Report on

Development of Coastal Areas

Affected by Salinity

(NATIONAL COMMITTEE ON THE DEVELOPMENT OF BACKWARD AREAS)

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Report on Development of Coastal Areas Affected Areas

CONTENTS

SUMMARY OF CONCLUSIONS AND RECOMMENDATIONS

1 INTRODUCTION

1. The National Committee on the Development of Backward Areas has identified different types of fundamental backwardnesses and is seeking remedies for rectifying the same. The coastal areas; affected by salinity constitute one such category.

(para 1.1)

2. The problem of salinity in coastal areas is a national problem and requires detailed studies in all the coastal slates. The development of such areas- requires special attention because they have remained neglected since long and the deve-lopmental efforts of the post-independence plan era have also not generally reached there for want of proper strategy, infrastructure and impediments due to backwardness.

(Para 1.6)

II STRATEGY OF DEVELOPMENT

3. The Committee is of the view that for special treatment as saline areas, coastal saline areas need to be identified as:

(a) Soil salinity areas where the top soil is saline;

(b) Water salinity areas where either the water strata for great depths is saline, or even if top 30 ft. has fresh water where fresh water is entirely by rainfall alone.

(Para 2.2)

4. With a view to providing the right type of development technology suiting of different conditions such areas may then be classified into : — -

(a) Saline soils;

(b) Saline alkali soils;

(c) non-saline alkali soils; and

(d) degraded saline alkali soils.

(para 2.5)

5. The entire area of Sundarban faces the problem of salinity, water logging and drainage. In the absence of upland water supply the area is exposed to tidal action making the water highly brackish. For the development of the Sunderban an integrated programme simultaneously covering crop production, fisheries, animal husbandry and forestry and providing for improvement in infrastructural facilities including communication and supply of potable water will be necessary. For the

protection and development of land and for increasing availability of fresh water for agricultural and drinking purposes, engineering and other measures as envisaged both in the Interim plan of development of the Sundarban and in the Sundarban Delta Project should be undertaken. Industrial development should be restricted to such agro-based industries as do not aggravate the problem of fresh water in view of its limited availability. As an integral part of the overall development of the region, river road and rail transport facilities should be considerably improved. Electrification should be extended to the area to support development.

(Para 2.8)

6. On the east coast the principle of developing existing skill will lead to the obvious strategy of developing fisheries. The next important part of the economy will be agriculture in which some beginning of development can already be seen in these areas wherever fresh water is available. Development of village industries and tertiary sector growth will have to follow the primary growth in both fisheries and agriculture.

(Para 2.9)

7. In the West coast the entire economy will be based on fisheries except where agriculture be developed on the lines of Kuttanand. It will be found that such development on the West coast today would be a high cost development and may not give a competitive agricultural economy to the population.

(para 2.9)

8. The Committee has generally been informed that there is no arrangement for any systematic soil surveys in most States particularly in the coastal areas. The Committee would urge that if a solution is to be found for the problem of the coastal areas affected by salinity, these areas can only be identified on the basis of a systematic soil survey. It is only then that it would be possible for the State Governments to identify areas of high, medium and low saline conditions and seek remedial measures.

(Para 2.10)

9. It is important to undertake evaluation of the various measures taken by the State Governments to reduce the problem of salinity and how far these have been successful.

(Para 2.10)

10. The fishermen class in the coastal saline areas subsist mainly on marine fisheries. Optimal utilisation of the potential needs to be aimed at.

(Para 2.11)

11. The current controversy on the serious competition between traditional boats and mechanised boats needs to be resolved. Demarcation can be based on cost-benefit analysis and suitable rehabilitation of the displaced fishermen, if any, should be done. Possibilities of processing and marketing including export of frozen fish has

to be worked out rationally and optimally.

(Para2.11)

12. Brackish water fishery provides a sizeable potential for development. On account of large areas of brackish water, the reservation of the pursuits for the smaller people would help improve substantially the economics of these persons. Individual farms of smaller size are desirable but these need to be supported through areas development approach and also through the provision of appropriate supporting services including technical consultancy services.

(Para 2.12)

13. The transfer of technical knowledge to the fishermen is very vital and this responsibility should be shouldered by the State Governments by providing the technical consultancy free of charge. The systematic development of the fishermen class should be the focus of attention and would have to be intensified.

(Para 2.12)

14. Hectare for hectare brackish water fisheries which can develop prawns in addition to brackish water fish, give much greater income than the composite fish culture followed in inland fresh water fisheries. Fresh water being the most difficult ingredient in the coastal saline areas, its utilisation for culture fisheries whilst a more remunerative technology in brackish water is available, will not be warranted. The Committee, therefore, recommends that culture fisheries in the coastal saline areas should invariably be brackish water fisheries.

(para 2.13)

15. With the higher rainfall on the east coast it should be possible to bring drainage waters from the land mass through controlled channels to leach the top soil in the saline areas and also impregnate the sub-soil with fresh water pushing down the saline accuifer. Proper fresh water use is, therefore, the main strategy for agriculture in these areas. Further, as fresh water will be scarce inspite of these attempts, the cropping system that will be developed has to be based on suitable cash crops whose water requirements will be low.

(Para 2.14)

16. Very little work has so far been done on finding suitable horticulture cultivators of various fruit trees suited to the area. The Agricultural Universities will have to rapidly survey available information about suitability of fruit trees for their coastal saline areas and in due course undertake development of the necessary cultivers for better production. Any how, coconut production would prime facie appear to be the most remunerative horticultural strategy.

(Para 2.15)

11. For the appropriate development of horticulture etc. and also for the protection of habitation, the shelter belt approach is very desirable. The Committee would like to

commend the strategy of complete shelter belt for habitations.

(Para 2.16)

18. Animal husbandry will have to take a back seat for the time being, until the agricultural Universities check on the type of fodder that can be grown in the coastal areas and which will be suitable for animal rearing.

(Para 2.17)

19. Sundarban has, developed a cheap road system which allows for utilising pedal trays to move the goods to the collecting markets. The strategy of road development will have to take note of these innovations.

(Para 2.18)

III BRACKISH WATER FISH CULTURE

20. A project profile for brackish water culture development by the West Bengal expects distinguishes three types of areas suitable for brackish water culture and they are:

(i) Zones of low saline and low tidal amplitude;

(ii) Zone of moderately saline and moderate tidal amplitude; and

(iii) Zone of high salinity and high tidal amplitude;

If the brackish water areas in the other coastal states are investigated, it will be found that these three types will be replicated all along the coast. Each of these zones; require a different type of brackish water culture.

(Para 3.2)

21. The areas most favourably situated in the zone of high salinity and high tidal amplitude should be selected in each of the coastal saline states, for brackish water culture during these two plans. (Para 3.3)

22. For the low salinity and low tidal areas the bheri culture appears to be the most economic approach. It does not interfere with the paddy culture and, at the same time, gives, a subsidiary income in fish culture. Such areas will have to be identified in all the coastal states and a programme of action developed. (Para 3.5)

23. Large areas have to be embanked for culture fisheries. In agriculture, already there are very substantial land reforms, laws which fix the rights of various parties on the land for agriculture. For culture fisheries at present there is no such law. It is suggested that the laws should provide compulsorily for common operations and for arbitration by governmental machinery. It should also define the rights of the owners of the land to the produce on a fair and equitable basis. The Committee recommends that the Fisheries Division in the Ministry of Agriculture should take up the development of a model law.

(Para 3.6)

24. In the zone of moderately saline and moderate tidal amplitude, where the designs can be suitably developed on the model applicable to the high salinity, it is desirable to follow a culture fisheries approach. In other areas where capital cost on culture fisheries is very substantial, immediate introduction of bheri culture of the controlled variety would benefit the people to a very large extent. The Committee would advise the classification of such lands in the coastal saline States and developing a suitably phased programmes.

(Para 3.7)

25. In areas where paddy-cum-prawn culture is now prevalent and in new areas where the technique can be introduced, it is necessary to improve the method. Introduction of water carrying mixed fry, both desirable and undersirable varieties, will have to be replaced by selective introduction of the better varieties which can give the best return out of the nutrition in the water.

(Para 3.8)

26. For a two crop routine which is more profitable method, fry of the right type has to be available at the right time. It should be possible generally by collecting the fry from the area where it is available to send it to the grower in the season when he wants it. The problem here is the transport of fry. While scientists should find out the best method to reduce transport mortality, obviously steps have to be taken to produce uniform batches of fry so that transport losses can be minimised.

(Para 3.11 & 3.12)

27. The Committee would recommend that the Ministry of agriculture, taking into consideration the various experiments that have been done and innovations introduced, should prepare a model for a production centre for prawn fry. The cost-benefit of the production and the price at which the fry has to be sold will also have to be established. The coastal States should have at least one pilot centre close to an area where culture prawn fisheries are now under development.

(Para 3.13)

28. The development of paddy-cum-prawn culture can probably be introduced quickly all over the coastal states provided areas are identified, extension work is done and necessary arrangements, made for fry supply on demand. The Committee recommends that each coastal state should now do the basic investigations as has been done by West Bengal for Sundarban and identify suitable areas, for development and lay on the expertise and extension and provide the necessary infrastructure including arrangements for fry supply.

(Para 3.14)

29. Culture prawn fisheries is a capital intensive industry. Whilst the fishermen class should be given every facility to enter into this new line and given reasonable help by way of loans, grants etc. the Committee feels that there is a limit beyond

which the fishermen class as individuals will not be able to avail of this programme. A corporation idea on the lines of the Assam Plantation Corporation Act may be helpful. Various conditions will have to be imposed on the lease holder so that the programme is operated as a whole and individual vagaries do not spoil it. It may be worthwhile for the Ministry of Agriculture to set up a Working Group to study this problem and suggest a model project.

(Para 3.17)

30. It will be much easier to introduce controlled culture in small farmer's holdings under brackish water with holdings between 2 - 5 hectares. In effect, this will be small industry. The Committee recommends that these enterprises should be treated on the same footing as. small industries and all the benefits given to trie small industries should be made available to such entrepreneurs; in addition to such benefits as are given to small farmers.

(Para 3.18)

31. The Committee recommends that a few areas of 100 to 200 hectares may be given out to large entrepreneurs, under very strict conditions including utilisation of local labour. One condition should be that they would put up a fry production centre and supply fry, on fair price, to the small farmed entrepreneurs round about. The Working Group dealing with the fishermen's programme can also look into the development of a model contract form for lease of these areas with large entrepreneurs.

(Para 3.19)

32. One of the major constraints to the development of acquaculture has been the paucity of trained personnel at various levels. Training of fishermen and others offering supporting services has to be carried out on a very large scale by each of the coastal states.

(Para 3.20)

IV MARINE FISHERIES

33. Any development of the coastal saline areas must stabilise the traditional economy of the non-mechanised boat sector who almost had monopoly in fishing in the coastal areas which are the most remunerative areas for fishing in the sea. At the same time, we have to support mechanised craft which can go far beyond the depths and distances which the traditional craft can handle and can exploit that vast fishery resources of the economic zone of the country. Where there is pressure and conflict between the mechanised and traditional crafts in certain highly fished areas, there are many areas along the coast where not much fishing is taking place because of lack of basic facilities like communications, fresh water and easy access to a fresh fish market.

(Para 4.13)

34. Where there are large concentrations of catemarans and dinghis it can be

examined by pilot schemes whether a mechanised boat can be engaged to pull them out to the fishing areas in numbers. The Committee would suggest that pilot schemes of this nature should be started and the cost benefit worked out and demonstrated so that a methodology can be developed applicable to the various coastal states.

(Para 4.16)

35. It is possible to introduce labour intensive mother vessel fishing to enable traditional fishermen to go out far into the sea.

(Para 4.17)

36. The most important diversification that can be done with the present technological knowledge is introduction of purse-seining for catching pelagic fish in the coast.

(Para 4.20)

37. The Committee would seriously recommend that the ground level statistics of rempaniusers and mechanised boat users in all those areas where conflict has arisen should be done and, if possible, an introduction of the joint interest method followed in Karnataka may be a solution.

(Para 4.21)

38. The allegation that the purse-seiners are interfering with the coastal movement of the pelagic fish in season may not at all be scientifically tenable. It is desirable that the fishery research and oceanic research look into this problem so that unnecessary conflict by lack of proper knowledge may not continue.

(para 4.22)

39. Now that a reasonable amount of survey of fishery resources mainly polagic has been done on both the coasts, areas where long lines and pole and line fishing by improved means can be introduced should be demarcated.

(Para 4.23)

40. Mechanised boats require jettis for landing. A programme for construction of fishing jettis round the coasts at such locations where jettis can be constructed and where the available potential is not being exploited close to the coast by traditional fishermen and in the distance by mechanised boats can be identified and jettis constructed. This will help in diversifying mechanised boats from highly fished areas to the new areas. This planned deployment should be attemped.

(Para 4.24)

41. The question of subsidising the price of diesel for mechanised boats or reducing the excise is a problem continuously under examination. Some concrete steps in this direction would greatly improve the economics of mechanised boat fishing.

(Para 4.25)

42. There is over exploitation of juveniles of prawns, in certain back waters of the country. In the interest of both the traditional fishermen and the mechanised boats, regulations to conserve the juveniles and allow for the breeding cycle to go through without serious interference is an immediate necessity.

(Para 4.26)

43. Much of the cat fish caught are the incubating males. Hence operation of high efficiency gear has to be regulated in terms of number, area of operation, period of operation, mesh size etc. as unbridled introduction of modern craft and gear can have a devasting influence on the fishery.

(Para 4.27)

44. Deep sea fishing will not greatly add to direct employment opportunities for the fishermen class in the coastal areas. At the same time, without deep sea fishing the country will not be able to exploit the vast potential within the economic zone which at present is being peached upon by fishing crafts of various countries. The Committee has not been able to examine the problems of deep sea fishing in any great depth and, therefore, can only say that in the interest of all concerned, it is desirable to increase the fishing vessels force for deep sea fishing and also attend to the infrastructure to make the fishing economics ;

(para 4.30)

45. The Committee would seriously recommend that the Ministry of Agriculture must take up a comprehensive marketing programme for fish by supporting pilot projects of innovating marketing. Linkages will have to be established between the coastal States and interior States who can be the consumers. The Committee would recommend that the Ministry of Agriculture should carry out a survey all along the coast finding out the seasons when there are large catches in particular pockets of the cost leading to a sharp fail in prices and, at the same time, identify markets, in the country where such fish can be sold at economic prices allowing for the transport charges.

(Para 4.33 & 4.34)

V CROP PLANNING AND ALLIED PROGRAMMES

46. Soil and water salinity and the lack of irrigation are the principal constraints affecting crop planning in saline coastal areas.

(Para 5.1)

47. If efforts are made to evolve and introduce a scientific crop planning in the coastal saline areas, it should be possible to increase crop productivity substantially. For this purpose, it is necessary to make more intensive efforts for evolving suitable crop patterns for different salinity conditions and soil characteristics. The long duration nature of kharif crop is recognised as a constraint for increasing the land use intensity in such areas. Therefore, measures have to be considered how far long

duration kharif paddy can be replaced by short duration paddy and suitable rabi crop viz; barely, sugarbeet, sunflower, cotton etc. which can be grown after harvesting of the kharif crop.

(Para 5.7)

48. Cropping intensity in coastal saline areas provides tremendous scope for improvement. This can mainly be done by providing irrigation facilities and also introducing dry farming techniques in these areas. All the sweet water reserves, surface as well as underground, need to be exploited and put to more judicious use for improving productivity. As much of fresh water as possible needs to be conserved for raising rabi and summer crops. As irrigation water is likely •to be scarce, advantage of the moisture present (in the soil at the time of kharif harvest would have to be taken for raising early short duration and rabi crops.

(Para 5.9)

49. The Central Soil and Salinity Research Institute at its Canning and Research Station has succeeded in identifying a few useful rice varieties and other salt tolererit crops. Development of period bound varieties is, desirable so that harvest can be controlled. The newly developed varieties should be tried on the cultivators field before introducing on a large scale.

(Para 5.10 & 5.11)

50. Due to high saline soil and poor water quality, no crop other than kharif rice is generally possible under commercial cultivation. It is essential to introduce a suitable second crop (rabi) which can tolerate salinity effectively and can grow better than others in moisture stress conditions.

(para 5.13)

51. Possibilities of introducing inter-cropping should be fully explored. For instance, possibility of prawn culture along with coconut, development has been proved. Similar experimentation are desired for making optimum use of natural resources.

(Para 5.17)

52. Trial-cum-demonstration farms need to be established in affected areas which should operate under the guidance of technical hands. The introduction of new rabi crops e.g. vegetables will require the establishment of new marketing, input supply and credit arrangements. Hence measures to introduce new rabi crops in the area must be accompanied by steps to establish an appropriate credit, input supply and marketing infrastructure in these crops. Sundarban has established that, given the necessary support, vegetables can be an important crop in some of these areas.

(Para 5.18)

53. Canning experimentation is an heavy black soil. In other areas the situation is different. As such location specific research would be desirable.

(para 5.19)

54. There is, plenty of scope to develop horticulture in coastal saline areas by introducing technology capable of giving good monetary returns to the growers. The obvious strategy would, therefore, be to select and propagate right type of fruit crops suited to local topographic and salinity conditions,. Further, improved varieties of fruits with a view to raising their yields and resistivity to salinity and water logging conditions which are common in these areas, would have to be evolved through field research conducted at different centres set up for the purpose.

(Para 5.21)

55. The most successful horticulture plant is coconut which has immense potential for plantation in coastal areas,. Coconut plantations with suitable inter-cropping can be an important employment and income generation measure in these areas. The gross return per tree is quite profitable. Moreover there could be substantial opportunities for non-agricultural employment in processing units e.g. coir.

(Para 5.22 & 5.23)

56. Cashew can be cultivated quite successfully in sand dunes which at present are unutilised and often encroach on adjoining farm lands year after year. Cashew trees once stablished stabilise the soil. An integrated pattern of coastal horticulture involving coconut, cashew and causarina holds great promise.

(Para 5.24)

57. Amongst fruit trees sapota and Guava have potential for development in all areas. In many areas having temporary water stagnation, Jamun could be planted. If salinity is brought down through reclamation measures, many other fruit crops can also be grown.

(Para 5.25)

58. Area-wise approach has, to be made for selecting suitable fruit crops for different ecological conditions and research support would be necessary to develop special species of different fruits so that good crop yields are achieved and horticulture becomes more remunerative to the people. The essential requirements for these purposes are (a) the availability of suitable planting material, (b) enough sweet water to sustain the plant in the early stages of growth, (c) arrangements, for credit during the long gestation period; and (d) arrangements for marketing.

(Para 5.27)

59. Multipurpose afforestation of coastal areas is the need of the hour. On the eastern coast, shelter belt plantation requires to be taken up along the entire coast. This, could be achieved only if the participating farmers are ensured of economic returns from such plantations and also their requirements of fuel and timber are met from such farm forestry. There is very good scope for forestry development on west coast also. Salinity resistant trees for meeting the local requirement of fuel and wood may be raised all along the coast which would also check the menance of felling of

trees in the adjoining forest areas.

(Para 5.29, 5.30 & 5.35)

60. For any meaningful enhancement of livestock production work in the coastal saline areas, the main problems are provision of drinking water, feed and fodder, marketing facilities and legistics. In addition, there is at present dearth of infrastructure for supply of foundation and production stock of cattle, pigs- and poultry including ducks.

(Para 5.40)

61. As a basic approach, a balance between cows and buffaloes and other animals on the basis of ecological conditions in different regions has to be struck and seasonal adjustment made.

(Para 5.41)

62. For improving different breeds of animals, artificial insemination programme would have to be extended to these areas in a phased manner. Breed improvement programme should have the dual purpose of increasing the livestock products as well as the drought quality of farm animals. Veterinary dispensaries and live stock Aid Centres need to be set up at convenient places to cover such areas. Mobile veterinary dispensaries may have to be organised for meeting the requirements of difficult areas.

(Para 5.41)

75. While natural depressions, creeks, channels etc. having saline water may gainfully be utilised through development of brackish water fishery, sweet water resources have to be protected from the ingress of saline waters and utilised for irrigation and drinking purposes. Surface water flow during the rainy season has to be regulated through a well planned system of drainage works for controlling the salinity in the top soil. Embankments and bunds are to be erected for protecting sweet water from the ingress of sea water and other saline waters.

(Para 6.33)

76. The present groundwater development in coastal tract is very limited but when the ground water withdrawals are to be increased, the existing saline and fresh water disposition may be disturbed and the process of ingress of saline water may be accelerated. Hence scientific management at the vital ground water resource will require critical evaluation of the changes, brought about consequent ' to withdrawals and must so regulate the draft as to prevent the ingress of saline water in fresh water bodies.

(Para 6.46)

77. Due to the peculiar and complex hydro-geologic set up in the coastal belt be set with salinity hazards, the following precautions are required to be taken for proper development and management of ground water:

(i) Geophysical investigation must precede tubewell designs so that the strainers

are located against fresh water acquifers

(ii) The shrounding materials between the fresh water aquifers and saline water acquifer are required to be sealed by a quick setting cement to avoid! conte mnation.

(iii) Gravel shround materials should be carefully selected to avoid sand fillings in tubewells.

(iv) Indiscrimate pumping from tubewells should be discouraged.

(v) In the coastal areas of Gujarat there is said to be salinity ingress from the sea. In such areas exploitation should be controlled and induced recharge of fresh water coming from the upper hinterland should be prevented escaping straight into the sea by means of small dams etc. so that percolation of fresh water underground might increase.

(Para 6.59)

78. The Committee would like to emphasise that there is considerable scope for exploitation of ground water in the coastal areas and would, therefore, recommend : —

(a) In the alluvial plains deep tubewells for irrigation are now taken up as a stage programme in aquifers, as, deep as 400 ft. Keeping to the cost benefit acceptable generally such wells should be taken up in the coastal areas, even if they are deepen

(b) In particularly difficult areas where both top and sub-soil water is saline and salinity persists to great depths, if alternative sources of fresh water for better agriculture is lacking, it may be necessary to stretch a point and allow for deep tubewells for irrigation even if it is a little more costlier than levels so far accepted.

(c) Even if the economics of deep tubewell, water is generally adverse for agriculture, as a drinking water amenity and for industrial purposes like cleaning and processing of fish, it is necessary to provide deep tubewell systems wherever possible. This is a basic amenity which the Committee will recommend as necessary.

(Para 6.60)

79. For good agriculture, the first essential is to ensure that saline intrusion is reduced as much as possible and whatever saline intrusion does take place, it is leached out by suitable introduction of fresh water during the rainy season wherever possible.

(Para 6.61)

80. Where saline intrusion in summer is now taking place, the areas should be investigated on a watershed basis and low ridges provided on the ridges of the watershed. The investment in these structures will not be very much and the Committee would recommend that priority selection of such areas and urgent steps to see

that this is done may be taken up.

(Para 6.62)

81. The fresh water drainage from the hinter land will have to be suitably guided and directed towards the watersheds, where the salinity has to be leached. At the same time, steps should be taken to see that such introduction does not lead to heavy water logging in the lower reaches of the watershed as has happened in the Sundarban.

(Para 6.63)

82. In many of the delta areas of the country, there are irrigation systems which extend towards deltas. These irrigation systems are themselves the cause of heavy water logging in the coastal areas which together with admixture of saline water makes these areas unfit for agriculture. The normal irrigation practice is to leave tail ends of the canals open. In these areas where water logging is a serious problem, canal control is essential. If cannals have to be drained, there should be definite drainage structures leading them away from the low lands. Further, the freshwater available in such canals can also be utilised in the off-season for flushing out the salinity in the coastal agricultural areas. This planned development of the lower reaches of irrigation system must be done in each state on a priority basis.

(Para 6.65)

VII DEVELOPMENT OF SAURASHTRA AND KUTCH AREAS OF GUJARAT

83. While recognising the sea ingress problem to be the prime problem of the Saurashtra area, the National Committee would like to stress that the control measures would have to find the most economic engineering solution. It feels that tidal regulators may be a high cost technology and would sound a note of warning towards its adoption without judiciously weighing the pros and cons. The Committee feels that recharge technique would be much more economic and reasonable for adoption. The Committee has, observed effective use of one way regulation, in mini creeks and run-off in the Sundarban region of West Bengal and would recommend for its adoption after careful detailed study. The Committee has also noticed difficulties in controlling large creeks and here again would recommend the adoption of techniques tried successfully in Sundarban.

(Para 7.8)

84. The suggested device of a static barrier or impermeable cut-off wall for the salinity control measure, beside being quite costly, cannot prevent upward movement of salt water which already underlies the overdrawn extraction area. The Committee would recommend an earnest-pilot research to establish whether the methods could alleviate the problem.

(Para 7.9)

85. At present, hardly any measures for checking of surface flow are there and as such a large portion of the monsoon precipitation goes over to sea. One way of

tackling that would be through control of river flows in the upper reaches and measures to induce water retention in upper reaches. Further, down the course of rivers, check dams, percolation tanks and recharge wells in hard area locations are the possibilities open for adoption. The possibilities can be studied through a detailed investigation of the area on a comprehensive watershed approach, be adopted.

(Para 7.18)

86. A single line of gates can regulate the manageable parts of any flood throughout the monsoon season. The Committee would urge the adoption and optimum utilisation of such measure and introduction of any design modifications, if called for.

(Para 7.19)

87. On the problem of afforestation, the Committee would like to reiterate the suggestion that the tree selection should be the one which benefits the water balance and not prove counter productive in terms of recharge.

(Para 7.21)

88. The broad conclusion of earlier Commissions etc. had been that the Kutch area can be agriculturally improved if part of the Narmada flows could be diverted to this area. Such a measure would not only substantially mitigate the acute problem of drinking water but also create conditions for reclaiming substantial area of the Rann for agricultural purposes. In this context the feasibility of bringing water to the Little Rann to control salinity for brackish water fish culture could also be considered.

(Para 7.27)

89. The developmental efforts in the Kutch areas have obviously to be directed toward acquaculture development.

(Para 7.28)

90. The Committee feels that in the Rann of Kutch very large areas are suitable for development of brackish water fisheries. The Committee would urge that the proper assessment of these areas should be done through a detailed survey with basic parameters. The two vital aspects needing special attention are checking of tidal ingress and the supply of fry. Measure for tidal ingress have already been dealt with at length. With regard to the supply of fry, the Committee visualise two practical ways, to catch the fry where it is and put the same in these areas, or to bread the fry elsewhere and then bring to these areas. The Committee is confident with effective tackling of the problems and with suitable provisions for nutrition in the water and design development, brackish water fish culture can become a major base for the economics of Saurashtra and Kutch area of Gujarat.

(Para 7.37)

91. The pattern of water use in Kutch areas is likely to undergo a change after the completion of and the operation of the Sardar Sarovar Dam. In such a situation

brackish water fisheries may not provide the answer for optimum utilisation of the resources of the area. For that purpose a fresh look at the problems would be desirable to evolve suitable development strategies for the areas with a balance between fresh brackish water culture. Pilot schemes and sufficient research effort should be carried out to take full advantage of the changed conditions when they occur.

(Para 7.38)

VIII DEVELOPMENT OF SUNDARBAN AREA IN WEST BENGAL

92. Considering the physical and other characteristics of the Sundarban area and keeping in view the constraints pointed out above, the strategy for development in this area has- necessarily to be as follows:

(i) Extending irrigation by utilisation of excess rain water, construction of sluices and network of drainage, channels to remove drainage congestion;

(ii) Once irrigation becomes available, an attempt should be made to convert the present non-cropped area into two cropped area to the maximum extent possible. Whatever little has so far been attempted has clearly established that |Cr.*,,V given the irrigation, the yield in rabi can be very much higher and the crop production can also be diversified;

(iii) Land-use should be made more intensive in order to raise production status, '. particularly, of small and marginal farmers;

(iv) There is a lot of potential for the development of fisheries and there is, already ' a ready market in the Calcutta city. Next to agriculture, fisheries would appear to be the most important programme of development in this area;

(v) There is also good scope for taking up horticulture, animal husbandry, fishery, poultry, piggery, dairy etc. which would create new avenues of productive employment

(vi) Natural resources and local skills must be utilised for development of cottage and small industries;

(vii) Inirastructural facilities including extension support, input supply, credit facilities, marketing/processing arrangements, communication etc. would have to be provided ; and

(viii) The last but the most important point is that the organisation structure would have to be so streamlined that not only there is adequate delegation of financial and administrative powers to the development authority, but it has the necessary powers to coordinate, supervise, and monitor the execution of programmes.

(Para 8.29)

93. The Committee found that the works in the Growth Centres on the Sundaraban are being executed by the board and that there is no support at all to the programme

from the Agricultural or Animal Husbandry Departments. The Committee feels that this sort of truncated approach will not do. If these Growth Centres have to succeed, the sub-plan strategy of Tribal Welfare Programme would appear to be extremely relevant.

(Para 8.37)

94. The Committee would like to stress the development of a comprehensive plan of irrigation through drainage and optimum utilisation of tank development. The economics of tank development are favourable and hence need to be encouraged. If energetic steps are taken for appropriate development of tanks" to store rain water, there are immense possibilities of increasing the second crop acreage and also raising the yields of the crops grown therein.

(Para 8.43 & 8.45)

95. Coconut cultivation can go up substantially and the field enquiries show an awareness. But there is no arrangement to supply good quality seedlings either for 'Dab' or 'Hardnut'. The Sundarban Development Board should consider temporary hiring of services of out side expertise on development of high-yielding varieties of coconuts.

(Para 8.47 & 8.48)

96. Bee keeping is one of the fields which holds bright prospects for enhancing the production of honey in the area.

(Para 8.52)

97. Inland water transport being the main mode of transport, the development of boats is the natural solution. The Committee would suggest that either loans should be advanced to individuals who want to adopt plying of boats on commercial basis or to Cooperative Societies for owning and renting the services of the boats.

(Para 8.53)

98. The Committee would strongly urge that the concept of delegation of powers, both financial and administrative, as recommended by it in its report on "Organisation of Administrative and Financial Structures for Backward Areas Development" should be fully implemented if the organisation has to be effective. Also, it would be necessary that proper linkages are established with the State level Technical Departments so that expert advice and technical guidance at a higher level is available to the personnel working in the Sundarban organisation.

(Para 8.56)

99. It is essential that as many of the project personnel as possible stay in the project areas and do not have the tendency to stay in nearby Greater Metropolitan Calcutta and come for work to the project.

(Para 8.57)

INTRODUCTION

1.1 The National Committee on the Development of Backward Areas has identified different types, of fundamental backwardnesses and is seeking remedies for rectifying the same. The coastal areas affected by salinity constitute one such category.

1.2 Coastal saline soils are found along the long coastal line which runs about 6,000 kms. The problem occurs in varying degree in the States of West Bengal, Orissa, Andhra Pradesh, Tamil Nadu, Kerala, Karnataka, Maharashtra and Gujarat. While no factual data are available as to the extent of the area affected by salinity, the problem area is estimated to be about 30 to 40 thousand sq. kms. The important areas needing attention are the Sundarban of West Bengal, the delta areas of Krishna, Godavari and Cauveri, Kari soils in Kerala, Khar land of Maharashtra and coastal areas of Gujarat and Rann of Kutch. The nature of the problem is different in different parts and so the problems associated with these lands also vary. The eastern and south western areas receive moderate to high rainfall. The rainfal is low with an arid type of climate in the Saurashtra and Kutch areas of Gujarat.

1.3 The saline soils of Sundarban in West Bengal are probably the result of inundation of backwaters from sea. In Kerala, the Kari soils are peaty in nature, containing 10 - 40% organic matter. These are low lying and remain submerged under water during the monsoon. Soils are alluvial in nature. These low lying tracts are believed to have been once parts of the area and were formed by gradual silting up by the sediment brought down by rivers.

1.4 Khar and Khanjan lands are found in the coastal districts both in Maharashtra and Gujarat. These lands are subjected to periodic inundation of tidal waters. In Maharashtra the problem areas occur in the districts of Ratnagiri, Kolaba and Thana. The problem also occurs in North Kanara district in Karnataka. In Gujarat the problem is widespread in Saurashtra region and in the districts of Ahmedabad, Amreli, Broach, Kaira and Surat. These soils have been primarily recovered from sea and are further formed by gradual silting by the sediment brought down by the rivers draining in these areas. Thus, for example, Kathiawar (in Saurashtra) was formerly an island which has risen slowly and become connected with the mainland.

1.5 Except in the district of Sundarban in West Bengal and the Great and Little Rann of Kutch in Gujarat, the coastal saline areas, with top saline layer, are limited to a strip along the coast both on the east and the west of Peninsula. This Peninsular saline region is somewhat wide in the district of Midnapore and in the coastal districts of Orissa but the width taper off on the east coast as one goes down to Kanyakuinari. On the west coast the Peninsualar saline region is very narrow obviously because the Western Ghats are very close to the sea. The description of the present saline areas in Annexure I gives the nature of salinity from state to state showing how the climatic and environmental factors affect the type and intensity of salinity Inundation of the saline strip is more common in the West coast where the tidal effect is quite substantial. One the east coast because of the littoral drift and formation of land and the proximity of sand-dunes to the sea, tidal effect is not so prominent.

1.6 As India has a lengthy sea coast spread over eight states, the problem of

salinity in coastal areas is a national problem and requires detailed studies in all the coastal states. The development of such areas requires special attention because they have remained neglected since long and the developmental efforts of the post-independence plan era have also not generally reached there for want of proper strategy, infrastructure and impediments due to backwardness.

1.7 An analysis made of the demographic situation in the saline areas of Orissa (Annexure 1 .2) reveals that:

(a) The population density in areas covered by salinity is higher than the average density of population in rural Orissa.

(b) Size of villages is generally larger in saline areas' compared to that in non-saline areas,

(c) The areas being coastal, the location of large sized villages near the coasts can be inferred to be on account of the prevalence of activities linked with fishing pursuits therein.

1.8 Looking at the demographic picture, one can assume that if detailed analysis is done of the saline areas in the other State also, the pattern will probably be repeated in the east coast as well. In the west coast, predominance of fishermen class and non-existence of various other classes of occupation would probably be noticed. The Great and Little Rann of Kutch is a separate problem.

1.9 Although not much effort has been made of the development of coastal areas, a number of Committees/Commissions did incidentally look into these problems also. The first one was the "study of waste lands including saline and alkaline and water lands and their reclamation measures" constituted by the Committee on Natural Resources in the Planning Commission in 1963. The study was mainly concerned with the waste lands and the saline and alkali soils in other parts of the country. The problem of coastal saline soil was, however, considered by this Committee only from the point of view of reclamation of land. The National Commission on Agriculture which looked into this problem and suggested in its report in 1976 that coastal saline areas have problems of backwardness and need special treatment for proper development. They have also dealt with in good detail the problems of development in the Rann of Kutch and Sundarban in West Bengal, the two major coastal areas affected by salinity.

1.10. Considering the importance of the areas affected by coastal salinity the Committee has decided to submit a separate report about the developmental problems and the approach in these areas as their problems and remedies have to be different from the normal salinity affected areas in other parts of the country.

1.11 At the outset, the Committee would hasten to add that it has greatly been handicapped by lack of adequate basic data. The Committee, however, is grateful to the concerned Stale Governments particularly the Governments of West Bengal and Orissa who extended their whole hearted support in giving whatever information was available with them. The Sundarban Development Board was particularly helpful not only in arranging meetings in Calcutta where experts from other States also

participated but also in organising a number of visits to be the Sundarban areas to enable the Committee to have an on the spot idea of the various problems. The Committee also had the benefit of advice of other experts in the field from the Ministry of Agriculture, ICAR and other research institutions.

1.12 The Committee had sent a check list of points (Annexure 1.8) to the concerned State Governments for supply of basic information. The Committee is happy that response from the State Governments was, quite encouraging and some information was made available.

1.13 In the following chapters, the Committee has attempted to deal with the problems of these areas, strategy of development and suggested specific line of action for development of fisheries, both marine and brackish which constitute, by far, the most important potential of development in these areas and also dealt with the steps necessary for developing the other potential in these areas.

