3.5.2 Water Resources Development Plan

(1) Reliability of Water

The main objective of the rehabilitation of this tank and water resource development is to assure irrigation water supply to the crops in the tank command area. The rainfed tanks depend on rainfall for their inflow, which is a concerning the reliability, however, it is possible to estimate the frequency of occurrence of storms, based on past rainfall record of the area. According to the Indian Meteorology Department, the definition of drought is based on the seasonal rainfall deficiency and the following classification was made based on the total seasonal (September - December) rainfall occurred in a particular calendar year; (i) Excess > 1000 mm; (ii) Normal 750 - 1000 mm; (iii) Deficit 500 - 750 mm; (iv) Scanty < 500 mm. Thus the probability of the availability of water is estimated as presented below.

Liability of Water Based on Rainfall

Classification	No. of Years	Total No. of Years	Probability (%)
Excess	10	60	16.67
Normal	19	60	31.66
Deficit	17	60	28.33
Scanty	14	60	23.33

Among the 60 years period, 31.66 % of the years are classified as normal followed by deficit years, 28.33 %, and scanty years 23.33 %. The excess rainfall occurred only in 10 years accounting for 16.67 % of total years.

Apart from this, another important aspect is the occurrence of drought or flood based on the rain storm. The choice of long return periods will result in large system capacities, the cost of which is often prohibitive. On the other hand, shorter return periods would result mostly in partial crop failures and/ or reduction in crop yields. As the basic data necessary for the these procedures such as yield variations due to water deficit and price fluctuations are not available, the selection of design return period will have to be based on the past experience, both local and foreign and judgment. The current practice is to use a 5 year return period (probability 20%) for drought rainfall. For a 5 year return period, the drought monsoon rainfall is estimated as 975 mm.

The above facts and figures lead to develop drought management strategies as follows:

a) Expansion of minor irrigation and promotion of rain water harvesting techniques such as percolation ponds and the joint and efficient use of different sources of water through village level and tank water user's association.

b) Developing and introducing a Monsoon Management Strategy, based on crop life saving research and contingency plans to suit different weather probabilities, so that adverse impact of unfavorable monsoons on crop cultivation can be minimized.

c) Ensuring that harvesting rainwater and adopting efficient system of irrigation water management become a way of life, as in the past.

d) Supporting anticipatory research designed to enhance village capability to meet potential changes in precipitation for planning the use of land and water scientifically and conserve common property resources such as Echur Tank and community wells.

(2) Water Quality

The water quality tests based on its pH and electrical conductivity in the Pilot Tank Areas were conducted by the Study Team during the field inspection.

According to the FAO (Irrigation and Drainage Paper 29 rev.1), the degree of restriction of the water for irrigation is defined based on its electric conductivity as tabulated.

Irrigation Water Quality

Electric Conductivity	Degree of Restriction
less than 0.7 dS/m	No influence
0.7 to 3.0 dS/m	Slight to moderate
more than 3.0 dS/m	severe

The remaining tank water rather shows alkalinity but does not exceed pH 9.0, and EC shows less than 0.3 dS/m. Groundwater in the ayacut shows rather alkaline water with pH range between 7.5 and 8.4, besides it, EC indicates less than 0.7 dS/m except tail area of the ayacut. These results shows not so much of salinity hazard to the crops characterized at present.

(Unit μS/cm)

Crop	Yield Potential			
	100%	90%	75%	50%
Cotton	5,100	6,400	8,400	12,000
Groundnut	2,100	2,400	2,700	3,300
Paddy	2,000	2,600	3,400	4,800
Carrot	700	1,100	1,900	3,100
Cucumber	1,700	2,200	2,900	4,200
Onion	800	1,200	1,800	2,900
Pepper	1,000	1,500	2,200	3,400
Tomato	1,700	2,300	3,400	5,000

(3) Irrigation Water Requirement

The major and dominant crop in the tank study area is the paddy rice. Based on the long term climatalogical data, reference crop evapotarnspiration values were calculated using the Penman method. For the rice crop, the crop coefficient values vary from 0.8 to 1.1. After taking into account the percolation losses of 3 mm/day for red soils and monthly effective rainfall the gross irrigation requirement was estimates as shown in Table 3.5.3, assuming an irrigation efficiency of 40 %. The entire registered ayacut of 58.68 ha is divided into three blocks to stagger the crop

planting period. By this procedure the seasonal irrigation water requirement for Echur Tank is calculated as 0.988 Mm^3. At present, the field irrigation channels are made up earthen materials which facilitate heavy percolation and conveyance losses. By lining the entire portion of field canals, the irrigation efficiency will be increased to near 75 %. This increased efficiency will decrease the irrigation water requirement to 0.567 Mm^3 per season. By lining only, nearly 0.421 Mm^3 per season of water is saved which can be used to irrigate additional area or stored in the tank to raise a second irrigated crop in the following months.

(4) Water Balance

The inflow to the tank and the outflow from the tank are the only two factors which govern the storage capacity of the tank. Since the inflow to Echur Tank entirely depends upon the monsoon rainfall (over a free catchment area of 1.57 Km^2) which is variable, water stored in the tank to cater the irrigation requirement also varies. Naturally if more outflow is required, more capacity has to be provided, if there is a ample supply of water. The tank capacity, inflow and the outflow from the tank are governed by the storage equation, given by

[Runoff] - [Evaporation]-[Seepage]- [Gross Irrigation Requirement] = [Changes in Storage]

The first step in calculating the water balance is estimation of runoff based on the daily rainfall data using the dry-damp-wet method. The evaporation losses are estimated from the waterspread area-elevation curves and the surplus water flowing out is predicted from the capacity-elevation relationships. Detailed water balance analysis was carried out.

By topographic survey, the capacity of the tank is determined as 0.464 Mm^3. As per the annual (January - December) water balance calculations for the years 1986 - 1995, (Table 3.5.4 and 3.5.5) under the present irrigation efficiency of 40%, the irrigated area varies from 4 % to 100 % of the registered ayacut. In average, the tank water could irrigate only 32 % of the registered ayacut. Among the last 9 years, spill-out occurred only in two years namely, 1993 and 1994 accounting for 22.2 %. The average value of runoff - irrigation water requirement is 86 %. By canal lining it is possible to increase the irrigation efficiency to 75 %. In such case, near 100 % irrigability could be achieved only in two years and average irrigated area raises to 46 % of the ayacut. With the reduced water requirement, the runoff - irrigation ratio is increased to 151 %, implying that, if evaporation losses are controlled and tank capacity is enough, it is possible to irrigate the entire ayacut with tank water. The monsoon (September - December) also shows the same trend, but little bit increased the leakage of spill out and decreased runoff-irrigation ratio. However, in both cases, under improved irrigation efficiency also, 100 % achievement in irrigated area is not observed. Hence, along with canal lining, it becomes necessary to increase the tank storage by desiliting.

(5) Drainage Water Requirements

The peak flow for a given drainage basin is the rate of flow following a storm at the instant when drainage is great. The design of the water control structures depends largely on the expected flood discharge. This drainage water requirements considerably vary with the topography of the tank area. The peak runoff rates are mainly conditioned by the natural drainage. In Tamil Nadu, for computation of maximum flood discharge the Ryve's formula is used.

$Q = CM^{2/3} - cm^{2/3}$

where; Q = discharge in cusec
C = 500, runoff coefficient
c = 100, 1/5 of C
M = Area of combined catchment in sq.miles
m = area of intercepted catchment in sq.miles

Therefore; $Q = 500 \times 0.606^{2/3}$
$= 358.06$ cusec
$= 10.14$ m^3/sec

Another scientific method to determine the drainage water requirements is rational method which states that:

$Q = CIA/360$

where Q = Peak rate of runoff in m^3/sec
I = Intensity of rainfall in mm/hr for a duration equal to time of concentration
C = Runoff coefficient = 0.5 for agricultural areas
A = Area of equivalent catchment (ha)
$Q = (0.5 \times 90 \times 157)/360 = 19.63$ m^3/s

Both estimation results in the Pilot Tank areas are summarized in Table 3.5.6.

From the hydrological point of view the rational method is preferred over empirical method and also considering the safety allowance for the drainage structures, the value of 19.63 m^3/s is to be taken as the design flood discharge, after considering the seriousness of disaster, local loss, inconveniences. This estimated drainage requirements needs to be utilized for determining the spillway structures, their by reducing the chances of being overtopped and consequently damaged.

(6) Basin Water Management

Even though, Echur Tank is an isolated tank, there are many tanks located very closely, forming a basin grid influencing the hydro and socio-environment of Echur Tank. In Chain tank basin management there are three aspects viz. (1) Hydrological (2) Socio-economical and (3) Administrative & financial aspects.

1) Hydrological and Socio-economical Aspects

Echur Tank basin water management covers a large field encompassing many scientific and engineering disciplines such as meteorology, hydrology, hydraulic engineering, foundation engineering, agricultural engineering and agronomy. Hence, there exist several factors (such as some ratios) that affect the irrigation or water management of this tank. A comprehensive information on all Pilot Tanks are available in the Table 3.2.1.

i) Ratio of Free Catchment - Command area

Since Echur Tank is a rainfed tank, it is important to know the ratio of catchment to command area because, the tank storage is entirely a function of quantity of rainfall received in a given time within the free catchment of the tank. It was found that Echur Tank has a free catchment which is 2.68 times more than that of the command area. This indicates that the changes that take place as a result of encroachment and social forestry which can drastically cause a reduction in actual command area of the tank even during average annual rainfall years.

ii) Ratio of Tank Waterspread Area and Command Area

Larger the waterspread area indicates greater losses by way of evaporation. A more precise and appropriate way to define larger waterspread area is by the ratio of waterspread area to command area. The ratio is 0.72, which implies that for every ha of waterspread the tank irrigates 0.72 ha. This indicates that the shallow storage and suggests for policy implications on deepening the tank by way of desiliting which could increase the command area by:

- Increasing the storage capacity of the tank
- Vegetative method of soil and water conservation system such as use of grasses for controlling the soil erosion in catchment areas of tanks that have proved cheaper and more effective when implemented correctly. This system will go a long way in reducing siltation of tanks to great extent and to increase their life.
- Reducing the evaporation losses by larger surface area exposed to the sun. As evaporation has disastrous effects in hot dry climate zone

because they account for nearly 10 - 15 %.

iii) Ratio of Tank Waterspread Area to Capacity

This ratio is 0.905 km^2/Mm^3. Engineering solutions like raising the bund height and temporarily store the surplus by storing the surplus by placing wooden or metal shutters in the surplus weirs shall only increase the waterspread area thereby exposing a larger waterspread area for evaporation. Hence permanent rehabilitation measures need to be developed.

iv) Ratio of Capacity to Command Area

This is 0.008 Mm^3/ha. Even by assuming that the tank has two fillings on an average, it could be quite evident that the water availability of this amount is far less than the irrigation requirement of 0.016 Mm^3 for a single crop of rice under the current levels of efficiencies (storage, conveyance, and field application). Existing designs and management procedures make it almost impossible to provide a timely and reliable water supply for modern agriculture based on high yielding crops. Furthermore, actual water conveyance losses are much higher than assumed for the design of canal systems, which reduces the area that can actually be irrigated.

