INTERIM REPORT

OF THE

NATIONAL COMMISSION

ON

AGRICULTURE

ON

MODERNISING IRRIGATION SYSTEMS

AND

INTEGRATED DEVELOPMENT OF COMMANDED AREAS

GOVERNMENT OF INDIA
MINITRY OF AGRICULTURE
NEW DELHI

(FEBRUARY, 1973)

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SUMMARY OF RECOMMENDATIONS

1. With revolutionary progress in the science and technology of agriculture, many of the older systems of irrigation in the country do not meet the requirements of modern agriculture and call for modernisation.

(Paragraph 1.2)

Augmenting Irrigation Supplies

2. Where sufficient ground water is available in the canal command, its exploitation should be accorded high priority as results are almost immediate.

(Paragraph 2.1)

3. Application of relatively small amount of ground water to smooth out the irregularities of canal flows has been found to be extremely beneficial by bringing about a shift in the cropping pattern for higher value crops and larger gross sown area. Economically, the arrangement is fully justified. Installation of tubewells in canal commands for conjunctive use should be encouraged where conditions are suitable.

(Paragraph 2.3)

4. If in a canal command, a cultivator chooses to irrigate exclusively from his own well or tube-well despite availability of canal water, it would be justifiable to charge him an irrigation cess to cover the cost of maintenance and operation of the irrigation facility.

(Paragraph 2.4)

5. In most States, there are restrictions on sinking tubewells or wells within a prescribed distance of irrigation channels. These should be reviewed with a view to relaxing them to the extent feasible in the interest of larger conjunctive use of surface and ground water.

(Paragraph 2.5)

Reducing Transit Losses—Lining

6. Not all the water that seeps from canals can be got back by pumping as a substantial portion of it is irretrievably lost through evapotranspiration. Both from consideration of cost and the quantity of water saved, lining is the better alternative than pumping.

(Paragraph 3.3)

7. As water courses on new projects are constructed at Government cost, the Commission recommends that lining of water courses on

all projects—old and new—and the subsequent maintenance, should also be done at Government cost. Maintenance of unlined water courses should continue to be the responsibility of cultivators.

(Paragraphs 3.8 and 3.9)

8. The Intensive Agricultural Programmes should concern themselves also with the proper conveyance and application of irrigation water in the field.

(Paragraph 3.10)

9. The work of lining has a good employment potential in rural areas. This aspect should be borne in mind.

(Paragraph 3.11)

Application of Irrigation to Fields

10. In many irrigation projects, there is need for propagating the most suitable method of irrigation taking into consideration the terrain and the nature and depth of soil and carrying out land shaping to the extent necessary. This calls for an organised effort on the part of Agriculture Department and financial support from institutional sources for land shaping.

(Paragraph 4.11)

11. Irrigation water in black cotton soils should be applied at a low rate for sufficient length of time to enable the total irrigation water to soak down. Good drainage in these soils is very important.

(Paragraph 4.12)

Importance of Drainage

12. There should be adequate provision for drainage in irrigation schemes. This has not always been the case.

(Paragraph 5.2)

13. To be effective, the drainage system should extend to field drains. Also, for efficient functioning of drainage, the nalas lower down have to be kept clear of all obstructions. States should review their powers in respect of these matters and assume adequate powers where they are deficient.

(Paragraphs 5.3 and 5.4)

14. It would be proper that the responsibility for construction and maintenance of field drains should correspond to that for water courses and field channels. The extension staff should provide the necessary technical guidance to farmers in the matter.

(Paragraph 5.5)

Crop Planning in Irrigation Projects

15. In adopting any particular cropping pattern its long term effect on soil fertility should be carefully considered.

(Paragraph 6.6)

16. Higher production can be secured by choosing crops and varieties whose water requirements correspond more closely to the availability of supplies in the irrigation system.

(Paragraph 6.7)

17. State Governments should equip themselves with necessary legal powers, where these are inadequate, to enforce changes in cropping pattern where considered necessary in the overall interest of the community.

(Paragraph 6.9)

Operation of Irrigation System

18. Canal systems should have proper regulatory structures so that individual channels can be closed or run to suit the demand.

(Paragraph 7.2)

19. Supplying canal water to scattered patches of land for nurseries leads to considerable waste of water. If nurseries are raised in compact blocks, preferably in the head reaches of minors, on a commercial scale either by Government or by Co-operative Societies, it would lead to economy in the use of water. Alternatively, the nurseries should be raised with ground water if that be adequately available in the area.

(Paragraph 7.3)

20. The scheduling of irrigation supplies should aim at meeting the water requirements during crucial stages of plant growth. For operating channels to the best advantage, the Irrigation Engineer should consult the Agricultural Officer well before a crop season.

(Paragraph 7.4)

Integrated Development of Commanded Areas of Major and Medium Irrigation Projects

21. The provision for marketing, storage and communications under the Central Sector of the Plan has proved extremely beneficial to the commanded area development projects. The Commission recommends that this Central Sector Programme should continue on a larger scale during the Fifth Plan period and should cover, in addition to the larger commands already taken up, a comprehensive number of major and medium irrigation projects where irrigation development is inhibited for lack of infra-structural facilities. Where necessary, this programme should also finance these developments in projects the construction of which would be continued or taken up in the Fifth Plan.

(Paragraph 8.7)

22. The Commission recommends that the integrated pilot projects under the commanded area programme proposed by the Planning Commission for the Fifth Plan should be taken up under the Central Sector and worked out expeditiously so that guidelines for other areas could be laid down quickly.

(Paragraph 8.8)

Pattern of Financing Ayacut Development Programme

23. Credit has been the main difficulty in the implementation of the commanded area development programme. The Commission has two alternative suggestions to make in this regard. The State can form a Land Improvement Corporation which can take up the entire work of land shaping, construction of channels and drains as also ground water units and recover the investment with interest from the produce per hectare on an agreed formula. In the alternative, the concept of Farmers' Service Society, recommended in the Commission's Interim Report on "Credit Services for Small and Marginal Farmers and Agricultural Labour" can be adopted. A comprehensive arrangement for long, medium and short term credit is the most important aspect of the whole problem of agricultural development.

(Paragraphs 9.2 to 9.4)

Administration and Coordination of Ayacut Development Programme

24. A comprehensive programme of ayacut development requires a well-planned and coordinated effort for which there has to be a suitable organisation. A time-phased master plan should be prepared for which a suitable officer of the Agriculture Department should be nominated as a Coordinator. Any additional staff required for preparing the master plan should be provided.

(Paragraphs 10.1 and 10.2)

25. At the implementation stage, it is necessary to set up a special administrative agency headed by a technical person with adequate administrative background. Technical Officers required for this programme should be seconded to this agency but should keep liaison with parent departments for technical guidance on complex problems. A separate organisation is recommended for each project costing more than Rs. 10 crores, and one for all others together in each State.

(Paragraph 10.8)

26. At the State headquarters, a Committee of Secretaries and the Heads of the Departments concerned under the chairmanship of Chief Secretary should supervise and review the work of ayacut development. This Committee should decide matters referred to it and give any directions to the ayacut development authorities considered necessary.

(Paragraph 10.10)

27. In the post-implementation stage, after the main items of ayacut development are done, the task of the special organisation would be mostly over and further routine work can revert to the departments and organisations concerned.

(Paragraph 10.12)

Review of Pre-Plan and Earlier Plan Schemes

28. The Commission recommends that a comprehensive review of pre-Plan and earlier Plan projects should be carried out in order to modernise them for better service to present day agriculture.

(Paragraph 11.1)

29. The review should be made by a team of specialists in irrigation engineering, agronomy and soils. The responsibility for the reviews has to be that of Irrigation Department, the Agriculture Department making other specialists available for forming the team.

(Paragraph 11.2)

30. At the instance of the Commission, some projects have been reviewed by the States concerned. These reviews, though not comprehensive in all cases, have shown scope for improvement in respect of:

(i) saving on water losses by lining channels;

(ii) raising of rice nurseries with carry over water of a reservoir or with ground water, and advancing the date of transplantation for higher yield;

(iii) adoption of shorter duration varieties of rice thereby saving on supply from reservoir for use in ensuing rabi;

(iv) land levelling in ayacuts for better use of irrigation water in the fields;

(v) construction of water courses and field channels as also field and service drains; and

(vi) introduction of Warabandi.

(Paragraphs 11.5.1 to 11.9.8)

31. It may not be practicable to carry out all the improvements on a project simultaneously on account of financial and other constraints. But there should be a clear picture of the total improvement which is to be brought about and the work on individual aspects should be so carried out as to ultimately fit into the overall plan of improvement.

(Paragraph 11.10)


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INTERIM REPORT
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SECTION I

INTRODUCTION

1.1. The present assessment of irrigation potential of all the economically utilisable water resources of the country, both surface and underground, places it at about 93 million hectares, which would be only about half of the total area under crops. These resources are not evenly distributed and vary from abundant in the Indo-Gangetic plain to negligible in the Saurashtra-Kutch region of Gujarat, the south-western part of Rajasthan and other arid regions. In the drought affected area, which comprises about 16 per cent of the total geographical area of the country, the irrigation possibilities are meagre. With full harnessing of the water resources only about one-fourth of the cropped area there would be irrigated. With half of the cropped area in the country having to remain rainfed and a much larger proportion in the drought areas having to be content with precarious rainfall, it becomes important that the irrigation facilities should be utilised with utmost efficiency to derive the maximum benefit from them and serve a larger area.

1.2. In recent years, the science and technology of agriculture has made revolutionary progress and given rise to new patterns of demand for inputs amongst which irrigation is an important one. These demands have to be met satisfactorily for optimum production. Many of the older irrigation systems in the country, and even some of the more recent ones, do not meet the requirements of modern agriculture adequately and call for modernisation. The Irrigation Commission (1969-72) has dealt with at some length the question of improvements to existing irrigation systems in order to increase their efficiency and usefulness. It has pointed out that in the run-of-the-river schemes, which derive their supply of water solely from diversion works on rivers, shortages are experienced during the low stage of river flows which occur in summer in the peninsular rivers and in winter in the Indo-Gangetic rivers. The earlier irrigation systems of north India were designed with low intensities and cultivators given a share of water proportionate to their holdings in the commanded area. They have naturally been applying water thinly to irrigate as much area as feasible. This mode of irrigation is not conducive to high yields, particularly from high yielding varieties.

The Commission has further pointed out that on many irrigation systems, the channel capacities are inadequate for meeting peak demands during crucial periods like transplanting of rice, Kor irrigation of rabi crops, etc. Because of inadequate channel capacities, the period of irrigation during these crucial stages gets prolonged resulting in lower yields. Tail reaches of canals suffer most from these inadequacies.

1.3. Apart from structural improvements of these projects, such as remodelling of headworks where the existing ones are not functioning satisfactorily like the Tajewala and Okhla weirs, providing regulators and escapes for better control in the operation of canals, enlarging channel capacities where necessary, improvement of drainage in the commanded area, etc., the Irrigation Commission has recommended that inadequate supplies in the canals should be supplemented by providing storage backing where feasible, diverting surplus water from another basin and the use of ground water. Also, the Commission has recommended a review of the existing projects with a view to improving their efficiency and usefulness.