ANNEXURE1.1

STATE-WISE POSITION OF COASTAL AREAS AFFECTED BY SALINITY

Nature of Salinity

The nature of salinity in different areas varies from State to State and from one region to another within the same state. While in most of the areas lack of drainage system has been the main contributing factor, in some areas, overdraft of ground water, ingress' of saline sea water and unscientific agricultural practices are also adding to the problem in a big way. The statewise position is dealt in the following paragraphs.

Gujarat

The salinity ingress have affected vast areas of fertile and productive tract in the narrow coastal plain of Saurashtra. Due to low reliability of the monsoon rainfall and lack of adequate surface water irrigation system, these areas have traditionally used ground water for irrigation. Prior to extensive introduction of diesel or electric motor pumps during the past two or three decades, ground water was withdrawn by man or animal powered appliances which set limits on the rate of extraction. Thus a delicate balance was maintained between recharge and discharge which controls the position of the interface between the fresh water body and the underlying saline water of aquifer systems. Introduction of motorised pumping and rapid expansion of rural electrification removed the constraints on rates of extraction of ground water as a result, an overdraft condition was established and ground water quality deteriorated and consequently the area got affected by salinity.

The most adversely affected region lies within a coastal strip about 160km in length between Madhavpur and Una and includes the talukas of Mangrol, Maria, Veraval, Kodinar and Una. Within this region, the salinity ground water area has increased from about 35,000 ha in 1971 to 100,000 ha. in 1977. Some 120 villages in the five talukas with a combined population of 2,80,100 people are adversely affected by the increased salinity of ground water.

The soils along the coastal belt can be classified as Calcic Cambiosols or sols burns calarious. The soil depth varies from 25 to 100 cm. the texture is loam to clay loam near the coast and grades to sandy loam more inland. Well developed soil profiles with distinct textures and structure alternative with lighosols/soils which are limited in depth by continuous coherent hard rock within 10 cm of the surface. The physical, soil characteristics, of the well developed soils are good and do not constitute any restriction for good crop production.

The hydro dynamics of a fresh water salt acquifer system are such that an overdraft can continue in shallow wells tapping the upper part of the fresh water body for period of years before detrimental effects become evident. Over 95 per cent of the water mined is provided by the upward movement of the fresh water deficit by salt water. Water level response in wells may be very small and a considerable time may lapse before the rising interference brings salt water to or near the depths penetrated by wells. Thus the damage new surfacing in about 12,500 wells which are out of

commission or under restricted use has been developing over many years- of overdraft. Water levels in some areas within a few kilometers of the coast, have now declined to an alarming six metres below mean sea level. The trend in area irrigated by ground water within the affected area is still downward and at an apparent accelerating rate so that water quality deterioration will obviously continue for the immediate future.

Maharashtra

In this state extensive area of Khar land (coastal saline soils) occur along with coast which have become unfit for cultivation on account of unproductivity of the soil mainly due to salinity. The sea water enters through the creeks during high tides and submerges large area of cultivable land. These periodical inundations render the land progressively saline and in time makes it completely unfit for growing any crop. Even if the encroachment of saline, creeks water over such land it stopped by putting an embankment, on account of evaporation process in summer, the brackish water from local high water table rises through the capillary enriching the upper crust of the soil with soluble salts and thus the salinity problem persists.

From the Zai creek in North to the Terekhol creek in outh, Maharashtra state has got about 720 kms of coastal belt which cover the districts of Thanna, Kulaba and Ratnagiri. The climate of the region is hot and humid and the rainfall ranges between 2540 mm to 3160 mm. Except some parts of Ratnagiri District the soils are more or less clay loan to clay in texture having poor structure, poor drainage and low infUtera-tion rate. PH of the soil ranges from 0.7 to 8.5. The total soluble salts in the soil vary from 3 to 6 per cent, the predominant salt sodium chloride (Na cl) which may be even as high as 6.0 per cent).

The Khar lands in Maharashtra do not have any source of irrigation. No systematic study of the ground water has been carried out so far in this region. Thus, the cultivation in the area is possible only in kharif season.

Karnataka

The coastal saline soils occupy approximately an area of 12,000 ha in the two districts of North Kanara and South Kanara of Karnataka. The two districts receive an annual rainfall of over 3000 mm most of which occurs during the period from June to September. In many places the surface soil is sandy loan type, but there is con-siderable illuviation of clay to the lower horizons. This results in the changing of the subsurface layers during the summer months.

The low lying regions of the two districts near the sea or the reiverlets are subject to inundation by the heavy rainfall received during the kharif season. The high tidal waves overflow the embankments of the rivers and the back water canals. The tidal waves are active practically all the year round, but the salinity hazard is not noticed during the monsoon period as there is dilution of the sea water in the land due to the heavy rains. A break in the monsoon, specially if too long, enhances the salinity of the sea water and canal water substantially. The influx of flood water into the fields during this period hinders the crop growth and consequently brings down the yield of the standing crop of rice, which is in the flowering stage. With the

receding monsoon and with the periodic inundation of the fields, the soil becomes more and more saline from October onwards. Inundation is at its peak in January and February due to high tidal waves. As a result, rabi crops such as cow pea, green gram, horse grain, groundnut etc. are raised only in the upper reaches, which are not submerged and where there is residual moisture. With the receipt of the monsoon, the salts are diluted and washed back into the sea.

Tamil Nadu

In this State, the problem of salinity exists both in coastal areas and inlands. The exact nature and intensity of the problem has, however, not been systematically surveyed in detail. The soils of coastal areas offer many unique problems like salinisation, water logging, clay pan formation and sea water inundation. The salt affected soils occur in the extensive areas all along the east coast from Chingleput, South Arcot, Tanjora, Ramnad to Tirunelveli. It has been estimated that about one lakh hectares in the coastal belt pose salinity problems.

The low lying areas along the east coast of Thanjaur and Ramanathapuram district are saline or possible sodic. These localised areas are at or near sea level and may be influenced to some degree by sea water intrusion, but probably due to lack of internal drainage, salts have been accumulating over a long period of time from the irrigation water. About 8000 hectares adjoining kazhuvely swamp in South Arcot are affected by salinity. Similarly, the areas near Chindambaram in South Arcot district and Paramakudi in Ramanathapuram district are also affected.

The impact of salinity on present land use varies from district to district as under:

Chingleput :

In the northern parts of the districts, the coastal areas are mainly utilised for salt industry or, left as swamps. In the southern parts, besides salinity, soils lacking proper ripening are also prevalent when the soil is irrigated, it becomes very soft and loose and interferes with ploughing and other agriculture operation. When dry soil becomes so hard that crop growth is affected to the extent of even withering. This problem also prevails in Madurantakam taluk of Madras.

South-Arcot:

In coastal sandy belt, casurina is cultivated to a large extent and groundnut to a limited extent, utilising the available ground water. As most of the coastal areas is either of equal level of sea level, frequent inundation by ingress of sea water is a problem, resulting in many swamps. Such swamps are seen in Kaluveli, Marakaram, Picha-varam and Gavrapattu. A little interior where sea water inundation is not a major problem, land is cultivated for such as rice, groundnut, ragi, sugarcane, chillies, utilising the ground water potential of Panniar basin. , , . .

Thanjavur

In the coastal area bordering Thanjavur district, salinity problem exists in parts

of the talukas of Sirkali, Mayuram, Nagappatinam, Pattukottai and Thrithuraipoondi. The entire area is cultivated mainly to long duration rice crop, except in Sirkali taluka where double crop is followed. In all other taluks, only a single crop of rice is raised. The crop is transplanted generally in August, so as to coincide with the rains, to reduce the injury due to salinity. The impact of salinity is, however, felt in raising the rice nursery. Land level being flat and slightly sloping towards the east, inundation is a problem during rainy season. In certain areas of Thiruthuraipoondi local rice variety 'Kar' is raised and only panicles are harvested due to water stagnation. In vadarnyam taluk where salinity is somewhat acute, tobacco is grown in about 600 hectares along the coast. In coastal area of the veundar basin comprising parts of Thiruthuraipoondi and Mannargudi talu-kas, the available cultivable area is often inundated due to intrusion of sea water rendering even rice cultivation a difficult proposition.

Ramanathapuram:

Salinity problem exists in the talukas of Tiruvandari, Ramanathapuram and Mudukalathur. Most of the area in this belt is monocropped to rice both under irrigated and rainfed conditions. Only in small areas where irrigation facilities are available rice crop is followed by crops like chillies or cotton. In the coastal belt from Ramanathapuram to Mandapam, a fragipan has developed about 30 cm below the soil surface and rice is grown under semidry conditions in such soils.

Tirunelveli

The coastal area around Tuticorin and Truchendur are mainly used by the salt industry. In Tiruchandur coastal dune areas ocacia (Udai) is cultivated followed by millets. In the coastal belt from Tuticorin to Santhangulam, there are vast stretches of red steriled and locally known as Theri. These lands have been partially reclaimed using heavy doses of tank silt and crops such as Banana, Coconut and vegetables and even rice are grown.

Aadhra Pradesh:

Nearly half of the food production in Andhra Pradesh is contributed by eight coastal districts extending over a coast line of approximately 900 km. namely Srikakulam, Vizayanagram (Visha-khapatnam), East Godawari, Krishna, Guntur, Prakasam and Nellore. No systematic soil survey of the state has been conducted so far. However, on the basis of the general surveys of soil samples received from these coastal districts it is roughly estimated that about 1.76 lakhs hectares are affected by salinity, the bulk of which be in the districts of Prakasam, Guntur, Krishna and East Godawari.

The soil along the coast (about 10 - 15 km from the sea) are mostly sandy in nature and of marine origin. Even in places where heavy textured soils occur, they are usually underlain by a sandy strata which is met with at some depth in the profile. The sub-soil water is also found to be generally rich in salt content in certain areas. Due to the absence of any significant rainfall during the rabi season, the seleciton of suitable crops and management practices assume considerable importance in all the areas where salinity of the soil or quality of irrigation water is a problem.

Orissa

The total salt affected soils in the State estimated to cover about 4.04 lakh hectare, distributed over the four coastal districts of Balasore, Cnttack, Puri and Ganjam. However, the nature and distribution of salinity have not been studied in detail and their precise district-wise figures are not available. According to one survey there are large chunks of saline land around Basudevpur and Chandable area of Balasore district, and Rajkanika, Mahakalpada and Rajnagar area of Cuttack. A per the estimates of District uppal Committee there are 10,724 acres in 11 CD Blocks in the districts of Cuttack and Puri which have problems of soil salinity. In addition, there is a strip of land about 18 miles in width running along the Bav of Bengal in Kujang and Kanika of Cuttack district which is uninhabited. On the basis of remote sensing survey conducted by the soil and land use Survey Division of the State, the classification of soils in the four coastal districts is as under:-

('000 hectares)

	Low land mixed forest mangrove	Sand/salt flats	Total
Balasore	22-63	2.00	24-63
Cuttack	59-20	29.17	88-37
Ganjam	130-94	2.24	135-18
Puri	91-20	8.78	97-98
Total	303-97	42.19	316-16

West Bengal

The sea coast in the state stretches from Digha in the Midnapur district in the east to the outfall of River Raimangal in the 24 Parganas district in the east. The whole of this coastal region is affected by the problem of salinity to varying extent. Besides, a strip along the bank of Hoogly in Howrah district covering part of Shyampur, Uluberia, Panchala, Sankrail and Balijagacha Blocks, have shown a marked presence of saline water. Clear demarcation of this strip has not been yet possible, but random sampling of water from existing wells in the area have indicated presence of saline water almost parallel to the bank of Hoogly stretching from South West to North East. On a broader estimate, about 1/3rd of the Howrah district is covered by this strip.

The coastal region can be divided into two distinct parts according to the geographical and topographical nature viz. (i) South 24 Pargnas District which form part of the huge Gangetic delta, lies to the east of River Hooghly and is covered by dense brushwood forest; (ii) South Midnapur which lies to the west of river Hooghly and has been found mainly from the silt carried by rivers; Rupnarain, Cossye and Subranarekha. In South 24 Parganas district, the area on the south of 'Dampieis Hodges' line is highly saline and is generally known as "Sundarban". The Sundarban are criss crossed by numerous tidal creeks of varying widths and depths and comprises mainly of islands, some of which are covered by forests. But the rest of the

area is reclaimed by putting marginal embankments and drainage sluices and is cultivated. The general topography of the land is, flat and consists mainly of a series of saucer shaped basins. Unlike the Sundarban, the South Midnapur area is attached to the main land but here also the general topography of the land is flat and there are also a number of saucer shaped basins in this area.

It is estimated that 15 Blocks of south eastern Midnapur districts covering a total area of 2500 sq. km poses salinity problems. Similarly 7360 sq. km. of 24 Parganas (south) and part of north comprising of 35 blocks are found to be infested with salinity problems. On this basis, approximately 53% of 24 Parganas District and 15% of Midnapur district may be termed as saline areas.

The entire saline belt lies in the active deltaic plains of the Ganga where in the acquifers occur under confined condition. The fine sands are the main constituents of these multiple aquifers. From the available information, indication of occurrence of fresh acquifers in limited scale of depth has been observed.

Inter-connected Factors (rainfall, tides, ground water, acquifers etc.)

Rainfall

Most of the average 700 mm rainfall in coastal areas of Gujarat occurs in the period from mid-June through September. Because of the comparative high wind movement, the evapo-transpiration losses on the Saurashtra Peninsula are higher than those in other regions of the state. Recharge of ground water through natural sources has not kept with the draft, resulting in ingress of sea water.

The khar lands of Maharashtra receive an average rainfall of 2540 mm to 3160 mm. No sources of irrigation have yet developed in this area and any systematic study of the ground water has also not been made so far.

The two districts of South Kanara and North Kanara in Karnataka are favoured with an annual rainfall of over 3000 mm most of the which is received from June to September. The low lying regions of the two districts near the sea on the reverlets are subjected to inundation by the heavy rainfall received during the kharif season. During the months of June and July there is no salinity problem. So long as there are frequent showers, the crop growth does not get adversely affected till August. However, any long break in monsoon enhances the salinity of the sea water and canal water substantially. With the receding monsoon and with the periodic inundation of the fields, the soil becomes more and more saline from October onwards. Inundation is at its peak in January and February due to high tidal wages. Ground water generally occur under water table conditions and also under semi confined to confined conditions in some parts. The development of ground water is being attempted through wells and is restricted to a narrow strip in the coastal region and to valley portions. Generally, the quality of water is good except in a few places along the coast where the wells are deeper.

The coastal districts in Tamil Nadu receive very heavy rain mainly during the north west monsoon. The average rainfall ranges from 820 mm in Tirunelveli followed by 840 mm in Ramanathanpuram to 1210 mm in Chingleput and 1260 mm in South

Arcot.

Coastal Andhra Pradesh has humid to sub-humid conditions. The total annual rainfall in the eight coastal districts of the State ranges from 757 mm in Prakasam to 1139 mm in East Godawari. Over 90% of the rainfall is received in the months from June to October. In certain tracts ground water is tapped through dug wells. The quality of ground water is highly variable depending not only on the proximity to the sea, but also on the extent to which good quality waterflows through the region.

In Orissa, the coastal areas have tropical monsoon climate. The annual rainfall in the four coastal districts ranges from 1296 mm in Ganjam to 1568 mm in Balasore. about 80 - 85 per cent of the rainfall is received during monsoon season i.e. from June to October. Almost in the entire low lying plains, floods is a common feature in these districts owing to the absence of any storage reservoirs across the river systems. The Subarn-rekha, Baitarni Brahrnani and Mahanadi rivers, along with their tributories constitute major drainage system in the districts of Balasore, Puri and Cuttack.

The average rainfall in coastal areas of West Bengal is estimated at about 1803 mm of which about 86 per cent is received during the months from June to October.

It is evident from the above that almost all the coastal areas affected by salinity have good rainfall and thus plenty of surface water is available to be made use of for cultivation, horticulture, tree plantation and fishery development. There is also good potential of ground water in some regions which can be exploited for agriculture in a guarded manner. A balance between the draft and the recharge would, however, have to be maintained for controlling the quality of ground water as well as the salinity of the soil.

Tides

The effect of tide is manifested in a regular alternation or rise and fall of the water level of sea and the esturaine channels and creeks.

The occurrence of tides have direct bearing in the formation of coastal saline soils and also on their development. The tidal flow repeatedly inundates the soils and impregnate them with salts, thus converting the soils and sub-soil water saline. The high tide inundates the areas to the extent of 0.3 to 1.0 metres in the coastal area under Umrath, Gujarat.

The high tide level during summer rises upto 1.3 metres above the general ground level. On eastern coast in Sundarbans, the highest tide would inundate the lands to a depth of 2 metres while the high tides level determine the height of the sea dykes, that of the low tides will locate the site and elevation of the one way sluice gates in the sea dykes.

ANNEXURE-1.2

Demorgaphic situation in Saline Area of Oriasa

At the instance of the National Committee on the Development of Backward Areas, the Government of Orissa furnished a map indicating the saline affected coastal areas. With the help of this map and those provided in the 1977 Census publications an attempt has been made to segregate the villages lying in the saline affected areas. With the nature of material available only a close approximation could be made and scientific precision cannot be claimed. All the same the analysis is based on such segregation to provide useful insight into the demographic aspects of saline and other areas. Out of the 13 districts of Orissa only four coastal districts of Balasore, Cutiack, Puri and Ganjam are saline affected. Of these four districts the saline areas in Ganjam district are only njarginal in character. Roughly nine per cent of inhabited villages, six per cent of the total area and twelve per cent of the total rural population is accounted for the saline affected areas of Orissa.

2. Statement I comprehends the data about density of population in the four saline affected districts and also the whole of rural Orissa. It yields the information about the saline and non-saline areas separately as well. The statement yields the following significant observations: —

(i) Of the whole of rural Orissa 11.8 per cent is accounted for by the saline affected areas;

(ii) In the four saline affected districts, the percentage of area under salinity varies from 1.4 per cent in Ganjam, to 26.2 per cent in Puri, 29.7 per cent in Balasore and 36.4 per cent in Cuttack. The combined figure for the four districts works out to 25.3 per cent;

(iii) 5.9 per cent of total rural area of Orissa is saline affected;

(iv) Saline affected area varies from 0.8 per cent in Ganjam, to 28.0 per cent in Balasore, 32.3 per cent in Puri and 35.8 per cent in Cuttack. The combined figure for the four districts works out to 22.7 per cent;

(v) As against the overall density of 130 for the rural Orissa, the one for non-saline areas is 115 and that for saline areas is 263;

(vi) The variation in densities in the saline affected areas is from 173 in Puri to 290 in Balasore, to 300 in Ganjam and 323 in Cuttack everywhere much higher than that for all rural or non-saline areas of Orissa as a whole.

3. Statement 2 comprehends the data about the size of villages in the saline and non-saline areas of salinity affected districts and the totality of rural Orissa. The prime observations run as: —

(i) 43.7 per cent and 76.1 per cent of villages in the non-saline areas of Orissa have a population of less than 200 and 500 respectively. The comparable percentages for saline affected areas are 24.5 and 62.7 per

cent, respectively. This leads to the conclusion about the prevalence of large sized villages in the saline affected areas.

(ii) The above phenomena is observed in case of the saline affected districts as well — be it the individual districts as such or the combination of all the four.

4. Statement-3 indicates the position about the proportion of saline affected villages to total villages in the saline districts and the whole of rural Orissa. The important observations emerge as: —

(i) Even though there are 9.1 per cent of Orissa villages in the saline affected areas, the percentage shows quite a rise with the higher size classification of villages, moving upto as high a figure as 20.8 per cent in the case of villages with a population of 5000 or and more.

(ii) Practically the same phenomena is Observed in each of the saline affected districts individually as well as collectively. The extreme case is depicted in the case of Balasore where in case of villages with a population of 500 or more, the villages are in the saline affected areas.

(iii) On account of large sized villages in the saline districts, which are coastal districts as well, it would be safe to conclude about the location of larger villages on coasts on account of the fishing activities therein. A similar sort of inference is supported from the statement-4 as well.

5. A comparative picture of detailed industrial and occupational pursuits in the saline and other areas could yield and preponderance of certain pursuits, say fishermen, in saline areas. Unfortunately, the requisite details are not available and hence the envisaged exercise could not be had. Even the available district level data is only for single digit of industrial classification and as such analysis can be only very broad based viz; a comparison of saline affected districts with others. The obvious limitations of such an analysis cannot be sidetracted. Some relevant data is comprehended in statement-5. The following inferences can be made from this.

(i) Proposition of cultivators is generally lower in saline affected districts and possibly in the saline affected areas therein, in comparison to that in rural areas of Orissa.

(ii) Proportion of agricultural labourers, in comparison to that in rural areas of Orissa, is lower in saline prone districts and plausibly in the affected areas therein.

(iii) The behaviour of the composite industry group, livestock, forestry, fishery, hunting etc. is quite mixed and devoid of any clear cut inferences. May be, with relevant details, the preponderence of fishing pursuits and lack of livestock and artisans pursuits may get singled out in the saline affected areas.

Annexure 1.3

Statement 1. Density of population in saline and non-saline rural areas of saline affected Districts of Orissa (Based on 1977 Census data)

		Unit	District				All Four Districts combined	Whole of rural Orissa
			Balasore	Cuttak	Pnri	Ganjam		
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
I.	Population							
	(i) Salino Areas	No.	513424	1273636	557515	29385	2373910	2373910
	(ii) Non-Saline Areas	"	1216926	2248419	1554197	2004617	7024159	17725310
	(iii) All Areas	"	1730350	3502055	2111712	2033952	9398069	20099320
	(iv) % in Saline Areas	%	29.7	33.2	26.4	1.4	25.3	11.8
2.	Area							
	(i) Saline Areas	Sq. km.	1770.18	3941 .67	3231.47	97.73	9041.05	9041.5
	(ii) Non-Saline Areas	"	4554.22	7080 .03	6789.03	12300.27	30723.55	145142.55
	(in) All areas	"	6324.40	11021.70	10020.50	12398.00	39764.60	154182.60
	(iv) % in Saline Areas	%	28.0	35.8	32.3	0.8	22.7	5.9
3.	Density of Population							
	(i) Saline Areas.	Per Sq. Kms.	290	323	173	300	263	263
	(ii) Non-Saline Areas	"	267	318	229	163	229	115
	(iii) All Areas	"	274	320	211	164	236	130

Annexure 1 -4

Statement 2: Comparative percentage distribution of inhabited Villages in salinity and non-saline areas of salinity affected Districts of Orissa (Based on 1977 Census data)

Districts	Population size Classification of Villages						
	Less than 200	200-499	500-999	1000-1999	2000-4999	5000 & above	Total
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
1 Balasore							
(i) Non-Saline Areas	35.6	35.5	10.4	8.0	1.5		100.00
(ii) Saline Areas	29.8	35.7	20.3	9.4	3.9	0.4	100.00
2. Cuttack							
(i) Non-Saline Areas.	22.9	33.4	36.4	14.2	3.1	neg.	100.00
(ii) Saline Areas	22.6	37.7	25.1	11.8	3.0		100.00
3. Puri							
(i) Non Saline Areas	34.2	34.7	21.5	7.1	2.3	0.2	100.00
(ii) Saline Areas	24.6	40.7	22.7	9.8	2.3	0.1	100.00
4. Ganjam							
(i) Saline Areas	47.5	21.6	16.7	10.3	3.5	0.1	100.00
(ii) Non-Saline Areas.	32.7	28.6	28.5	6.1	6.1	--	100.00
5. All 4 Saline Districts							
(i) Non-Saline Areas	33.5	30.7	20.0	10.1	2.7	0.1	100.00
(ii) Saline Areas	24.5	38.2	23.7	10.6	2.9	0.1	100.00
6. Whole of Rural Orissa							
(i) Non-Saline Areas	43.7	32.4	17.0	5.8	1.1	neg.	100.00
(ii) Saline Areas	24.5	38.2	23.7	10.8	2.9	0.1	100.00

Annexure 1.5

Statement 3: Percentage share of Villages, by various population size classifications in saline areas to total area of salinity affected Districts and whole of Rural Orissa (Based on 1971 Census data)

Districts	Population size classification of Villages						
	Less than 200.	200-499.	500-999.	1000-1999	2000-4999	5000 & above	Total
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Balasore	15.9	18.5	19.5	21.0	37.0	100.0	18.4
Cuttack	36.8	40.0	36.9	32.6	35.7	.	37.1
Puri	23.7	33.8	31.3	36.6	30.0	28.6	30.1
Ganjam	0.8	1.5	1.8	0.7	2.0		1.2
All the four Districts	17.1	27.4	25.6	24.1	24.9	33.3	23.3
Whole of Rural Orissa	5.7	10.8	11 .5	12.8	15.2	20.8	9.1

Annexure 1.6

Statement 4: Percentage of population lining in Villages in different ranges to total Rural Population

	State/District	Percentage of Population living in Villages with population size of					
		Less than 200	200-499	500-999	1000-1999	2000 - 4999	5000 & above
	(J)	(2)	(3)	(4)	(5)	(6)	(7)
A	Rural Orissa	8.89	24.89	30.61	23.89	11.12	0.80
B	Saline Districts	6.45	21.08	29.78	27.25	14.47	0.97
	1. Balasore	8.02	29.51	30.40	23.87	11.18	1.04
	2. Cuttack	4.47	20.07	31.12	30.76	13.39	0.19
	3. Ganjam	8.32	14.97	25.13	29.66	20.67	1.25
	4. Puri	6.68	25.02	31.49	21.85	12 .99	1.97
C.	Non.Saline Districts	11.03	28.23	31.55	20.56	8.18	0.65
	1. Sambalpur	77.28	22.50	30.77	25.91	12.82	0.72
	2. Sttndergarh	6.51	27.34	33.50	22.10	9 .64	0.91
	3. Keonjhar	7.35	31.94	34.99	19.85	5.39	1.48
	4. Mayurbhanj	10.07	36.78	35.30	14.13	3.72	
	5. Dbenkanal	7.97	21.04	25.96	26.68	17.76	0.59
	8. Baodh-Khandmal	43.38	36.93	13.57	4.05	2.07	
	7. Balangir	6.16	30.91	36.59	21.34	5.00	
	8. Kalahandi	8.73	22.15	34.82	25.80	8.50	
	9. Koraput	14.70	29.31	30.23	18.55	5.61	1.60

Annexure 1.7

Statement 5: Percentage of distribution of workers in certain selected Industrial pursuits in Rural Orissa

Area	Industrial Category				
	Cultivator	Agril. Labour	Livestock, forestry fishery, hunting, etc.	Other	Total
(1)	(2)	(3)	(4)	(5)	(6)
1. Orissa	52.87	30.21	2.07	15.85	100.00
2. Saline Affected Districts					
(i) Balasore	59.29	28.90	1.09	10.72	100 .00
(ii) Cuttack	52.26	23.58	1.82	17.34	100.00
(iii) Puri	51.38	27.95	3.32	17.35	100.00
(iv) Ganjam	44.81	34.50	3.01	17.68	100 .00

ANNEXURE 1.8

NATIONAL COMMITTEE ON THE DEVELOPMENT OF BACKWARD AREAS PLANNING COMMISSION

Checklist for discussion on problems of coastal areas affected by salinity

1. Extent of coastal area affected by intrusions of saline water and soil salinity.

2. Present method for coping with this problem and how far successful.

3. Impact of problem on cropping intensity, cropping pattern and productivity.

4. Further measures required to reduce salinity e.g. embankments, closure dams, flushing with fresh water.

5. Changes in agricultural practices required.

6. Ground water resources: relative position of saline and sweet -water acquifer amount of fresh water that is available, technical problems in tapping water, extent of utilisation so far and present plans for development.

7. Other freshwater resources: extent to which available possibility of inter-basin transfers, extent of utilisation so far and present plans for development.

8. Horticulture and forestry: present level of development, further possibilities, type of trees that could be planted, role of fodder trees.

9. Animal husbandry and dairying: present level, critical constraints for further development, how these can be relieved.

10. Fisheries: brackish and sweet water fisheries, marine fisheries, present level of development, further potential, infrastructure required.

11. Communication & transport: deficiencies in present linkages with interior, problems of transport within the region, measures required to improve transport network, role of inland water transport, bridges.

12. Village and Cottage Industries: present level of development, support provided at present by state Government, KVIC and other bodies, measures required for further development.

13. Energy: present position regarding power supply, role of firewood and its impact on environment measures required to ensure supply of power, coal, petroleum products.

14. Development administration: present pattern of implementation of programmes for agriculture and rural development, extent of local planning, sanctioned staff in position in development administration problems in posting staff.

2. STRATEGY OF DEVELOPMENT

2.1 At the outset, the Committee would like to indicate the criteria for delineating backward coastal areas affected by salinity. It is important to identify the type and extent of salinity which makes the areas difficult to develop. The surge in development of rural India started with the Green Revolution which was based on irrigation and use of high yielding varieties of seeds. The deficiency which makes this surge impossible in the coastal areas is the absence of sweet water in sufficient quantities to initiate the Green Revolution. The White Revolution that followed in the rural India in the milk programme also becomes difficult for lack of sufficient potable water for both people and cattle. This lack of sweet water has to be defined in specific terms so as to identify such areas for ameliorative action. When the top soil is saline it inhibits agriculture and fodder growth and hence also animal husbandry. Top soil salinity is, therefore, a clear classification for identification of the problem of saline areas. In parts of the coastal area the top 20 or 30 ft. may hold fresh water gathered during the monsoon. This phenomena is a long term creation in areas of medium and high rainfall and the annual replenishment is slow and uncertain. The top soil salinity get moderated in many areas and the saline water strata is pushed down by the fresh water, salt water being more dense than fresh. Unless fresh water flows from outside these areas can be brought in, the fresh water availability is limited and cannot sustain better agriculture or animal husbandry. There may be a fresh water zone in the top 30 ft. with saline water below and the maintenance of the fresh water is dependent on the rainfall. These areas, even whilst the top soil and water is fresh, having limited fresh water, will have to be treated as water saline areas needing a special treatment. There are areas where water salinity is all pervasive at the top and at great depths and are obviously water salinity areas which need special treatment. Even if the fresh water is available in these areas at great depths, utilisation of such waters for reducing the top salinity for agriculture and animal husbandry would be a high cost economy.

2.2 The Committee is, therefore, of the view that for special treatment as 'saline areas', coastal saline areas need to be identified as:

(a) Soil salinity areas where the top soil is saline;

(b) Water salinity areas where either the water strata for great depths is saline, or even if top 30 ft. has fresh water where fresh water is entirely by rainfall alone.

2.3 The salinity level varies from area to area both in top soils and in the water salinity. The salinity criterion (above mentioned) shall be such salinity which is above the level acceptable in the areas for animal and human consumption and above the levels of salinity acceptable for intensive remunerative agriculture.

2.4 The Committee had suggested to the State Governments that "areas where top soil is affected by salinity" could be considered as coastal salinity affected areas. In case of water salinity, the criteria suggested was to consider these areas as surface salinity areas where saline water was found upto the depth of 30 wt. Based on these criteria, the State Governments were requested to map out these areas. From the exercise carried out, on the eastern coast, by the Government of Orissa and West Bengal, it is observed that most of the blocks of the area are either fully or sub-

stantially covered. The saline affected areas of other States are in the nature of narrow strips and as such major portion of blocks are rarely covered. The prevalence of such a situation raises doubts about the identification and adoption of block for special treatment under this type of backwardness.

2.5 It would then be desirable to identify and demarcate such areas and prepare detailed maps. Yearwise information on low salinity, moderate salinity and high salinity areas within these areas will also have to be collected. With a view to providing the right type of development technology suiting to different conditions such areas may then be classified into:

(a) saline soils,

(b) saline alkali soils,

(c) non-saline alkali soils; and

(d) degraded saline alkali soils.

2.6 Once the identification is done, the next question would be to consider the development technology suited to different conditions. The coastal saline areas suffer from soil or water salinity because the sea is closely. When the top acquirer of the coastal area is connected to the sea, water intrude in the acquifer unless there is a counter-vailing force of fresh water from the interior coming down from higher regions to the coast, when a balance is struck as in the Junagarh cost of Gujarat. There are areas where the top acquifer does not get any fresh water from the interior and in these areas the soil salinity and water salinity prevails from the surface to great depths. But in these zones, the sea water percolation gradually tapers in depth as we proceed into the interior away from the sea and the top fresh water zone in the acquifer deepens.

2.7 The National Commission on Agriculture (1976) examined the problem of development in two important coastal areas, namely, Sundaraban, in West Bengal and Rann of Kutch in Gujarat. It has stated that the vast dedicated plain called the Rann of Kutch has special problems of development. The saline in crustations due to the ingress of sea water brought in by the tidal waves mainly during the mansoou have rendered this vast expanse of area uncultivable and uninhabitable except for a couple of islands in the Great Rann. The saline swampy soils requires reclamation to make the region cultivable. Since a good portion of the Little Rann gets inundated by river waters, possibilities of reclamation are more in this area provided fresh or low salinity water is available in sufficient quantity, and suitable arrangements for drainage can be made. The broad conclusion emerging from earlier studies is that substantial area could be reclaimed and the problem of drinking water mitigated, if part of the Narmada flow could be diverted to this area. In this context, the feasibility of bringing the Narmada water to the Little Rann to control salinity for brackish water fish culture can be considered. It is believed that in the shallow tidal backwaters, fish culture can be a possibility. A study in depth of the possibility of fish culture in the Little Rann may be taken up with a preinvestment survey in the selected areas.

2.8 The entire area of Sundarban faces the problem of salinity, water logging and drainage. In the absence of upland water supply the area is exposed to tidal action making the water highly brackish. For the development of the Sundarban an integrated

programme simultaneously coverings crop production, fisheries animal husbandry and forestry and providing for improvement in infrasfructural facilities including communication and supply of notable water will be necessary. For the protection and development of land and for increasing availability of fresh water for agricultural and drinking purposes, engineering and other measures as envisaged both in the Interim Plan of Development of the Sundarban and in the Sundarban Delta Project should be undertaken. Industrial development should be restricted to such agro-based industries as do not aggravate the problem of fresh water in view of its limited availability. As an integral part of the overall development of the region, river, road and rail transport facilities should be considerably improved. Electrification should be extended to the area to support development.

2.9 On the east coast the principle of developing^ .existing skills will lead to the obvious strategy of developing fisheries. The next important part of the economy will be agriculture in which some beginning of development can already be seen in these area wherever fresh water is available. Development of village industries and tertiary sector growth will have to follow the primary growth in both fisheries and agriculture. In the West coast the entire economy will be based on fisheries except where agriculture can be developed on the lines of Kuttanand. It will be found that such development on the west coast today would be a high cost development and may give a competitive agricultural economy to the population.

2.10 The Committee has generally been informed that there is no arrangement for any systematic oil surveys in most States particularly in the coastal areas. The Committee would urge that if a solution is to be found for the problem of the coastal areas affected by salinity, these areas can only be identified on the basis of a systematic soil survey. It is only then that it would be possible for the State Governments to identify areas of high, medium and low saline conditions and seek remedial measures. It is equally important to undertake evaluation of the various measures taken by the State Governments to reduce the problem of salinity and how far these have been successful.

2.11 Marine fishery mostly by a catamarans and small boats is the order of the day on the east coast and small boats on the west coast. The fishermen class in the coastal saline areas subsist mainly on marine fisheries. Optimal utilisation of the potential need to be aimed at. The current controversy on the serious competition between traditional boats and mechanised boats need to be resolved. Demarcation can be based on cost-benefit analysis and suitable rehabilitation of the displaced fishermen, if any. Possibilities of processing and marketing, including export of frozen fish has to be worked out rationally and optimally.