The surface water resources of Echur Tank basin consists of direct runoff from rainfall and flow in streams. However, irrigation is largely depend on available tank water and ground water. The total groundwater recharge of the Tirukalukundram block to which, Echur Tank belongs was estimated to be 8,152 ha. Utilizable recharge is 6,929 ha.m, Net groundwater draft is 4,222 ha m and the balance available is 2,707 ha m. Hence, remaining 39.06 % of groundwater resources is available for exploitation. Similarly, the total surface water resources can not be utilized due to certain limitations, as under:

- Topographical, geological, technological and environmental constraints
- Constraints in the utilization of flood flows. Concentration of surface flow in four monsoon months necessitates proper tank rehabilitation storage structures.
- The utilizable quantum also depends on the quality of water being suitable.
- The non-proximity of water to the land fit for cultivation. Tail end farms are too away from the tank.

Hence, conjunctive use of surface and ground water needs to be promoted. Some of the different variables involved in the process of conjunctive use of surface and ground water resources are:

- Monsoon irrigation from tank and all or most of the early monsoon demands from ground water wells. The withdrawal so effected is quickly replenished

during rainy season. The non-monsoon canal supply thus released can be reallocated to other needy areas which are not equally rich in ground water resources.

- Tail end farms of the tank basin command area are usually subject to chronic shortage. Surface and ground water resources can be pooled with advantage in such areas.
- Reduction to some extent of tank supplies to private well command area so as to improve utilization of ground water resources without affecting crop adversely
- Having exclusive command area for tanks and wells. Ground water wells can either then intersperse or fringe the tank command area.

2) Constraints and Potentials for Development

The total irrigation potentials created from the chain tank in the basin is not being utilized for the following reasons.

- Lack of or inadequate field channels
- Inadequate drainage facilities, seepage, impeded drainage, absence of field drainage channels.
- Inadequate preparation of land for irrigated agriculture such as poor land size and shape, poor leveling and so on.
- Inadequate water supply, wasteful use of water, maldistribution of available water and tail end difficulties for water use.
- Improper crop planning and scheduling of irrigation without having a scientific view on availability of water, soil type and regional agro-climatic conditions.
- Lack of supplemental irrigation
- Lack of proper coordinating agency or deficiency in its functioning amongst PWD, agriculture, revenue and cooperative finance departments

However, there are considerable scope and it is feasible for further development through better water management through economic utilization of basin water resources and augmentation of the supplies by tapping new water resources of storage under:

a) Conservative Water Use

Comparatively new and unconventional methods like sprinkler and drip systems of irrigation avoid loss of water through percolation and evaporation and hold great saving of water to the extent of 50 % compared to presently practiced irrigation methods. As a rehabilitation measure, conveyance losses can be reduced by lining the canals. Dry land technology may be adopted to grow crops under poor reach conditions.

b) Artificial Recharge

In large irrigated areas, there are attractive possibilities of providing underground storage through recharge provided by irrigation as well as excess rainfall in wet years for use in the dry years. Percolation tanks may be constructed at suitable places for replenishing the underground water.

c) Command Area Development

It is to increase the already created irrigation potential to secure optimum crop yield per unit of water, per unit of land and per unit of time.

d) Increasing the Irrigation Efficiency

Water application efficiency needs to increased (from present 45 % to 75 %) by canal lining, land shaping, smoothening the land slope, and optimal plot size. With increased efficiency more areas can be irrigated with the same amount of water.

e) Change in Cropping Pattern

Emphasis on high water consuming paddy need to be shifted to growing cereals requiring less water like maize, pearl millets etc.

f) Equitable Water System

Farmers assured of equitable and adequate supplies desist from over-irrigation. Volumetric supply of water needs to be encouraged and water rates charged on volumetric basis rather than present carpet rate of Rs.35/ha.

g) Flood Use

Farmers generally welcome floods to certain extent for they bring manurial silt. What is desired is control of floods during the early part of monsoon in time for nursery preparation of paddy. Apart from tanks, storage of flood water in local depressions like percolation ponds, where feasible need to be encouraged.

h) Grid of Water System

Inter basin transfer of water resource from tank areas where surplus water available to tank areas of scarcity is one of the promising means for augmentation of water resources. Thus all supply channels, tanks, *uranis*, and pools of the sub-basin should be linked so as to form one single system.

i) Evaporation Reduction

Attempts need to be made to reduce evaporation by controlling the rate at which water escapes from water surface of the tank by covering the water surface with a thin mono-molecular film. It was found that hexadeconal or acetyl alcohol is effective. It is considered that evaporation losses may be reduce by one third. A reduction of wind speed by wind breaks is the another method used for controlling evaporation since wind velocity has profound effect on evaporation. However, the cost-effectiveness needs to be studied in detail.

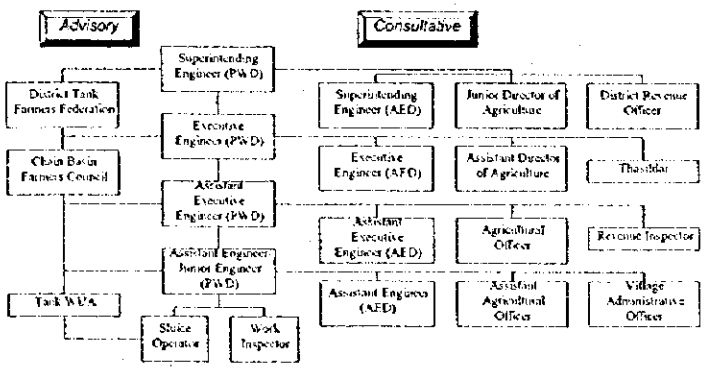
3) Administrative and Financial Aspects

In chain tank basin management, the important aspect is the participatory and chain basin approach to the tank rehabilitation. Moreover, a comprehensive and systematic program for the repair and maintenance of chain of tanks is necessary. This can be achieved by formation of multi-tier farmers association. By this approach, all farmers from catchment to farm level in the chain will form

Tier	Association	Level	Responsibilities
I	Echur WUA	Tank/village	To identify and suggest need based tank management program
II	Palar Minor Basin Farmers Council	Minor/chain basin	To resolve conflicts arising among the chain of tanks
III	Kanchipuram District Tank Farmers Federation	District	To identify the opportunities available for inter and intra chain basin water transfer

one single association of their own with specific responsibilities as shown below.

Eventually the WUA need to be made as a multipurpose organization with the responsibilities of equitable water sharing, financial contribution to the tank rehabilitation and maintenance. The techno-mangerial quality control guidance will be provided by PWD. Later training need to provided to farmers on scientific water management and improved agricultural practices. The proposed advisory, consultative and administrative set up for Echur Tank basin management is illustrated in the figure:



PROPOSED ADVISORY, CONSULTATIVE AND ADMINISTRATIVE SETUP FOR CHAIN BASIN MANAGEMENT

(7) Groundwater Development

As shown in Table 2.3.1, the groundwater in the region has been highly exploited by the formers for intensive cultivation. This has resulted in the lowering of groundwater table. Inspite of this more groundwater development can be carried out in this region if jointed and fractuated zones are identified by intensive subsurface studies using geophysical methods.

3.5.3 Tank Irrigation Facilities Rehabilitation Works

General layout of irrigation facilities is shown in Fig. 3.5.1, and required items for rehabilitation works are described in the table.

Countermeasures for rehabilitation of Echur Tank

Component	Rehabilitation works	Section for Rehabilitation Works	
Tank Bund Improvement (Total bund length 1218m)	• Strengthening of the bund for reshaping to standard size.	298m	
Intake works (Sluice)	• Modification of intake system using gearing shutter • Protection of back-fill for side slope.	Wing wall type Tower head type	2 units
Surplus arrangement	• Widening as 16.5m of width of Bye-wash type weir. • Provision of rough stone for revetment	Bye-wash type weir	1 units
Selective Lining for Field Channel including On-farm development	• Installation of lining canal up to 10ha • Provision of diversion boxes with paddle shutter for equal distribution. • Reshaping of existing canal. • Provision of incidental device such as cart, cattle, and canal/crossing.	600m as main 1,350m as branch	2 units 3 units
Building for Farmers' Association	• Provision of community hall for WUA, local farmers and inhabitation.	50m^2	1 No.

3.6 Farmers' Organization

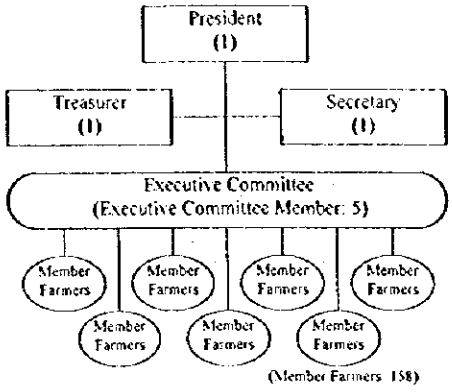
3.6.1 Present Situations of Farmers' Organization

There is no such registered organization as water users' association in the ayacut area as described in Sub-chapter 3.3.1. They have their informal society for water distribution appointing *Neerkatis* for monitoring water distributions.

3.6.2 Proposed Farmers' Organization

(1) Water Users' Association

Since there are 166 farmers in the ayacut areas, the number of the Executive Committee Member becomes to be five (5) and the number of member farmers is 158 deducting the number of office bearers from the total farmers. The functions of the proposed WUA for Echur Tank are described in Sub-section 4.3.4 of Volume II: Master Plan Report



PROPOSED ORGANIZATION FOR WATER USERS' ASSOCIATION OF ECHUR TANK

(2) Farmers' Organization for Agricultural Production

As explained in Sub-section 4.3.4 of Volume II, the sections which have the following functions are proposed to be attached to the WUA in Echur Tank areas to realize sustainable agricultural development.

