CHAPTER XI

CONCLUSION: PROBLEMS AND FUTURE PROSPECTS

It is explicit from this analysis that the irrigation potentials of West Bengal are not fully utilized. At present, about 36% of gross cropped area is availing irrigation facilities as against 25% during 1960s. In this context, two interesting features may be noted. Firstly, the spatial dimension of irrigated area in West Bengal still remains insignificant in comparison to the national perspective. In fact, West Bengal ranks eighth in the intensity of irrigated farming, the leading State being Punjab, recording 83% of her gross cropped area under irrigation. Secondly, the growth rate of irrigation, in recent years, remains somewhat sluggish. These observations are paradoxical in view of the fact that West Bengal happens to be one of the most humid States of India, with prolific water resources, and as such categorically falls under 'wetlands'.

It would be erroneous to state that irrigation has totally failed in the revitalization of the agricultural or other sectors of economy of West Bengal. Undeniably, irrigation has induced beneficial changes in certain respects. Tangible benefits have been reaped from irrigation in extension of farmlands in the districts located in the semi-arid
western plateau. The system has positive impact on cropping intensity and crop yields, the former being most responsive to irrigation. In case of crop yields, it has acted as a catalyst in the introduction and spread of HYV seeds and fertilizers. Cropwise, boro rice and wheat are most benefitted from irrigation in West Bengal. Even though surface water through canals still constitute the major source of irrigation accounting for 35% of GIA, it is being supplemented by groundwater irrigation. Groundwater is lifted through shallow and more recently through deep tubewells. But up to this date, only about 20% of the total groundwater reserves of this State is said to be utilized in farming. Thus, there exists considerable scope for the extension of this type of irrigation in future.

Taking into cognizance all these facts, the ambiguous performance of irrigation becomes conspicuous. Despite the aforesaid benefits, achievement has often been found to be less than the visualized targets. The inefficiency of the existing irrigation system in West Bengal has become more glaring in years of deficient rainfall. Such a paradoxical phenomena requires further clarification.

The fundamental reason for the present impasse is our inability to make efficient use of the available water resources of this State. This in general, may be attributed to certain factors. **Prima facie** this arises from lack of
Pl 75. INCHADIH, a village with forests, jhoras, barren lands and patches of aman fields.

Pl 76. A view inside INCHADIH village.
Pl 77. MOHANPUR, an unirrigated village of the plateau fringe

Pl 78. TILABAID, though officially a canal irrigated village, is receiving limited water in farming.
Pl 79. ANDHARIYA village getting benefits of both canal and seepage water in farming.

Pl 80. Farmlands get seepage water of Kangsabati reservoir at MUKUTMANIPUR village.
Pl 81. Sewage water being used to irrigate boro fields at Amrai.

Pl 82. Wheat cultivation in rabi season in the low-lying areas of Amrai village.
PI 83. An extensive sand bar along the coastal village of Beguakhali.

PI 84. Residual soil moisture being utilised for rabi vegetables at Uttarpara Nij.
Pl 85. Taldi, an unirrigated village, besides the now derelict Bidyadhari river.

Pl 86. Potato cultivation in the relatively irrigated village of Dighirpar.
Pl 87. Localised patches of boro, fed by tanks in the humid coastal tracts at Dighirpar.

Pl 88. Limited farming in the unirrigated Barind tract at Misipur village.
Pl 89. Extensive cultivation of boro with STW irrigation in the moribund riverine tracts of Old Maldah P.S.

Pl 90. Vegetable cultivation at Paranpur village by River Lift Irrigation.
Pl 91. Isolated patches of vegetables and boro grown along the derelict bed of the Saraswati river.

Pl 92. Multiple cropping is possible at Saota village due to STM irrigation facilities.
P1 93. Tanrai village is more benefitted from the STUs than the Kangsabati Canal.

P1 94. Water stored by DTU facilities at Marayanpara village is later used for farming.
Plate 95. Narayanpara is a typical DTU irrigated village.

Plate 96. Paraj is a multi-cropped village alongside the head reach of the DVC Main Branch Canal.
Pi 97. Though adjacent to Paraj, Manikbazar village is deprived of canal water due to its higher location.