2.12 Brackish water fishery provides a sizeable potential for development. On account of large areas of brackish water, the reservation of the pursuits for the smaller people would help improve substantially the economics of these persons. Individual farms of smaller size are desirable but these need to be supported through area development approach and also through the provision of appropriate supporting services including technical consultancy services. The transfer of technical knowledge to the fishermen is very vital and this responsibility should be shouldered by the State Governments by providing the technical consultancy free of charge. The systematic development of the fishermen class should be to the focus of attention and would have

to be intensified.

2.13 The National Commission on Agriculture in its analysis of the development of Sundarban had suggested development of fresh water fisheries by utilising reservoirs of fresh water to compensate the loss of the brackish water fisheries in the project area. At the time the NCA gave its report, knowledge about brackish water fisheries was still with the research laboratories and very little practical application of the science bad been translated to the field. In the last five years, the development of brackish water fisheries has been brought in as a Plan scheme in the Fifth Plan and onwards. It has now been established that hect are for hectare brackish water fisheries which can develop prawns in addition to brackish water fish, give much greater income than the composite fish culture followed in inland fresh water fisheries. Fresh water being the most difficult ingredient in the coastal saline areas, its utilisation for culture fisheries whilst a more remunerative technology in brackish water is available, will not be warranted. The Committee, therefore, recommends that culture fisheries in the coastal saline areas should invariably be brackish water fisheries.

2.14 The experience of Kuttanad, the ring bunds of Cuttack district of Orissa and the development of fresh water drainage system in Sundarban shows conclusively that with the high rainfall on the east coast it should be possible to brine drainage waters from the land mass through controlled channels to leach the top soil in the saline areas and also impregnate the sub-soil with fresh water pushing down the saline acquifer. The high rainfall all along the east coast allows for this leaching of the saline area and storing fresh water in these areas for drawal during the off season. Incidentally all along the east coast spring and summer cyclones are not uncommon thereby providing further fresh water for leaching. Proper fresh water use is, therefore, the main strategy for agriculture in these area. Further, as fresh water will be scarce inspite of these attempts, the cropping system that will be developed has to be based on suitable cash crops whose water requirements will be low. Sundarban has shown that substantial income can be obtained from a vegetable-cun-water melon cultivation. Chillies predominate in the vegetable sector. Each area will have to develop us own cash crops keeping in view the types of salinity, the amount of additional water available from outside the area and the prevailing market conditions.

2.15 The northern part of Sundarban is an important horticulture area in West Bengal. In fact the Udyan area of Sundarban is famous for the variety and the quality of its fruits and for vegetable growing. The initial salinity of the area does not appear to have inhibited the development of a remunerative horticulture economy. Very little work has so far been done on finding suitable horticulture cultivars of various fruit trees suited to the area. In Thailand, the best pomellos are grown in the saline fringes. The agricultural Universities will have to rapidly survey available information about suitability of fruit' trees for their coastal saline areas and in due course undertake development of the necessary cultivars for better production. Anyhow, coconut production would prima facie appear to be the most remunerative horticultural development strategy.

2.16 For the appropriate development of horticulture etc. and also for the protection of habitation, the shelter belt approach is very desirable. The Committee would like to commend the strategy of complete shelter belt for habitations.

2.17 Animal husbandry will have to take a back seat for the time being, until the agricultural Universities check on the type of fodder that can be grown in the coastal areas and which will be suitable for animal rearing. At present goats are the most versatile feeders who may be able to absorb the flora that can be grown as fodder in the coastal areas. Sheep may be next in the line. Experimental schemes will have to be developed before animal husbandry can become an important part of the saline areas development. In Andhra Pradesh, there is already a history of sheep rearing in coastal areas.

2.18 The scattered nature of villages and the sandy nature of the coastal areas lead to a lack of road communication. A few schemes were developed over the plan era for connecting important marine fishery centres with the main roads for fish marketing. These roads are all-weather roads. If a general strategy of agricultural development, is taken up and a programme of locating at large number of fishery jethies and berbours alone the. coast is developed, there will be a need for substantial road communications to bring the marketable goods to the main urban markets. An all weather road programme for the type of vehicles now prevailing in the rest of the state may prove very costly and hence may not be achieveable within an acceptable time frame. Besides, the diesel truck may not be having the truck-load and with, rising diesel prices may become a very costly proposition. Sundarban has developed a cheap road system which allows for utilising pedal trays to move the goods to the collecting markets. The strategy of road development will have to take note of these innovations.

2.19 Sundarbans has established that boat traffic carrying goods is the cheapest wherever such communications can be established. All along the coast line on the east coast where a variety of products can be developed, back, waters and creeks allow for boat traffic of this sort. Particularly in Orissa there is continuous availability of boat ways from the Puri district into Midnapore. The possibility of developing such boat traffic as and when the productivity of both fish and agriculture develops will have to be examined at the right time.

2.20 While the Committee is discussing in detail in subsequent chapters the detailed approach to the various developmental problems, the Committee would stress that all available information in the country relating to developmental planning in coastal areas, affected by salinity should be assimilated and utilised. There should be a link between research and extension and the development activities should be carried out in a coordinated manner. Training the development personnel should be arranged and courses should be so organised as to give the development workers adequate knowledge about eco-system, extension methods, management, laws including property rights. This collation of information can best be done at the Central level in the Ministry of Agriculture. The Committee would strongly recommend that *a* Cell be created in the Ministry for specially looking after the coastal saline areas not only with a view to disseminate whatever information becomes available either from the national research institutes or the actual work carried out in various parts of the country but also to coordinate the activities of various State Governments and review the progress.

3. BRACKISH WATER FISH CULTURE

3. The potential for brackish water fish culture is computed at 1.71 million hectares against only 30,000 hectares are under some sort of fish culture. Besides an area of 8.9 million hectares of shallow seas are available, part of which at least could be used for mariculture. The details of these resources are given in Annexure I.

3.2 As of today maximum experience in brackish water culture is available only in the Sundarban area of West Bengal. In this area there has been a traditional bheri culture which produced a lot of prawns for the market. By introduction of technology into these areas, the yields have been stepped up substantially. Parallel to this, both at Kakadweep station of the Central Inland Fisheries Research Institute (CIFRI) and in some pilot programmes under the State Fisheries Development Corporation (SFDC), Prawn culture has been attempted under controlled conditions. In Annexure 3.2 a project profile for brackish water culture development by the West Bengal experts is attached. This profile distinguishes three types of areas suitable for brackish water culture and they are:

(i) Zone of high salinity and high tidal amplitude.

(ii) Zones of low saline and low tidal amplitude;

(iii) Zone of moderately saline and moderate tidal amplitude; and

If the brackish water areas in the other coastal States are investigated, it will be found that these three types will be replicated all along the coast. Each of these zones require a different type of handling of brackish water culture.

Zone of high salinity and high tidal amplitude

3.3 At Annexure 3.3, is a project profile designed for a brackish water prawn fish farm on Henry's Island in the Sundarban. The comments of the Committee at the end of the profile is important. The economics of this scheme is exceedingly satisfactory even though the capital costs per hectare of the project is fairly high. The comments show that cheaper designs have been prepared for areas better situated in Sundarban itself. The area of brackish water in the country is very substantial. During the present Plan and the next Plan, we shall probably be nibbling at the fringe of the problem of brackish water culture. It is, therefore, desirable that the areas most favourably situated in this zone of high salinity and high tidal amplitude should be selected in each of the coastal saline states for brackish water culture during these two Plans.

Zone of low saline and low tidal amplitude

3.4 This is also a zone in the Sundarban profile. At present, it is reported that 18,000 hectares, of this land is utilised for brackish water fish culture after taking a paddy crop. Eighty per cent of this land is used for the mixed cropping of crop culture and fish culture and 20 per cent is fully utilised for fish culture. Formerly, bheri culture was the practice here. In this a large area within suitable embankments was flooded with water from the estuary after the paddy crop was harvested. This was carried fry of various types of fish and prawns. The mixture contained varieties which consumed the

food but were not very productively and predators which fed on the other varieties. As a result of the balance in nature of certain amount of prawn per hectare was harvested by the bheri owners. Some fish was also harvested. When the technology of developing pure fry was taken up, a large number of people collected such fry of prawns selectively and such select fry was fed into the bheris on a large scale. Thereby large scale employment was provided for the poorer sections in the area and the bheri yields became much larger in prawns. It was estimated that the yield of prawns more than trippled. There can be further refinements in the system by putting a sieve at the entrance to the embanked area before letting in sea water and trying to remove as much as possible of unwanted and predator class fauns from entering the bheri. If after this pure prawn and other selected fish fry was introduced, yields will probably be much larger. The technologists will have to take up such operational research programmes in the various States. At present, paddy-cum-fish culture is prevalent also in Kerala and can be introduced in all the coastal saline States. Operational search in all these States in necessary.

3.5 For the low 'salinity and low tidal areas this bheri culture appears to be the most economic approach. It does not interfere with the paddy culture and, at the same time, gives as subsidiary income in fish culture. Such areas will have to be identified in all the coastal States and a programme of action developed.

3.6 Individual field embankments in such areas is obviously undesirable. It will effect the leaching out of the salinity from the lands during the rains and obstruct drainage and reduce paddy yields. Large areas have to be embanked for culture fisheries. In agriculture, already there are very substantial land reforms laws which fix the rights of various parties on the land for agriculture. For culture fisheries at present there is no such law and in Sundarban there is a complaint that the more powerful people are utilising the bheris for absorbing fishery profits without reference to the owners of the lands. Fishery return on the land is not amenable to the agricultural laws and should not be. In Goa, there is a system of such common fish culture on paddy lands and the regulations governing the division of the output can be studied to develop a suitable model law for bheri culture in coastal saline areas. It is suggested that the laws should provide compulsorily for common operations and for arbitration by governmental machinery. It should also define the rights of the owners of the land to the produce on a fair and equitable basis. The Committee recommends that the Fisheries Division in the Ministry of Agriculture should take up the development of a model law. There is a great scope for such bheri culture in all the coastal saline areas.

Zone of moderately saline and moderate tidal amplitude

3.7 In West Bengal, at present about 2,000 hectares of this zone is following a bheri culture. An alternate to bheri culture is culture brackish water fisheries. Economics should determine the choice between these alternatives. A bheri culture is suitable where culture brackish water fisheries will be highly capital intensive. Wherever culture fisheries can be done profitably, it is not advisable to stick to bheri culture. The difference in yields between the two methods is very substantial. Such of the moderately saline areas with moderate tidal effect where the designs can be suitably developed on the model applicable to the high salinity, it is desirable to follow a culture fisheries approach. In other areas where capital cost on culture fisheries is very substantial, immediate introduction on bheri culture of the controlled variety would

benefit the people to a very large extent. The Committee would advise the classification of such lands in the coastal saline States and developing suitable .phased programmes.

Design for development

3.8 Paddy-cum-prawn culture: In areas where this is now prevalent and in new areas where the technique can be introduced, it is necessary to improve the method. Introduction of water carrying mixed fry, both desirable and undesirable varieties, will have to be replaced by selective introduction of the better varieties which can give the best return out of the nutrition in the water.

3.9 In Kerala, on the other hand, paddy-cum-shrimp culture is the practice, paddy being cultivated during the rainy season where fresh water conditions prevail, and shrimp being cultivated during the non-rainy season when paddy cultivation is not possible due to high salinity. The low tidal amplitude permits use of relatively simple dykes hence shrimp culture is possible at a low cost. However, the virtual absence of Tiger Prawn fry (Penaeus mondon) in this zone considerably lowers the unit income. The dominant species is poovalen (Metapenaeus dobsoni), a medium sized shrimp, which is often caught in the juvenile stage during the low tides associated with new moon and full moon. Hence, the value realised is not very high. It must be mentioned that farm site price of Poovalen (Metapenaeus dobsoni) is about Rs. 6 kg. as against Rs. 60 kg. for tiger prawn. However, Naran or white prawn (P. indicus) is also available to some extent in Kerala and by selective stocking a higher production and unit value can be realised also in Kerala. Another inherent difficulty in Kerala arises from the low natural food supply because of the poor tial influx. This can be overcome by artificial feeding.

3.10 Kerala tried a selective introduction of Penaeus monodon and it was successful. Fry of Penaeus monodon (Tiger prawn) is not found and Penaeus indicus (white prawn) is found in small quantities. A replacement of the cheap varieties like Metapenaeus dobsoni by introduction of the better varieties under controlled conditions would improve the income from this culture very substantially.

3.11 In some areas in West Bengal it is already noticed that prawn culture is dsne throughout the year. A similar opportunity does exist in many other coastal States. For a two crop routine in such waters which is more profitable method, fry has to be available of the right type at the right time.

3.12 The Ministry of Agriculture had through the Central Inland Fisheries Research Institute, Barrackpore, carried out a survey of the availability of various prawn fry and the season when they are available in plenty in various parts of the coast. The present results of the survey indicating the season when fry of various important brackish water fish and prawn are available in the various backwaters of the country is attached at Annexure 3.4. It should be possible generally by collecting the try from the area where it is available to send it to the grower in the season when he wants it. For the time being, this is the best adjustment that can be made between demand and supply. The problem here is the transport of fry. Kerala tried to transport Penaeus monodon fry from West Bengal for use in Kerala. There was very substantial mortality because of cannibalism. Experiments have shown that where mixed fry even of one variety is

sent. Cannibalism is very large. While scientists should find out the best method to reduce transport mortality, obviously steps have to be taken to produce uniform batches of fry so that transport losses can be minimised. Thanks to the spade work done under the Induced Breeding Programme of the Central Inland Fisheries Research Institute, transport of fry over long distances and over time has been well established. It is suggested that because of the spike in the monodon the cover of the container may be pierced. These are the problems which are within the competence of the scientists to solve.

Controlled breeding of prawns

3.13 Over the years many stations in India have been trying to breed the prawns from breeders eggs to fry. Problems of feed have been investigated and some amount of success has also been achieved. The Hindustan Lever Centre in Bombay which had the benefit of advice from Dr. Dwivedi of the Central Institute of Fisheries Education, Bombay has already done commercial production and despatch. In the Marine Research Station in Kerala recent work done by Dr. All Kunni, Adviser (Fisheries) of Kerala and other centres has by now established cheap methods of prawn fry production. Equipment required is extremely small and space needed for the production will not be much. The Committee would recommend that the Ministry of Agriculture taking into consideration the various experiments that have been done and innovations introduced, should prepare a model for a production centre for prawn fry. The cost-benefit of the production and the price at which the fry has to be sold will also have to be established. The coastal States should have at least one pilot centre close to an area where culture prawn fisheries are now under development.

Phasing of Development

3.14 The development of paddy-cum-prawn Culture can probably be introduced quickly all over the coastal States provided areas are identified, extension work is done and necessary arrangements made for fry supply on demand. The Committee recommends that each coastal^ State should now do the basic investigations as has been done by West Bengal for Sundarban and identify suitable areas for development and lay on the expertise and extension and provide the necessary infrastructure including arrangements for fry supply.

3.15 The most remunerative and intensive production of prawn would be in the zone of high salinity and high tidal amplitude. Here controlled pure culture of prawn with some brackish water fish (non-predatory) .has given very high returns per hectare. Considering the vast amount of such brackish water with high tide, high salinity characteristics, any expansion of this method of prawn culture would benefit both the fishermen and the country, by substantially raising the productivity per hectare of saline water which at present is rather low.

3.16 In the comments on Annexure 3.3 the Committee has indicated that even within this zone the capital cost of construction of a suitable structure for prawn culture varies very sharply. Having made an estimate of the number of hectares each State feels it can reasonably handle during a Plan period, the objective should be to identify the most economical areas from the point of view of capital expenditure in the zone. This selectivity will first of all reduce overall cost of production and given an impetus to the

growth of the industry. It will be quite time before one has to think of the more difficult areas.

3.17 Culture prawn fisheries is a capital intensive industry. Whilst the fishermen class should be given every facility to enter into this new line and given reasonable help by way of loans, grants etc; the Committee feels that there is a limit beyond which the fishermen class as individuals will not be able to avail of this programme. Firstly, the programme is highly cost intensive. However, generous the grant may be, there will be a substantial portion of loan attached to the scheme. The poor fishermen will boggle at the idea of signing his name to a loan bond of such magnitude. Some headway be made in this sector by choosing in terms of common cost, the cheapest area and bringing the fishermen under a common management with individual rights in particular tanks. A corporation idea on the lines of the Assam Plantation Corporation Act may be helpful. Various conditions will have to be imposed on the lease holder so that the programme is operated as a whole and individual vagaries do not spoil it. It may be worthwhile for the Ministry of Agriculture to set up a Working Group to study this problem and suggest a model project.

3.18 It will be much easier to introduce controlled culture in small farmers holdings under brackish water with holdings between 2 - 5 hectares. Given sufficient subsidies and loans, entrepreneurs may be forthcoming from this class to enter into this programme. Though the capital cost may be a little high, because of the fencing costs of small areas, the individual attention and control would compensate for this. In effect, this will be a small industry. The Committee recommends that these enterprises should be treated on the same footing as well in small industries and all .the benefits given to small industries should be made available to such entrepreneurs in addition to such benefits as are given to small farmers.

3.19 Unless some big entrepreneurs take up a larger area and provide the validity of the operational research findings of the researcher that this is a highly remunerative enterprise, the ordinary fishermen and the local entrepreneurs will riot come forward easily. The Committee, therefore, recommends that a few areas of 100 to 200 hectares may be given out to large entrepreneurs under very strict conditions including utilisation of local labour. One condition should be that they would put up a fry production centre and supply fry, on fair price, to the small farmer entrepreneurs round about. The Working Group dealing with the fishermen's programme can also look into the development of a modeal contract form for lease of these areas with large entrepreneurs.

Training requirements for brackish water culture

3.20 One of the major constraints to the development of aquaculture has been the paucity of trained personnel at various levels. Training of fishermen and others offering supporting services has to be carried out on a very large scale by each of the coastal States. Though some amount of training has been organised for fresh water fish culture in many States, very little has yet been done for brackish water fish culture. The reason is that this technology is yet developing and we have not yet developed the necessary technical expertise of the type required to train the fishermen and others in this

3.21 Many of our fish farmers, though having vast experience of traditional fish farming, lack the essentials of technical know-how and the scientific basis of fish culture. It is imperative for them to have correct ideas about the basic principles of fish development. For instance, even though the fundamental knowledge that the fish needs for its growth adequate oxygen, food and space is obvious and should be commonly known to all, many who undertake fish culture show little awareness of these requirements and often display complete ignorance on that count. A package of broad based training programmes for this category would be crucial for the success of any programmes in the field.

3.22 There are a number of other categories of personnel who are to be suitably trained and equipped for the job. The training of persons who in turn are to train the fish farmers would form one such important category. Extension services for conveying the research findings to the fish farmers for adoption need to be manned by persons who are fully trained for the job. Similarly, a host of other fully trained personnel may. be needed for undertaking many needed supportive services.

3.23 The training is needed right from the selection of sites for aquaculture to design and construction of pond/farm. The important aspects of training need to comprehend selection of species for aquaculture and their biological requirements; seed procurement and production; preparation of ponds for nursing, rearing and stocking; enrichment of the pond soil and water; nutrition and artificial feeding; sanitation; fish health; and harvesting post-harvest technology.

3.24 The content of various courses should be ail comprehensive in nature. An idea on the same can be had from what follows. Courses in selection of sites for aquaculture should primarily be based on topographical suitability for particular system of aquaculture. Other important elements deserving special attention are climatic factors, soil type, water supply, physical and chemical features of water and its productivity. Socio-economic, political and legal factors need to be given due attention. We need to comprehend as well consumer habits and preferences, transportation and communication facilities available, accessibility and nearness to markets. Knowledge about the agricultural planning in the area would also be a help.

3.25 The course on design and construction of pond/farm need to comprehend factors like source of water supply, dikes and water control structures, uses of pumps, aerators and other machinery used in farm construction.

3.26 The course on selection of species of aquaculture and their biological requirements should primarily comprehend knowledge on their oxygen requirements; growth rate, feeding habits, efficient conservation of food, tolerance limit of temperature, salinity, CO_2, NH_3 and PH. It would be desirable to impart knowledge on aspects like environments; physical, chemical and biological parameter, species resistance. Knowledge about good table quality needs stress as well.

3.27 Courses on seed procurement and production should include training on prospecting of suitable sites of seed procurement; their hydro-graphical conditions such as topography and other physical, chemical and biological parameters; design and construction of different gear and methods of sorting of desired seed from collection.

3.28 Pond preparation courses need to impart knowledge on control of aquatic insects, predaters, weed fishes and the weeds. A knowledge of interrelationship between these factors and the fishes and different methods of their control is very important and as such should form a part of the course.

3.29 Enrichment of the pond soil and water may require Basic knowledge of the production process in the pond. As such courses on the subject should include the basis of improvement and restoration of pond bottom; method of soil and water analysis; objectives, basis and effects of liming and organic and inorganic fertilisation, method and sequence of their application, use of micro-nutrients etc.

3.30 Nutrition and artificial feeding aspects need knowledge of nutritional requirement of cultivated organism in terms of essential nutrients, The course on these aspects should impart knowledge on factors like essential aminoacids, fats carbohydrates, vitamins and minerals; nutritional requirements during different life stages; conversion rates and digestability of feeds, importance and contribution of artificial feed in increasing fish growth and production: fortification of conventional feed as per the requirements of the cultivated organism; method of feeding etc.

3.31 Sanitation, fish health and fish culture hazard are the most important aspects which need clear understanding for those who are involved in fisheries education, extension, training or practical fish culture. These aspects involve the knowledge about importance and influence of pond sanitation on fish health and public health, factors responsible for occurrence of diseases among cultivated organisms.

3.32 Courses on harvest and post harvest technology should comprehend method and timing of harvesting, gears needed for harvesting; different types of nets, net making and mending, sorting and grading of catch, transportation of fresh fish; causes of fish spoilage, method of preservation and processing; chilling, freezing and other methods; and quality control standard and method.

3.33 For the training needs indicated above, annexures 3.4 and 3.5 give details to help organize the training in seed collection arid culture of commonly cultivated fin and shell fish in brackish water.

3.34 The Fresh Water Acquaculture Research and Training Centre of the CIFRI at Dhauli in the Puri District of Orissa has organised a. training course of nine months for the field level technical workers in fisheries in Orissa state. Similar programme of training the field level technical workers in the various coastal States where potential for brackish water fish culture is large and has now got to be organised. C1FRI is the obvious leader for drawing up the ingredients of this training course and starting the process of developing their own Central institutions for such training and supporting similar training institutions in the various States. Whether the brackish water culture should also be included in Dhauli Research and Training Centre or a separate one has to be located else where (may be Kakadweep) is a matter for serious consideration on a priority basis by the Indian Council of agricultural Research.

3.35 Meanwhile, every State having the potential for brackish water fish culture will now have to plan their own training centres and the need for the experts for training in these centres, who obviously have to be at a technical level much higher than what is

now available in the State in the field system. Technology has to be carried to the field at a level which is considered necessary by the State level experts. Till the development of suitable facilities, a State may take Central help to the extent possible.

3.36 The Dhauli Research and Training Centre has post-graduate training for various aspects of fresh water fish culture. For brackish water fish technology similarly post-graduate training has to be given to selected field experts in the various States so that they can assume the leadership, for the technical revolution in training and application in their respective States. The Committee recommends that the CIFRI should organise this technological revolution to support the brackish water fish culture through appropriate institutions of their own and replications in the States. This is an important research and training programme which will deserve substantial help and contribution from the ICAR to the State Research and Training ventures which may be accepted.

Annexure 3.1

State-wise existing and potential area of brackish water and inshore area available for mariculture

Serial No,	State/Union Territory	Estuarine and Brackish water area (in. ha)	Potential in shore area (0-18m) available for mariculture (m.ha)	Area utilised presently commercial brackish water farming (ha.)	Present yield kg/ha/ year
1	2	3	4	5	6 *
1	Gujarat	0.376	4.752	88	35.5
2	Maharashtra	0.081	0.593		
3	Goa	0.019	0.019	nil	
4	Karnataka	0.008	0.259	4800	258
5	Kerala	0.243	0.254	5117	700
6	Tamil Nadu	0.080	1.606		
7	Pondicherry		0.067		
8	Andhra Pradesh	0.200	0.414		
9	Orissa	0.299	0.768		
10	West Bengal	0.405	0.078	20000	300
	Total	1.711	8.910	30005	1293.5

Sources : Marine Fisheries, Information Service no. 3, November 1978 p. 12 Central Marine Fisheries Research Institute, Cochin.

A PROJECT PROFILE FOR BRACKISH WATER AGRICULTURE IN WEST BENGAL

The coastal region of West Bengal with an ecology of tropical mangrove forests, offers an unique habitat for the development of coastal aquaculture. Though the coastal line is only about 65 Kms long (along the sea face) the tidal effect is felt far inland submerging large tracts of land with every tidal rise and making them unsuitable for agriculture purpose due to deposition of sodium salts, mainly chlorides and sulphates. The extent of saline soil in the State is approximately 0.8 million hectares of which 90% belong to the district of 24 Parganas known as the Sundarbans and the rest is in the district of Midnapore.

TOPOGRAPHY

2 Most of these areas are low lying and level parts of the deltas of the Ganga River System with elevations mostly less than 10 m from the sea level. In the Sundarbans of district 24 Parganas the maximum elevation above the sea level is 9 m. and the minimum is 2 m while in Midnapore there are a number of saline sand dunes where the elevation is 13.2 m above sea level. Along the coast the elevation is 3 m above sea level.

River System

2.1 Most of the estuaries of the Ganga River System pass through this region before meeting the Bay of Bengal. Larger of these estuaries are the Harinbhanga or the eastern most estuaries are the Matlahi, the Thakuran, the Saptamukhi and the Hoogly or the western most estuary. Midnapore lies on the West of the Hooghly. A number of distributaries interconnected these estuaries of which the Kalindi, the Bidhadhan the Bidya, the Herebhanga, the Gasaba are worth mentioning. Such interlacing of water system has given rise to a network of level islands of different dimensions covered by a canopy of lush green vegetation of different varieties of mangrove plants.

Tidal effect

2.1 The tidal amplitude is known to vary from 1m to 5 m depending on the season, the location of the site and its distance from the sea face. During the spring tidal period the high tide inundates these areas to an extent of 0.3 m to 1 m. During summer months the soring high tides rises even beyond 1.3 m above the general ground level. The highest high tide of the year inundates upto 2.0 m if there is no protective dyke.

Soil

2.2 The soil in general are of moderate to heavy texture and are saline in nature. Depending on rainfall or otherwise the soil salinity fluctuates between the seasons. Generally speaking the salinity ranges from 4 mmhos/cm to 35 mmhos/cm. Though soils of diffrent textures like clay, clay loan, simty clay, silt, loan, sandy loan and sand are available in the region but depending on the distribution they may be classified into three basic groups as silty soil, silty clay-loan and silty clay. The general properties of these three types of soils are annexed in Appendix-I.

Climate

2.3 The climate is a typical tropical humid climate with an average annual rainfall of 1500 mm (the maximum air temperature is around 35 C and the minimum i§ 13 C). The rainfall is mainly concentrated during the South West monsoon period of June to September when about 75% of the rainfall is experienced in the region. The rest occurs during October to December. The details of monthly mateorological data pertaining to air temperature, rainfall, wind velocity, relative humidity are presented in Appendix-II.

The area experience cyclonic storms during September to early December. Storms largely originate between the latitudes 8 to 15 N and move initially in NW direction but a number of them finally recurve and move in a NE direction striking the coastal region of West Bengal on its way to Bangladesh. Based on 30 years record the average number of storms and depressions during October to December are four of which only two cross the coast.

3. Land Use

3.1 Reclaimed Areas : Of the entire area of 0.80 million hectares, 0.25 million hectares are provided with perimeter dykes in an attempt to reclaim them for agricultural purposes by protecting them from regular tidal submergence. Due to underground water table being present at a shallow depth of 1 m to 2 m below the surface enriched with high salt content, saltsi accumulates on the surface of the soil due to capillary rise of sline ground water during the dry months of the year making the soil unsuitable for agriculture. It is only during the monsson months that due to heavy concentrated rainfall in a short span of four months, flat topography, low infiltration rate, lack of proper drainage facility and continuous flow of run off water from the head region, the ground water table practically reaches the surface considerably reducing the soil salt concentration 2 mmhosi/cm on an average and making it suitable for agriculture with the help of accumulated flood water. Thus the entire area is a monocrop area, the only crop grown being paddy durnig the monsoon months. For the remaining period of the year this reclaimed land remains unused. However, a system of alternating fishery with paddy cultivation has since been taken up in the upper reaches of some of the estauries where the tidal rise permit inundation to an optimal depth of about a meter or so.

3.2 The unreclaimed area of 55 m. hectare the coastal saline zone, particularly the Sundarbans, is covered with a luxuriant growth of mangrove plants, Almost all species of tropical mangroves are available in this region. Of them the red mangrove, Rhizophora, ssp, gove grow in deeper waters and ordinarily are not exposed even dur-ing the low tides. With their extensive crop root system they harbour a rich fauna of the young ones of a number of varieties of penacid prawns and those of economically im-portant marine finfish like mullets, thread fins, ex-eyed herrings etc. At a little higher level the black mangrove, of which Avicennia spp. are most common, produce erect roots that stick up through mud and seve as pheumatopheres. Cerioos rexburghiana is, another widely distributed mangrove in the Sundarbans. A luxuriant growth of algae around these mangroves harbour a rich fauna of the low aberrant groups of lower invertebrates and forms the pasture ground for the young ones of a large number of economically important for fine and prawn.

There are enormous blanks in the Sundarbans which can be categoriesed into three types : —

(a) Blanks devoid of any vegetation

(b) Blanks under scrubby growth of Ceriosp roxburghiana

(c) Blanks containing scanty growh of Exoceraria agellocha.

No afforestation can be carried out in these blanks due to heavy salt deposition of lack of proper coverage to encourage plant growth or the soil being too hard to allow any cultivation.

4. Local inhabitants and their economic status

Local inhabitants of the area largely belong to the backward communities who are illiterate and economically depressed.

4.1 About 45% of them are traditional fishermen who fish in the open estuaries, creeks, and bays to earn their livelihood. Since the area is difficult to approach they hardly get remunerative return from their day's catch so much so that at times majority of them may not earn even a single meal to day f of their families. The condition is further aggravated during the pre-monsoon and monsoon months when due to inclement weather fishing in the open water becomes extremely difficult.

4.2 The bulk of the remaining population belong to agriculture community whose main vocation is to till the lands as share croppers landless labourers. Since the area is a monocrop area where only paddy is grown during the monsoon months, the population, depending on land, face serious hardship during dry months when exodus to the urban areas in search of alternate means of livelihood takes place. Some of the members of such uprooted families remain in the city never to return to the village to help revive rural economy.

5. Reconstruction of rural economy through Agriculture

This seasonal migration can be arrested and year round vocation can be offered to the local inhabitants through aquaculture by utilising the enormous aquatice resources of region. Enriched by the fallen leaves of the mangrove and the nutrients brought in by the flowing waters from the sewagefed river and the uplands of the Indo-Ganga plains, the waters of the Sundarbans estuaries are highly productive. Low and flat levelled topography of the land, high tidal amplitude and due to low infiltration rate, impounding and exchange of tidal water through the construction of low cost dykes and water gates pose no problem. Seed prospecting investigation in a number of these estuaries have indicated that a large number of varieties of curyhaline cultivable species of finfish and prawn inhabit these waters and that their young ones are available in plenty during different seasons of the year and I can be profitably collected for stocking in the proposed impoundments. It is needless to point but that salt marshes are one of the most fertile areas of the world and that the dry matter productivity in such region varies between 2000 g and 3000 g/m3/ annum of which negligible fraction is directly useable by man. Therefore, the management problem in such situation is to arrange to

utilise the resources rather than produce which can be best done through planned and scientific aquafarming.

5.1 Present status of acuafaring in the region

Based on the salinity regimes and the tidal amplitudes the entire coastal region of West Bengal from North to South can be divided into three zones.

(i) Zones of low saline and low tidal ant plitude

(ii) Zone of moderately saline and moderate tidal amplitude.

(iii) Zone of high salinity and high tidal amplitude

Representative areas under Zone I are covered by the Police Stations of De Ganga, Harpa, Barasat, Rajarhat, Basirhat, Swarupanagar, Hasnabad, Sandeshkahli, Hinglegung, and Minakhar. A system to alternating agriculture during the monsoon season with brackish water aquaculture during the dry months has been developed here. The procedure adopted is to construct water gates on the perimeter dykes through which tidal water is let in from the adjoining tidal system after the paddy is harvested in November-December. Due to continuous flushing of the fresh water from above the river salinity is minimum at this time of the year and the sub-soil water table being very near the surface penetration of salt into the soil system is not possible.

Approximately, 18,400 hectares of area is under this type of culture. The species cultured are mainly prawn, mullets, poreches and other varieties of finfish. In areas of very low salinity Indian Major Crops are also cultured. This system of fish culture is known as 'bhery/ghery culture'. Details of the Bheries are enclosed (Appendix III).

The moderate saline zone hasj also been partly reclaimed for agriculture. In this region also a system of pisciculture as in Zone I has been started. Total of 200 hectares of area is under such culture practices in the Pokico Station of Kultali, Mathurapur, Gunning, Basanti, Pathar-prantima, Kakadwip, Namkhana and Sagar.

The high saline zone is still unreclaimed and largely covered by mangrove forests.

6. Proposed programme for development of Brackis/Water Acquaculture

The present system of acquaculture existing in the low saline and moderate saline zone envisages culture of prawn and finish in traditional methods of impounding them through tidal ingress. In certain areas in addition to stock received through tidal ingress, selective stocking of quality prawn and finfish is resorted to. On the whole nursery management practice is a loose tool resulting in heavy mortality and unneces-sary wastage of stocking material.

It has, been reported earlier that there are large blanks in the forest region where due to peculiar ecological conditions afforestation cannot be undertaken. These areas can also be fruitfully utilised for development of aquafarms on scientific principles taking into consideration the peculiar mangrove ecology which is the mainstay for the

productivity in the region. Out of 0.40 million hectares of such area, approximately 20,000 hectares can be developed immediately.

The development cost/ha vis-a-vis the return expected is enclosed (Appendix IV).

In addition to such low lying areas there are a number of enclosed bays and sandy coastal areas which can also be profitably utilised for mussel culture, oyster culture, and seaweed culture so that the industries based on these produce can also develop to the benefit of the local inhabitants.

Therefore, the proposed profile for development of brackish water aquaculture in the region will centre around:

(i) The improvement of existing bhery/ ghery culture system to rationally utilise the area as also seed resource for better yield

(ii) To bring under culture available land resources in the forest belt by constructing scientific aquafarms without disturbing the existing mangrove ecology. The proposed aquaculture aquafarms will be constructed in the different types of blanks as detailed in earlier chapter on a phased manner. In the first phase approximately 4000 ha. in the fringe areas of the forest region nearer to human habitation are proposed to be : developed which will be followed by the development of next 16,000 ha. in the second phase.

(iii) Utilisation of enclosed bays, channels, creeks having sandy substratum for development of mussel, oystar and seaweed culture.

7. Socio economic impact of the project

The development of brackish water aquaculture as indicated above will have a tremendous favourable impact on the local rural economy. This will not only generate year round employment potential for the local inhabitants but will also help in making the protein deficiency through increased production of fish.

In addition to generating direct employment potential this will also encourage indirect employment in the field of collection of fish and prawn seed from the open estuaries and their supply to different fisheries, transport and marketing of fish from the fisheries to different urban centres of consumption, supply of inputs, ice etc., for the culture of fish and its preservation. The impact of such development will also tell upon the social structure which is bound to improve with better development of communication system.