- Operation and maintenance technology for water-saving irrigation
- Agricultural technology extension services crop diversification and value-added agriculture, etc.
- Various agricultural supporting services such as supply of agricultural input materials, marketing, including agricultural credit services

3.7 Project Evaluation

3.7.1 Project Costs and Benefits

(1) Project Cost

Unit cost for rehabilitation works are estimated based on the *Standard schedule of Rates for Anna & M.G.R District* issued by PWD. At the 1997 price level, direct construction cost is estimated at about Rs. 1,717,000, as shown in the table.

Direct Construction Cost for Echur Tank

Rehabilitation Work	Cost (Rs.)	Percentage	Unit Rates (Ayacut 58.68ha) (Rs./ha)
Tank Bund Improvements	13,000	0.76%	222
Sluices Improvement	196,000	11.42%	3,340
Surplus Improvement	113,000	6.58%	1,926
Tank Supply Channel Improvement	-	0.00%	-
Selective lining for Field Channel & OFD	1,265,000	73.68%	2,1558
Building for Farmers' Association	130,000	7.57%	2,215
Community Well	-	0.00%	-
Direct Construction Cost	1,717,000	100.00%	

The Project cost consisting of direct cost, supervision charges, contingencies, preparation work cost and overhead charges is Rs.2,523,000, as shown in the table.

Project Cost for Rehabilitation Works in Echur Tank

Description	Cost (Rs.)
Direct Construction Cost	1,717,000
Petty Supervision Charges & Contingencies	276,000
Preparation Cost (Govt. Share)	25,000
Overhead Charges	505,000
Total	2,523,000

Economic price for the economic analysis is estimated using the conversion factor (SCF, 0.8) for the direct construction cost.

(2) Project Benefits

The Project is aimed mainly at stabilizing the agricultural production through the year in the relatively small command area of about 58.7 ha by a better water supply from the tank and the introduction of proper agricultural production techniques for better farming system for higher farm revenues to improve living conditions of small and marginal farms after the rehabilitation works.

At present, though the command area is dominantly cropped with paddy for double crops in a year from August to April, but the cultivated area for the second paddy crop starting from January to April has been occurred in only a limited part (10 ha) of the whole command area due to lack of water supply from tank. The whole command area is mostly left in fallow condition from May to July.

With the Project implementation, major benefits of the Project, therefore, will economically come from two sources: 1) increases of crop benefits, and 2) value-added benefits from post-harvest treatments.

For the increases of crop benefits, the present total cropping areas will be increased for about 120 %, from 59.0 ha to about 71.6 ha. The areas for paddy cultivation would be changed only by a rather larger area for the second crop Paddy yields will be made for 5.0 tons per ha from the present figure of 4.65 tons. The present area for the second crop, paddy (10 ha) and groundnut cultivation (2 ha) will be shifted to paddy (5 ha) and vegetables (ladies' finger-Okura, 19.6 ha) for higher farm incomes. This will result in the increase in net production value from presently about Rs. 1.0 million to approximately Rs.1.7 million (Table 3.7.2). Economic price of rice is shown in Table 3.7.2.

Besides, with the establishment of various facilities for organizing farm management and improving treatments on storing, marketing etc., an estimated amount of value-added of about Rs.0.1 million as 5 % of the net agricultural

production value "with Project" in this tank area would be obtained accordingly.

3.7.2 Economic Evaluation

The economic evaluation to judge the project viability in terms of direct contribution to the national economy. The Project covers a command area of 58.6 ha with a total number of 166 farms for a total number of approximately 750 beneficiaries.

For the economic analysis, applying the standard conversion factor (SCF) 0.8, the related EIRRs for Echur Tank area, therefore, are as follows:

i)	EIRR in basic conditions :	22.8 %
ii)	EIRR at 10% cost-increase:	20.6 %
iii)	EIRR at 10% benefit-decrease:	18.9 %
iv)	EIRR at 3-year benefit delay:	14.1 %

From these figures, the EIRR in basic conditions of 22.8 % shows the Project viability. Even the risk case of 3-year delay of benefits showed the lowest EIRR of 14.1 % which is also a high EIRR figure.

3.7.3 Financial Evaluation

In this Project, the financial evaluation is made for mainly dealing with the analysis of farm budget for the representative farms in both cases of "without project" and "with project". The related results are calculated for a representative farm as follows:

-	"Without Project" Net Income per Farm:	Rs.4,798
-	"With Project" Net Income per Farm:	Rs.9,875
-	Value added "With Project"	Rs.494
-	Incremental Net Farm Income:	Rs.5,571

With the project implementation, the increase in annual net farm income for an average farm in this tank area will be about Rs.5,600. This limited amount could improve somehow the farm budgets of small and marginal farms, but for improving the living standards of these farm categories, off-farm economic activities are subjected to be employed largely.

However, in order to achieve these figures, proper supports on technical aspects as well as more investments in farm inputs should be made for small and marginal farms. This should be made in a new scheme of financial support for these farm categories in the newly established farmers' organization.

3.7.4 Labour Force Requirement

Monthly labor force requirement for the planned cropping schedule of each Pilot Tank Area including Echur Tank Area are shown in Table 3.7.3. The peak of labor requirement in the area comes June. The labor force requirement is 4,096 man-day per month. This labor requirement can be satisfied by the staggering period of 6 days when the potential family labor is used. The potential family labor in the area is 697 man-day.

3.7.5 Farm Household Economy

With the Project implementation, the farm household economy of small and marginal farms will be somehow improved accordingly. From the financial analysis on farm budgets of these farm categories, farm benefit of about Rs. 5,100 and a value added of about Rs.500 for a total amount of Rs.6,000 would be annually obtained by an average farm in this tank area.

This amount is somehow modest but with better conditions on water supply and supporting institutions for agricultural production, small and marginal farms would apply various activities of the integrated agriculture for improving their basic living standards.

Even for landless farmers, apart from the proposed work scheme for landless people in the farmers' organization as mentioned in the above, they would obtain more labour works from big and medium farms to support their living expenses. A legislative measure to make big and medium farms in the tank areas hiring on annual basis a quota of landless farmers i.e. 2 males or 1 male and 2 females per ha, if permissible, would be promoted for basically supporting their living.

3.8 Environmental Issues

3.8.1 Present Environmental Conditions

(1) Health and Sanitary Conditions

Major diseases in this area are bronchitis, mumps, diarrhea, dysentery and common fever, however there are only small number of cases occurred. Diarrhea is a seasonal disease occurring in the wet season. In relation to irrigation and drainage, two waterborne diseases, i.e. schistosomiasis and Guinea worm which are found in other places of India, do not occur in Tamil Nadu. Three mosquito-related diseases, malaria, filariasis and Japanese encephalitis which are found in some places in Tamil Nadu, also do not occur in this area. Only rare malaria case found in this area is a case infected in Chennai or other sea shore areas.

(2) Natural Environment

The Tank Area is generally flat land. Catchment area is mostly covered by eucalyptus forest. No aquatic weeds are seen in the tank though tank water at this season is very minimal. Wildlife rarely seen by the villagers are only monkeys and natural birds.

(3) Surface Water and Groundwater

The quality of tank water is found fair for irrigation use even though pH value is relatively high. Groundwater is also utilized widely for irrigation for around three months after the tank water becomes unavailable in the dry season. There are about 70 private open dug wells in the ayacut. From the result of the water quality measurement conducted by the Study Team, it can be stated that the groundwater will have no salinity problems and sufficiently good for irrigation use.

3.8.2 Environmental Impact of the Project

Initial screening of the environmental impact was conducted based on the present environmental conditions of the Study Area and formulation of the Master Plan. Then, as shown in Table 3.8.1 and Table 3.8.2, in the feasibility study of Echur Tank area, the environmental impact by the Project was examined through the field survey and in consideration of the components of the Project, according to the JICA Environmental Guidelines.

(1) Social Environmental Impact

1) Social Institutions and Customs

Introduction of WUA is planned in the Project and such new farmers organization will require changes in existing institutional structures and customs. Since the improved water management system needs a new water sharing arrangement and rather severe water distribution operations, friction and conflict related to the water distribution among beneficiaries may arise. It is also noted that the traditional rural communities based on the village Panchayat are conservative and their social capacity is limited to deal with new changes of the existing institutions and customs.

In order to avoid the friction or conflict among farmers caused by a new water management system, an effective procedure must be carefully taken in organizing the process of a WUA. The sufficient period for preparation activities is required and farmers participation must be obtained. Farmers contribution to the project implementation shall also be considered to enhance the ownership by the farmers. Various farmers training programmes and technical assistance shall be extended by the government agencies with cooperation of NGOs.

Cooperation among government agencies such as PWD, AD and AED is also important for success of the Project.

2) Health and Sanitary Issues

Although present use of agro-chemicals such as chemical fertilizers and pesticides is low due to mainly high prices, as the irrigated agriculture is expanded and the socioeconomic conditions are improved through the Project, the use of agro-chemicals may be increased in the future.

It is considered that the increase of agrochemical use will not be at a rapid pace in this area, however the AD shall give the farmers the guidance for the appropriate use of agro-chemicals and monitor their actual application of natural manure, bio-chemicals and agro-chemicals. For rural health and diseases the Project will not be a cause of any waterborne or mosquito-related diseases.

(2) Natural Environmental Impact

Groundwater with EC value of about 0.65 dS/m is suitable for irrigation, and groundwater in this area will still have development potential.

In consideration of the geographical situation of the area, i.e. 20 m in altitude and 10 km distance to the coastline, likely problems of groundwater development will be the changes of groundwater table and pollution due to sea-water intrusion. The sea-water intrusion, according to the PWD report, has been occurred in the range from 2 km to 8 km in the coastal region of Tamil Nadu.

Although such problems and pollution have not been observed at present in this area it is considered that large scale groundwater extraction will easily lower the water table resulting in the sea-water intrusion. Existing boreholes being used for potable water would be affected at the initial stage of the sea-water intrusion.