1.4. In addition to any improvement of engineering works and augmentation of supplies, the existing projects have to be modernised by cutting out avoidable losses, making the best use of the available supplies by scientific application of water in the field, proper choice of cropping pattern and judicious regulation of supplies. Therefore, while we fully support the recommendations of the Irrigation Commission referred to in the preceding paragraph, we would like to emphasise the importance of making a comprehensive review of the old and earlier Plan projects in order to make them serve the needs of present day agriculture better. Also, in our view, it is important that there should be no undue delay in the development of ayacuts. For this an integrated programme covering all facets of this development has assumed urgency. In order that action on these important matters is taken without loss of time and reasonable funds are provided in the Fifth Plan for the purpose, we have considered it necessary to make an interim report on them.

1.5. The Commission issued a Questionnaire to States with a view to studying the measures which would be necessary for integrating development programmes in the commands of major and medium irrigation projects. The Questionnaire is reproduced at Appendix I. The Commission also requested a few States to review some medium sized storage projects which have been in operation for some years in order to get an idea of the scope of improvement in these projects and to establish a methodology for such reviews. The Commission visited, in this connection, three projects viz., the Badua Project (Bihar) in February 1972, the Ghod Project (Maharashtra) in October 1972 and the Harsi Project (Madhya Pradesh) in December 1972. During these visits, the results of the studies carried out by the State authorities were discussed with them. Broad conclusions and views in respect of these projects are given in the latter part of this Report.

SECTION II

AUGMENTING IRRIGATION SUPPLIES

2.1. In reviewing irrigation systems, the possibility of creating additional storage reservoirs higher up the river or the transfer of surplus water from another river basin to augment the irrigation supplies has to be examined. This would require field investigations if the schemes have not already been investigated. These would be long term measures. Deficiencies in supplies, however, can be met in a relatively short period by exploiting ground water where available, or by direct pumping from the river where feasible as has been done on the Ganga river to supplement supplies of the Sarda Canal. In tracts where sufficient ground water is available, we recommend that its exploitation should be accorded a high priority, as results are almost immediate and benefits keep on accruing with the pace of investment.

2.2. There are several ways in which a combined or conjunctive use of surface and ground water can be made. It can take the form of supplementing canal supplies with water from State owned tubewells or use of water from private tubewells and filter points in the ayacut for irrigating the same or additional area during periods of low canal supplies or canal closures. State tubewells can be sunk to irrigate high patches of land in the canal commanded area. Also, in irrigation systems which run for one crop season only, ground water could be used for a second or third crop.

2.3. A question can be raised about the economic justification of making an investment on ground water in canal served areas. That it is fully justified is amply shown by the numerous private tubewells and dug wells which are coming up in canal commands in north India. Application of relatively small amounts of tube-well water to smooth out the irregularities of canal flows has proved extremely beneficial by bringing about a shift in the cropping pattern for higher value crops and larger area under irrigation. In a study made in Pakistan* a few years ago it was shown that an additional supply from tubewells of only 15 per cent of the canal supplies could more than double the net value of production and increase the gross sown area by 30 per cent with better cropping pattern. We recommend that an organised attempt should be made to encourage installation of tubewells in canal commands where conditions are suitable. For this credit facilities and technical advice should be provided liberally.

*Report on Land and Water Development in the Indus plain—1964.

2.4. The Irrigation Commission has dealt with the question of water rates for conjunctive use of surface and ground water. It has suggested normal irrigation rates where canal supplies are augmented by State tubewells, or where a cultivator supplies supplemental water from his own well or tubewell to canal irrigated fields thereby deriving additional benefit. That Commission has suggested that if in the canal commanded area a cultivator irrigates exclusively from his own ground water source, when canal water is not available or is available inadequately, he should not be charged any water rate. We agree with these recommendations. However, where in a canal command there is adequate supply of canal water and a cultivator still chooses to irrigate from his own well or tubewell, the position becomes different. Such a situation is covered by a recommendation made by the "Committee to Suggest Ways and Means of Improving Financial Returns from Irrigation Projects" set up by Government of India in 1964. This Committee of Ministers recommended that "In States where irrigation charges are optional, in consideration of the irrigation facilities having been made available for an area, there should be a charge to cover at least the maintenance and operation charges, whether the facility is actually made use of or not". We are in agreement with this recommendation, already adopted in a number of States.

2.5. In most States, there are some restrictions in exploiting ground water in the canal commanded areas. Generally, these are in the nature of prohibition of sinking of wells or tubewells within a prescribed distance from the canal or distributary. In Gujarat and Maharashtra, if irrigation is done with water from a tubewell or well located within 30 metres of a Government canal, full water rates are levied as for flow irrigation from canals. In Mysore State, the restrictions are more stringent. Here no well or tubewell is permitted within a distance of 150 metres of main canal, 30 metres of branch canal and 7.5 metres of a distributary having a discharge of less than 0.3 cumec (10 cusecs). Also, in the perennial zones, no new well is permitted except in high patches where flow irrigation from canal is not feasible. Even there, half the canal water rate is charged. In U.P., private tubewells are discouraged within 100 metres of a canal and 200 metres of a State tubewell by refusing electric connection for the pumps. A farmer can, however, use diesel power and get away with it. In West Bengal, the State Government would not permit pumping within a distance of 600 metres from a canal or the nearest tubewell. Madhya Pradesh authorities have expressed the view that pumping of ground water should not be allowed closer than 300 metres from a canal and 450 metres from a tubewell in the alluvium, and 900 metres in rocky areas. Thus, the restriction in respect of exploitation of ground water in the proximity of irrigation channels varies from State to State. The main object of these restrictions has been to prevent increase in the channel losses due to withdrawal of ground water from their proximity. Also, water charges are levied on the ground

that canals contribute to replenish ground water in the area. These reasons lose much force where channels are lined. Experiments have shown that when wells or tubewells are sunk close to irrigation channels, the resulting depression in the ground water table induces heavier percolation and seepage losses. Except where channels are lined, therefore, it would not be desirable to permit tubewells or open wells too near the canals. The area of influence of a tubewell or well depends on the rate of pumping and the texture and depth of soil. As soil conditions vary from State to State and even area to area in the same State, there can be no uniform norm for these restrictions. But in several States, the restrictions lean towards abundant caution to the detriment of fuller use of ground water. We, therefore, recommend that States should review these restrictions with a view to relaxing them to the extent feasible in the interest of larger conjunctive use of surface and ground water and increasing the scope of irrigation.

SECTION III

REDUCING TRANSIT LOSSES—LINING

3.1. At a symposium on canal lining held in 1960, it was reported that unlined canals in India carried a discharge of about 11,300 cumecs and that lining of channels could save enough water to irrigate an additional six million hectares. No fresh appraisal has since been made but as several new projects have been completed during this period, the figures would now be higher. However, not all these channels can be lined for reasons of cost and practicability. For rice crop water has to be kept standing in the field for most of its growth period during which time water percolates from the entire field. Under these conditions saving of percolation from a water course loses significance. Also, in other areas, channels may not require lining in reaches of low permeability. Nevertheless, the possibility of saving an enormous quantity of water by lining channels is obvious. The water thus saved can be utilised for making up inadequate supplies or irrigating more area.

3.2. In general, the seepage losses on small channels are relatively greater because the ratio of wetted area to volume of water carried is higher. It might be stated that depth of water in a channel has only a marginal effect on the rate of percolation. Poor maintenance so common on the smaller channels, and in many cases rat holes, add to the losses. Lining of smaller channels, therefore, bestows greater benefit, costs relatively less and is easier to carry out. But it can be argued that the smaller channels generally run for less time, which counters these advantages to some extent. In working out the economics of lining a channel, all these factors have to be considered.

3.3. The possibility of reclaiming the seepage loss from a canal by pumping ground water, as an alternative to preventing the loss by lining, needs to be examined. The main considerations in the choice would be the extent of saving in cost and water. In a scheme, prepared by the Government of Andhra Pradesh for supplemental irrigation by pumping ground water in the Krishna and Godavari deltas, the capital cost worked out to about Rs. 620 per hectare. Against this, lining of channels was estimated at Rs. 500 per hectare. The cost of maintenance of lined channels is relatively small but that of pumping considerable. In fact, in this particular case, the cost of pumping operation for two years would be as much as the total cost of lining the channels. In the hard rock areas, the cost of extraction of ground water is significantly more than in alluvium but not so the cost of lining, which tilts the balance further in favour of lining. As regards retrievement of water lost through seepage

and percolation, it is to be observed that not all that water reaches the ground water table. According to Central Ground Water Board a third to half of the seepage water gets absorbed in the top layers of adjoining soil depending upon its nature, and is lost through evapo-transpiration. Of the remaining quantity that reaches the ground water table only about 70 per cent can be drawn out locally. The rest regenerates elsewhere where it may or may not be utilisable. Against this, lining would save more than 80 per cent of the loss. It, therefore, appears that both from consideration of cost and the quantity of water saved, lining is the more desirable alternative.

3.4. The Dhorighat Pilot Project for Soil and Water Management in Azamgarh district, U.P., was taken up in 1968-69 to demonstrate improved methods of soil and water management. A report on this project revealed that there it was not economic to line field channels which served an area of less than 6 hectares or which ran for less than 400 hours in a year.

3.5. In several States, like Gujarat, Haryana, Tamil Nadu, etc., farmers have started using concrete pipes for distribution of water to the fields. The pipes are laid underground at a depth of a couple of feet and the land remains available for growing crops except for the deep rooted ones. The pipelines once properly laid and made leakproof require little subsequent maintenance. These do not interfere with farming operations as they offer no obstruction. As the pipelines operate under pressure, these can be laid on undulating terrain uphill or down without having to follow a contour or requiring levelling of land. These are particularly suitable where water is pumped from a well or a tubewell, as the well or tubewell need not in that case be located at a high point in the farm and can be at the most convenient spot. Pipelines can be used with advantage on contour canals also where the slope of land provides the necessary gradient for flow of water through pipes. Pipelines have an initial high cost but in many situations the saving of high value land and precious water, low cost of maintenance and adaptability to uneven terrain make them amply worthwhile.

3.6. In Haryana, the cost of pipelines laid in position is working out to about Rs. 20 per metre for unreinforced pipes and about Rs. 25 per metre for reinforced pipes. These figures show the order of cost involved in laying underground cement concrete pipelines. Costs in other States may be somewhat higher or lower. As against these costs, the cost of a lined water course excluding that of land would be in the range of Rs. 7 to 12 per metre length depending on the specifications. Where land cost is Rs. 30,000 per hectare or more, it would be desirable to make a comparative study to see whether pipeline would not be the more economical means of conveying water apart from its other advantages.