Appendix-I

Soil Profile Characteristics of Canning Farm Soils (West Bengal)

Depth (cm)	Organic	Sand	Silt	Clay	PH of Saturated paste	CEG (me/100g)	ECE (m/hos/cm)	MG++	K+ me/1	NA+	Ca++
Silty Soil											
0—15	0.54	19.7	56.8	23.4	6.7	12.8	14.7	37.2	0.5	94.5	SO. 3
15—30	042	25.6	47.8	26.0	7.1	12.6	12.8	52.0	0.4	80.0	17.4
30—45	0.36	20.9	52.6	26.5	7.3	12.6	15.1	34.3	0.4	100.7	19.0
45—60	0.22	25.4	48.2	26.4	7.4	12.8	12.6	33.1	0.5	83.5	18.1
60—75	0.27	20.9	54.2	25.1	7.2	14.1	12.1	12.0	0.5	80.0	17.7
75—100	0.28	29.1	47.0	23.9	7.0	10.2	34.2	143.3	0.4	50.0	58.5
Bitty Clay Bee											
0—15	6.67	8.6	49.8	41.6	6.6	20.1	9.2	40.6	0.4	40.0	19.8
15—30	0.49	8.6	40.7	41.7	6.3	19.8	8.3	18.8	0.6	55.5	7.6
30—45	0.43	8.1	51.4	40.4	6.5	20.6	7.7	26.4	0.5	40.0	7.2
45—60	0.41	9.3	41.2	49.5	6.6	..	..	..	..	..	..
60—75	0.40	8.3	47.5	44.2	6.5	20.5	13.1	38.8	0.4	86.8	19.2
75—100	0.41	7.3	53.3	39.5	5.9	17.3	11.9	27.5	0.5	77.5	18.2
Silty Clay											
0—15	0.56	10.00	51.2	38.8	5.5	15.6	9.0	24.2	0.6	50.0	9.2
15—30	0.45	7.1	51.8	41.1	5.8	16.2	6.5	16.8	0.6	41.0	7.6
80—45	0.41	8.0	40.6	42.4	6.4	16.1	8.7	23.3	0.6	60.0	8.1
45—60	0.38	1.4	65.6	43.0	6.7	15.3	11.1	33.6	0.5	27.5	11.7
60—75	3.39	7.2	52.8	40.0	6.7	15.2	11.6	31.2	0.4	80.0	9.9
75—100	0.42	8.5	49.0	42.6	6.7	17.8	12.6	44.0	0.4	83.5	12.6

Appendix — II

Average Metetrological Data for the Coastal Area

Month	January	Feb-ruary	March	April	May	June	July	August	Sept.	October	Nov em-ber	December
Maximum Temperature	26.1	29.4	33.5	34.9	35.1	33.1	31.3	31.0	31.4	30.7	28.8	26.1
Minimum Temperature °C	14.1	17.3	21.2	24.9	26.7	26.3	26.8	26.9	24.0	24.1	13.1	14.6
Relative (I) Humidity	90	90	90	89	88	92	93	94	93	92	90	89
% (H)	46	43	44	56	53	80	83	85	81	69	52	47
Wind Velocity KM/Hr.	4.0	4.0	6.0	9.3	16.6	12.0	12.9	9.8	5.4	3.1	3.0	3.0
Rainfall	1.5	2.2	3.5	6.1	14.2	30.0	38.3	37.8	30.0	30.0	2.4	1.2
												196.6

Appendix III

Distribution of Bheries/gheries in North Sundarbans Area

S. No.	P.S.	Total No. of bheries
1	Sandeshkhali	40
2	Barasat	104
3	Rajarhat	44
4	Swarupnagar	2
5	Hingalgung	1
6	Haroa	88
7	Basirhat	45
8	Hasanbad	22
9	De Ganga	8
10	Galighata	2
11	Minakhan	33
	Total	389

Distribution of bheries/gheries in South Sundarbans Area

S.No	P.S.	Total No. of bheries
1	Kultali	23
2	Mathurapur	19
3	Canning	19
4	Basanti	11
5	Patharpratima	3
6	Kakdwip	1
7	Namkhana	2
8	Sagar	—
	Total	78

Economics of per hectare development of Brackishwater fishfarm in South Sundarbans, West Bengal (Based on experience of developing 200 ha. farm at Henry's Island, West Bengal.

		Value
A.	***Capital Cost***	
	1. Value of Island	Proposed to be paid on renuil basis Es.
	2. Cost of water gate	17,000.00
	3. Construction of pond (1 m deep)	11,670.00
		28,670.00
	4. Contingencies @ 5%	1,433.00
	5. Physical escalation @ 5% over capital cost	2,867.00
		32,970.00
B.	***Recurring Cost***	
	1. Rent of Land	(300.00)
	2. Nets and tackles	Rs. 5,000.00
	3. Cost of Drying	Rs. 500.00
	4. Cost of 4 Operator @ Rs. 8.72 day for one year	Rs. 13,000.00
	5. Cost of seed No. Rate Tiger (P. monodon)	1,500.00
	Prawan 2 x 15,000 @ 50/1000	
	Chapra (P. Indicus) 2 x 20,000 @ 50/1000	800.00
	Mullet fry 15,000 @ 50/1000	750.00
	Feed 720 kgs. @ 4/kg.	2,880.00
		Rs. 24,430.00
C.	Income	
	1 (i) From sale of tigar prawn of 400kgs. x2 @ Rs. 45 per kg.	Rs. 36,000.00
	(ii) From sale of white prawn of 250 kg. x 2 @ Rs. 35 per kg.	17,500.00
	(iii) From sale of Mullets of 675 kgs. @ Rs. 10 per kg.	6,750.00
		60,250.00
	2. %Return of investment	4.97%
	3. %Return on operating cost	146.62%

ANNEXURE 3.3

HENRY's ISLAND PROJECT ON BRACKISH WATER PRAWN AND FISH FARMING

Physical features

The Henry's Island at Gakkhali, on which the proposed Brackishwater fish farm will come up, is bounded on the north by a cluster of inhabited hamlets and on the east by the river Saptamukhi. On the south and it is open to Bay of Bengal. The Fredricks Island lies on its western side.

The location of the island is a Latitude 21 33 to 21 35 30 and Longitude 88 17 to 88 20.

Adjoining the island is a long braided channel, Bakkhali Khal which originates from the sea, runs all along the outer periphery of the island and opens to Saptamukhi river at its. tail end. The main supply of water to the farm ponds will be available from this tidal channel which, on the other hand, receives tidal water from the sea. This tidal channel, however, flows in a number of channels and cross channels between its banks into the project site.

The island is throughly covered with immature forest consisting of mangrove bushes and shrubs,

Hydraulic conditions of the estuary at the island

(a) Elevation : The average 'elevation of the island can be assumed at 1.5 m above M.S.L, (C.T.S.) since the maximum area of the island is covered under 1.5 m above mean sea level, while the central part is at a slightly higher elevation.

The elevations and depressions of the ground, noted during contouring of the island, show it to be almost a table land while uniformly paced contour lines indicate a uniform slope of the island towards, the creeks.

(b) Hydraulic conditions:

(i) Tidal amplitude-tidal amplitude of Bakkhali channels in the new moon phase 1 in September 1968 was 3.18 m. Tidal i" inundation of the island at that height varied from 25.5 cm to 57.0 cm on the surveyed areas of the Henry's island.

(ii) Tidal movement and flow pattern: Tidal flows in the Bakkhali channel and consequent rise in water level with time due to variations in tidal motions are all governed by the tidal actions in the bay. The flow remains unidirectional through out the phase of flood tide cycle and changes into reverse direction during the transition period.

Tidal rises observed at a particular place in the Bakkhali Khal from the *L.L.W.L. to **H.H.W.L. during flooding in different sparing tides indicate that tidal heights sharply increase between third and fifth hour of the tidal phase with consequent increase in velocity and discharge of tidal flow into the channel.

Waves and their effect on dykes

There are two prominent wind changes that are commonly found at lower sundarbans. The wind blows from north east direction during December — March and South and South East direction during April — November. The wind action on the surface water produces from low waves to moderately high waves when influenced by incelement weather. These waves run up the slope of the dyke, break up in shallow water which produce surface currents and increase in hydrostatic pressure at the place of convergence. While falling with diversing currents the waves have tendency to carry earth from the body of the dyke from the zone of saturation and thus erode the surface of the embankment.

Soil Characteristics

Studies conducted on soil profiles of the site reveal that the percentage of sand is poor in deeper layers while the percentage of clay is slightly more in deeper strata than in the surface layers. A thick stiff black clay layer is encountered approximately at 2.14 m down wards from ground level which is extremely puffy when exposed to air but is highly impervious when thoroughly saturated with water.

Silt content is higher at the surface layer with a slightly decreasing trend in the deeper strata.

The glibly saline Bakkhali soil is moderately alkaline in reaction, deficient in available nitrogen and organic content, but fairly rich in available phosphours.

The mechanical composition of soil samples of different profiles taken from a pit of Henry's Island is given below:

Compiling Centre	Profiles (cm)	Mechanical sand (%)	Silt(%)	Composition day (%)
Hentry's II	(ii) Surface at 30cm depth	42.5	41.2	16.3
Pit No. (I)	(ii) Surface at 90cm depth	47.5	37.5	15.0
	(iii) Surface at 120cm depth	42.5	36.2	21.3
	(iv) Surface at 150cm depth	36.5	41.2	22.3
	(v) Surface at 150cm depth	28.7	41.5	29.3

* L.L.W.L.: Lowest Low water Level.

** H.H.W.L.: Highest High Water Level.

On the basis of this analysis it may be said that the soil is loamy texutre and has comparatively low permeability. The liquid limit is rather low and when the moisture content in the soil exceeds the liquid limit, the soil looses Its stability and erosion follows:

Design and layout of the Farm

Shri A. N. Ghosh, Scientists in charge of the Brackishwater Division of CIFRI and a Member of the Board of Directors SFDC, was requested in 1976 to prepare a project for the development of 200 hectares of forest land covered with mangrove at Henry's Island for the purpose of prawn farming.

The existing hydraulic considerations at the farm site have been taken into consideration for designing the layout plan of the farm. The shape, size, depth etc. of each individual impoundment have been decided keeping in view the tidal amplitudes at the farm site, flow pattern in the tidal channel, velocity of flow and available discharge during the tidal cycle, so that it is possible to submerge the impoundment to the desired level during a tidal phase.

The whole area has been separated into two main blocks and the construction of the farm is proposed to be done in a phased manner so that fish and prawn culture can be undertaken simultaneous to the development and construction of the farm. After the construction of the farm in Block I is over, it will be put into commission before the construction of the second block is taken into hand.

The layout of the farm impoundments and feeder canals have been decided on the basis of the contour levels. The areas shown in the contour may indicating low elevations have been occupied by large impoundments a less excalation in these regions will afford sufficient submergence by tidal influx. Similarly, at higher elevations, impoundments of comparatively small sizes have been provided to minimise expenditure on deep excavation. However, compartments are so designed that efficient water management is ensured for successful farming.

In designing the layout plan emphasis has also been laid on how best the wave pressure created by the wind blowing on the vast expanse of impoundment surface and acting on the pond dykes can be minimised.

Taking into consideration the tidal movements this project was prepared in such a manner that excavation from compartments was possible by gravity and filling up tidal rise.

With a view to protect the marginal dykes, as a precautionary measure, a clear width of 50 m of forest belt has been left throughout the border of the farm site.

Dykes are stable against head water pressure overtopping and slipping, as slopes provided are gentle. Cross-section of the dyke has been decided m such a way that material available from excavation of an individual pond is sufficient for erecting the perimeter dyke of that particular pond without losing efficiency. This procedure minimises the cost of construction as leads and lifts involving in earthwork exacavation

are appreciably reduced.

A clear 2 m wide berm has been left between the lines of embankments and the edge of impoundments all along the perimeter. Similarly a 2.5 m wide berm has been provided for the feeder canals.

(c) Feeder canal	Top width	— 33m
	Bottom width	— 31m
	Side slopes	— 1.1
	Sectional area	— 32som.

The feeder canal provided to each block runs through the middle separating the block into the segments with a series of impoundments on its either flank. The impoundments will get usual supply of water from the respective feeder canal.

(d) Sluices: On either end of each feeder canal, sluices of permanent structure will be constructed which will work as main sluices for proper regulation of flowing water. The vent areas of sluices that have been provided in the design, are sufficient to inundate the impoundments to their optimum level during the rising tide phase of each spring tide. The main structure of a luice consists of three openings, each 15m in width, open although its height, two wing walls upstream and downstream and pucca aprons. Sheet piling, as cut off wall for preventing scouring and undermining the floor base, have been provided as ancillary to the sluice structure.

Individual impoundments will be fed through open type sluice structures with controlling wooden gates for proper regulation of flow into or from the pond.

The permissive possession of the land at Henry's Island was obtained by the SFDC on 27-1-1978. Considering the condition of terrain which was thickly wooded, it was felt necessary to start the excavation of ponds along the fringe areas which could be easily cleared and approach from the nearby villages was easier. Accordingly, the work for 16 hectares of central sector project was initiated in February 1973 along with the construction of masonary sluice gate and secondary gates to each compartment. The work was carried out under the direct .supervision of our Engineers under the guidance of Shri A. N. Ghosh who originally designed it. In the initial stage Shri S. K. Ghosh was Engineer-in-Charge of the project. Shri A. K. Dutta took the charge to complete the project soon after initiation.

Initially the work had to centre round the removal and clearance of the jungle, providing ring bund for protecting the project area from regular inundation with tidal influx, sinking of tube wells to provide drinking water to the labourers and other workers at the site and clearing of the area within the project site for the dwelling of the labourers and other supervisory staff.

By June 1978, 16 hectares in the excavation of the ponds, including secondary gates, were completed. However, due to various difficulties related to the wage rise, prolonged flood etc. the work had to be suspended during the remaining period of 1978.

The work was restored in 1979, and Block I of 100 hectares in the excavation of ponds and canals, provision of secondary sluice gates and the construction of the main sluice gate was completed by 1980. It may be mentioned that this work has been done manually without the help of any machine in an area remote from habitation and that work was completed in a record time of approximately thirteen working months.

The total cost in construction of ponds and provision of water gates has amounted to Rs. 26.60 lakhs for 100 hectares area. On an average Rs. 26,600 has been spent for per hectare development in this project. The work in construction of Central Canal and excavation of ponds in the Block II of another 100 hectares area is underway. So far as have developed 24 hectares of this block in ponds and canals.

Culture of prawn and fin fish has been taken up in the first 100 hectares area from this season and first crop is expected to be harvested by May in this year. It is anticipated that in the initial year the average production of 500 kilo per hectare of water area could be obtained. With an ecological balance being set up in the system the production rate is likely to improve further.

Comments of the Committee:

The capital investment of Rs. 32,970 per hectare in the 100 hectare project does hot include the administrative building, pump house0 and the tube wells (appendix IV of Annexure 2.2). A fresh water tube well is essential for the people working in the fisheries and also during the construction period. At Henry's Island the tube well has to go down in 1100 ft. to strike fresh water. But the extra cost per hectare will not be very substantial. As this is a Corporation project, the staff and other buildings are of high cost. If the programme is designed for a group of fishermen who will come from the neighbouring villages, each accommodation will only be temporary with local material and hence the addition to the capital cost of the project will not be large. Shri A. N. Ghosh has designed two other programmes— one for Sundarban authority at Mahisani Island and another at Jharkhali Island. In both of these cases the per hectare cost of construction of tanks and sluices is much lower. The costs are about Rs. 11,000 and Rs. 4,000 respectively.

The details are given in Annexures 3 6 & 3.7 respectively. The design has to be extremely location specific and full benefit should be taken up to the nearness of tidal water and the present contours of the land. In Henry's Island the digging had to be substantial.

When tidal water is let into the project area, it generally carries with it a lot of seeds and fry of varieties not suitable for development and predators. Though there is a screening at the entrance to the feeder canal, this does not completely filter these unrequired fauna. In order to ensure that the water that gets into the breeding tanks do not carry these unrequired fauna, the feeder canal is supposed to be stocked with predators like bekti. By this means that the feeder canal is also utilised as a production area. This has to be noted.

The main objective is to utilise the tidal water which carries a lot of plankton and feed, for the fish and prawns in the breeding tanks, effectively to look after the growth of

the fish and prawns without any large scale concentrated feed additions. At Henry's Island, only 720 kgs. of concentrates are provided for the nursery stage of the prawns. It is expected that the tidal waters themselves will carry sufficient feed for the full growth of the fish and prawns. This is a great advantage in tidal waters in mangrove forests. In all designs this advantage should be maintained.

In the working routine, provision is made for shelters where the nursery prawns and the moulting prawns can hide. This is essential to prevent cannibalism. It has been noted that under such shelters where the salinity of the water is more than 15000 ppm, blue green algae develops as a malting for both phyto-plankton and 300 plankton development. Maintenance of salinity levels is, therefore, important. In brackish water culture, we shall be aiming at varieties which can stand high level salinity.

Where the high tidal effect is felt, Shri Ghosh estimates that it should not be difficult to get a yield of 400 kg. of tiger prawn and 250 kg. of white prawn per harvest (two harvests a year). He has estimated that the mangrove area has sufficient nutrition and development of nutrition to provide for such yields without special concentrate feed. In areas where effect is much lower, naturally yields will be lower. Probably yields can be maintained (in such areas) by suitable flushing more frequently. This may add to recurring costs but will be compensated in yields.

ANNEXURE 3.4

Brackish water Prawn and Fish seed Collection, peak periods of seed availability and periods suitable for training

Serial No.	Training Centre	Period of seed availability Jan. Feb. March April May June July Aug. Sep. Oct. Nov. Dec.	Period suitable for training
1	Hooghly Metlah estuarine system (West Bengal)	L.P. L.T. M.C. L.C. C.C. P.M. P.I.	15 days or one month during April — May and August-Sept. to cover all the species.
2	Mahanadi estnarine system (Orissa)	L.P. L.T. M.C. L.C. C.C. P.M. P.I.	15 days or one month during winter season specially for mullets and same duration during monsoon for Lates calicarifer.
3	Chilka Lake (Orissa)	L.P. L.T. M.C. L.C. C.C. P.M. P.I.	15 days or one month during winter season specially for Mugil cephalus and same duration during monsoon for Lates calcarifer.
4	Tamil Kadu Coastal Waters	L.P. L.T. M.C. L.C. C.C. P.M. P.I.	15 days or one month during April-May specially for Chanas and Penacus Monodon.
5	Pulicat Lake	L.P. L.T. M.C.	One month daring April to September to cover all the four species.

Serial No.	Training Centre	Period of seed availability Jan. Feb. March April May June July Aug. Sep. Oct. Nov. Dec.	Period suitable for training
		L.C. C.C. P.M. P.I.	
6	Keraia backwaters.	L.P. L.T. M.C. L.C. C.C. P.M. P.I.	15 days or one month during winter and post-winter months specially top prawns.
7	Maharashtra coastal Waters	L.P. L.T. M.C. L.C. C.C. P.M. P.I.	15 days or one month during June to September spe- cially for L. Parsia.
8	Goa estuarine system	L.P. L.T. M.C. L.C. C.C. P.M. P.I.	15 days or one month during February to May specially for Chanos Glumes L. Persia and Penaous indicus.

L.P.= Liza Parsia L.T.=Liza Tade M..C.=Mugalcephalus L.C. = Lates calcerifer
C.C.=Chanes chanas P.M. = Penaeous monodon P.T. = Penaeus indicus.

Annexure 3.5

Duration of training needs on the various aspects of brackishwater fish and prawn farming

S.No.	Training Needs	Duration
1	Selection of site and construction of farm	15 days
2	On the collection and segregation of brackishwater prawn and fish seed	One month
3	On the nursery rearing of brackishwater prawn and fish seed	One month
4	On Pond preparation:	
	4.1 Eradication of pests and predators	One month
	4.2 Removal of metabolites	
	4.3 Manuring	
	4.4 Water management	
5	On stocking and pond management	Five months
6	On supplementary feeding	One month
7	On harvesting and economies	15 days
	Total	Ten months (February to November)

Annexure 3.6

Estimate for the construction of tanks and Sluices for Mahisani Island

1.	Reclamation cost	Cost per ha.	
		Rs.	Rs.
	(a) Excavation and disposed of earth including construction of main dykes and area filling and compacting as per specification and drawing with lead upto 240 M and lift upto 2 M. in all types of soil including cost of closure of sub-creaks.	35,19,000	
	(b) Jungle clearing and uprooting the tree for lay out of tanks and embankments.	1,48,000	
		36,89,000	8,579
2.	(a) Construction of main masonary sluices (4 nos.)	8,00,000	
	(b) Construction of secondary sluices (36 nos)	3,60,000	
		11,60,000	2,698

Annexure 3.7

Estimate for the construction of tanks and sluices for Herohhanya - Jharkhali Islands

1. Reclamation Cost	Cost Rs.	Cost per Ha. Rs.
(a) Excavation and disposed of earth including construction of main dykes and area filling and compacting as per specification and drawing with lead upto 240M and lift upto 2 M in all types of soil including cost of closure of sub-creeks	12,07,436	
(b) Jungle clearing and uprooting the tree for lay out of tanks and embankments	1,79,075	
	13,86,511	2,516
2 (a) Construction of main massonry sluices (3 nos.)	6,00,000	
(b) Construction of secondary sluices (22 nos.)	2,20,000	
	8,20,000	1,488

4. MARINE FISHERIES

Fishing Community

Fishing is a traditional vocation along the coastal tracts. According to Central Marine fisheries Research Institute, during 1973 — 77 there were a total of 1.435 million marine fishermen, of which 22.5% (3,22,532) were active fishermen. Total number of fishing crafts and fishing gears were 0.11 million and 0.74 million lakh respectively.

4.2 State-wise details about the fishing population crafts and gears etc. is given in Annexure 4.1.

4.3 Fishable resources: India has a coast line of 6100 kms. and a continental shelf of 0.61 million sq. km. and an exclusive economic zone of 2.02 million sq. km. the latter being almost two-thirds of the land surface of the country. The present marine fish production is approximately 1.4 million tonnes per annum as against a potential of 4.5 million tonnes from the exclusive economic zone. Over the last 30 years as many as 16,000 mechanised boats have been introduced and according to the recent survey 62.16% of the 1978 marine fish production of 1.4 million tonnes was contributed by the non-mechanised sector, while the mechanised sector contributed 37.8% of which the contribution of the deep sea fishing sector was less than 1%.

4.4. While it would appear on a cursory examination of the above mentioned statistics, that India has an enormous potential for fisheries development, it has to be emphasised that the harnessing of this potential bristles with various kinds of problems. The present position in respect of coastal fishing and deep sea fishing, is briefly discussed to enable a discussion of the strategy proposed to be adopted.

Coastal Fisheries

4.5 As already indicated, there is a fishing population of 1.435 million persons in the marine sector almost all of them fish in the coastal areas. This zone accounts for the bulk of the rich fishery resources. As one goes into the outer seas the resources become diffused, varieties available', command very low price, while the cost of exploitation increases substantially. From these considerations, both traditional crafts and small mechanised crafts have been concentrating on the coastal fishery resources. However, with the increasing pressure on this limited resource, particularly for varieties like shrimp having very good export market, it became necessary to demarcate zones.

4.6 Most of the sea prawns (Penaes or Meta-Penaens) caught in the coastal areas have a definite nursery phase in the back waters. The small fry migrate to the back waters and at a certain period of growth the prawn goes out into the sea back for maturing and breeding. The intensity of fishing in the back waters, which form the nursery for most of the prawn species, has increased by leaps and bounds. The mesh size of nets used has progressively reduced. The situation is one which calls for urgent and strong measures to reduce the fishing intensity in the coastal waters by way of imposing conservation measures like mesh restrictions, closed season, sanctuaries, annual quota etc. All these are difficult measures to implement.

4.7 Introduction of 16,100 mechanised boats over the last three decades with approximately an investment of Rs. 81 crores was no mean achievement. The evaluation study conducted by the Planning Commission has indicated the return per unit of investment of non-mechanised boats is twice that of powered boats and generates almost 7 times more direct employment opportunities than mechanised boats. Nevertheless, the traditional fishing sector received very little encouragement by way of investment and technological improvement. Nevertheless, the traditional sector more than kept pace with the mechanised sector, as revealed by the increase in the number of non-mechanised boats compared to the increase in the number of mechanised boats even though infrastructural facilities by way of boat yards, fishing harbours, ice plants, cold storage etc., were generally not available or at least seldom availed of by the traditional sector.

4.8 In this context, continued introduction of mechanised boats cannot be done automatically. While it is true that the fishing capability has been considerably increased and the main source of shrimp production which earns about Rs. 250 crores in foreign exchange is largely (69%) contributed by the mechanised boats, their introduction has to some extent affected the income and earnings of the traditional fishermen although the latter still account for 62.16% of the marine fish production. Out of 16,000 mechanised boats, there are only about 400 gillnetters (in Tamil Nadu and Kerala) and 235 purse-seiners (Karnataka). Practically all other boats are undertaking trawling. Purse-seiners have almost doubled the Karnataka fish catch. A study at Neendakara in Kerala where a very large number of mechanised boats are in operation, has shown a steady decline in the catch of prawns even though Karikadi, a species of prawn not having estuarine phase, is the pre-dominating variety. In Cochin, where poovalam, a species having an estuarine phase in the predominant variety, the reduction in the catch of prawn per unit effort in 1978, compared to 1970 was almost to 25%. At Kakinada also the study has shown a similar reduction in the catch per unit effort of mechanised boats indicating that the fishery has already crossed the level of optimum production of course in certain areas of concentrated effort and the decline after 1977 was probably the result of diminishing returns due to over fishing. All the studies come to the inevitable conclusion that the pressure of fishing particularly on the coastal shrimp and other coastal varieties is very much above sustainable levels.

Traditional Sector

4.9 The main technological improvement in the traditional sector has been the introduction of synthetic twines, outboard engines, insulated boxes, etc.

4.10 On fishing craft, the attempts of the Bay of Bengal Project in improving catamarans by fixing small diesel engines on one hand and still retaining beach landing facility appears to be promising. The arrangement is that while crossing the breaker zone, the engine cover will be hermetically sealed and propeller shaft tilted up to prevent damage. These catamarans are intended to operate from open beach as surf landing boats. The main propulsion is by soil and the engine provided is only as a stand by However, more work in this direction has to be done before the same can be recommended for adoption,

4.11 In Sri Lanka, where conditions similar to India exist, most of the canoes have

already been replaced by Fibreglass Reinforced Plastic (FRP) dinghis, powered with small HP kerosene engines and are operating from and river mouths. These dinghis are priced low with relief on excise duty on the material that goes into its production as well as capital subsidy and cost of boat and out-board motors. About 1500 such dinghis are introduced per annum and such bulk production also helps to distribute overhead charges, which would have otherwise pushed up prices.

4.12 In respect of fish handling, use of insulated boxes and increased availability of ice would serve to increase the period of freshness of fish and hence better marketability. The scheme is proceeding satisfactorily with private finance.

4.13 The macro statistics shows that the fishermen's population in the coastal areas is very substantial (1.435 million) during 1973 — 77 against whom only 22.5% were found to be active fishermen. Thus there is a large fishermen population in the coasts which can do with better employment in fisheries and greater earning capacity. In spite of the lack of special attention to the traditional non-mechanised craft sector in the coast, it has already been observed that the increase in the non-mechanised boats compares with the increase in the mechanised boats and production-wise they are keeping their heads up. At the same time, serious incursions into their field of activity by mechanised boats has been noticed. Any development of the coastal saline areas must stablise the traditional economy of the non-mechanised boat sector who almost had monopoly in fishing in the coastal areas which are the most remunerative areas for fishing in the sea. At the same time, we have to support mechanised craft which can go far beyond the depths and distances which the traditional craft can handle and can exploit the vast fishery resources of the economic zone of the country. Whereas there is pressure and conflict between the mechanised and traditional crafts in certain highly fished areas, there are many areas along the coast where not much fishing is taking place because of lack of basic facilities like communications, fresh water and easy access to a fresh market. The Ministry of Agriculture, already seized of this problem, have circulated a model Marine Fisheries Regulation Bill and States have started enacting their laws. This legislation is intended both for avoiding clashes among the fishing communities as well as for regulating fishing with a view to conserving the resources, particularly the over-fishing of breeding stocks and capture of juveniles. The States' attention is apparently more towards the demarcation of zones in a bid to minimise such clashes, while measures designed to conserve the breeding stocks as well as larvae, fry and juveniles have received scant attention. In the meanwhile, fishing effort has been continuously on the increase.

4.14 There is certainly need to improve the working of the traditional craft in the non-mechanised sections. Some experimentation in this has already been explained in paragraph 10 above. Considering the high cost of diesel or kerosene and the likelihood of the prices increasing further, unless the investment and the running expenses in out-board motors or any other propeller shaft can be expanded on a large scale, the increase in catch because of the facilities and the cost-benefit ratio will have to be worked out very carefully. These studies have not yet been done. The Central Institute dealing with crafts and gears should do the necessary home work and work out whether any of these recommendations have a value today or we are only trying to involve fishermen in expensive system which may not work. This applies equally to the fibre board experiment in Sri Lanka (Fibreglass Reinforces Plastic).

4.15 Probably the cost benefit will indicate that providing a mechanical propelling unit to each traditional craft 1o surmount the difficulties of crossing the surft and get into the fishing areas quickly, will at the end prove to be counter productive. Can we find some other method of utilising mechanisation and reducing cost per traditional craft?

4.16 Where there are large concentrations of catchments and dinghis it can be examined by pilot .schemes whether a mechanised boat can be engaged to pull them out to the fishing area in numbers. Probably about 20 boats can be pulled out over the surf and quickly to the fishing area. It may not be necessary to have special mechanised boats for this. In any community where both mechanised boats and catamarans and dinghis are predominant, mechanised boats can do this for a fee either in money or in fish. With the help of the fishery experts, the community can work out the norms. The Committee will suggest that pilot schemes of this nature should be started and the cost benefit worked out and demonstrated so that a methodology can be developed applicable to the various labour intensive.

4.17 It is possible to introduce labour intensive mother vessel fishing to enable traditional fishermen to go out far into the sea. Mother vessel fishing has been tried in Kerala in 1948 with very promising results, but was not pursued. This can be reviewed and improved to bring about efficiency and technical improvements. To begin with the scheme can be introduced for fishing in submerged roofs that fringe the coast at a distance of 60 — 160 kms. from the store. These reefs are not suitable for active gear and only passive gear like hand lines, traps is suitable. These can be operated from small canoes and catamarans. A mother vessel, fitted with eco-sounder and radio direction finder, could tow 20 such canoes and catamarans to the fishing ground and back every day to enable them to fish in these grounds. The mother vessels may carry ice and may have a provision for insulated storage cooking food etc. These may be obsolete or old vessels in good working conditions, which are available as disposals at throw away prices. Alternatively, floating islands can be created with ice production capacity, living facilities etc., which can be towed and left at the fishing ground for the season and arrangements made for batches to come and go at regular intervals. Details of these can be worked out.

4.18 The Wedge Bank, South West of Tuti-corin, falls within the economic zone of India. This is one of the richest fishery areas in submerged ridges. The country has not yet exploited this area at all whereas foreign vessels have been moving round in the area and poaching. The reason is that the rich fisheries can be exploited by passive gear by small boats and the area of fishing is too far from the coast. The mother ship technology is certainly extremely suitable for exploiting our rights in the Wedge Bank. There are other areas also. Incidentally, the reefs round under Andamans and Nicobar may be amenable to a similar approach. Of course, harbours in Andamans & Nicobar Islands are limited but wherever harbour facilities exists, pilot schemes can be tried.

Mechanised Craft

4.19 As already mentioned, over 90 per cent of mechanised boats are designed as trawlers. With limited size and horse power they can effectively fish up to a depth of 20 fathoms only. With the prohibition of their operation in the inner 5 kms. in many areas their number is fast approaching optimum levels and further introduction should be on a

selective basis. The technology of two boat trawling and use of high opening .trawl nets can considerably increase the catch. The gradual increase on hull and engine costs and sudden fuel hike by over 100 per cent in the last one year had been by far the greatest set back to mechanised boat operations, a situation in which mechanised vessel operations are economical only for high prices varieties, and high volume varieties and that too only if some concessions are provided on the cost of fuel. It may be worth recalling in this connection that a study conducted in 1967 by an F.A.O. expert indicated the feasibility of gradual in progressive reduction in subsidy. However, in spite of the economic viability of mechanised boat operations, the recovery position was never satisfactory, particularly when Government offered hire purchase or stood guarantee for institutional finance. The situation caused by natural fluctuations, calamities like cyclone, slump in export prices etc. and above all patronage from political circles often came in the way of this sector establishing its creditability as a sound investment sector by banking quarters. This sector is also in need of technological improvements to survive the situation created by spiralling price increase on hull engine, fuel and wages. These are discussed subsequently in this paper.

4.20 The most important diversification that can be done with the present technological knowledge is introduction of purse-seining for catching pelagic fish in the coast. Karnataka under a very active Director of Fisheries had introduced purse-seiners in a large scale based on Mangalore. The potential of this technique can be seen from the fact that whereas in 1976 there were no purse-seiners and hence no catch by purse-seiners, in 1978 the catches were of the order of 83765 tonnes. No other figures are needed to explain how important this technique is for increasing fish catches in the coastal areas of the country. At the same time the introduction of purse-seiners had led to certain controversy which have got to be faced.

4.21 The purse-seiners utilised by mechanised boats are now being utilised mainly in the pelagic areas not very far from the coast. The traditional fishermen along the coast have been also fishing for this pelagic fish which comes close to the coast at certain seasons of the year. The traditional non-mechanised boats are utilised for this purpose. In addition, in Goa and, to some extent, in North Kerala, the rampani system of catching pelagics in the coastal Bays has been affected. It is reported that the traditional rampani net catch went down from 41,202 tonnes in 1976 to 10,350 tonnes in 1978. It is certainly desirable that traditional fishermen should not be put to serious loss. At the same time, in the interest of adding to fish catches it has to be noticed that introduction of purse-seining has more than doubled catches. The effective catches for the season have gone up remarkably. The Director of Fisheries, Karnataka, when he introduced this new technique of purse-seining, foresaw the difficulty and effectively nipped it in the bud by seeing that the rampani users were all participants in the purse-seining programme. This foresight has not been present in other parts of the country. Particularly, in Goa situation is now one of active confrontation between the rampani netters and the mechanised boat owners. The Committee would seriously recommend that the ground level statistics of rampani users and mechanised boat users in all these areas where conflict has arisen should be done and, if possible, an introduction of the joint interest method followed in Karnataka may be a solution. Anyway, it is clear that there has to be a solution towards increasing our catches. Increased catches lead to secondary and tertiary growth of employment which again benefit the fishermen community.

4.22 Kerala has tried to solve the problem by prohibiting purse-seiners throughout Kerala whereas the rampani effect is only in North Kerala. Conclusions are obvious. The allegation that the purse-seiners are interfering with the coastal movement of the pelagic fish in season may not at all be scientifically tenable. If the distance limit is imposed for the purse-seiners, they will be fishing streams which normally would not have come towards the coast. Further, during season the influx is so large that if the distance limits enforced there should be no conflict of interest. Further, a more fact of a losser catch close to the coast in a year does not mean that somebody is interfering with the flow. It has been established long ago that along the Kerala coast there are upwellings of non-oxygen bearing waters which push away the pelagic streams and prawns from the near coast to far distant places. It is desirable that the fishery problem so that unnecessary conflict by lack of proper knowledge may not continue.

4.23 Purse-seiners are not the only type of diversified fish that is available in our coasts. It is reported that introduction of small long liners as well as mechanised versions of pole and line fishing boats in Lakshadweep has been successful. On the other hand, such facilities provided in Andaman Islands have not been taken up, by the people. Now that a reasonable amount of survey of fishery resources mainly pelagic has been done in both the coasts, areas where long lines and pole and line fishing by improved means can be introduced should be demarcated. Mechanised boats congregated too thickly at particular centres may be pursuaded to diversify to those new opportunities. It is a pity that fishing vessels from places like South Korea and Thailand are using these diversified; fishing methods to take out some of the most fashionable fish from round our economic zone whereas we are not making any use of the technology or the potential.