3.8.3 Recommendations

As a result of the environmental impact study described above, it can be concluded that the Project will not induce any serious direct negative environmental impact. But, the development activities may induce some indirect impacts. Details are presented in Volume IV of the Report.

i) For the establishment of WUAs, it is recommended that an effective procedure involving NGOs with close cooperation among government agencies shall be provided.

ii) For the expansion of the irrigated agriculture, it is recommended that AD shall extend the guidance to the farmers on agrochemical use.

iii) For the groundwater development for irrigation, it is recommended that the scale of groundwater development and the depth of wells in relation to sea water intrusion shall be carefully planned.

Table 3.2.1 Hydrological Characteristics of Pilot Tank

Pilot Tank	Echur	Cherukkanur	Polambakkam	Enadur	Vadakkupattu	Siruvalai	A. Ramalingapuram	Pandikanmoi	Sengangulam	Kurumbi
Rainfall Station	Chengalpattu	Tiruthani	Madurantagam	Kanchipuram	Sriperumpudur	Sivaganga	Sattur	Paramakudi	Manamadurai	Karaikudi
Basin	Palar	Nandiyar	Kiliyar	Kanchipuram	Adayar	Vaigai	Vaippar	Vaigai	Lower Gundar	Manimuthar
Annual Rainfall (mm)	1,151.1	1,036.9	1,111.5	1,155.8	1,234.9	851.5	719.3	721.4	977.4	1,019.2
South West Monsoon (June-Sep)	454.6	459.4	426.8	515.3	435.6	298.0	159.1	180.9	301.0	404.2
North East Monsoon (Oct-Dec)	603.6	471.4	627.0	535.2	716.6	390.2	370.4	381.9	488.7	458.4
Winter (Jan-Feb)	29.9	27.0	29.3	23.2	30.1	32.2	43.0	43.1	43.7	47.7
Summer (Mar-May)	63.0	79.1	28.4	82.1	52.6	131.1	146.8	115.5	144.0	108.9
Catchement Area										
Free Catchment (Km^2)	1.57	1.96	2.28	14.60	6.32	1.42	6.34	2.60	2.49	2.46
Intercepted Catchment (Km^2)	0.00	0.00	3.69	13.08	4.66	12.77	146.34	0.00	0.00	4.34
Equivalent Catchment (Km^2)	1.57	1.96	3.01	17.22	7.25	3.97	20.97	2.60	2.49	3.33
Combined Catchment (Km^2)	1.57	1.96	5.97	27.68	10.98	14.19	152.68	2.60	2.49	6.80
Tank										
Water Spread Area [WSA] (Km^2)	0.420	0.703	0.887	1.958	1.430	0.357	0.772	0.411	2.075	0.169
Registered Ayacut (ha)	58.680	91.260	94.590	574.670	417.240	49.250	76.550	41.880	99.230	52.670
Capacity (Mm^3)	0.464	1.523	1.507	3.205	2.538	0.374	0.639	0.382	2.124	0.151
Ratios										
Free Catchment/Regd Ayacut	2.676	2.148	2.406	2.541	1.515	2.873	8.282	6.208	2.509	4.669
WSA/Regd. Ayacut	0.716	0.770	0.938	0.341	0.343	0.725	1.008	0.981	2.091	0.321
Capacity/Reg. Ayacut	0.008	0.017	0.016	0.006	0.006	0.008	0.008	0.009	0.021	0.003
WSA/Capacity	0.905	0.462	0.589	0.611	0.563	0.955	1.208	1.076	0.977	1.119

Table 3.3.1 Socio-economic Conditions of Ayacut Areas

Description	Northern Study Area					Southern Study Area				
	Echur Tank	Cherukkanur Big Tank	Polambakkam Tank	Enadur Big Tank	Vadakkupattu Tank	Sirumalai Tank	A. Ramalinga-puram Tank	Pandikanmoi Tank	Sengangulam Tank	Kanumbi Tank
1 District Name	Kanchipuram	Tiruvallur	Kanchipuram	Kanchipuram	Kanchipuram	Sivaganga	Virdunagar	Ramanathapuram	Sivaganga	Sivaganga
2 Taluk Name	Thirukalikundram	Tiruttani	Madurantakam	Kancheepuram	Sriperumbudur	Sivaganga	Sattur	Paramakudi	Manamadurai	Karaikudi
3 Village Name	Echur	Cherukkanur	Polambakkam	Enadur	Vadakkupattu	Paganeri	A. Ramalinga-puram	Pandikanmoi	Sengangulam	S. R. Patnam
4 Registered Ayacut (ha)	58 6	91 3	94 6	524 7	417 3	53 2	75 6	43 9	99 2	52 7
5 Cropping Intensity (%)										
- Average	166	-	127	124	162	100	100	100	110	100
6 Main Crop	Paddy	Paddy	Paddy	Paddy	Paddy	Paddy	Paddy	Paddy	Paddy	Paddy
7 Farm Size										
- Marginal Farmer (Below 1 ha)	67	158	42	357	284	82	40	75	250	79
- Small Farmer (1 - 2 ha)	92	61	81	68	54	20	7	30	39	27
- Medium and Large Farmer (Above 2 ha)	7	9	16	23	17	4	2	5	24	6
- Total Farmers	166	268	139	448	355	106	49	110	313	112
- Share of Marginal Farmers (%)	40	74	30	80	80	77	82	68	80	71
- Share of Small Farmers (%)	55	23	58	15	15	19	14	27	12	24
- Total Share of Marg. and Small Farmers (%)	96	97	88	95	95	96	96	95	92	95
- Ave. Farm Size (ha)	0 35	0 34	0 68	1 28	1 18	0 50	1 54	0 38	0 32	0 47
8 Farmers' Organization										
- Water Users' Association	Informal	Informal	Informal	Informal	Informal	Informal	Informal	Informal	Informal	Informal
- Decision Procedure	Group	Group	Group	Group	Group	Group	Group	Group	Group	Group
9 Caste Composition (%)										
- Others	0	0	9	2	10	10	0	0	0	0
- BC	5	20	35	25	28	12	90	65	95	80
- MBC	50	60	5	25	20	73	0	0	0	0
- SC	42	18	50	47	40	5	10	35	5	20
- ST	3	2	1	1	2	0	0	0	0	0
10 Religious Status	Hinduism	Hinduism	Hinduism	Hindu, Muslim, Christ.	Hinduism	Hindu, Muslim, Christ.	Hinduism	Hinduism	Hinduism	Hindu, Christ.
11 No. of Hamlets in Ayacut										
- Name of Hamlet 1	Echur	Cherukkanur	Polambakkam	Enadur	Vadakkupattu	Paganeri	A. Ramalinga-puram	Pandikanmoi	Sengangulam	S. R. Patnam
- Name of Hamlet 2	-	-	-	Chettierpet	-	-	-	-	-	Nagavayal
- Name of Hamlet 3	-	-	-	Kattavakkam	-	-	-	-	-	-
12 Social Institutions and Infrastructures										
- Drinking Water (%)	100	100	100	100	100	75	100	50		100
(Water Quality)	(Fair)	(Fair)	(Good)	(Good)	(Good)	(Good)	(Good)	(Saline)	(Fair)	(Good)
- Electricity (%)	78	90	64	90	79	80	85	90		60
- School Institutions	Primary (1-5)	Primary (1-5), Middle (6-9)	Primary (1-5), Higher (6-12)	Primary (1-5), Middle (1-8)	Primary (1-5), High (6-10)	Primary x 2 (1-5), High (6-10), Higher (-12)	Primary (1-5), Primary (Pvt.) (1-5)	Primary (1-5)	Primary (1-5)	Primary (Pvt.) (1-5), Middle (1-8)
- Clinic and Health Institutions	None	None	PHC	HSC	HSC	PHC, Maternity Hosp	HSC	None	None	None
- Access Roads	OK	OK	OK	OK	OK	OK	OK	OK		OK
- Cottage Industries Facilities	None	None	None	Champher Factory	None	None	Matches Factory	Charcoal Factory	None	None
- Community Halls, etc	Com. Hall	None	Com. Hall	None	TV Cell (14)	Com. Hall	Com. Hall	Com. Hall	None	Com. Hall
- Wells (Nos.)	70	83	57	55	35	1	2	2	10	?
13 Distance to Towns										
- Main Employment	Thirukalikundram	Tiruttani	Madurantakam	Kancheepuram	Chengalpattu	Sivaganga	Sattur	Paramakudi	Thiruppuvaram	Karaikudi
(Distance km)	(5)	(10)	(9)	(7)	(15)	(17)	(3)	(12)	(15)	(12)
- Main Market (Regulated Market)	Chengalpattu RM	Tiruttani RM	Madurantakam RM	Kancheepuram RM	Kancheepuram RM	Sivaganga RM	Sattur RM	Paramakudi RM	Manamadurai RM	Karaikudi RM
(Distance km)	(20)	(20)	(25)	(10)	(22)	(20)	(15)	(10)	(18)	(20)
14 Average Amount Sold (1,000 Rs /farm/year)	10-15	10-15	15-20	20-25	20-25	10-15	15-20	5-20	15-20	10-15
15 Social Conflicts/Problems	No	No	No	No	No	No	Yes	No	No	No

