town. In 1971-72, only an insignificant amount of water could be spared for irrigation. Thus, in three years out of seven cultivators in the commanded area of these two reservoirs were very hard hit and that at a time when they needed relief most,

because of failure of rains. The sei project which is under construction in an adjoining catchment will afford some relief by supplying 51 Mcum to Jawai reservoir. Even so the arid Pali district will remain exposed to the severity of droughts.

5.32 If the Jawai water which is committeed for Jodhpur water supply is made available for irrigation in the Jawai commanded area, it would afford further relief in Pali district. In lieu, Jodhpur town can draw water from Rajasthan Canal which would be a dependable source and which can cater for the growing water requirements for domestic and industrial use. The Rajasthan Canal water will, however, have to be brought, via Phalodi Lift Canal, over a distance of about 200 kilometres and lifted nearly 135 metres. It would naturally be expensive for irrigation but not too expensive for domestic and industrial use. The conveying channel or pipeline can also provide rural water supply en route. This should be considered along with any exploitation of groundwater that may be feasible for the purpose.

5.33 Rajasthan Canal water would be used mainly for irrigation but there would be other requirements to meet. There are minerals in the area and some more might get discovered. There are prospects of striking oil in Jaisalmer district. For exploiting these, new townships may arise. Water would be required there both for domestic and industrial use.

Groundwater is not likely to meet these priority requirements in some areas both on account of quantity available and quality. These requirements, as they arise, will, therefore, have to be met mostly from Rajasthan Canal. It is difficult at this stage to pinpoint the locations where water may be needed but these priority requirements have to be borne in mind. Supply of water for these purposes may require enlargement of capacity of some of the smaller channels but the larger channels would hardly be affected. Also, it would make only an insignificant dent on the total irrigation on the canal. For instance, if 6 cumecs (200 cusecs) get diverted for these uses, the intensity of irrigation will come down only by about one per cent.

Cropping Pattern in Rajasthan Canal Area

5.34 The cropping pattern which has been adopted in the Project Report of 1970 is mainly for food and cash crops. The provision for fodder in the cropping pattern is only 4.5 per cent in kharif and one per cent in rabi in an irrigation intensity of 110 per cent. In our Interim Report on "Milk Production through Small and Marginal Farmers and Agricultural Labourers," we have drawn attention to the investigation in the relative profitability of dairy, mixed and arable farming, carried out by the Indian Council of Agricultural Research over a period of six years

(1962-63 to 1967-68) at Nasirpur in Patiala district. This study had shown that in this particular case the average annual net return per hectare was Rs.1,480 for dairy farming, Rs.1,348 for mixed farming with 70 per cent fodder and Rs.1,107 for arable farming. Both dairy farming and mixed farming give higher income than arable farming, but in the case of exclusive dairy farming the farmer has to purchase his required foodgrain from other sources. In view of this, we recommend mixed farming for the canal commanded area. The cropping pattern adopted in the Project Report and that considered suitable for mixed farming are given below:

	As per 1970 Project Report		Now recommended
Kharif			
	Percentage of CCA		Percentage of CCA
Vegetables	1.0	Vegetables	1.0
Cotton	16.5	Cotton	11.0
Groundnut	5.0	Groundnut	4.0
Pulses	7.5	Pulses	8.0
Fodder crops	4.5	Fodder crops (Zaid and kharif)	15.0
Bajra	12.5	Bajra or Jowar	10.0
Total Kharif	47.0	Total Kharif	49.0

Rabi				
	Wheat	30.0	Wheat	24.0
	Mustard	10.0	Oilseeds	10.0
	Gram	20.0	Peas	7.0
	Sugarbeet	2.0	Berseem	1.0
	Berseem	1.0	Other fodder	14.0
Total Rabi		63.0	Total Rabi	56.0
Intensity of Irrigation:		110.0		105.0

The recommended cropping pattern is based on an intensity of irrigation of 105 per cent. The details in respect of water depth and brief reasons for the shift in emphasis are given in Appendix IV.

Method of Irrigation

5.35 Rajasthan Canal water being precious, it has to be used in the most economical manner by minimising losses in watercourses, field channels and in the field. In the Command Area Development Programme, provision has been made for lining watercourses and land levelling. Normally, furrow or border strip methods of irrigation would be adopted depending upon the soil and the crop. However, it may be economical for the farmer to use sprinkler or drip method of irrigation for vegetable and orchard crops. During high temperatures and high winds, however, evaporation losses from sprinkler sprays become heavy and also uniform application of water becomes difficult. Under

these conditions sprinkler irrigation may not be feasible. Sprinkler and drip irrigation should be tried out experimentally to find out its economics and suitability under various conditions obtaining in the region. For this purpose, we recommend that a few pilot schemes should be sanctioned forthwith. If found economical, sprinkler irrigation should be encouraged among the farmers by demonstration and making the necessary facilities available.

Raising of Water Rates

5.36 The current water rates on Rajasthan Canal for flow irrigation are very low. These vary from crop to crop and range between Rs.15 per hectare for kharif fodder crops and Rs.37.50 per hectare for berseem. For no loss on this irrigation system the average rate for flow irrigation would be of the order of Rs.200 per hectare. On the lift canals, because of additional cost on lifting water, the rate would work out to a higher figure, but this incremental rate would be around Rs.150 per hectare. We would recommend the raising of water rates for flow irrigation and shifting part of the burden of lift irrigation to flow irrigated areas. The principles of fixing water rates are discussed in the Report of the Irrigation Commission and should be taken into consideration in revising the water rates.

Recasting of Rajasthan Canal Project

5.37 In the light of our recommendation for deletion of unsuitable areas from the CCA of Phase II, bringing a substantial area under lift irrigation and adoption of a cropping pattern with

greater emphasis on fodder crops than before, the project needs to be recast. But before this can be done surveys and investigations of lift area have to be carried out. We recommend that funds should be made available for the purpose immediately, as it is important that the revised project should be ready without loss of time, in order not to hold up the construction of Phase II of the project which should be completed within 10 years. We also recommend that the development programme should be taken up in suitable phases so as to complete it within 15 years. It should go faster than at present to fit in with the construction programme of the canal.

Cropping Pattern on Gang and Bhakra Canals

5.38 In the Ganganagar district, there are two other canals, namely, the Gang Canal and the Phakra Canal, which provide irrigation to 670,000 hectares of CCA. The intensity of irrigation obtaining at present is about 80 per cent although designed originally for 62 per cent. The cropping pattern is arable crops oriented. This area is to get 500 Mcum extra water out of the Ravi Beas waters allotted to Rajasthan. With this additional supply, it should be possible to increase the intensity of irrigation to about 100 per cent in conjunction with the groundwater that has now become available due to rise in water table in irrigated

areas. It is suggested that in these areas also a cropping pattern suitable for mixed farming as recommended for Rajasthan Canal should be adopted for greater prosperity of the farmers there.

Other Water Resources

5.39 The Rajasthan Canal will irrigate areas in the D_2E_2 zone of the desert. The water resources of the $C_2D_1E_1$ zone in the eastern part of the desert comprise slightly better rainfall, some groundwater and water from the Luni river and its tributaries like Jawai, Sukri, Bandi, Guiya Nala, etc. The water of these streams is being utilised through a number of storage dams already constructed on them and through inundation irrigation during monsoon months. Their monsoon flows also recharge the groundwater and some irrigation is done through wells. Thus, out of a cropped area of 3.69 million hectares in this zone, about 0.17 million hectares was irrigated in 1969-70 through various means. This area would, therefore, have to depend mainly on rainfall which in normal years would be sufficient for raising one low-water-requiring short duration crop like bajra and sesamum in kharif and some gram during rabi with residual moisture. However, when the Navgaon dam in Gujrat gets built, some water of the Narmada river would be available for irrigation in Barmer and Jalor districts. Also, irrigated areas can be increased slightly with some more development of

groundwater and better management to reduce losses. The productivity per unit of water can be improved by adopting a fodder oriented cropping pattern, through extension and demonstration work.

5.40 There has been a suggestion that the waters of the Ganga below Hardwar, surplus to the requirement of Uttar Pradesh, should be diverted for the benefit of arid areas in Haryana and Rajasthan. But the U.P. authorities have indicated that the entire supply of the river in this reach would be utilised in that State itself, leaving nothing for diversion to other needy areas. Three large dams, the 237 metres high Tehri dam under construction, the 169 metres high Kotlibhel dam proposed to be taken up for construction in the Fifth Plan and the 245 metres high Uttayasu dam under investigation would, according to these authorities, store enough water to enable full utilisation of the river flows in U.P. It would be desirable to make detailed studies regarding the utilisation of the waters of the Ganga, in its upper reaches, taking into account the available groundwater and the needs of the neighbouring arid areas.

HARYANA

5.41 In Haryana, some parts of the districts of Hissar, Rohtak and Bhiwani which had desertic conditions are now prosperous because of irrigation facilities which were introduced there. But some portions, particularly the larger part of the new Bhiwani district, continue to be without adequate irrigation facilities.

Even the groundwater available in these areas is saline. The general slope of land in Haryana is from northeast to southwest. But in the southern portion the slope is in the reverse direction. The existing canals terminate where the slope changes. The higher areas to the south, where desert conditions prevail, can be irrigated only by lift canals. The State has recently undertaken the construction of some lift irrigation schemes for the area, namely, the Jui Canal, the Indira Gandhi Canal and the Birendra Narain Chakravarty Canal to provide irrigation in a gross area of 119,000 hectares. The State is planning a large lift irrigation scheme, called the Jawaharlal Nehru Canal, costing about Rs.30 crores, for irrigating 143,700 hectares (gross) in Rohtak, Mahendragarh and Bhiwani districts, with a possibility of extending irrigation to 28,000 hectares in the neighbouring drought areas of Jhunjhunu district in Rajasthan. The source of water for these lift canals is the Yamuna river for a period of 40 to 60 days during the monsoon and the share of Ravi-Beas waters for the rabi season. There is, however, no agreement as yet between the States that claim a share of Yamuna waters. Also Punjab and Haryana have yet to agree on their share of the Ravi-Beas waters. These differences require urgent attention as delay in arriving at agreements would hamper development of the water resources.

GUJARAT

5.42 In Gujarat, parts of the districts of Banaskantha and Mehsana fall in the desert area and have more or less similar conditions as obtain in the western parts of Rajasthan. In both these districts, the State Government has already taken up irrigation projects like Dantiwada, Sabarmati and Saraswati which will provide irrigation in a CCA of 133,220 hectares. Another project, called the Sipu Project, is likely to be taken up in the Fifth Plan. These projects will make a significant contribution to the well being of the people of these areas. But the real development will take place only when the waters of the Narmada are harnessed with the construction of Navgaon dam. It is hoped that a settlement of the Narmada water dispute will take place at an early date.

SECTION VI

RAINFALL AND CROPPING PATTERNS

6.1 Cropping pattern is largely determined, under rainfed condition, by the amount and the monthly distribution of rainfall, rather than the average annual rainfall. Out of the experience over the years the farmers have evolved for the arid areas certain cropping patterns with very small margin of variability. Since the range of variability of rainfall is large in areas of low rainfall there is danger of crop failure because of a rigid cropping pattern.

Rainfall Patterns

6.2 It is necessary to understand the rainfall patterns of the area with which this Report is concerned. The Commission is already engaged in delineating the country on the basis of the distribution of the twelve months' rainfall. Rainfall is examined for every tehsil (taluk) for every month. It is expressed in symbols for the sake of convenience. The following symbols are used:-

Symbol	Monthly rainfall (cm)
A	30 or more
B	20 - 30
C	10 - 20
D	5 - 10
E	Less than 5

6.3 The rainfall limits have been fixed with due regard to crop requirements. Rainfall of 30 cm each in three or more consecutive months is good for paddy and 20 - 30 cm range can sustain a crop

like maize. A monthly rainfall of 10 -20 cm spread over three to four consecutive months can sustain the less-water-requiring crops like jowar, pulses, some oilseeds like sesamum. A rainfall around 10 cm per month (i.e. lower range of C or upper range of D) for three or more consecutive months can be helpful only to crops like bajra or coarse pulses like moth or guar. Rainfall of less than 5cm per month cannot ordinarily support any worthwhile production of arable crops. The lower limits of D and upper limits of E are just good for some grasses and trees. The number of months during which a particular range of rainfall is received is indicated by a numeral subscript. For example, A_2 means 2 months of A type rainfall. In the desert area with which this Report is concerned, rainfall of 5 cm or more is received only in the period of four months of June-September and in this too, only four patterns occur. These are: (i) $D_2 E_2$, (ii) $D_3 E_1$, (iii) $C_1 D_1 E_2$ and (iv) $C_2 D_1 E_1$. The distribution of tehsils in these patterns is shown in Table 6.1. The names of the tehsils are given in Appendix V. Essentially, the patterns in this region are only two. $D_2 E_2$ accounts for 23 tehsils. $C_2 D_1 E_1$ accounts for another 51. This covers 74 out of the 79 tehsils of the area. These patterns are based on data for a period of 50 years or more as issued by the India Meteorological Deaprtment.

Table 6.1

Number of Tehsils in Different Rainfall Patterns

	D_2E_2	D_2E_1	$C_1D_1E_2$	$C_2D_1E_1$	TOTAL
JUNE	<5	<5	<5	<5	
JULY	5-10	5-10	5-10	10-20	
AUGUST	5-10	5-10	10-20	10-20	
SEPTEMBER	<5	5-10	<5	5-10	
HARYANA					
Hissar	-	3	-	2	5
Bhiwani	-	-	-	3	3
Rohtak	-	-	-	1	1
RAJASTHAN					
Ganganagar	11	-	-	1	12
Churu	2	-	-	5	7
Bikaner	4	-	-	-	4
Jodhpur	2	-	-	3	5
Jaisalmer	2	-	-	-	2
Barmer	2	-	2	1	5
Jhunjhunu	-	-	-	4	4
Sikar	-	-	-	6	6
Nagaur	-	-	-	8	8
Pali	-	-	-	5	5
Jalor	-	-	-	4	4
GUJARAT					
Banaskantha	-	-	-	6	6
Mehsana	-	-	-	2	2
TOTAL	23	3	2	51	79

Existing Cropping Pattern

6.4 The Commission is also engaged in examining the cropping patterns of the country on tehsil basis. In defining cropping pattern, a crop combination occupying 70% or more of the gross cropped area in at least two contiguous tehsils each has been designated as the cropping pattern. In order to express the cropping pattern in the form of notations, usually the first letter of a crop is taken to represent it, e.g. W = Wheat, B = Bajra, C = Cotton, F = Fodder. In some cases even two letters are used in order to avoid confusion, e.g. P = Paddy and Pu = Pulses; G = Gram and Gn = Groundnut; Jk = kharif Jowar and Jr = rabi Jowar. Pu denotes pulses other than gram and tur. The common pulses in this desert region are 'moth' under dry conditions, guar under slightly better conditions and mung or urad under still better conditions. O denotes oilseeds other than groundnut. Rape and mustard are taken in rabi under irrigated conditions, otherwise a common oilseed of Rajasthan is sesamum (til). Area under a particular crop is denoted by a numeral subscript as shown below:

Subscript	% of gross cropped area occupied by a crop
1	greater than 70
2	50 - 70
3	30 - 50
4	10 - 30
5	Less than 10

Some examples of the cropping patterns are explained

below in order to facilitate understanding:

B_I	=	Bajra as a single crop occupies more than 70% of the gross cropped area.
$Pu_2\ B_3$	=	Pulses and bajra make up more than 70% of the area. Pulses occupy 50-70% area, Bajra occupies 30-50% area.
$G_3\ B_4\ W_4\ C_4$	=	All these make up a total of more than 70% of area. Gram occupies 30-50% area. Other crops are in the range of 10-30%.
$G_3\ B_4\ F_4\ /C_4\ /W_4$	=	$G_3\ B_4$ are common, but would make a total of 70% or more in combination with one or more of the remaining crops.
$C_4\ W_4\ F_4$	=	All crops are in the range 10-30%, but the first crop, viz. cotton, has more area than other crops. Except for the first crop in such a sequence, the descending order of arrangements does not necessarily apply to other crops, specially when the crops are many.

6.5 The distribution of existing cropping patterns in different tehsils under different rainfall zones is presented in Table 6.2. These patterns take into account the impact of irrigation water which is available in some tehsils. The details can be seen in Appendices VI and VII.

Table 6.2

Distribution of Cropping Patterns in Tehsils Falling Within Different Rainfall Zones.

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Cropping Pattern	Number of tehsils in different rainfall zones having a particular cropping pattern				Districts
	D_2E_2	D_3E_1	$C_1D_1E_2$	$C_2D_1E_1$	
$C_4W_4F_4$	3	-	-	-	Ganganagar
$W_4F_4G_4C_4/O_4$	2	-	-	-	Ganganagar
$G_4B_4W_4C_4/Jk_4$	-	1	-	3	Hissar, Rohtak
$G_3B_4W_4C_4$	-	2	-	-	Hissar
$G_3B_4F_4/C_4/W_4$	6	-	-	1	Ganganagar
B_3G_3	-	-	-	3	Bhiwani
C_3Jk_4	-	-	-	1	Mehsana
$B_4Jk_4W_4O_4/C_4.'Gn_4$	-	-	-	1	Mehsana
$B_4O_4Jk_4F_4Pu_4$	-	-	-	1	Nagaur
$B_4O_4Pu_5Jk_4/W_4$	-	-	-	1	Pali
$F_4B_4O_4Jk_4$	-	-	-	1	Pali
$B_3O_4Jk_4F_4Pu_4$	-	-	-	3	Pali
$B_3Jk_4F_4/C_4$	-	-	-	2	Banaskantha
$B_3Pu_4F_4$	-	-	-	3	Churu, Jodhpur, Nagaur
Pu_2B_3	2	-	-	-	Bikaner
Pu_3B_3	3	-	-	4	Churu, Bikaner, Sikar
B_3Pu_3/F_3	2	-	-	2	Bikaner, Jodhpur, Churu, Jhunjhunu
$B_2Pu_4/F_4/Jk_4$	1	-	-	20	Jodhpur, Jhunjhunu, Sikar, Nagaur, Jalor, Banaskantha
B_1	4	-	2	5	Jaisalmer, Barmer, Jodhpur, Jalor
TOTAL ~~TALUKS~~	23	3	2	51 = 79	

6.6 The following broad conclusions emerge from Table 6.2:

(i) When irrigation water is available, as in areas of Ganganagar and Hissar, there is a wide choice of crops, e.g. cotton and jowar in kharif and wheat and gram in rabi and oilseed and fodder crops in both the seasons. Where irrigation supplies are not adequate the proportion of gram increases over wheat.

(ii) When irrigation water is not available at all, the choice of crops even in the district of Bhiwani and parts of Rohtak in Haryana gets restricted to bajra in kharif. In these areas, as some winter rains are received, gram is taken in rabi.

(iii) When crop production depends entirely on monsoon rainfall, rainfall pattern $C_2 D_1 E_1$ presents better chance of survival of crops and, therefore, the choice is relatively wider (e.g. in 8 tehsils of Mehsana, Nagaur and Pali districts). In Mehsana, the soils even in this type of rainfall distribution can conserve enough water to support crops like cotton, jowar or even groundnut. The choice of other crops includes bajra, pulses, fodder and oilseeds. Oilseeds (mainly sesamum) is a common feature of most of these tehsils. However, the crops are mostly in the range 10-30% and to this extent it indicates the helplessness of the farmer in not being able to

raise any crop in a big way. In isolated pockets, people venture to take even wheat, but that is of no consequence.

(iv) Within $C_2 D_1 E_1$ zone, the drier the area, the more restricted is the choice of crops. In this gradual change, the first stage is that the proportion of bajra increases to 30-50%, the other crops diminishing accordingly. The second stage is that the crops get restricted to only bajra and pulses, their proportion being determined by local situations. The pulses can be anyone of the three, viz. mung, guar, and moth with the descending order of water availability. In the third stage, bajra covers 50-70% of the cropped area. The farmers take a chance with pulses or fodder or jowar but with little hope of success. About 20 tehsils out of a total of 51 in $C_2 D_1 E_1$ zone represent such a stage. The next stage is when a farmer can take only bajra crop. There are 5 tehsils of this kind even in $C_2 D_1 E_1$ zone.

(v) In $D_2 E_2$ areas, the choice of crops, is restricted mainly to bajra and pulses. Pulses predominate in the range 50-70% of gross cropped area in some situations, but otherwise bajra goes on increasing in proportion with the deterioration of soil moisture conditions till he is left with no choice

other than bajra. The pulse which is taken as a companion to bajra under extreme stress condition is moth.

Relative Yield Index of Crops

6.7 In order to have an idea of the performance of crops in a particular area in relation to all-India average, the district-wise production data were examined for the years 1968-69 - 1970-71. A serious handicap with the production statistics is that these figures are available for the district as a whole and not for individual tehsils. Because of this, an appraisal of yield performance becomes difficult when the tehsils of a district are distributed over more than one kind of rainfall zone. Barmer is a typical example. Its two tehsils, Pachpadra and Sheo fall in $D_2 E_2$ zone. Its another two tehsils, Barmer and Chohtan, fall in $C_1 D_1 E_2$ zone and its tehsil Siwana, fall in $C_2 D_1 E_1$ zone. The Relative Yield Index (RYI) of bajra for the whole district is 45%. This can hardly represent the poor conditions of $D_2 E_2$ area, where the yield must have been of a lower order, if taken separately. In order to avoid such a difficulty only a few districts have been chosen here for examination which fall wholly or mostly in a particular rainfall zone. The crop performance which has been examined for such selected districts relates to only rainfed conditions and not irrigated conditions, because under irrigation any crop will give comparatively a better perforance. The analysis is presented

in Table 6.3. It is clear that the yield level of even bajra is very poor in $D_2 E_2$ zone. In fact, it is a clear pointer that growing of arable crops is not worth the effort in such a zone solely on the basis of rainfall. In $C_2 D_1 E_1$ areas, the yield of bajra is generally in the tolerable range of 70-80% of all-India index, which shows that the best lands are put under this crop. Pulses and sesamum are taken as close companions. The yield of sesamum is better only in one district, viz. Jalor.

Table 6.3

Relative Yield Indices of Selected Crops for Certain Districts (local yield expressed as percentage of the all-India yield).

	Bajra	Pulses	Jowar	Sesamum
$D_2 E_2$				
Bikaner	15	23	-	-
Jaisalmer	23	-	-	-
$C_2 D_1 E_1$				
Jhunjhunu	73	48	-	-
Sikar	78	60	-	-
Nagaur	44	40	19	31
Pali	83	64	56	55
Jalor	72	47	-	105
Banaskantha	73	35	44	-

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6.8 Suggestions for cropping pattern in the irrigated areas have already been made in the previous Section. A favourable situation to which pointed attention is, however, necessary here is that the dry atmospheric conditions eliminated by nature many of the pests and diseases and, therefore, are very conducive to healthy

growth. Because of this reason, areas with such conditions are particularly suited for seed production. As the country needs quality seed of all kinds of crops in large quantities, these areas can play a big role in this context. This would bring higher returns. We therefore recommend that in irrigated areas quality seed of all kinds of crops should be produced in large quantities.

6.9 In $D_2 E_2$ zone, grasses alone can survive. In other areas, other crops push out fodder crops for economic reasons. It is often argued that farmers cannot be weaned from growing bajra in $D_2 E_2$ zone, because it is their staple food. The farmers can be easily convinced that the returns which will accrue to them through organised forage production will be much higher than through the production of bajra. This would, however, require a good distribution system for foodgrains. In the context of aridity of the area, an assured supply of fodder is certainly a boon. Added to grass raising for forage, the seed industry pertaining to grasses can also be profitably developed in $D_2 E_2$ zone.