4.24 Mechanised boats require jettis for landing. A programme for construction of fishing jettis round the coast was taken up by the Ministry of Agriculture. Now that a reasonable estimate of available pelagic and also demersal fishery all along the coast is available, such locations where jettis can be constructed and where the available potential is not being exploited close to the coast by traditional fishermen and in the distances by mechanised boats can be identified and jettis constructed. This will help in diversifying mechanised boats from highly fished areas to the new areas. This planned deployment should be attempted.

4.25 The capital cost of mechanised boats and the cost of energy, particularly the latter, has been going up year after year. The Department of Heavy Industries has announced a policy providing 33 per cent of indigenously constructed fishing berths. The question of subsiding the price of diesel for mechanised boats or reducing the excise is a problem continuously under examination. Some concrete steps in this direction would greatly improve the economics of mechanised boat fishing. At the same time, the owners of mechanised boats themselves can take many steps which will improve their economy. Some of them that can be identified are:—

(a) In the Gujarat coast, particularly round Veraval and Dwaraka, large timber constructions of mechanised boats for length upto 52 ft. has been followed. The initial capital cost of a timber boat is about a 5th to 6th of that of a steel mechanised boat of that size. As a 52' boat is probably the longest that the mechanised boats can use, it is obvious that all concerned should give attention to following the cheaper capita! path

and the Central Institute for Gear and Boat Development should specially attend to the problem of making timber boats more satisfactorily. Timber boats from Thailand were found to be very effective in our waters. Designing of timber boats to suit out needs would be useful.

(b) By reducing the speed of mechanised boats by one knot by fixing of governors, it is reported that there can be a reduction of 30-40 per cent of fuel consumption. Speed restriction to save energy and, at the same time, not effect profitability has to be the order of the day. Sooner this approach can be propagated and got accepted by the mechanised boat owners, the better.

(c) Fixing knot nozzles, particularly on trawling boats, increased power output by 35 per cent. Thus boats with smaller horse power can be effectively use in trawling. This is also a capital reduction technology.

(d) Slot Blade propellers increase power output by 35 per cent. This technology should be demonstrated by the experts and the cost benefit should also be properly worked out and indicated to the mechanised boat owners.

(e) If small boats can be helped, to stay at a time 4-5 days away from port, the overall cost of propulsion per unit of catch goes down and boats will be able to follow thick shoals effectively. It is reported that proper designing ol living accommodation facilities like folding berths, kitchenette, toilet etc., can be done in small boats to allow the crew to remain outside for 4-5 days. In addition, there has to be provision for effective cold storage of the catches for a period of time so that at landing they can remain fresh. Some pilot designs and effective demonstrations are needed.

(f) Mechanised boats that use passive gears like gillnets, hand lining, trap fishing, pole and line fishing do not require high power that trawlers require for dragging their nets along the bottom. Cost of propulsion will thereby go down very substantially. Before the traditional fishermen who at present look to only prawns as a money spinner can take to these new types of fishing, sufficient demonstration of the profitability andthe cost benefit will have to be done by the extension organisations:. The Committee would recommend that the State Fisheries Corporation should introduce these pilot schemes utilising fishermen in the coast who will learn the art and establish the economics of these low power mechanised boats for specially diversified gear.

(g) Small mechanised boats using Fireglass Reinforced Plastics which brings down the load to be pulled, may be effective. Pilot studies have yet to be done on the economics of these crafts. It has been suggested that such light craft can be fitted with sails and auxiliary engines so that wind power can be utilised effectively thereby saving fuel costs. Research and extension of this technology should be now done.

Prawn Conservancy

4.26 There is over-exploitation of juveniles of prawns in certain back-waters of the country. There are indications to show that indiscriminate netting of juveniles by using small mesh nets by the traditional fishermen and non-observance of the need for limiting trawl catches of mechanised boats to prawns above a certain size so as to allow

for the breeding cycle, the overall catch in the areas of influence of these back-waters is definitely owing down. In the interest of both the traditional fishermen and the mechanised boats, regulations to conserve the juveniles and allow for the breeding cycle to go through without serious interference is an immediate necessity. It is unfortunate that whereas the Central Model Bill has suggested conservation measures like mesh restrictions, closed season, santuaries, annual quota etc., the States have not yet paid sufficient attention to the need for conservancy. In the interest of fishermen class in the coastal areas, there is an immediate need to see that the suggested - restrictions are brought in and the conservancy rules are enforced by punitive action on both traditional fishermen and mechanised boats.

Conservancy of Pelagics

4.27 Yet another study by CMFRI has brought to light the extensive damage to oil sardine spawners due to fishing by purse-seiners. Purse Seiners have caught occasionally heavy catches of eat fish as high as 200 tonnes a day by a Polish vessel 'Languista' but it was only recently that the fact has been brought to the notice that much of the catch fish caught are the incubating males. Hence operation, of high efficiency gear has to be regulated in terms of number, area of operation, period of operation, mesh size etc., as unbridled introduction modern craft and gear can have a devasting influence on the fishery. In Norway, whose fish production went up from one million in 1940 to a peak production of 3.2 million tonnes in 1977, showed distinct signs of decline with the 1980 production estimated to be in the region of 2.2 million tonnes, leading to a surplus capacity of 20-25 per cent, condemnation orders and sales grants have been introduced in order to reduce fleet strength and to rid the fleet of obsolete vessels in a bid to reduce the efforts.

4.28 The need for controlling purse-seiners operated by mechanised boats io a distance from the shore so as to prevent their intervention in the fish flow in season hugging the coast has already been mentioned. This control should also be exercised suitably.

Deep Sea Fishing

4.29 While extensive areas are available for deep sea fishing, Government's approach is still restrictive. On the one hand, preference is given to State Corporations, cooperative and small and medium entrepreneurs, their response has not at all been encouraging. On the other hand, big houses having the necessary capital, managerial experience and ability to absorb initial losses are not only being encouraged, but a restrictive approach is adopted. They are also not eligible for soft financing. If the programme of deep sea fishing is to succeed, all such restrictions should be removed and necessary incentives, tax concessions etc., should be given so as to make our 'presence' felt in the 200 miles EEZ lest our policies become an open, invitations for poaching by foreign fishing vessels.

4.30 Deep sea fishing will not greatly add to direct employment opportunities for the fishermen class in the coastal areas. At the same time, without deep sea fishing the country'' will not be able to exploit the vast potential within the economic zone which at present is being poached upon by fishing crafts of various countries. Besides, as the

catches from the deep seas increased, the employment in the secondary or tertiary sectors will grow up very substantially and lot of this expansion of employment opportunities will go to the fishermen class and the other poorer classes of labour in the coastal areas. The Committee has not been able to examine the problems of deep sea fishing in any great depth and, therefore, can only say that in the interest of all concerned, it is desirable to increase the fishing vessels force for deep sea fishing and also attend to the infrastructure .to make the fishing economical.

Marketing

4.31 The present catches from the sea are, no doubt, only a fraction of the potential available Yet, in certain seasons even these catches have led to serious fall in prices thereby leaving fishermen as poor as before. It was long ago realised that effective marketing of fish is the only answer.

4.32. Because sea fish is marketed either as fresh fish or dried fish, the market for sea fish has been divided sharply into the coastal areas where fresh fish sold and the interior where only dried fish is available. As a result, the fresh fish market is limited by the clientele along the coast. Any large increase in catches in any particular season only leads to waste. The extra catches are either sold at rock bottom prices or made into fish meal. The other alternative is to dry the fish and send them to the interior markets. Drying again cannot be done in all seasons. With these limitations, if catches have to be marketed economically, improved the interior markets for fresh fish is the only answer.

4.33 Karnataka started with great foresight a link up between the catches in Mangalore Port with an interior market in Bangalore. In order to reduce transport costs and also improving acceptability of various miscellaneous varieties of fish, the catches were filleted or made into paste, deep frozen and sent to the Bangalore market for sale through a refrigerated chain. This is one method of increasing fresh fish consumption. The Committee would seriously recommend that the Ministry of Agriculture must take up a comprehensive marketing programme by supporting pilot projects of such innovating marketing as in Karnataka, in all the coastal States of the country. Linkages will have to be established between the coastal States an interior States who can be the consumers.

4.34 Another effective marketing strategy that has been established for sea fish is that followed by the Gujarat coastal fishing community. Transport operators have developed, who carry sea fish from Veraval to Calcutta and Siliguri by lorry in insulated containers with ice. Four year's ago, the transport charge per kilogram was only 28 paise, from Veraval to Calcutta and 33 paise from Veraval to Siliguri per kilogram. The Committee would recommend that the Ministry of Agriculture should carry out a survey all along the coast finding out the seasons when there are large catches in particular pockets of the cost leading to a sharp fall in prices and, at the same time, identify markets in the country where such fish can be sold at economic prices allowing for the transport charges. Calcutta is an exceedingly good market for mackerel. Kerala does not find a market because of plentitude. These are indicators. Further, many markets supposed to be consuming only fresh carp like Calcutta and the markets of North India and Punjab markets which were supposed to be non-fish users like Delhi and Punjab are now consuming sea fish in. quite large quantities. A Central marketing survey and a plan of

action based on that is indicated.

ANNEXURE 4.1

Census on Marine Fisherman Population, Crafts, Gears etc. in India—(1973 —77)

S. No.	Items	West* Bengal & Orissa	Andhra Pradesh	Tamil Nadu	Pondicherry	Kerala	Karnataka	Goa	Maharashtra	Gujarat	Total
1	2	3	4	5	6	7	8	9	10	11	12
1	Coastal length (in km)	1080	970	960		600	270	119	600	1500	6090
2	No. of fishing villages	179	408	374	21	268	145	40	299	179	1913
3	No. of landing centres	51	280	371	24	223	93	40	173	108	1365
4	Marine fishermen population										
	Male	17769	75358	93718	4676	125217	30064	6191	47803	29788	430784
	Female	17284	72235	91173	4781	124864	30403	5088	50046	31060	426933
	Children	26029	89677	10369S	6957	141819	38365	3586	103574	63738	577441
	Total	63082	237470	288586	16414	391900	98832	14865	201423	124586	1435158
	Active	10576	64592	68317	3785	80898	31740	4067	41539	22518	322532
	% of active to toal population	24.7	27.2	23.7	23.1	20.6	22.0	27.4	20.6	18.1	22.5
5	Fishing Crafts										
	Mechanised	58	418	1533	47	1026	1044	192	2034	1734	8886
	Non -mechanised	6667	25976	30501	1767	21718	6248	1118	8288	4197	106480
	Total	6725	26394	32034	1814	22744	72S2	1310	10322	5931	114566
6	Fishing Gears										
	Sampani		—	—	—	—	164	112	—	—	276
	Shore ceiue	375	1471	1920	34	1739	493	53	16300	_	22385
	Nylon gill net .	1427	16676	3232	—	3044	4478	—	136596	10491	175944
	Bottom set gill net	—	1481	5955	—	246	844	_	—	—	8526
	Gill net	5048	18541	111023	1301	7763	9219	1345	8410	118172	280822
	Draft net	323	1889	7966	359	6763	1945	—	—	5329	24574
	Drag net	2466	5729	3678	298	—	936	58	12635	1341	27141
	Parse Seine	_	—	—	—	—	—	—	—	—	—
	Bag net	1034	159	1855	458	534	13	—	20503	17031	41587
	Purse Seine	-	—	—	—	—	124	22	—	—	—
	Travel net	_	—	—	13	269	246	144	1966	167	2805
	Boat aeine	1561	6480	4875	—	9027	—	—	—	—	21943
	Encircaling net	—	—	_	—	*279	—	—	—	—	279
	Hooks & lines	48	2587	6107	43	2887	966	177	—	1598	14143
	Others	24478	11267	12644	271	845	5908	652	52693	5655	118413
	Total fishing gears	40760	66280	159255	2777	33396	25066	2563	24913	159784	738984

* Census covers only Central coast of Midnapar district.
** Excluding Kutch region.

5. CROP PLANNING AND ALLIED PROGRAMMES

Crop Planning

5.1 Soil and water salinity and the lack of irrigation are the principal constraints affecting crop planning in saline coastal areas. In the East Coast, mono-cropping of inundated low land with long duration paddy which stands water logging as well as salinity to a certain extent has been the practice in these areas. The inherent productivity of the soil is very high. In years of well-distributed rainfall and absence of natural calamities like cyclones, in many such areas, the salinity of the soil is leached away and a bumper harvest of paddy becomes possible.

5.2 Some information with regard to the present state of crop production is available for the Sunderbans. The economy of this region Is almost entirely dependent upon agriculture which provides employment to 88.5 per cent of the population. The cultivated area in the region is over 2.95 lakh hectares of which 96 per rent of the area being cultivated only once in the Kharif Season (Aman paddy). The yield of aman paddy is about 1.75 tonnes per hectare which is rather low. Experiments powers, have shown that with improved varieties and better drainage it is possible to get a yield upto about 2.50 tonnes per hectare. Yield of Rabi Crops are generally higher. Yields in respect of newly introduced varieties in Rabi are:

Crop	Yield Level (T/Ha.)
Boro paddy	4.63
Chillies	4.00
Sunflower	0.80
Wheat	1.80
Mung	0.90
Water melon	20.00

5.3 The introduction of a second crop using sweet water drawn from river lifts and ponds has been attempted in some of these areas. In the Sunderbans, a campaign for the introduction of a second crop has been carried out through 27 growth centres. At. the start of the programme, 100 per cent subsidy was given to the selected marginal and small farmers on the basis of a planned cropping pattern but at present only a 50 per cent subsidy is given. Further, the farmers even without subsidy, they continue to grow the next year. It has, however, been observed that, even without subsidy, they continue to grow the crops in subsequent years out of their own resources. The number of participants farmers has gone up from about 3500 in 1976-77 to nearly 43,000 in 1979-80. The area covered has gone up from 1900 acres to 22,000 acres. Economics of certain important rabi crops is given in Annexure 5.1.

5.4 A second crop of paddy or groundnut, gram, sugarcane, sugarbeets and dhaincha are grown in areas of Andhra Pradesh, Gujarat and Tamil Nadu where irrigation water is available. Successful attempts have also been made in Orissa to grow a second crop of early high yielding paddy during Rabi, by lifting sweet water from the

rivers in these areas. Crops like pulses which are grown on residual moisture are generally possible in years of saline intrusion. Under the conditions of limited or no irrigation, the second crop is water melon, chillies, vegetables and barely in some pockets in West Bengal, fodder crops like Pilli Pesarahemp and pulses like black gram, green gram and cereals like jowar, bajra etc. in Krishna District of Andhra Pradesh and vegetables in Maharashtra and Goa are also grown.

5.5 Since there is little scope for bringing more area under cultivation, the only way of increasing crop production in coastal saline areas is to improve the yield by checking the salinity and its adverse effect on productivity through various measures. The age old method of controlling the salinity has been the construction of embankments and ringh bunds as a protective measure to stop ingress of sea water to these lands. Locally, sometimes farmers use mango leaves, tamarind waste and other organic refuse to neutralise the salinity of soil. In some areas, flushing of saline areas with sweet water followed by fresh water irrigation to leach the salts down the soil profile is a practical method adopted by the farmers. This aspect of salinity control is dealt with separately in the Chapter on Irrigation, Drainage and Salinity Control.

5.6 There are some crops which have got higher degree of salt tolerance than others. In the same crop some varieties are suspectible to low level of salinity at germination and seedling stage but can tolerate fairly high degrees of salinity at later stages of growth. A list of field crops, fruit, trees, etc. having different degrees of tolerance to salinity is indicated in Annexure 5.2. As the intensity of salinity normally fluctuates over the year and in different areas have different intensities of salinity and land characteristics, suitable cropping patterns would have to vary from region to region.

5.7 It is clear from the above that if efforts are made to evolve and introduce a scientific crop planning in the coastal saline areas, it should be possible to increase crop productivity substantially. For this purpose, it is necessary to make more intensive efforts for evolving suitable crop patterns for different salinity conditions and soil characteristics. The long duration nature of kharif crop is recognised as a constraint for increasing the land use intensity in such areas. Therefore, measures have to be considered how far long duration kharif paddy can be replaced by short duration paddy and suitable rabi crop, viz., barely, sugarbeet, sunflower, cotton, etc., which can be grown after harvesting of the kharif crop.

5.8 The yield of traditional paddy varieties grown during kharif in these areas is rather low at present, but can be stepped up considerably by developing improved strains of paddy which are more resistant to salinity, tall in stature, have short duration maturity periods and need minimum irrigation.

5.9 Cropping intensity in coastal saline areas provides tremendous scope for improvement. This can mainly be done by providing irrigation facilities and also introducing dry farming techniques in these areas. All the sweet water reserves, surface as well as underground, need to be exploited and put to more judicious use for improving productivity. As much of fresh water as possible needs to be conserved for raising rabi and summer crops. As irrigation water is likely to be scarce, advantage of the moisture present in the soil at the time of kharif harvest would have to be taken for raising early short duration rabi crops.

5.10 The Central soil and Salinity Research Institute at its Canning Research Station has been doing good work to improve the rice varieties suitable for kharif cropping and to identify suitable crops and development of their varieties for rabi cultivation. It is also attempting to develop cultural and agronomic practices for these crops to optimise their production.

5.11 It has already succeeded in identifying a few geno-types which are very much salt tolerant and could be used asrparent in recombination breeding programme by screening a large number of rice germplasm collected locally and from different saline areas of India and abroad. AH the varieties identified are tall indica and photo sensitive. Some of the varieties identified by them have proved to be very successful both at, vegetative and ripening stages. The Tamil Nadu Agricultural Department as well as the International Rice Testing Programme have also confirmed the observations noted at the Canning Research Station. The induced mutation breeding for salt tolerance and high yields have led to the evolution of two rice mutants of cultivar IR 8 which mature about 20 — 25 days earlier than the parent and are dwarf, high yielding and salt tolerant. These two mutants have been tried at Canning (West Bengal), Karnal in Haryana, Kapurthala in Punjab, Mandya and Gangawati in Karnataka. The All India Coordinated Rice Improvement Project included these two varieties for preliminary varietal trials conducted in 12 locations spread all over India. These mutants have been named at CSR-4 and MUT-2. The CSR-4 variety is reported to have yielded an average production of 3.8 tonnes per hectare and the time taken for maturity is generally at an average of 120 days. Further effort is going on. It is essential that this work should be pushed through and the varieties should now be tried at the cultivators fields before introducing these two varieties. Details of the research being carried out are available in some of the technical bulletins brought out by the Central Soil Salinity Research Institute, Karnal (Bulletin No. 5 of 1979).

5.12 Due to high rainfall, most of it occurring during the monsoon season, cultivation in the lowlying area becomes a major problem particularly in the East Coast. To increase the yield in such conditions, the CSSRI Station has started screening of varieties suited to the water logged conditions. The focus need to be on having period bound varieties and lesser duration. The yield performance of some of the varieties is as under:

Varieties	Yield (T/Ha.)
BKN-6986 (NS)	3.81
Pankaj	3.76
NC-1281	3.58
Mahsuri	3.58
SR-26B	2.71
Malabati (Local)	1.99
Kalamota (Local)	1.22
Kalamota (Sel)	2.44

Recently this work has been further intensified in collaboration with the Central Rice Research Institute, Cuttack. In this programme, Rained Low and Rice Observational Nursery consisting of genetically diverse rice varieties from different parts of the world has been screened. Out of 259 collections tried in the monsoon season of 1979, six varieties have been found to be highly acceptable and 20 others are promising. Further evaluation is being carried on. The Committee would recommend that this should be pursued vigorously.

5.13 As due to high saline soil and poor water quality, no crop other than kharif rice is generally possible under commercial cultivation, it is essential to introduce a suitable second crop (rabi) which can tolerate salinity effectively and can grow better than others in moistrue stress conditions. A large number of genotypes of different crops have been tested for suitability and feasibilty. Among the various cereal crops, barely has been found more promising than wheat and oats in the saline and short winter conditions. Some of the barely varieties have given as high a yield as 3.68 tones per hectare. Similarly, among the oil-seed crops, linseed has been observed to be comparatively less prone to the problem of heavy mortality at the germination stage which seems to be the foremost problem in regard to oilseed crops. It has now been established that the linseed varieties identified by the CSSRI can yield 3 to 4 quintals per hectare under local conditions.

5.14 Chilli is another crop which has been observed to be salt tolerant and performs well with minimum amount of irrigation water. Cotton has also been attempted but the cotton crop has some limitation, namely, it has very long duration bringing the latter pluckings into the active monsoon resulting in loss of yield and its high sensitiveness to insect pests resulted in high expenditure in crop protection. Owing to such difficulties, this crop cannot be extended to the farmers fields on a large scale. Attempt should, therefore, be made to develop a variety of an early duration and highly resistant to pests and diseases to cope with the problem of these areas.

515. Another promising crop is sugarbeet. Sugarbeet is known to be salt tolerant crop and produces very high yield. Its utility in these areas, however, lies in the fact that it can provide an important cattle feed which can support animal husbandry programmes in the area. The Committee would recommend that such like fodder varieties of sugar beet and other crops should be encouraged in these areas.

5.16 The Committee, during its visit to Sri Ramakrishna Ashram in Nimpith area of Sundarbans, observed that a number of vegetables have been successfully grown in the saline soils. The vegetables noted were different varieties of cabbage, cauliflower, brinjal, chilli, knolkhol, beet, carrot turnip, tomoto spinach, pea, onion etc. A similar phenomena has been observed in coastal saline areas of Orissa wherein possibilities of growing different field crops, forage crops, fruits, vegetables, plantation crops and grasses etc. have been successfully explored (Annexure 5.2 gives details).

5.17 Possibilities of introducing inter-cropping should be fully explored. For instance, possibility of prawn culture along with coconut development has been proved. Similar experimentation are desired for making optimum use of natural resources.

5.18 Research alone is not adequate. Propagation of any crop for cultivation in such

areas would require demonstrations in the field conditions. Trial-cum-demonstration farms need to be established in affected areas which should operate under the guidance of technical hands. The introduction of new rabi crops e.g. vegetable will require the establishment of new marketing, input supply and credit arrangements. Hence measures to introduce new rabi crops in the area must be accompanied by steps to establish an appropriate credit, input supply and marketing infrastructure in these crops. Sunderbans has established that, given the necessary support, vegetables can be an important crop in some of these areas.

5.19 Canning experimentation is on heavy black soil. In other areas the situation is different. As such location specific research would be desirable which should be followed by adaptive research on the farmers' fields as quickly as possible.

Horticulture

5.20 Horticulture development is very important to improve the agricultural economy of these areas. The coastal States have a tropical to subtropical agroclimate which afford conditions suitable to a number of tropical and sub-tropical fruits and plants. The majority of the residents of coastal areas are agriculturists and some of them have acquired proficiency in cultivation of fruits. Horticulture is not only labour intensive, but is important to maintain the ecological balance, and over and above all supplies, healthy, adequate and balanced nutrition which is badly required in these areas.

5.21 There is plenty of scope to develop horticulture in coastal saline areas by introducing technology capable of giving good monetary returns to the growers. The obvious strategy would; therefore, be to select and propagate right type of fruit crops suited to local topographic and salinity conditions. Further, improved varieties of fruits with a view to raising their yields and resistively to salinity and water logging conditions which are common in these areas, would have to be evolved through field research conducted at different centres set up for the purpose.

5.22 The most successful horticulture plant is coconut which has immense potential for plantation in coastal areas. A scheme for the extension of coconut cultivation by landless agricultural labour was taken up in the Sunderbans. So far about 49,000 seedlings have been distributed by the Sunderbans Development Board to landless families. However, the programme has been constrained by the lack of planting material.

5.23 Coconut plantations with suitable intercropping can be an important employment and income generation measure in these areas. The gross return per tree is quite profitable. Moreover there could be substantial opportunities for non-agricultural employment in processing units, e.g. coir. The only requirement will be drainage since most of these areas are low lying and prone to flooding. Kerala has solved this problem by planting coconuts on raised mounds. There is great scope for development of coconut around households and on the embankments of tanks, drains.

5.24 Cashew can be cultivated quite successfully in sand dunes which at present are unutilised and often encroach on adjoining farm lands year after year. Cashew trees once established stablise the soil. An integrated pattern of coastal horticulture involving

cocount, cashew and ©asuarine holds great promise.

5.25 Amongst fruit trees Sapota and Guava have potential for development in all areas. In the case of citrus also, the experience of countries like Israel, indicates a promising opportunity. In many areas having temporary water stagnation, Jamun could be planted. If salinity is brought down through reclamation measures, many other fruit crops can also be grown. In this context the orchard development in Udyan area of Sundarbans is worth mentioning.

5.26 In Sunderbans, promotion of backyard orchards mainly for landless agricultural labourers and extension of coconut is becoming popular. At the out set two perennial trees viz., Lemon and Papya which are ecologically suitable for the region are being introduced. However, horticultural development on a large scale is not possible at present, as the higher lands care scarce which are found around homestead on the banks of tanks, embankments etc. With the improvement of drainage situation, digging of more channels, setting up sluices and construction of irrigation tanks etc., some more areas would be available for horticulture. There is great scope for development of coconut in the regions around the homestead and embankment of tanks, rivers and rivulets.

3 5.27 The above potentialities indicate the need for intensive horticultural development in coastal areas affected by salinity. Area-wise approach has to be made for selecting suitable fruit crops for different ecological conditions and research support would be necessary to develop special species of different fruits so that good crop yields are achieved and horticulture becomes more remunerative to the people.

The essential requirements for these purposes are (a) the availability of suitable planting material, (b) enough sweet water to sustain the plant in the early stages of growth, (c) arrangements for credit during the long gestation period; and (d) arrangements for marketing.

Forestry

5.28 Development of forestry also has significant protective as well as productive functions and is essential for raising the income of people living around. It not only supplies timber, fuel, fodder and variety of other products but also has a moderating influence against floods and erosion and help to maintain soil fertility. Specially in coastal areas, raising of plantations and farm forestry would provide shelter from the havocs of cyclonic storms and also make available fuel and timber which are scarce in these areas.

5.29 Multipurpose afforestation of coastal areas is the need of the hour. In many areas, it would provide shelter from the cyclonic and disastrous storms which cause heavy loss of life and property and human sufferings from time to time. Such afforestation also protects the high and wide sand dunes along the coast and check their further encroachment on the adjoining farm lands. Taking advantage of the shelter belt plantation, the sandy coastal tracts can be successfully planed with coconut, sapota, guava, etc. with appropriate inter-crops including pine apple.

5.30 On the eastern coast, shelter belt plantation requires to be taken up along the entire coast. In this strip, as the Government land and private lands are intersepread, shelter belt will not be complete and effective unless the local farmers are motivated to take up such plantation. This could be achieved only if the participating farmers are ensured of economic returns from such plantations and also their requirements of fuel and timber are met from such farm forestry.

5.31 As cyclone protection work, such shelter belts are being raised in some areas of Orissa for which a special programme has been formulated. Under this programme, a one kilometre width belt along the entire sea coast is proposed to be planted with different plant species, suited to these major1 situations in areas where:

(i) continuous high sand bars and mounds exist ;

(ii) sand bars are short and discontinuous and small shifting sand dunes exist; and

(iii) flat low silty lands reclaimed from the sea occasionally inundated tidal-bores.

Plantation under the three above situations require different plant species and treatments to provide shelter belt as well as the scope for some economic exploitation. Lot of work was done in the states through a centrally sponsored schemes which was later transferred to the states. The Committee, however, understands from the Ministry of Agriculture that states can carry out the programme of shelter belt plantation under the on-going Rural Forestry scheme.

5.32 In Sundarban, Mangroves cover all the reserved forest area of which 55 per cent k under natural vegetation and 41.3 per cent is covered under water. The balance is comprised of sandy, barren, char areas. Wax, honey, golpata, betal leaves, dhani grass timber and firewood are the products of this area.

5.33 In West Bengal, Krishnachura, Jhau, eucalyptus and assashmani trees do well in comparatively higher situation. Cashew nut is also successful in light soils. In the fore shore area outside the embankment, natural regeneration of mangrove species is possible. It is learnt that artificial regeneration has not been attempted so far. Work in this regard is necessary to gain experience and to develop the method of regeneration. Some such regeneration of the mangrove species has already been done in Bangladesh. The conditions there are a little different as they have comparatively less saline areas in that country. Therefore, original work would have to be done on the subject within the parameters of local conditions.

5.34 The saline lands adjoining the sea in Karnataka are without any tree growth excepting mangrove species. The area adjoining the saline lands are steep and undulating inter-spersed with a number of rivers and streams and agricultural fields. The hills are mostly blank and devoid of any tree growth due to excessive fellings over the years. Among the important wood based industries set up in coastal areas are a number of saw mills, cane furniture units, plywood companies, packing case units, boat building units etc.

5.35 There is therefore very good scope for forestry development on west coast also. Salinity resistant trees for meeting the local requirement of fuel and wood may be raised all along the coast which would also check the menance of felling of trees in the adjoining forest areas. Mango and other trees specially which may be used in boat building and packing case industries already existing in these regions would be an economic proposition. Raising of suitable varieties of fodder trees would also help in the development of animal husbandry in this region. Tree growth in areas adjoining saline areas can help improve the economies of the people in the saline areas as well.

Animal Husbandry

5.36 Animal husbandry in coastal areas affected by salinity has been in neglect since long and is now in a very bad shape. Not only the density of live-stock population is considerably low in these areas, but the general health of animals is also quite poor. Farm animals are very weak in physique and thus unable to perform field jobs efficiently. Livestock products in terms of milk, meat, eggs etc., of these areas are much below the required level. Animal husbandry development can, therefore, provide an important subsidiary occupation to the residents of coastal saline areas.

5.37 The immediate critical constraints on animal husbandry development in these areas are the problems for supply of drinking water to the animals and non-availability of leguminous fodder. At these areas are naturally swampy, infestation is rampant. Means of communication being inadequate, veterinary services including artificial insemination facilities are not being provided to the desired extent and as a result thereof, animal mortality in these regions is considerably high. The fodder grown is usually of poor quality and other nutritious feeds are non-existent.

5.38 In spite of many constraints, private poultry farming is fairly popular in some regions. But, ordinarily the birds reared by them are of local variety which are low egg producing breeds. Duck keeping is also practiced in some pockets. These are maintained traditionally in small groups and seem to thrive well in the rivers and creeks of saline areas. Unfortunately, the ducks maintained by the villagers are non-descript variety. They are poor egg-layers, laying just a little over 100 eggs per bird per year.

5.39. Rearing of sheeps and goats in small herds by nomadic shepherds is also being practised in some coastal sandy belts. The main forage is the vegetation obtained from the sea shrubs (Auicennia sapp). The leaves are collected and fed to sheeps. The history of sheep rearing in coastal areas of Andhra Pradesh can be a pace setter for other areas. The usual objection to goat husbandry, based on the fear that goats can damage trees and orchards may not be applicable in coastal areas.

5.40 For any meaningful enhancement of livestock production work in the coastal saline areas, the main problems, are provision of drinking water, feed and fodder, marketing facilities and logistics. In addition, there is at present dearth of infrastructure for supply of foundation and production stock of cattle, pigs and poultry including ducks.

5.41 As a basic approach, a balance between cows and buffaloes and other animals on the basis of ecological conditions in different regions has to be struck and seasonal adjustment made. The veterinary system including basic structure of services there

under which is reported stationary in these areas, has to be achieved and made mobile. For improving different breeds of animals, artificial insemination programme would have to be extended to these areas in a phased manner. Breed improvement programme should have the dual purpose of increasing of livestock products as well as the drought quality of farm animals. Veterinary dispensaries and livestock Aid Centres need to be set up at convergent places to cover such areas. Mobile veterinary dispensaries may have to be organised for meeting the requirements of difficult areas.

5.42 Supply of drinking water for animals may be made from tanks and ponds which have embankment protection from ingress of saline water. Small tanks protected by ring bunds can also store fresh rain water for use of animals. In some regions, drinking water supply to the animals may be made by sinking of shallow/deep tubewells depending upon the ground water acquifers of the areas.

5.43 As the biggest single constraint in the livestock farming relates to the proper nutrition of the animals, improved fodder cultivation is of urgent necessity. Suitable varieties of fodder, fodder trees and shrubs should be propagated in these areas. Alfalfa (Lucerne), Singali bani (Auicennia allea), Bada bani (Auiconnia afficialines), Rhodes grass, seal babul, para grass, Dhanicha and Auecennia supp. are some of the varieties that can be grown in saline areas. It would be advisable to establish experimental fodder grams for trial of various types of salinity resistance fodder plants. Fodder seeds and cuttings to successful varieties should be distributed to the farmers under a fodder development programme. Arrangements fir supply of feeds in promising areas may also be taken up by these farms.

5.44 Duck farming should be encouraged in coastal saline areas on an intensive scale provided it does not, in any way hamper with the progress of brackish water fishery development in these areas. Better quality of ducks are good egg-layers under modern methods of management, although they require less attention comparatively. Khaki cambell ducks is one of the breeds that can be reared in rural areas of saline tracts. Another Chinese breed which has been successfully raised in Haryana may also be tried in some areas. Duckeries may be set up in selected areas for rearing good breeds of ducks suited to the local ecological conditions, which may also supply quality drakes for distribution amongst the villagers for upgrading indigenous stock.

5.45 Poultry development also needs to be intensified for supplementing the incomes of the people in these areas. Chicks of high yielding variety should be distributed by the organised poultry farms set up for the purpose. Economical poultry rearing in Kerala is done due to the large availability of cheap protein from fish waste and other sea products. This must be studied so that a similar system can be developed elsewhere. As the proper marketing facilities do not exist in these areas. Such poultry farms may also operate as centres for collection of eggs and poultry meat and also for distributing poultry feeds at fair prices in lieu of the products received from the people.

Annexure 5.1

Economics of Selected rabi crops

S. No.	Name of the Crop	Input cost Rs.		Value of output	Irrigation per acre	Duration
1	2	3		4	5	6
1	Wheat	(a) Seeds	150.00	1120.00	3	30 to 120 days
		(b) Fertilisers	200.00			
		(c) Pesticides	40.00			
		*(d) Labour cost	350.00			
		Total	740.00			
2	Chillies	(a) Seeds	15.00	1800.00	3	180 days
		(b) Fertilisers	300.00			
		(c) Pesticides	50.00			
		(d) Labour cost	504.00			
		Total	870.00			
3	Mung	(a) Seeds	64.00	1200.00	3	90 to 100 days
		(b) Fertilisers	124.00			
		(c) Pesticides	100.00			
		(d) Labour cost	250.00			
		Total	538.00			
4	Sunflower	(a) Seeds	30.00	900.00	3	90 to 100 days
		(6) Fertiliser	150.00			
		(c) Petsticides	52.00			
		(d) Labour cost	180.00			
		Total	412.00			
5	Water melon	(a) Seeds	45.00	3750.00	4	100 to 120 days
		(b) Fertilisers	500.00			
		(c) Pesticides	150.00			
		(d) Labour cost	750.00			
		Total	1445.00			

*In reality labour cost may be excluded from Input cost.

Annexure 5.2

Relative Tolerance of Crops to Salt

High Salt Tolerance	Medium Salt Tolerance	Low Salt Tolerance
	FIELD CROPS	
Barley (grain)	Wheat (Grain)	Bean (field)
Cotton	Rice	
Sugercane	Sorghum (grain) Maize	Mung Arhar
	Sunflower	Linseed
	Castor bean	Sesamum
Methi (Fenungreek)	Jowar Bajra Mustard	
FORAGE CROPS		
	Alfalfa (Lucerne)	
	FRUITS	
Date Palm	Pomegranate Grape	Orange Lemon
	VEGETABLES	
Beet, garden	Tomato	Radish
Spinach	Cabbage Cauliflower	Green beans
	Lettuce	
	Sweet Cor	
	Carrot	
	Onion	
	Peas	
	Cucumber	
	Plantation Crops	
Presopis Julifera		
Accacia arabioa (Babul)		
Aidirachafca indica (neam)		
Casurina equisetifolia (Jhaun)		
	Grasses and Others	
Sporobulus	Para Grass	Blue panic grass
Chloris-gavana	Brachiaria mutica	(Panicum antidotale)
		Cenchrus cilliaris
Cynodon dactylon		Cenchrus setigeruse
Sesbania aculeata		Dichanthium
(Dhanicha)		Annnlatum

The above table of plantation and grasses and other crops are listed in the order of their tolerance to salinity.