Table 3.4.1 Present and Proposed Land Use in the Pilot Tank Areas

Code No.	Study Area	Present				Plan			
		Crop	Cropping Time	Area Sown(ha)	Percent to Command Area	Crop	Cropping Time	Area to be Sown (ha)	Percent to Command Area
N-1	Echur (58.6 ha)	Paddy	Sep-Dec	47.0	80.2	Paddy	Sep-Jan	47.0	80.2
		Paddy	Jan-May	10.0	17.1	Paddy	Jan-May	5.0	8.5
		Groundnut	Jan-Apr	2.0	3.4	L. Finger	Jan-Apr	7.0	11.9
						L. Finger	May-Aug	12.6	21.5
		Total		59.0	100.7	Total		71.6	122.2
N-2	Cherukkanur Big (91.3 ha)	Paddy	Jul-Oct	83.0	90.9	Paddy	Jun-Oct	83.0	90.9
		Paddy	Dec-Mar	50.0	54.8	Paddy	Nov-Apr	50.0	54.8
		Sugarcane	Jun-Jun	20.0	21.9	Sugarcane	Jun-Jun	20.0	21.9
		Casuarina	4-5 Years	12.0	13.1	Banana	May-May	4.0	4.4
		Total		165.0	180.7	Total		157.0	172.0
N-3	Polambakkam (94.6 ha)	Paddy	Jul-Nov	12.3	13.0	Paddy	Sep-Jan	79.7	84.2
		Paddy	Oct-Feb	79.7	84.2	L. Finger	Feb-May	4.3	4.5
		Groundnut	Jan-Apr	2.0	2.1	Black gram	Jun-Aug	4.3	4.5
					0.0	Egg plant	Feb-Jul	4.3	4.5
					0.0	Turmeric	Jun-Mar	5.0	5.3
					0.0	Banana	May-May	5.0	5.3
		Total		94.0	99.4	Total		102.6	108.5
N-4	Enadur Big (574.7 ha)	Paddy	Jul-Jan	322.0	56.0	Paddy	Jul-Nov	102.0	17.7
						Paddy	Aug-Dec	220.0	38.3
						Groundnut	Jan-Apr	10.0	1.7
						L. Finger	Jan-Apr	5.0	0.9
						Chili(Green)	Jan-Aug	50.0	8.7
						Banana	May-May	5.0	0.9
		Total		322.0	56.0	Total		392.0	68.2
N-5	Vadakkupattu (471.3 ha)	Paddy	Aug-Dec	370.0	78.5	Paddy	Aug-Dec	370.0	78.5
		Paddy	Jan-Apr	225.0	47.7	Paddy	Jan-Apr	225.0	47.7
						Banana	May-May	5.0	1.1
						Turmeric	Jun-Mar	5.0	1.1
						Tomato	Mar-Jul	4.0	0.8
						L. Finger	Feb-May	4.0	0.8
						Tomato	Mat-Oct	4.0	0.8
						L. Finger	Aug-Nov	4.0	0.8
		Total		595.0	126.2	Total		621.0	131.8
S-1	Siruvalai (49.3 ha)	Paddy	Aug-Dec	49.3	100.0	Paddy	Aug-Dec	42.4	86.0
						L. Finger	Sep-Dec	6.9	14.0
		Total		49.3	100.0	Total		49.3	100.0
S-2	A Ramalinga-puram (76.5 ha)	Paddy	Sep-Jan	66.0	86.3	Paddy	Sep-Jan	66.0	86.3
		Cotton	Feb-Jun	1.2	1.6	L. Finger	Feb-May	14.0	18.3
		Greengram	Feb-May	3.5	4.6	Greengram	May-Aug	14.0	18.3
		Total		70.7	92.4	Total		94.0	122.9
S-3	Pandikanmoi (41.9 ha)	Paddy	Oct-Feb	40.6	96.9	Paddy	Oct-Feb	40.6	96.9
		Cotton	Jan-Apr	2.5	6.0	Cotton	Feb-Jun	10.0	23.9
		Chili(Dry)	Dec-Apr	2.0	4.8	Blackgram	Feb-May	10.0	23.9
						Greengram	Feb-May	10.0	23.9
		Total		45.1	107.6	Total		70.6	168.5
S-4	Sengangulam (99.2 ha)	Paddy	Aug-Dec	50.0	50.4	Paddy	Aug-Dec	50.0	50.4
		Cotton	Jan-May	10.0	10.1	L. Finger	Feb-May	5.0	5.0
		Ragi	Jan-Apr	40.0	40.3	L. Finger	May-Aug	5.0	5.0
						Chili(Green)	Jan-Aug	5.0	5.0
						Ragi	Jan-Apr	40.0	40.3
		Total		100.0	100.8	Total		105.0	105.8
S-5	Krumbi (52.7 ha)	Paddy	Jun-Sep	16.0	30.4	Paddy	Aug-Dec	52.0	98.7
		Paddy	Oct-Feb	52.0	98.7	Chili(Green)	Jan-Aug	5.0	9.5
		Groundnut	Feb-May	10.0	19.0	Turmeric	Jun-Mar	5.0	9.5
		Blackgram	Feb-Apr	6.0	11.4	L. Finger	Feb-May	5.0	9.5
						L. Finger	May-Aug	5.0	9.5
						Egg plant	Jan-Jun	5.0	9.5
						Tomato	Jan-Jun	5.0	9.5
		Total		84.0	159.4	Total		82.0	155.6
	Whole			1,584.1	98.4			1,745.1	108.4

Total command area: 1,610.1 ha

Table 3.4.2 Present and Proposed Crop Production in the Pilot Tank Areas (1/2)

Code No.	Study Area	Present					Plan					Increased Production (%)
		Crop	Cropping Time	Area Sown(ha)	Yield (kg/ha)	Production (tons)	Crop	Cropping Time	Area to be Sown (ha)	Yield (kg/ha)	Production (tons)	
N-1	Echur (58.6 ha)	Paddy	Sep-Dec	47.0	4,650	218.6	Paddy	Sep-Jan	47.0	5,000	235.0	98
		Paddy	Jan-May	10.0	4,650	46.5	Paddy	Jan-May	5.0	5,000	25.0	
		Groundnut	Jan-Apr	2.0	1,500	3.0	L. Finger	Jan-Apr	7.0	15,000	105.0	-
							L. Finger	May-Aug	12.6	15,000	189.0	-
		Total		59.0		268.1	Total		71.6		554.0	207
N-2	Cherukkanur Big (91.3 ha)	Paddy	Jul-Oct	83.0	4,000	332.0	Paddy	Jun-Oct	83.0	4,800	398.4	120
		Paddy	Dec-Mar	50.0	4,000	200.0	Paddy	Nov-Apr	50.0	4,800	240.0	
		Sugarcane	Jun-Jun	20.0	100,000	2,000.0	Sugarcane	Jun-Jun	20.0	125,000	2,500.0	125
		Casuarina	Per Years	12.0	22,500	270.0	Banana	May-May	4.0	27,965	111.9	-
		Total		165.0		2,802.0	Total		157.0		3,250.3	116
N-3	Polambakkam(94.6 ha)	Paddy	Jul-Nov	12.3	3,800	46.7	Paddy	Sep-Jan	79.7	5,000	398.5	114
		Paddy	Oct-Feb	79.7	3,800	302.9	L. Finger	Feb-May	4.3	15,000	64.5	-
		Groundnut	Jan-Apr	2.0	1,250	2.5	Black gram	Jun-Aug	4.3	1,200	5.2	-
							Egg plant	Feb-Jul	4.3	20,000	86.0	-
							Turmeric	Jun-Mar	5.0	25,000	125.0	-
						-	Banana	May-May	5.0	27,965	139.8	-
		Total		94.0		352.1	Total		102.6		819.0	233
N-4	Enadur Big (574.7 ha)	Paddy	Jul-Jan	322.0	4,000	1,288.0	Paddy	Jul-Nov	102.0	4,750	484.5	119
							Paddy	Aug-Dec	220.0	4,750	1,045.0	
							Groundnut	Jan-Apr	10.0	1,900	19.0	-
							L. Finger	Jan-Apr	5.0	15,000	75.0	-
							Chili(Green	Jan-Aug	50.0	2,500	125.0	-
							Banana	May-May	5.0	27,965	139.8	-
		Total		322.0		1,288.0	Total		392.0		1,888.3	147
N-5	Vadakkupattu (471.3 ha)	Paddy	Aug-Dec	370.0	4,500	1,665.0	Paddy	Aug-Dec	370.0	5,000	1,850.0	109
		Paddy	Jan-Apr	225.0	4,700	1,057.5	Paddy	Jan-Apr	225.0	5,000	1,125.0	
							Banana	May-May	5.0	27,965	139.8	-
							Turmeric	Jun-Mar	5.0	25,000	125.0	-
							Tomato	Mar-Jul	4.0	15,000	60.0	-
							L. Finger	Feb-May	4.0	15,000	60.0	-
							Tomato	Mat-Oct	4.0	15,000	60.0	-
							L. Finger	Aug-Nov	4.0	15,000	60.0	-
		Total		595.0		2,722.5	Total		621.0		3,479.8	128
S-1	Siruvalai (49.3 ha)	Paddy	Aug-Dec	49.3	3,900	192.3	Paddy	Aug-Dec	42.4	5,000	212.0	110
							L. Finger	Sep-Dec	6.9	15,000	103.5	-
		Total		49.3		192.3	Total		49.3		315.5	164
S-2	A.Rama-lingapuram (76.5 ha)	Paddy	Sep-Jan	66.0	3,500	231.0	Paddy	Sep-Jan	66.0	5,000	330.0	143
		Cotton	Feb-Jun	1.2	980	1.2	L. Finger	Feb-May	14.0	15,000	210.0	-
		Greengram	Feb-May	3.5	450	1.6	Greengram	May-Aug	14.0	1,200	16.8	1,050
		Total		70.7		233.8	Total		94.0		556.8	238
S-3	Pandikanmoi (41.9 ha)	Paddy	Oct-Feb	40.6	2,000	81.2	Paddy	Oct-Feb	40.6	4,000	162.4	200
		Cotton	Jan-Apr	2.5	560	1.4	Cotton	Feb-Jun	10.0	725	7.3	518
		Chili(Dry)	Dec-Apr	2.0	635	1.3	Blackgram	Feb-May	10.0	700	7.0	-
							Greengram	Feb-May	10.0	800	8.0	-
		Total		45.1		83.9	Total		70.6		184.7	220
S-4	Senganguiam (99.2 ha)	Paddy	Aug-Dec	50.0	4,750	237.5	Paddy	Aug-Dec	50.0	5,000	250.0	105
		Cotton	Jan-May	10.0	1,000	10.0	L. Finger	Feb-May	5.0	15,000	75.0	-
		Ragi	Jan-Apr	40.0	2,000	80.0	L. Finger	May-Aug	5.0	15,000	75.0	-
					-	0.0	Chili(Green	Jan-Aug	5.0	10,000	50.0	-
					-	0.0	Ragi	Jan-Apr	40.0	2,750	110.0	-
		Total		100.0		327.5	Total		105.0		560.0	171
S-5	Krumbi (52.7 ha)	Paddy	Jun-Sep	16.0	4,200	67.2	Paddy	Aug-Dec	52.0	4,500	234.0	78
		Paddy	Oct-Feb	52.0	4,500	234.0	Chili(Green	Jan-Aug	5.0	10,000	50.0	-
		Groundnut	Feb-May	10.0	1,400	14.0	Turmeric	Jun-Mar	5.0	25,000	125.0	-
		Blackgram	Feb-Apr	6.0	500	3.0	L. Finger	Feb-May	5.0	15,000	75.0	-
						0.0	L. Finger	May-Aug	5.0	15,000	75.0	-
						0.0	Egg plant	Jan-Jun	5.0	20,000	100.0	-
						0.0	Tomato	Jan-Jun	5.0	15,000	75.0	-
		Total		84.0		318.2	Total		82.0		734.0	231
Whole	Paddy(Rainy season)		-	1,188(75%)	4,121	4,895(57%)	Paddy(Rainy season)		1,203(69%)	4,855	5,840(47%)	-
	Paddy(Dry season)		-	285(18%)	4,575	1,304(15%)	Paddy(Dry season)		230(13%)	5,000	1,150(9%)	-
	Others		-	111(7%)	-	2,388(28%)	Others		312(18)	-	5,353(43%)	-
	Total		-	1,584(100%)	-	8,588(100%)	Total		1,745(100%)	-	12,342(100%)	-