6.10 Underground water has been tapped in many areas in $D_2 E_2$ zone. Many tubewells are coming up in this zone. Tubewell water is primarily meant for drinking purpose. The balance can be used to grow crops on a limited scale. The choice of crops has, however, to be made very judiciously. Therefore, green fodders cannot be grown to any large extent, barring, of course, individual requirements on a very restricted scale. Vegetable and orchard

crops are the best choice. Oilseeds like sunflower and safflower can also be tried. Seeds of vegetables especially cucubits can profitably be raised. Fruits grown under dry conditions are sweet and delicious. Pomegranate, citrus and papaya fruits would be suitable.

6.11 In $C_2D_2E_1$ zone, the cropping patterns, as they exist, cater to all kinds of local conditions pertaining to soil and rainfall. It is not the change in cropping patterns but increasing the yield level of crops which is important. Here again, it is not as much the limitations of inputs as the limitations of water which act as a serious handicap. The rainy months are indeed few, the months when some useful rainfall occurs are only two viz., July and August. The efforts have, therefore, to be concentrated to conserve water wherever possible so that water is available in the months of September and October also.

6.12 Possibility also exists of establishing crops like bajra by transplanting than by direct seeding. Research in this regard should be intensified so that definite recommendations could be made as early as possible. This would go a long way to ensure the required population of crop plants in any hectare of land.

SECTION VII

SAND DUNE STABILISATION

7.1 It is estimated that about 58% of the arid area of Rajasthan is covered by sand dunes of various forms, sizes and orientations. Unless managed with caution and foresight, sand from the dunes is likely to be transported to fertile land, and on to the road and railway lines causing widespread deterioration. On the basis of the investigations carried out at the CAZRI in the central Luni basin* on the orientation, distribution and origin of sand dunes, the following points of general interest emerge: The sand dunes covering an area of about 13,000 hectares in the central Luni basin belong prdominantly to three types, namely, longitudinal, parabolic and transverse, varying in height from 2 to 20 metres. Of these, the first two types are considerably larger in size, and have been formed by the westerly and south-westerly winds, the axial direction being SW-NE. The sand dunes show little horizon differentiation and are constituted of about 90% fine sand and 3-4% clay. The old and stabilised dunes contain 3.8 to 5.5% calcium carbonate, whereas in the new and active dunes the calcium carbonate content is around 0.8 - 2%. While the western part of the dune appears to attain maturity, the eastern part is undergoing active change. From those of the stabilised dunes which were subjected to cultivation and grazing over the crests, flanks and windward sides, the

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* Pandey, S.Singh, Ghose B (1968) Orientation, distribution and Origin of Sand dunes in the Central Luni basin, Symp. Proc.Prob. Indian Arid Zone 84-91.

surface sand has been exposed to wind and blown out forming small but active shifting dunes.

7.2 On the basis of experiments* carried out over ten years, techniques were standardised of afforesting shifting sand dunes. They consist in (i) fixing barrier strips in parallel or chess board design, (ii) afforestation by direct seeding and planting, and (iii) protection against biotic interference. It is being observed that in areas receiving 150-250 mm rainfall, subsoil moisture is available in shifting sand dunes. Closure of the areas followed by mulching with local shrubs just before rains is the first step. Sonia (Crotolaria burbia), kheemp (Leptadenia pyrotechnic), bordi (Zizyphus nummularia), buii (Aerva pseudotomentosa), phog (Calligonum polygonoides), sewan (Lasiurus sindicus) and murat (Panicum turgidum) have proved to be economical and useful for erecting such barriers or for mulching as these are locally available. The indigenous and exotic tree species which have proved successful are: kumat (Acacia senegal) siris (Albizzia lebbek), Israeli babul (Acacia tortilis), khejri (Prosopis cineraria), sissoo (Dalbergia sissoo), ardu (Ailanthus excelsa), ber (Zizyphus mauretiana) and farash (Tamarix articulata). The successful grass species are: sewan, murat, safed dhaman (Cenchrus ciliaris) and kala dhaman (Cenchrus setigerus).

7.3 Experiments done on sand dune fixation in Hastera**, a village in Chomu tehsil of Jaipur district, 45 km from Jaipur city, are encouraging. Because of overgrazing and human and animal interference of various kinds, the

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* Bhimaya, CP, R.N.Kaul, Ganguly, B.N. (1961) Sci and Cult. 27, 224-228.

** Sankhala. K.S. (1964). Symp. Proc.Prob.Indian Arid Zone 197-199.

village, once well populated, is now a deserted one. The formation of new dunes and march of old ones can be seen during the hot season (April-June). The average annual rainfall is 60 cm and the average maximum and minimum temperatures are 44°C and 2°C, during summer and winter. The average humidity is 54.8%. The unstable dunes were planted with rhizomes with one or two leaves of munj (Saccharum munja) which were available locally, in contour lines on both windward and leeward sides 1-3 metres apart depending on the size of the dune. The planting was done 30 cm in lines and 40-50 cm deep to cover the rhizomes. The area was closed to grazing with the help of the Panchayat but not fenced. Old leaves died in a few days and new leaves appeared within 10-15 days. Those not showing any green leaf were replaced. This was in July 1958. Next year some seeds of kumat and Butea monosperma were sown in addition to the rhizomes. Germination was good. This was followed by planting of nursery raised seedlings of sissoo and Holoptelea integrifolia on the leeward side of the munj clumps of the previous year. The whole area was partly fenced with mud wall and partly with barbed wire. Dunes seemed to respond well to these treatments but those in the flat region, having high pH and salinity failed to do so. Ipomoea biloba planted on the dunes covered them. The sissoo trees have also shown signs of establishment. All the dunes of the village have been gradually tackled in the same way.

7.4 Sand dune fixation and grass development now being implemented along the main canal indicate that there is

no basis for the apprehension that trees planted will trap sand and cause silting up of the canals by the tripping of trapped sand along the canal sides. In fact, in the untreated areas sand tripping has been observed, whereas in the treated ones, there was no sand tripping at all. The strip should be wide enough, not less than 25 metres, in order that the trapped sand is further away from the canal, otherwise there is danger of sand tripping into the canal, and obstructing the flow of water.

7.5 That shrubs planted as fence constitute foci for sand dune formation and thereby threaten the very area which is intended to be protected against blowing sand was the experience at the Jodhpur air field. In the absence of shrubs the same sand would have spread uniformly instead of dune formation.

Moisture Availability

7.6 Afforestation is likely to succeed on sand dunes provided adequate water is available. The information on this point is sketchy and not at all decisive. As already mentioned, shifting dunes have been found to support some kind of vegetation showing water availability in the subsoil layers.

7.7 The stabilisation of shifting dunes through vegetation was attempted at Osian, Jodhpur, 72 km WNW of Jodhpur. Two dunes, one stabilised having some natural covering of bhuma bauli

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* Krishnan, A, Bhatt, P.N. and Rakhecha, P (1966) A soil moisture regime and microclimatological Study over sand dunes in western Rajasthan, Ann. Arid Zone, 5, 1-9.

(Acacia jacquemontii) and murat, and another unstabilised and almost barren were selected. The unstabilised dune shows a sharp discontinuity in moisture 1.5 - 2 m below surface, the lower layers having more than 5% moisture. The stabilised dunes have 1-2% moisture below 1.5 m, but some pockets of moist zone (2.5 to 4%) below 1.2-1.8 m were noted in course of January, March, June and August observations. August observations showed highly moist (5-7%) zones at 25 cm depth. Again highly moist (5-7%) layers occured at 4-7 m depth during March-July. The moisture concentration in stabilised dunes during hot weather might have come from below or due to downward movement of rainwater, the upper layer moisture being used up by vegetation. In stabilised dunes (near Barmer and Gadra Road) having plants and hence allowing evapotranspiration the moisture content was below 1% up to 91 cm and never went above 3% up to 183 cm. Wilting points of dune sand being about 1.0 and of Jodhpur soil 2.5, the survival of plants was doubtful. The moisture balance could be maintained by tapping moisture from below. Moisture from upper layers is depleted in vegetated sites by the quick growing annuals and grasses.

7.8 In the unstabilised dunes high moisture content, about 2%, was recorded within 30 cm*. The root systems of grasses like safed dhaman, kala dhaman, Panicum antidotale, etc. are between 117-196 cm. Sewan roots go down to 403 cm. These grasses dry up in summer months due to adverse soil moisture. Water balance studies

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* Lahiri, A.N. (1964). Symp. Proc. Prob, Indian Arid Zone, 153-159.

at varying depths carried out by the torsion balance technique with khejri at Jodhpur in 1963 reveal that since the entire rainfall of 157 cm during that year was lost by evapotranspiration from soil layer above 5 cm, the trees must have extracted for their survival water below 2 m by penetrating the kankar layer at that depth. Grasses which are able to withdraw water from a depth of 1 m at most dried up after regeneration on receiving rainfall at the end of 70 days because of the critical amount of water (22 mm) left up to that depth after evapotranspiration.

7.9 Water being the most limiting factor in sand dune stabilisation and water being the costliest and most important input in any desert development programme, the question of using water for sand dune stabilisation does not arise at all unless the sand dunes are a danger to towns, roads and railways. However, water would be available during the first five years or so of the construction of channels in the commanded area of Rajasthan Canal for uses other than arable farming. To stabilise shifting sand dunes in the commanded area and along the canals, branches and major distributaries, they should be brought under grass and tree cover during that period. The programme for stabilising such dunes has been outlined in Section VIII.

SECTION VIII

FOREST DEVELOPMENT

RAJASTHAN

8.1 Forests occupy a negligible position in the total land use in the eleven arid districts of Rajasthan as the following figures show:

Reserved forests	1177 sq km	0.56%
Protected forests	1438 sq km	0.69%
Unclassed forests	441 sq km	0.21%

The forest areas are confined mainly to Barmer, Jalor, Nagaur, Jhunjhunu, Sikar and Pali districts, with little bits in other districts. In Ganganagar district, an area of about 2,400 hectares near Hanumangarh was transferred to the Forest Department in 1956 for raising irrigated plantations on experimental basis. The first plantation was raised in 1958 on 320 hectares under semi-irrigated conditions.* Since then irrigated plantations have been raised on canal land in Bikaner and Ganganagar districts by the Forest Department.

8.2 The indigenous forests belong to subtype Tropical Thorn Forest of the major forest type Dry Tropical Forest. Open savannah consisting of grasses, mostly sewan (Lasiurus sindicus) and dhaman (Cenchrus ciliaris) with scattered trees and shrubs are found.

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*Bharat Singh. The First Irrigated Plantation of Rajasthan. Indian Forester, 89(10), 1963.

Tree species like Eucalyptus, Israeli babul (Acacia tortilis), sissoo (Dalbergia sissoo), etc. have been introduced in the irrigated plantations along canals and roads. Elsewhere, in the region, because the trees are very scattered, fuelwood is generally obtained by lopping of khejri (Prosopis cineraria), which has tremendous power of survival and growth in spite of continuous lopping, and by uprooting of phog (Calligonum polygonoides). The latter practice is risky in the sense that it creates the foci of sand blowing in the desert. Some charcoal for fuel purposes is also produced from phog, vilayeti babul (Prosopis juliflors) and bhuma bauli (Acacia jacquemontii).

Approach to Future Forest Development

8.3 Since the Forest Department controls only an insignificant area in these arid districts, its major activity would have to be on lands of other departments and extension work. The future forestry activities in the desert area should be as follows:

(i) Plantations including canalside plantations, farm forestry, roadside plantations, and shelter-belts and wind-breaks.

(ii) Creation of grass reserves and fodder banks.

(iii) Sand dune stabilisation.

Canalside Plantations

8.4 Canalside plantations are being raised at present in the districts of Ganganagar and Bikaner on both sides of the main canal and its branches, distributaries and minors. The Project Report* on the development of the commanded area of Rajasthan Canal envisaged a programme of 14,000 row km in 10 years. It was estimated that along the main canal the acquired land, at least 25 metres on either side of the canal, would suffice for 5 rows on each side. On the branches and distributaries, the land acquired on either side would be sufficient for 3 rows of plantation. On smaller channels it was considered possible to take up one row on either side. The main canal is about 470 km long, the branches and distributaries about 730 km and the smaller channels about 2,400 km.

8.5 Canalside plantations were introduced in the region more than a decade ago when tree planting was taken up on the Gang canal and its larger channels in Ganganagar district. On Rajasthan Canal, plantations only in borrow-pits on either side of the canal are termed as canalside plantations. Instead of only 25 metres width envisaged in the Project Report, these plantations sometimes extend upto 300 metres. However, the

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* 'Development of Rajasthan Canal Command Area - Project Report', Agriculture Department (Special Schemes), Rajasthan, 1971.

plantations on the dunes or high ground along the canal are not treated as canalside plantations. These have been taken up as an item of sand dune stabilisation. We feel that all irrigated plantations along the canal, its branches and distributaries should be classed as canalside plantations, as they serve the same purpose and the width of land or its height has no significance in this respect.

8.6 The technique of plantation and species to be planted may, however, differ according to land configuration. The spacing adopted for plantations in borrow-pits is 5 m x 3 m, whereas on high ground and dunes along the canal it is 5 m x 5 m. For the borrow-pit plantations, irrigation is done by siphoning water from the canal. The quantity of water used in this case is much more than in plantations on high ground where diesel pumps are used for watering the plants. The species preferred for borrow-pit plantations are sissoo, babul (Acacia nilotica) and Eucalyptus. For high ground the preferred species are Israeli babul, vilayeti babul, ber (Zizyphus sp.) and farash (Tamarix sp.); grasses like sewan, dhaman and munj (Erianthus munja) are also sown or planted. Of all the tree species tried, vilayeti babul is found to affect the growth of grasses. As already pointed out in the previous Section, there is no basis for the apprehension that trees planted will trap sand which might blow or slip into the canal.

8.7 The Project Report, referred to in paragraph 8.4, has estimated that fuelwood grown locally will cost Rs.75 per tonne, while bringing it from outside will cost Rs.140, as it will involve an average lead of 400 km by rail and 100 km by road. Apart from the cost, the burden on the rail and road network will get reduced as the plantations mature in this area.

8.8 Since watering is essential for raising trees in the arid region, their planting will necessarily have to be confined to areas where water would be available. As in the early stages of development of canal commanded areas, there would be some water to spare for raising plantations, a large scale programme of tree growing should be drawn up and implemented during that period on a priority basis. All attempts should be made to complete planting within four to five years of water becoming available in an area. Nurseries should be planned ahead, so that tall seedlings are available by the time they are needed. Later when the second rotation plantations are raised, water requirement would be much less as the subsoil water table will have risen by then and a large part of regeneration will be by coppicing.

8.9 For Rajasthan Canal area, plantations should be located only along the main canal, branches and major distributaries. No plantations along the smaller distributaries or minors should be attempted, as the available land there is not enough for more than single line planting. Tending and protection

of single line plants is difficult and expensive and such planting, therefore, is neither feasible nor desirable. The area available for canalside plantation would be of the order of 16,000 hectares, which would support a plantation programme of 32,000 row km. The average cost of plantation on canal lands would be around Rs.1,000 per row km and the total amount required for the programme would be Rs.3.20 crores. On an average rotation of 15 years, the outturn of fuelwood is expected to be not less than 75 tonnes per hectare. At a price of Rs.5 per quintal at site this should fetch Rs.3,750 per hectare.

8.10 For irrigated plantations in the arid zone, sissoo, babul, Israeli babul, ber, farash and Eucalyptus are, by and large, the suitable species. Irrigated mulberry plantations have been raised successfully in the past under arid conditions in the Punjab. However, mulberry should be introduced only after adequate local research. If successful, mulberry would provide material for sports goods and basketmaking.

8.11 Some data on the growth of irrigated plantations in Ganganagar and Bikaner districts in the canal commanded area were obtained from the Forest Department, Rajasthan, and are presented below:

Table 8.

Growth of Irrigated Plantations in Canal Commanded Areas in Ganganagar and Bikaner Districts

Species \ Age	Average Height in Metres			
	2 years old	3 years old	4 years old	5 years old
Eucalyptus	4.2	5.0	-	6.0
Babul	3.5	3.9	4.2	5.0
Sissoo	3.2	4.7	5.0	-
Israeli babul	2.5	3.0	3.7	4.8

When compared with the growth data in the Table below, it is found that the growth potential is almost equal to Quality II sissoo under irrigated conditions.

Table 8.2

Growth and Yield Statistics of Irrigated Plantations of Sissoo - Quality II

Years	Dia. in	Height ft.	Total basal area sft/ ac.	No.of stems nos/ ac.	Stem timber (accumulated) cft/ac	Smallwood with barks (accumulated) cft/ac.	Thinning (accumulated) cft/ac.
5	2.2	22	24	909	-	209	95
10	4.5	37	41	371	32	782	275
15	6.9	47	54	208	305	1091	531
20	9.6	56	63	125	911	1125	903

Source: Growth and Yield Statistics of Common Timber Species - Vol.II, Forest Research Institute, Dehra Dun, 1970.

Converted into metric units, the yield from such plantations on a 15 year rotation is likely to be the following:

Timber	-	20 m^3/ha
Fuelwood (smallwood and thinnings)	-	115 m^3/ha

8.12 To have an idea of the magnitude of the fuelwood problem, the requirement per unit of population has to be considered. Calculated on the basis of the study of 'Domestic Fuel Consumption in Rural India' by the National Council of Applied Economic Research (1965), the fuelwood consumption in this region works out to about 185 tonnes or about 280 cubic metres per 1000 persons. The area of plantation required on a 15 year rotation will thus be 36 hectares per 1000 persons, exploiting 2.4 hectares every year. On this basis, the extent of plantation required for fuelwood alone will exceed 350,000 hectares. However, existing farmland trees as extensively seen in Nagaur district, agricultural refuse like cotton stalks, and coal in urban areas will meet a substantial part of the requirement. Therefore, even a quarter of the above area, if brought under new plantation, would go a long way to meet the requirement of fuel and small timber in the region and discourage the uprooting of phog. But the land available along the canals for plantation is only about 16,000 hectares which is a small fraction of the requirement. Therefore,

farm forestry will have to be encouraged in a big way to meet part of the requirement.

Farm Forestry

8.13 Khejri is an indigenous tree eminently suitable for adoption as the primary species in farm forestry. It is found that neither the town of Nagaur nor the rural population in most parts of that district has any problem regarding fuelwood supply, because of the large number of khejri trees growing on cultivated lands.

8.14 Under the farm forestry programme, in addition to continuing the present practice of growing trees in the fields, tree planting on bunds and boundaries of fields should be encouraged to serve as wind-breaks. The farm forestry programme should be so organised that a substantial programme of planting of khejri and other suitable species of trees is taken up by the farmers themselves. The farmers should be induced and encouraged to take up this work on their own. Such a farm forestry programme should receive special emphasis in the Rajasthan canal commanded area in order to protect lands under arable crops against wind erosion and sand casting and to augment the supply of fuelwood and leaf fodder. For the successful implementation of such a large programme of farm forestry it would be necessary to develop a strong extension organisation under the Forest Department with suitable and adequately trained personnel. The programme should be organised on the lines

recommended in the Commission's Interim Report on Social Forestry.

Procurement and Distribution

8.15 The uprooting of phog should be gradually controlled by banning its movement outside the State. It would be necessary to have arrangements for distribution of fuelwood amongst big towns, defence establishments and bigger settlements. Initially, fuelwood would have to be brought from outside the desert area to augment local supply. A well planned programme of procurement and distribution should be drawn up. The procurement and distribution agency for the fuelwood should be the same as for food and fodder.

Roadside Plantations

8.16 Roadside plantations are necessary to prevent or reduce deposition of wind blown sand on the road, to provide the much needed shade and for aesthetics. To be effective against sand casting on the road there should be at least five rows of trees on the windward side. On the leeward side, three rows are desirable. For this, an adequate width of land on either side of the road should be acquired where already not available. The suitable species for roadside plantations are neem (Azadirachta indica), siris (Albizzia lebbek), ardu (Ailanthus excelsa) and Israeli babul. These trees provide good shade and have a long useful life. Where sufficient land is not available

for planting five rows of trees on the windward side and three rows on the leeward, only one or two rows of widely spaced trees can be planted for shade.

8.17 Roadside plantations should be considered as social benefits. Fuelwood and small timber derived from these plantations would be only a secondary consideration. These plantations should not, therefore, be treated as a commercial proposition in this region.

8.18 It is seen that in Rajasthan Canal Project area, the programme is to construct about 800 kilometres of main roads in 10 years, and the Project accordingly provides for the planting of 3,200 row km (2 rows on either side) in that period. Taking into account the existence of the roads outside the Rajasthan Canal Project area and our recommendation in paragraph 8.16 for planting 8 rows of trees, 5 rows on the windward side and 3 on the other, a programme of 8,000 row km of planting over 1000 kilometres of roads should be attempted. The total cost is estimated to be Rs.96 lakhs only at the rate of Rs.1,200 per row km. Nurseries and supply of watering trucks should be planned ahead.

Wind-Breaks and Shelter-Belts in Canal Commanded Area

8.19 While wind-breaks should be planned as part of farm forestry and planted by the farmers themselves to protect their crops against the desiccating effect of hot winds, shelter-belts

are required to be established departmentally as it would require careful planning and acquisition of land for the purpose.

8.20 Shelter-belts would require irrigation in the initial stages. Therefore, the programme of shelter-belts should be formulated and executed in the early stages of development of the commanded areas. No shelter-belts programme can be suggested for rain-fed areas outside the canal command, as water would either be not available or would be too expensive for this purpose. In the rainfed areas, the programme of pasture development as recommended later in paragraph 9.39 will help to minimise wind erosion to a great extent.

8.21 The shelter-belts programme in the Fifth Five Year Plan should be of the order of 20,000 hectares. The cost is estimated to be Rs.3 crores at the rate of Rs.1,500 per hectare. In the next 10 years, another 60,000 hectares should be taken up under the shelter-belts programme.

Grass Reserves

8.22 The experience under Desert Development Programme and Drought Prone Areas Programme so far undertaken shows that grass reserves can be successfully created under rainfed conditions, provided the blocks have large areas and their protection is assured. Large blocks of government rang,lands of a minimum size of 200 hectares and preferably located far away

from habitation would be suitable for the purpose. Large blocks are easy to supervise and manage and cost relatively less to fence than small blocks.

8.23 In the grass reserves, of which each district should have adequate area, no grazing should be allowed. The entire production of hay should be collected, baled and stored in fodder banks. The hay should normally be kept stored for three years but should be disposed of in the fourth year, if not used up in the meantime to meet the requirements during scarcity. Thus, at any time there will be a stock of 3 years' production of hay in the fodder banks. It is recommended that at least 200,000 hectares, as explained later in paragraph 9.39, should be brought under grass reserves. At an average cost of about Rs.600 per hectare for development of grass reserves, the amount required would be Rs.12 crores. In addition, approximately an amount of Rs.16 per quintal would be required for harvesting, baling, transport,etc. of hay collected annually.