6. IRRIGATION, DRAINAGE AND SALINITY CONTROL

Of about 7.0 million hectares of salt affected soils in the country, about 2.1 million hectares comprise saline soils in the coastal tracts of West Bengal, Orissa, Andhra Pradesh, Pondicherry, Tamil Nadu, Kerala, Karnataka, Maha-rashtra, Gujarat and Goa. The figures as compiled by the Central Soil Salinity Research Institute. Karnal are given in the table below:

Extent of coastal saline soils in India

(Million hectares)

West Bengal	*2.800*
Orissa	*0.400*
Andhra Pradesh	*0.040*
Tamil Nadu	*0.004*
Kerala	*0.016*
Maharashtra	*0.040*
Gujarat	*0.714*
Karnataka and Goa	*0.036*
Total	***2.10***

6.2 These soils occur in the river deltas in a narrow strip of land ranging from a few kilometers of about 50 kms. close to the sea coast, along the low lying lands, estuaries and in the .inland depressions all along the sea coast of India. The salinity of the soil is attributed to the inundation of the land with sea water during the high tides and ingress of sea water along the estuaries, creeks, drain sand rivers. The frequent inundation with saline water renders the soil saline. Moreover, underground water-table is present at a shallow depth enriched with high salt content. Salts accumulate on the surface of the soil due to the capillary rise of saline ground water during the dry periods of the year.

6.3 Most of the area is low lying and is nearly level part of the deltas of the river system and is stretched between the Eastern Ghats and the Bay of Bengal on eastern coast and between the Western Ghats and the Arabian sea on western coast. Topographically, these areas are low lying and have elevations mostly less than 10 m above the mean sea level.

Maximum and minimum elevation above mean sea level of some of the coastal places

State	District	Elevation (m) above sea level	
		Maximum	Minimum
West Bengal	24 parganas	9	2
	Howrah	6	4

	Midnapur	132	3
Andhra Pradesh	East Godavari	6	SL
	West Godavari	3	SL
	Krishna	3	SL
	Guntur	18	SL
Tamil Nadu	Madras	SL	SL
	Chingleput	8	SL
	Tanjavur	5	SL
	Kamanathapuram	6	SL
Kerala	Allepeey	19	SL
	Ernakulam	10	SL
	Trichur	10	SL
Maharashtra	-	150	SL
	Surat	10	SL
	Valsad	50	SL

SL – Sea Level

6.4 The major rivers flowing through the coastal belts are Hooghly and other mouths of Ganges, Mahanadi, Godavari, Krishna and Cauvery on Eastern coast and Narmada and Tapti on western coast: the rivers of the coast flow from west to east having confluence with the Bay of Bengal and of the west coast from east to west having confluence with the Arabian sea.

6.5 The effect of the tides is manifested in a regular alternation in rise and fall of the water level of the sea and the estuarine channels and creeks. The tidal range (difference between the highest water level and the lowest water level) is known to vary from zero at Cape Comorin to about 6m at the Northeast points of Bay of Bengal and in the Arabian sea tidal flow repeatedly inundates the soils and impregnates them with soluble salts, thereby rendering (the soils of) the sub-soil water saline.

6.6 In general, the sub-soil water is encountered within 1 to 2 m below the ground level in the premonsoon season in all regions. It rises to the ground surface in the monsoon and gradually falls to about 1m to 2m in the dry season (Dhruvanarayana, 1977; Patel, 1979 ; Mondal and Verde, 1979; CSSRI, 1977). The effect of tidal movement in the acquifer was investigated at CSSRI Research Station Canning by means of piezometers inserted into the acquifer. It was observed that the tidal movement in the aquifer.

6.7 An analysis of the meteorological data regarding rainfall, wind velocity, relative humidity, minimum and maximum air temperatures in different months of the years in respect of West Bengal, Orissa, Andhra Pradesh, Tamil Nadu, Kerala, Maharashtra and Gujarat indicates that the maximum and minimum air temperature varies from 39.4 deg. C to 12.0 deg. C. The percentage relative humidity is very high throughout the year, varying from 65 to 96. There is a wide variation of rainfall from 920 mm to 3010mm in the entire coastal area. The coastal saline area of Gujarat, especially Saurashtra and Kutch, receives lowest rainfall and thus, in presence of high saline ground water, presents more serious problems of management. Excepting south coastal Andhra

Pradesh and coastal Tamil Nadu, the rest of the area receives the bulk of the rainfall from the Southwest monsoon from June to September. The south coastal Andhra Pradesh and coastal Tamil Nadu have an extended monsoon season upto December, with the advent of north-east monsoon from October. Table below gives the seasonal distribution of rainfall at some coastal saline locations.

Region	Rainfall to September		Rainfall October to December	
	mm	% of annual rainfall	mm	%of Annual rainfall
Sunderbans West Bengal	1325	75	177	10
Orissa	1140	76	180	12
Coastal A.P.	570	57	330	33
Tamil Nadu .	310	33	480	47
Kerala	2010	67	550	18
Coastal Karnatalsa	2850	87	260	8
Konkan	2700	94	130	5
Gujarat region	930	96	30	3
Saurashtra and Kutch	450	94	20	4

6.8 Cyclonic storms develop in the Bay of Bengal during October-November and strike the east coast causing heavy damage to life and property. In October, the storms largely originate between latidues 8 to 14 deg. N and move initially in NW direction, but a number of them finally recurve and move in NE direction. The average number of storms or depressions during October to December based on 80 years records is four; of these only two crossed the coast (NCA, 1975). These cyclonic storms when, they occur together with high tides may cause overtoppling of protective bunds, thereby causing damage to the standing crops and rendering soil saline.

6.9 The characteristics of salt-affected lands occuring in the coastal tracts show wide variation in different areas. The soil in general are of moderate to heavy texture and are saline in nature. Sodium chloride is the dominant salt excepting in Kerala, where sodium sulphate constitutes the major component. The soil is acidic to neutral in reaction. The salinity status of the soil also fluctuates with the seasonal variation.

6.10 Coastal erosion is an age old problem to common almost all countries, whose coasts are exposed to high seas and storms. It is a normal phenomena, occuring under the action of natural agencies such as waves, winds, tidal currents, littoral currents etc. which are at play year in and year out. It is only when utilisation of the coastal strips for commercial or other purposes involves stipulation of a static shore line that the problem of coastal stability comes to the forefront. The natural fluctuation of the beach, which was of little consequence earlier than becomes vitally important and calls for providing coastal protection measures suited to the site.

6.11 India is not exception to the problem of coastal erosion occuring since a long

period in the past. Typical evidences that could be cited in this connection are the data for the coast-line of Kerala and the coast at Digha in Midnapore district of West Bengal. Superposition of the coastline of Kerala in the reach Kayamkulam to Neendakara for the year 1987 and 1977 shows a significant recession in a period of 90 years amounting to an average rate of the order of 0.963 metres per year. Similarly the study of earlier charts and recent aerial photographs of the coastal reach at Digha by Prof. Niyogi of I.I.T. Kharagpur, indicated that the erosion at Digha dates as far back as 1877. According to him the rate of erosion when averaged over a period of 91 years (1877 to 1968) worked out to as high as 11.5 m per year.

6.12 In the Bay of Bengal and the Arabian sea, cyclonic disturbances and storms are quite frequent. The frequency of disturbances are five to six times more over the Bay of Bengal than over the Arabian sea. The monsoon seasons also vary between the two coasts. The Bay of Bengal experiences the North east monsoon for about four months from mid-September to mid-January and the Arabian Sea experiences the southwest monsoon for about four months from mid-May to mid-September. The resulting sea waves affect the shoreline considerably. These monsoon winds in turn give rise to swells on the coast on the sea side which also affect the shore processes. The 'coastline undergoes gradual changes due to these shore processes, resulting in erosion in certain locations. It has estimated that there is a littoral drift of about one million tonnes of sand per annum at Madras Harbour. This littoral drift phenomena modifies the shore causing silting of natural and artificial channels near the coast, obstructions of harbour entrances, reductions of harbour depths and at times may also be the indirect cause for erosion.

6.13 The entire coastline of Tamil Nadu is, more or less, stable except the reaches which are affected by human interference as well as the reaches that are affected by cyclones and storms. The area north of the Madras Harbour and Fisheries Harbour and the area in Mamalla-puram north of the shore temple protection structure are examples of the former. The shore in the Kanyakumari district in Tamil Nadu which has a steep slope is an example of the latter. In other areas, there is an oscillation between erosion and accretion due to the changing wave action. The net result is a balance. In Andhra Pradesh there are only two places where the erosion problem is serious viz; the beach of Visakhapatnam town and the area near Uppada. In Orissa the Paradeep harbour and the Gopalpur harbour has raised problems of erosion in the area north of the harbours due to this human interference. In West Bengal, the sea coast stretches from Digha in Midnapur district in the western end to the outfall of the Raimongal river in 24 Paragans district have a problem of erosion. Certain islands of the Sundarbans are also subject to erosion like Sagar and Mousuni. In the coastal reaches of Maharashtra and Gujarat the problem is not very severe and is experienced in isolated patches — Verseva and Ratnagiri in Maharashtra and scattered places in Gujarat.

6.14 The Government of India sought the service of Mr. G. M. Watts of the U. S. Army Corps of Engineers in 1963 for technical advice on measures to be undertaken for coastal problems. On the basis of his recommendations, the Ministry of Irrigation and Power of the Govt. of India constituted the Beach Erosion Board on 2nd February, 1966 in the first instance for the State of Kerala. On 4th June, 1971 the jurisdiction of this Board was extended to the entire coastline of India and comprehensive franchise to deal with the problem of coastal erosion was given to this Board. Various measures

have been taken in consultation with the Board to deal with the problem of arresting coastal erosion in the various places mentioned in paragraph 15. Some measures have been successful and some not.

6.15 The National Commission on Floods had gone into this question and made certain suggestions in its report submitted in March, 1980. The Committee would endorse its approach in regard to tackling this problem and would particularly draw attention to the fact that protection problem against sea water should not be considered in isolation nor on adhoc basis except in cases where protection cannot be postponed to safeguard permanent installations. Since artificial beach nourishment confines the problem to the area affected, every effort should be made to adopt this method wherever economically and practically feasible. If sea walls or revetments become inescapable especially for treating emergency situations, the design slopes should be so fixed as to be most economical in respect of the size of stones to be used and the design wave to be adopted. This aspect needs further research for meeting the conditions existing at different points along our coasts.

6.16 The littoral drift on the each coast has led to substantial coastal acretion starting from the Puri district in Orissa and ending in the 24 Parganas n West Bengal. Baring the spots mentioned in paragraph 13 within the stretch where erosion is taking place, the rest of the coast is experiencing a continuous accretion over time. In some places it is quite substantial. It is stated that the land at Konark in the Puri district of Orissa has extended into the sea about 10 feet per year over the past 700 years. The major sediment contribution from the river systems falling into this coast in the Bay of Bengal is responsible for the coastal accretion when taken together with the littoral drift which has a continuous northward movement in this zone. When the Tikarpara dam project was examined in Orissa in the early 60s, it was found that a holding back of the sediment in the Mahanadi at Tikarpara may have a retrogression effect in the coastline round about Paradeep harbour. When dealing with reserviors, holding back silt loads in the river systems which are falling in the areas of coastal accretion in the country, careful estimates of possible effect of such hold back will have to be considered.

DRAINAGE

6.17 Drainage congestion is caused both due to natural and artificial factors. In flat areas with very flat slopes available for natural drainage, the disposal of run-off resulting from rainfall takes considerable time. In some cases, there are not natural outfalls e.g. in Flat bowl-shaped basins. In the low lying coastal saline soils, the surface drainage problem in most areas is very acute. These natural topographical factors cause drainage congestion. In other areas, when the natural drainage has an outlet in a river, the area is not drained as long as the river continues to be in floods, thus denying gravity drainage. The resulting drainage congestion or accumulation of water affects crops, as most crops cannot stand submersion beyond .a particular depth for long durations. Artificial problems of drainage are created on account of inadequate waterways in structures like bridges culverts, etc. Similarly, in some cases railway lines, roads, etc. are constructed across the natural drainage lines, resulting in drainage congestion.

6.18 The problem of waterlogging is essentially a sub-surface phenomenon. An area

is said to be waterlogged when the water table rises to an extent that the soil pores in the root zone of a crop become saturated. The depth of the water table which may be considered harmful to the growth of crop would depend upon the type of soil, the quality of water and the period for which table remains high. Generally speaking, the water table of about 1.5 metres below the ground could cause adverse effect on agricultural operations. The problems of drainage congestion (is predominant in the alluvial flat plains of Punjab, Haryana, Uttar Pradesh, Bihar, Assam and the) exists in the coastal areas of West Bengal, Orissa and Andhra Pradesh.

6.19 In West Bengal, sitting of encroachments mto the Damodar, has resulted in deterioration so far as their carrying capacity is concerned. The areas being low, once they are flooded during the rainy season, drainage congestion persists for long periods. In Orissa, congestion occurs at the mouths of the rivers due to inter-mingling of water and formation of a number of cross channels aggravated by sand bars across the mouths and tidal lockage. In Andhra Pradesh, the prinicipal rivers originating in the eastern ghats and traversing the coastal region, empty into a natural depression named Kolleru Lake. As the outlet capacity is insufficient, foreshore lands get inundated.

Surface drainages

6.20 In our country, the drainage is mainly understood and implemented only as a flood control measure. Farm level drainage bas been only sporadic. At Mahamathanagar District Farm in 24 Parganas (Sunderbans), it has been found that with the improvement in drainage, the yield of paddy went up by 5.85 quintal; per hectare with an average of five year in about 100 acres of land.

6.21 Another study on the efficiency of existing surface drainage system in Sunderbans has revealed the need for construction of peripheral bunds to clearly demarcate catchment and also the various fields so that the inflow of excess water from outside the area into the catchment and the flow from one zone to another is regulated. About 25 cm high peripheral bunds are recommended so that a minimum of 15 cm standing water can be retained in the field to meet the water requirement of the probable subsequent dry spell. It is also recommended for channelisation of the catchment to directly route the excess rain water from the different zones to the outlet and opening of the sluice gate more frequently and for longer periods to maintain the desired water level in the catchment. While designing the surface drainage system, the rainfall pattern and crop requirements should be taken -into consideration.

Sub-surface drainage

6.22 Persistence of high water table with poor quality of ground water calls for a good subsurface drainage system in coastal saline areas. Due to marine origin and the impeded surface and sub-surface drainage the soils have become highly saline and present unfavourable characteristics for crop growth. So far not much work has been done on the sub-surface drainage of these soils.

6.23 A pilot demonstration project for drainage and reclamation of the coastal salt-affected area near Umrath (Gujarat) was initiated sometime back on an area of 250 hectares which was provided with sea dykes, shallow rains etc. Canal/rain water to a

depth of 15 cm was ponded. It was reported that in two years of ponding, the original salt content ranging from 4.7 to 7.4% in the root zone was reduced to 0.6 to 1.2%. Similar efforts to leach out the salts by means of continuous and intermittant ponding with good quality water in the field plots in the absence of artificial sub-surfaced drainage were also made out by the CSSRI Research Station, Canning. However, these attempts met with little success. Another experiment with open ditches as sub-surface drains has now been initiated by them and results are encouraging. On the whole, the reduction in soil salinity has been more in the plots having the drains at 15 metre spacing and a maximum of 65.80 kg/ha, of salt was removed from these plots.

6.24 The above studies indicate the need for taking up a sub-surface drainage programme in coastal saline areas. The pattern of such drainage system would however have to be evolved taking into consideration the local peculiar factors of each area. Scientific studies in this .field would have to be initiated in all th& States."

Salinity Control

6.25 The age old method for controlling the salinity in coastal areas has been the construction of embankments as a protective measure to stop ingress of sea, water to these lands. Such bunds existing in Sunderbans (West Bengal), Orissa, Gujarat, Maharashtra, Karnataka etc. are protecting large areas of coastal lands but many of them need improvements and renovation. There is also need to protect rest of the areas by constructing saline embankments along the sea coast in between the area demarcated by creeks and streams,

6.26 It has been reported that the bunds constructed in the Sunderbans are plagued with wave action. A suitable shelter with trees or grasses has to be developed around these bunds so as to check this wave action. Provision of shelter belts will protect drifting of saline sands into the inland areas thereby protecting the land from salinity. Shelter belts with proper Julifera' has been tried successfully in the saline embankments of the Rann of Kutch.

6.27 The dykes/ embankments have to be provided with one way sluice gates so that the ingress of sea water into the land is prevented during high tides and the inland excess water is drained out to the sea during low tides. Saucer shaped lands away from the sea would have to be protected by raising ring bunds around them with regulated outlets.

6.28 In some areas, flushing the saline fields with sweet water followed by fresh water irrigation to leach the salts down the soil profile is a practical method adopted by the farmer. A study conducted at CSSRI Research Station, Canning has shown that the leachability of the soil as such is poor and may be improved in different ways, viz ; (i) appropriate soil management, (ii) lowering of water table, (iii) improvement of drainage conditions and (iv) adoption of suitable water management practices.

6.29 One of the curative measures which has been found useful in improving the saline soils is the use of chemical amendments such as gypsum, sulphur, iron sulphates etc. But they are costly and their use require close technical supervision for deciding the dose and the particular kind of chemical to be used. Any soluble calcium salt acts as an

amendment. Use of CAN as nitrogenous fertilizer does good to the crop by way of having some neutralising effect on salinity.

6.20 Various studies carried out at Canning indicate that :

(i) Surface soil mulching with rice husk helps in improving the soil physical conditions.

(ii) mixing rice husk with surface soil by ploughing during fallow winter period after the harvest of kharif rice significantly increases the rice yield during following monsoon.

(iii) manipulation of the surface 15 cm of moderately heavy textured soil either through addition of sand or rice husk improves the leachability of the soil.

6.31 The use of saw dust and lice husk as mulch on the soil surface in order to reduce the rate of soil salinitation has also been tried in Gujarat. From another reclamation trial conducted near Machlipatnam, it has been found that application of rice straw, green manuring are some of the measures which are locally adopted by the farmers to treat saline soils. In Tamil Nadu, application of organic matter and gypsum are found to be beneficial. For reclamation of the acid sulphate soils of Kerala, application of lime, pressed or delomite are recommended.

6.32 Where there is inundation of sea water, stagnant surface water ditches turn saline. Treatment of the water with powdered charcoal reduces salinity to some extent. Very light charcoal powder from Ipemea or calctropis sticks and paddy straw charcoal serves the purpose. The charcoal may be dusted on the surface of the water and mixed by split bamboo by beating on the surface of water before irrigation.

Surface Water Irrigation

6.33 While natural depressions, creeks, channels etc. having saline water may gainfully be utilised through development of brackish water fishery, sweet water resources have to be protected from the ingress of saline waters and utilised for irrigation and drinking purposes. Surface water flow during the rainy season has to be regulated through a well planned system of drainage works for controlling the salinity in the top soil. Embankments and bunds are to be erected for protecting sweet water from the ingress of sea water and other saline waters.

6.34 Before utilising the river waters for irrigation on a large scale, it is necessary to investigate the quality of water in different seasons and tidal periods, especially in the northern coastal areas, it is essential as the larger tidal ranges are found to occur there. The quality of river waters in Sunderbans have been investigated at the Research Station, Canning (CSSRI) and it has been found that most water are unsuitable for irrigation due to high salinity.

6.35 The rainfall in coastal areas during kharif season is far in excess of the requirement of khrif crop. If this excess rainfall is properly stored, it can be utilised for irrigating the crops in the dry period. The water balance study for Canning areas has shown that about 450 mm of rainfall would be excess after meeting the losses and

demands for rice crop in kharif season. It shows the need for storing excess water at all feasible sites and probable places. In some States there are net work of streams and drainage ways which flow fully during the period of heavy rainfall and remain almost dry during non-monsoon period. Reservoir schemes on these streams are considered quite essential for utilisation of excess surface flows which otherwise go waste. Closed minor tidal rigers may also be utilised for the purpose of storing excess flows.

6.36 Localised rain water also needs to be stored in small tanks and dug out farm ponds in areas which are protected from salinity hazards. Such stored water may be utilised for irrigating peripheral areas through gravity flow channels wherever feasible. For higher lands, the water may be lifted for irrigation through pumpsets and small lift schemes.

Salinity Problems of Ground Water in Coastal Tracts

6.37 India has a very long coastal line, extending from Gujarat in the west to West Bengal in the east bordering, as it were, the entire Peninsular region. West coast is comprised, by and large, by a variety of hard rocks whereas the east coast is underlain by a thick pile of unconsolidated sediments. These unconsolidated sediments from extensive ground water reservoirs having considerably yield potential. However, near the sea coast in a narrow belt sub-parallel to the shore line, and more conspicuously in the delta regions of the major river systems, ground water is beset with salinity hazards. Salinity, however, does not maintain any uniform pattern of disposition. At certain reaches the saline ground water occurs above fresh ground water and in other reaches it is the reverse. At certain locations there is a fresh water aquifer horizon trapped, as it were, between two saline aquifer horizons. This peculiar mode of occurrence of ground water is required to be appreciated in its proper perspective in determining the steps required to harness ground water potential of the coastal regions.

6.38 In Ganga delta region the salinity problem in ground water has its widest expanse. The salinity problem extends from coast to Calcutta. This tract is underlain by alternations of sand and clay beds. Individual sand beds often attain thickness of 20 metres and from powerful aquifers. However, from the stand point of quality there are two broad groups of aquifers. The "Upper group" from land surface down to 152 m is saline and "lower group" below it comprises fresh water aquifers. From the regional stand point productive aquifers occur betwen 190 to 300 metres below land surface. Properly designed tubewells, tapping these aquifers, easily yield around 150 M3/hr. Along the coast, the saline belt gradually tapers to hardly 5 to 10 kms. Width in Orissa coast. In this tract also the upper aquifers down to 130 metres continue to be saline. Below this, the powerful sand-gravel aquifers are freshwater bearing. Tubewells tapping these fresh water aquifers in the depth span of 170—300 metres yield around 150 M3/hr.

6.39 In the Mahanadi-Brahmani delta region the saline belt expands upto 50 kms from sea. The fresh water aquifer horizons are available in deeper horizons in the depth span of 150 to 300 m and production wells are capable of yielding 150 M^2/hr.

6.40 In the western part of Mahauadi delta there is reversal of salinity profile. The fresh ground water body comes above the saline ground water. Thickness of the fresh

water aquifer zone varies from 30 metres to 100 metres. At Puri, however, there is a second fresh water aquifer between depth range of 130 to 250 metres. Scientifically contracted tubewells are capable of yielding above above 100 M3/hr.

6.41 In the Godavari-Krishna delta region the thick pile of unconsolidated sediments overlying the Gondwanas, have a series of aquifer horizones. Ground water in the coastal belt has salinity hazards. Tubewells tapping carefully selected aquifers in the depth span of 36 to 70 metres are capable of yielding 36 to 1108 M3/hr.

6.42 In Gujarat along the Saurashtra coast in Una-Mangral Madhavpur tract acute problem of salinity hazard has manifested itself. In the last ten years ingress of sea water in the millionlite limestone aquifersis said to have advanced 7.5 kms inland. The ground water quality in the belt has been progressively getting more saline. One of the other principal cause attributed is over-exploitation of ground water. The Gujarat problem is being dealt with in a separate chapter.

Ground Water Irrigation

6.43 Orissa: The hydrogeological studies and exploratory drillings have revealed a number of water bearing horizons underlying Orissa coastal tract and thickness of which is generally expected to be considerable. The water bearing horizons are extensive but in vicinity of the coast in |he outfall area of major rivers, the sand zones often pass on to the clay resulting in a rather interconnection and intricate aquifer system. In the intake area, near upland regions, these acquifers appear to be in semi-defined to unconfined state of disposition.

6.44 The ground water exploration has revealed that salinity hazards are not uniformly distributed in the ground water system. Fresh ground water occurs both above and below the saline ground water body. Round Chasakanda, Kundupur, Jajgand, Kumarbdi and Boyalish Mozas the salinity is generally in upper horizon while in the south eastern part of around Apriol, Junitti, Potalia the saline zones are at deeper levels. The ground water is saline at all levels around Masakani, Duodia and Razanau Gaon. The quality of ground water is fresh and potable in North-Western part around Jaleshwar, Bromashewar, Kasba-Jeypore, Basunderpur, Dubla, Sujanpur and Bolalish Moza.

6.45 The estimated fresh ground resources of 13,144 sq. km. coastal tract is around 3935.40 MOM. And the annual replenishable recharge is around 2972.69 MOM. On basis of present estimates of recharge and reserves, it is envisaged that there is a large scope for ground water development in coastal tracts of Orissa through heavy duty tubewells.

6.46 The present ground water development in coastal tract is very limited but when the ground water withdrawals are to be increased, the existing saline and fresh water disposition may be disturbed and the process of ingress of saline water may be accelerated. Hence scientific management at this vital ground water resource will require critical evaluation of the changes, brought about consequent to withdrawals and must regulate the draft as to prevent the ingress of saline water in fresh wat bodies.

6.47 Gujarat : (a) Junagarh and Amreli tracts : The exploratory drillings carried out in

the coastal tracts of Junagarh and Amreli districts have revealed that the thickness of the sedimentary formations vary from 170 m in the northern parts to over 300 m near the coast. The principal water bearing formations, having the saturated thickness of 5 to over 20 m are in confined and unconfined conditions. All the unconfined aquifers occur in hydraulic continuity and act as single system.

6.48 The chemical quality of ground water in coastal plains is generally good. For wells falling with in inland depressions, coastal depressions and coastal ridges, the quality is inferior. Vertical variation in chemical quality was observed upto 2 to 3 kms from coast.

6.49 The total recharge from rainfalls was estimated to be R 24.7 MCM and the return flow from irrigation to be about 7.7 MCM. The total draft was estimated to 35.4 MCM. Hence the net overdraft of 2.83 MCM/annum already exists in the area. For any future development therefore, it is suggested that surplus surface run-off water may be stored in detention Reservoirs on underground storage through artificial recharge. A pilot project for study feasibility of artificial recharge in coastal tracts has been taken up.

6.50 Baroda, Broach and Surat tracts: Groundwater evaluation of Narmada Outfall area covering the districts of Baroda, Broach and Surat has located in all five aquifers between the depth ranges of 40 to 207 m. The dynamic ground water resources of 4832 sy. kms. area are estimated at 507 MCM which is about 12.2 per cent of the average rainfall. Out of 507 MCM of total recharge, about 168 MCM is saline and only 340 MCM is fresh and available for exploitation. The annual draft is about 340 MCM which is equal to the quatum of annual recharge. Thus the Narmak-Mahi Doab covering an area of 4832 sq. Kms. has already reached an optimum stage of development. Before launching any programme of further development in near future, therefore, it is considered advisable to watch the behaviour of the water table for 2-3 years.

6.51 West Bengal: The exploratory drillings carried out in coastal tracts of 24 Parganas and Midnapure districts have shown that the principal water bearing formations of the area are silt, sand and sub-recent alluvium interbeded with clays. There occur as alternate layers to varying depths. The studies have indicated promissing fresh water aquifer over lained by a saline ground water body.

6.52 The upper aquifer the thickness of which varies from 30 to 50 m, occurs in the depth span of 152 m below ground and is generally saline. The lower aquifer of thickness ranging from 25 to 60 m occurs from about 190 to 300 m below land surface and is fresh. The saline and fresh water aquifers are separated by a bed of clay the thickness of which varies from 30 to 60 m. It has been observed that generally near the coast, the upper aquifer is saline while the lower is fresh. The ground water is fresh in upper horizon around Digha but becomes gradually saline in further south. For wells falling in inland depressing, coastal depressions and coastal ridges, the water is saline.

6.53 The yield of lower fresh acquifers varies from 170 to 200 M^3 ph. So far the ground water development in the area is insignificant compared to the vast potential established. The response of ground water system to prolonged and extensive pumping is not yet known.

6.54 Some of the remaining states have also made broad assessment of ground water pontentialities in their coastal regions. In Karanataka, ground water in major aquifers generally occur under water table conditions in some parts." The ground water-recharge, discharge and balance potential has been assessed for the two coastal districts of Dakshina Kannada and Uttra Kannada and it is found that there is still vast scope for further exploitation' of ground water through constructing of wells. Generally the quality of water is good except in a few places along the coast when the wells are deeper. The occurance of black impervious clay below sand bed along coastal tract and back waters affected river banks pose problems with regard to deepening of wells and quality of water. So far no attempt has been made in delineating saline and fresh water cones in the State.

6.55 In Ahdhra Pradesh, the assessment is that out of the total area of 12,600 sq. kms in Krishna Godawari Delta, more than half of the area i.e. about 6,600 sq. km. is saline water zone. The total exploitable ground water potential in fresh water zone is of the order of 2,58,000 hectare meters. The present draft is estimated at 43,000 hectares meters, thus leaving an exploitable reserve of the order of 2,15,000 hectares meters for future extraction and development. This quantum of ground water potential can be developed by means of shallow tubewells or filter tsoints of about 30,000 in Krishna Delta and 24,000 in Godawari Delta. But even in this zone no detailed studies to demarcate saline water and fresh water zones has been conducted so far.

Ground Water Exploitation:

6.56 It would, thus, appear from the above findings, that good quality ground water is available in many pockets of coastal saline area which may play an important role in the development of agriculture and allied fields therein. Particuin area where the availability of fresh surface water is scarce, ground water would be the only source to depend upon. However, the exploitation of this source in saline areas poses many intricacies and has, therefore, to be attempted with great caution. In the first place, intensive surveys for locating ground water aquifers in coastal areas have to be conducted in all the States. Areawise sweet and saline water aquifers have to be identified and their mutual interference has also to be assessed precisely.

6.57 Water balance studies ground water potential have to be carried out in all the coastal saline areas on a regular basis. Exploitation of ground water has to remain within the worked cut limits always. Wherever necessary and feasible, ground water recharge schemes have to be executed for replenishing the source.

6.58 Shallower acquifers may be tapped through private schemes like construction of open wells sinking of filter points and small tubewells. Particularly in sandy tracts, to washing effect of rain, flood etc. the top acquifers hold fresh water to a depth of 10 — 30 meters in certain areas. The unconfine fresh water acquifers provide good scope for installation of open wells and filter points. Ground water development through such structures does not generally pose serious technical problems.

6.59 Due to the peculiar and complex hydro-geologic set up in the coastal belt beset with salinity harzards the following precautions are required to be taken for proper development and management of ground water.

1. Geophysical investigation must precede tubewell designs so that the strainers are located against fresh water saline water bearing aquifers and in cause in some reaches of the coast the fresh water bearing aquifers lie above saline water bearing acquifers and in some reaches, it is opposite.

2. The shrounding materials between the fresh water acquifers and saline water aquifers are required to be sealed by a quick setting cement to avoid contemination.

3. Gravel shround materials should be carefully selected to avoid sand fillings in tubewells. Pre-packed gravel strainers are generally affective in controlling the problem.

4. Indiscriminate pumping from tubewells should be discouraged. Ground water pumpage rates are required to be so regulated as to avoid situations leading to (i) deterioration in chemical quality and (ii) ingress of sea water.

5. In the coastal areas of Gujarat there is said to be salinity ingress from the sea. In such areas exploitation should be controlled and induced recharge of fresh water coming from the upper hinterland should be prevented escaping straight into the sea by means of small dams etc. so that percolation of fresh water under ground might increase.

6.60 The Committee would however like to emphasise that there is considerable scope for exploitation of ground water in the coastal areas. It is true that the detailed statement of saline and fresh water aquifers position in various parts of the east coast given earlier shows that the picture is mixed one. In many parts the fresh water aquifer even if it is distinct and separate from the top aquifers, are at the very deep levels. At the same time, these deep distinct acquifers have an artesian effect because of certain sloping conditions of the clay layer in these areas. This is particularly noticeable in the coast of Balasore, Cuttack and in some parts of Andhra Pradesh, amongst others. As a result of the artesian effect, even if the tubewells are deep, the capacity of the tubewells and the discharge volume is much larger than in the deep aquifers in the alluvial parts of the country. Fresh water being the most important lack in the saline areas, maximum use should be made of these deep aquifers subject, of course, to economic considerations. The Committee would therefore recommend : —

(a) In the alluvial plains deep tubewells for irrigation are now taken up as a state programme in aquifers as deep as 40 ft. On comparative cost-benefit, it will be found that in the deep aquifers mentioned above, the per hectare cost will compare even for deep tubewells at greater depth. Therefore, keeping to the cost benefit acceptable generally for state level deep tubewells for agriculture, the same benefit should be given for comparable cost benefit structures in the coastal areas, even if they are deeper.

(b) In particularly difficult areas where both top and sub-soil water is saline and salinity persists to great depths, if alternative sources of fresh water for better agriculture is lacking, it may be necessary to stretch a point and allow for deep tubewells for irrigation even if it is a little more costlier than levels so far

accepted.

(c) Even if the economics of deep tubewell water is generally adverse for agriculture, as a drinking water amenity and for industrial purposes like cleaning and processing of fish, it is necessary to provide deep tubewell system wherever possible. This is a basic amenity which the Committee will recommend as necessary.

Steps to be taken for better agriculture

6.61 The description of salinity intrusion on agricultural lands indicates that in many areas in the deltas of the east coast, particularly liable to tidal intrusion during the summer, there is very free play of saline water on agricultural fields. Where tidal effect is high, particularly on the coastal areas, heavy embankments have been provided as in Sunderbans in West Bengal, Bhograi area of Balasore in Orissa and Kanika area in Cuttack district in Orissa amongst several. Even in these areas sometimes because of the opening of higher reaches of the watershed to saline intrusion, salinity effects agricultural lands during the summer. For good agriculture, the first essential is to ensure that saline instrusion is reduced as much as possible and whatever saline intrusion does take place, it is leached out by suitable introduction of fresh water during the rainy season wherever possible.

6.62 Where sale intrusion in summer is now taking place, the area, should be investigated on a watershed basis and low ridges provided on the ridges of the watershed as explained in paragraphs 22 and 26 to keep off summer saline intrusion. Along with this, |n the watershed itself, there must be provision at point of exit of water of suitable one way sluice to ensure proper drainage of the water let in for flushing. The investment in these structures will not be very much and the Committee would recommend that priority selection of such areas and urgent steps to see that this is done may be taken up.

6.63 Providing water for flushing of saline area under agriculture has been done as explained earlier in this chapter by various methods in several parts of the east coast. The fresh drainage from the hinter land will have to be suitably guided and directed towards the watersheds where the salinity has to be leached. At the same time, steps should be taken to see that such introduction does not lead to heavy water logging in the lower reaches of the watershed as has happened in the Sundarbans. A suitable system of drainage and diversions will have to be worked out on a large watershed basis. This survey and action will be a corollary to the desaiinisation programme explained above.

6.64 In the strategy the Committee has already explained that where water logging is taking place in the saline effected areas during the rainy season, instead of trying to use the water for fresh water fish culture it may be better to use the low lands for brackish water fish and prawn culture. In heavily embanked area, if such culture has to be undertaken within the embankments, there has to be suitable sluices for letting in the water under control to the brackish water farms. This obviously necessiates that such farms will have to be close to the bunds. This should be suitably taken care of in brackish water fish culture.