Pi 98. At Hoera South, boro cultivation is confined within DTU Command Area.
Pl. 99. The monkeys cause considerable damage to potato cultivation in the canal irrigated tracts of Hoera North village.

Pl. 100. At Sibaichaadi village, difference in micro-relief influences irrigation techniques and associated cropping pattern.
Pl 101. The DVC sluice gate at Hoera village.

Pl 102. Irrigated rabi crop along the DVC canal at M.Ramnagar village.
Pl 103. Banana cultivation along the Kunti river with RLI at Narayanpara village.

Pl 104. Mussainpur village still remains backward due to her inability to use canal water.
Pl 105. Deforestation along the right bank of the Kangsabati Upper catchment.

Pl 106. Gully plugging at Puruliya Dist to arrest siltation.
adequate government initiative to introduce effective irrigation system in the wetlands of the State. Neglect of ecological considerations in the implementation of irrigation projects has also been a cause of its retarded performance. This has been further aggravated by the laissez faire attitude of the rural people. The people are usually dependent on rainfed agriculture for generations and as such lack motivation in irrigated farming. Some prefer to adhere to the traditional irrigation technology. Absence of adequate technological diffusion has resulted in a perception gap between the bureaucracy and rural community. Although there exists considerable viable areas of development, these factors have resulted in a laxity of implementation.

It is therefore necessary to identify the genesis of these problems so as to portray the future prospects of irrigated agriculture in West Bengal. The genesis of such malfunctioning of irrigation in this State may be deciphered and classified as ecological, socio-economic, technological and political in nature.

ECOLOGICAL PROBLEMS

The location specific character of irrigation should be considered when planning for its optimum utilization. This is evident from the various constraints imposed by the physical environment or those problems accruing from faulty management.
1) **Too much dependence on Monsoon Water**: This is basically a climatic problem pertaining mostly to the utilization of surface water resources in certain areas of this State. Despite the construction of dams and reservoirs, susceptibility to monsoonal fluctuations still persist as manifested in the seasonal and annual variations of reservoir water levels. Intake of water by the canals from the storage reservoirs thereby is considerably reduced during the winter and summer seasons thus restricting availability of water for double or multiple cropping. The canals have plentiful supply of water during the monsoon season. During this time, the farmers generally do not require irrigation water in farming, as moisture supply from natural rain is quite sufficient for farming in the entire State.

In the use of groundwater, such fluctuations are of less magnitude. Even then, minor fluctuations are perceptible in years of drought as well as in the plateau fringe tracts. Crop yields are drastically reduced at such times as in 1982. During this period, the villagers experience 3 m drop in their STW water level. This necessitates deeper digging and placing of pumps at lower levels, thus incurring higher costs.

2) **Siltation of Reservoir Beds**: In case of the major irrigation projects, the detrimental effects of deforestation in catchment areas are well marked. Deforestation accelerates soil erosion. This results in progressive siltation of the
Pl 107. Silting up of canal beds and invading of vegetation.

Pl 108. Progressive silting up of canal beds at Tilabaid village.
reservoir beds. In the Kangsabati Project, the annual sediment load within the reservoir amounts to 3.617 ham/sq. km. in place of the predicted rate of 3.296 ham/sq. km. This phenomenon has not yet posed any problem, mainly due to its recent implementation. Surveys carried by the River Research Institute, Government of West Bengal, have revealed that in Mayurakshi Project reservoir, there is reduction of its storage capacity from 68 to 25 mcm during 1964-1972. Although soil conservation measures have been taken up, the annual sedimentation index has increased from 0.34 mcm/256 sq. km. in 1960s to 0.52 mcm/256 sq. km. (1000 sq. miles) in 1980s. Depletion of storage capacities of Maithon and Panchet Reservoirs of the DVC have also been calculated as about 40% during 1963-1973. At present the annual silt deposition amounts to 25.6 ham/25 sq. km. in the Maithon reservoir and 20.5 ham/25 sq. km. in the Panchet reservoir. A direct consequence of this is the increase in the chances of floods along the lower reaches. Excess discharge of water from the canals during this time results in waterlogging along low-lying areas. These waterlogged areas naturally become the breeding grounds of mosquitoes endangering the health of the people.