Table 3.4.2 Present and Proposed Production in the Pilot Tank Areas (2/2)

Code No	Study Area	Present							Plan						
		Crop	Productn (tons)	Unit Price (Rs/kg)	Gross Income (1,000 Rs)	Productn Cost (Rs/ha)	Productn Cost (1,000 Rs)	Net Income (1,000 Rs)	Crop	Productn (tons)	Unit Price (Rs/kg)	Gross Income (1,000 Rs)	Productn Cost (Rs/ha)	Productn Cost (1,000 Rs)	Net Income (1,000 Rs)
N-1	Echur (58.6 ha)	Paddy	218.6	5.20	1,136.7	11,700	549.9	586.8	Paddy	235.0	5.20	1,222.0	11,700	549.9	672.1
		Paddy	46.5	6.50	302.3	11,700	117.0	185.3	Paddy	25.0	6.50	162.5	11,700	58.5	104.0
		Groundnut	3.0	13.00	39.0	7,340	14.7	24.3	L. Finger	105.0	4.50	472.5	23,463	164.2	308.3
									L. Finger	189.0	4.50	850.5	23,463	296.0	554.9
		Total	268.1	-	1,478.0	-	-	796.4	Total	554.0	-	2,707.5	-	1,608.6	1,639.3
N-2	Cherukkanur Big (91.3 ha)	Paddy	332.0	5.20	1,726.4	11,700	971.1	755.3	Paddy	398.4	5.20	2,071.7	11,700	971.1	1,100.6
		Paddy	200.0	6.50	1,300.0	11,700	585.0	715.0	Paddy	240.0	6.50	1,560.0	11,700	585.0	975.0
		Sugarcane	2,000.0	0.75	1,500.0	24,215	484.3	1,015.7	Sugarcane	2,500.0	0.75	1,875.0	24,215	484.3	1,390.7
		Casuarina	270.0	1.40	378.0	9,513	114.2	263.8	Banana	111.9	3.00	335.6	25,100	100.4	235.2
		Total	2,802.0	-	4,904.4	-	-	2,749.8	Total	3,250.3	-	5,842.3	72,715.0	2,140.8	3,701.5
N-3	Polambakkam (94.6 ha)	Paddy	46.7	6.50	303.6	11,700	143.9	159.6	Paddy	39.85	6.50	2,590.3	11,700	932.5	1,657.8
		Paddy	302.9	5.50	1,666.0	11,700	932.5	733.5	L. Finger	64.5	4.50	290.3	23,463	100.9	189.4
		Groundnut	2.5	13.00	32.5	7,340	14.7	17.8	Black gra	5.2	14.00	72.2	4,144	17.8	54.4
		-	-	-	-	-	-	-	Egg plant	86.0	3.00	258.0	20,000	86.0	172.0
		-	-	-	-	-	-	-	Turmeric	125.0	4.00	500.0	25,100	125.5	374.5
		-	-	-	-	-	-	-	Banana	139.8	3.00	419.5	25,100	125.5	294.0
		Total	352.1	-	2,002.0	-	-	910.9	Total	819.0	-	4,830.2	109,507.0	1,388.2	2,742.0
N-4	Enadur Big (574.7 ha)	Paddy	1,288.0	6.50	8,372.0	11,700	3,767.4	4,604.6	Paddy	484.5	6.50	3,149.3	11,700	1,193.4	1,955.9
		-	-	-	-	-	-	-	Paddy	1,045.0	6.50	6,792.5	11,700	2,574.0	4,218.5
		-	-	-	-	-	-	-	Groundnut	19.0	13.00	247.0	7,340	73.4	173.6
		-	-	-	-	-	-	-	L. Finger	75.0	4.50	337.5	23,463	117.3	220.2
		-	-	-	-	-	-	-	Chili	125.0	25.00	3,125.0	23,938	1,196.9	1,928.1
		-	-	-	-	-	-	-	Banana	139.8	3.00	419.5	25,100	125.5	294.0
		Total	1,288.0	-	8,372.0	-	-	4,604.6	Total	1,888.3	-	14,070.7	103,241.0	5,280.5	8,790.2
N-5	Vadakkupattu (471.3 ha)	Paddy	1,665.0	6.00	9,990.0	11,700	4,329.0	5,661.0	Paddy	1,850.0	6.00	11,100.0	11,700	4,329.0	6,771.0
		Paddy	1,057.5	6.00	6,345.0	11,700	2,632.5	3,712.5	Paddy	1,125.0	6.00	6,750.0	11,700	2,632.5	4,117.5
		-	-	-	-	-	-	-	Banana	139.8	3.00	419.5	25,100	125.5	294.0
		-	-	-	-	-	-	-	Turmeric	125.0	4.00	500.0	25,100	125.5	374.5
		-	-	-	-	-	-	-	Tomato	60.0	4.00	240.0	21,488	86.0	154.0
		-	-	-	-	-	-	-	L. Finger	60.0	4.50	270.0	23,463	93.9	176.1
		-	-	-	-	-	-	-	Tomato	60.0	4.00	240.0	21,488	86.0	154.0
		-	-	-	-	-	-	-	L. Finger	60.0	4.50	270.0	23,463	93.9	176.1
		Total	2,722.5	-	16,335.0	-	-	9,373.5	Total	3,479.8	-	19,789.5	163,502.0	7,572.1	12,217.4
S-1	Siruvalai (49.3 ha)	Paddy	192.3	5.00	961.4	11,700	576.8	384.5	Paddy	212.0	5.00	1,060.0	11,700	496.1	563.9
		-	-	-	-	-	-	-	L. Finger	103.5	4.50	465.8	23,463	161.9	303.9
		Total	192.3	-	961.4	-	-	384.5	Total	315.5	-	1,525.8	35,163.0	658.0	867.8
S-2	A.Ramalingapuram (76.5 ha)	Paddy	231.0	5.20	1,201.2	11,700	772.2	429.0	Paddy	330.0	5.20	1,716.0	11,700	772.2	943.8
		Cotton	1.2	15.00	17.6	10,630	12.8	4.9	L. Finger	210.0	4.50	945.0	23,463	328.5	616.5
		Greengram	1.6	12.00	19.2	4,144	14.5	4.7	Greengram	16.8	12.00	201.6	4,144	58.0	143.6
		Total	233.8	-	1,238.0	-	-	438.6	Total	556.8	-	2,862.6	39,307.0	1,158.7	1,703.9
S-3	Pandikanmoi (41.9 ha)	Paddy	81.2	5.20	422.2	11,700	475.0	-52.8	Paddy	162.4	5.20	844.5	11,700	475.0	369.5
		Cotton	1.4	15.00	21.0	10,630	25.6	-5.6	Cotton	7.3	15.00	108.8	10,630	106.3	2.5
		Chili(Dry)	1.3	25.00	31.8	23,938	47.9	-16.1	Blackgram	7.0	14.00	98.0	4,144	41.4	56.6
		-	-	-	-	-	-	-	Greengram	8.0	12.00	96.0	4,144	41.4	54.6
		Total	83.9	-	475.0	-	-	-74.5	Total	184.7	-	1,147.2	30,618.0	664.2	483.0
S-4	Senganguilam (99.2 ha)	Paddy	237.5	5.10	1,211.3	11,700	585.0	626.3	Paddy	250.0	5.10	1,275.0	11,700	585.0	690.0
		Cotton	10.0	15.00	150.0	10,630	106.3	43.7	L. Finger	75.0	4.50	337.5	23,463	117.3	220.2
		Ragi	80.0	4.20	336.0	5,750	230.0	106.0	L. Finger	75.0	4.50	337.5	23,463	117.3	220.2
		-	-	-	-	-	-	-	Chili(Gree	50.0	10.00	500.0	23,938	119.7	380.3
		-	-	-	-	-	-	-	Ragi	110.0	4.20	462.0	5,750	230.0	232.0
		Total	327.5	-	1,697.3	-	-	776.0	Total	560.0	-	2,912.0	88,314.0	1,169.3	1,742.7
S-5	Krumbi (52.7 ha)	Paddy	67.2	5.20	349.4	11,700	187.2	162.2	Paddy	234.0	5.20	1,216.8	11,700	608.4	608.4
		Paddy	234.0	5.20	1,216.8	11,700	608.4	608.4	Chili	50.0	10.00	500.0	23,938	119.7	380.3
		Groundnut	14.0	13.00	182.0	7,340	73.4	108.6	Turmeric	125.0	4.00	500.0	25,100	125.5	374.5
		Blackgram	3.0	14.00	42.0	4,144	24.9	17.1	L. Finger	75.0	4.50	337.5	23,463	117.3	220.2
		-	-	-	-	-	-	-	L. Finger	75.0	4.50	337.5	23,463	117.3	220.2
		-	-	-	-	-	-	-	Egg plant	100.0	3.00	300.0	20,000	100.0	200.0
		-	-	-	-	-	-	-	Tomato	75.0	4.00	300.0	21,488	107.4	192.6
		Total	318.2	-	1,790.2	-	-	896.4	Total	734.0	-	3,491.8	140,152.0	1,295.7	2,196.1
Whole		Paddy	6,200	5.89	36,504	11,700	17,233	19,271		6,989.8	5.9	41,510.5	11,700.0	16,762.6	24,747.9
		Others	2,388	1.15	2,749	10,467	1,164	1,585		5,352.5	3.2	16,969.1	18,032.0	5,633.5	11,336.0
		Total	8,588	4.57	39,253	11,614	18,397	20,856		12,342.3	4.7	58,479.6	12,834.0	22,396.1	36,083.8