3.7. The responsibility for determining the need for lining canals, distributaries and minors as also for construction and subsequent maintenance, must necessarily rest with the Irrigation Department. Government should provide funds for lining from Plan resources as for new works. The position in the case of water courses and field channels is different. On major and medium irrigation projects, a distinction is made between water courses and field channels. The former is built at Government expense to convey water from an outlet to a 40 hectare block or as may be prescribed. Beyond the water courses, farmers have to construct field channels. The responsibility for maintenance of both water courses and field channels lies with the beneficiaries.

3.8. Since it is an accepted policy that water courses are to be constructed at Government cost, it follows that their lining, both on new and existing projects, should also be carried out at Government cost. On existing projects, it would not be practicable to do this work at the cost of the beneficiaries. The water saved on lining can be utilised to make the supplies more adequate where these are inadequate or to increase the intensity of irrigation in the existing ayacut or to extend irrigation facilities to new areas. In the first case, Government would be merely discharging its responsibility of providing adequate irrigation. There would, however, be a case for raising tariff if it had been pitched low on account of inadequacy of supply. In the other two cases, additional revenue will accrue to the State. Lining of water courses is best done by the Irrigation Department as work done through Panchayat Samities or any other non-technical body is not likely to be satisfactory. Also, although lining of water courses may appear a simple matter, for a large scale operation the choice of suitable material and the specification to be adopted from point of view of impermeability, durability and cost would entail research and experiments. These can more suitably be carried out in the research stations of Irrigation Department.

3.9. A point for consideration would be whether beneficiaries should continue to be responsible for the maintenance of water courses even after these have been lined. The maintenance of a kutcha water course is a simple matter as it involves only earthwork which a farmer can do himself. Repairs to a lined water course would require materials not readily at the disposal of farmers and the services of a mason. Any organisation like a Panchayat or a Cooperative would attend to repair work only when the damage becomes extensive and serious. On the other hand, a department which has these facilities at its disposal could attend to damages before these become large thereby saving on repair costs and wastage of water. We are, therefore, of the view that Government should assume responsibility for the maintenance of lined water courses, the beneficiaries continuing to be responsible for the upkeep of unlined ones. Some strengthening of field staff may become necessary where the mileage of lined water courses is considerable.

3.10. For deriving full benefit of lining, certain other steps need to be taken in advance or concurrently. While unlined water courses, and more so field channels, can be easily realigned to suit any changed disposition of land holdings, not so the lined channels which are more permanent in nature. Also unlined water courses do not always follow the best alignment. Where a programme of lining water courses is taken up, their alignment should be reviewed and improved. This operation is best taken up in conjunction with land improvement and consolidation of land holdings. The advantage of saving water in an ayacut by lining water courses and field channels would be only partial if wasteful application of water continues for want of proper land shaping. In fact, the programme of lining should form part of a wider programme of improvement of agriculture in an area. Hitherto even the Intensive Agricultural Programmes have not seriously concerned themselves with the proper conveyance and application of irrigation water in the field. It is important that these matters should receive due attention in agricultural development programmes.

3.11. Lining of water courses has a good employment potential spread over a large rural area. A hectare of irrigated land normally requires about 75 metres of water course. If half of the irrigated area of 20 million hectares at present served by major and medium irrigation projects is to have lined water courses, about 750 thousand kilometres would have to be lined. This would cost about Rs. 600 to 700 crores and provide employment of more than a million man-years.

SECTION IV

APPLICATION OF IRRIGATION TO FIELDS

4.1. In an irrigation system, the extent of benefit which can be derived from the available supplies depends in no small measure on the efficiency with which water is applied in the fields. The criteria for good irrigation are: uniform application of water in adequate quantity and at the correct time, minimum waste of water through deep percolation and surface run-off and least soil erosion and damage to land. There are four different methods of irrigation, namely (i) surface, (ii) sub-surface, (iii) sprinkler, and (iv) drip or trickler. The method most suitable in a given situation depends on the nature of terrain, the depth and permeability of soil, type of crops grown, quality of water, cost of labour and the economics and efficiency of the method in relation to the profitability of irrigating the crop.

4.2. The method of surface irrigation is the one which is most commonly used. It can be in the form of check basin, border strip, furrow, corrugation or contour ditching. For efficient surface irrigation, land has to be fairly even and reasonably level. If the terrain is uneven, proper land formation becomes a pre-requisite for any form of surface irrigation.

4.3. The method of check basin irrigation is specially suited to heavy soils with low infiltration capacity. The land has to be fairly flat with grades less than 0.1 per cent and with practically no cross slope. It is suitable for close growing crops sown on medium to coarse textured soils and for rice grown on heavy soils. Size of the check basin depends upon the stream size and the type of soil. The preparation of check basins is somewhat expensive and the basins are not conducive to the unhampered use of farm machinery.

4.4. The border strip method of irrigation is well suited for close growing crops and also for some row crops like cotton. This method can utilise larger stream flow safely. It requires less labour. The width of the border may range from 3 to 10 metres, depending upon the stream size. The longitudinal slope can vary from 0.1 to 0.25 per cent for heavy soils and 0.20 to 0.60 per cent for sandy soils; the border length can be between 60 and 250 metres.

4.5. Furrow irrigation is eminently suited for row crops like maize, sorghum, sugarcane, cotton, tobacco, groundnut, potatoes and vegetables. Furrows may be laid along the slope of the field in the case of gently sloping land or may be laid across the slope when the down slope exceeds the safe limit of 5 per cent. The latter are called contour furrows.

For most annual crops, spacing of furrows more than 75 cm is not desirable. On fine and medium textured soils, cross slopes upto 8 per cent are satisfactory when furrows are 22—25 cm deep. On coarse textured soils, the upper limit for cross slopes is 5 per cent. Furrow irrigation requires less quantity of water than the border strip method as only part of the land has to be wetted, which saves on evaporation losses.

4.6. Contour furrows are used in all soils except the very light sandy soils and soils which crack on drying. On light textured soils, the slope along the contour furrow must not exceed 4 per cent. Land which is too steep for furrows may first have to be bench-terraced and the furrows made on the benches.

4.7. Corrugations are suitable for irrigating close growing crops on slopes or rolling land as also on soils with low permeability. Normally the slope should not be less than 1 per cent and can be as high as 8 per cent where run-off from rain is not a serious problem and the irrigation supply is properly controlled. Spacing of corrugations more than 75 cm is not desirable. For efficient irrigation, these should be closer but not less than 40 cm apart.

4.8. Contour ditching is the cheapest method of surface irrigation. The application efficiency is, however, low as uniform water application is difficult to achieve. This method is suitable for close growing crops on rolling lands. The spacing of ditches is determined by soil texture and slope and can vary from 15 metres for 0.5 per cent slope to 75 metres for a fine textured soil with 1 to 2 per cent slope.

4.9. For purposes of this report, the other methods of irrigation—subsurface, sprinkler and drip—are less important, being mostly in the research stage and very little in use. In subsurface irrigation method, water is applied beneath the ground surface usually by creating and maintaining an artificial water table at some predetermined depth, depending on the rooting characteristics of the crop grown. Moisture reaches the plant roots through capillary action. In the sprinkler method of irrigation, water is applied from above as a spray somewhat resembling rainfall. This method is finding favour in coffee plantation on sloping and undulating land and has given higher yields. In drip irrigation, water is provided, drop by drop, through perforations in pipes to keep the soil around plants constantly wet. This method is suitable for irrigating orchards and vegetables in desert areas where water is very scarce.

4.10. A statement in tabular form of the land slopes, soils, quality of water, crops for which the different methods of irrigation are suitable along with their order of cost and efficiency is given at Appendix II for ready reference.

4.11. In many irrigation projects, there is need for propagating the most suitable method of irrigation after studying the terrain and the

nature and depth of soil, and carrying out land shaping to the extent necessary. This calls for an organised effort on the part of Agriculture Department and financial support from institutional sources for land shaping.

4.12. There are large tracts of heavy black soils in the country. Besides the Deccan trap area, black soils predominate in Bellary district (Mysore), Kurnool and Cuddapah region (Andhra Pradesh), Surat and Broach districts (Gujarat) and Jalaun and Banda districts (U.P.). These soils have unique irrigation characteristics. They crack when dry and swell when wet. They have a good water holding capacity but have a low rate of infiltration. Therefore, irrigation water has to be applied at a low rate for sufficient length of time to enable the total irrigation water to soak down. This requires that the field strips should have a flat grade. The heavier the soil the flatter the grade has to be. Studies conducted at Siruguppa Research Station have shown that in Tungabhadra Project area for efficient water management in black soils, a land grading of 0.05 to 0.5 per cent is required. Under the Water Management Pilot Project in Bellary district, fields have been levelled to a grade of 0.2 to 0.6 per cent. Good drainage in these soils is most important to prevent their becoming soggy with rain water or excessive irrigation water held in the root zone. When there is insufficient natural moisture to germinate seed, it is preferable to give a preplant irrigation, as irrigation after sowing in the dry would wash some of the seed and fertiliser into the soil cracks. The rate of infiltration in these soils being low, once wet there is not much of percolation loss from channels and water courses. But when channels are first opened for irrigation, a good deal of the water is lost in the cracks. Also unlined channels running for some time lead to waterlogging of the adjoining areas. These considerations have to be kept in mind in planning irrigation in black soil.

SECTION V

IMPORTANCE OF DRAINAGE

5.1. Crops suffer damage when there is excess water in the soil in the root zone, as it retards aeration. In soils which are too wet and roots tend to spread out near the surface and remain shallow. This reduces the volume of soil from which the plant may draw nutrients. It also makes the plant more vulnerable to subsequent drought conditions as the shallow roots may fail to avail of the sustaining moisture which may be present further down. The susceptibility to damage due to excessive soil moisture differs in different crops as also in the stages of their growth.

5.2. In all irrigation systems it is important to provide adequate drainage. Water percolating from irrigation channels and irrigated fields can raise the ground water table and cause waterlogging and salt efflorescence. For want of proper drainage, large areas on some of the old irrigation systems became waterlogged and salt infested, particularly in the alluvial plains of north India. Subsequent remedial measures in the shape of extensive drainage works and shallow tubewells to depress the ground water table have not restored the damaged lands to their original health. In recent years, there has been increasing awareness of this problem and it has been laid down that in all new irrigation schemes, there must be adequate provision for drainage. It is, however, noticed that these provisions are not always adequate and that the drainage is not planned comprehensively. We wish to emphasise the importance of drainage in irrigation systems.

5.3. To be effective, the drainage system should extend to field drains. Field drains are required not only for crops requiring light irrigation but also for rice fields. It is important to remove unwanted water from rice fields, particularly during the stage of seed bed preparation and harvest. Even during the growth period of rice periodical draining of water has been found beneficial. In recent drought years, it was experienced that short breaks in the supply of water to rice fields had resulted in higher yields.

5.4. For the efficient functioning of drainage system in irrigated areas, the nallas lower down have to be kept clear of all obstructions. These natural waterways are apt to be encroached upon for illicit cultivation and blocked for lifting water for irrigation or catching fish. The responsibility for the proper maintenance of these should be placed squarely on some department. In most States, this responsibility lies with the Irrigation Department. Irrigation Acts in some of the States

empower Government to construct and maintain field and other drains, and in most States to prohibit the creation of obstructions in notified streams and drains. The States may review the position in this regard and assume adequate powers, where these are deficient.