3) Impact of Minor Variations in Micro-Relief on Canal Irrigation: Canal irrigation in its true form is gravity flow irrigation. This is prevalent along the undulating western parts. Along the moribund riverine areas of the east, even
a minor difference in micro-relief necessitate drainage incurring additional expenditure. Field surveys reveal other localized problems, as noticed in case of Paraj and Manikbazar located within the DVC canal command area and are traversed by the DVC Main Branch Canal. While Paraj gets the benefit of canal irrigation, Manikbazar is deprived of it due to its location along relatively higher ground.

4) **Difficulties of Groundwater Exploitation in the Rocky Terrain** : Groundwater exists here mostly within secondary porosities, in the underlying gneisses and schists. Boring wells in such terrain involves complicated and expensive technology. In comparison, the returns are not remunerative as the entire ecological set-up is not very favourable for irrigation. Nevertheless experiments with deep tubewells are now being carried out along the plateau fringe zones.

5) **Problems of Shallow and Deep Tubewell Irrigation System in Red Soil Areas** : In the western plateau tracts, iron-rich groundwater results in thick deposition of iron oxides in the tubewells. After few years, such wells are discarded as observed at Sagma village in Puruliya district. Lack of adequate rainfall in this area further aggravates this problem.

6) **Problems of Shallow and Deep Tubewell Irrigation along the Bhabar Zone** : This region with its excessively coarse
textured soils, is confronted with distinct problems. During the rainy season water table reaches very near the ground. At other seasons it goes down to even 30m. In such cases it would be uneconomical to exploit groundwater unless selective crops are cultivated. An additional problem is the choking of shallow and deep tubewells.

7) **Water Quality Criteria**: This aspect poses a problem along the coastal zones of Medinipur and 24 Parganas districts. Surface and groundwater salinity along with soil salinity are not congenial to irrigated agriculture. Monocropping of rice, specially with recently developed salt resistant varieties like CSR-1, CSR-4, etc., is practised here. The success of double cropping usually depends on residual moisture. Freshwater irrigation through tanks is practised on a local scale but they are inadequate. In recent years deep tubewells resort to tapping of deeper freshwater aquifers. Yet their overutilization must be prevented as this would result in penetration of saline sea water. In certain villages, bordering major tidal rivers like the Bidyadhari, yearly inundations by tidal waters have gradually increased the salinity of deep tubewell water.

High iron content in the groundwater is a characteristic feature of Calcutta region. This is due to sub-surface flow from the western plateau tracts. Although, this does not yet pose a problem in irrigation, yet it may do so in
future. Water quality appears to be a constraint in case of irrigation with sewage water as in the case of Amrai (Durgapur P.S.). Water of stagnant reservoir is occasionally polluted with accumulation of trace elements.

8) Scheduling of Irrigation: Optimum allocation of irrigation water should be in consonance with the physical and agro-climatic setting of a specific region. For example, varied toposequences are diversely responsive to similar water applications. Water requirements of crops may fluctuate with variations in the atmospheric evaporation and soil water content. Studies on the management of rice crop have revealed that with flooding, maximum grain is harvested during December-April, a period of medium evaporative demand. While under low atmospheric demand, saturation is found to give better yield than flooding. But an unsaturated soil water regime reduces generally the yield under the various levels of atmospheric evaporative-demand.

SOCIO-ECONOMIC PROBLEMS

Irrigation efficiency is also dependant on the social set-up of the people like their demographic components, agricultural system, socio-economic status of farmers, cost of irrigation and so on.

9) Uneconomic Nature of Land Holdings: A direct consequence of progressive increase in population is fragmentation of
Pl 109. Lifting of canal water by power pumps in the moribund riverine plain at Haripal PS.

Pl 110. The monsoon water collected in low-lying areas is later used for farming in the drought prone areas.
landholdings. About two-thirds of the holdings are less than 2 ha in size, being much less than the economic holding size of 2.5 ha. Moreover due to rural-urban migration, the number of tenant farmers and landless labourers are on the increase. There is thus a general reluctance to invest on irrigation and associated inputs like HYV seeds and fertilizers. In case of small and marginal, landholdings, overall production falls short of meeting overhead costs, even if irrigation is made available to them. The absentee landlords are not fully interested in improving production as they are not totally dependent upon agriculture. Majority of the farmers have neither the economic capacity nor the technical ability to adopt modern irrigation in their subsistence agricultural system.