8.24 In Rajasthan, the work relating to the creation of grass reserves under the Desert Development Programme and the Drought Prone Areas Programme is being handled by the Forest Department. This Department has already some experience and expertise in this work. Therefore, the Forest Department in the State could with advantage be entrusted with the implementation of the proposed programmes of grassland development and grass reserves. It has to be realised, however, that

the programmes of grass reserves and grassland development recommended in paragraph 8.23 above and later in paragraph 9.39 envisage coverage of very large areas. The creation of an organisation to implement such large scale programme should receive careful consideration. The Commission, therefore, recommends that a separate Wing should be created under the State Forest Department which should employ adequate number of agrostologists, agronomists and range management specialists who should possess sufficient knowledge and experience in this special type of work. Where necessary these specialists should be trained within the country or abroad. The supervisory staff should be employed on a long term basis to facilitate their gaining experience and in making use of such experience on a continuing basis.

8.25 Improved grasslands and grass reserves in this area must be maintained in perpetuity for the economic benefit of the farmers and the livestock breeders in the arid region. Therefore, once the programmes of grassland development and grass reserves are taken up by the Forest Department the areas should on no account be converted later on into forest plantations. As the objective of these programmes is to provide sufficient grazing and hay for feeding the livestock, there is need for close association of other concerned departments such as animal husbandry, dairy development, sheep

development, agriculture, etc. It is, therefore, recommended that for the proper planning of programmes, judicious conservation and utilisation of grasslands and hay, and for reviewing the working under these programmes from time to time, there should be a coordinating body in the State headquarters consisting of the heads of departments of forest, sheep development, animal husbandry, dairy development and agriculture. This coordination body will have the responsibility for laying down policies and programmes and providing guidance on the implementation of the programmes/schemes. Formation of a similar inter-departmental coordinating committee at the district level would be necessary.

8.26 It is recommended that the grass reserves should be entirely under the ownership and management of the Government; and hay for storage in the fodder banks should be received from these reserves. To supplement the quantity of hay stored in fodder banks, the Village Panchayats and individual farmers may also be encouraged to conserve grass on cooperative basis for which necessary extension assistance could be provided by specialists in the departments of forest, animal husbandry, sheep development, dairy development and agriculture.

8.27 As already recommended in our Interim Report on Social Forestry: (i) scientific methods should be adopted in the improvement of grassland and grass reserves, such as selection of the most suitable

grass species, application of fertiliser, proper protection measures, tractor ploughing and scientific practice of harvesting; and (ii) the orogramme of seed production should be properly organised involving the local farmers in production of seeds of recommended grasses. The seeds produced by the farmers should be purchased at reasonable rates for processing and distribution by well organised agencies as recommended by the Commission in its Interim Report concerning mutliplication and distribution of quality seed. The Forest Department should obtain its requirement of grass seeds for grassland improvement from these agencies in addition to the production from their own seed farms.

Fodder Banks

8.28 The programme of grass reserves would require arrangements for storage and preservation of hay in fodder banks based on the productivity of grass reserves under average conditions. The total stock of hay should be built over three years, as indicated in paragraph 8.23. The annual area of grass reserves required in each district would have to be calculated and allocated on the basis of the expected productivity.

8.29 The estimated hay production from improved grasslands in Barmer district under the Desert Development Programme from fifth year onwards is 20 quintals per hectare per year. The expected yield of hay under rainfed conditions in Rajasthan Canal Project is 15 quintals per hectare. In Jorebir in Bikaner

district an area of 400 hectares was fenced. As a result of protection the yield of hay during 1971 and 1972 was 10 and 12.5 quintals per hectare respectively. The annual grasses have low nutritive value whereas perennial grasses like dhaman, sewan and karad (Dichanthium annulatum) have high protein content (7 - 10%). But ecological succession of these species is a slow process and even reseeded grasslands are a heterogeneous mass. However, according to one estimate* in well established reseeded rangeland with dominance of above species, average yields of 12, 15 and 20 quintals per hectare could be expected during years of normal rainfall. Taking into account good as well as bad rainfall years and other factors, we expect that the average yield of hay on "good" grasslands may be about 7 to 8 quintals per hectare.

8.30 An Evaluation Committee** of the Ministry of Agriculture recommended that a detailed plan for the storage of adequate quantity of hay as close to the centres of consumption as possible should be prepared by the Forest Department. The depots should be established near roads or railway stations to facilitate transport.

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* Communication from the Chief Conservator of Forests under his No.F.27(1)/72-Relief/CCF/11955 dated 24.11.1972.

** Committee for Evaluation of Pilot Projects sanctioned under Desert Development Programme, constituted under Ministry of Agriculture, No.F.10-2/72-CAD dated February 24, 1972.

We commend the suggestions of the Committee. The Committee also recommended that the baling of hay should be done by steam pressing in preference to hand pressing. But steam pressing would not be feasible in view of the scarcity of fuel and water. However, to reduce the bulk and hence the expenditure on storage and transport the baling should be done by hydraulic presses.

8.31 The grass reserves, when gradually brought up to the target of 200,000 hectares are estimated to yield annually 15 lakh quintals of hay at an average yield of 7.5 quintals per hectare. Since 3 years' production would have to be stored, a phased programme for providing storage arrangements, with fire fighting equipment at each storage depot, should be initiated. It may be mentioned that in Gujarat, which has a long tradition of fodder banks, semi-permanent godowns are constructed for storage of hay with provision for fire fighting equipment at each godown. However, in view of the prohibitive cost involved and considering that the rainfall in this region is low, we recommend that storage be done in the open in hay stacks (locally known as 'ganjis'), but there should be pucca plinth for each hay stack. It was ascertained that in military fodder farms, 1,790 quintals of baled hay are stacked at each place on a pucca plinth measuring 21 metres x 9 metres. The cost incurred by the military farms for construction of the pucca plinth

of this area is generally Rs.5,000. However, considering that some building materials would have to be transported over long distances, the construction of pucca plinth, including the cost of fencing the depot area with barbed wire and providing fire fighting equipment at each depot, may cost Rs.3.50 per quintal. The total amount required is Rs.1.60 crores. All the stacks should be properly thatched. The thatching should be with coarse grass in bamboo frame, and the thickness of thatching should normally be 50 to 75 mm. The recurring annual cost for stacking, thatching, cutting fire lines around the ganji, weighing, abelling and for protection and maintenance staff is likely to be Rs.2 per quintal.

Sand Dune Stabi-lisation

8.32 The technique and approach for sand dune stabilisation have been described in Section VII. The programmes for canalside and roadside plantations would help in the stabilisation of shifting sand dunes along the canals, branches and major distributaries and also at places where the sand dunes are a danger to roads. It is not possible to indicate the extent of works required for the stabilisation of sand dunes which pose a threat to towns and railways. However, surveys should be undertaken and the works taken up wherever necessary.

8.33 So far as shifting sand dunes within the gross commanded area of the Rajasthan Canal are

concerned, the programme of shelter-belts recommended earlier will cover a part of such dunes. There are possibilities of large scale works of stablisation of shifting sand dunes in the uncommanded area within the gross canal commanded area, because of the availability of surplus water during the first five years or so of the construction of channels. It is understood that a large part of such inter-command dune lands is government owned. These have to be planted over with grass and trees, both for their stability to prevent sand-casting on adjoining cropped areas and to provide fodder for livestock and trees for fuel, fodder and shade. Since the success of the programme would depend on the efficacy of protection afforded later, it should be taken up only after enlisting the support of the Village Panchayats. Wherever a minimum area of 20 hectares is available in a compact block, the programme should be taken up, for which the entire investment should come out of the Government funds, but protection should be the responsibility of the Panchayats. Grazing of cattle should be restricted; and trees should be protected and lopping allowed only under supervision. The villagers may be allowed to cut grass on payment, but a price preference should be given for the sale of grass (the prescribed fee should be moderate) as well as for any occasional tree that is likely to be felled. The income from such sales should be shared equally between the Government and the Village Panchayats.

8.34 No precise figures are available about the area of Government owned shifting sand dunes. It is found that the net uncommanded area within the gross commanded area of the Rajasthan Canal is about 12 lakh hectares. On the basis of a rough estimate, 10 per cent of this area could be available in compact blocks of shifting sand dunes of 20 hectares and over. At the rate of Rs.1,000 per hectare, the programme of sand dune stabilisation for 120,000 hectares works out to Rs.12 crores.

Forest Research

8.35 For any large scale programme to be taken up for afforestation, grassland improvement and sand dune stabilisation, a backing of research would be necessary. There are numerous problems concerning water economy, introduction of species, artificial regeneration of khejri and increasing its growth rate etc., which should receive concentrated attention for research. The Forest Department should establish, on a priority basis, a base for research on different aspects of forestry in desert areas. This would help in supplementing the efforts by the Central Arid Zone Research Institute (CAZRI) in this direction. Considering the place of forestry in the development of the region, the CAZRI should also give adequate importance to research in forestry along with other agricultural problems. The organisational aspects with regard to forest research in the States, each having its own peculiar problem, is being dealt with in a separate Report of the Commission.

Desert National Park

8.36 In Rajasthan desert, every part has been disturbed either by over-use or neglect. This kind of human interference is still prevalent. There is no area which can be considered representative of the natural conditions of the desert. For understanding the life cycle of plants and animals of the region, it is necessary to study the ecological status of the desert. The knowledge is essential for undertaking proper measures to arrest deterioration of the desert and to reclaim it.

8.37 A suitable area should be located so that it can be preserved for continued studies under undisturbed desert conditions. This area should be exclusively for the purpose of scientific study and excluded from recreational use. The selection should not, therefore, be based merely on the availability or abundance of wildlife. However, considering that a large area in relatively thinly populated surroundings is needed, we feel that a suitable area can best be found in Jaisalmer district. In this district there are rolling sand dunes with all the desert phenomena of shifting sand, quick sand, inland drainage basins, scrub, dry savannahs and wildlife of the desert. An area of at least 100 sq km should be selected for this purpose, notified and maintained as a Desert National Park. Since the State Government has adopted the Wildlife

(Protection) Act, 1972 there should be no difficulty in according the Desert National Park the desired legal sanction.

8.38 It is estimated that over a period of five years the non-recurring expenditure on the Desert National Park would be about Rs.20 lakhs to meet the cost of fencing, compensation for vacating any cultivated land, sand-buggies and camels for transport within the park, communication equipment and transport, construction of huts, construction of 'bandhis' to hold up rainwater at suitable places, etc. The recurring cost on staff, maintenance, research and other contingencies is estimated to be Rs.3 lakhs annually.

HARYANA

8.39 Significant additions to forest areas in the desert tracts of Haryana have been made since Independence. Most of the forests were created on the sides of roads, canals and railway lines and on bunds, termed as 'strip forests'. Sizeable afforestation in compact blocks has also been done in the desert tracts under various schemes. The man-made strip forests and afforestation in compact blocks have been declared as protected forests. The following Table gives the extent of forest area in the desert tracts in Haryana:

(Table 8.3 on page 125)

Table 8.3

Forest Area in Desert Tracts in Haryana

(in hectares)

District	Reserved forests	Protected forests			Unclassed forests
		Compact blocks	Strip forests	Total	
Hissar	-	155	6,844	6,999	354
Bhiwani	-	37	2,033	2,070	-
Rohtak	172	40	24,343	24,383	-
Mahendra-garh*	-	1,305	2,226	3,531	399
Total	172	1,537	35,446	36,983	753

Source: Haryana Forests - Independence Silver Jubilee Souvenir, April, 1973.

* A part of Mahendragarh district is now included in the desert area delineated in this Report.

Afforestation and grassland development have also been done in panchayat and private lands. The management of such lands is vested in the Forest Department under the provisions of the Indian Forest Act, 1927 and Punjab Land Preservation (Chos) Act, 1900. Under the Indian Forest Act, 1927, the areas are closed with the consent of the majority of the owners, and the works are carried out by the Forest Department in accordance with the terms and conditions mutually agreed upon between the land owners and the Government. In the case of Punjab Land Preservation (Chos) Act, 1900, closure may be compulsory or voluntary; the works are carried out at the cost of the Government and the revenue

derived goes to the land owners. The following Table gives the areas so far undertaken for management by the Forest Department under these provisions:

Table 8.4

Other Areas under the Control of Forest Department

(in hectares)

District	Closed under Section 38 of the Indian Forest Act, 1927	Closed under Punjab Land Preservation (Chos) Act, 1900	Total
Hissar	43	-	43
Bhiwani	348	271	619
Rohtak	-	1,429	1,429
Mahendragarh*	2,147	1,057	3,204
Total	2,538	2,757	5,295

Source: ibid

* A part of Mahendragarh district is now included in Bhiwani district.

8.40 The estimated area in desert tracts affected by wind erosion posing a serious threat to proper functioning of the irrigation system and lines of communication is given in Table below:

Table 8.5

Area affected by Wind Erosion in Desert Tracts of Haryana

(in thousand hectares)

District	Total area affected
Hissar*	920
Rohtak	17
Mahendragarh*	221
Total	1,158

Source: Master Plan for Soil Conservation in Haryana August, 1973.

* Parts of these districts are now included in Bhiwani district.

In addition to areas affected by wind erosion, there is a problem regarding the management of grazing grounds in villages which are generally the village common lands. They have deteriorated in most of the cases to a stage of almost no return due to constant over-grazing.

8.41 For the treatment of the desert areas, a number of programmes have been undertaken so far. In 1955, the Government of Punjab (which included Haryana, as constituted now) initiated a scheme of 'Immobilisation of Desert'. In 1969, a pilot project under the 'Desert Development Programme' was also taken up. A Centrally sponsored scheme of raising of shelter-belts along Loharu canal system is also in operation from 1971-72. Besides, some plantations have been created recently on the sides of Jui canal under Marginal Farmers and Agricultural Labourers (MFAL) scheme. The works so far carried out have proved to be useful but the extent undertaken is quite insignificant as compared to the magnitude of the problem. The State Soil Conservation Board has prepared a Master Plan for soil conservation in Haryana, which includes a big programme of development and reclamation of the desert tracts. Based on the experience of the different schemes, it is felt that the following forestry activities should be carried out in the desert tracts of Haryana:-

a) Afforestation in compact blocks and in the gaps of the Aravalli hills;

b) creation of plantations on the sides of canals, roads and railway lines (known as 'strip forests' in Haryana);

c) sand dune stabilisation;

d) farm forestry (to serve as wind-breaks around agricultural lands); and

e) grassland development.

Afforestation

8.42 Afforestation in compact blocks and in the gaps of the Aravalli hills will serve as barrier to reduce the velocity of wind, which is the primary agency for erosion in the desert areas, and will make available in course of time the much needed small timber, fuel and leaf fodder. The preferred species are sissoo, siris, babul, ber, farash, neem, bassion (Melia azedarach), Parkinsonia aculeata, castor and sarkanda (Erianthus munja). Planting techniques have already been standardised. The cost of such afforestation is likely to be Rs.1,250 per hectare, including staff and contingencies. It is recommended that at least 20,000 hectares should be afforested within the next 15 years at an estimated cost of Rs.2.50 crores.

Strip Forests

8.43 There has been considerable progress in the creation of plantations on the sides of canals, roads and railway lines since Independence, and so far over 35,000 hectares have been covered and declared as protected forests. Conditions are favourable for raising of such strip forests on commercial basis. These should, therefore, be organised on the lines recommended in the Commission's Interim Report on Social Forestry.

The State Government should mobilise institutional finance for these plantations. Due to the present energy crisis it is all the more necessary that adequate supplies of fuelwood should be arranged in the shortest possible time in the rural and semi-urban areas. The programme of creating strip forests will add substantially to the availability of fuelwood and small timber to the population at places convenient for transport and supply. The important species suitable for strip forests are sissoo, Eucalyptus, babul and siris. For planting of all plants, Haryana uses an indigenously manufactured plant extractor which allows transport and planting of tall plants with balls of earth and long roots without any damage to the roots. The cost of raising strip forests including staff and contingencies is Rs.750 per row km. A physical target of 80,000 row km should be attempted in 15 years. The cost would be about Rs.6 crores.

Sand dune Stabilisation

8.44 The stabilisation of sand dunes is rather problematic. It is the experience in Haryana that the mobility of the dunes varies with their height. The smaller the dune the more active it is. Therefore, the smaller dunes (less than 1.5 metre in height) are treated first and medium sized dunes (1.5 metre to 3 metres) receive second preference. High dunes (more than 3 metres) are relatively stable except at the crest. As there are favourable conditions regarding availability of water, a physical

target of at least 20,000 hectares should be planned for 15 years. The technique has been described in paragraph 7.2. The cost of sand dune stabilisation including staff and contingencies is about Rs.1,000 per hectare, and the total expenditure is likely to be Rs.2 crores.

Farm Forestry

8.45 Under the farm forestry programme, the present scheme of planting of trees along the peripheries of cultivated lands to reduce wind velocity and to create favourable micro-climatic influences should be encouraged. This programme will also make available the much needed fuel and small timber for the farmers themselves. In addition to the planting of the branch cuttings of farash and container plants of jand (khejri in Rajasthan), planting of sarkanda tufts and sowing of castor seeds on high ridges along field boundaries are practised. Sissoo stumps are also planted along water channels to serve as wind-breaks. The Forest Department should create adequate number of nurseries for making available to the farmers tall plants at a nominal price. Farm forestry programme should be organised on the same lines as recommended in paragraph 8.14 for desert areas in Rajasthan.

Grassland Development

8.46 The grassland development programme, as recommended later in paragraph 9.62, should be executed by the Forest Department. For this purpose, a separate Wing should be created under the Forest Department, which should employ adequate number of agrostologist, agronomists

and range management specialists, who may be trained within the country or abroad, as necessary. There should be a coordinating body at the State headquarters. Scientific methods for grassland improvement should be adopted and steps taken for production, processing and distribution of grass seeds. In this connection, paragraphs 8.24, 8.25 and 8.27 may be referred to.

GUJARAT

8.47 The two arid districts of Gujarat where conditions similar to the western districts of Rajasthan prevail are Banaskantha and Mehsana. Even within these two districts, edaphic, climatic and topographic conditions vary within wide limits; the eastern and northern boundaries of Banaskantha are flanked by low hills whereas the western parts of both these districts bordering the Little Rann of Kutch are subjected to periodic inundations. It is the area between these two extremes which is a sandy alluvial plain practically devoid of vegetation. The conditions, therefore, are ideal for sandstorms. The situation is aggravated by uncontrolled grazing. Sand dune formation is, therefore, a common feature.

8.48 There is practically no forest area in Mehsana district whereas in Banaskantha district, the forest area is localised mostly in the north and in the east. The details of the forest area

in Banaskantha district are as follows:

Reserved forests - 456 sq km

Protected forests - 12 sq km

Unclassed forests - 968 sq km

Under the existing conditions, production forestry has no scope there. The forestry activities in these districts will, therefore, consist of the following:

(a) Afforestation in the form of shelter-belts;

(b) farm forestry;

(c) mixed forestry, comprising raising of grass and leaf fodder, fruit trees and fuelwood trees on suitable waste lands, panchayat lands and village commons; and

(d) grassland development.

Shelter-belts

8.49 Santalpur tehsil borders the Rann of Kutch on the north and south. The west of Vav tehsil is also on the Rann border. The salt-bearing winds from the Rann of Kutch are damaging sizeable lands in the cultivable belts of these tehsils. Shelter-belts should, therefore, be located suitably along the border of the Rann adjoining these tehsils. Suitable areas should also be selected in the commanded area of the Dantiwada reservoir for creation of shelter-belts. The shelter-belts programme should be organised in the same manner as recommended in the Commission's Interim Report on Social Forestry. Land should be acquired where necessary and handed over to the Forest Department for planting and subsequent maintenance. A

coordinating agency should also be created at the district headquarters with experts from Agriculture and Forest Departments in the State Government. A programme of 20,000 hectares in fifteen years should be attempted. The total outlay is likely to be Rs.3 crores, at the rate of Rs.1,500 per hectare inclusive of the cost of land that may have to be acquired.

Farm Forestry

8.50 The pilot scheme for farm forestry in the Fifth Plan recommended in the Commission's Interim Report on Social Forestry should cover both the districts of Banaskantha and Mehsana. The Forest Department should organise extension units in the districts to propagate directly and through the agricultural extension staff the advantages of the programme and the methods of tree plantation. The forest extension units should also develop nurseries for supplying seedlings to the farmers at a nominal price. Later on, from the Sixth Plan period onwards, there should be an aggressive programme of farm forestry.

Mixed Forestry

8.51 In these areas fuelwood is in short supply. The rural population, therefore, uses cow dung extensively thus depriving arable fields of an important source of organic manure. As such, a programme of mixed forestry in the vicinity of habitations on suitable waste lands, panchayat lands and village commons would be a

very appropriate programme; and it would have a great social impact. The approach should be the same as recommended in the Commission's Interim Report on Social Forestry. In the first 15 years an area of 15,000 hectares may be taken up. At the rate of Rs.1,000 per hectare including staff, the total outlay works out to Rs.1.50 crores.

Grassland Development

8.52 The grassland development programme, as recommended later in paragraph 9.69, should be executed by the Forest Department. For this purpose, similar action as recommended in paragraph 8.46 should be taken by the Forest Department in Gujarat.

SECTION IX

LIVESTOCK DEVELOPMENT

Rajasthan

Livestock - Mainstay of Rural Economy of Arid Zone

9.1 Livestock production plays an important role and contributes in a large measure to the rural economy of Rajasthan State. It has been estimated that the livestock sector of agriculture accounts for about 12% of the total income of the State.* According to the Livestock Census 1972 the total livestock population in the State is 39.09 million. This includes among other animals 12.46 million cattle, 4.69 million buffaloes, 8.56 million sheep, 12.15 million goats and 0.74 million camels. It has also been estimated that the total quantity of wool produced annually in the State is around 14 million kg which constitutes about 40 per cent of the total wool production in the whole country. The State produces various types of wool varying from coarse fleece to medium and fine wool. Even though the bulk of the wool produced is of carpet quality, nearly one million kg of fine wool is also produced in this State.

9.2 In the western arid zone of the State, in particular, livestock raising is depended upon as the principal source of livelihood of the people.

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* Draft Fifth Five-Year Plan 1974-79 - Rajasthan Planning Department, Government of Rajasthan.

According to the socio-economic survey* conducted by the Central Arid Zone Research Institute, Jodhpur, about two-thirds of the earners in the households surveyed followed animal husbandry as the main occupation. This area is also of special significance with regard to livestock production in the State because of the fact that the home tracts of certain well-defined and superior breeds of cattle such as, Rathi, Nagori, Tharparkar, Kankrej and of breeds of sheep like Nali, Pugal, Magra, Chokla, Marwari and Jaisalmeri lie in this region. The geographical area covered by the 11 districts lying in the western arid zone of the State is about 208,626 sq km. This constitutes 60.9% of the total area of the State. But only 38% of the human population in the State lives in these 11 districts. The population of livestock in these districts is 16.3 million including 3.47 million cattle, 1.12 million buffaloes, 5.11 million sheep, 5.82 million goats and 0.62 million camels. The total livestock and total cattle, buffaloes, sheep, goats and camels in this area as percentage of the corresponding totals for the whole State work out as 41.6, 27.8, 23.9, 59.6, 47.8 and 83.7 respectively. It will be evident from the above figures that inspite of heavy losses in this area in recent years, the population of livestock in terms of percentage of the total stock in the State is greater than the corresponding percentage of human population in this zone of the State.