5.5. Whereas water courses and field channels are constructed to carry water to individual fields, field drains are required to take away the surplus water from there. It would be proper that the responsibility for construction and maintenance of field drains should correspond to that for water courses and field channels. The construction of water courses upto a 40 hectares block or as may be prescribed is the responsibility of project authorities and their subsequent maintenance that of the beneficiaries. The same should apply to field drains. Within the prescribed block, the construction and maintenance of field drains may be left to the farmers who should be provided with proper guidance in the matter of alignment and design by the Extension staff.

5.6. In designing field drains, a balance has to be struck between the need of speedy removal of surplus irrigation or rain water and the loss to cultivation of the area occupied by the drains. The spacing of field drains has to take into account the soils and the topography. The Water Management Division of Ministry of Agriculture has recently brought out a hand book for agricultural drainage, which provides useful guidance for the field staff.

SECTION VI

CROP PLANNING IN IRRIGATION PROJECTS

6.1. In planning water use in a canal system, the important points to consider are: what to grow in the light of available supplies of water, climatic conditions, land capability, and above all profitability to the farmer; on how much area to grow the selected crops; when and how often to irrigate; and how much water to apply. A fair amount of information on these various aspects is already available for various agro-climatic situations as a result of research work done over years.

6.2. Water requirements of crops depend primarily on climatic and soil factors. Broadly speaking, crop season in India is predominantly kharif followed by rabi. The area under cultivation during hot weather is very small being less than 5 per cent. During kharif, the monsoon meets a substantial part of water requirement of crops.

6.3. The irrigation policy, referred to later in paragraph 11.3, would ordinarily guide the choice of crops for the project area. But this choice is fairly flexible and wide and within the policy frame should ordinarily be left to the farmer so long as the crops chosen are suitable from consideration of water delivery schedule and soil characteristics. Illustratively, Table 1 shows crops which fit in different ranges of total utilisable water available during kharif and rabi. Table 2 gives duration of important crop species.

TABLE 1—*Crops for Different Ranges of Water Availability*

Water Supply (mm) Total	Kharif Crops	Rabi Crops
150—250	Green manure crops (sunhemp, sesbania)	
250—400	Pearl millet; sorghum & maize fodder; pulses; greengram, blackgram; oilseeds; castor, sesame; agave.	Barley; gram peas, safflower, sunflower, linseed, mustard.
400—600	Sorghum; groundnuts; soyabean; tobacco; cotton; vegetables.	Wheat, barley, sorghum, potato, onion and coriander.
600—1000	Maize; cotton; jute; vegetables; turmeric; ginger.	Berseem, lucerne.
More than 1000	Rice	

TABLE 2—*Duration of Important Crop Species*

Duration (days)	Crops
Less than 60	Leafy vegetables; green manure crops; forage crops.
60—90	Vegetables ; forage crops, pearl millets; maize for cobs; green gram; black gram.
90—120	Rice, sorghum; wheat; maize; groundnut; barley; safflower; Jute linseed; sunflower, vegetables; gram; mustard; soyabean; tobacco;
120—150	Rice, sorghum; wheat; cotton; groundnut; vegetables; jute, safflower gram; mustard; soyabean; tobacco.
150—180	Rice; sugarbeet; berseem; lucerne; turmeric; ginger; pigeon pea.
More than 300	Sugarcane.

6.4. Within limits some extra moisture stress does not seriously affect yield. Therefore, flexibility in scheduling of supplies is permissible. Deep rooted crops can tolerate longer dry spells than the shallow rooted ones. Among the different groups, the species in increasing order of moisture stress tolerance are:

Cereals	Kharif	Rice, maize, pearl, millet, sorghum, crow-foot millet.
	Rabi . . .	Wheat, oats, barley.
Pulses . .	Kharif . . .	Cowpeas, black gram, green gram, soyabean, pigeon pea, cluster bean.
	Rabi . . .	Lentil, peas, gram.
Oilseeds . .	Kharif . . .	Groundnut, sesamum, castor.
	Rabi . . .	Linseed, sunflower, safflower, mustard.

The dependability of supplies in an irrigation system has thus a bearing on the choice of crops.

6.5. The total storage of moisture in a soil depends upon its depth and water holding capacity. The finer the texture the greater is its water holding capacity. These properties govern the depth and interval of irrigation and consequently the scheduling of canal supplies. Different crops have different optimum moisture ranges for maximum production. But, by and large, it is desirable to irrigate when 40 per cent of available moisture has been depleted.

6.6. For new irrigation projects, cropping patterns should be determined by a careful study of the prevailing conditions which include the quantity and distribution of rainfall, the soil characteristics, the depth of ground water table, the extent and pattern of availability of irrigation supplies and the economic value of the various crops. In adopting any particular cropping pattern, its long term effect on soil fertility should be carefully considered. Irrigation of soils with salt contents is likely to lead, in the long run, to problems of salinity and alkalinity unless adequate drainage is provided. Marketability of different crops changes from time to time, which necessitates a change in the cropping pattern also. The planning of irrigation projects should allow for this contingency.

6.7. A proper cropping pattern with the choice of varieties whose growth period and time of sowing and harvesting would suit the irrigation schedule, should give increased production. Storage schemes offer greater flexibility in regulating supplies as releases can be made to suit the requirements. On these schemes, therefore, the choice of cropping pattern can be wide. In some of the crops, notably rice, short duration varieties have been evolved whose yield is no less than that of the long duration varieties though the grain is somewhat coarser. In period bound crops, the staggering of sowing time along a distributary can considerably ease the difficulty of meeting demand for water during the crucial stages of crop growth.

6.8. Hot weather crops use up water at a faster rate than rabi and kharif crops because of the higher rate of evapotranspiration in summer. During this period the evaporation losses in reservoirs are high. The waters of tanks and reservoirs, therefore, are best used for crops other than the hot weather crops. On larger reservoirs which have a carry over or a substantial dead storage, however, the summer evaporation loss is inevitable, though on a depleted live storage the loss would be less. On multi-purpose reservoirs where hydropower has to be generated throughout the year the tail-race water can be utilised with advantage for irrigating hot weather crops during that season. Elsewhere this crop is best grown with ground water.

6.9. On some of the existing projects, the cropping pattern may require a change in order to ensure better use of the irrigation supplies and secure increased production. Some cultivators, steeped in tradition, may, however, be unwilling to accept the change. It is, therefore, important that State Governments should equip themselves with necessary legal powers, where these are inadequate, to enforce the change in the overall interest of the community.

6.10. The adoption of proper cropping pattern is of utmost importance in the development of agriculture in the country. The Commission will deal with the subject more comprehensively in its Final Report, bringing out the present patterns in various agro-climatic regions and recommending the more suitable ones for future adoption.

SECTION VII

OPERATION OF IRRIGATION SYSTEMS

7.1. On the run-of-the-river schemes the scope of improvement in the scheduling of canal supplies is limited by the river flows and their non-dependability and variation from year to year. On these systems the larger requirement at any period of crop growth can be met only from supplemental sources like ground water. Higher production can, however, be secured by choosing crops and varieties whose water requirements correspond more closely to the availability of supplies in the system.

7.2. Adequate control structures, such as regulators, are important in any canal system. Some of the older systems with rice as the main crop are deficient in this respect. On some of them when the canals are opened, all the distributaries and minors run simultaneously and during periods of slack demand a great deal of water is wasted. Canal systems should have proper regulators as in north India so that any channel could be closed when required and channels run on a roster during periods of slack demand.

7.3. Cultivators need premonsoon supply of water for raising rice nurseries for transplanting seedlings when rains come. On irrigation projects these nurseries are generally scattered all over the commanded area. Supplying canal water to these scattered patches of land is quite wasteful. But if canals are not run to supply water to these early nurseries, their raising is delayed till the monsoon sets in. This delays the transplanting operation and yields are affected. If nurseries are raised in compact blocks, preferably in the head reaches of minors on a commercial scale either by government or by cooperative societies, it can ensure economy in the use of water for the nurseries as only the portions of channels serving these need be run. Alternatively, the nurseries can be raised with the use of ground water if that be available. Such nurseries provide a better control on the quality of seedlings and application of fertilisers and pesticides to them. These also facilitate regulated sowing of seeds to suit the subsequent transplanting operation. This arrangement should prove commercially successful and would leave the farmers free to attend to other preparatory operations.

7.4. The importance of timely supply of irrigation water cannot be overemphasised. If the sowing of wheat is delayed beyond three weeks of its proper sowing time, a drop in the yield of 3 quintals per

hectare is likely to occur for each week's delay. Likewise, if transplanting of rice is delayed by a month a heavy drop in the yield of even upto 50 per cent may take place. Yields get considerably reduced if water is not supplied during the crucial stages of plant growth, such as emergence, seedling, tillering, pre-flowering, flowering and grain formation. The scheduling of irrigation supplies should aim at meeting these requirements. If these cannot be met in full, the running of channels should conform to the more crucial stages of growth of the predominant crop. For instance, for wheat if only three irrigations can be given, the choice would be crown root initiation, jointing and milk stages and for two irrigations, the first two. For operating channels to the best advantage, the irrigation engineer should consult the agricultural officers well before a crop season.

SECTION VIII

INTEGRATED DEVELOPMENT OF COMMANDED AREAS OF MAJOR AND MEDIUM IRRIGATION PROJECTS

8.1. On most new irrigation projects, the pace of development of irrigation in the commanded areas has been quite tardy. An appraisal during the Third Plan period brought home that without a reasonable Plan investment on ayacut development the pace of utilisation on irrigation waters would remain slow. A decision to make such an investment was taken in 1964-65, but very little took place in the Third Plan period.

8.2. During the period 1966-69 covered by annual plans a package approach to ayacut development was formulated comprising—

(a) improvement of administrative arrangements;
(b) soil surveys;
(c) land levelling and shaping;
(d) determination of proper irrigation practices and drainage requirements;
(e) cropping patterns;
(f) consolidation of holdings;
(g) provision of inputs like credit, seeds, fertilisers, pesticides and agricultural machinery;
(h) building up of an adequate research base;
(i) extension and farmers' education and training;
(j) rural roads;
(k) marketing and storage; and
(l) processing industries.

Though it was intended to launch the scheme as a joint venture of the States and the Centre on 50:50 basis, this scheme never got off the ground.

8.3. When the Fourth Plan was formulated it was agreed that all these developments were necessary in the ayacuts of irrigation projects to expedite utilisation of the irrigation waters and to get maximum return from them. The Union Government agreed to finance a comprehensive communication and marketing programme including storage for an agreed commanded area, provided the State agreed to arrange for all the other necessary services and inputs in the above package. It was

also contemplated that the cooperative sector would be utilised fully to enable the farmers to get credit for land shaping and levelling, formation of drainage channels in the fields and for organising processing industries in the markets.