10) Non-Systematic Utilization of Water Resources: It has been observed during field surveys that fear psychosis of the farmers may often lead to non-systematic utilization of water resources. Because of the fluctuation of water supply in the canals, farmers in proximity to branch canals or head reaches of distributary canals tend to extract excess water for the cultivation of summer and winter crops. The farmers at tail-end reaches or at distance from the main canals thus suffer from water scarcity. Consequently, they prefer to cultivate less water demanding local varieties of cereals. In contrast, over application of irrigation water along the higher reaches often damage standing crops.
11) **Lack of Social Awareness** : The farmers are not well conversant to the problems arising from over-utilization or wastage of irrigation water. At times excessive irrigation results in shortage of drinking water. For example around Haldia industrial complex, overutilization of ground-water in farming has led to a lowering of the groundwater table during the last five years. In the police stations of Arambagh/Pursurah groundwater use has exceeded 90%. Unless steps are taken for its recharging or its excessive withdrawal is restricted, serious repercussions will take place in future.

The farmers quite often are not in a position to repay their loans or taxes in time. The profit reaped from irrigated farming is quite often spent on extravagant social functions as well as on luxury items to improve their socio-economic status. This proves to be unproductive in the long run. The next result is poor capital inflow against the investments made by the State Irrigation Department. This has adverse effect on the proper maintenance of irrigation channels.

12) **Erratic Nature of Water Taxes** : The prevalent tax rates of irrigation water are erratic in nature. Taxes are fixed on the basis of the area of the farm and not on the amount of water actually used. This tends to oblivate the volumetric consumption of irrigation water, which may vary irres-
PI 111. Minor irrigation sites at ecologically suitable spots in the drought prone plateau area at Paura Pahari village.

PI 112. The Hanumantha river being dammed in the foothill zone of Puruliya Dist.
pective of net irrigated area. In addition the consumptive use of crops vary with diversities in terrain, soil texture and PET. It is imperative to restructure the present system by introducing fresh water rates on the basis of its volume of consumption in farming. Canal irrigation involves nominal taxes, which provide strong incentives to irrigated agriculture. But lack of proper supervision often results in the surreptitious use of main branch canal and navigation canal waters as well as the illegal obstruction of water flow in the head reaches. In such cases the farmers at tail ends have to pay full taxes despite using much less water than their requirements.

The water rates are considerably high for government operated River Lift schemes and deep tubewell irrigation. In the context of wide disparity in the economic conditions of the farmers, the present water rate appears to be irrational. At present, the rich and affluent farmers are capable of paying such taxes. They are also in a position to ensure remunerative return through application of other costly inputs. In some cases the Government allows free use of irrigation water during the first two or three years of irrigated farming. But in the absence of cash returns from the farmers the system does not work after some years. The machinery, in many cases, is worn out and cannot be replaced or repaired due to paucity of funds. Quite often the system becomes obso-
lete resulting in an overall loss. At times, even during years of deficit water supply, tax rates remain similar as they do not incorporate the number of waterings in the field.

With respect to shallow tubewell irrigation, a different picture sometimes emerges. The rich farmers usually purchase shallow tubewells. Besides their own use, they rent out their machines on an hourly basis to other farmers. The small or marginal farmers are again confronted with the same economic problem.

TECHNOLOGICAL PROBLEMS

A laissez-faire attitude to the aforesaid ecological problems and lack of co-ordination between the administrative machinery and the people have resulted in the present under-utilization of the existing irrigation facilities in West Bengal. Some of the major issues may be highlighted.

13) Over Emphasis on Major Irrigation Projects: In canal command areas, the fundamental thrust is towards flood control with irrigation as a secondary component. This has adverse impacts on agriculture. Often during periods of heavy rain, excess water is discharged into the canals to prevent bursting of dams. This results in extensive crop damage caused by man-made floods.

In case of the Kangsabati Project, for example, if the
PI 113. Pumping of ground water for irrigation during the dry season needs shifting of the entire STW system at lower depths in Goghat PS.