Table 3.5.1 Field Inspection in the Northern Study Area

Location	Code			712	1053	597	440	344	Remarks
	Name of Tank			Echur	Polambakkam	Vadakkupattu	Enadur Peria Eri	Cherukkanur Big	
	Name of District			Kanchipuram	Kanchipuram	Kanchipuram	Kanchipuram	Tiruvallur	
	Name of Taluk			Chengalpattu	Madurantakam	Sriperumbudur	Kanchipuram	Tiruthani	
	Name of Village			Echur	Polambakkam	Vadakkupattu	Enadur	Cherukkanur	
	Categorization			**NR-1**	**NR-2**	**NR-4**	**NR-3**	**NR-2**	
Bund Dimension	Crest width (m)		Existing	2.00	2.00	2.00	2.20 to 2.90	2.50	
			Standard	(2.00)	(2.00)	(2.00)	(2.00)	(2.00)	
	Height of Bund		Earth fill	About 1.00	About 2.00	About 2.00	About 2.50	About 2.00	
			Rock fill	About 1.50	-	About 3.00	About 1.50	About 1.50	
	Slope	Front	Existing	1.73:1		1.33:1		1.33:1	Water side
			Standard	(1.5:1)		(1.5:1)		(1.5:1)	
		Rear	Existing	2.74:1		1.73:1			Ayacut side
			Standard	(2.0:1)		(2.0:1)			
Soil mechanics	Type of Soil			SC	SC	SC	SC to SP	SC to GC	
	Source of Material			Homogeneous	Homogeneous	Homogeneous	Homogeneous	Homogeneous	
	Surface Soil Hardness	Hard Index	(mm)	30 to 35	30 to 35	18 to 33	13 to 16	30	Top of the bund
				-	-	-	8 to 10	5 to 13	Part of the intake works
		(Average Value)		33	32	28.9	15.6	30	
		*Bearing Capacity	(kg/cm^2)	82.93	52.25	24.41	3.21	28.86	
			(t/m^2)	829.3	522.5	244.1	32.1	288.6	
	Estimated Permeability		(cm/s)	10^{-4} to 10^{-5}	10^{-5} to 10^{-6}	10^{-5} to 10^{-6}	10^{-4} to 10^{-5}	10^{-5} to 10^{-6}	
Test Boring						In Ayacut		In Ayacut	

Table 3.5.2 Field Inspection in the Southern Study Area

Location	Code			1940	1332	1660	1557	2222	Remarks
	Name of Tank			A. Ramalingapuram	Kurumbi	Sengangulam	Siruvalai	Pandikanmoi	
	Name of District			Virudhunagar	Sivaganga	Sivaganga	Sivaganga	Ramanathapuram	
	Name of Taluk			Sattur	Karaikudi	Manamadurai	Sivaganga	Paramakudi	
	Name of Village			Ramaingapuram	S. R. Pattinum	Sengangulam	Paganeri	Manjur	
	Categorization			**SR-1**	**SP-2**	**SP-4**	**SP-1**	**SP-1**	
Bund Dimension	Crest width (m)		Existing	1.30 to 2.00	1.90 to 2.00	2.00	3.80 to 4.00	1.70	
			Standard	(2.00)	(2.00)	(2.00)	(2.00)	(2.00)	
	Height of Bund		Earth fill	About 1.00 to 1.20	About 1.50	-	About 3.00	About 1.50	
			Rock fill	Revetment is not installed.	Revetment is not installed.	Revetment is not installed.	Revetment is not installed.	Revetment is not installed.	
	Slope	Front	Existing	1.73:1	2.35:1	1..19:1	2.74:1	1.73:1	Water side
			Standard	(1.5:1)		(1.5:1)		(1.5:1)	
		Rear	Existing	2.75:1	2.75:1	2.75:1	1.9:1	2.74:1	Ayacut side
			Standard	(2.0:1)		(2.0:1)			
Soil mechanics	Surface Soil Hardness	Type of Soil		ML to CL (Black Cotton Soil)	SM to SC	ML to CL (Black Cotton Soil)	SM	ML to CL (Black Cotton Soil)	
		Source of Material		Homogeneous	Homogeneous	Homogeneous	Homogeneous	Homogeneous	
		Hard Index	(mm)	14 to 23	30 to 33	10 to 32	28 to 31	18 to 32	Top of the bund
				28 to 30	-	-	28 to 31	18 to 32	Part of the intake works
		(Average Value)							
		*Bearing Capacity	(kg/cm²)	2.51 to 9.93	28.9 to 82.9	1.36 to 52.3	21.3 to 32.9	4.63 to 52.3	
			(t/m²)	25.1 to 99.3	289.0 to 829.0	13.6 to 523.0	213.0 to 329.0	46.3 to 523.0	
	Estimated Permeability		(cm/s)	10-4 to 10-5	10-5 to 10-6	10-4 to 10-5	10-5 to 10-6	10-4 to 10-5	
	Test Boring			-	-	In Ayacut	-	In Ayacut	

Table 3.5.3 Fortnightly Irrigation Water Requirement for Paddy in the Pilot Tank Areas

Pilot Tank	Category	Irrigation Water Requirement for Paddy Rice (Mm^3)								
		Sep I	Sep II	Oct I	Oct II	Nov I	Nov II	Dec I	Dec II	Total
Echur	Pre-Project	0.084	0.155	0.195	0.166	0.131	0.131	0.084	0.042	0.988
(Ayacut =58.68 ha)	Post-Project	0.058	0.096	0.118	0.088	0.070	0.070	0.045	0.022	0.567
	Water Saved	0.026	0.059	0.077	0.078	0.061	0.061	0.039	0.020	0.421
Cherukkanur	Pre-Project	0.113	0.206	0.233	0.188	0.141	0.141	0.107	0.053	1.182
(Ayacut =91.26 ha)	Post-Project	0.081	0.131	0.146	0.100	0.075	0.075	0.057	0.028	0.693
	Water Saved	0.032	0.075	0.087	0.088	0.066	0.066	0.050	0.025	0.489
Polambakkam	Pre-Project	0.114	0.207	0.242	0.194	0.115	0.115	0.098	0.049	1.134
(Ayacut = 94.59 ha)	Post-Project	0.083	0.132	0.151	0.104	0.061	0.061	0.052	0.026	0.671
	Water Saved	0.031	0.075	0.091	0.090	0.054	0.054	0.046	0.023	0.463
Enadur	Pre-Project	0.654	1.182	1.406	1.119	0.808	0.808	0.671	0.335	6.983
(Ayacut = 574.67 ha)	Post-Project	0.483	0.765	0.884	0.597	0.431	0.431	0.358	0.179	4.128
	Water Saved	0.171	0.417	0.522	0.522	0.377	0.377	0.313	0.156	2.855
Vadakkupattu	Pre-Project	0.502	0.912	0.982	0.773	0.494	0.494	0.547	0.273	4.977
(Ayacut = 417.24 ha)	Post-Project	0.365	0.584	0.621	0.412	0.263	0.263	0.292	0.146	2.946
	Water Saved	0.365	0.365	0.365	0.365	0.365	0.365	0.365	0.365	2.920
Siruvalai	Pre-Project	0.053	0.091	0.100	0.074	0.063	0.063	0.055	0.027	0.526
(Ayacut = 49.25 ha)	Post-Project	0.041	0.061	0.066	0.039	0.034	0.034	0.029	0.015	0.319
	Water Saved	0.012	0.030	0.034	0.035	0.029	0.029	0.026	0.012	0.207
A. Ramalingapuram	Pre-Project	0.114	0.207	0.242	0.194	0.115	0.115	0.098	0.049	1.134
(Ayacut = 76.53 ha)	Post-Project	0.083	0.132	0.151	0.104	0.061	0.061	0.052	0.026	0.670
	Water Saved	0.031	0.075	0.091	0.090	0.054	0.054	0.046	0.023	0.464
Pandikanmoi	Pre-Project	0.098	0.170	0.184	0.138	0.101	0.101	0.102	0.051	0.945
(Ayacut = 41.88 ha)	Post-Project	0.073	0.112	0.119	0.074	0.054	0.054	0.054	0.027	0.567
	Water Saved	0.025	0.058	0.065	0.064	0.047	0.047	0.048	0.024	0.378
Sengangulam	Pre-Project	0.121	0.215	0.223	0.173	0.110	0.11	0.103	0.051	1.106
(Ayacut = 99.23 ha)	Post-Project	0.088	0.138	0.142	0.092	0.059	0.059	0.055	0.027	0.660
	Water Saved	0.033	0.077	0.081	0.081	0.051	0.051	0.048	0.024	0.446
Kurumbi	Pre-Project	0.053	0.091	0.100	0.074	0.063	0.063	0.055	0.027	0.526
(Ayacut = 52.67 ha)	Post-Project	0.041	0.061	0.066	0.039	0.034	0.034	0.029	0.015	0.319
	Water Saved	0.012	0.030	0.034	0.035	0.029	0.029	0.026	0.012	0.207

Pre-Project Irrigation Efficiency = 40%
Post-Project Irrigation Efficiency = 75%

Table 3.5.4 Summary of Waster Balance in the Pilot Tank Areas (1/2) (January to December)

Present Condition (F=40%)

Echur Tank (A=1.57km²)

Year	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	Average
Total Rainfall(mm)	526.1	1,013.3	843.5	527.3		936.6	539.8	2,330.4	1,507.4	1,408.0	1,076.0
Total Run-off(m³)	274,495	760,588	511,567	200,591		696,000	359,593	2,752,704	1,250,192	1,013,657	866,599
Evapo.&Percolation Losses(m³)	107,020	87,401	116,032	50,888		86,317	48,432	261,461	522,688	467,628	193,985
Irrigation Water(m³)	1,001,867	1,001,867	1,001,867	1,001,867		1,001,867	1,001,867	1,001,867	1,001,867	1,001,867	1,001,867
Spill out (m³)	0	0	0	0		0	0	1,060,563	159,192	0	136,527
Estimated Irrigation Area	6.0%	33.0%	26.0%	5.0%		20.0%	11.0%	100.0%	57.0%	27.0%	31.7%
Runoff Ratio	0.332	0.466	0.366	0.242		0.474	0.424	0.752	0.528	0.459	0.452
Spill out	0.000	0.000	0.000	0.000		0.000	0.000	0.389	0.127	0.000	0.057
Evapo.&Percolation Losses	0.390	0.118	0.227	0.254		0.121	0.135	0.095	0.418	0.461	0.247
Runoff/Irrigation	0.274	0.759	0.511	0.200		0.695	0.359	2.748	1.248	1.012	0.865