8.4. The original provision made for the programme in the Fourth Plan was Rs. 15 crores and covered the following ten commanded areas:—

(i) Kosi (Bihar)
(ii) Nagarjunasagar (Andhra Pradesh)
(iii) Tungabhadra (Mysore)
(iv) Rajasthan Canal (Rajasthan)
(v) Kangsabati (West Bengal)
(vi) Mahi-Kadana (Gujarat)
(vii) Tawa (Madhya Pradesh)
(viii) Cauvery Delta (Tamil Nadu)
(ix) Pochampad (Andhra Pradesh)
(x) Jayakwadi Stage I (Maharashtra)

As a result of the mid-term appraisal of the Fourth Plan, it was decided that the following commanded areas should also be included in the programme with an outlay of Rs. 5 crores during the years 1972-73 and 1973-74:—

(i) Sone (Bihar)
(ii) Shetrunji (Gujarat)
(iii) Salandi (Orissa)
(iv) Purna (Maharashtra)
(v) Gandak (U.P. & Bihar)
(vi) Chambal (M.P. & Rajasthan)
(vii) Tungabhadra (A.P.)

The total provision for the Fourth Plan was raised to Rs. 22 crores. The programme was initiated in the three commanded areas, viz., Kosi, Nagarjunasagar and Tungabhadra in the second year of the Fourth Plan. The actual expenditure incurred on the programme for 1970-71 was about Rs. 2.6 crores. The anticipated outlay for 1971-72 was about Rs. 3.2 crores. There is a provision of Rs. 4.0 crores for 1972-73.

8.5. International Development Association, an affiliate to the World Bank, has been helping the country with soft loans for irrigation projects in the past on the condition that the States concerned agree to organise agricultural development in the ayacut. In the last few years starting with the Mahi-Kadana (Gujarat) and repeated in Tawa

(M.P.) and Pochampad (A.P.), they have agreed also to finance the ayacut development programme in several aspects. These include—

(i) water distribution system to the farmer's field;

(ii) drainage from the farmer's fields onwards;

(iii) land levelling and shaping;

(iv) important market communications;

(v) marketing, storage and processing; and

(vi) ground water exploitation in the commanded area to supplement surface irrigation.

The States are to agree to provide the necessary administrative support and the research, extension and training facilities for the field staff and selected farmers. Agro-economic benchmark surveys are to be done and later updated. Consolidation of holdings was to be attempted and if successful carried out comprehensively. Thus, the seal of world thought has been placed on our concept of comprehensive ayacut development without which irrigation does not give good returns.

8.6. Except in the commands of Nagarjunasagar and Tungabhadra projects as also in Mahi-Kadana, Tawa and Pochampad projects, where the World Bank scheme is in operation, the participation of States in the package deal programme has not been quite satisfactory. Difficulties in organising credit facilities for some of the inputs and to some extent in adjusting additional items in the Plans already finalised in the States have been responsible for it. In reply to our questionnaire, however, the States have reiterated the need for the package approach.

8.7. The provision of marketing, storage and communications under the Central sector has proved extremely beneficial to the commanded area development projects. Some more investments on these items will be required for the large commands where these have already been taken up during the Fourth Plan. In addition, a large number of commanded areas where the irrigation has not developed for lack of infrastructure will have to be systematically developed during the Fifth Plan period. The Commission, therefore, recommends that the Central Sectors programme of development of markets, storage facilities and communications in the commanded areas should continue on a larger scale during the Fifth Plan period and should cover in addition to the larger commands already taken up, a comprehensive number of major and medium irrigation projects in the country where the irrigation development is inhibited for lack of infrastructural facilities. The Central sector programme should also finance, where necessary, these developments in the commands of projects the construction of which would be continued or taken up in the Fifth Plan.

8.8. Some of the difficulties in the States in fulfilling their part of the agreement regarding the services, inputs and organisation are traceable to a lack of understanding of the magnitude of the problem. The

Planning Commission is, therefore, proposing to take up an integrated pilot project in the Central sector to establish the boundaries of the problem and the ways in which the responsibility can be distributed among the Plan finances, institutional finances and local public effort. These projects which will cover roughly 4,000 hectares each, will be initially taken up in selected districts where canal irrigation has been recently introduced. The programme contemplates utilisation of the Central sector scheme for rural engineering surveys for mapping out the village contours and conducting soil survey of the selected area. Thereafter, the most suitable alignment of water courses and field drains, as also feeder drains will be determined and laid out. In addition, wherever possible, the programmes for consolidation of holdings, land levelling and land shaping will also be simultaneously worked out. As a result of the survey, the following programmes will be finalised:

(a) land levelling and land shaping;

(b) realignment and lining of water courses, where necessary;

(c) training of nalas and their clearance, wherever necessary;

(d) drainage system for the commanded area, especially for the waterlogged portion;

(e) provision of supplementary irrigation facilities from ground water resources, wherever possible and necessary; and

(f) consolidation of holdings where feasible.

The project will bring out details of the required organisation and controls and the proper credit structure for getting the work done on an area basis. The National Commission on Agriculture recommends that these pilot projects should be taken up in the Central sector and worked out expeditiously, so that guidelines for other areas can be laid down quickly.

SECTION IX

PATTERN OF FINANCING AYACUT DEVELOPMENT PROGRAMME

9.1. The various components of the ayacut development programme are financed at present from four sources: Centre, State, institutional agencies and farmers' own resources. The cost of land levelling and shaping is met partly by farmers' own efforts and partly by institutional credit provided by Land Mortgage Banks and Agricultural Refinance Corporation. In reply to our Questionnaire (Appendix I), States have made a number of suggestions regarding financing of the programme. Bihar has suggested a single agency for financing the entire programme in the form of Agricultural Credit Corporation which would provide loans to farmers with concessional rate of interest as an inducement to them. Maharashtra has stated that while the main elements of infrastructural complex will have to be provided by the Government, institutional finance from ARC, AFC, commercial banks and cooperatives etc. can be inducted mainly for land development, farm mechanisation, processing industries and for working capital. It is also of the opinion that commercial banks or AFC may be invited to provide finance for development on an area basis. Kerala has opined that the programme may require World Bank assistance and assistance from the Centre through Special Employment Programme and Commanded Area Development Programme.

9.2. The expenditure on land shaping, field channels and drains varies widely according to the nature of terrain. In Chambal Ayacut, the cost is as high as Rs. 4,000/- per hectare. When the land is good loam and fairly level, the expenditure may not exceed Rs. 500/- per hectare. If to this investment we add for the provision of ground water, where the potential is good, the per hectare cost becomes higher but more economic. Although the economics of these investments is quite favourable, yet the period of repayment has to be reasonably long to allow the farmer to get some immediate benefit from them. If the capital investment is to be fully productive, a high-yielding varieties programme has to be put through for the improved land. This requires fairly large short-term finances for inputs. The intensive cultivation may require some better plough cattle. This needs medium-term loans. All told, the per hectare requirement of long, medium and short-term facilities is fairly high. Only the large farmers in the area will be able to furnish the required security to the Financing Agencies for the full credit. The small and marginal farmers will have to depend on the nstitutions for it. It is by now quite clear that the cooperative and

banking sectors have considerable reservation in giving full accommodation for a credit-worthy project if not backed by credit-worthiness of the borrower. Credit has thus been the main difficulty in the implementation of the area programme. The Commission has carefully considered this matter and has two alternative suggestions to offer.

9.3. The State can form a Land Improvement Corporation which can take on the entire work of land shaping and construction of channels, drains and ground water units. It can recover the investment with interest from the produce per hectare on an agreed formula. This should leave sufficient surplus produce with the farmers to cover his short term credit. This would be workable. The main difficulty is the reservation of Plan funds for the equity capital of this venture. As at least 40 per cent of the capital expenditure will have to be given to the Corporation in the form of equity to enable it to tap the rest as loans from the institutional sector, the plan outlay involved will be quite large. In order to minimise the investment, the Corporation may initially bear the capital charges only for the small and marginal farmers, taking capital from institutional sources for the large farmers in the farmer's name and making a service charge for it.

9.4. The other approach can be to use the concept of Farmers' Service Society recommended in the Commission's Report on 'Credit Services for Small and Marginal Farmers and Agricultural Labour' to deal with the requirements of the small and marginal farmers, leaving the large and very large farmers to avail directly of bank finances. The Farmers' Service Society can organise the reclamation and construction service for the whole area and apportion the charges per hectare to all the farmers in the area. The Society will take payment from the large and very large farmers for the service and arrange the necessary long, medium and short term credit for the small and marginal farmer clients to enable them to pay the charges and do their farm operations. We commend to the State either of these approaches. We are emphatic that without a comprehensive arrangement for long, medium and short term credit for the reclamation and development programme and the requirements of cultivation, the commanded area approach will not be successful. This is the most important aspect of the whole problem of agricultural development.

SECTION X

ADMINISTRATION AND COORDINATION OF AYACUT DEVELOPMENT PROGRAMME

10.1. A comprehensive programme of ayacut development has to concern itself not only with raising irrigated crops but also such developments as support and interest the farmer in his farming enterprise. The work of ayacut development is, therefore, a complex affair and involves work in many fields and by several organisations. It requires a well-planned and coordinated effort for which there has to be a suitable organisation.

10.2. The work of ayacut development, like the irrigation project itself, has three stages, viz.,

(i) investigation and planning

(ii) implementation

(iii) post-implementation, corresponding to operation and maintenance of the project.

The responsibility for ayacut development rests with State Governments. The Union Government may assist by way of providing guidance and providing funds for certain items of ayacut development such as marketing, storage and communications, on selected projects. At the investigation and planning stage, which should be concurrent with the preparation of the irrigation project, a time-phased master plan should be prepared for which a suitable officer of the Agriculture Department should be nominated as the coordinator. If additional staff is required for preparing the master plan, it should be provided. The major tasks at this stage pertain to soil surveys for determining the most suitable cropping pattern for the ayacut, formulation of schemes for land levelling and shaping, water distribution and drainage beyond the outlets and ayacut roads. In addition, proposals have to be drawn up for setting up experimental and demonstration farms, training of farmers in irrigated agriculture, and development of horticulture, forestry, animal husbandry, fisheries and agro-industries. Arrangements have to be chalked out for making the required credit available to the farmers, for supply of good seeds, fertilisers, pesticides and agricultural machinery, and for storage, transportation and marketing of the produce. If consolidation of holdings is required and is feasible, a programme for it also should be laid down.

10.3. Where adequate soil data are not available for establishing the suitability of the area for irrigation and determining the cropping

pattern for it, the Agriculture Department should arrange a soil survey of the area in consultation with the Irrigation Department so that the survey may meet the requirements of both the departments. This work should normally be got done through the State Soil Survey Organisation but assistance can also be taken from the Rural Engineering Survey Organisation recently organised in the various States or the All-India Land Use and Soil Survey Organisation.

10.4. For working out a scheme for land levelling and shaping, the Agriculture Department would require large scale contour maps of the area. Where not already available, these can be prepared by the Soil Conservation Division under the Agriculture Department or the Rural Engineering Survey Organisation. Land levelling and shaping has to be in conformity with the alignment of distributaries and minors. As soon as the Irrigation Department has determined the alignment of these channels, it should make the maps available to the Agriculture Department for working out the proposals for land levelling and shaping.