PI 114. Hardy cereals being introduced in regions of deficit soil moisture in the Barind tract; this is a typical dry farming technique.
Monsoon storage level is kept at RL 131.68m as contemplated in the project the interests of irrigation suffer. There is negligible rainfall in October in most of the years and irrigation requirement for both kharif and rabi irrigation is about 70,926 ha which implies a reservoir water level of RL 132.28m. This is indicative of an encroachment of about 0.62m in the contemplated flood absorption space.

14) In-efficient Use of Traditional Technology: The ancient overflow irrigation system has been grossly underestimated and neglected. In case of excess discharges from the reservoirs, they could form additional absorbers of flood water. In this context, mention may be made of the traditional Jhor Bunds of Bankura and Purulia districts. This system has now been neglected, being relegated to a minor position in the command areas. In the past, tanks acted as reservoirs of excess flood waters from rivers and private canals, to be made available for irrigation at a later period. In a way, they perform the dual task of flood control and irrigation. To-day most of these tanks have been silted up, being occasionally used in domestic purpose or watering kitchen gardens.

Cost of renovating these tanks are high and returns from tank irrigation low. In fact pumps are seldom used for lifting water. Usually family labour is involved for using 'dongas', hence saving lifting costs. But in the past, the rural people found the system most economic and viable. In the dry season the silt of these reservoirs was used as manures in
the fields. The clay and silt were also used as housing materials.

15) Some Deficiencies in the Barrages: The two barrages of the Mayurakshi Project can regulate partial flows of the river system. Considerable flows are maintained below these barrages due to regeneration and return flow from the vast irrigated areas. It has been suggested that pick up weirs/barrages may be constructed across these rivers lower down at suitable places, so that seepage and other water thus available by pumping can be used or diverted for irrigating the lower areas in the Mayurakshi Command Area.

16) Some Lacunae in the Canal System: Excluding the Main Branch Canals, all distributary canals as well as field channels are unlined, resulting in water loss within the coarse textured soils. Percolation losses have led to silting up and even vegetative growth along canal beds. There is also the incidence of intensive gullying along the canal banks as noticed at Paruldanga Village (Birbhum district) situated within the Mayurakshi Command Area. At Nimo village (Bardhaman district) the distributary canal beds are silted up by about 3m during the last 20 years. Dredging operations are expensive but, since the water of the DVC is now supplemented by DTWs, the problem has not assumed critical proportions. Such unlined canals result in transmission losses. In the Mayurakshi Command Area for example, a total loss of
about 10% has been estimated in between the barrage head regulator and the canal outlet during the kharif season. The River Research Institute, W. Bengal has also calculated the transmission losses in the Left Bank Main Canal of the BVC system. Between Paraj and Rajbundh along the middle reach of one of the main branch canals, there is a loss of 41 cusecs, whereas between Rajbundh and Durgapur along the upper reach the loss is by 27 cusecs (Sarkar, 1969).

There are large number of outlets issuing from the Main and Branch Canals. Whereas the outlets from the Main Canals are controlled, the outlets of the Branch Canals are uncontrolled, leading to wastage of water. Controlled outlets are found to be more beneficial. Quite often the canal system terminates at minors and distributaries of capacities of about 2-3 cusecs and the outlets provided are of such sizes. This volume of discharge is too large for the farmers to handle. The present system of field to field flooding results in enormous loss of water. Steps are being suggested to prevent such indiscriminate use. Setting up a junction box at the end of the leading channel from each outlet is desirable so that the discharge of the outlet gets distributed into two or more channels. This will divide the present area of 81 ha under each outlet into manageable blocks of 20-24 ha.

17) Improper Land Levelling: The uneconomic size of holdings precludes land levelling operations which are expensive. Un-
even application of water is a natural corollary, often exposing good farmlands to waterlogging hazards.

18) **Technological Defects of RLI and Groundwater Irrigation:**

One limiting factor being faced by these types of irrigation is erratic power supply, particularly electric power. Narayampara village (Hughli district) receives DTW irrigation. Within 5 years (1980-85) there has been a loss in 'boro' rice area by 46 ha due to fluctuating power supply. Although initial costs of installing electricity operated STWs are very high, yet if they function in a stable manner, its operational cost is less than diesel operated units. Such erratic supply of power has become a deterrent in the spread of irrigated agriculture.