6.65 In many of the delta areas of the country, there are irrigation systems which extend towards deitas. These irrigation systems are themselves the cause of heavy water logging in the coastal areas which together with admixture of saline water makes these areas unfit for agriculture. The normal irrigation practice is to leave tail ends of the canals open. In these areas where water-logging is a serious problem, canal control is essential. If canals have to be drained, there should be definite drainage structures leading them away from the low lands. Further, the fresh water available in such canals can also be utilised in the off season for flushing out the salinity in the coastal agricultural areas. This planned development of the lower reaches of irrigation system must be done in each state on a priority basis.

7. DEVELOPMENT OF SAURASHTRA AND KUTCH AREAS OF GUJARAT

Ingress of saline sea water in the coastal areas of Saurashtra and Kutch in Gujarat State poses a somewhat special problem. Considering the importance of certain location specific problems in this area, it has been decided to devote a specific chapter on the problems of this coastal region.

Saurashtra

7.2 Saurashtra is surrounded by the sea on three sides. Saurashtra peninsula has deccan trap rock every where 10 — 15 km. inland from the coast line. An idea of the conditions therein can be had from the following table:

Formation	Age	.formations thickness in na.	Lithology
Alluvium	Recent	1 to 10	Beach sand, sand dunes, saline marshy lands and different soils
Miliolitie Limestone	Pleistocene to recent	5 to 50	White, brown cream coloured medium grained ooltic limestone showing Krast topography.
Ghogha and Pirea beds	Upper mieeene to Pliocene	2 to 10	Yellow clacareous clays and limestone with conglomerates.
Gaj Beds	Miocene	80 to 150	Yellow and grey clays with yellow coloured fisslliferous limestone.
Laterites	Post trappen	1 to 10	Laterities hard ferrugenous lime stone.
Deccan trap	Upper Cretaceous to eocene	Not known	Massive and amygdaloidal basalt.

7.3 The climate in this area is predominately under the influence of the south west monsoon. The coastal plain in Saurashtra is narrow but fertile. Besides field crops many orchards and vegetable gardens have been raised in this tract. The primary source of irrigation, on account of meagre and uncertain rainfall and inadequate surface water, has been ground water. The traditional way of tapping this ground water has been from open wells by manual or animal operated devices. On account of the limited quantity of water which could thus be withdrawn, a natural balance could be maintained between recharge and discharge which controls the position of the interface between the freshwater body and the underlying saline water of the aquifer system. This balancing situation gets disturbed with over draft of water resulting from extensive use of diesel and electric pumps. This deterioration was noted to a limited extent in 1950s and 1960s and to a considerable extent by 1970. The State Groundwater Organisation started the detailed examination from 1971 onwards. The detailed investigations have revealed that the badly effected coastal strip is about 160 km. in length and lies between Madhavpur and Una in the district of Junagadh. It has been found that in seventies each year about 0.5 to 1 km. of the area from the coast line inwards is affected by increase in salinity in groundwater. This has resulted in turning irrigation wells out of use and the agriculture

lands as saline waste lands.

As such, about five to eight kms. of the area inland has turned saline till now. The extent of intrusion observed at various points of the areas are :

Area around villages		Extent of coast area affected by intrusion of saline water (in km.)
1.	Madhavpur	5.75
2.	Shil .	5.50
3.	Mangrol	6.00
4.	Chorwad	6.00
5.	Varaval	5.00
6.	Kodinar	7.50
7.	Una .	7.50

The coastal area between Una-Bhavangar, Bahdavapuri Okha-Jodiya and Kutch covering 800 kms is also affected by salinity on account of direct sea water intrusion, upto 2 to 8 kms inland. The area covered are Bhavangar, Ghogaha, Talaja, Madhuva, Rajula, Jafrabad, Porbandar, Bhatiya, Okha, Kharabhaliya, Jam-nagar, Jodiya, Morbi Anjar, Naliya, Mandvi, etc : A detailed study is under way for precise demarcation of saline zones and availability of ground water resources.

7.4 The basic reasons contributing to salinity are (i) lateral ingress of sea water in lower aquifers, (ii) heavy withdrawal of ground water; (iii) poor natural recharge; and (iv) tidal water ingress in upper aquifers. It is estimated that ground water salinity has increased from 3500 hectares in 1971 to 100,000 hectares by 1977. during this very time span, the irrigated area decreased from 24500 hectares to lb,900 hectares, about 12,500 wells have gone out of commission due to deterioration in the quality of ground water. Increasing salinity has led to reduction in yield, particularly in sugarcane and declining rates of recovery of sugar from sugar-cane. The area which was once famous for its luxuriant growth of vegetables, fruits and other high value crops has experienced withering effect. An idea of the increasing damage on account of salinity can be had form Annexure-I.

7.5 For studying the problem of artificial recharge in north Gujarat and salinity in Saurashtra area, the Government of Gujarat appointed a "Recharge Committee" in 1972. Construction of check dams, bandharas (ungates weirs) and tidal regulators were the prime recommendations of the Report submitted in 1975. The Government, in 1976, appointed a High level committee (HLC) to "examine the existing proposals already in hand and other proposals as found suitable and chalk out time-bound programme for fixing priority of works to be taken upto arrest the salinity ingress and to reduce the problem". The Committee was requested to include the area from Una in the East to Madhavpur in the West within its purview of study. The report of HLC was submitted in October 1979 and has been accepted by the Government for implementation. Certain measures towards implementation have already been initiated by the Gujarat

Government.

7.6 The proposals of the HLC fall with three categories o.e. (i) salinity control measures, (ii) recharge measures and (iii) management techniques. The salient features of these proposals are given in what follows.

7.7 For prevention of salinity intrusion in the ground water, the salinity control measures suggested by the HLC include :

(a) Gated tidal regulations on the large rivers and bandharas (ungated weirs) on the smaller rivers to prevent sea water inflow into the land via tidal rivers and creeks and thence to the ground water by infiltration; and

(b) Static barrier or impermeable cut fall well to prevent direct inflow of sea water from the coast into the top aquifers.

7.8 While recognising the sea ingress problem to be the prime problem of the area, the National Committee would like to stress that the control measures would have to find the most economic engineering solution. It feels that tidal regulators may be a high cost technology and would sound a note of warning towards its adoption without judiciously weighing the pros and cons. The Committee feels that recharge technique would be much more economic and reasonable for adoption. The Committee has observed effective use of one way regulation in mini creeks and run-off in the Sundarban region of West Bengal and would recommend for its adoption after careful detailed study. The Committee has also noticed difficulties in controlling large creeks and here again would recommend the adoption of techniques tried successfully in Sundarban.

7.9 The suggested device of a static barrier or impermeable cut-off wall for the salinity control measure, beside being quite costly, cannot prevent upward movement of salt water which already underlies the overdrawn extraction area. The Committee would recommend an earnest pilot research to establish whether the methods could alleviate the problem.

7.10 For Mehasana and coastal Saurashtra areas the Central Ground Water Board in collaboration with the State Ground water Organisation and with UNDP assistance is undertaking a project for detailed studies on all aspects related to artificial recharge. This resulted from the earlier detailed studies by the Central Ground Water Board which had concluded that the only solution was in recharging the aquifers in the areas through suitable means. The project was sanctioned by the Government of India in January 1980 but the work commenced in April 1980. The project is proposed to be completed in 4 years.

7.11 Under the category of recharge measure, the HCL has proposed inducing additional recharge through check dams, recharge tanks, spreading channels and recharge wells. Additionally afforestation including creation of shelter belts, planting in waste lands and establishment of scattred trees in hedgeraws etc. has also been recommended to facilitate ground recharge of precipitation.

7.12 As envisaged by the HLC, check dams with double stop-log gates could be installed on streams to regulate post-monsoon flows and to extend the period for recharge through the wetted surface beneath the reservoir pool. The gates would not be operated during the monsoon period, but towards the end of the rains the stop-1 logs would be inserted and the space between each pair of gates would be filled with an earth core. In calculating recharge, the report considers an infiltration area of 10 ha, an infutra-uon ra.e 01 about 50 mm per day and period lor recnarge 180 days. This gives an annual recharge estimate of 0.6 MCM per check dam.

7.13 The HLC report proposes construction of recharge tanks to store water to induce the recharge or renovation of existing tanks for this purpose. The tanks may be fed by diversions ironi chek dams during the monsoon or from their own catchment. In estimating the amount of induced recharge, the report assumes an average infiltration area of 10 ha, an infiltration rate of about 50 mm/day and a water retention period of 120 days. This implies that a depth of water of 6 m. and a total volume of about 0.6 m MCM/ annum would be recharged by a tank. Seven possible tank sites are identified in the Report of which three are existing but require renovation.

7.14 T he recharge wells as perceived in the HLC report would be one to three metres in diameter and filled with ruble, gravel and sand to form an inverted filter. The wells would be located in the beds of rivers or recharge tanks where high permeability acquifer are located at some depth below ground level. The report estimates the average cost of such units at Rs. 32.000 and recommends construction of 200 at a total cost of Rs. 6, 4 m. The recharge resulting from 200 wells (calculated at 216 m/day through 90 days for each well) is estimated in the report to be about 4 MCM/annum.

7.15 T he HLC also recommended that 60 km. length of water spreaking channels be constructed parallel to the coast on the landward edge of the highly permeable acquifer unit and up the hydraulic gradient from the ground water deficit area. The channels would be fed from the tail distributary of eight surface irrigation systems served by storage reservoirs. The HLC recommended that the channels be located so as to minimise land acquisition and that no irrigation be foregone in the commands to provide water in spreading channels. The channel dimensions are calculated by regarding them as temporary storage for excess water which could be delivered in flood periods by the tail distributaries. On the basis of an average tail distributary discharge capacity of one cumec and a flood duration of three days, a channel 10 km. along with fillable cross sectional area of 26 m (2.6 m x 10m) would provide the required storage. An infiltration rate of about 50 mm per day is assumed on the wettled channel surface of a reach of 60 Km. length over a period of six months, giving an annual recharge of 8 MCM/annum. This implies that the channel would be filled the equivalent of about six times during the flood season.

7.16 The HLC estimated the costs of connecting channels from the irrigation areas and 60 km of spreading channels at Rs. 24.0 m. Assuming mat me irrigation systems from which the water is obtained, are viable in their own right, the capital cost of inducing 1 MCM/annum of recharge by this method would be Rs. 3.0/m. If any part of the systems must be charged against recharge, this capital cost would rise accordingly.

7.17 The HLC proposed an afforestation programme on the coastal plain as a means

of water conservation and to induce recharge by reducing run off and increasing infiltration rates. The afforestation programmes would include creation of shelter belts, planting on waste lands and establishment of scattered trees in bed grows and on fields in farm land. The estimated cost of the afforestation is Rs. 3 3.0/m and it is believed that it will provide a recharge benefit of 20 MCM/ annum.

7.18 At present, hardly any measures for checking of surface flow is there and as such a large portion of the monsoon precipitation goes over to sea. One way of tackling that would be through control of river flows in the upper reaches. Soil conservation practices with vegetative solid cover could induce water retention in upper reaches. Further, down the course of rivers, check dams, percolation tanks and recharge wells in hard area locations are the possibilities open for adoption. The possibilities can be studied through a detailed investigation of the area. The tackling of the problem by bits and pieces would not help. A comprehensive watershed approach needs to be adopted. The same has been dealt at length in the Report on Backward Hill Areas already submitted by the Committee. The Committee would strongly recommended its adoption in the present context and would also urge the judicious use of water management technology as well.

7.19 For check dams, the HLC envisages double stoplog gates to be installed on streams to regulate post monsoon flows .and extend the period for recharge through the wetted surface beneath the reservoir pool. The Committee has observed in Sundarban area of West Bengal that single line of gates can regulate the manageable parts of any flood throughout the monsoon season. The Committee would urge the adoption and optimum utlisation of such a measure and introduction of any design modifications, if called for.

7.20 Check dams, recharge tanks etc. offer immense possibilities of a minor irrigation potential. Optimum utilisation of such a potential is the obvious answer which the Committee would endorse. The Committee has dealt with problems of irrigation, in all its aspects in the proceeding chapter and would commend the same for the Saurashtra areas as well.

7.21 On the problem of afforestation, the Committee would like to reiterate the suggestion that the tree selection should be the one which benefits the water balance and not prove counter productive in terms of recharge.

7.22 In the case of water management techniques, the two approaches suggested by the HLC are respect of (i) change in crop pattern, and (11) regulation of ground water extraction. Changes in crop pattern are envisaged through:

(a) selection of salt tolerant crops,

(b) selection of low water consuming crops, and

(c) selection of crops for the kharif season which require little or no irrigation.

Trial-cum-demonstration farms have been suggested with technical guidance flowing from the Gujarat Agricultural University and having the following objectives.

(a) establishment of nurseries for salt resistant fruit crops for distribution of farmers ;

(b) development of cropping patterns for salt resistant species ;

(c) carrying out crop water requirement trials to introduce crops with lower demands of water in the area ;

(d) extending information on agricultural practices to farmers through demonstrations ; and

(e) experimentation with water conserving irrigation techniques such as sprinkler or drip irrigation.

7.23 We are really trying to have fresh water by recharge etc. measures. On the fringes there is bound to be saline water effects. Because of the highly fertile soil the best use of this can be made by introduction of saline resistance crops. High value cash crops are possible. Cultivators of cash crops which can give good results under the saline conditions are to be choosen and encouraged. Right variety of the crops are to be choosen so that the alternate crops suggested can give a reasonable return. Unless this aspect can be effectively demonstrated the chances of farmers taking to new cultivators is small. The Committee would recommend the organisation of a well knit system of extension services. Such a system need to be fully backed by research findings of the agriculture universities and related institutions. For ensuring the desired changes to take place the Committee would observe that effective steps should be taken to ensure adequate flow of credit at reasonable terms and to see that no bottlenecks are created in the supplies of inputs and in creating a dependable network of marketing where necessary. The Committee has drawn attention to these aspects in the relevant chapters of the Report. The Committee is happy to note that Gujarat has already noted most of these problems and are trying to find the remedies.

Kutch

7.24 The Kutch area of Gujarat has one gulf, large number of creeks, estuarine area, mangrove tracts with marshes and swamps. A vast marshy salt plain area in the Kutch district is known as the Rann of Kutch. There are two distinct portions of this area viz; the Great Rann in the north and the little Rann in the Southeast. The approximate area coverage in the two cases is 17000 and 5000 square kilometres respectively. The Rann gets inundated during the south west monsoon. The Rann of Kutch is only a little higher than the high tide level of sea water. The sea water is driven over large areas of the Rann of Kutch by winds during the southwest monsoon and this renders vast expanse uncultivable and uninhabitable except for a couple of islands in the Great. Rann. The coastal areas of Kutch are vast and appear to be suitable from the general topographic and biological features for the development of aqua-culture. The only major port of Kandla in Gujarat is located in the Kutch district. Besides, this area has one intermediate and three minor ports.

7.25 The Gulf of Kutch is well-known for its qualitatively and quantitatively rich fauna and flora and is accepted as a vast nursery for a large variety of marine organisms. This

gulf has extensive inter-tidal areas with vast mud-flats almost all around its areas. It has mostly soft muddy (silt and clay) bottom with patches of live and dead coral reefs in the central and western regions. Regular migration-patterns have been established with reference to some of the commercially imperial;: varieties like Prawns, Threadfin and Jew-fish, Mullets, Hilsa and Pomfrets. As a result this area sustains important fisheries of varying magnitude for the above mentioned varieties apart from sedentary varieties like Pearl Oysters, Window-plane Oysters, Edible Oysters, Sacred chank, Sead-weeds, Corals etc. Lobsters and turtles are also caught from this Gulf. There are no perennial rivers emptying into this Gulf — the important seasonal rivers of this region are Banas, Machhu, Rukmavati Bhadar, Und, Aji, etc. However, there is substantial land surface run-off into this gulf from the vast land area around it inspire of the scanty rain-fall in that area, resulting in appreciable fall in salinity in general and near-fresh water conditions obtaining in certain regions during and immediately after the monsoon. The upper reaches of the Gulf sustains a very rich prawn fishery — the predominant species being Metapenaeus kutchensis. This exploitation of this fishery gets under way in July/ August immediately after the monsoon around Surajbari-Malia areas, Staked bag-nets are operated in creeks with the aid of low-draft flat bottom wooden boats. Reversal of the net during ebb and flow of the tide ensures capture through filtration. The fish operation lasts till September/October. Again in the months of November/December from the lower reaches of the little Rann of Kutch (where a seasonal lagoon is formed through a sandbar after the monsoon influx a substantial prawn harvest occurs. Though the fishing season is of short duration the total catch is of the order of 1000 tonnes valued at Rs. 5 million catering to the needs of the export-based processing plants at Veraval and Porbandar and sometimes during bumper crop even to those at Bombay.

7.26 Fishing is the main occupation of the residents of Kutch district and primarily the fishermen are using traditional methods of fishing. Socio-economic conditions of the large majority of them are below par. The operations are seasonal providing occupation and means of sustenance for about 3 to 4 months in the upper reaches of the Gulf of Kutch. Concerted efforts towards reclamation cari considerably help improve the lot of the inhabitants of the area.

7.27 Earlier several agencies as well as the Irrigation Commission and the National Commission on Agriculture had considered the feasibility of reclaiming the Rann of Kutch. The broad conclusion which has emerged in that the Kutch area can be agriculturally improved if part of the Narmada flows could be diverted to this area. Such a measure would not only substantially mitigate the acute problem of drinking water but also create conditions for reclaiming substantial areas of the Rann for Agricultural purposes. In this context the feasibility of bringing water to the Little Rann to control salinity for brackish water fish culture could also be considered. During the monsoons rain and river waters tend to reduce the salinity of the Little Rann. Depending upon the rainfall, varieties of fishes like hilsa and prawns enter the tidal backwaters of the creeks in the Little Rann for breeding purposes. But control fish culture is by and large non-existant.

7.28 The developmental efforts in the Kutch areas have obviously to be directed towards acquaculture development. This can help in economic upliftment of rural population, particularly fisherfolk, in creating self-employment opportunities with reasonably good returns.

7.29 The Department of Fisheries (Government of Gujarat) initiated action for the development of coastal acquaculture in the State, by organising preliminary survey in early seventies. Based on tae survey reports it was proposed to establish a coastal agncuKure farm at Surajbari in Kutch District. The Department called for an expert of the Central Marine Fisheries Research Institute, Cochin to advise on the survey in the Rann of Kutch and Banni areas. The gist of the report of the fisheries scientist for Rann of Kutch reads as under: —

"The site for the proposed marine prawn farm is by the northern side of the creek, between, Surajbari road bridge and the rail bridge. At the time of visit (9 A.M.) the tide was low and the area was fully exposed. There was muddy water in the erroded cnannel running lengthwise in the site. This channel is part of the number of channels developed at the time of ebb tide. Local fishermen were using stake nets in this channel during the turn of the tide but could not examine their catches. But their catches generally consists of small aquacultures of prawn belonging to Mete-penaeus Katchenres, Palaemorv styliferas etc. The prawn fishery of the area was thoroughly dependent on the rain water or flood water coming from Dantiwada Dam. In 1973, the monsoon was good and the darn got breached. With this result the salinity of the water in that area came down 1.57% in September, 1973 and then onwards increased to 36% in November. The salinity went on increasing up to 89% in the subsequent months. The high catch of prawns was obtained in the months of July to November, and it stopped when the salinity increased further, from November 1973. This phenomenon of gradual increase in salinity exists resulting reduced chanks for mariculture. (Salinity data does not seem to be reliable as the entries in the salinity register kept at Kandla showed values about 80% in a number of places. Highest record of salinity is 102.54%. Such high values of salinity is very improbable as the salinity of the sea water is normally round 35%).

7.30 In view of the report of the fisheries scientist, the department attempted a prawn culture experiments at Surajbari in early 1974. But the experiments did not give satis-factory results due to the high salinity of water in the area. The experiments were, therefore, abandone. The experiment seem to depend on natural flow of fish fry. Natural flow depends on low saline conditions which apparently did not exist at that time. Fisheries chapter has given the details of the approach that is desirable and the Committee would urge serious studies and adoption of the same.

3.31 As regards the Banni area of Kutch District, Shri B. Sivaraman, Member of Planning Commission, in his tour report of 9th August 1977 suggested as under: "As the depression will any how have salinity it may be advisable to make use of the natural situation and do bracidshwaternish culture in a Dig way in this area. I have suggested that immediately a hsherytank of one acre can be dug in che deeper poriion of the depression and the salinity ot the water inside the bund watched throughout the whole year. This will give us some oasic data on which we can decide on the type of fish to be grown in this area. At present, tne salinity should be sufficient to grow prawns and fisn luce milk lish, mullets, and bekthi. Probably, after the end of the depression are closed ana che salinity gradually decreased, other types of fish may have to be thought of. I do not foresee any changes in the pattern in the next decade. As the present price of prawn is very high and there is a so well developed market in the Middle East for fresh fish, this venture should be profitable. The maldars who are Mohammedans should not

have very great difficulty in getting their children settled on this fisheries on a remuneration employment. I would, therefore, advise that one or more lakes may be organised during the next working season and along with the experimentation on salinity, 'growing of mixture of prawns and other fish may also be attempted by the fisheries department".

7.32 A a follow-up on the tour findings and reports of Shri Sivaraman, Member Planning ! Commission, the concerned Department of the Gujarat Government conducted a survey in the Banni area with a view to assess the possibility of establishing a brackishwater fish farm. But due to a high salt content of the soil, and frequent floods in the region, the department could not take up any activities of development of, fisheries. The entire problem of backishwater fisheries has been dealt with in an earlier chapter. The Committee would urge serious considerations of the same.

7.33 The Government of Gujarat undertook a preliminary survey about the scope of coastal acquaculture, along the entire coastal area from 1976 to 1980. The survey tried to select sites for development. In this report the main factors considered were topography, tidal amplitude, salinity, nature of soil, organic production, availability of seed and pollution aspects. In case of Kutch district two extensive areas have been found suitable for establishing aquaculture farms. These areas are Mundra and Tuna. The survey indicates the following details.

1. Mudra

There is a vast area of about 1000 hectares fed by several large and small creeks during high tide. Of this vast area about 200 hectares can be easily converted into a farm. Area is more or less a mud-flat and is expected to be quite productive due to presence of organic matter and detritus. Near Mundra there is a liver 'Bhuki' which is seasonal and during monsoon fresh water is discharged into the sea. The highest tide is 5.5 m and toe salinity of the creek reaches maximum of about 40 p.p.t. during May, June months. Mundra is connected by moiorable all weather road to Kandla and Bhuj. Electricity and water supply are available at the siie. The main biota includes prawn species of P. indicus, P. Mondon, Metapenaeus Mono-ceros, M.kuichensis and M brevicornis, Mugil spp. and Lates celcarijer. In view of the exits ing favourable factors as mentioned above, this site is recommended for fish and prawn farming. The F.A.O. coastal aquaculture team visited the site in May 1981 and have suggested the site for development.

2. Tuna

This is a small fishing village with a fishermen population of 500. Area is connected by road. From Kandla port it is about 35 km. away. There is an extensive marshy area of more than 500 hectares with mangrove vegetation. Developing 50 ha. area is envisaged at this site. Prawn seedlings of Metapenaeus spp. are available in the creek area. Additional data of tidal amplitude and salinity are being collected for finalisation of the suitability of the site.

7.34 Comprehensive coastal aquaculture project is intended to help the economically

backward sections of fishermen along the coast who will be able to sustain themselves solely or augment their present income through managi a small fish farm as a family holding just like a small/marginal farmer. Those fishermen who are now subsisting on intertidal fishing will be able to manage easily a farm of one hectare by himself with the help of his family. These 1 hectare units are to be constructed and passed on to fishermen families together with the minimum required working capital mostly in kind, to enable the family to operate and manage 'the farm. The capital cost and the iriital working capital shall be considered as a term loan to be repaid in ten annual equal instalments. The land for the farm is expected to be available on long-lease from Government at a notional rental/ lease of Rs. 200 per hectare/annum. Technical know-how will be provided by the Fisheries Department through trained technical personnel acting as Extension Personnel, who will be closely associated with these groups. Marketing will be effected through either the existing fishermen cooperative body which has sufficient infrastructure and experience. Alternatively organising such family groups operating small farms into small cooperatives also will be considered. The project economics are shown in Annexure II.

7.35 Apart from the small farms it is envisaged to establish twenty medium scale farms of about 10 ha. each to be operated and managed by small group/primary fishermen cooperatives in order to promote group activity in this sphere which might prove more suitable in view of the type of operations, the high inital investment and the labour component. The project economics are shown in Annexure III.

7.36 In order to achieve a quick breakthrough in the field of developing suitable technology to suit the conditions existing in Gujarat the project envisages the setting up three Experimental-cum-demonstration farms each of 5 hectares areas in three different locations. One of these farms in proposed to be located in Kuch district. It will evolve and perfect technique of polycul-ture (prawn and fish).

7.37 We have dealt wtih brackish water fish culture, in its various facets, in one of the chapters of this Report. Herein we have discussed various types of programmes, methodologies have been laid down and principles indicated. The Committee feels that in the Rann of Kutch very large areas are suitable for development of brackish water fisheries. The Committee would urge that the proper assessment of these areas should be done through a detailed survey with basic parameters. The two vital aspects needing special attention are checking of tidal ingress and the supply of fry. Measures for tidal ingress have already been dealt with at length. With regard to the supply of fry, the Committee visualizes two practical ways, viz. to catch the fry where it is and put the same in these areas, or to breed the fry elsewhere and then bring to these areas. The Committee is confident that with effective tackling of the problems and with suitable provisions for nutrition in the water and design development, brackish water fish culture can become a major base for the economics of Saurashtra and Kutch areas of Gujarat.

7.38 With the coming up of the Sardar, Sar-dar Sarovar Dam in Gujarat, the ingress of brackish waters because of the Narmada will go up in the Kutch, area. The final order and decision of the Narmada water Disputes Tribunal has ensured sufficient water flow for the Sardar Sarvar Dam from the concerned States of Madhya Pradesh, Rajasthan, and Maharashtra. The pattern of water use in Kutch areas is likely to undergo a change after the completion and the operation of the Dam. In such a situation brackish water

fisheries may not provide the answer for optimum utilisation of the resources of the area. For that purpose a fresh look at the problems would be desirable to evolve suitable development strategies for the areas with a balance betwen fresh water culture and brackish. Herein the Committee would like to stress that pilot schemes and sufficient research effort should be carried out to take full advantage of the changed conditions, when they occur.

7.39 The feasibilty studies for reclaiming the Rann of Kutch had been considered earlier by different agencies including the Irrigation Commission and the National Commission on Agriculture. Apparently not much action has been taken. It is understood that second High Level Committee for the remaining areas and also one for Kutch areas have been set up by the Government of Gujarat.

7.40 In earlier chapters, aspects like development of marine fisheries, brackish water fisheries, crop planning, irrigation, drainage, etc, have been extensively dealt with. On the lines suggested therein, the Committee would recommend that early steps should be taken to ensure the optimum utilisation of the resources of the Saurashtra and Kutch areas.

Annexure 7.1

Details of damages to irrigated area due to salinity

			1970-71					191	76-77	
S. No.	Crop	Total area under irriga-tion (Hec-tares)	Produce per Hectare s	Market rate of produce	Total value of produce (Hec-tare)	Total area under irriga-tion (Hee-tare)	Produce per Hect.	Market rate of produce	Total produce	Vlaue of (Es. lakh)
1	2	3	4	5	6	7	8	9	10	11
1	Mango	510	400 3£t.	2000 /MT	48.20	308	2	OMT	2000/M T	12.32
2	Coconut	304	20000 Ncs	70/100 Nos	55.18	243	8160	Nos	70/100 Nos	13.88
3	Banana	1520	19.5 MX	1000/M T	293.35	596	14	OMT	1000/M T	83.44
4	Sugarcaua	10370	210 MX	100/MT	2170.70	8703	120	OMT	100/MT	1044.36
5	Wheat	7797	1 SMT	1250/M T	175.43	5728	1.2	Ml'	1250/M T	85.92
6	Groundnut	1381	1 MT	2000/M T	37.42	311	0.80	M'}	2000/M T	4.97
7	Bajara-Jawar	1187	1.4 MT	1250/M T	20.77	437	1.00	SIT	1250/M T	5.46
8	Vegetables	815	1.2 MT	2000/M T	19.58	594	0.60	MT	2000/M T	7.13
	Total	24474			2825.19	16920				1257.48
	Less : Expenditure of irrigation about Rs.4000 per hectare				(-)978.86					(-)676.80
	Net Benefit				1846.23					580.68

(i) Eeduction in area irrigated : 24474 —15920= 7554 hectares

(ii) Total loss : 1846.23 - 580.68 = 1265.55 lacs

(iii) Considering recovery at 75% benefit by the project to the area already affected wiill be about 1265 x 0.75=949 lacs say 9.00 crores

Source: Table 7.2 of the Report of the High Level Committee to examine the problems of Salinity Ingress along Coastal Areas of Saurashtra.

Annexure 7.2

Detailed financial break up for 1hectare farming

A. CAPITAL COST	
Cost of construction	Rs 30,000
Total of (A)	Rs. 30,000
B. Recurring Cost	
1. Lease/Rental of Land	Rs. 200
2. Cost of neta and materials	Rs. 1,600
3. Cost of feed	Rs. 600
Total of (B)	Rs. 2,200
Grand Total (A+B)	Rs. 32,200

C-RETURNS

	Production		Sale Proceeds
Variety	Quantity	Rate/Kgs	Amount
Prawns	500	Rg. 20	Rs.10,000
Fish	1000	Rs. 4	Rs. 4,000
Total	1500		Rs.14,000

Source: Appendix V of tho Report on *Scope* for Development of Coastal Aquaoulturo ia Gujarat State by feminism onerate of Fisheries, Gujarat, 1981.

Annexure 7.2

Detailed financial break up for 10 hectare farming

A. CAPITAL COST	
1. Cost of construction @Rs. 30,000	Rs. 3,00,000
Total of (A)	Rs. 3,00,000
B. RECUKBING COST	
1. Lease/rental on land	Rs. 2,000
2. Cost of nets and materials	Ra. 12,000
3. Cost of feed	Rs. 5,000
4. Miscellaneous	Ra. 5,000
Total of (B)	Rs. 24,000
Grand Total of (A+B)	Rs. 3,24,000

C. RETURNS

	Production		Sale Proceeds
Variety	Quantity Kgs.	Rate/Kgs.	Amount Rs.
Prawns	500	20	1,00,000
Fish	1000	4	4,000
Total	1500		1,04,000

Source: Appendix VI of the Report on Scope for Development of Coastal Aquaculture in Guiarat State by Commissionerate of Fisheries, Gujarat, 1981.

8. DEVELOPMENT OF SUNDARBAN AREA IN WEST BENGAL

Sundarban in West Bengal is one of the major areas affected by coastal salinity. It has its own special features. Hence a separate Chapter on the development of Sundarban.

8.2 The Sundarban area is a delta which has been formed mainly by the continuous deposition of silt carried down by the Ganga river Ihrough the Bhagirathi-Hooghly. This process has also been assisted by tides from the sea face. The Indian portion of this deltaic region lies between the river Hooghly in the west and the Ichamati-Kalin Raimangal river system in the east. Administratively it is a part of the 24 Parganas District of West Bengal. In the north, the Dampier-Hodges Line demarcates the area from the rest of the district of 24 Parganas in West Bengal. The entire area is criss-crossed by rivers, channels and creeks.

8.3 The Sundarban region measures 9,629 sq. km. with a total population of a little over 2 million as per 1971 Census. However, nearly 44.3 per cent of the region is covered by the forests declared as 'reserve' since 1911. The inhabited area measures 4,493.6 sq. km and the area under reserved forest covers 4,263.1 sq. km.

8.4 The Sundarban is one of the most backward regions of the State. The area was under mangrove forest and began to be colonised from 1833. Scientists consider the land reclamation operations premature resulting in physical problems like drainage congestion. The surface water is generally saline and unsuitable for human or agriculture use. Fresh ground water is found at depths ranging from 300 — 400 metres and its exploitation is costly. A firm idea of the extent of availability of groundwater is not available as the region is not yet fully covered by ground-water surveys.

8.5 The region is exposed to severe storms and cyclones on the on set of monsoon as also in the postmonsoon period. The settled areas are guarded by earthen embankments of over 3,600 km in length.

8.6 Concentration of backward classes is particularly marked in the region with Scheduled Castes and Scheduled Tribes accounting for about 42 per cent of the total population (as against 25.6 per cent in the State). The per capita income in the Sundarban is far lower than the State average (Rs. 444 against Rs 1.007 in 1973-74). It is projected that the per capita income in the region will rise to Rs. 511 by 1981 which will be less than half of the present per capita income of the State.

8.7 The proportion of agricultural workers to total workers 88.5 per cent is higher than that for the State (57.5 per cent). The incidence of landless agricultural labour is also higher in the region. Landless agricultural workers constitute 50.2 per cent of the total cultivators in the region as against 44.8 per cent in the State. The percentage of landless workers is increasing steadily in the region. It is estimated that between 1961 and 1971 landless workers increased by 9.9 per cent in the State against 15.7 per cent in the region.

8.8 The communication facilities in the region is extremely poor, the total length of railways being 42 km. in an inhabited area of 4,500 sq. km. Large part of the region is

constituted by islands separated from each other by tidaj rivers. This inaccessibility is acting as a serious constraint to development.

8.9 The region has recorded a very fast rate of population growth between 1961 and 1971. During this period, Sundarban had 4 growth rate of 34.68 per cent against West Bengal average of nearly 27 per cent. In 1971, the region had an overall density of 365 persons per sq. km. The projected population by 1990-91 is 3.6 million.

8.10 The region is also socially backward. TJie literacy percentage in Sundarban is 20.7 as against 20.93 for the State. The techno-economic survey of the area conducted by the Sundarban Development Board in 1973 and 1976 indicated that, on the whole, nearly 50 per cent of households are indebted. The average outstanding loan per indebted family worked out to Rs. 197.02.

8.11 The region is traversed by the tidal rivers except the Hooghly which forms the western most boundary. No tidal river of the region has connection with the upland river system. The main estuaries from east to the west are Raimongal, the Kalindi, the Cosabe, the Bidyadhari, the Herobanga, the Bidya, the Malta, the Thakuran, the Saptamukhi and the Hooghly.

8.12 The average tidal amplitude in these estuaries ranges from 1.5 metres to 5 metres. The highest high water for a year is generally experienced in July-August and lowest high water in December-Jan. The tidal rivers suggest that most of the premature section are lower than the average high tidal level and so, unless the land is protected adequately by embankments, inudations may occur at times.

8.13 The salinity in the estuaries of Sundarban is determined by the amount of fresh water re-cieved by them from their catchment areas, which in turn is estimated by the amount of rainfall in the repective command areas. On an average, the entire area may be divided into low salinity upto 8 PPT; moderate salinity from 8 PPT to 20 PPT, high salinity above 20 PPT. Low salinity period generally stretches from August to October, moderate salinity from November to February and high salinity period from March to July. The upper Sundarban area enjoys two regimes of low and moderate salinilty high salinity period is generally non-existent there.

8.14 Much of the region lies below 3 metre contour level. However, there are patches of hurmockey ground in the Bishnupur Mograhat Diamond Harbour and Kulpi Police Station area as well as in Baruipur Jaynagar and Mathurapur Mandirbazar area. These patches are generally occupied by the settlements or are used as roads. A few fingerlike extension of the relatively high areas are found in the lower part of the delta. These extensions have in most cases been used for transport development.

8.15 The natural soil associations found in the Sundarban deltaic region formed as a result of physical phenomena, climate and watershed had originated from the parent materials, viz. (i) Ganga alluvium and (2) Salinised Ganga alluvium. The direct deposits of Ganga alluvium rich either in calcite or magnesite are normally salt free and rich in divalents. Sometimes they are rich in calcite while at other times in Magnesite or dolomite. The indirect deposits are Ganga alluvium which returing from the sea tides after getting salinised are deposited in the estuarine region. The silt and clay leads

carried down beyond the delta into the sea undergo partial transformation in their exchange complex due to exchange reaction with sodium choloride of the sea water. These con-stitutents in suspension rush back during tides through numerous tidal rivers, channels and creeks and get partially deposited in the inland flood plains due to the gravitational force becoming greater than the suctional force exerted by the ebb water.