10.5. Water courses up to 40 hectare block are required to be constructed by the Irrigation Department at project cost. Field channels beyond the water courses should, therefore, be included in the proposals for ayacut development. We have recommended that field drains should be treated in the same manner as water courses and field channels. There should, therefore, be provision for field drains up to 40 hectare block, corresponding to water courses, in the estimates for the irrigation project and for the smaller drains to individual fields in the proposals for ayacut development.

10.6. The investigations and formulation of proposals for development of ayacut roads can be done either by the P.W.D. (Roads Department) or the Irrigation Department who would be the main department carrying out investigations in the area.

10.7. Proposals for development in other fields such as horticulture, forestry, animal husbandry, fisheries, cooperation, marketing, agro-industries, transportation, storages, recreation and tourism should be formulated by the concerned departments, the Agriculture Department which has the main responsibility for preparing the overall project report for ayacut development acting as the coordinator.

10.8. At the implementation stage, it is necessary to set up a special administrative agency to coordinate and expedite the various developmental programmes in the ayacut. In fact, financing institutions would insist on there being such an organisation. This agency or organisation should be headed by a competent technical person with adequate administrative background. Ordinarily, the choice of the person should be from the discipline in which the maximum development is to be carried out under the programme. Technical officers required for this

programme should be seconded to the development organisation but should keep liaison with their parent departments for technical guidance on complex problems. It would be desirable to have a separate development organisation for each large project, say, costing more than Rs. 10 crores, and a separate one for all others together in each State.

10.9. The level at which the administrative agency or organisation should be set up would depend on the size of the project. For the larger projects, say with an ayacut of one lakh hectares or more, the organisation should be headed by a technical officer of the status of a Commissioner. Where this development programme is financed by the Union Government, that Government would require to approve of the choice of the officer. The officer should be vested with the powers of Head of a Department for all administrative matters in respect of all segments of development in the ayacut. All technical officers working on the ayacut development should be responsible to this officer. On larger projects, in order to ensure coordination at block level, coordinating teams should be set up consisting of representatives of Revenue, Agriculture, Irrigation and Cooperative Departments with Area Agricultural Development Officer as the coordinator or convenor.

10.10. At State headquarters, the work of ayacut development of various irrigation projects should be supervised and reviewed by a committee of Secretaries and Heads of the Departments concerned, under the chairmanship of the Chief Secretary. The Committee should discuss and decide matters referred to it and give any directions to the ayacut development authorities considered necessary.

10.11. The main help which the farmers require at the implementation stage is credit facility. The success of ayacut development depends to a large extent upon the adequacy and timeliness of the credit. We have dealt with this aspect earlier in this Report.

10.12. After the main items of ayacut development, such as the setting up of experimental and demonstration farms, evolving of suitable cropping patterns, land levelling and shaping, construction of water courses, field channels, field drains, ayacut roads, storages, etc. are done, the task of this special organisation would be mostly over and further routine work can revert to the departments and organisations concerned.

10.13. On existing projects which require further development of ayacut in certain aspects, the procedure and arrangements should be on the same lines as for new projects.

SECTION XI

REVIEW OF PRE-PLAN AND EARLIER PLAN SCHEMES

11.1. In the Plans, irrigation developmental programmes have been mainly in the shape of new irrigation schemes. Some remodelling or replacement of old and decrepit major engineering structures, like the Krishna Anicut and Sone weir has been done primarily to safeguard existing irrigation supplies. Also on certain canals, supplemental supplies have been provided through augmentation tubewells or river pumping schemes. A few old channels have also been lined to save on transit losses. All these isolated efforts at improvement of existing canal systems have been mainly in the field of engineering. None of these systems have been reviewed comprehensively for improvement in all aspects covering engineering structures for safety and better regulation, augmentation of supplies in the system where deficient, efficiency in conveyance of water to the field, scientific application of water to crops and adoption of cropping patterns which would confer the maximum benefit. Such reviews of the old and the earlier plan projects are called for in order to modernise them for better service to present day agriculture.

11.2. These reviews should be carried out by officers of the same high level of competence as are required for formulating a new irrigation scheme. In fact, the review should be a *de novo* formulation of the scheme conditioned by the existing physical constraints. This would indeed be a task for a team of specialists in irrigation engineering, agronomy and soils. The association of an agricultural economist in these reviews would be desirable. The responsibility for the reviews has naturally to be that of the Irrigation Department, the Agriculture Department making other specialists available to form the team. The progress of the reviews may be watched by the Development Commissioner and there should be a forum to iron out difference of views and take decisions.

11.3. To start with, the irrigation policy in respect of the project should be clearly laid down by Government. The various irrigation policies have been discussed by the Irrigation Commission in its Report (1972). The choice would be for deployment of irrigation supplies for (i) maximum production per unit of area; (ii) maximum production per unit of water; or (iii) maximum area served. The reviews may call for some experiments and observations. Alternative cropping patterns and varieties may have to be field-tested before adoption. Soil analysis may become necessary if adequate data on soils in the commanded area are

not available. Observations may become necessary to determine percolation and seepage losses as also evapotranspiration losses during different seasons. These measures should be initiated early, so that a proper review of projects is not inordinately delayed. These tasks would need to be assigned for completion according to a laid out time table.

11.4 In December 1971, a few States were requested to make a review of some selected medium sized storage projects where irrigation is more or less fully developed. These reviews for which guidelines were suggested, covered engineering, water utilisation and agronomic aspects. Studies already made, though not quite comprehensive, reveal interesting results. These are briefly described below:—

Lower Bhawani Project (Tamil Nadu)

11.5.1. This is a storage irrigation project, with a reservoir capacity of 925 m.cu.m. of which 900 m.cu.m. is the live storage capacity. The project, completed in 1956, at a cost of Rs. 10.34 crores, envisaged irrigation of 84,000 hectares as under:

	Area in hectares
Rice	4,000
Cotton	40,000
Groundnut millets, etc, ...	40,000
Total ..	84,000

The canal has a head discharge of 65 cumecs. The entire irrigation system is unlined except for a small portion of 22 kilometres on the distributaries. The soil in the ayacut is generally porous and seepage losses are heavy. The terrain of the ayacut is undulating. With the growing of rice in the fields located at higher levels, seepage from them rendered the adjoining lower fields unfit for growing other crops. The cultivators of lower areas, therefore, also took to growing rice. This completely changed the cropping pattern on the project. With more area under rice than originally stipulated, shortage of water was experienced in the ayacut. To meet the situation the State Government introduced, in 1959, a zonal system, under which only half the ayacut is irrigated in each season, *i.e.* 15th August to 15th December and 16th December to 15th March. There is no restriction on the crops to be grown in the first season, but in the second season irrigation of rice is prohibited.

11.5.2. Investigations and studies now made by the State Government show that the quantity of water that can be saved by lining the canal and distributaries upto 1000 hectares limit would be about 14 cumecs. This would add 225 m.cu.m. to the 1000 m.cu.m. available at the outlets at present.

11.5.3. There is an estimated loss of 20 per cent in the water courses and field channels on this project. This can be reduced to not more than 5 per cent by lining them at a cost of Rs. 2 crores.

11.5.4. In a State where every drop of water is precious, the need for saving on losses and adopting a cropping pattern which would make the best use of available water resources is obvious.

Badua Project (Bihar)

11.6.1. A visit to the Badua Project in Bihar during February 1972 revealed that there was scope for better utilisation of the water impounded in the reservoir. This project, which started irrigating in 1963, comprises a 42 metre high dam with a live reservoir capacity of 110 m.cu.m., and canals taking off on either bank of the river Badua. It is designed to irrigate 35,500 hectares in kharif and 7,100 hectares in rabi, making an annual irrigation of 42,600 hectares. In 1968, which was a year of good rainfall, 35,700 hectares were irrigated in kharif and 1,600 hectares during rabi.

11.6.2. Kharif irrigation on Badua project starts with supply of water for rice seed-beds at the break of rains. Thereafter water is released for transplanting over a period of 40 days. The last irrigation for kharif is given in the last week of October. Because stored water is specifically released for a short period for irrigating seed-beds, there is a temptation to sow all the seed-beds at that time. On subsequent release of water for transplantation, the lands which get water at the beginning of the roster can have seedlings of proper age. The lands which get irrigation on the 40th day of the roster get seedlings which have grown older by more than a month. It has been established that for high yielding paddy, the seedlings have to be of an exact age at the time of transplantation. Delay in transplantation, and particularly when it is prolonged, reduces yields very much. A short duration release of water from the reservoir for seed-beds, therefore leads the farmers to transplant overage seedlings in almost three-fourth of the ayacut. This is one of the reason why paddy yields are low under these conditions. If rice nurseries could be raised with ground water or water stored for the purpose in small tanks and of the time table for running the canals for transplantation could be indicated to the cultivators in advance, they would raise seedlings in a regulated manner so that these would be of the right age for transplantation.

11.6.3. On the Badua project, as on similar other projects, the introduction of nonphotosensitive varieties (period bound) which are of shorter duration can lead to better use of stored water. A paddy which can be harvested by the end of October would be more suitable. This means paddies of 120—125 days' duration. For a crop which is to be harvested by the end of October, the last watering need not be beyond the 10th of October. This would save 15 days' supply from the reservoir. The water thus saved can irrigate a larger rabi area. It would also enable the sowing of rabi in good time. There is also need on this

project to reduce the transplantation period from 40 days to about 3 weeks. This may require remodelling of the canals to carry a larger discharge during this period.

Shetrunji Project (Gujarat)

11.7.1. On this project, located in an arid region of 500—600 mm annual rainfall, a considerable increase in irrigation can be secured by lining channels to reduce water losses. The project was completed in 1965 at a cost of Rs. 6.96 crores. It has a storage reservoir with a live capacity of 377 m.cu.m. The canal system is designed to irrigate annually 34,850 hectares in a culturable command of 57,730 hectares. All the channels are unlined and consequently there is a substantial transit loss of water of about 27 per cent between the canalhead and the outlets. There is a further loss in the water courses and field channels.

11.7.2. A study made by the Gujarat authorities shows that by lining the distribution system up to outlets, enough water would be saved to irrigate an additional 11,330 hectares, that is, an increase of nearly one-third of the present irrigated area. By spending Rs. 356 lakhs on lining and construction of new channels for serving additional area with the water thus saved, the cost of providing the additional irrigation comes to about Rs. 3,140 per hectare and the benefit-cost ratio 1.25:1. This cost compares favourably with some of the medium irrigation schemes which have been sanctioned for the State recently as below:

Janjesari	...	Rs. 3,976 per hectare
Sorathi	...	Rs. 3,361 per hectare
Fulzar	...	Rs. 3,294 per hectare

11.7.3. There are water courses and field channels in an area of only 26,400 hectares in a commanded area of 57,730 hectares. According to the State authorities, there is a water loss of 25—35 per cent between the outlets and the fields and nine-tenth of this can be saved by lining. Thus, if all the channels in the project from canalhead to the field are lined, it would give nearly 50 per cent increase in irrigation. This should be most welcome in this arid region. The cost of lining water courses and field channels has been figured out by the State authorities to be around Rs. 70 lakhs. This would give as good a benefit-cost ratio as the lining of channels up to outlets only and therefore would be equally justified.