Use of diesel as fuel in irrigation pump-sets has its benefits. But quite often crisis occurs due to its short supply, as observed at Mubarakpur village (Maldah district). The villagers are sometimes deprived of government allocated diesel supply during such a crisis, due to interference of vested interest groups. They usually sell a local plant - arum - to obtain money for purchasing fuel from the open market. Irrigation water is used in turns. Another practical problem is adulteration in diesel oil, wherein the operational efficiency is hampered.

Since the RLI and DTW irrigation involves an elaborate set-up, their maintenance cost is comparatively high. The
existing number of servicing stations are too inadequate for
the number of installations. Hence in case of damage in any
part of the machine, these are left unattended. Such obsolete
RLI machines have been observed during field surveys at
Paranpur (Hughli district).

Appropriate technology is still lacking with respect
to the ecological setting of tubewells. The coating of iron-
oxides in STWs situated in red soil areas, choking of STWs
and DTWs within the excessively sandy 'bhabar' tract and
scientific extraction of DTW water in saline coastal zones
need to be well looked after for better results.

POLITICAL PROBLEMS

19) Inappropriate Planning: Excessive stress is now given
on Command Area Development in major river valley projects.
There is an obvious lack of co-ordination between the atti-
tudes of bureaucracy and the aspirations of the people
reaping the benefits. Allocation of water is done in a
planned manner only up to the distributary phase. But its
ultimate availability to the people for farming now appears
to be nobody's concern. A controversial situation arises in
the maintenance of the canal networks. The Department of
Irrigation and Waterways shifts the responsibility to the
Department of Agriculture and vice versa. The ultimate
result is that the villagers have to maintain the waterways
in their own ways. In addition it is difficult to meet the varying demands of irrigation from different sectors within such extensive areas.

Regarding the distribution of RLLs and DTWs, arbitrary decisions are taken on the requirements of the villagers. At times vested interests operate to prevent judicious distribution of medium or minor irrigation schemes. In the densely populated zones where groundwater is already being over-utilized, closely spaced tubewells may result in the lowering of the water table within a short period.

The allocation of agricultural credit and electrification of villages involve similar problems. These do influence the efficiency of irrigation in an indirect manner.

FUTURE PROSPECTS

Water resource planning for sustainable future development in irrigation encompasses the following criteria:

i) Identification of long-range goals for irrigation and related aspects.

ii) A prior objective appraisal of present and projected future problems and requirements.

iii) Suggestion of alternative solutions.

iv) Lastly, formulation of the plan for optimum utilization of the resource appropriate for the area.
It can also be said that such planning should be based on the intrinsic relationship between the hydrologic cycle and other environmental parameters—physical, technological and socio-economic. The optimum utilization of irrigation water is thus the outcome of the effective and comprehensive environmental, technological and institutional planning.

1) **Eco-Development Approach**

The ecological problems facing or issuing from irrigation implicates lack of environmental considerations. To mitigate these problems it is imperative that development be with respect to the ecological setting.

Regarding the major command areas it may be stated that effective measures have been implemented primarily through "Watershed Management". At present, the DVC proposes to develop 67 mini-watersheds throughout the Valley where biological as well as mechanical measures are being carried out through Forestry, Extension and Engineering Divisions of the Department as well as by State Agencies. Upto 1980, nearly 61% of the total problem areas have been covered, (Soil conservation 46 %, Forestry 68 %, Upland Treatment 52 % and Engineering 69 %). Positive impacts are manifested in the decreasing trends of sediment deposits. In the Maithon reservoir annual sediment yield is reduced from $8.09 \times 10^6$ cum in 1963 to $6.96 \times 10^6$ cum in 1973, and the corresponding figures
Pl 115. Terraced farming in hill slopes to check landslides in Darjiling Dist.

Pl 116. Encrustation of saline layers on fallow lands in the coastal areas of 24 Parganas South -- a common feature during the dry season.
for Panchet reservoir are $13.2 \times 10^6$ cum and $9.87 \times 10^6$ cum respectively. By treating 15% of Panchet Watershed over a period of 12 years, the decrease has been 25%. These measures undoubtedly increase the estimated life span of the reservoirs, as well as their flood absorption capacities. In the Mayurakshi and Kangsabati Project areas such measures are still in their incipient stage.