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* Socio-Economic Survey of Livestock breeders in Anupgarh - Pugal Region of Western Rajasthan - Human Factor Studies Division Report No. 65/2, CAZRI, 1965

9.3 As already detailed in the earlier Section, the rainfall is meagre and uncertain in this area. Crop production alone cannot be depended upon for the economic sustenance of the inhabitants as crops fail during years of scanty rainfall. Certain species of grasses such as anjan (Cenchrus setigerus), dhaman (Cenchrus ciliaris) and sewan (Lasiurus sindicus) known for high nutritive value are, however, able to grow even in years of scanty rainfall. Therefore, the people in this area have been depending primarily upon livestock production as their main source of income. In view of high aridity, even livestock production is being carried out under difficult and uncertain conditions. The grass cover in grazing lands lasts only for three to four months after monsoon. The availability of kadbi from crops like bajra is also limited. Therefore, the breeders of cattle and sheep have to depend on other sources outside their homeland for maintaining their livestock. This has made it necessary for the breeders to practise various patterns of migration. It has been stated by local people that before the partition of the country, cattle and sheep breeders hailing from the western parts of the arid zone had easy access to the irrigated cultivated lands in Sind for stuble grazing after kharif and rabi harvests. The distances to be covered were short and there was plenty of stuble grazing. After Partition both the sheep and cattle breeders had to look to areas in other directions for migration with their livestock in search of water, feed

and fodder.

Migration of Cattle Breeders

9.4 The traditional cattle breeders in the breeding tracts of Rathi, Tharparkar and Kankrej cattle practise seasonal migrations in search of grazing, water, etc. for their herds. Rathi tract lies between Pugal in Bikaner district and Anupgarh in Ganganagar district where the soil is sandy in most parts and saline in low lying areas. In years of average rainfall, ample grazing is locally available either in village lands or in interdunal valleys which can sustain the stock till December and thereafter, breeders migrate with their herds. The migration of these breeders is limited in extent and scope. They generally migrate to canal areas in Ganganagar district where they market surplus cattle, milk and milk products and maintain their herds sometimes on purchased feeds.

9.5 Cattle breeding tract in Jaisalmer district is fairly extensive and thousands of migratory cattle breeders predominate in this area. During the months of July to September they generally maintain their herds on grazing available within 15-30 kilometres of their settlements. Thereafter, they usually migrate to more distant areas in the districts of Jodhpur, Bikaner and Ganganagar. The professional cattle breeders rearing Thari or Sanchore cattle in the Barmer district

migrate during summer months along the Luni river while others migrate to Sheo tehsil. When rains fail altogether these breeders migrate to distant areas in Rajasthan and to Gujarat and Madhya Pradesh.*

Effects of Migration

9.6 In spite of good breeds and types of cattle maintained by these migratory breeders their economic condition has continued to remain marginal and unstable. While a good year brings them some prosperity, bad years invariably bring them heavy losses and hardships. During the migrations some of the cattle die as a result of starvation while a large number have to be sold away at distress prices along the migratory routes for purchase of grains etc. Further, yields of animals go down considerably during migration. It has been stated that after December animals are milked only once a day and in summer they are not milked at all due to scarcity of both grazing and water. The marketing of fluid milk is out of the question for these migratory breeders and milk is converted into ghee which is sold to itinerant traders and dealers at whatever prices offered. The small herds which are left after long migration during bad years do not ensure even a bare living for the breeders and their families. They have to wait till the youngstock grow up and often during

* Makhijani H.J. - Nomadic Cattle Breeders in India - Central Council of Gosamvardhana, New Delhi, 1957.

this period scarcity recurs causing great suffering.

Migration of Sheep Breeders

9.7 A fairly large percentage of sheep in Rajasthan is also maintained on migratory basis. It has been observed that about 38% of the sheep population in this State are migratory and that the average flock size of migratory sheep is around 70 against the average size of 40 in stationary flocks.* According to an estimate about 1.5 million sheep migrate from the State every year and that out of this about 0.6 million sheep are on permanent migration.** Sheep migration is a regular practice with the sheep breeders from the western arid districts of Jaisalmer, Barmer, Jodhpur, Pali, Jalor, Nagaur and Bikaner. It is understood that prior to attainment of Independence and partition of the country, sheep from Jaisalmer and Barmer districts used to migrate to the canal areas of Sind during the months of March to June while the sheep from the eastern areas used to migrate towards further east or southwards to the bordering areas in the States of Uttar Pradesh, Madhya Pradesh and Gujarat.

9.8 Sheep breeders from the districts of Jaisalmer, Barmer and Bikaner and parts of Jodhpur practise temporary migration extending over periods

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* Daroga Singh, M. Rajagopalan and J.S. Maini - Monograph on estimation of wool production -ICAR.

** Sapre M.V.-Migration of Sheep in Rajasthan -(Mimeo

of 6 to 9 months. The flock owners usually start migration with their sheep after Diwali festival in the month of November. Sheep flocks excepting those from Barmer and Jaisalmer districts usually migrate towards the south to Madhya Pradesh taking different routes and finally reach Nagda which is a central place for sale of wool. Sheep flocks also move towards east to Uttar Pradesh along the Chambal and Yamuna river belts. It has been estimated that about 0.2 to 0.3 million sheep from Jaisalmer and Barmer and parts of Jodhpur and Jalor migrate towards Gujarat and the breeders arrange for the sale of wool at Deesa in Gujarat. As the routes towards Madhya Pradesh are new and quite unfamiliar to the sheep breeders of Jaisalmer and Barmer, they do not migrate long distances except under very acute conditions of drought and scarcity of fodder. This may perhaps be one of the reasons for heavy losses of sheep sustained by the sheep breeders of these districts during continuous drought periods. Sheep flocks from parts of Bikaner, Churu and Sikar districts usually migrate towards north to areas in Haryana, Punjab and Delhi. About 0.6 million sheep in the State are on permanent migration and bulk of these come from Nagaur district. Sheep owners of this district practise permanent migration because of heavy pressure on land and they depend on the forest areas in Rajasthan and Madhya Pradesh for the grazing of their sheep.

Effects of Migration

9.9 Maintaining sheep on migration through most part of the year does not permit the sheep owners to obtain adequate income from their flocks. With such a system of constant movement of sheep over long distances with uncertain supplies of water and fodder, the sheep owners are unable to adopt scientific methods of breeding for genetic improvement of stock. Shearing of sheep in distant places and sale of wool at far away markets do not give them any chance for organised collection, processing and marketing of wool and the sheep breeders are unable to bargain for a remunerative price. They are entirely at the mercy of the agents of traders of wool from different markets like Beawar.

9.10 The system of constant migration is one of the main reasons for the high percentage of illiteracy with these sections of people. Even children of the family have no chances of education because they are also constantly on the move and are used by their family for grazing the sheep flocks. Apart from the other social backwardness, lack of literacy is a contributing factor for these sheep owners not appreciating and adopting improved sheep husbandry practices brought to them through extension workers. During migration, sheep from different areas mix up in the grazing zones increasing the chances of introduction of various diseases even in disease-free flocks. They are

also prone to pick up endo and ecto parasites in the migratory routes even though such maladies may not be common in their home tracts.

9.11 From the foregoing, it will be clear that rearing of livestock on a nomadic system is the main occupation of the local population for their sustenance in the arid regions of Rajasthan as crop production has remained a gamble due to hostile agro-climatic conditions and the existing vegetative situation is also not very favourable for any stabilized livestock production. The local fodder resources for maintaining livestock are confined to the residual kadbis of cultivated crops of which bajra is the principal one and the grazing from privately owned and common grasslands. A comparison of the livestock population and the landuse statistics shows that in the arid districts, grazing areas available per head of bovine and per head of livestock are 1.1 hectare and 0.38 hectare respectively as against the corresponding figures of 0.47 and 0.22 hectare for the whole State. The number of cattle and buffaloes for every thousand hectares of net cultivated area in the arid zone is 657 as against 939.5 for the State.* Even though the availability of land for livestock raising is more in the arid zone, the production of kadbi as well as of grass yields in these lands is low, seasonal and uncertain and the quality is also

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* Rajasthan Intensive Cattle Development Project - Ministry of Agriculture, New Delhi, 1973 - Annexure I, Appendix 4-6.

poor. The inadequacy of fodder resources as well as their availability only during the months of July to November is responsible for the nomadism of the livestock breeders of these areas.

9.12 The pressure of livestock in this area has been increasingly growing since somewhat earlier than the last two decades. The increase in cattle, buffaloes, sheep and goats in the arid districts has respectively been 45.6%, 42.1%, 67.2% and 94.2% between 1951 and 1966. The corresponding increase in the rest of the State is only 11.5%, 37.0%, 57.0% and 78.6%. The larger increase of livestock population in the dry districts compared to more favourable areas in the State cannot be easily explained. It may perhaps be presumed that the local people have been increasing the number of livestock with them as livestock husbandry alone has some scope of giving them an additional income in this area where crop raising very often proves a failure. Such a continued increase in livestock population without due attention to augmenting fodder resources would lead to disastrous consequences. This is what actually happened between 1966 and 1972 during which period, because of continuous drought for three or four years, the local people sustained heavy losses of cattle and sheep in six arid zone districts as shown in Table 9.1.

This should be taken as a warning. In any plan for desert development all efforts should be made to undertake massive and effective programmes for augmenting fodder resources.

Table 9.1

Decline in Cattle, Buffalo and Sheep Population in Six Districts in Western Rajasthan between 1966 and 1972

(Number in '000)

District	Cattle		Buffalo		Sheep	
	1966	1972	1966	1972	1966	1972
Barmer	637	180	28	14	792	568
Bikaner	356	223	45	29	534	402
Jodhpur	607	426	57	48	663	683
Jaisalmer	344	66	1	0.3	591	313
Jalor	484	248	93	66	516	453
Pali	585	522	141	122	660	627

9.13 One potential source of fodder production for feeding cattle in this area is utilisation of the commanded areas under Bhakra and Gang Canal systems, the first and the second phases of the Rajasthan Canal Project including the proposed lift canals. A mixed farming pattern should be undertaken in these commanded areas. It has been noticed recently that farmers in the intensively irrigated areas of Punjab and Haryana are getting interested in diversifying agriculture and tapping additional sources of income through milk production and rearing of livestock. Based on this experience it has been recommended that the cropping pattern in these commanded areas should also include cultivation of suitable fodder crops. Improved

varieties of fodder crops should be included in the crop rotations and also grown as catch/companion crops. Inclusion of leguminous fodders in the cropping plans should be encouraged particularly for the farmers owning high yielding cattle as they are highly nutritious and rich in protein. The cropping pattern recommended for adoption in canal commanded areas includes cultivation of zaid and kharif fodder crops in 15% of the area, rabi fodders in another 14% of the area and berseem in 1% of the area under irrigation. Through extension work in these areas and as a result of incentives developed for the marketing of milk, it is anticipated that about 0.37 million hectares could progressively be brought under fodder cultivation over the years. With adequate cultural practices these commanded areas should be able to produce annually about 8 million tonnes of green forage. In addition, there will be a production of about 2.15 million tonnes of bhusa/kadbi as by-products of food crops. Therefore, these areas when ultimately developed would be able to support two million cattle including youngstock.

9.14 In the areas outside the command of the canal systems in these 11 districts, cultivation of crops like bajra, moth, jowar, etc. will continue. This area is estimated to be around 6 million hectares. The bhusa/kadbi yield from this source is anticipated to be around 7.5 million tonnes, sufficient to support

about three million cattle including youngstock. Assuming that all the green fodder and dry forages produced in these arid districts would be reserved and utilised for feeding cattle and buffaloes only, it will be sufficient to maintain about 5 million cattle and buffaloes. The population of cattle and buffaloes in 1966 in these districts has been enumerated at 5.8 million and in 1972 at 4.6 million. The above position with regard to fodder availability even after one or two decades of development in this area goes to show that not only cattle numbers will have to be contained at the present level but as suggested hereafter, a large number of cattle should also be shifted gradually to the existing and future irrigated areas. In any case, further addition of cattle into this area from outside should be avoided right from the beginning under any colonisation policies/programmes that may be undertaken.

Approach to Cattle Development and Milk Production

9.15 The home tracts of breeds of importance such as Rathi, Nagori, Tharparkar and Kankrej lie in the arid zone of Rajasthan. Hariana cattle also predominate in the districts of Sikar, Jhunjhunu and Churu which lie adjacent to Haryana State. Rathi cattle even in the absence of any organised programmes of development possess potentialities for high milk production. Tharparkar and Kankrej cattle have proved to be very useful dual purpose cattle under proper management and feeding conditions. Nagori

cattle are highly priced for their draught quality. These animals fetch very high prices from the neighbouring States and the farmers of Nagaur district derive considerable income from the sale of their stock. The raising of cattle in this area is undertaken by the breeders in adverse agro-climatic conditions and as a result they are unable to adopt any sustained and systematic programme for breed development. The main approach to cattle development should envisage simultaneous attention to four aspects, viz., (i) reducing, if not possible, containing cattle population in the area, (ii) augmentation of feeds and fodder resources in the area itself in order to ensure supply of adequate nutrition to the animals, (iii) prevention, in a large measure, of the present nomadism of cattle breeders and (iv) breed improvement through planned breeding programmes. When the area of command under Rajasthan Canal Project is progressively brought under intensive cultivation, the additional fodder production in this area should be utilised for the maintenance and improvement of cattle in the arid zone. In other words, a large proportion of improved breeds/types of cattle in the arid zone should be transferred to the canal commanded areas; induction of inferior cattle from other areas by the settlers who are allotted land in the Rajasthan canal command should be discouraged. It is felt in some quarters that cattle breeders of the area are mostly nomadic and

therefore they would not be interested to settle on irrigated land. Because of this consideration, the colonisation authorities might like to give preference to people outside the arid zones to come and settle in the commanded areas. If such a procedure is adopted, the irrigation facilities developed in this area will not in any way help in the economic amelioration of the local people who are mainly cattle and sheep breeders. The socio-economic survey (referred to in paragraph 9.2) which covered about 12,000 households showed that almost all the families evinced a desire to shift to agri-cultural economy under irrigation and reduce the number of cattle and sheep if need be. Even in case sufficient number of families do not come forward for settled farming from the arid zone areas, it may be possible to select such of the farmers in districts like Nagaur as already practise some system of crop cultivation combined with cattle raising. A large number of these farmers who would be prepared to move with their cattle can be given preference while alloting land in the canal commanded areas. If this approach is accepted the pressure on the existing meagre fodder resources in the arid zone would be relieved to a great extent. This would also incidentally reduce pressure on grassland which could be developed as pastures for sheep raising in the arid regions.

Breeding Policy

9.16 The only incentive for farmers to cultivate fodder crops will be financial returns they could expect from fodder cultivation. Such a venture can be remunerative only if the fodder is used for feeding high yielding cows. Crossbred cows with exotic inheritance would be the best for this purpose. In view of the anticipated availability of sufficient dry and green forage in the canal commanded areas and as cattle would be maintained on a stationary basis in a mixed farming economy, there would be very good scope over the years for supplanting progressively the indigenous foundation stock in these areas by crossbred progenies through a planned crossbreeding programme. Exotic inheritance for such a crossbreeding programme should preferably be from the Jersey breed in view of medium size of this breed and because it is anticipated that marketing of milk from this area for a number of years to come will be more product-based than as fluid milk. The level of exotic inheritance should also be maintained only at 50% until such time as the farmers have fully become conversant with the rearing of crossbred animals and green fodder production has adequately increased. At a later stage, if found necessary, exotic inheritance may be raised to a higher level.

9.17 As regards development of cattle in non-commanded areas, it is anticipated that pressure on

land would be reduced to a certain extent as a result of partial shifting of cattle to the commanded areas. Cattle, however, will continue to be maintained mainly on crop residues such as kadbi and bhusa, and available grazings. The husbandry practices are not expected to change significantly excepting that migration to distant areas and for long periods would be reduced. In view of these considerations the cattle breeding policy in these areas should be directed mainly towards improvement through selective breeding. In the case of breeds like Rathi, Tharparkar and Kankrej, the selection should be for milk production. In the case of Nagori cattle, selection should be for draught quality as the breeders of such cattle derive a large income by sale of good quality bullocks. In the irrigated areas, farmers would require large numbers of good quality bullocks for intensive cultivation. The people who would be settled here from the arid areas will not possess the required number of good quality bullocks with them to undertake intensive cultivation. Even if there is mechanisation in agriculture in canal commanded areas, requirement of good bullocks is likely to remain for quite some time in the future. Therefore, there would be demand for Nagori bullocks from the farmers in these areas and elsewhere. More intensified and planned efforts are called for in improving the draught capacity as well as ensuring uniformity in Nagori cattle. As no

yardstick is at present available for measuring objectively draught capacity of bullocks, it will be advisable for the Indian Council of Agricultural Research to continue and intensify investigations in this direction.

Artificial Insemination and Natural Breeding

9.18 The choice of the method of breeding - artificial insemination or natural service - will have to be carefully thought out for the different areas. In view of the migratory nature of cattle rearing in most parts of the dry region, artificial insemination has not so far proved very successful or popular. From the information received from the Animal Husbandry Department of Rajasthan Government it is seen that only 12 artificial insemination centres with 112 sub-centres have so far been established in the 11 districts of the dry region and that these are also mainly located in and around urban areas. The number of artificial inseminations done every year is also very meagre (13,000 in cows and 2,500 in buffaloes in 1971-72). This goes to show that even though artificial breeding was introduced in this area nearly 20 years ago, it has not been much of a success so far. In spite of slow progress, efforts will have to be continued for making increasing use of this technique without which rapid improvement of breeds and in production on a massive scale will not be possible. Artificial insemination should be taken up in right earnest in the canal commanded areas where it is proposed

to undertake crossbreeding with exotic breeds for high milk production providing all the requisite facilities. This technique should be introduced right from the beginning of colonisation of farmers so that they are educated on the advantages and utility of this system. Artificial insemination should also be intensified in the milksheds of the existing and proposed dairy schemes in and around urban areas. In non-commanded areas also where migration will be restricted to the minimum, gradual introduction of artificial insemination should be encouraged. In other areas, recourse to natural service will have to be taken and intensified so that service from superior bulls is made available at least to the majority of the cows owned by the farmers. This will need a large number of superior bulls of different breeds. Even at present for a total of about 1.5 million breedable cows and 0.6 million breedable she-buffaloes there are nearly 3,200 bulls and 320 buffalow bulls of approved type for natural breeding in these districts. Bulls for natural service are purchased from breeders. This system may be unavoidable in the present circumstances and somewhat more beneficial than mating cows with just any bull. The State Government should consider measures for establishment of cattle breeding farms of adequate size with superior foundation stock and undertake scientific breeding programmes preferably based on progeny testing. Key Village and Herd Registration Schemes should be intensified in the breeding tracts where superior cattle of Rathi, Tharparkar and Kankrej breeds are concentrated.

Schemes for Improved Breeding

9.19 In the arid zone covering 11 districts, there are at present 9 Key Village Centres and one Intensive Cattle Development Project with 112 artificial insemination sub-centres attached to them. In all, about 80 bulls and about 30 buffalo bulls are maintained for artificial insemination. There are no artificial insemination centres in the districts of Churu, Jaisalmer and Jalor. Considerable expansion of artificial insemination facilities is called for, if an intensive crossbreeding programme is to be introduced in the commanded areas of Bhakra, Gang and Rajasthan Canals including the proposed lift canals and in the milksheds of various dairy schemes proposed to be taken up in this region. In each of the districts a central semen station should be developed with facilities for maintaining at least 25 breeding bulls. Each station should also be provided with adequate equipment and other facilities for collection, processing, storage and transport of semen. About 50 or more sub-centres should be located in each district at places which are connected by good communication facilities. Care should be taken to provide complete breeding coverage in the villages located in milksheds and canal commanded areas on a priority basis. In all these villages where milk collection would be organised through primary producers' cooperatives, the artificial insemination facilities should be made available. As being practised in Kaira district

in Gujarat, the services of secretaries of the primary cooperatives should be made use of for doing the insemination of cows and buffaloes of all the farmers of the area. In addition, similar semen stations with sub-centres should also be established at Anupgarh, Pugal, Bikrampur and Nachna for intensive crossbreeding of cattle in the commanded areas on the western side of the Rajasthan canal. The facilities already existing at the Key Village Centres should be merged with the proposed district artificial insemination centres.

9.20 In areas where artificial insemination service cannot be extended, the Village Panchayats should be induced to maintain superior breeding bulls for natural service. About 500 to 1,000 bulls for natural service should be maintained in each district to meet the needs of remote villages and for breeding of cows in herds migrating for short periods. These bulls may be obtained from the schemes mentioned in the two previous paragraphs.

Dairy Development and Milk Marketing

9.21 It has been recommended earlier that mixed farming should be encouraged in the canal commanded areas. This is for diversifying agriculture, to ensure additional income through dairying and to release pressure of livestock on land in the non-commanded arid areas. Success in the endeavour would be possible only if steps are taken from the beginning to provide a remunerative market for the milk produced. The Commission has noted with satisfaction that the

Rajasthan Government has recently launched large scale dairy development and milk marketing projects in some parts of western Rajasthan under its Fourth Five Year Plan and has also planned for further expansion of the projects under the Fifth Five Year Plan. Steps have already been taken for the setting up of feeder balancing plants of one lakh litre capacity in Bikaner and Jodhpur. The Bikaner dairy plant will be supported by four chilling plants to be located at Lunkaransar, Mahajan, Dungargarh and Churu. These chilling plants would collect milk from villages located on convenient routes. Jodhpur plant will be supported through milk collection from two chilling plants in Nagaur district - Nagaur and Merta - and two chilling plants in Barmer district - Barmer and Balotra. Jodhpur dairy would also collect milk from the chilling plants to be located at Pali and Jalor. There are no dairy schemes in the districts of Sikar and Jhunjhunu. Milk chilling centres should be started at convenient locations such as Nawalgarh in Jhunjhunu district and Sikar in Sikar district. These could be linked to Jaipur dairy project. In Pali district, two more chilling centres could be established at Bali and Jaitaran. Milk collection and marketing in Jalor district could also be linked to the dairy project being established at Raniwada. These dairy schemes will still leave out areas which are likely to come under the command of the lift canals in and around Phalodi and Bap, Kolayat and Deshnok and Taranagar. Establishment of three additional chilling centres in these areas would be necessary.

Rajasthan Government is contemplating to start a balancing dairy at Pokaran in the near future. When milk production and collection in Barmer district are augmented, the chilling plant in Barmer would be converted into a balancing dairy to handle about 50,000 litres a day. There is also a proposal to set up two chilling plants in Churu district at Churu and Sardarshahar. It is anticipated that these dairies and chilling plants would cover the milksheds in or near the commanded area of the newly proposed lift canals on the eastern side of the Rajasthan canal.

9.22 The Commission has observed that commanded areas of Bhakra, Gang canal and Rajasthan canal systems in Ganganagar district have been left out from the coverage of dairy programmes proposed for the Fifth Five Year Plan of the State. The Commission was given to understand that the farmers in this area have not shown interest in milk production and adoption of mixed farming practices. Such a lack of interest or initiative for milk production might be attributable to lack of any organised channels of remunerative marketing of milk or milk products. If a suitable system of milk collection and milk marketing is organised in this area, it can be expected that these farmers also would take interest in raising cattle for milk production for obtaining additional income as has been observed in the case of farmers in the Punjab and Haryana States in recent years.