8.16 Rain water leaches the deposit under different environmental conditions to result in –

(i) Normal soils, when leaching of the salts takes place partially in the presence of calcite, magnesite or dolomite, in the parent desposits,

(ii) Saline alkali soils, when leaching takes place in the absence of the dolomite in the original desposits and in the presence of excess sodium choloride enhancing enirance of sodium into the exchange complex.

(iii) Non-saline alkali soils, when salts get completely leached away and sodium ion enters the exchange complex.

(iv) Degraded alkali soils (saline Turf Soils), when hydrogen ion from organic acids takes part in the formation of these soils if this process takes place in the presence of buried half-decomposed organic matter in the soil profile.

8.17 The annual average rainfall in the Sundarban is around 1,763 mm (70 inches). In some abnormal years, it might be as low as 1,224 mm (Cosaba, 1972), or 1,270 mm (Sagar, 1976) while in other years it might be as high as 2,770 mm (Cosaba, 1976) or 2,729 mm Sagar, 1972). Ninety per cent of the annual rainfall occurs during May to October, 70 - 75 per cent in 58 - 64 days of the main monsoon season of four months (June to September).

8.18 The region experiences frequent cyclonic storms at times of severe intensity which cause heavy devastation specially if the storm surge occur in synchronisation with the high tide as it occurred during 1976 (Kharif) damaging many embankments and agricultural lands in Pathar-pratima and some other islands of the Sundarban.

8.19 In the early years of the 19th century, cultivation started in Malta and Bidyardhari basins, east of Calcutta, which were either swampy or under forest and jungles. The ground level was lower than the high tide level. The circuit embankments above tidal level were rect-ed to prevent ingress of saline water. Then, by clearing forest and jungles within the portected zones cultivation was done. The drainage was done during low tide through improvided wooden box sluices. During 1831 — 1833, systematic lease was given to the settlers. This hastened colonisation of Sundarban by premature reclamation. as per the terms of lease of the reclaimed lands of 1879, the maintenance of the embankments was the responsibility of the 'Zamindars' or 'Jot-dars'. After enactment of the Estates Acquisition Act of 1955, the responsibility for maintenance of these embankments was vasted in the State Government in the Land and Land Revenue Department. Since 1960, however, the Irrigation and Waterways Department of the State Government has been made responsible for maintenance of these embankments. As per Estates Accmisi-tion Act of 1955, all the cultivating tenants have become the tenant of the land directly under the State upto the ceiling fixed under the Act.

8.20 The main forest species in the Sundarban are Goran (Ceriops rox-burghiana), Bani (Avi-cennia Officinala), Gangwa (Excoecaria aga-locha), Passur) Carapa mollucenia), Keora (Sam-neratia spp), etc. The Sundari (Heriferia minor) trees from which the name of Sundarban is said to have developed, are found scarcely. Owing to the reclamation of the area and the ever increasing pressure of population, the wild life in the area is faced with gradual extinction. The most noted species are Royal Bengal Tiger, spotted dear, wild Beer and Crocodiles.

8.21 The economy of the region is almost entirely dependent upon agriculture which provides employment to 88.5 per cent of total workers in the region. The cultivated area in the region extends over 2.95 lakh hectares of which less than one per cent is irrigated. The region is, therefore, a mono-cropped area with 96 per cent being cultivated once in the kharif season (Aman paddy). Due to lack of irrigation and absence of know-how regarding dry farming, most of the cultivated area remains fallow for six months in a year. Only around 6,000 hectares have irrigation facilities and the corp-ping intensity is only 103 per cent. The yield of aman paddy, the main crop in the area, is rather low at 1.75 tonnes per hectare which is ever declining. The yield levels which have been achieved in respect of the newly introduced rabi crops are of the follwing order —

Crop	Yield Level (TI. Ha.)
Boro paddy	4.63
Chillies	4.00
Sunflower	0.80
Wheat	1.80
Mung	0.90
Water Melon	20.00

8.22 This could be considered satisfactory levels of yield and might be improved mar-ginally in case of chillies (4 to 5 tonnes) and sunflower (0.8 to 1 tonne). The yield of aman paddy, however needs to be increased substantially. It is estimated that with the improved varieties and better drainage the yied level for this crop can go up to 2.25 tonnes/ha.

8.23 Next to agriculture, fisheries are the main source of employment and production. The total annual requirement of fish of Calcutta alone is assessed at 100,000 tonnes. But the annual supplies vary between 25 to 75 thousand tonnes of which Sundarban accounts for 6 thousand tonnes only. The 150 bheries of the region produce about 3 thousand tonnes and the balance 3 thousand tonnes is supplied from the catches in the estuarine area. There is good scope for development of brackish water, fisheries in Sundarban. A recent survey of the availability of fish seed in estuarine water indicates the estuarine area of the region is very rich in fish seed, particularly varieties of prawn. The lendings in the estuarine area accounts for nearly 2 thousand tonnes a year, 85 per cent of which is realised between November and February. State Fisheries Development Corporation runs of fish farm at Maharaj Ganj (Namkhana Block). Another

200 hectares brackishwater fish seed farm is being developed by the Corporation in Henry's island.

8.24 Major constraints in the growth of animal stock in Sundarban region are shortage of animal and poultry feed and inadequate veterinary coverage on account of which animal mortality in the region is considerably high. Animal stock of the region is estimated as below:

(000 No.)

Cattle	524
Sheep and goat	210
Poultry Bird	656
Other	5

Animal stock works out to 28.7 numbers per 40 hectares. The total annual production of milk is estimated at 1,890 million litres and of eggs, 23 million numbers.

8.25 In 1973 the West Bengal Government constituted three boards for development of the Darjeeling hill area, Jhargram sub-division and the Sundarban. Sundarban Board was set up by an order of the State Government and is authorised to coordinate all development activities carried out in Sundarban area by the State Government departments and other development agencies. In January, 1979 it was further stipulated that the Sundarban Development Board under the administrative control of the Development and Planning Department will be the overall coordinating agency in the matter of planning, formulation and implementation of the integrated project which was proposed to be executed with financial assistance from the International Fund for Agriculture Development. In addition, there is a Cabinet Coordination Committee consisting of the Minister incharge of Irrigation Sundarban Development who is the Chairman of the Committee as well as Sundarban Development Board and Ministers incharge of Agriculture, Animal Husbandry, Fisheries, Forests etc. as Members. There is also a Committee of officials headed by the Planning Adviser Government of West Bengal and consisting of Secretaries of Irrigation, Agriculture, Animal Husbandrv, Fisheries and Forest Departments. The Member-Secretary, Sundarban Development Board is the convenor of this Committee.

8.26 The Sundarban Development Board, at the time of its constitution, formulated a 10 years programme involving a sum of about Rs. 86 crores. Although the State Government had accepted the Plan but the constraint on the resources at the State level did not allow it to implement this Plan. The Board has, therefore, formulated annual development plans and is executing them either itself or through other Government Departments. The table below would indicate the budget provision from 1973-74 to 1980-81. It is understood that budget provision was fully utilised.

Year	Budget Provision
1973-74	32.15 lakhs
1974-75	37.56 lakhs
1975-76	50.74 lakhs

1976-77	60.00 lakhs
1977-78	120.00 lakhs
1978-79	150.00 lakhs
1979-80	220.00 lakhs
1980-81	220.00 lakhs

In addition, about 6,000 metric tonnes of wheat was received annually upto 1978 worth Rs. 80 lakhs for execution of development programmes approved by the Board in addition to those finances from S ate Government budgetary resources. This wheat was used for carrying out food for work programme through which wages to the labour were paid wholly in wheat (without any cash components). The wheat was mainly used for minor irrigation like work re-excavation of derelict canals and tanks, strengthening of river side embankments and construction of village path-ways.

8.37 Any integrated area development programme for the Sundarban has necessarily to keep in view the following salient features -

(i) Lack of irrigation facilities due to surface flows being saline and groundwater level being too deep for economic exploitation;

(ii) Soils can be sufficiently productive if properly managed and suitable cropping patterns introduced;

(iii) Occasional breach of embankments by cyclones and storms;

(iv) Arrangements for adequate rnarketins/ processing facilities for increased production; and

(v) Adequate extension and training programme for the selected beneficiaries as well as for the staff.

8.28 At the instance of the Government of India, the State Government have in July, 1979, prepared a project for being funded by the International Fund for Agricultural Development at an estimated cost of about Rs. 24 crores. This project aims at creating the necessary physical infrastructure and covers a geographical area of 3.36 lakh hectares which has been selected on the criteria of high concentration of small/ marginal farmers or Scheduled Castes and Scheduled Tribes or lack of irrigation facilities/proper drainage. The project aims at improvement of drainage condition in more than 71.000 hectares of cultivated land and creation of irrigation facilities in 15,000 hectares by construction of sluices, intermediate drains and contour bunds, re-excavation of farm ponds etc. It also aims at strengthening of marketing facilities, setting up of market centres, development of communication facilities which includes brick paved roads, bridges and jetties. Development of fisheries and social forestry is also included. The IFDA Project has since been sanctioned.

8.29 Considering the physical and other characteristics of the Sundarban area and keeping in view the constraints pointed out in para 27 above, the strategy for

development in this area has necessarily to be :

(i) extending irrigation by utilisation of excess rain water, construction of sluices and network of drainage chan-s nels to remove drainage congestion;

(ii) once irrigation becomes available, an attempt should be made to convert the present mono-cropped area into two cropped area to the maximum extent possible. Whatever little has so far been attempted has clearly established that given the irrigation, the yield in rabi can be very much higher and the crop production can also be diversified;

(iii) Land-use should be made more intensive in order to raise production status, particularly, of small and marginal farmers;

(iv) there is lot of potential for the development of fisheries and there is already a ready market in the Calcutta city. Next to agriculture, fisheries would appear to be the most important programme of development in this area;

(v) there is also good scope for taking up horticulture, animal husbandry, fishery, poultry, piggery, dairy etc. which would create new avenues of productive employment.

(vi) natural reasources and local skills must be utilised for development of cottage and small industries:

(vii) infractructural facilities, including extention support, input supply, credit facilities, marketing/processing arrangements, communication etc. would have to be provided and

(viii) the last but the most important point is that the organisation structure would have to be so streamlined that not only there is adequate delegation of financial and administrative powers to the development authority, but it has the necessary powers to coordinate supervise and monitor the execution of programmes.

8.30. The Sundarban Development Board is, at present, following by and farge, the above strategy and the Committee is in general agreement with its approach.

8.31 As mentioned earlier, the Sundarban Development Board was set up in 1973. It has attempted to carry out development activities through the establishment of Growth Centres and at present 27 Growth Centres are functioning in the region. The purpose behind organisation ol Growth Centres, as stated by the Sundarban Development Board, is as under : —

(i) It will help grouping productive talents and entrepreneurs at grass-roots level.

(ii) Initiate farming activities in dry season fallow farms thereby raising the land-

use intensity. Cropping advise, supply of inputs are provided by the Board management of land and farming remain the responsibility of selected groups.

(iii) Similarly, in organisation of non-farm activities, guidance in scheme formulation and financial assistance through loan are being provided but managerial and operational responsibility lie with the local entrepreneurs.

(iv) These activities organised and concentrated at selected centres are expected to demonstrate that with how little resources, production could be raised manifold if the people combine, work and utilise the latent local possibilities The pedestal of (he growth centre programme therefore is the quality of human participation. Achievements would rise and fall accordingly.

(v) It is projected that gainful experience of growth centres would radiate in their respective catchment areas. Encouraged and enlightened by these growth centres, residents of adjacent villages would take up similar operations themselves.

For discharge of stipulated functions, rank of settlements in respect of modality was a principal consideration. The growth centres have been selected mostly on this basis."

8.32 This experiment was first started in 1974-75. The Sundarban Development Board are carrying out most of the development activities through these Growth Centres and the Board has observed that enthusiasm for participation in this programme is steadily rising. At the start of the programme, 100 per cent subsidy in the form of fertilisers, seeds, pesticides, was given to the selected marginal and small farmers on the basis of a planned crop pattern, but at present only 50 per cent subsidy is being given to them. Further the recipient farmers of one year do not get the subsidy in the next year, but as was observed from a study, they continue to grow the crops in subsequent years out of their own resources. The significant increase in the number of participant farmers, area covered and output may be seen from the following table: —

Year	50% subsidy (in Rs.)	No. of participants farmers	Area covered (Acres)	Output (Rs.)
1976-77	5,83,742	3,498	1,937,42	35,19,744
1977-78	17,65,770	17,902	9,007,60	1,89,65,331
1978-79	26,53,442	31,643	14,328,83	3,11,55,620
1979-80	37,56,619	42,021	22,031,18	4,39,62,442

The important crops grown out of this programme: Chilly, Watermelon, Mung (Pulses), Wheat, Vegetables like Potato, sweet potato, pnipn, etc.

8.33 A scheme for promotion of backyard orchard mainly for landless agricultural labourers, was introduced in the region. At the outset, two perennial trees, viz., Lemon and

Papya, which are ecologically suitable for the region were introduced. Similarly, the scheme for extension of cultivation of coconut was taken up for the landless agricultural workers. Both these schemes could not be carried out last year because of non-availability of seedlings. In fact, the Board is feeling difficulty (o collect agricultural inputs due to the overall shortage of seeds, fertilizers etc. in the State. In 1980-81, about 22,000 coconut seedlings were distributed to the landless families through the Growth Centres. So far, 49,274 coconut seedlings have been distributed to the landless families in the region by the Board.

8.34 The scheme of distributing poultry birds, pigs, etc. for establishment of home units of animal husbandry could not reach the target for non-availability of these products from Government farm. However, the number of units sanctioned so far is given below:

	No. of Units	Amount required
1. Piggery	86	1,17,480
2. Poultry	4,478	2,68,680
3. Dairy (Desk)	284	1,90,280

8.35 As complimentary efforts to Growth Centre programme, labour intensive construction programme for removal of drainage congestion, creation of irrigation facilities by re-excavation of derelict canals and tanks etc. are being carried out. 100 million eft. of earth- work creating employment of about 9 million mandays have been executed by the Board under "Food for Work" Programme so far. An area of about 15,000 hectares has been brought under second crop through minor irrigation facilities created under this scheme. The following table will reveal the progress of civil works for the last three years.

No. of different construction schemes

Year	Jetty	Foot Bridge	Brick paved road	Culvert	Others	Total
1	2	3	4	5	6	7
1977-78	26	82	—	97	58	263
1978-79	19	35	20	104	2	180
1979-80	27	27	94	95	59	302

Others included excavation/reexcavation of acanals, tanks, ponds etc.

8.36 With a view to eradicate illiteracy, the Board has introduced adult literacy schemes since 1st October, 1977, and it is being continued. At present there are 259 Adult Literacy Centres foi males and 124 Centres for females, the total being 383. On an average, there are 20 candidates and 1 teacher in each centre. The classes are held generally in the local Free Primary School in the evening for two hours a day for males, and in a suitable place in the noon time for two hours a day for the women.

8.37 The Committee visited four Growth Centres in Sundarban, namely, (1) Roydighi, (2) Kuemuri, (3) Dakshin Barasat, and (4) Jatala Jalaberia in April, 1980. The details of the programme at the four Growth Centres visited showed clearly that there is no support at all to the programme from the Agricultural or Animal Husbandry Departments. The works are being executed by the Board through its own staff. The Committee feels that this sort of truncated approach will not do. If these Growth Centres have to succeed, the sub-plan strategy of tribal development Programmes would appear tp be extremely relevant.

8.38 The Committee has already dealt with the various steps necessary for different types of developmental activities in the subject-matter chapters of this report. In the paragraphs to follow, the Committee would like to point out additional steps necessary in the case of the Sundarban.

Drainage and Irrigation

8.39 A study on the efficiency of the existing drainage system in Sundarban has revealed the need for construction of peripheral bunds to clearly demarcate the catchment and also the various fields so that the inflow of excess water from outside the area into the catchment and the flow from one zone to another is regulated. About 25 cm high peripheral bunds are commended so that a minimum of 15 c. standing water can be retained in the field to meet the water requirement of the probable subsequent dry spell It is also recommended for channelisation of the catchment to directly route the excess rain water from the different zones to the outlet and opening of the sluice gatg more frequently and for longer periods to maintain the desired level in the catchment.

8.40 The S.D.B. had decided Inat they will re-excavate the derelict drainages in the area measuring 400 km. of inlcrmedi to drains and 400 km. of derelict drains and hold back influx of tidal brackish water into the live drainages by constructing 150 sluices (one way) with 10 master sluices and 10 major closures. As regards major closures there appears to be a technical controversy. In tidal area, the silt carried down in live drainages are washed out by tidal action. If tidal action is prevented by closures silting will be heavy in the drainages. One has to balance between storing more fresh water and preventing silting up. The main point is that technically there is nothing against reviving old drainages and desilting live drainages. Also away from the main tidal effect of desilting minor drainages can be closed by one way sluices to retain fresh water after the rainy season and also prevent intrusion of salinity due to the tidal effect. Unfortunately, this excellent scheme has been neglected for the last two years. From 1974 till 1977-78 small length of derelict drains were excavated with CARE Food for Work. The S.D.B. has not invested any money in this most effective fresh water retention programme. It appears desirable to draw up a master plan quickly, and spend the funds from the "Irrigation" head in the budget. West Bengal's investment in irrigation had always been low and on priorities it should be possible to finish this programme as a major irrigation scheme benefiting a large area.

8.41 At present, one kilometer of drainage is equated with 50 acres of rabi cultivation on the sides of drainages using the water in the drainage. An equation between the length of the drainage done and rabi cultivation developed in the four growth centres we visited will show clearly that over and above the cultivation on the sides, cultivation has

developed at a distance from the drainage by use of kutcha wells because the drainage keeps the subsoil for a great distance free of salinity and fresh water from the rainfall is retained. Thus, the special effect of the drainages is much more than 50 acres per kilometer. The Committee would, therefore, advise an aggressive programme of drainage with sluices and controls and a parallel programme of utilisation of kutcha wells for rabi cultivation.

8.42 In Balasore on similar terrain, while the sub-soil water is high, people use what are called "pat" wells which are shallow wells 10 — 25 ft. deep using clay rims (baked) by potters. This can be tried there, incidentally giving employment to the potters. The clay in these parts Is suitable even for Raniganj tiles. There is, there-fpre, np difficulty in making 'pat' well rings,

8.43 Another aspect which the Committee would like to stress is the development of a comprehensive plan of irrigation through drainage and optimum utilisation of tank development. The economics of tank development are favourable and hence need to be encouraged. Per hectare cost of the improved drainage system, which will support a second crop, was well within Rs. 5,000 and hence a major development of this sys'em was warranted. As regards ground-water, the studies made have indicated promising fresh water, acquifer over laid by a saline ground water body. While the upper acquifer is generally saline, the lower acquifer of thickness ranging from 25 to 60 m. occurs from about 190 to 300 m. below land surface and is fresh. So far the groundwater development in this area is insignificant compared to the vast potential established. The Committee has dealt with the steps necessary for exploitation of groundwater in paras 77 to 86 of the Chapter on "Irrigation Drainage and Salinity Control" of this report.

Crop Planning

8.44 It has already been established that the yield of traditional paddy varieties grown during kharif in this area is rather low at present, but can be stepped up considerably by developing improved strains of paddy which are more resistant to salinity, tall in stature, have short duration maturity periods and need minimum irrigation. The Central Soil and Salinity Research Institute at its Canning Research Station (located in the Sundarban area) has been doing good work to improve the rice varieties suitable for kharif cropping and to identify suitable crops and development of their varieties for rabi cultivation.

8.45 We have already pointed out that if energetic steps are taken for appropriate development of tanks to store rain water, there are immense possibilities of increasing the second crop acreage and also raising the yields of the crops grown therein.

Horticulture

8.46 The Sundarban Development Board has already established that there is considerable scope for development of vegetables which have a ready market in the nearby Calcutta city, and crops like chillies and water melon. There is no proper technical support or system for supply of high quality seeds. The programme is sponsored by field workers without any high technical expertise. Necessary services are also lacking. Committee during its visit saw Mosaic disease in lady finger which can spread to water melon, mung and other crops. High quality seeds, which are disease,

resistant, are now available. The Agriculture Department has to provide the field support. Unfortunately, they take no part in the programme. This is a tragedy because the Benoir system of extension has been accepted in West Bengal and it is not clear that what other job they have got to do in the Sundarban areas. Under Benoir system they should be able to actively support the rabi programme and see to the right inputs being provided1. Further, the field workers of SDB deal only with small and marginal farmers. There is no information about the involvement of larger farmers in the programme. Our objective in backward areas is all round development. So production increase in the large farms is also necessary for overall economic development of the labouring classes. That there is a significant effect is seen by this fact that in Kuemurl it was found that in 1980 agricultural labour wages were as high as Rs. 8 to Rs. 10. The SDB should also take no!e of the need for overall development.

8.47 Coconut cultivation can go up substantially and the field enquiries show an awareness. But there is no arrangement to supply good quality seedlings either for 'Dab' or 'Hardnut'. Agriculture Department is aware of the national Compaign to utilise the TXD or DXT hybrids in the hardnut variety. Yet, not one hybrid nut has been supplied in Sundarban, the most potential area for coconut cultivation. Many states have started base farms for producing these nuts, Kasargod also supplies annually a limited amount of nuts to each state. No attempt appears to have been made to tap this potential for rapid economic growth in the coastal area. As one enters Sundarban from Calcutta along the main road to Roydighi, one comes into the Bagan area of West Bengal. It is not clear why the Sundarban area adjoining cannot be made into Bagan areas by concentrated effort once the drainage channels open up the fresh water recharge. Custard Apple, Sapita, Mango, Jackfruit are all fruit areas already known to the people and can be grown with benefit. In this the coordination role of the University and the State administration and both of them with the SDB is necessary.

8.48 The Sundarban Development Board should also consider temporary hiring of services of outside expertise like that of Experts from Kerala on development of high-yielding varieties of coconuts.

Fisheries

8.49 It has already been pointed out in para 23 above that next to agriculture, fisheries provide the main source of employment and production and that there is lot of potential for the development of fisheries in this area, particularly when there is a readily available market iri the nearby city of Calcutta.

8.50 The Committee has dealt with in great detail the steps necessary for undertaking brackish wafer fisheries in the relevant Chapter. The recommendations made therein are applicable to the Sundarban also. In fact, the Committee has discussed in that Chapter the scope for encouragement of fisheries in the moderately saline and moderately tidal amplitude zones like Sundarban. The Committee has pointed out therein that it is not economically advisable to stick to 'bhericulture' and it is desirable to follow a 'culture fisheries' approach. The Central Inland Fisheries Research Institute at its kaka-dweep Station and the West Bengal State Fisheries Development Corporation have undertaken some pilot programmes for development of brackish water fisheries. The Committee has analysed the project profile prepared by the West Bengal State

Fisheries Development Corporation in the relevant chapter. The scheme analysed by (he Committee indicates that it is highly capital-intensive. However, the Corporation has designed two other programmes — one at Baruipur and another at Jharkhali where the per hectare cost is much lower. The design has to be extremely location specific and full benefit should be taken of the nearness of the tidal water and the present Contours of the land. The Committee would reiterate that the recommendations made by the Committee in the chapters dealing with the development of fisheries could be developed on the right lines, it would open up considerable avenues of income in the Sundarban. .

Animal Husbandry

8.51 A visit by the Committee to Sundarban indicated that there is no technical support for animal husbandry in this area. At D ak shin Bar a-sat, the Committee found that a person taking to pure exotic pig breeding cost heavily for lack of technical health cover and prompt advice. The frozen semen artificial insemination which is supported by Operation Food is not working here. It is time the link up between high technical infrastructure and advice is linked up with the field programme by a coordination structure.

Village and Cottage Industries

8.52 The Committee has already dealt with the problem in its report on the development of village and; cottage industries'. All that the Committee would like to point out here is that bee keeping is one of the fields which holds bright prospects for enhancing the production of honey in the area. The development of bee keeping as a household industry need not be over-stressed Even the students can be taught the art of bee keeping in the boxes. The training for the purpose is rather simple and the cost of boxes is also low. Supplemental income to students can help them in pursuing further studies. Cooperative Societies would appear to be the right agency for this purpose.

Transport

8.53 The development of transport would seem to hold good prospects in enhancing the mobility of the local people and in making their produce more marketable. It was noticed by the Committee that the addition to cost through transportation was rather very small compared to the additional benefit it brought in enhancing the price at which the product could be sold in the rather distant markets. The cost of transport of one quintal of vegetables from the Headquarters Jetty to Kakadweep was only Rs. 2 and the cost for watermelon only Rs. 1.50. This showed a highly efficient water transport system which coul3 be further improved by providing out board motors. Inland water transport being the main mode of transport, the development of boats was the natural solution. The Committee would suggest that either loans should be advanced to individuals who want to adopt plying of boats on commercial basis or to Cooperative Societies for owning and renting the services of the boats.

Credit

8.54 The Committee observed during its visit that the role of credit in the developmental efforts was not up to the mark. In a particular block which the Committee

visited, it was claimed that an annual credit to the tune of Rs. 8 lakhs was being advanced, yet there was hardly any development to justify that amount. The Committee would stress that credit must be linked with the development of individual families of the area. It was also noticed that the block authorities had no information on the activities of the Land Development Bank covering the area nor was the United Bank, with impressive rental accommodation, pursuing capital investment in agriculture. This would require to be looked into.

Organisation & Personnel

8.55 A development project with the assistance of the International Fund for Agricultural Development has since been taken up and its implementation has started during 1981-82. A new project organisation is being set up vide chart at I. Annexure 8.1.

8.56 While the organisational set up appears to be prima facie satisfactory, the Committee would strongly urge that the concept of delegation of powers, both financial and administrative, as recommended by it in its report on "Organisation of Administrative and Financial Structure for Backward Area Development" should be fully implemented if the organisation has to be effective. Also, it would be necessary that proper linkages are established with the State level Technical Departments so that expert advice and technical guidance at a higher level is available to the personnel working in the Sundarbans organisation. It is not known whether the technical personnel in the proposed organisation are being taken on deputation from the existing Departments or they are being recruited directly from the market. Without knowing the full details, the Committee is unable to comment on the merits of the organisational set up. The Committee would, however, stress that it is best that the technical expertise is drawn from the parent cadres. Such an approach would enable the organisation to send back those who are found wanting and not get burdened with unwanted staff. Also, in due course, the staff would get frustrated unless they are linked up with a major cadre.

8.57 Most of the project area in Sundarbans lacks basic amenities for personnel to stay within the project area. It is essential that as many of the project personnel as possible stay in the project areas and do not have the tendency to stay in nearby Greater Metropolitan Calcutta and come for work to the project. For this purpose, it is important that the policy recommended by it in the chapter on "Personnel Policies" in its report referred in para above are also kept in view while implementing the new organisational set up.

General

8.58 During its visit to a block, the Committee observed the absence of some of the key personnel like B.D.O. and others. Some of the posts had not been filled for quite some time. Eight of the top posts were vacant. Administrative apathy on this score has to be viewed with concern. Furthermore, it was gathered that of the officials supposed to be working in the block, a majority would be away for major portion of the time to the urban centres to which they belong. They stay in common mess leaving their families elsewhere. Lack of amenities hindered the availability of the personnel in the area. It was suggested that a probe be held among the present personnel to find out as to the variety and degree of incentives which could keep the personnel in the area. The

alternatives suggested are: —

(1) Housing and Medical, Education Faci-lities and/or

(2) Incentive for maintaining two establishments.

8.59 It was noticed that family-wise approach had not been adopted. In this context the adoption of the Tamil Nadu example in Somangalam is stressed. In the overall project formulation of the area no real coordination takes place between Block work and work of the departments. It is stressed that an appropriate link up with the Panchayat Samiti and others need to be agreed upon to have a workable plan of action.

8.60 The Committee would like to express its general appreciation of the approach being followed by the Sundarban Development Board. Not only it has adopted the right approach but also introduced quite a few innovations which would not only help the development of this area but could also prove as a pace setter for similar area in other parts of the country.

Sd/-

(B. Sivaraman)
Chairman

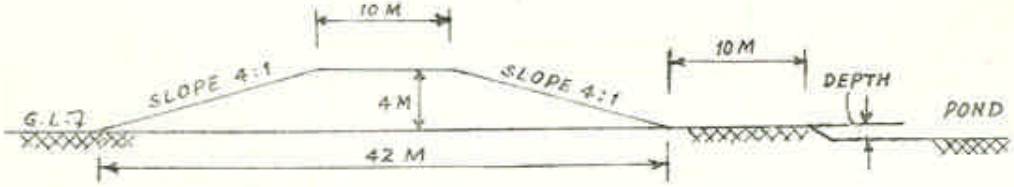
New Delhi,

12th November, 1981.

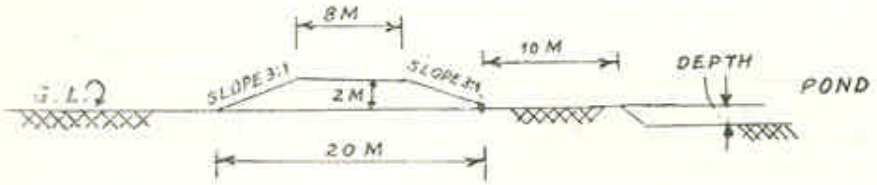
INDIA

SUNDARBAN DEVELOPMENT PROJECT

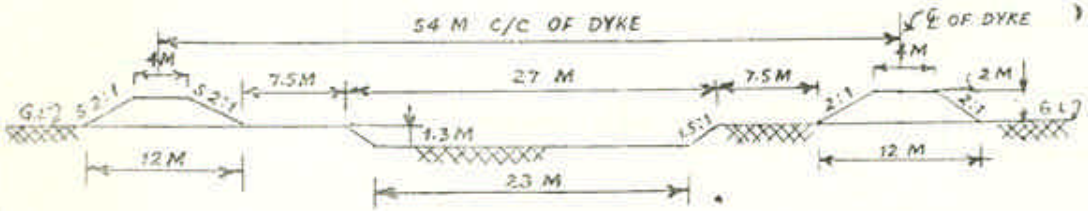
PROPOSED BRAKISH WATER FISH FARM ON MAHISANI ISLAND



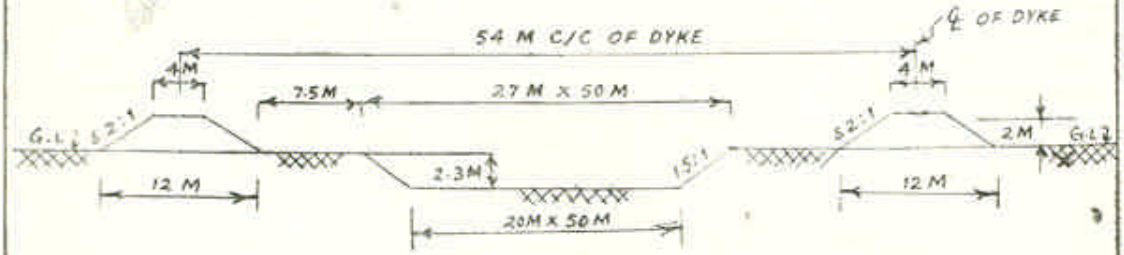
CROSS-SECTION OF MAIN DYKE



CROSS-SECTION OF SECONDARY DYKE



CROSS-SECTION OF FEEDER CANAL AND CANAL DYKES



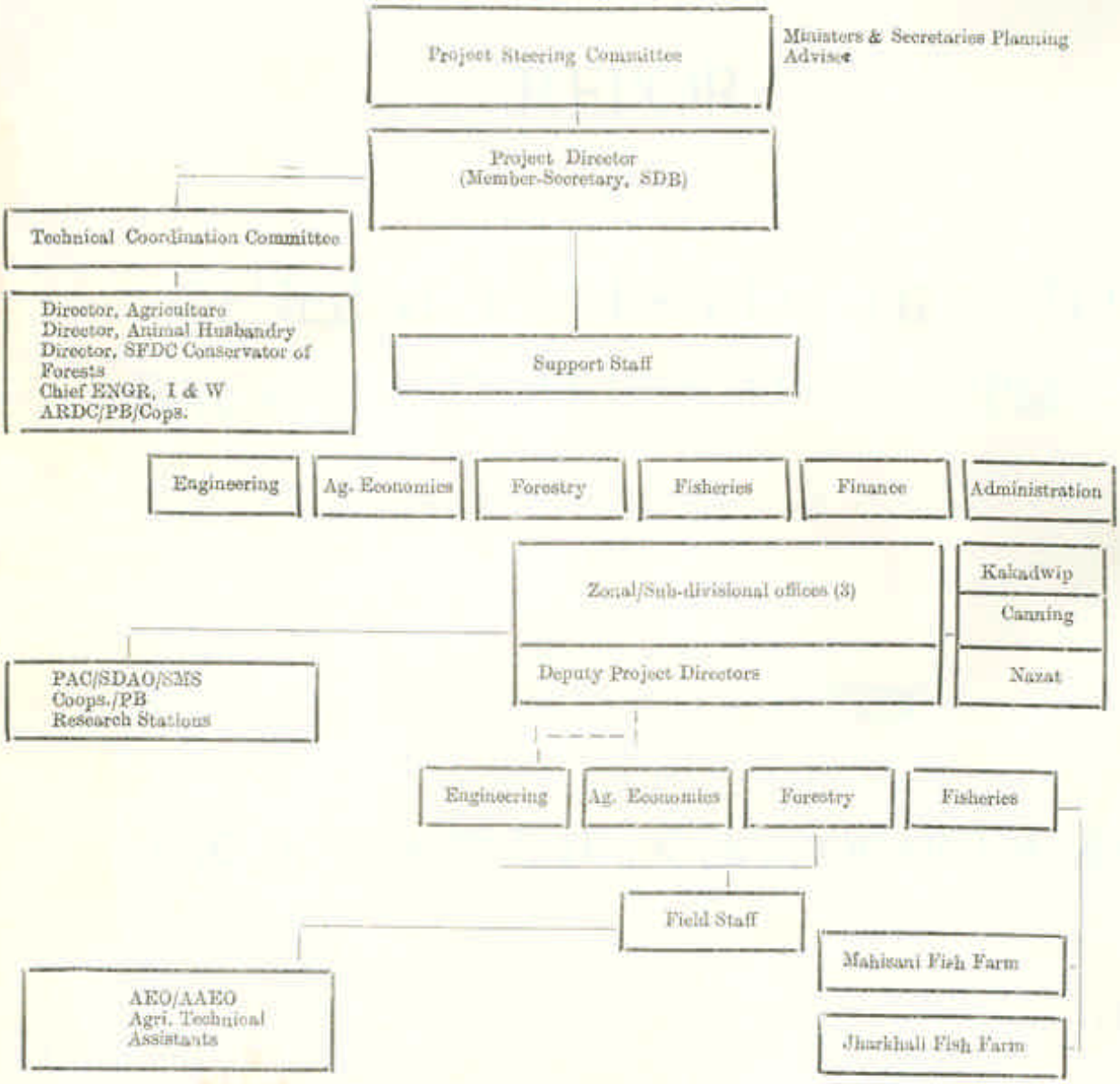
CROSS-SECTION OF SILT TRAP

SCALE : 1 CM = 4 M

111-112

INDIA
SUNDARBAN DEVELOPMENT PROJECT (with IFAD assistance)
PROJECT ORGANISATION

(This is being set up. Implementation has started from 1981-82)



SDB : Sundarban Development Board
PAO : Principal Agric. Officer
SDAO : Sub-divisional Agric. Officer
SMS : Subject Matter Specialist
PB : Participating Banks
AEO : Agric. Extension Officer
AAE : Assistant Agric. Extension Officer

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