Flood Moderation Schemes have been especially implemented as flood control form the major constituent of the major projects.

Specific mention must be made of 'Dryland Agriculture' which include techniques of soil and crop management as well as improved system of cultivation in which the maximum amount of moisture can be conserved in the soil (Kanitkar et al, 1960). This has been effective in the drought prone areas as in Puruliya, Bankura and Medinipur West. In fact this has been suggested as an alternative to irrigated farming, to make maximum use of the deficient water resources. In Puruliya district, for example, 63 micro-watersheds have been undertaken for treatment. Besides these, drought resistant varieties or crops with low consumptive use are being introduced, such as inferior cereals and oilseeds. These include millets like bajra, 'gundlu', ragi, maize and oilseeds such as rape and mustard, linseed, groundnut, being largely dependent on
residual moisture or low doses of irrigation water. Improved short duration HYVs or drought resistant varieties of 'aman' rice are being introduced to adjust to monsoon rainfall. Subsequently the other crops can be cultivated during the non-monsoon period. Inter-cropping with maize and groundnut, jowar and arhar, etc. form economic practices. Such inter-cropping and sequence cropping consists of growing short and long duration crops together. Such short maturing hybrids include CSH1, CSH2 for sorghum, HB1 and HB2 for bajra and so on. Micro-relief differences are also being considered. Along the highest lands such as the 'tanr' and 'baid' lands dry farming is practised in an intensified form as these lands suffer most due to moisture stress. The least water requiring crops have been recommended for these tracts.

Dry farming techniques also include contour bunding, bench terracing, land levelling, gully plugging, etc. Such practices are being initiated in the drought prone districts. In Bankura district, for instance, 111 ha have been brought under contour bunding, 69 ha under gully plugging, 7 ha under bench terracing. In Puruliya district 60.4 ha have been covered under contour bunding and 76 ha under bench terracing.

Along the coastal zones, the salinity problem is being combated through selective crop cultivation and saline soil
treatment. The Coastal Soil Salinity Research Institute has played a vital role in this field. Certain package practices have been evolved for saline soil treatment.

i) Embankments around fields should usually be one metre higher than flood heights and are 1-3 m wide. Towards the sea/stream slopes should be 1 : 3 and towards the villages 1 : 2. Construction of sluice gates if constructed over the embankment will remove excess rainwater and prevent saline water from entering.

ii) Land levelling is essential for successful irrigated farming.

iii) Stored water should be used. It has been estimated that out of 1750 mm of water stored after its use in rainfed agriculture, evapo-transpiration and other uses, For 1 bigha farm land about 1/5th bigha area should be cut with 3 m depth to store rain water. This could also be used as fisheries.

With regard to selective cropping, salt tolerant varieties of rice have been successfully cultivated. CSR-1, CSR-2, CSR-3, CSR-4 (Mohan) are examples but such varieties cannot tolerate greater than 25 cm water pressure. If salinity is low and water level 20-50 cm, CSR 26B, Matla, Kalamota varieties are favoured. For rabi crops, rice can be cultivated if irrigation water is available. Otherwise salt tolerating crops like barley, chillies (EC 35, CA 960, Suryamukhi),
lady's finger and watermelon can be grown. It is being recommended to cultivate mesta and cotton with available irrigation water. The pineapple crop with high tolerance against water stress and a shallow root system has been suggested for the productive utilization of higher lands in the saline soils (Sengupta, et. al, 1987). Proximity of Calcutta region forms an additional advantage for vegetable and fruit cultivation.

For sustained growth of all crops in varied ecological settings, consumptive use studies are being conducted by different Research Institutes and Research Farms. If their recommendations are followed, crop production may be augmented.

2) **Symbiosis of Traditional and Modern Irrigation Systems**

The technological constraints confronting irrigation are varied and need to be combated in a systematic and scientific manner. If restorative measures are taken to treat unlined canals, encrustation of tubewells or their choking, efficiency of irrigation is likely to be increased. Studies have revealed that there is enormous scope of improving field channel efficiency. Such channels should have gradients of about 0.1°. It is desirable to line them only along more vulnerable areas with single layer bricks or stones, polythene sheets, etc. At present overall irrigation efficiency has been estimated to be 40% (Sengupta 1983).
Pl 117. A view of the Central Soil Salinity Research Institute at Canning.