9.23 Under the first phase of the Rajasthan Canal Project considerable work has already been completed in colonising farmers and introducing intensive agriculture. It has also been brought to the notice of the Commission that the proposals for I.B.R.D.-assisted Rajasthan canal commanded area development project covering two lakh hectares do not include special programme for livestock production. It is emphasised that if mixed farming with adequate attention to animal husbandry in general and milk production in particular is not popularised in Phase I area of the Rajasthan Canal Project it would set up a negative trend which would affect introduction of mixed farming in other commanded areas as well. It is necessary, therefore, to plan in this area improvement of cattle for milk production, organisation of milk collection through cooperatives, arrangement for processing of milk and milk products and other inputs required for raising poultry, sheep, etc. It is, therefore, recommended that during the Fifth Five Year Plan itself the Rajasthan Government should consider setting up milk chilling plants in Ganganagar, Hanumangarh, Rawatsar and Anupgarh and also a milk products factory in Suratgarh. The setting up of a milk products factory is recommended in view of the fact that there is no nearby large market for fluid milk.

9.24 A large area would be coming under Rajasthan canal command in its second phase. On colonisation and progressive improvement in milk production through crossbreeding a considerable amount of milk is expected

to be produced in this area. In view of the distances involved and in the absence of any large urban area for fluid milk consumption the main thrust in dairy development and milk marketing in this area also should be based on a system of converting milk into milk products. As the area under canal command is extended, chilling centres should be set up successively at Pugal, Bikrampur, Nachna and Ramgarh. Bikrampur is located in the centre of the Phase II area of the Rajasthan Canal Project and hence the establishment of a milk products factory in or near this place is recommended. For the utilisation of milk from the southern part of this area, i.e. around Nachna and Ramgarh, chilled milk could be transported up to Pokaran where balancing dairy should ultimately be converted into a large milk products factory. The capacity of each chilling plant may be 10,000 - 20,000 litres. The dairy plants and milk products factories should have a capacity to handle one lakh litres of milk.

9.25 The cattle development and milk marketing schemes should be organised on the lines indicated in the Commission's Interim Report on 'Milk Production through Small and Marginal Farmers and Agricultural Labourers'. The Commission has recommended a functional cooperative system for the dairy business envisaging the formation of primary milk producers' cooperative societies at the village level and a Union of these cooperatives at the district level.

The functions of the primary societies, its relation to the district units, the procedures for flow of credit to the farmers, etc. have been detailed in the above mentioned Report. One more important input for milk production enhancement recommended is an assured supply of balanced concentrate feed mixtures at reasonable prices. It is, therefore, suggested that dairy development programme should also include the establishment of two feed mixing plants - one each in or near Jodhpur and Suratgarh.

Sheep Development.

9.26 Sheep rearing is also an important occupation in the rural areas of Rajasthan. The sheep population is distributed in all the districts of the State, but in the arid areas of the west and northwest region of the State a large number of rural people depend on sheep raising alone for their livelihood. It has been estimated under the survey referred to in paragraph 9.2 that about 50% of the households are engaged in raising flocks of sheep. According to the Livestock Census (1972) in Rajasthan, the total sheep population in the State is a little over 8.5 million while the sheep population in the 11 arid districts is 5.1 million (constituting nearly 60% of the total population of the State). The home tracts of the six out of eight breeds/types of Rajasthani sheep lie in this zone. These sheep produce wool of medium to fine quality and also the best carpet quality wool in the country. But

the conditions under which sheep are reared in this area are extremely unfavourable from the point of view of the owners as well as for taking improved measures for development. According to a study on feeding and breeding practices of sheep in Rajasthan State* about 5 per cent of the sheep flockowners are landless and about 55 per cent possess less than 8 hectares of land. Therefore, a large majority of flockowners graze their sheep on private or government lands. The availability of grazing is more sparse in the arid zone. The sheep breeders of this region, therefore, have remained socially backward and economically weak. Under the adverse agro-climatic conditions of this zone, crop raising remains a gamble but sheep rearing offers comparatively better scope for sustaining the economy of the people. Sheep have got natural flocking instinct. Because of this characteristic they could be flocked together and migrated conveniently. Therefore, main emphasis should be placed on sheep development with simultaneous improvement of grasslands in the areas of the arid zone which are not covered by any irrigation scheme.

9.27 The total culturable waste land and area classified as permanent pasture in the 11 districts, are 4.56 million hectares and 9.74 million hectares respectively.** If both these types of land could be

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* Note on State-wise Estimates of Annual Wool Production based on Sample Surveys for estimating wool production and collecting information on sheep keeping practices, IAPS, 1969.

**Rajasthan Intensive Cattle Development Project - Ministry of Agriculture, New Delhi, 1973 -Annexure-I Appendix-6.

reserved only for sheep grazing, the area that would be available per head of sheep comes to about one hectare. In that case sufficient grazing and hay required for the total sheep population would become available in the local area. But, the actual situation is that the grass cover and the yield of grass are very poor in these lands due to indiscriminate over-grazing and because of near total lack of any measures for protection and improvement of grasslands. Further, the available grazing is needed for maintenance of cattle, goats and camels as well. It is, therefore, necessary to consider measures for providing improved grazing for sheep. This could be done in two ways - additional land may be brought under pasture either by converting certain proportion of land at present under cultivation of bajra into grasslands or by developing pastures in areas which remain uncultivated or fallow at present. The quality of hay should also be improved and yield increased in the existing grazing areas through adoption of improved grassland management practices.

Development of Government Grasslands - Results of Experiments

9.28 Over the last two decades work on range management has been in progress at the Central Arid Zone Research Institute with particular reference to water scarcity conditions.* It has been shown that grass production could be

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* Ahuja L.D. - Forage Production with special reference to Arid Zone, CAZRI, Jodhpur, 1973.

substantially stepped up through land development, fencing, reseeding, use of fertilisers, soil conservation and water management. The results indicate that with adequate protection and controlled grazing, the forage yield on the range lands could be practically doubled in about 3 to 5 years' time. It has been estimated that during years of normal rainfall, air-dried forage production in 'very poor', 'poor', 'fair', 'good' and 'excellent' grasslands is 200, 500, 750, 1000 and 1500 kg/hectare respectively, when protected. Fertiliser application and reseeding with better perennial grasses, suiting different soil and rainfall conditions, give increased yields of forage material. Amongst the different soil and water conservation measures on range lands, contour furrows are considered to be the most suitable. Fencing with angle iron poles and barbed wire although initially costly has been found to be more effective and more economical in the long run. The Institute has also worked out the cost per hectare with regard to various measures of range development. Smaller the area of a block greater is the cost of fencing per hectare; and blocks less than 200 hectares have been found to be relatively costly to develop.

9.29 It is recommended that all available grazing lands in possession of Government should be reserved as range lands and no allotment should be made of this land to the landless for cultivation of crops. An assessment of available Government land according

to size of blocks should be made in each district. All blocks of land over 200 hectares should be taken up progressively for pasture development and controlled grazing of sheep. In areas where the Government blocks are scattered and are of small size, steps should be taken for their consolidation. It has been reported that there are large tracts of grazing land particularly in Barmer and Jaisalmer districts where the grass is not being utilised because of lack of water for man and his animals. The possibility of tapping ground water in these tracts or of extending water supply to these areas from other sources should be explored on a priority basis.

9.30 These blocks of Government lands should be fenced, reseeded and protected from excessive grazing during the initial years in order to facilitate growth of good and extensive grass cover. Fertiliser application should be attempted wherever necessary. Other improvements such as introduction of legumes in grass ranges, growing of suitable trees offering top feed, providing water points, shelter for stock, watch and ward, etc. should form part of the development measures. The objectives of such large scale grassland development are (i) to provide additional grazing for extended periods for sheep flocks, (ii) to store grass as hay to meet the needs of livestock during the lean months of the year and (iii) to conserve surplus dried grass during normal and favourable rainfall years to meet shortages during recurrent drought years, which are common features of

this area.

9.31 Large blocks of Government rangelands located far away from normally inhabited villages may be developed mainly as grass reserves for hay making and storage. The hay collected from these reserves should be stored in fodder banks as already detailed in paragraphs 8.28, 8.30 and 8.31. Hay from these fodder banks should be used to meet emergency requirements for feeding cattle, sheep and other livestock during the years of drought. In other grasslands to be developed by Government, controlled and rotational grazing should be practised. The development of a plot of grassland through fencing, reseeding, land development etc. will take about three years or so. But the number of head of livestock permitted for grazing there should be determined by the carrying capacity of the plot, which for the same size would vary from area to area depending on rainfall pattern. In areas where there are concentrations of cattle and the grasslands have a cover of tussocky grasses like sewan it would be a good practice to permit cattle to graze first and allow sheep to follow. Such a system would enable rational grazing and better utilisation of pastures as sheep cannot fully utilise taller growths of grasses like sewan.

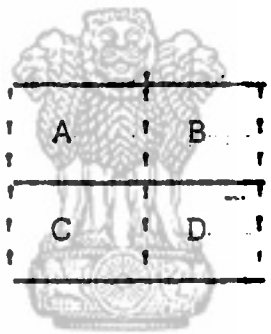
9.32 Since the development of reseeded grasslands would be a time-consuming process due to rainfall in the arid zone occurring for a short period, from July to first week of September, it should be taken up in a phased manner. When certain portions of available

grasslands are closed and taken up for development, other areas would be available for grazing to sustain the existing cattle and sheep population. Introduction of animals for grazing in a reseeded pasture immediately after the onset of monsoon will result in uprooting of freshly germinated seedlings. The animals would also consume palatable species of grasses and freshly sprouting shoots emerging out of the tussocks of perennial species, resulting in depletion of seed stocks of annual and perennial species, devigorisation of rhizomes of the perennial species of grasses and encouraging the preponderance of unpalatable and undesirable species of grasses and weeds. In order to have sustained use of grasslands it is essential to defer grazing during the earlier periods of development soon after monsoon to facilitate proper establishment of vegetation and ensure good seed production for self-seeding. A rotational system of grazing is recommended because in the absence of such a controlled and deferred grazing, the grasslands will tend to deteriorate very fast. Therefore, it is advised that a systematic rotational grazing should be adopted.

9.33 A rotation that may be considered suitable and could be adopted with advantage in the grasslands of arid zone is described below. Each large block of grassland should be divided into four compartments by providing fireline type belts each about 6 to 10 metres wide through mechanised means wherever possible. This will considerably save costs on internal fencing.

Each of the compartments may be closed to grazing for a full year by rotation and the rest of the three compartments used for grazing in rotation at an interval of one month starting from July. The compartment in which grazing is permitted during July in a year should be closed for grazing for the whole of the succeeding year and this procedure should be continued in other compartments by turns. The closed compartments recommended in each block of grassland will provide seeds of perennial and desirable species not only for regeneration in that compartment but also in the other three compartments through dispersal. The block which is subjected to early grazing i.e. during July, will provide nutritious fodder for the livestock but it will receive some initial setback. However, during the rest period of this compartment during August and September the vegetation will have sufficient time for regeneration, recouping vigor and seeding. The compartments which will be grazed for the first time during August would have by then established annual and perennial species of grasses with well developed tillers in flowering and seeding stages. Therefore, this compartment will not be subjected to injury by grazing during that month. The compartment which is subjected to grazing for the first time in September will have succulent, mature and well-established grass cover with sufficient seed stocks. By rotating these blocks for yearly deferment for hay and seed production, the compartments which are subjected to early grazing in July will get sufficient time and rest

to recuperate for optimum yield in the succeeding year. When the second rotation is started from October the perennial grass species would be in green or semi-green stage, the seed shedding and dispersal would be well on its way and the future production of grasslands will not be affected by grazing. The hay that would be obtained from the compartments closed for grazing could be stored and fed to animals under stall/feeding during pregnancy and sickness and for other causes and also for use during the unfavourable seasons of the year. The rotational grazing explained above is graphically presented below:



Each block is to be divided into four compartments viz., A, B, C and D as shown in the above/sketch and rotational grazing carried out as in Table 9.2 below.

Table 9.2

Grazing Schedule for Different Compartments

Year of working	Closed to grazing during the entire year	Months of grazing in different compartments		
		July-Oct. Jan-April	Aug-Nov. Feb-May	Sept-Dec. March-June
1st year	A	B	C	D
2nd year	B	C	D	A
3rd year	C	D	A	B
4th year	D	A	B	C

9.34 In areas where the blocks of grasslands developed are of smaller size and are located within reasonable distance from each other, instead of having separate compartments within each block, groups of four blocks of approximately the same size could be chosen for practising controlled and rotational grazing as suggested. The recommended system of rotational grazing should not only be practised in freshly developed grasslands but also in already existing large tracts of good grasslands with climax vegetation. Where the availability of water has been the constraint for their full and proper use, extension of drinking water for man and animal in these localities should be taken up on a priority basis.

Grass Seed Production

9.35 For the large programme of grassland development considerable quantities of seeds particularly of perennial grass species would be required. There is acute shortage of seeds of good varieties at present even for the limited programme of grassland improvement currently in operation. Therefore, one of the important pre-requisites for the grassland development programme would be production and supply of adequate quantities of seeds. Large quantities of grass seeds could be collected from the land earmarked as grass reserves for hay making and storage. However, it might take some time before these grass reserves would be fully established.

Specialised grass seed production for anjan, dhaman and karad (Dichanthium annulatum) will have to be undertaken in properly organised grass seed production farms in areas with good soils and having rainfall over 400 mm, and where irrigation facilities are available. Grass seed production farms of about 200 hectares and above should be established in many locations with adequately trained and qualified staff, sufficient funds and adequate facilities for mechanised cultivation, seed processing and storage, etc. In the case of sewan, large blocks of land with well established sewan grass tussocks will have to be developed in suitable locations in the districts of Barmer, Bikaner and Jaisalmer. It has been estimated that the cost of establishment of a seed multiplication block will be about Rs.1,000 per hectare and the annual operational cost would be around Rs.300 per hectare.*

Development of Village Common Grazing Lands.

9.36 Another substantial source for augmenting production of grasses is the blocks of village common grazing lands. At present these village commons are over-grazed and are given barely any time and chance for regeneration. Pasture demonstration plots established under the Key Village Schemes in the State have shown that fencing, reseeding and other measures considerably improve

* Ahuja L.D. - Forage Production with special reference to Arid Zone, CAZRI, Jodhpur, 1973.

the carrying capacity of village common grazing lands. Such demonstration on larger plots of land should be undertaken on an extensive scale in the arid districts also. Blocks of Government land of 200 hectares or a little more developed as pastures near the villages should serve the purpose of demonstrating to the Panchayats and the farmers. The Village Panchayats should be encouraged to undertake grassland improvement and regulated grazing in village grazing lands on the lines detailed in the paragraph above. Similar work has been undertaken with success under the IADP programme in Raipur district in Madhya Pradesh. It is emphasised that adequate extension support and some financial assistance should be extended to these Panchayats.

9.37 In the eastern part of arid zone viz., the districts of Churu, Nagaur, etc., the availability of village common grasslands or Government lands is limited. Landless flockowners practise permanent migration to the forest areas of Rajasthan and Madhya Pradesh. Majority of the sheep breeders practise partial migration within the district for stubble grazing. Some farmers allocate a small part of their holdings for grazing. In these districts it is considered necessary to encourage sheep breeders owning land to earmark some area as pasture for sheep. This is necessary because of the fact that in this area crossbreeding of local sheep with exotic breeds for improvement in the quality and quantity of fleece would be attempted. The farmers should be provided financial assistance for undertaking land development, use of

fertiliser and reseeding in their privately owned grasslands. Wherever practicable, it should be done on a cooperative basis.

Area Recommended for Pasture Development

9.38 On the assumption that protected and improved pastures would yield on an average 750 kg air dried grass per hectare, about 2.5 million hectares of existing grasslands and culturable wastes will have to be brought under improved range/grassland management to meet the requirements of 5 million sheep in the area. However, note should be taken of the fact that in normal years sheep have access to stubble grazing within arid areas and grazing facilities in the forest areas of Rajasthan and Madhya Pradesh. When Rajasthan Canal Project is completed, about 1.2 million hectares would be under irrigated cultivation under its command and this additional area would also become available for stubble grazing of sheep after harvest and where the sheep breeders can migrate temporarily. There would be considerable area outside the command on the western side of the canal. It is anticipated that this area would offer some grass cover for the grazing of sheep.

9.39 Taking into consideration all these sources of grazing, it is considered necessary that at least one million hectares of grassland/ culturable wastes should be brought under protected grassland development out of a total of 5.3 million hectares of culturable waste lands and permanent

pastures available in the 11 districts. It is understood that large areas of Government land are available in these districts for grassland development, but precise estimates of the size and extent of such land in each district are not readily available. Subject to availability, the Government should take up 800,000 hectares of land for development as pastures including about 200,000 hectares in large blocks as grass reserve for fodder banking.* About 100,000 hectares of village common lands may be developed through Village Panchayat agencies. Individual farmers owning sheep should be assisted to develop another 100,000 hectares of private grasslands. It is estimated that an average, Rs.600 will be required for development of one hectare of pasture land including fencing, land development, reseeding and watch and ward. The Government of Rajasthan already has a programme of providing piped water supply to all the villages in the area to meet the needs of human beings and livestock. Some of the pastures may, however, be at some distance from the pipelines which

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* The recurrence of drought in the region is anticipated once in three years. On the assumption that there would be about 75% of crop failure in drought years, grass supply equivalent to production from 750,000 hectares would be required to feed livestock at optimum level. This means creation of grass reserves to an extent of 250,000 hectares as three years' production will be collected and stored. As the yield in grass reserves is expected to go up progressively and fodder will be required mainly to meet emergency requirements to tide over the drought, it is assumed that 200,000 hectares will suffice.

may have to be extended to these pastures to provide water facilities within easy reach of livestock there. For this extension of water supply, a provision of Rs. 50 per hectare on an average may be made. The Village Panchayats may be given a loan/subsidy of Rs.300 per hectare mainly to cover expenses on fencing and reseeding. Loan given may be recovered through grazing fees charged from sheep owners. The loan/ subsidy for individual sheep farmers may be around Rs.100 per hectare mainly for soil conservation and reseeding. On the above basis it is estimated that a provision of Rs.43 crores would be needed for development of grassland for grazing, in addition to outlays required for grass reserves and fodder banks amounting to Rs.13.6 crores already indicated in Section VIII. The allocation of area for districts will have to be worked out in detail by the State Government taking into consideration the availability of land. Immediate attention is needed in areas where crossbreeding in sheep with exotic breeds would be introduced and in districts which are more prone to drought conditions and have larger intensity of livestock population. The whole programme of grassland development may be phased out over three Plan periods. Government of India may consider providing the above mentioned cost on development of grasslands while the State Government should bear the expenditure on organisational infrastructure, execution of the programme and recurring costs. The programme and quantum of expenditure recommended for

pasture development which would, in the coming years, give permanent relief to the people there would be worthwhile.

Programmes for Sheep and Wool Development-Breeding Policy

9.40 As mentioned earlier, recognised breeds/types of sheep predominate in western Rajasthan. Starting from the northern side of this region and going down to the south one would find in sequence the breeding tracts of the following sheep breeds viz., Nali, Magra, Pugal, Chokla, Marwari and Jaisalmeri. All Rajasthani breeds/types of sheep are fairly good in respect of bodyweight and wool yield. However, the quality of wool varies in these different breeds ranging from fine to medium in Chokla and Nali breeds and medium to coarse grades in others. These sheep contribute a large percentage not only to the total wool production in the country which is predominantly of the coarse or carpet type but they also produce a fairly large quantity of medium to fine variety of wool. Development of sheep in this State should, therefore, aim at further augmentation of fine wool production and also at improving the quantity and quality of carpet wool which has high export value.

9.41 Crossbreeding studies in sheep have shown that introduction of exotic inheritance in the Rajasthani sheep definitely improves the yield and quality of wool as also the bodyweight of the cross-bred progeny. However, before launching any large scale programme of crossbreeding, the capacity of

the area to support sheep with heavier bodyweight and with larger fleece of improved quality should be kept in view. Because of these considerations, Chokla and Nali breeds whose breeding tracts lie in areas with comparatively better rainfall should only be chosen for crossbreeding with Rambouillet or Merinos for production of superior quality wool suitable for apparel use. As the ultimate level of exotic inheritance that may be found optimum for stabilisation cannot be anticipated, it is very necessary that the crossbreeding of these sheep should be introduced in a well planned and progressive manner. For years to come it would be advisable not to increase the exotic inheritance in the resultant progeny beyond a level of 50%. Introduction of higher levels of exotic inheritance should be considered only after the performance of such crossbred sheep has been fully studied. Sheep breeders should be encouraged to use crossbred rams with 50% exotic inheritance during the first one or two years which will enable them to raise a uniform flock of crossbred sheep with 25% exotic inheritance. When this stage is reached, the flockowners should be supplied with crossbred rams with 75% exotic inheritance. Such a system would ultimately enable replacement of the sheep flocks of local types by crossbred sheep having 50% exotic inheritance. For such a programme of crossbreeding to cover the entire area of Chokla and Nali breeds having a total breedable ewe population of about 1.55 million, a large number of purebred exotic rams and crossbred

rams with 50% and 75% exotic inheritance will be required. A firm and phased target of breeding coverage to convert the indigenous sheep flocks into crossbred types should be drawn up for each breeding tract. Based on this, the number of crossbred rams of different levels of exotic inheritance and also the period during which they will be required should be worked out. After this information has been obtained, large scale crossbreeding of selected indigenous foundation ewe stock with superior rams of exotic breeds should be taken up in the existing or new sheep breeding farms preferably located in the region itself.

9.42 Sheep breeding will have to be developed in an intensive manner in the areas of the arid zone outside the canal command. It is anticipated that with improved breeding and better pasture availability the flockowners would be able to improve the quality and production of their stock. To achieve this, sheep husbandry extension organisation will have to be considerably strengthened. The flockowners should be educated on the usefulness of systematic and periodic culling of inferior stock and the use of good quality ewes and superior rams for breeding. Such an education is particularly necessary in areas where selective breeding is recommended for the improvement of carpet quality sheep like Marwari, Jaisalmeri, etc. Without strong extension support it will be difficult to enable sheep flockowners to produce sheep with

carpet wool of uniform quality.

9.43 As regards the approach to development of carpet wool breeds like Magra, Marwari and Jaisalmeri, it is recommended that in the immediate future, breeding programmes should envisage production of improved sheep with heavier bodyweight and wool yields of uniform quality. Hence selective breeding is recommended in view of the fact that these areas will continue to be marginal at least for a decade or so and the carrying capacity of the grasslands under improvement would not be enough to support much heavier sheep with increased wool of finer quality. Further, sheep of these areas will continue to be maintained on migration, even though on a restricted scale, in terms of period and distance of migration. Marwari and Jaisalmeri sheep have the characteristics of being able to walk long distances and to survive under scarcity conditions. Crossbred sheep may not survive under such system of rearing. As carpet wool of uniform quality will be popular both for internal consumption and export, it is desirable to maintain certain number of sheep of carpet quality in the country and improve them further. After two decades or so, the existing condition of pasture availability may improve as a result of implementation of various measures suggested in this Report. At that time, crossbreeding of these breeds of sheep with exotic breeds could be introduced to produce finer wool, if considered necessary.