11.7.4. About 2,000 hectares in the commanded area require land levelling. When this is done and more scientific method of irrigating fields introduced, the benefit of irrigation will get significantly enhanced.

11.7.5. There are about 5,000 open wells in the project area. These are utilised for irrigation of about 3,200 hectares during kharif and rabi

seasons. There is little water in most of these wells during hot weather. It is reported that tubewells are not feasible in this area. If irrigation channels of the project are lined there will be some reduction in the annual ground water recharge. Studies need to be made to determine the extent of this reduction and its effect on existing well irrigation as also on drinking water quantitatively and qualitatively. It has, however, to be observed that of the water which percolates and seeps from unlined channels only a portion reaches the ground water table, the rest being lost through evapo-transpiration from adjoining lands. This consideration, on quantifying may show that the balance of advantage lies in lining the channels.

Ghod Project (Maharashtra)

11.8.1. This project costing Rs. 5.9 crores was taken up in 1954. It envisaged irrigation of 25,252 hectares in a culturable commanded area of 41,909 hectares. The approved cropping pattern was as under:

	Area in hectares
Sugarcane	1,942
Overlap sugarcane	647
Two-seasonals	5,665
Kharif	10,117
Rabi	6,881
Total	25,252

11.8.2. The area actually irrigated in 1971-72 was:

	Area in hectares
Sugarcane	1,805
Two-seasonals	2,499
Kharif	635
Rabi	7,487
Total	12,426

This is less than half of what was envisaged and the irrigation intensity is as low as 28 per cent.

11.8.3. The season-wise utilisation of water available at canalhead is as under:

		m.cu.m
Kharif	July to October	45
Rabi	October to February	88
Hot weather	March to June	68
	Total	201

It is seen that 34 per cent of the available supply is utilised during hot weather.

11.8.4. The transit losses on this project are very high as the canal passes through strata which have high permeability. During a visit to the project in October 1972, a broad assessment was made of this loss. The figures for 1970-71 emerged as under:

	Left Bank Canal (m.cu. m.)	Right Bank Canal (m.cu.m.)	Total (m.cu.m.)
Amount of water let in at canalhead . . .	120	41	161
Loss in the main canal and branches . .	50	20	70
Amount of water at distributary head . . .	70	21	91
Lost in the distribution system at 30% of water let in the distributary head	21	6	27
Amount of water available at outlets . . .	49	15	64
Lost in water courses and field channels at 16 % (assumed) of water available at outlets . . .	8	2	10
Water available at field head	41	13	54

Thus in 1970-71, of the water let in at the canalhead, the quantity available at the field-head was only 34 per cent on the left bank canal, 31.6 per cent on the right bank canal and 33.5 per cent on the entire project. In 1971-72, the loss was less but still very considerable. That year, the quantity let into the canals was 145 m.cu.m. of which 49 m.cu.m. was lost in transit, leaving 96 m.cu.m. at distributary head. By the time this quantity reached the outlets, it was reduced to 67 m.cu.m. With further loss in the water courses and field channels it came down to only 56 m.cu.m. As such, during 1971-72, of the water released from the reservoir, only 39 per cent reached the fields, 61 per cent having been lost in transit.

11.8.5. On this project, the water lost through percolation and seepage is not altogether a total loss. It serves to augment ground water in the area. It also increases the regenerated flow in the Bhima river. No observations have been made for a precise evaluation of these contributions. It is, however, noticed that since the construction of this project, well irrigation in the commanded area has substantially increased. In 1961, the area irrigated from wells in the canal command was 75 hectares of sugarcane and 460 hectares of seasonal crops. By 1971, this increased to 426 hectares and 1360 hectares respectively. Some of the knowledgeable cultivators who were interviewed during the visit stated that there was scope for exploiting more ground water in the area.

11.8.6. Notwithstanding these contributions to ground water and flow in the Bhima river, the fact remains that a large amount of water is irretrievably lost through evapotranspiration from lands wetted by seepage water along the channels. This loss may well be over thirty

m.cu.m. per annum. The increased regenerated flow in the Bhima is picked up at Ujjani Dam lower down, but this water is not available for use in the command of Ghod project. If the channels had been lined, it would have saved enough water to increase the intensity of irrigation from the present 28 per cent to about 60 per cent; of course irrigation from wells would not have increased to the extent it has done now. As matters stand, it may not be feasible and economical to resort to wholesale lining of channels, but it would be of considerable advantage if selected reaches, where losses are particularly heavy, are lined.

11.8.7. The Kharif irrigation on this project is low and much below that envisaged in the project report. According to the present mode of reservoir operation, irrigation water becomes available only from 1st July with the onset of rains. This is late for growing cotton, jowar and other kharif crops. If some water is carried over in the reservoir from the previous season for sowing of cotton towards the end of April or early in May and Jowar and other kharif crops in June, the kharif areas can be substantially increased. Because of support from rain, with a given quantity of water, about twice the area can be irrigated in kharif than in rabi. With a carry over, reservoir losses would increase as a larger area would be exposed to evaporation during the hot weather. It has been roughly estimated that if 20 m.cu.m. of water is carried over, the increase in evaporation loss would be of the order of 1.5 m.cu.m., which is a small loss considering the total reservoir capacity and the advantage which the carry-over would bestow. This arrangement needs to be worked out in detail.

11.8.8. At present about a third of the annual supply is utilised during hot weather primarily for irrigating sugarcane. During this season the evapotranspiration losses are at their maximum. It should be possible to irrigate perennial crops during this period with ground water. If the canals are run only for eight months of kharif and rabi and kept closed during hot weather, it can save a good deal of water loss. The water thus saved can be utilised in the ensuing kharif season. It would have been easy to enforce this arrangement when the project was constructed. Now because of vested interests, the various implications of the change would require careful consideration. If with this arrangement the ground water shows signs of exhaustion on irrigating the present increased area under sugarcane, the channels may have to be run intermittently instead of a complete closure to sustain the ground water supply.

11.8.9. It is suggested that the State Government should carry out the necessary experiments and make observations to determine the loss of water in various reaches of channels and the quantity of seepage water which is irretrievably lost through evapotranspiration. In the light of this knoweldge consideration should then be given to lining of channels in selected reaches. Also, consideration should be given for a

small carry-over in the reservoir to advance the present belated kharif sowing, and keeping the channels closed for most of the time during hot weather, utilising ground water for irrigating perennial crops during that period.

Harsi Project (Madhya Pradesh)

11.9.1. The 40-year old Harsi project in Madhya Pradesh is an example of a scheme which offers scope for improvement in water management. The original project had envisaged irrigation in a culturable commanded area of 60,700 hectares in Gwalior district with an irrigation intensity of 50% as under:

	hectares
Paddy	7,080
Wheat	20,230
Sugarcane	3,040

11.9.2. The actual irrigation in 1971-72, taken as a representative year, was as under:

	hectares
Paddy	1,090
Wheat	2,670
Sugarcane	360
Total	4,120

This is about 28 per cent more than the area stipulated in the Project Report. The increase in area has been brought about by the cultivators by applying water thinly and giving fewer irrigation than actually required. There is clamour for more and more water almost in every season. The reservoir is practically empty at the beginning of the rainy season and no water is available for raising rice nurseries. Raising of seedlings has thus to wait for the break of rains.

11.9.3. As on most unlined canal systems in the country, there is heavy percolation and seepage loss on this Project also. Of the water entering the canal head, 30 per cent is lost up to outlets. Then there is a further loss in water courses and field channels, assumed to be 18 per cent of the supply entering the canal head. Thus, of the water which enters the canal head, nearly half is lost by the time it reaches the field. The soil in the Project area is mostly clayey and overlies rocky strata. During the Commission's visit on 1st December 1972, knowledgeable farmers of the area stated that there was little scope for exploiting the ground water in the area. Under these circumstances, the loss of water on the project is a total loss, little being retrievable by pumping.

11.9.4. There is considerable scope for increasing production of sugarcane in the canal command if more water could be made available. There is a sugarmill in the Project area which at present is able to utilise only part of its capacity because of insufficient sugarcane supply. The yield of sugarcane is quite low, being of the order of 200 quintals per hectare. The low yield is ascribed to shortage of water particularly from April to June.

11.9.5. Recently, the Sindh Project Stage I costing about Rs. 5 crores was sanctioned to divert daily flows of the Sindh river into Harsi reservoir. A storage dam is to be built on the Sindh river in Stage II of the Project. At present, the Harsi reservoir gets fully depleted up to dead storage level in June. Cultivators have therefore, to wait for the break of rains early in July for raising rice nurseries. This delays transplantation of rice and in consequence the yield remains low. With the completion of the Sindh Project Stage I, it should be possible to utilise the June flows of the Sindh for raising nurseries so that seedlings are ready for transplantation with the break of rains. Also, it should be possible to carry over some water in the reservoir from the previous season for that purpose and early opening of the canals.

11.9.6. Although supplementing supplies in the Harsi reservoir from the Sindh river is a welcome arrangement, the loss of half the Harsi supplies through percolation, seepage and other wastage should not be ignored. Lining of channels including water courses, therefore, should receive consideration as resources permit.

11.9.7. Because of shortage of supplies, the more powerful cultivators, particularly in the headreaches of outlet commands, take most of the water and weaker cultivators suffer. There is a feeling amongst the irrigators that outlets on the project provided about 40 years back require a revision to better conform to the actual irrigation requirements. It would improve matters considerably if outlets are reviewed and Warabandi is introduced on this Project. The present system of agreement for irrigation can then be dispensed with as it seems to serve no useful purpose. The system of Warabandi being new to the area, it would require adequate arrangements for educating the cultivators in its operation as also for its enforcement. Cultivators seem to prefer enforcement by a canal magistrate to that by Panchayat. Further, it would enable the cultivators to plan their cropping better if at the end of the rainy season and well before rabi sowing they are informed of the roster on which various distributaries and minors would run. This roster should be prepared jointly with the Agriculture Department in the light of the quantity of water in the reservoir. The present system of 'Ailan' by which cultivators are informed of excess or shortage in the reservoir over normal storage does not enable them to know as to when a channel would be opened and closed and at what interval.

11.9.8. While lining of channels and other structural improvements can be done in due course, there are a few steps which can be taken immediately to improve the functioning of this Project. These are—

(a) construction of water courses and field channels throughout the command as also field and service drains;

(b) reviews of outlets for a more equitable distribution of water on various channels;

(c) introduction of Warabandi to ensure equitable distribution of water among cultivators.