Pl 118. Embankments along tidal creeks are built to combat salinity problem.
Further improvement in the conjunctive use of surface and ground-water is a basic step towards water conservation. In major canal command areas, for instance irrigation with tubewells will prevent waterlogging which may arise due to incessant percolation from unlined canals during the monsoon season. Groundwater irrigation during the winter and summer seasons will thus extract this additional water, simultaneously mitigating the problem of meagre availability of canal water during this period. Such complementary irrigation is being practised along many of the CADP villages. Memari village (Bardhaman district) depicts the positive impact of combined canal and DTW irrigation.

A symbiotic use of traditional and modern irrigation system proves to be beneficial. It has also been suggested that in the densely populated regions where groundwater has been over utilized, artificial groundwater recharge structures like percolation tanks could rectify matters. Revitalization of the overflow irrigation canals and renovation of tanks is also essential, specially in the saline coastal zones where freshwater irrigation is an impending necessity. If this is supplemented by DTWs, tapping the deep, freshwater aquifers, it could prevent over extraction of groundwater. At the same time double or multiple cropping will be feasible. The State Government has taken recent measures to renovate the old private canals, which to-day have assumed the form of
discarded and detached 'river bodies. Hence they may more precisely be termed as 'tanks'. These are responsible for the meagre irrigation that is characteristic of the extreme coastal zones as in Sagar P.S. Without this, irrigation would have been relatively impossible in these areas.

3) **Irrigation with Comprehensive Planning**

Consolidated efforts towards increasing the efficiency of irrigation should be through comprehensive planning, rather than through piecemeal measures. It has been observed that there is lack of co-ordination between the different sectors as well between the government and beneficiaries. This is the fundamental cause for low utilization of the existing water resource of this State. Hence an integrated approach is necessary between the Departments of Agriculture, Forestry, Soil Conservation as well as Irrigation and Waterways. Only then can the ecological and technological problems be handled efficiently. Moreover, there should be direct sharing of responsibility in the use of irrigation water and a mutual understanding between the government and farmers through an interlinked body. A prior knowledge of the socio-economic set-up would be useful. Functioning through co-operative bodies can ensure judicious allocation of irrigation water according to the demands of the villagers, thus reducing its undue wastage. In this context it may also be stated that stress should be given on the development and
maintenance of medium and minor irrigation projects encompassing smaller areas. Farmers are in a position to tackle the problems of minor projects but this is not feasible in major projects. In case of major irrigation projects, there exists considerable time lag before water is allocated on demand basis or before repairs are conducted. The Government has already implemented 23 medium projects and numerous minor irrigation projects.

CONCLUSION

Taking a rational view of all these facts, it may be conceded that the future prospects of irrigated agriculture in West Bengal is not totally discouraging. Irrigation has conferred its benefits upon net sown area, cropping intensity and crop yields. Of these, intensity of cropping has manifested maximum response. This does not imply that irrigation has not influenced net sown area, but in this field its role has been complicated by demographic factors. With respect to crop yields irrigation has played a catalytic role by augmenting the use of HYV seeds and fertilizers. Its benefits in the socio-economic field have yet to be assessed as this has been complicated by urbanization and industrialization. Moreover, they are apparent only in the long run.

Efficiency of irrigation may be enhanced gradually through realization of its relationship to the other environ-
Pl 119. Extensive gullying along canal bank in Bankura Dist.

Pl 120. Detached sections of river beds termed khals, recently being redug for irrigation at Sagar P5.
mental variables, through the consorted use of traditional and modern irrigation systems and also through a co-ordination between the various performing sectors. This requires comprehensive planning with equal emphasis being given to surface and groundwater resources. In view of the fact that surface water is susceptible to monsoonal fluctuations and due to increasing moribund conditions in the eastern parts, it would be advisable to rely more on groundwater irrigation. At present only 20% of the total reserves of groundwater have been utilized. As such there is considerable scope for its future development. Stress must also be given on the selective adaptation of technology based upon ecological considerations as well as upon the conjunctive and judicious use of surface and groundwaters to ensure maximum benefits in the long run.