Marketing of Wool

9.44 It has been pointed out in paragraph 9.8 that in the arid zones the majority of sheep breeders often migrate with their flocks and the returns they get from the wool are not very remunerative. The Rajasthan Government had, therefore, initiated a scheme in 1964-65 for the purchase, grading and sale of wool with the object of giving a fair price to the sheep breeders and to prevent their exploitation by middlemen traders or the agents of merchants from major wool markets. The scheme included grading and auction of wool to enable supply of standard graded products and higher financial returns. Of the three grading centres in the State two centres at Bikaner and Jodhpur handle grading and sale of wool in the western districts. Each of these grading centres is capable of grading about 0.5 million kg of wool per year but only about half of this quantity is being handled at present.* Thus it will be seen that only a small fraction of the total quantity of about 6.8 million kg wool produced in this area is handled on an organised basis for the benefit of the sheep breeders. As migration of sheep is progressively reduced in the future and the quality and the yield of wool of sheep are improved through better breeding, feeding and management, the need for organised marketing of wool

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* Source: Directorate of Sheep and Wool, Rajasthan.

would become more necessary to improve the economy of the sheep breeders. The Commission in its Interim Report on "Poultry, Sheep and Pig Production through Small and Marginal Farmers and Agricultural Labourers for Supplementing their Income" has recommended special programmes for and assistance to small and marginal farmers and agricultural labourers for sheep breeding in all the 11 districts of the arid zone. It has been recommended in that Report that sheep breeders' cooperatives should be organised in each district both at the rural level as primary cooperatives and at the district level as a Union. All the recommendations made in that Interim Report concerning credit, cooperation and marketing facilities for sheep breeders should be implemented on a priority basis in these areas. When these cooperatives are formed they should undertake such functions as collection, processing, grading, warehousing and marketing of wool. It will be necessary to establish an autonomous body at the State level for wool marketing to support the district Unions and the primary cooperatives. At present the functions of purchase and sale of wool under the grading scheme are performed by the State Directorate of Sheep and Wool. Even though some small profits have been obtained under this scheme during the last two years, the progress is not very satisfactory as the quantity of wool handled is far below the expected target. A much larger and concerted effort is required to handle not only the present level of production of wool but also the increased output which we expect to result from the implementation of various measures suggested

in this Report. Such large expansion and handling of trade should better be left to a separate autonomous organisation which has greater freedom to operate on commercial lines, establish an efficient marketing structure, ensure remunerative prices to sheep breeders and which does not have to work under the various constraints faced by a Government agency. Moreover, the programmes of sheep development suggested by us will throw a heavy responsibility on the Directorate of Sheep and Wool, which need not be further burdened with the trading in wool. It is, therefore, recommended that an autonomous body which can work on commercial lines, take prompt decisions and act quickly should be set up in the interest of the success of the marketing programme. The autonomous body may be in the form of a Wool Board or a Corporation for the State and it may undertake only commercial functions starting with shearing of wool and terminating with sale through auction or other means. The Directorate of Sheep and Wool can concentrate and utilise its expertise on production aspects of sheep and wool and provide efficient and adequate extension service for better breeding, feeding, management and health cover for sheep and goat stock. The staff of both the Directorate of Sheep and Wool and the Wool Board could jointly help in the formation and successful functioning of sheep breeders' cooperatives at the primary and district levels.

Marketing of Sheep and Goats for Meat Markets

9.45 It is well known that with a large sheep and goat population, Rajasthan State is a major supplier of sheep and goats for the meat markets in the neighbouring States. Bulk of the sheep and goat trade of the State comes from the western region of the State. According to the Special Schemes Organisation of the Rajasthan Government nearly 0.25 million goats go out for slaughter from Barmer district, 0.3 million from Jodhpur district and about 40,000 from Jaisalmer district every year. It is also known that sheep and goats go to the markets in Punjab, Delhi, western Uttar Pradesh in the north and to Ahmedabad and Bombay markets in the south. It is reported that sheep are taken to these markets mostly on foot or by trucks.

9.46 Even though the sheep and goat trade for meat markets is large, no detailed and reliable information and statistics are available on the number of animals sent out, routes taken, modes of transport, different channels of trade operating, returns obtained by the breeders, the share of profit at different levels, loss of animals and loss in bodyweight of animals during transit, etc. It is understood that Rajasthan Government has proposed a techno-economic survey on the marketing of sheep and goats as an advance action for the Fifth Five Year Plan. Such a study is long over due

and the Commission recommends that this survey covering all the aspects mentioned above should be taken up and completed expeditiously.

9.47 It is, however, evident that the present system of disposal of sheep and goats by the breeders is of least benefit to them. The marketing of sheep and goats should be one of the very important activities of the sheep breeders' cooperatives earlier recommended at the rural and district levels. The district Unions should be assisted with finances and technical guidance for the organisation of stockyards, purchase and transport, managerial staff, etc. The Commission is of the view that it will also be necessary to change the present pattern of transporting livestock over long distances to the meat markets and provide slaughtering facilities within the State and transport dressed carcasses (frozen or chilled) and processed and unprocessed packed meat. The State Government has already proposed the establishment of a large modern slaughter house at a convenient place like Jodhpur. This programme should be implemented as early as possible, as it will provide large economic benefits to the sheep and goat producers. The Commission would like to point out that this would be the first attempt in the country for organised collection and marketing of sheep, development of stockyards and long distance transport of chilled or frozen meat and other mutton products. As the arid zone experiences severe hot and dry atmospheric conditions during summer months, problems relating to spoilage and shrinkage of carcasses

would have to be tackled. It is, therefore, considered necessary that meat technological studies on these various aspects should be undertaken in advance so that pitfalls are avoided in the future. The Central Food Technological Research Institute, Mysore, may undertake pilot studies on these problems.

Utilisation of Wool for Local Employment

9.48 Wool produced in the arid areas is mostly marketed either for export or for utilisation in woollen mills in other States. As the migration gets progressively reduced, it would be of economic advantage to the local people if arrangements are made for the maximum utilisation of wool through local cottage industry. For this purpose, a large number of shearing centres and a number of service units for preliminary processes like scouring, carding, etc. should be started. Special arrangements should also be made for training young artisans in the villages in the latest spinning and weaving methods, making use of locally produced wool.

9.49 The State Khadi and Village Industries Board has been implementing a programme for improving the economic conditions of rural artisans using wool for various purposes. The programme mainly consists of supply of wool to spinners, yarn to weavers and sale of finished products. The Board has already undertaken the wool programme in places like Bikaner and

Jaisalmer. Even though its work has enlarged during the last few years, the Commission was informed that further expansion has not been possible due to certain regulations and lack of additional financial support. It has also been observed that the Board is obtaining imported wool for use by the artisans. It is recommended that the Board should be assisted not only to establish additional centres for wool utilisation programmes but also to expand their activities to help a large number of artisan families. The Small Scale Industries Department of the State Government should be entrusted with the function of supporting these activities. As far as possible, these rural wool based industries should utilise the locally available wool. This is necessary to provide an assured and remunerative market for the wool produced by the breeders in the area. This programme will definitely create an impact in improving the economic conditions of a large number of rural artisans in the desert areas.

Goat Population - Need for Reduction in Number

9.50 Rajasthan is a premier sheep breeding State; it has got a larger goat population. The goat population has also been showing a steep increase. The total population of goats in the State in 1951 was 5.59 million and it rose to 12.14 million in 1972, showing an increase of 117.3%. The increase in the goat population in the arid zone is of a much larger magnitude. The population in this region was 2.19 million in 1951 and it rose to 5.82 million in 1972,

which is an increase of 165.7%. Another interesting feature noticed is that while the cattle and sheep population showed a decline during 1966 to 1972 in the arid zone, the goat population increased considerably from 4.26 million to 5.82 million.

9.51 The trend of increase in the goat population particularly in the desert areas is disturbing because if goats are allowed to browse indiscriminately they produce a devastating effect on vegetation. Goats are maintained in mixed flocks with sheep as they act as good foster mothers for raising lambs. The flockowners are also able to dispose of goats during any part of the year and during migration to get some money for meeting their day to day expenditure. Goats are sold in large numbers for meat markets in other States and large cities. Goats are also utilised as a supplier of milk for the poorer sections of the people and goat hair is used for manufacture of ropes, blankets, etc. Goat skins are valued for internal use and for export. It is presumed that goats have been maintained along with sheep in the arid zone by the sheep breeders to supplement their income as goats withstand serious drought conditions better than the sheep. However, as the available grazing is not sufficient to meet the requirements of even the cattle and sheep, goats should be considered as a serious competitor to these species. Goats are also responsible for the progressive deterioration of the grasslands. Therefore, if goats are allowed to continue even at the present level they would stand in the

the required development of grasslands. It is

recommended that goat flocks should not be permitted to graze on specially developed grasslands. Also the number of goats in mixed sheep and goat flocks should be restricted when such flocks are allowed to graze in these lands. The sheep owners should be educated on the advisability of improving their sheep flock and reducing the number of goats. It is further recommended that goat population should be reduced progressively to an extent of 25 to 30% of sheep population in these areas. This cannot be achieved in a short period of time but as the quality of sheep is improved considerably and local employment using wool is augmented to supplement the income of the family of the sheep breeders, the flockowners could be slowly weaned away from goat rearing to sheep raising.

Camel Development

9.52 Nearly three-fourths of the camel population in the country is found in Rajasthan and this is concentrated mostly in the western districts of the State. Of the total population of 0.74 million camels in the State, 0.62 million camels are in the 11 arid districts, which constitute nearly 84% of the total stock. The Livestock Census figures from 1951 onwards show that camel population has been showing a steady increase in these districts. It was 0.27 million in 1951, 0.47 million in 1961, 0.56 million in 1966 and 0.62 million in 1972. One interesting observation is that in spite of the severe drought conditions experienced during the period from 1966

to 1972 when the number of cattle, buffaloes and sheep decreased, the population of camels showed an increase from 0.56 million to 0.62 million. This is perhaps because the camel is naturally well adapted to desert conditions.

9.53 Camels are mostly bred and kept by Raikas and other nomadic tribes and they are useful animals particularly for landless labourers and small and marginal farmers who cannot afford to purchase and maintain good bullocks for cultivation, transport, etc. Camels are the only species of animals which could be used for riding and transport in the desert areas, where communication facilities are meagre. In recent years camels are being increasingly used in the Rajasthan Canal Project for haulage. They have their use also in the defence and police establishments in the border areas. Camels are also used for many other purposes. Its milk is used for human consumption in some areas. Its hair, either with or without other fibres, is used for making ropes, carpets and even blankets. Painting brushes of superior quality are made from camel hair. Camel meat is used for food and camel leather for the manufacture of shoes and other leather goods. Some cottage industries are based on the use of camel guts for handicraft products. In comparison to its multifarious usefulness for the people of the desert areas, development of camel has received scant attention so far. The Rajasthan Government initiated a camel development scheme as early as 1954 which included the establishment and operation of stud centres for camel

development. The Indian Council of Agricultural Research had also sanctioned a scheme in 1956 for the establishment of a camel breeding farm and 10 stud centres to operate broadly on the pattern of Key Village Scheme on cattle development. The objective of the scheme was to collect scientific data on camels and to improve the breed of camels by selective breeding. For various reasons this Scheme could not function satisfactorily and did not produce the desired information. At present the Department of Animal Husbandry provides on loan stud camels from the State camel breeding farm to the camel owners for breeding. The Commission has noted that the Fifth Five Year Plan of Rajasthan State has not provided for any scheme for the development of camels. It is recommended that the camel farm at Bikaner should be adequately expanded to enable it to take up a scientific breeding programme. This will also enable, besides taking up genetical studies, collection of data on reproductive physiology of the camel with particular reference to its breeding behaviour, nutritional needs and health requirements. These research investigations should be undertaken in close collaboration with the scientists at the College of Veterinary Science and Animal Husbandry at Bikaner. The farm should be linked with a number of camel development blocks in different districts on the pattern of the Key Village Scheme. As the breeding farm will help in the improvement of camels in the adjoining States also, outlay particularly for the expansion of the farm and its activities could be jointly borne by

the Indian Council of Agricultural Research, Government of India and the Government of Rajasthan.

HARYANA

Livestock Situation in Desert Areas of Haryana

9.54 Rearing of livestock is an important subsidiary occupation with the farmers in Haryana State, particularly in low rainfall areas. These areas are adjacent to the districts of Ganganagar, Churu and Jhunjhunu of Rajasthan and the livestock rearing conditions are more or less similar in both areas. The home tract of Hariana cattle includes this area and good specimens of the breed are found in large numbers in the tehsils of Hissar, Bhiwani, Hansi and Loharu. The sheep of the area are predominantly of Nali breed whose breeding tract lies in the neighbouring districts of Ganganagar and Churu in Rajasthan. Camels are found in large numbers in the tehsils of Sirsa, Bhiwani, Dadri and Fatehabad and are used both for agriculture and transport. The livestock population of the arid tehsils in 1966 and 1972 are given in Table 9.3.

TABLE 9.3

Livestock Population in nine Tehsils in the Desert Area in Haryana State in 1966 and 1972

(Number in hundreds)

Tehsil	CATTLE		BUFFALOES		SHEEP		GOATS		CAMELS	
	1966	1972	1966	1972	1966	1972	1966	1972	1966	1972
Dadri	561	634	445	663	168	123	242	185	120	143
Hansi	987	449	859	1074	326	339	172	181	10	11
Hissar	994	1111	930	1072	473	400	293	313	65	82
Bhiwani	790	679	427	469	457	339	583	343	205	172
Fatehabad	748	879	775	989	327	328	237	241	106	107
Sirsa	954	854	1003	1027	533	315	507	332	282	200
Loharu	-	201	-	121	-	61	-	94	-	62
Dabwali	-	330	-	334	-	160	-	215	-	134
Total	5034	5137	4439	5749	2284	2065	2034	1904	788	911

9.55 A comparison of the livestock population in 1966 and 1972 indicates a slight rise in the cattle population and a fairly large increase in the case of buffaloes and camels. The population of sheep and goats has shown a decline during this period. The increase in the number of buffaloes may be due to the fact that canal irrigation is being progressively introduced in these areas. The reduction in sheep and goat population may be due to shrinkage in the availability of land for grazing and also decreased availability of stubble grazing resulting from progressive increase of intensive cultivation practices. The camel is perhaps becoming more popular as its maintenance is considered

more economical by the farmers in the area and they can also be used for a variety of agricultural operations. The trend of increase in the number of buffaloes can be kept under check if only production of cow milk in this area is considerably increased and a remunerative market is created for it. While the decreasing trend observed in goat population is welcome, a similar trend in sheep is not desirable. Sheep have good potentialities for improving the economy of the farmers particularly the small and marginal ones in the area if the size of sheep and the quality of wool yield in them could be improved.

9.56 In spite of the fact that this area abounds in good quality livestock, very little organised efforts have been made in the past for improving their productivity. No schemes for marketing of milk and for organised collection and marketing of wool were taken up till the end of the Third Five Year Plan period. Only recently under the Fourth Five Year Plan a start has been made for taking up such programmes for implementation. One medium sized Intensive Cattle Development Project (ICDP) covering about 50,000 breedable cows and she-buffaloes has been started in Bhiwani with one central semen collection centre and 50 stockmen centres in rural areas. There are 8 Sheep and Wool Extension Centres in the districts of Bhiwani and Mahendragarh for improved breeding of sheep, control of diseases and shearing and marketing of wool. One Wool Grading and Disposal Centre was started in Loharu but later shifted

to Hissar. The State Government has recently decided to locate it finally at Bhiwani. The State Dairy Development Corporation has set up one condensed milk plant in Bhiwani with a handling capacity of about 35,000 litres of milk a day. This plant has already gone into production and at present its throughput is about 15,000 litres a day.

Approach to Cattle and Buffalo Breeding

9.57 As mentioned earlier, cattle in this area is of superior type and in a major part of the area purebred Harianas are found in large number. Buffalo population consists predominantly of good Murrahs as this area lies adjacent to the breeding tract of this breed, namely, Jind and Rohtak districts. The approach to cattle and buffalo development in this area should envisage breed improvement and increased milk production through planned breeding programmes and augmentation of feed and fodder resources. In addition to the Intensive Cattle Development Programme in Bhiwani, another medium sized ICDP is proposed to be established in Sirsa under the Fifth Five Year Plan of the State. A large area would still remain uncovered by any programme. It is, therefore, recommended that the ICDP at Bhiwani should be expanded to cover additional areas in Bhiwani tehsil as well as adjacent areas in Dadri and Loharu tehsils. In addition, improved breeding facilities should also be organised to cover areas in Dadri and Loharu tehsils,

Mahendragarh tehsil and the arid regions located in the south-western part of Jhajjar tehsil. One central artificial insemination (AI) station could be started in Mahendragarh town with about 50 or more AI units in the rural areas. While selecting areas for locating these units, preference should be given to the milk-sheds of the existing dairy projects and those proposed for establishment in the near future, and to areas which already have irrigation facilities. The breeding programmes should be linked with the cooperatives under dairy projects and organised on the lines indicated in the Commission's Interim Report on 'Milk Production through Small and Marginal Farmers and Agricultural Labourers'. The farmers of these areas may be inclined to continue selective breeding among Hariana cattle as Hariana bullocks are in good demand in and outside the State as draught animals. However, it is advisable to progressively introduce crossbreeding with Jersey breed with a view to increasing cow milk production. Such a system would benefit the people economically in the long run when facilities for collection and marketing of cow milk have been organised under a number of programmes proposed under the Fifth Plan and those recommended in this Report. Otherwise, the farmers will have to maintain buffaloes for milk production and cattle for production of bullocks which seem to be the present trend. A small beginning has already been made for crossbreeding the local cattle with Jersey breed under ICDP at Bhiwani. As recommended in the

case of Rajasthan (paragraph 9.16), the level of exotic inheritance should be maintained at 50% only until such time the green fodder availability is adequately increased in the area. At a later stage, if found possible, the exotic inheritance could be raised to a higher level.

Marketing of Milk

9.58 Organised collection and marketing of milk was non-existent in the area till the recent past. As already stated, the milk plant for manufacture of sweetened condensed milk at Bhiwani has a capacity to handle about 35,000 litres of milk per day. The State Government has proposed the establishment of a new milk plant in Sirsa in the Fifth Plan. In view of the progressive extension of irrigation and intensive cattle and buffalo development proposed in arid areas, it is recommended that additional programme of milk collection and marketing should be taken up in the near future. It is, therefore, suggested that the milk plant in Bhiwani should be expanded to handle at least 50,000 litres of milk a day with provision for further expansion to handle ultimately about one lakh litres of milk. Milk chilling plants should also be set up in Loharu and Dadri areas. The milk collected at Loharu and Dadri centres could be sent for marketing to Bhiwani or to Jind. Milk from Dadri could also be sent to the dairy plant proposed to be set up in Rewari or to the dairy plant at Rohtak being established under the 'Operation Flood' project.

Chilling plants recommended could be of the capacity of about 10,000 to 20,000 litres daily. It is emphasised that the dairy schemes should provide all the incentives for increased production and marketing of cow milk as recommended in the Commission's Interim Report on 'Milk Production through Small and Marginal Farmers and Agricultural Labourers".

Sheep Development

9.59 There has been a decrease in the number of sheep in this area during the recent past. It would be necessary to arrest this trend and improve their quality both for wool and mutton production. As Nali breed is predominant in the area, the present breeding policy adopted by the State Government is selective breeding of the Nali and progressive crossbreeding of Nali sheep with Hissardale and to some extent with exotic breeds like Corriedale. It is recommended that crossbreeding of Nali sheep should progressively be extended to cover ultimately all sheep of the area. To start with, crossbreeding may be introduced to replace the existing sheep with crossbred progeny having 50 per cent exotic inheritance. With a view to gradually acclimatising the crossbred sheep to the agro-climatic conditions in the area, sheep breeders may be encouraged to use crossbred rams with 50% exotic inheritance in the first instance and later with 75% exotic

inheritance to have ultimately flocks which will have crossbred sheep having 50% exotic inheritance. Such a programme has also been recommended for adoption for Rajasthan State. For a programme of crossbreeding to cover all the sheep in this area where the breedable ewe population may be around one lakh, a large number of purebred exotic rams as well as crossbred rams with 50% and 75% exotic inheritance will be required. It is understood that the Government Livestock Farm at Hissar is hardly in a position to supply more than 100 Hissardale and about 300 Nali rams every year. It is, therefore, recommended that the size of Hissardale and Nali sheep flocks at this Farm should be considerably increased so that in addition to purebred Hissardale and Nali rams, crossbred rams with 50% Corriedale inheritance could also be produced in large numbers every year. It is also recommended that in selected areas where good type of Nali sheep exists, crossbreeding may be introduced in a controlled and planned manner through sheep breeding extension centres for production of large number of crossbred rams at the field level which could be purchased and utilised for breeding elsewhere. The possibility of obtaining crossbred Corriedale-Nali or Rambouillet-Nali rams from the Central Sheep and Wool Research Institute, Malpura, Rajasthan, should also be explored.

9.60 The Wool Grading and Disposal Centre started during the Fourth Five Year Plan has not yet been fully established. It is recommended that adequate

facilities such as building, equipment, funds, etc. should be provided as early as possible. At present, the Centre handles about one lakh kg of wool. The Centre, however, could easily handle two lakh kg of wool or more every year provided adequate facilities are created for collection, transport, processing, storage and grading of wool. Sufficient funds (Rs.40.57 lakhs) have been provided in the Fifth Plan of the State for this purpose. The Commission in its Interim Report on "Poultry, Sheep and Pig Production through Small and Marginal Farmers and Agricultural Labourers for Supplementing their Income" has recommended inclusion of the districts of Hissar and Mahendragarh (including areas now under the newly formed Bhiwani district) for special sheep development programmes for the benefit of small and marginal farmers and agricultural labourers. The programmes recommended therein should be taken up on a priority basis in the tehsils of Hissar and Bhiwani districts, which are in the desert area. It has also been recommended in that Report that the best way to ensure economic returns from sheep production would be through organising sheep breeders' cooperatives both at the rural level as primary cooperatives and at the district level as a Union. All the recommendations made in that Interim Report concerning credit, cooperation and marketing facilities for sheep breeders should be given effect to on a priority basis in these areas. While collection and processing could be organised by the primary cooperatives, transport, warehousing and

marketing of wool should be undertaken by the Wool Grading and Disposal Centre at present functioning on a temporary basis in Hissar and later on to be fully established in Bhiwani.

9.61 Special programmes should be taken up in arid areas of Haryana, on similar lines as recommended for Rajasthan, to create facilities locally for the utilisation of wool produced to the maximum extent so that employment opportunities are augmented in the area with consequent additional income for the sheep breeders and artisans in the villages. At present there is no private, cooperative or public woo. industry in the area. The State Khadi and Village Industries Board should organise centres for woo. utilisation as is being done in Rajasthan. The Small Scale Industries Department of the State Government should also explore the possibilities of starting wool utilisation programmes.

Grassland Development

9.62 From the land use statistics available for Hissar and Bhiwani districts it is observed that the lands classified as 'not-available for cultivation' and as 'uncultivated land excluding fallow land' are progressively declining in extent. It has been estimated that in 1971-72 there were 72,000 hectares of land not available for cultivation and 46,000 hectares classified as 'uncultivated land excluding fallow land'.

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* Statistics supplied by Directorate of Animal Husbandry, Haryana.

It is anticipated that with the extension of irrigation in the area the availability of green and dry fodder for cattle and buffaloes may progressively increase. But the availability of land for stubble grazing and pasture land may diminish with the result that the sheep breeders may find it difficult to profitably raise good quality sheep. It is understood that the villages have under their control blocks of land which are intended for grazing of sheep and cattle but they are left undeveloped and allowed to deteriorate through uncontrolled over grazing. As recommended for Rajasthan (paragraph 9.36), programmes for development of village grasslands and adoption of controlled grazing, should be taken up in this area immediately. These lands should be taken over by Government for development and once these lands have been fenced, reseeded and brought under good cover of perennial grasses like Cenchrus species known locally as 'anjan' which grow satisfactorily in the area, these lands may be transferred to the Village Panchayats for maintenance. It is recommended that at least 20,000 hectares should be taken up for progressive development during the next 5 to 10 years. As the blocks of grassland would be smaller than those in Rajasthan, the cost per hectare is expected to be around Rs.850 and the outlay

required would be about Rs.1.7 crores.