11.10. Each of the projects studied shows considerable scope for improvement, which establishes the worthwhileness of the reviews. As a result of review of a project, proposals may emerge in respect of:—

(i) augmentation of supplies from other sources, surface or underground;

(ii) improvement of engineering structures, like remodelling of headworks, enlargement of channel capacities, lining, provision of more regulatory structures, extension of drainage system and improvement of outlets in respect of their structure and capacity;

(iii) ayacut development or improvement comprising land levelling and shaping; realignment of water courses and field channels and their lining, where necessary; field drains; ayacut roads and storage facilities; consolidation of holdings;

(iv) cropping pattern;

(v) operation of channels to better conform irrigation supplies to water requirement of crops.

Although desirable to do so, it may not be practicable to carry out all the improvements on a project simultaneously on account of financial constraints or other reasons. But it is important that there should be a clear picture of the total improvement which is to be brought about and work on individual aspects so carried out as to ultimately fit into this overall plan of improvement.

11.11. Funds required for (i) and (ii) above have to find a place in the budget of Irrigation Department. The work on individual items can be undertaken according to predetermined *inter se* priorities and the availability of funds. The financing arrangement for ayacut development has already been dealt with in an earlier section. Improvement in cropping pattern is a matter for Agriculture Department and the extension services. This would require increased budgetary provisions for staff and experimental and demonstration work. Operation of channels is purely a departmental matter and requires no outlay.

11.12. In the Plans, completion of incomplete projects has been accorded higher priority than new projects. Existing irrigation projects which are not performing satisfactorily and which are susceptible of improvement are not better than incomplete projects. These deserve serious attention. Investments already made on these projects should bear full fruit even if it means incurring some more expenditure to bring it about. The economic gain in the shape of larger production and greater employment opportunities will in most cases amply justify some further investment on them. Review of these projects would reveal several steps that can be taken, mostly, in the fields of agronomy, water management and operation which would enhance the utility of these projects without any significant expenditure. All these aspects have to be examined. It is necessary that the scope of improvement of these projects and the outlay involved should be determined in a systematic manner. This Commission, therefore, recommends that States should organise a comprehensive review of their pre-Plan and earlier Plan Projects and formulate a programme for their improvement.

To facilitate such a review guidelines are suggested at Appendix III. Where in a State a number of projects require reviewing, it may be necessary to set up a whole time special reviewing team of specialists. Some earmarked Plan provision for the purpose would focus and sustain attention to this important matter.

SECTION XII

ACKNOWLEDGEMENTS

12.1. The Commission takes this opportunity to thank all the officers of the Central and State Governments, institutions and individuals who offered valuable suggestions either in reply to its Questionnaire or during personal discussions.

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Member Secretary

NEW DELHI,
February 27, 1973

APPENDIX I

Questionnaire on Infrastructure in Commanded Areas of Major and Medium Irrigation Projects

In order to ensure that the benfits of new technology in agriculture are shared by the bulk of the farming population and are not limited to certain areas, the Commission proposes to study, in detail, the concept potential and measures necessary for integrating area development with special reference to dry and rainfed areas, commanded areas of irrigation projects and remote, economically backward, hilly and tribal areas. This questionnaire deals with provision of necessary infrastructures in the commanded areas of major and medium irrigation projects.

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(1) Have the area in the commands of major and medium irrigation projects, where there is scope for growth, been identified ? If so, a list of such areas may be furnished.

(2) Have the State Governments considered the necessity for establishment of a suitable infrastructure for marketing, processing etc. of the produce and also for meeting the consumer demands of the farmers with surplus funds in their hands? Rough estimates giving the broad magnitude of the requirements may be indicated in respect of each project.

(3) Have the project authorities any suggestion for financing the infrastructure they consider desirable? What is the present system of financing ? Are any improvements called for ?

(4) What would be the direct and indirect benefits if suitable infrastructures in the commands of major and medium irrigation projects are provided ?

(5) Would you consider creation of various infrastructures in disolation or in an integrated manner ? Would it not be better that the communication system, markets and the storage points form an integrated network ?

(6) With the provision of infrastructure facilities, intensive development of the commanded area would be accelerated. This activity would call for a larger input in terms of labour. There being acute shortage of labour, in some cases, this could result in generating employment for the rural masses. Could some estimate of the magnitude of employment be given ?

(7) It is felt that as part of the general planning of the area, systematic surveys should be undertaken in the commanded areas which would seek to determine and analyse the response of the farmer to water management, adequacy of land management, social and economic changes that might have occurred in the region, the changes in agricultural patterns since the institution of the project and benefits that have accrued to the farmer by provision of irrigation and infrastructure. Have such surveys been conducted by the agricultural university or any other organisation in your State ? If not, would you like to undertake such a survey in future ?

APPENDIX II

Comparative Suitability of Various Systems of Irrigation for Different Land Slopes, Soil, Crops, Cost, Efficiency, etc.

Serial No.	System of irrigation	Field or land slope	Soil		Stream size	Pattern of crop growing	Relative yield	Labour needed	Approximate cost of design or development per hectare	Irrigation efficiency %
			Texture	Infiltration						
1	2	3	4	5	6	7	8	9	10	11
Surface										
i.	Flood	Upto 10% sub-divided fields	...	...	Large	Close growing	Low	Maximum	Low Rs. 15	Low 30 to 50
ii.	Basin	1% Graded to almost level	...	Any rate	Large	Orchard & close growing	Medium	Occasionally more	Rs. 125 (Temporary)	75 to 85
iii.	Border strip	0·6% graded to almost level	Heavy, medium, relatively deep	Any but extreme	Large	Close growing grains, forage	Medium	Do.	Rs.500 (Permanant)	70 to 80
iv.	Furrow	5% mild or contour	Any	Any but very rapid	Medium	All row crops	Medium	Do.	Rs. 50	75 to 90
v.	Corrugation	Between 1 to 8%	Do.	Do.	Small	Close growing crops	Do.	Do.	Rs. 60	75 to 90

APPENDIX III

Guidelines for Review of Irrigation Projects (To be Modified to suit an individual Project).

1. Name of the project and its location.

2. Cost of the project.

3. Year of completion.

4. Gross commanded area.

5. Culturable commanded area.

6. Irrigation policy in respect of the project, i.e., whether
   - (*a*) Maximum production per unit of area ;
   - (*b*) Maximum production per unit of water ;
   - (*c*) Maximum area served.

   (If not already defined, it should be laid down by Government)

7. Annual irrigation, seasonwise,
   - (*i*) As per project report ;
   - (*ii*) Actual (average of five years).

8 Intensity of irrigation
   - (*i*) As per project report ;
   - (*ii*) Actual (average of five years).

9. Supply available at the head of the main canal (average of five years) during :

Kharif	June —October.
Rabi	November—March.
Hot weather	April-May.

10. Evaporation loss from the reservoir (in millimetres), by fortnights.

11. Average rainfall in the area by fortnights (in millimetres). How much of it is effective* rainfall (in millimetres).

12. Percolation and seepage loss in the canal system both quantitatively and as percentage of the supply let in at the canal head :
   - (*a*) main canal and branches alone;
   - (*b*) distributaries and minors alone;
   - (*c*) total loss up to outlets.

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*Effective rainfall is that portion of the rainfall during the crop season which is available to meet evapitransporation requirement of crops. It does not include the part of the rainfallwhich is lost as run-off or deep percolation below root zone.

13. Is lining feasible of
    (*a*) main canal and branches ;
    (*b*) distributaries and minors.

14. Cost of lining **
    (*a*) Main canal and branches ;
    (*b*) distributaries and minors ;
    (*c*) entire system up to outlets—(*a*) plus (*b*)

15. Quantity of Water available at outlets (average assumed)
    (*a*) withou
    (*b*) with li
        (*i*) main
        (*ii*) distr
        (*iii*) bot.

16. Is there

17. Is the drainage system adequate ? If not, what would be the cost to make it so ? Would lining seriously affect the spring level of the wells in the area.

18 Has consolidation of holdings been done in the commanded area ?

19. Are fields properly laid out and land properly prepared, including land levelling and shaping, where necessary, for irrigated agriculture ? What would be the cost per hectare and the total cost for the project for achieving this if not satisfactory at present ?

20. Are water courses *** and field channels† properly laid out or would they require realignment ? If so, to what extent and the cost thereof ?

21. Are water courses and field channels lined upto 6 hectare blocks ? If not what is the percentage loss in these of the water delivered at outlets ?

22. What would be the cost of lining these water courses and field channels ? Also what would be the benefit cost ratio ? Consider the use of underground pipelines as an alternative to lined water courses.

23. Are there field drains in the irrigated area ? Are they adequate ?

24. Do cultivators follow the most suitable method of irrigation in the field or do they require guidance from extension services ?

25. Has a proper soil survey been done in the commanded area to determine soil suitability for the various crops ?

26. State the irrigated areas under the various crops. Is the present cropping pattern suitable from consideration of soil, availability of water and climatic conditions or can there be a better pattern ? State the cropping pattern in the adjoining dry areas.

27. On the basis of research experiments, what is the optimum requirement of irrigation water (making allowance for effective rainfall, if any) in the field, for major crops in the ayacut.

** excluding reaches where owing to low permeability lining is not considered necessary.

***A water course is a channel built at government expense to convey water from an outlet to a forty hectare block or as may be prescribed.

†A field channel is a channel built by cultivators beyond the water course to serve the various fields within the blocks.

28. For the cropping pattern in vogue, as also for any proposed alternative pattern, calculate the water requirements on the project :

(*i*) at outlet ;

(*ii*) at distributary and minor head (i.e. adding losses in these channels);

(*iii*) at main canal head—

for various alternatives in respect of lining main canal and branches only;

lining upto outlets ;

lining entire system including water courses and field channels.

29. With the storage water available in a year at the canal head, how much area can be adequately irrigated on the basis of the most suitable cropping pattern and on lining the system to the extent it is economically justified ?

30. Work out the irrigation reqirement for the best cropping pattern, by fortnights.

31. Examine each channel for its adequacy to meet the peak requirement, allowing for any increase of the capacity due to lining. If the channel requires remodelling, please work out the cost.

32. Is ground water available in the area for supplementing canal irrigation or for extending irrigation ? What is the scope for such extension ? If any such conjuctive use is already being made, what is its extent ?

33. Are regulatory structures sufficient and adequate ? In the existing pattern of irrigation practice on the project, what is the pattern of closing and regulation of various channels in different crop seasons ? Does it conform to actual requirements of crops. Is any change necessary in regard to varieties ? If so, this should be worked out.

34. (*a*) which department is responsible for :

(*i*) maintenance of the canal system ;

(*ii*) regulation of supplies in the canals ;

(*iii*) distribution of water beyond the outlets ;

(*iv*) proper maintenance of water courses and field channels ;

(*v*) making assessment of irrigation charges ;

(*vi*) collection of irrigation charges.

(*b*) Does this pattern of responsibility obtain in all irrigation projects in the States ?

(*c*) What are the organisational arrangements for ensuring proper coordination between the departments concerned at the time of (*i*) ayacut development and

(*ii*) operation of the project.

(*d*) Are the existing organisational arrangements considered satisfactory ?

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