Camels

9.63 From the large population of camels, in the area and their good condition, it appears that this animal is favoured by the farmers of the arid area for agricultural and transport operations. At present, there is no scheme for development of camels in the State and the camel breeders depend entirely on Rajasthan for purchase of good camels. It is recommended that the State Government should consider the possibility of establishing about 10 stud centres to operate broadly on the pattern of Key Village Scheme on cattle development. For these stud centres superior he-camels may be selected from the camel breeding farms and/or established camel breeders in Rajasthan.

GUJARAT

Livestock Situation in Desert Area of Gujarat

9.64 The arid area in Gujarat lies contiguous to the arid zone of Rajasthan State and the agro-climatic and other conditions are also similar in both the areas. As in Rajasthan, livestock raising is an important occupation with the rural population in this area. Cattle, buffaloes, sheep, goats and camels are maintained in large numbers. The livestock population in 1961 and 1972 of the arid tehsils

of Gujarat is given in the Table below:

Table 9.4

Livestock Population in 8 Tehsils in the Desert Area in Gujarat State in 1961 and 1972*

(Number in '000)

Tehsil	Cattle		Buffaloes		Sheep		Goats		Camels	
	1961	1972	1961	1972	1961	1972	1961	1972	1961	1972
BANASKANTHA DISTRICT										
Vav	59	50	16	23	76	64	24	51	2	3
Tharad	63	48	20	24	42	36	26	48	2	3
Deodar	58	41	16	22	18	12	16	35	1	2
Kankrej	57	40	14	18	12	10	14	53	1	2
Radhanpur	27	22	8	10	7	6	9	15	0.4	0.4
Santalpur	33	25	7	10	20	15	12	20	0.2	0.4
MEHSANA DISTRICT										
Sami	41	40	13	18	4	5	9	18	0.1	0.2
Harij	18	14	8	10	1	2	4	10	0.1	0.2
TOTAL	356	280	102	135	180	150	114	250	6.8	11.2

(* figures for 1972 are provisional)

9.65 The quality of cattle is superior in this area as Banaskantha is the home tract of Kankrej which is a well-known dual purpose breed. Kankrej bullocks are excellent for use in agricultural operations particularly in heavy soils, and many other draught purposes; and these bullocks are sold to more intensively cultivated areas in other parts of Gujarat and in Rajasthan. The buffaloes found in this area are predominantly of

Mehsana type which are good milkers and are in demand in the State and in Bombay city. The sheep of the area is of Marwari breed similar to those found in Rajasthan. The livestock breeders of this area are put to a lot of hardship because of recurrent scarcity conditions and they also practise, to certain extent, migration like the livestock breeders in the arid zone of Rajasthan. The sheep breeders, in particular, migrate to cultivated areas in Rajasthan through Radhanpur and Himatnagar and towards Kutch through Samakhiali. That the livestock is reared under difficult conditions is indicated by the fact that the population of cattle and sheep has considerably decreased from 1961 to 1972. The number of buffaloes has, however, shown a large increase perhaps due to the fact that they are better cared for because of high milk production and the returns they bring to the farmers. As in the case of Rajasthan, the population of goats and camels has shown an increase. The above trends are more or less similar to those found in the arid areas of Rajasthan.

Approach to Cattle Development.

9.66 The productivity of livestock has remained stagnant in this area for want of organised attempts for providing adequate facilities for better feeding and breeding of livestock and marketing of livestock products such as milk, wool etc. There is urgent need for taking immediate and adequate

measures for improving the quality and productivity of cattle and buffaloes in the area. The State Government has proposed setting up of two medium sized Intensive Cattle Development Projects one at Tharad in Banaskantha district and another in Sami or Harij tehsil in Mehsana district as a part of Drought Prone Areas Programme. The animal husbandry programmes under the Fifth Five Year Plan of the State also include one ICDP in Banaskantha district which will cover mainly the milksheds of Banaskantha dairy at Palanpur. This project may not cover a major portion of the arid areas in Banaskantha district. It is, therefore, recommended that the two medium sized ICDPs proposed under the Drought Prone Areas Programme in the State should be taken up on priority basis. One of these projects could be located at Tharad to cover the cattle and buffalo population in Tharad, Vav and Deadar tehsils while the second project could be located at Thara to provide inputs and services for cattle development in the tehsils of Kankrej, Radhanpur, Santalpur, Sami and Harij. As the area is very extensive, the artificial insemination facilities from the ICDPs cannot reach remote areas in these districts. It is, therefore, recommended that a programme of distribution of large number of purebred bulls and buffalo-bulls should be taken up. It would be preferable to popularise the maintenance of these bulls by progressive breeders in the villages and in their absence, by the Village Panchayats. Subsidy could be extended to the custodians of the bulls and such a system would work out more economical than locating the bulls at the veterinary dispensaries and

first aid centres in the area. To meet the needs of superior quality bulls under these programmes it is advisable to strengthen the cattle breeding farm at Thara in Kankrej tehsil so that a scientific programme of genetic improvement of the stock could be undertaken in this farm. The herd size of this farm should be raised to at least 150 breeding cows. The breeding programme should be closely linked with the rural cooperatives under dairy schemes and should be organised on the lines indicated in the Commission's Interim Report on "Milk Production through Small and Marginal Farmers and Agricultural Labourers".

Dairy Development

9.67 In each of the districts of Banaskantha and Mehsana there is Milk Producers' Cooperative Union which collects milk through producers' cooperative societies in the villages. The Mehsana Union has a large dairy plant called Dudhsagar Dairy with a capacity to handle two lakh litres of milk per day. This dairy plant is being expanded under 'Operation Flood' project to have a capacity to handle 4.5 lakh litres a day. The Banaskantha District Cooperative Milk Producers' Union has been receiving financial assistance under the 'Operation Flood' project for the establishment of a dairy plant with a handling capacity of 1.5 lakh litres a day. This dairy is at present handling 55,000 litres of milk per day on an average and has two chilling centres one at Dhanera and another at Khimana. The existing milksheds of these two large dairies do not at present cover the arid areas of the two districts.

It is, therefore, recommended that additional chilling centres should be set up under both these dairy plants in the tehsils lying in the arid zone. This would not only help collection of more milk for the dairy but also help in improving the economy of cattle breeders of the area. During the Fifth Five Year Plan period three more chilling centres should be established in Banaskantha district at Vav, Kankrej and Deodar and two chilling centres in Mehsana district at Sami and Harij.

Sheep Development

9.68 There is a large sheep population in these districts. Organised programmes of sheep and wool development in this State have, however, been confined to Saurashtra and Kutch regions in the past. Only recently the State Animal Husbandry Department has started sheep extension programmes in Palanpur with the establishment of eight sheep extension centres. Even these centres are located in non-desert areas of Banaskantha district. It is recommended that the State Government should consider taking up intensive development of sheep and marketing of wool in the desert areas at an early date. As the Marwari sheep, predominantly found in this area, is similar to those found in Rajasthan, the breeding programme should be the same as recommended for that breed in Rajasthan i.e., selective breeding for production of increased quantity of carpet quality wool of uniform quality. The possibilities of taking up crossbreeding of the sheep with exotic breeds could be considered at a

later date when pastures are fully developed to support larger sized sheep with a heavy fleece of finer wool. The programmes for wool collection, processing, warehousing and marketing of wool should also be taken up on the same lines as recommended for the desert areas in Rajasthan (paragraph 9.44). In Gujarat, the functions of the Wool Board recommended for Rajasthan may be taken up by the Gujarat Sheep and Wool Development Corporation. As the desert area in Gujarat is compact and small, the State Government could consider setting up one more Intensive Sheep Development Project for this region under its Fifth Five Year Plan, under which all the above measures for improvement of stock, marketing of wool, etc. could be organised on a planned and intensive manner.

Grass-land Development

9.63 Improved cattle and sheep breeding programmes could be successful only if simultaneous arrangements are made for development of large areas of good grass lands in this area. This would also help in reducing the migration of livestock in search of water and fodder to other areas. In 1967-68, the total cultivable wasteland and permanent pasture and other grazing lands in this area were estimated at 58,000 hectares and 43,000 hectares respectively. It is understood that pasture lands are mostly saline with meagre grass growth. Lands which are not subjected to salinity and those with less preponderance of sand dunes could be developed

as pasture land on the same lines as recommended for Rajasthan. Grass varieties such as anjan and dhaman are recommended for most of the areas and sewan for more sandy areas. A total of 65,000 hectares of land at an estimated cost of about Rs.4 crores could perhaps be brought under grassland development including improved management practices as detailed for grassland development in Rajasthan (paragraphs 9.30 and 9.33).

Camels

9.70 Camel population has also been increasing progressively in this area. It rose from 16,780 in 1961 to 27,245 in 1972 in Banaskantha district. Similarly, the number rose from 7,664 in 1961 to 12,871 in 1972 in Mehsana district. Considering the usefulness of this animal in this tract, it is recommended that organised camel breeding should be undertaken in this area by starting about 5 camel stud centres. Improved he-camels for these stud centres could be obtained from the camel breeding farm and/or from progressive camel breeders in Rajasthan.

SECTION X

OUTLAYS AND PRIORITIES

10.1 The development of the desert area is a major task which covers programmes under many disciplines and in consequence concerns a number of departments. In view of its magnitude and complexity, it is important to have a comprehensive time phased plan of development with a clear idea of relative priorities. The implementation of some of the programmes hinges on the prior implementation of some others. For example, for dairy development it is necessary to raise sufficient green fodder, for which in turn water has to be made available. Likewise, plantations can be raised only where water is available within reasonable distance. Such interdependence of programmes has to be taken into account in phasing the various programmes.

10.2 The pace at which the development can be carried out will depend upon the availability of resources in men, material and money. For the successful handling of any major task, a suitable organisation is a prerequisite. For each item of development, there should, therefore, be a suitable organisation adequate in strength and expertise to implement the programme at the required pace. There are constraints in the supply of a number of essential materials. This has to be kept in view while formulating the programme. For example, for developing pastures the availability of barbed wire for fencing is essential and this may well prove to be a constraint. Then, there are certain physical constraints which cannot be ignored. For example, for providing fuelwood, a tree has to grow for about 15 years before it is mature for felling. As

will be noticed from the paragraphs that follow, large sums of money will be required for the development of the desert areas. This requirement will need special consideration in view of the fact that the desert area is deteriorating and unless checked this deterioration will be faster with the passage of time. This factor highlights the urgency of the task. Taking various aspects of the desert area development into consideration, we are of the view that it should be aimed at to complete this development in a period of 15 years, that is, by the end of the Seventh Plan period.

10.3 In Rajasthan where most of the desert area lies, besides the normal developmental programmes, the major items of development comprise the construction of Rajasthan Canal and the development of irrigation in the commanded area pasture development, grass reserves and fodder banks, sheep development, cattle and dairy development, tree plantations for fuel and small timber, shelter-belts and wind-breaks, and sand dune stabilisation in crucial areas. Of these, the Rajasthan Canal and the development of the commanded area require the largest amount. The canal project, allowing for modification in respect of new lift canals proposed in this Report, is at present estimated to cost Rs.363 crores of which Rs.191 crores will have been spent by the end of the Fourth Plan period. Thus, a sum of Rs.172 crores would be needed for completing the project. The estimated requirement for area development programmes in the canal commanded area is Rs.669 crores, of which Rs. 160 crores pertain to public sector and Rs. 509 crores to institutional sources. Very little

expenditure has so far been incurred on this item. Another item requiring a large outlay is the pasture development including grass reserves and fodder banks estimated to cost Rs. 57 crores. Excluding Rs. 509 crores for which institutional sources are to be tapped, it would be necessary to provide the following outlays over a period of three Plans to complete the various programmes:

(Rs.crores)

	Rajasthan Canal area	Remaining arid area in Rajasthan
Rajasthan Canal	172.00	
Area development programmes for canal commanded area	125.00	
Pasture development	-	43.00
Cattle development	1.63	2.54
Dairy development	4.80	1.05
Sheep development	-	3.66
Camel development	0.25	-
Sand dune stabilisation	12,00	*
Forestry including grass reserves and fodder banks	16.18	15.18
Total:	331.86	65.43

* As suggested in paragraph 4.12, a proper assessment would have to be made of the funds required for stabilising such dunes as pose a threat to habitations, roads and railway lines. These requirements will be additive.

Broad details of the above items are given in Appendix VIII. It is emphasised that these figures should be treated merely as indicative of broad magnitudes of the various programmes and that for each programme a proper estimate should be prepared after due investigation. In addition, other items of development under the Plan would include tubewells, piped drinking water supply, electrification, communications, social services, etc. as also some smaller items like khadins peculair to the area.

10.4 Both in Haryana and Gujarat, efforts are underway to harness the water resources for the benefit of desertic areas in these two States. The availability of water is expected to improve further when settlement is reached on the question of sharing the river waters. The outlays recommended in this Report for the development of desert region in these two States are, therefore, only for other programmes such as sand dune stabilisation, forestry, pasture development and fodder production and improvement of cattle, sheep and camel, and marketing of milk and milk products. The outlays required for these programmes in the desert areas of Haryana and Gujarat are as follows:

HARYANA	(Rs. crores)
Pasture development	1.70
Cattle development	0.18
Dairy development	1.05
Sheep development	0.13
Camel development	0.10
Sand dune stabilisation	2.00
Foresty	10.50
	15.71

GUJARAT	(Rs. crores)
Pasture development	4.00
Cattle development	0.23
Dairy development	0.75
Sheep development	0.30
Camel development	0.05
Forestry	4.70
	10.08

The details of these outlays are given in Appendices IX and X. In addition there would be other items of development under the Plan in these areas.

10.5 For the proper development of the desert area, the programmes should be implemented in an integrated manner and according to a predetermined time phase. But if there is paucity of funds during any period, judicious adjustment of the programmes becomes inevitable in order that the more urgent and important programmes do not unduly suffer. For this, it is necessary to lay down relative priorities of the various programmes.

10.6 The most urgent step in the development of the desert area is to check its further deterioration. This means elimination of overgrazing by improving pastures and growing fodder. It also means prevention of over-exploitation of fuel resources by raising new plantations, regulating the exploitation of the existing ones and meeting fuel deficits from outside sources until local resources develop. These are, therefore, first priority programmes.

10.7 The improvement of pastures is not dependent on the availability of irrigation facilities as no irrigation of pasture lands is contemplated. But, for regulated graz-

ing, areas have to be fenced in blocks of suitable sizes of not less than 200 hectares each. Some consolidation of holdings would be necessary to form these blocks and this should be done on a high priority basis.

10.8 As regards fuel resources, we have already recommended that supply of phog roots for fuel to areas outside Rajasthan should be banned to discourage digging up of phog roots in the desert area. This measure needs to be taken urgently. It hardly needs any outlay. New plantations can be raised only where water is available for watering the plants in their initial period of growth. The plantations will, therefore, have to be raised on canal lands and on high lands in the canal commanded area. Considering that trees take several years to become exploitable, this should be a priority item in the area development programme in the canal command. Tree plantation along the roads have also to be raised on a priority basis within reasonable distance of tubewells or other sources of water. Arrangement for supply of fuel from outside sources to meet local deficits can be through normal trade arrangements and would not be a burden on the Plan funds.

10.9 While prevention of the deterioration of the desert area should be a matter of urgent action, making full use of the available livestock resources should also be accorded higher priority than the measures for further development. Programmes of dairy development and marketing facilities as also shearing units for sheep and grading centres for wool should be developed on a priority basis. Under the dairy development schemes, the

initial thrust should be on provision of inputs and services for increasing milk production. Facilities for transportation, chilling, processing and marketing of milk and milk products should closely follow. In the rainfed areas, sheep and wool development should be taken up simultaneously along with pasture development. The establishment of shearing units, grading centres and arrangements for marketing should receive urgent attention to ensure good returns for the sheep breeders. These measures involve relatively modest outlays.

10.10 Much of the prosperity of the desert area will accrue from the development of water resources. In Rajasthan, the main contributor would be the Rajasthan Canal, though tubewell will make a significant contribution, particularly as a source of drinking water. The Rajasthan Canal and more so the development of the commanded area, however, require large outlays. It is important that because of these large requirements, other priority programmes mentioned above do not suffer. Between the programmes of further construction of the canal and the development of the commanded area of the portion already constructed, the latter should have priority. It is important that where irrigation channels have been constructed, all development measures should be expeditiously taken in order to make an early and full use of the irrigation facility, as otherwise the large outlay incurred on the construction of the channels would remain unproductive. Hitherto, the development programmes in the canal commanded area have lagged behind a great deal.

SECTION XI
ACKNOWLEDGEMENTS

11.1 The Commission takes this opportunity to thank all the officers of the Central Government and the State Governments of Rajasthan, Haryana and Gujarat as well as the institutions and individuals who offered valuable information and suggestions through correspondence or during personal discussions. In particular, the Commission would like to thank all those officers and public men who accompanied the Commission during its tour of the region.

sd/- Nathu Ram Mirdha
Chairman

sd/- B.Sivaraman
Vice - Chairman

Member

Sd/- Z.A.Ahmad

sd/- Choudhri Randhir Singh

sd/- T.A.Pai

sd/- Hari Singh

sd/- N.K.Panikkar

sd/- H.R.Arakeri

sd/- A.M.Khusro

sd/- D.P.Singh

sd/- Balwant Singh Nag

sd/- M.V.Krishnappa

sd/- M.S.Swaminathan

sd/- P.Bhattacharya

sd/- S.K.Mukherjee

sd/- Triloki Singh

sd/- J.S.Sarma
Member Secretary

New Delhi,
March 23, 1974.

Appendix I

(Paragraph 5.5)

Exploitable Ground water Potential of Western Rajasthan (District - wise)

MCUM

Sl.No.	District	Estimated annual re-charge/ annual economically minable yield	Existing annual pumpage	Surplus exploi-table poten-tial	Remarks
1.	Barmer	87.78	12.88	74.90	(for Siwana block only)
2.	Bikaner	31.40	9.06	22.34	
3.	Churu	80.00	26.07	53.93	
4.	Ganganagar	179.50	23.50	152.00	
5.	Jaisalmer	143.20	5.50	137.70	(For Lathi series and Kishangarh Tanot region)
6.	Jalor	460.96	292.88	168.08	
7.	Jhunjhunu	222.94	93.11	129.83	
8.	Jodhpur	228.50	130.26	98.24	
9.	Nagaur	353.92	129.01	224.91	
10.	Pali	290.23	212.36	77.87	
11.	Sikar	285.90	193.12	92.78	
	Total:	2364.33	1127.75	1232.58	

Appendix II

(Paragraph 5.12

Estimate for the Development of Rajasthan Canal Command Area

The Rajasthan Canal, according to the 1970 Project Report, is to command a culturable area of 1.14 million hectares, all by gravity irrigation except 51,000 ha on the Lunkaransar Bikaner Lift Canal. The Phase I of the Project covers a CCA of 540,000 ha including 51,000 ha of lift area and Phase II 600,000 ha all by gravity irrigation. It is now suggested that the CCA of Phase II be increased to 700,000 ha, 390,000 ha for gravity irrigation and 310,000 ha for lift irrigation through 5 lift canals. The reasons for this are explained in paragraphs 5.20 to 5.28.

The extra cost due to lift canals and increase in the CCA would be more than compensated by reduction in the cost of land levelling and several other items of development. The cost of these various items are given in the Statement at the end of this Annexure. The assumptions made are discussed below:-

1. Land Levelling and Shaping

The Rajasthan Government has submitted to the World Bank through Government of India a project report for the development of 200,000 ha of CCA in the head reach of Rajasthan Canal in Ganganagar district for obtaining a loan. After detailed discussions with the FAO/IBRD, the cost of land levelling has been worked out to

Rs.2,000 per ha on the assumption that on an average about 77 m^3 per ha of earth work would be required if a land plot of 0.25 ha is taken as the unit for levelling to an almost flat field with a small slope of 0 to 0.1 per cent in one direction. This cost has been worked out on the basis of actual experiments and a survey made of about 3,000 ha. The cost estimate for operating 35 hp tractors and blades was supplied by the Agro-Industries Corporation in 1973. An assumption has been made that the holding per farmer would be 6 ha of which only 4.8 ha would be required to be levelled in the first instance, the balance being taken up gradually by the farmer himself. On the basis of surveys carried out, it has been inferred that only 10 per cent of the CCA would require levelling in the Suratgarh area where canal irrigation has been in progress for the last 10 years and 23 per cent in the Anupgarh Shakha area where irrigation has been in progress only for the last 5 years. Keeping this in view, it has been assumed that in the balance 340,000 ha pf Phase I, where irrigation has been introduced only recently, about 30 per cent of the area would require land levelling and shaping. In Phase II area of the canal, it has been assumed that in 390,000 ha, 40 per cent of the area would require land levelling. The remaining area of 210,000 ha, which is now proposed to be dropped because it has been classified as Class VIth land, requires land levelling to the extent of 50 per cent and

at that double the cost rate because of higher sand dunes to be levelled. In the 310,000 ha of new area, which is now proposed to be taken up under the lift canals, it has been assumed that 30 per cent of the area would require land levelling because this land is no worse than that in Phase I of the canal. On the basis of these assumptions, the total cost of land levelling in 1.14 Mha CCA of Phase I and II of the 1970 Project, all irrigable by gravity, would be Rs.99 crores. In the proposal now made, the CCA of the two Phases would be 1.24 Mha, of which 310,000 ha would be under the five new lift canals. The cost in this case would be Rs.77 crores, which would give a saving of Rs.22 crores.

2. Water courses and their lining

In the 1970 Project Report of the Rajasthan Canal, although water losses have been assumed on the basis of lined watercourses, yet no provision has been made in the cost estimate for lining them. Even the cost of unlined watercourses provided in the estimate is on the low side, being only Rs.37 per ha. An item for lined watercourses was included in the proposal for obtaining loan from the World Bank. The FAO/IBRD Team have assumed a cost of Rs.1,000 per ha for a lined watercourse of 0.045 to 0.075 cumec (1.5 to 2.5 cusecs) capacity and of an average length of 30.5 metres per ha of the culturable commanded area. This includes the cost of earth work (all in embankment) and lining with a single

course of 5 cm thick baked tile laid over mortar bedding and plastered on top. It also includes the cost of the required regulators, drop structures and road crossings. On this basis, the cost of lined watercourses in 1.14 Mha CCA of the project would be Rs.114 crores and for 1.24 Mha in the new proposal Rs.124 crores. There would thus be an increase of about Rs.10 crores in the cost.

3. Village sites and services

Since the Rajasthan Canal passes mostly through uninhabited areas, new villages will have to be established so that the farmers could stay near their farms. It has been assumed that each village would provide for about 200 farmer families. This would involve site levelling, provision of drinking water, internal roads and footpaths, drainage, community buildings (including one primary school), health centre, panchayat offices and sites for shops, and laying of power lines. The cost is expected to be Rs.4 lakh per village. In Phase I of the Project, it has been figured out on the basis of the data collected that on Anupgarh Shakha and Suratgarh branch 75 new villages would be required per 100,000 ha. The same norm has been adopted for the entire CCA of 540,000 ha of Phase I. In the 600,000 ha CCA of Phase II of the Project, 150 villages would be required per 100,000 ha as this area is very sparsely populated and very few villages exist. In the current Project, the number of

villages to be set up would be 405 in Phase I and 900 in Phase II. The total cost of these would be about Rs.52 crores. In the new proposal, the flow areas of Phase II would require 150 villages per 100,000 ha of CCA but the lift areas would require only 75 villages per 100,000 ha as in Phase I of the Project. On this basis, with no change in Phase I, the total number of villages to be established in the two Phases would be 1223. The cost of these would be about Rs.49 crores. Thus in the new proposal there would be a saving of Rs.3 crores on this item in spite of the CCA being 100,000 ha more.

4. Agro Service Centres

The FAO/IBRD project proposals have assumed the setting up of 27 agro service centres in a CCA of 200,000 ha which was being considered in Phase I. These centres will be small towns with a population of about 3,000. They will enable farmers to procure agricultural inputs and consumer goods and provide repair and maintenance facilities for agricultural machinery. Each centre will have a secondary school, a primary school, a medical dispensary and the local office of the village panchayat. The cost of a centre is estimated to be about Rs.20 lakhs. It has been assumed that for an equal area double the number of centres would be required in Phase II than in Phase I as hardly any such facility exists in Phase II area at present. In the lift canal commands, however, conditions are similar to those obtaining in the Phase I area. Thus, it is estimated that while in the existing

Project an amount of Rs.47 crores would be required for Agro-Industries Centres, in the new proposal it would be only about Rs.44 crores. There would thus be a saving of Rs.3 crores on this item.

5. Markets and Mandis:

New Markets and Mandis would have to be established and the existing ones improved to enable the farmer to sell his produce at a fair price. These markets and mandis would be of various categories depending upon their population. The investment required for each would depend on its category. It would include expenditure on the market yards (auction, platforms, places for product storage and display, cattle yard, godowns, offices, a post office, farmers' rest houses, etc.) as also on normal facilities provided in a town. Since the area in Phase II of the project is much less developed, the number of market towns that will need to be established would be almost twice that in an equal area of Phase I or of lift canals. Preliminary estimates for establishing market towns in Phase I show that an investment of Rs.13 crores would be required per 100,000 ha of CCA. On this basis, the total cost in Phases I and II of the present Project would be Rs.226 crores. With Phase II modified to incorporate lift areas as now proposed, the cost would be Rs.212 crores. The new proposal would thus give a saving of Rs.14 crores.

6. Roads

Three types of roads have been considered - the arterial roads, the sub-arterial and feeder roads and the village roads. In the 200,000 ha of Phase I examined by the FAO/IBRD team, it has been assumed that arterial roads and some sub-arterial and feeder roads exist and that village roads would have to be fully provided. In the remaining 340,000 ha of Phase I, provision has to be made for arterial roads also. In the CCA of 600,000 ha in the present Phase II hardly any arterial, sub-arterial, feeder or village roads exist. These, therefore, have to be fully provided for. In the proposed lift areas, the conditions are similar to those in the 200,000 ha examined by the FAO/IBRD team. The cost of the village roads has been assumed to be Rs.80,000 per km and that of sub-arterial and feeder roads Rs.1,40,000 per km. The cost of roads in Phases I and II of the current project comes to Rs.48 crores while that for the proposal now made comes to Rs.47 crores, giving a saving of Rs.1 crore.

7. The other development costs would be on forests, stabilisation of sand dunes, processing and storage of agricultural products, animal husbandry including improvement of the breeds of cattle, establishment of processing industries for milk, strengthening of cooperatives, agricultre research, demonstration and monitoring.

The expenditure on these items would not be materially different in the new proposal. The markets for products would, however, be nearer from the lift areas and would thus save on transportation cost which would be an advantage to the farmer and he would be able to sell his products at a more competitive price.

Statement I

Itemwise Estimated Cost of Development for the Rajasthan Canal Command Area.

Phases I and II

		Flow irrigation only (Existing Projects)	Flow and Lift Irrigation (new proposal)	Difference
1.	CCA (Phases I and II '000 ha	490+50*+600 =1140	490+50*+390 +310* =1240	
2.	Irrigated area '000 ha	1254 (110% of CCA)	1302 (105% of CCA)	
3.	Land levelling (Rs.crores)	99.0	77.0	(-) 22.0
4.	Watercourse with lining "	114.0	124.0	(+) 10.0
5.	Village sites & services (1000 pop.) "	52.0	49.0	(-) 3.0
6.	Agro Centres and services (3000 pop.) "	47.0	44.0	(-) 3.0
7.	Markets & Mandi towns "	226.0	212.0	(-) 14.0
8.	Forestry and sand dune stablisation. "	28.0	28.0	-
9.	Roads. "	48.0	47.0	(-) 1.0
10.	Processing and storage of agri- products. "	29.0	29.0	-
11.	Animal Husbandry "	32.0	32.0	-
12.	Processing and marketing of animal husbandry products "	9.0	9.0	-
13.	Strengthening of cooperatives "	3.0	3.0	-
14.	Agricultural extension research and monitoring "	15.0	15.0	-
	Total Items 3 to 14: "	702.0	669.0	(-) 33.0

* Lift areas.

Appendix III

(Paragraph 5.27)

Approximate Cost Estimate of Construction of Lift Canals in Stage II of Rajasthan Canal Project.

(New proposal)

Name of the Lift Canal	Churu Lift Canal	Nagaur Lift Canal	Kolayat Lift Canal	Phalodi Lift Canal	Pokaran - Barmer Lift Canal
1. (i) Discharge at head(Cusecs)	1,000	575	575	850	875
(ii) Discharge at tail(Cusecs)	150	225	125	200	275
2. Length of main channel (miles)	52	90	25	25	80
3. Cusec-miles	29,800	36,000	8,250	13,125	46,000
4. Cost of channel @ Rs.2352 per cusec-mile (on the analogy of the cost of Bikaner Lift Canal(Rs.crores)	7.00	8.50	1.94	3.09	10.40
5. Average Lift (ft.)	100	300	100	110	200
6. Cusec feet	57,500	120,000	35,000	57,750	115,000
7. Cost of Lift works(pumps etc). @ Rs.354 per cusec feet(Rs.crores)	2.04	4.25	1.24	2.05	4.06
8. CCA(lakh acres)	2.00	1.15	1.15	1.70	1.75
9. Cost of distributaries and minors @ Rs.226 per acre of CCA (Rs.crore)	4.52	2.60	2.60	3.84	3.96
10. Total cost of lift systems(Rs.crores)	13.56	15.35	5.78	8.98	18.42

Total cost = Rs. 62.09 crores
Say Rs. 62 crores

NOTE:- In the Project Report all figures in respect of Lunkaransar-Bikaner Lift Canal are given in ft lb system. The figures for the new lift canals, which are based on that lift canal have, therefore, been given in ft. lb system, instead of in metric system, for facility of comparison.

Appendix IV
(Paragraph 5.36)

Suggested Cropping Pattern and Water Allowance on Rajasthan Canal

In arid regions, since there is shortage of water, it is necessary that the cropping pattern should be such as would give the best economic return per unit of water. Because of the fact that animal husbandry gives better return than arable crop raising and at the same time uses less water, but slightly more investment on the infrastructure, greater emphasis on fodder crops is suggested. In the suggested new cropping patterns, during kharif the area under cotton has been reduced while that under fodder crops has been increased. Similarly, during the rabi period, the area under wheat has been reduced while that under fodder has been increased. Peas are preferred to gram as it would give better return and more production under irrigated conditions. About 30 per cent of the CCA has been suggested under fodder crops, but when proper infrastructure for animal husbandry has been provided and the farmer finds it profitable, this area is likely to increase.

The monthwise water requirements of various crops, as indicated in the Project Report, have also been slightly modified in view of the results obtained through experiments at the various agricultural farms in the Rajasthan Canal command area operated by the State Government with the help of the UNDP/FAO. The water requirements indicated in the Rajasthan Canal Project Report 1970 are given in Statement II and the revised waterrequirements, as now proposed, in Statement III.

Statement II

Water Requirements of Crops at the Field
(Rajasthan Canal Project Report 1970)

Millimetres

Month	Kharif						Rabi				
	Light perennial fruits & veg.	Cotton	Hybrid Bajra	Ground-nut	Kharif Fodder	Pulses	Wheat & Barley	Gram	Mustard & Tara-mira	Sugar-beet	Berseem
April	225	150	-	-	-	-	-	-	-	125	225
May	225	150	-	-	-	-	-	-	-	-	-
June	225	150	-	188	113	113	-	-	-	-	-
July	150	150	113	75	150	75	-	-	-	-	-
August	150	150	113	75	150	75	-	-	-	-	-
September	150	150	113	75	-	75	-	-	-	-	150
October	150	75	75	75	-	-	188	113	100	113	150
November	75	-	-	-	-	-	-	-	75	75	150
December	75	-	-	-	-	-	75	100	75	75	75
January	75	-	-	-	-	-	75	-	75	75	75
February	75	-	-	-	-	-	75	100	75	150	150
March	150	-	-	-	-	-	75	-	-	150	225
	1725	975	414	488	413	338	488	313	400	763	1200

Statement III

Water Requirements of Crops at the Field (Revised)

Millimetres

Month	Kharif							Rabi				
	Light perennial fruits & veg.	Cotton	Hybrid Bajra or Jowar	Kharif Pulses	Ground-nut	Kharif Fodder Zaid* Fodder	Kharif** Fodder	Wheat	Peas	Mustard or Tara-mira	Rabi*** Fodder	Barseem@ or Lucerne
April	125	-	-	-	-	100	-	-	-	-	-	200
May	200	125	-	-	-	100	-	-	-	-	-	125
June	200	125	-	-	-	125	-	-	-	-	-	150
July	100	150	75	75	75	75	75	-	-	-	-	150
August	75	200	75	75	100	-	75	-	-	-	-	125
September	100	225	125	125	150	-	125	-	-	-	-	125
October	100	175	75	75	125	-	75	-	75	100	100	100
November	125	-	-	-	75	-	-	100	50	75	75	100
December	100	-	-	-	-	-	-	75	75	75	75	125
January	125	-	-	-	-	-	-	125	75	75	75	125
February	125	-	-	-	-	-	-	125	50	50	75	125
March	150	-	-	-	-	-	-	75	-	-	-	150
Total:	1525	1000	350	350	525	400	350	500	325	375	400	1600

* Napier, Guinee grass, Sudan, Sudan Jowar, Maize, Cowpeas.
** Jowar, Bajra, Pulses, Cowpeas, Guar
*** Oats, Peas, Mustard.
@ Berseem is sown in October and its cuttings are over in April. Lucerne is sown in May.

Appendix V

(Paragraph 6.3)

DISTRIBUTION OF TEHSILS IN DIFFERENT RAINFALL ZONES

D_2E_2	D_3E_1	$C_1D_1E_2$	$C_2D_1E_1$
Ganganagar 1. Karanpur 2. Ganganagar 3. Padampur 4. Raisinghnagar 5. Anupgarh 6. Sangaria 7. Hanumangarh 8. Tibi 9. Nohar 10. Sadulshahar 11. Suratgarh			**Ganganagar** 1. Bhadra
Churu 1. Sardarshahar 2. Dungargarh			**Churu** 1. Sujangarh 2. Rajgarh 3. Ratangarh 4. Churu 5. Taranagar
Bikaner 1. Bikaner 2. Nokha 3. Lunkaransar 4. Kolayat			
Jodhpur 1. Shergarh 2. Phalodi			**Jodhpur** 1. Jodhpur 2. Osian 3. Bilara
Jaisalmer 1. Jaisalmer 2. Pokaran			
Barmer 1. Pachpadra 2. Sheo		**Barmer** 1. Chohtan 2. Barmer	**Barmer** 1. Siwana
			Jhunjhunu 1. Khetri 2. Udaipurwati 3. Jhunjhunu 4. Chirawa

(~~Annexure~~ Appendix V contd:)

D_2E_2	D_3E_1	$C_1D_1E_2$	$C_2D_1E_1$
			Sikar 1. Neem Ka Thana 2. Danta Ramgarh 3. Sikar 4. Lachhmangarh 5. Fatehgarh 6. Sri Madhopur
Nagaur 1. Ladnu 2. Didwana 3. Nawa 4. Parbatsar 5. Degana 6. Jayal 7. Nagaur 8. Merta			**Pali** 1. Jaitaran 2. Sojat 3. Pali 4. Raipur 5. Kharchi **Jalor** 1. Jalor 2. Jaswantpura 3. Sanchore 4. Ahore
	Hissar 1. Dabwali 2. Sirsa 3. Fatehabad		**Hissar** 1. Hissar 2. Hansi **Bhiwani** 1. Bhiwani 2. Loharu 3. Dadri
			Rohtak 1. Jhajjar
			Banaskantha 1. Vav 2. Tharad 3. Deodar 4. Kankrej 5. Radhanpur 6. Santalpur
			Mehsana 1. Sami 2. Harij

Appendix VI

(Paragraph 6.5)

EXISTING CROPPING PATTERNS IN D_2E_2 AREAS

(HISSAR TEHSILS IN D_3E_1: REMAINING AREA IN D_2E_2)

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A. COTTON, WHEAT, GRAM AREAS

1. Cotton and wheat figure in patterns, but all crops in the range 10-30% of the gross cropped area;

$C_4W_4F_4$: GANGANAGAR - Karanpur, Ganganagar, Padampur.

$W_4F_4G_4C_4/O_4$: GANGANAGAR - Raisinghnagar, Anupgarh.

$G_4B_4W_4C_4/Jk_4$: HISSAR - Fatehabad.

2. Gram area 30-50% of the gross cropped area, rest crops in the range of 10-30%. Cotton and wheat also among rest crops.

$G_3B_4W_4C_4$: HISSAR - Dabwali, Sirsa

$G_3B_4F_4 / C_4 /W_4$ GANGANAGAR - Sadulshahar, Sangaria, Hanumangarh, Tibi, Nohar, Suratgarh.

B. BAJRA, PULSES

1. Pulses 50-70%, Bajra 30-50%

$Pu_2 B_3$: BIKANER - Bikaner, Nokha.

2. Pulses, Bajra all 30-50%

$Pu_3 B_3$: CHURU - Sardarshahar, Dungargarh
BIKANER - Lunkaransar

B_3Pu_2/F_3 : BIKANER - Kolayat
JODHPUR - Phalodi

3. Bajra increases to 50-70% and other crops reduce to 10-30% range.

B_2Pu_4/F_4Jk_4: JODHPUR - Shergarh

4. Bajra increases to more than 70% in area.

B_1 : JAISALMER - Jaisalmer, Pokaran
BARMER - Pachpadra, Sheo

Note: Three other tehsils of Barmer district also grow B_1 but they fall in $C_1D_1E_2$ and $C_2D_1E_1$ zone.

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Appendix VII

(Paragraph 6.5)

EXISTING CROPPING PATTERNS IN $C_1D_1E_2$ AND $C_2D_1E_1$ AREAS

$C_1D_1E_2$ AREA

B_1 : BARMER - Barmer, Chohtan

$C_2D_1E_1$ AREA

A. COTTON, WHEAT, GRAM, JOWAR Areas

1. Cotton 30-50%: other crops less than 30% of the gross cropped area.

C_3Jk_4 : MEHSANA - Sami

2. Areas where all these crops figure, but their spread within 10-30%

$G_4B_4W_4C_4Jk_4$: HISSAR - Hissar, Hansi
ROHTAK - Jhajjar

$B_4Jk_4W_4D_4/C_4/Gn_4$: MEHSANA - Harij

3. Gram increases to 30-50% range:

$G_3F_4B_4/W_4/C_4$: GANGANAGAR - Bhadra

B_3G_3 : BHIWANI- Bhiwani, Loharu, Dadri

B. JOWAR, BAJRA, PULSES, OILSEEDS, FODDER

1. All crops in 10-30% range

$B_4O_4Jk_4F_4Pu_4$: NAGAUR - Merta

$B_4D_4Pu_5Jk_4/W_4$: PALI - Raipur

$F_4B_4D_4Jk_4$: PALI - Kharchi

2. Bajra increases to 30-50%, other crops remain in the ranges 10-30%

$B_3D_4Jk_4F_4Pu_4$: PALI - Pali, Jaitaran, Sojat

C. OILSEEDS DROP OFF AND THE CHOICE STARTS GETTING RESTRICTED TO BAJRA AND PULSES/FODDER

1. Bajra still in 30-50% range, but other crops 10-30%

$B_3Jk_4F_4/C_4$: BANASKANTHA - Kankrej, Radhanpur

$B_3Pu_4F_4$: CHURU - Rajgarh
JODHPUR - Bilwa
NAGAUR - Nagaur

2. Bajra and pulses both in 30-50% range:

Pu_3B_3 : CHURU - Churu, Taranagar, Ratangarh
SIKAR - Sri Madhopur

B_3Pu_3/F_3 : CHURU - Sujangarh
JHUNJHUNU- Chirawa

Bajra increases to 50-70% range

$B_2Pu_4/F_4/Jk_4$: JODHPUR - Osian
JHUNJHUNU - Jhunjhunu, Khetri, Udaipurwati
SIKAR - Sikar, Fatehpur, Lachmangarh, Neem Ka Thana, Danta Ramgarh
NAGAUR - Jayal, Ladnu, Didwana, Nawa, Parbatsar, Degana
JALOR - Ahore
BANASKANTHA - Vav, Tharad, Deodar, Santalpur

4. Bajra becomes the sole crop (i.e. more than 70% in area).

B_1 : JODHPUR - Jodhpur
BARMER - Siwana
JALOR - Jalor, Jaswantapura, Sauchora.

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Appendix VIII

(Paragraph 10.4)

RAJASTHAN

REQUIREMENT OF OUTLAYS

(Period 15 years)

1. Pasture Development, Animal Husbandry and Dairy Development.

(Rs. crores)

Sl. No.	Programme	Total Cost	Commanded Area @	Remaining Arid Area
1.	Pasture development	43.00	-	43.00
2.	Cattle development	4.17	1.63	2.54
	(i) Artificial insemination	1.10	1.10	1.64
	(ii) Natural services	0.83	0.33	0.50
	(iii) Farms	0.60	0.20	0.40
3.	Dairy development	5.85	4.80	1.05
	(i) Chilling centres	1.95	1.35	0.60
	(ii) Milk products factory	3.00	3.00	-
	(iii) Feed mixing plant	0.90	0.45	0.45
4.	Sheep development	3.66	-	3.66
	(i) Sheep breeding farms	1.00	-	1.00
	(ii) Distribution of rams	0.22	-	0.22
	(iii) Shearing units	0.45	-	0.45
	(iv) Grading centres	0.44	-	0.44
	(v) Slaughter houses	1.00	-	1.00
	(vi) Stockyards	0.10	-	0.10
	(vii) Extension service	0.10	-	0.10
	(viii) Wool Board	0.25	-	0.25
	(ix) Assistance to Khadi Board.	0.10	-	0.10
5.	Camel development	0.25	0.25	-
	Total:-	56.93	6.68	50.25

@ See Part III B

Appendix VIII (Contd)

II. Forestry

(Rs. crores)

Sl. No.	Item	Total cost	Commanded Area *	Remaining Arid Area
1.	Canalside plantations	3.20	3.20	-
2.	Farm forestry	1.00	0.50	0.50
3.	Roadside plantations	0.96	0.48	0.48
4.	Shelter-belts	12.00	12.00	-
5.	Grass reserves	12.00	-	12.00
6.	Fodder banks	1.60	-	1.60
7.	Sand dune stabilisation	12.00	12.00	-
8.	Desert National Park	0.60	-	0.60
	Total:	43.36	28.18	15.18

See Part III B

III. Rajasthan Canal and its Commanded Area

A. Construction of Rajasthan Canal including share of Pong Dam and new Lift Canals

(Rs. crores)

	Total:	Expenditure till end of IV Plan and VI Plans	Balance in V
a) Share cost of Pong Dam etc.	99	85	14
b) Rajasthan Feeder upto Phase I	131	102	29
c) Phase II including new lift.	133	4	129
	363	191	172

B. Area Development Programme for the Canal Command Area

(Rs. crores)

Item	Total Requirement Public	Institutional
1. Land levelling	-	77
2. Watercourses with lining	-	124
3. Village sites and services	49	-
4. Agro Centres and services	11	33
5. Market and Mandi towns	-	212
6. Forestry and sand dune stabilisation	28*	-
7. Roads	47	-
8. Processing and storage of agricultural product	-	29
9. Animal Husbandry	2 @	30
10. Processing and marketing of animal products	5 @	4
11. Strengthening of cooperatives	3	-
12. Agriculture extension, demonstration and monitoring	15	-
Total:	125+28*+7@=160	509

* See part II

@ See Part I

Appendix IX

(Paragraph 10.4)

HARYANA

REQUIREMENT OF OUTLAYS

(Period 15 years)

1. Pasture Development, Animal Husbandry and Dairy Development.

(Rs. lakhs)

Sl.No.	Item	Total cost
1.	Cattle development	
	(i) Artificial insemination: Central A.I.Station with 50 Sub-centres	18.25
2.	Dairy development	105.00
	(i) Expansion of dairy products plant at Bhiwani	75.00
	(ii) Milk chilling plants at Loharu and Dadri	30.00
3.	Sheep development	18.50
	(i) Expansion of Hissardale and Nali Sheep flock at Govt. Livestock Farm, Hissar.	5.00
	(ii) Distribution of rams - 2000 rams	4.00
	(iii) Shearing & Extension Units	7.50
	(iv) Assistance to Khadi Board/ Small Scale Industries Department	2.00
4.	Pasture development	170.00
	Development of 20,000 hectares	
5.	Camel development	10.00
	(i) Stud Centres	
	Total:	321.75

Appendix IX(contd)

HARYANA

REQUIREMENT OF OUTLAYS

(Period 15 years)

II. Forestry

(Rs. lakhs)

Sl.No.	Item	Total cost
1.	Afforestation - 20,000 ha.	250
2.	Strip forests - 80,000 row km.	600
3.	Sand dune stabilisation - 20,000 ha	200
4.	Farm forestry	200
5.	Grassland development	-
	Total:	1,250

*The outlay for this programme has been included in the estimate for pasture development in part I of this Annexure.

Appendix X
(Paragraph 10.4)

GUJARAT

REQUIREMENT OF OUTLAYS
(Period 15 years)

1. Pasture Development, Animal Husbandry and Dairy Development.

(Rs. lakhs)

Sl.No.	Item	Total cost
1.	Cattle development	27.50
	(i)Distribution of 750 bulls	7.50
	(ii)Expansion of Kankrej Cattle Breeding Farm	20.00
2.	Dairy development	75.00
	(i) Chilling centres	
3.	Sheep development	30.00
	(i) Intensive Sheep Development Blocks	
4.	Grassland development	400.00
	(i)Development of 65000 hectares	
5.	Camel development	5.00
	(i)Establishment of Stud Centres	
	Total:-	537.50

Appendix X(contd)

GUJARAT

REQUIREMENT OF OUTLAYS

(Period 15 years)

II. FORESTRY

(Rs. lakhs)

Sl.No.	Item	Total cost
1.	Shelter-belts - 20,000 ha	300
2.	Farm forestry	20
3.	Mixed forestry, comprising raising of grass and leaf fodder, fruit trees and fuelwood trees - 15,000 ha	150
4.	Grassland Development *	
	Total:-	470

The outlay for this programme has been included in the estimate for pasture development in Part I of this Annexure.