Cherukkaour Tank (A=1.96km²)

Year	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	Average
Total Rainfall(mm)	799.9	1,068.7	769.0	881.0	945.8	1,305.0	515.0	862.0	1,169.9		923.3
Total Run-off(m³)	585,745	726,962	636,417	658,971	1,010,388	1,619,871	295,844	758,285	1,027,149		791,070
Evapo.&Percolation Losses(m³)	95,363	59,727	152,028	98,307	132,548	353,740	190,456	76,817	136,127		143,461
Irrigation Water(m³)	1,197,667	1,197,667	1,197,667	1,197,667	1,197,667	1,197,667	1,197,667	1,197,667	1,197,667		1,197,667
Spill out (m³)	0	0	0	0	0	0	0	0	0		0
Estimated Irrigation Area	18.0%	33.0%	46.0%	34.0%	36.0%	73.0%	2.0%	40.0%	39.0%		35.3%
Runoff Ratio	0.375	0.368	0.422	0.382	0.545	0.555	0.295	0.449	0.488		0.424
Spill out	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000		0.000
Evapo.&Percolation Losses	0.163	0.082	0.239	0.143	0.131	0.269	0.644	0.101	0.133		0.209
Runoff/Irrigation	0.489	0.607	0.531	0.550	0.844	1.386	0.247	0.633	0.858		0.661

Pulembakkam Tank (A=3.815km²)

Year	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	Average
Total Rainfall(mm)	1,054.7	818.5	2,330.4	526.1		1,409.4	992.1	1,266.6	1,099.2	1,262.2	1,197.7
Total Run-off(m³)	1,492,266	1,072,320	5,286,244	527,136		2,077,412	1,666,505	2,326,999	1,661,841	1,643,509	2,066,026
Evapo.&Percolation Losses(m³)	187,635	732,152	691,100	972,576		257,012	1,028,905	656,945	1,054,274	862,298	715,977
Irrigation Water(m³)	1,149,933	1,149,933	1,149,933	1,149,933		1,149,933	1,149,933	1,149,933	1,149,933	1,149,933	1,149,933
Spill out (m³)	0	0	2,150,039	13,198		500,332	0	0	0	0	295,952
Estimated Irrigation Area	23.0%	46.0%	100.0%	20.0%		73.0%	80.0%	70.0%	34.0%	75.0%	55.9%
Runoff Ratio	0.469	0.435	0.752	0.332		0.701	0.537	0.609	0.501	0.425	0.529
Spill out	0.000	0.000	0.407	0.025		0.168	0.000	0.000	0.000	0.000	0.067
Evapo.&Percolation Losses	0.126	0.683	0.131	1.845		0.086	0.640	0.202	0.634	0.525	0.550
Runoff/Irrigation	1.299	0.933	4.597	0.458		2.589	1.397	2.024	1.445	1.429	1.797

Enadur Tank (A=17.22km²)

Year	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	Average
Total Rainfall(mm)	932.5	1,133.2	971.3	1,225.6		1,390.0	995.0	1,316.0	1,499.0	1,585.0	1,227.5
Total Runoff(m³)	4,879,267	8,159,199	6,049,557	10,371,576		12,841,194	8,414,588	11,896,314	13,543,429	12,949,863	9,900,554
Evapo.&Percolation Losses(m³)	1,160,896	889,738	2,137,941	1,385,269		1,405,858	1,865,261	1,844,368	2,609,051	1,957,552	1,695,106
Irrigation Water(m³)	7,073,600	7,073,600	7,073,600	7,073,600		7,073,600	7,073,600	7,073,600	7,073,600	7,073,600	7,073,600
Spill out (m³)	0	0	0	322,926		1,452,085	414,585	2,091,284	3,469,563	4,339,695	1,343,544
Estimated Irrigation Area	63.0%	60.0%	72.0%	84.0%		100.0%	95.0%	98.0%	97.0%	65.0%	80.0%
Runoff Ratio	0.366	0.438	0.362	0.491		0.536	0.491	0.525	0.525	0.474	0.459
Spill out	0.000	0.000	0.000	0.031		0.113	0.049	0.176	0.256	0.335	0.107
Evapo.&Percolation Losses	0.242	0.109	0.353	0.134		0.109	0.219	0.155	0.193	0.151	0.185
Runoff/Irrigation	0.690	1.153	0.855	1.466		1.815	1.190	1.682	1.915	1.831	1.600

Vadakkupattu Tank (A=7.25km²)

Year	1986	1987	1988	1989	1990	[redacted]	1992	1993	1994	1995	Average
Total Rainfall(mm)	756.6	1,092.4	1,041.9	1,054.9		1,252.7	714.5	1,379.7	1,602.4	1,563.6	1,137.8
Total Runoff(m³)	2,082,094	3,307,303	3,002,159	3,208,570		4,862,154	2,217,949	4,335,030	5,590,431	7,573,832	4,017,725
Evapo.&Percolation Losses(m³)	969,073	1,177,298	1,395,683	1,092,742		1,451,084	1,533,905	656,855	2,048,537	2,342,087	1,396,232
Irrigation Water(m³)	5,041,867	5,041,867	5,041,867	5,041,867		5,041,867	5,041,867	5,041,867	5,041,867	5,041,867	5,041,867
Spill out (m³)	0	0	0	0		0	0	0	0	1,117,633	124,181
Estimated Irrigation Area	13.0%	7.0%	26.0%	27.0%		8.0%	11.0%	27.0%	15.0%	58.0%	19.6%
Runoff Ratio	0.381	0.418	0.397	0.420		0.533	0.428	0.433	0.550	0.677	0.471
Spill out	0.000	0.000	0.000	0.000		0.001	0.000	0.000	0.000	0.148	0.016
Evapo.&Percolation Losses	0.417	0.356	0.465	0.341		0.300	0.691	0.152	0.366	0.309	0.377
Runoff/Irrigation	0.413	0.656	0.595	0.636		0.963	0.440	0.860	1.109	1.502	0.795

With Channel Lining (F=75%)

Echur Tank (A=1.57km²)

Year	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	Average
Total Rainfall(mm)	526.1	1,013.3	843.5	527.3		936.6	539.8	2,330.4	1,507.4	1,408.0	1,076.0
Total Run-off(m³)	274,495	760,588	511,567	200,591		696,000	359,593	2,752,704	1,250,192	1,013,657	866,599
Evapo.&Percolation Losses(m³)	113,710	153,680	230,865	58,045		112,878	232,067	325,441	558,209	561,567	260,713
Irrigation Water(m³)	575,333	573,333	573,333	573,333		575,333	573,333	573,333	573,333	575,333	573,333
Spill out (m³)	0	0	0	0		0	0	0	0	1,447,867	206,283
Estimated Irrigation Area	6.0%	60.0%	45.0%	10.0%		33.0%	16.0%	100.0%	95.0%	48.0%	45.0%
Runoff Ratio	0.332	0.466	0.366	0.242		0.474	0.424	0.752	0.528	0.459	0.452
Spill out	0.000	0.000	0.000	0.000		0.000	0.000	0.533	0.165	0.095	0.099
Evapo.&Percolation Losses	0.414	0.208	0.451	0.289		0.162	0.645	0.118	0.466	0.554	0.365
Runoff/Irrigation	0.479	1.292	0.892	0.350		1.214	0.627	4.801	2.181	1.768	1.512

Cherukkaour Tank (A=1.96km2)

Year	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	Average
Total Rainfall(mm)	799.9	1,068.7	769.0	881.0	945.8	1,305.0	515.0	862.0	1,169.9		923.3
Total Run-off(m³)	585,745	726,962	636,417	658,971	1,010,388	1,619,871	295,844	758,285	1,027,149		791,070
Evapo.&Percolation Losses(m³)	121,178	134,803	200,805	118,274	193,366	483,666	317,912	97,607	265,744		241,817
Irrigation Water(m³)	699,867	699,867	699,867	699,867	699,867	699,867	699,867	699,867	699,867		699,867
Spill out (m³)	0	0	0	0	0	0	0	0	0		0
Estimated Irrigation Area	25.0%	50.0%	72.0%	56.0%	45.0%	100.0%	4.0%	55.0%	61.0%		52.1%
Runoff Ratio	0.375	0.368	0.422	0.382	0.545	0.555	0.295	0.449	0.488		0.424
Spill out	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000		0.000
Evapo.&Percolation Losses	0.207	0.185	0.316	0.179	0.191	0.341	1.075	0.129	0.259		0.320
Runoff/Irrigation	0.837	1.039	0.909	0.942	1.444	2.029	0.423	1.083	1.468		1.130

Pulembakkam Tank (A=3.815km2)

Year	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	Average
Total Rainfall(mm)	1,054.7	818.5	2,330.4	526.1		1,409.4	992.1	1,266.6	1,099.2	1,262.2	1,197.7
Total Run-off(m³)	1,492,266	1,072,320	5,286,244	527,136		2,077,412	1,666,505	2,326,999	1,661,841	1,643,509	2,066,026
Evapo.&Percolation Losses(m³)	201,865	875,530	900,833	980,628		287,243	1,099,911	786,108	1,155,616	1,056,496	804,757
Irrigation Water(m³)	677,067	677,067	677,067	677,067		677,067	677,067	677,067	677,067	677,067	677,067
Spill out (m³)	0	0	2,508,757	28,335		631,202	0	0	0	0	359,816
Estimated Irrigation Area	42.0%	75.0%	100.0%	30.0%		98.0%	100.0%	100.0%	55.0%	100.0%	77.8%
Runoff Ratio	0.469	0.435	0.752	0.332		0.701	0.537	0.609	0.501	0.425	0.529
Spill out	0.000	0.000	0.492	0.054		0.205	0.000	0.000	0.000	0.000	0.083
Evapo.&Percolation Losses	0.135	0.816	0.151	1.860		0.097	0.685	0.337	0.695	0.643	0.692
Runoff/Irrigation	2.204	1.584	7.808	0.779		4.398	2.373	3.437	2.454	2.427	3.051

Enadur Tank (A=17.22km2)

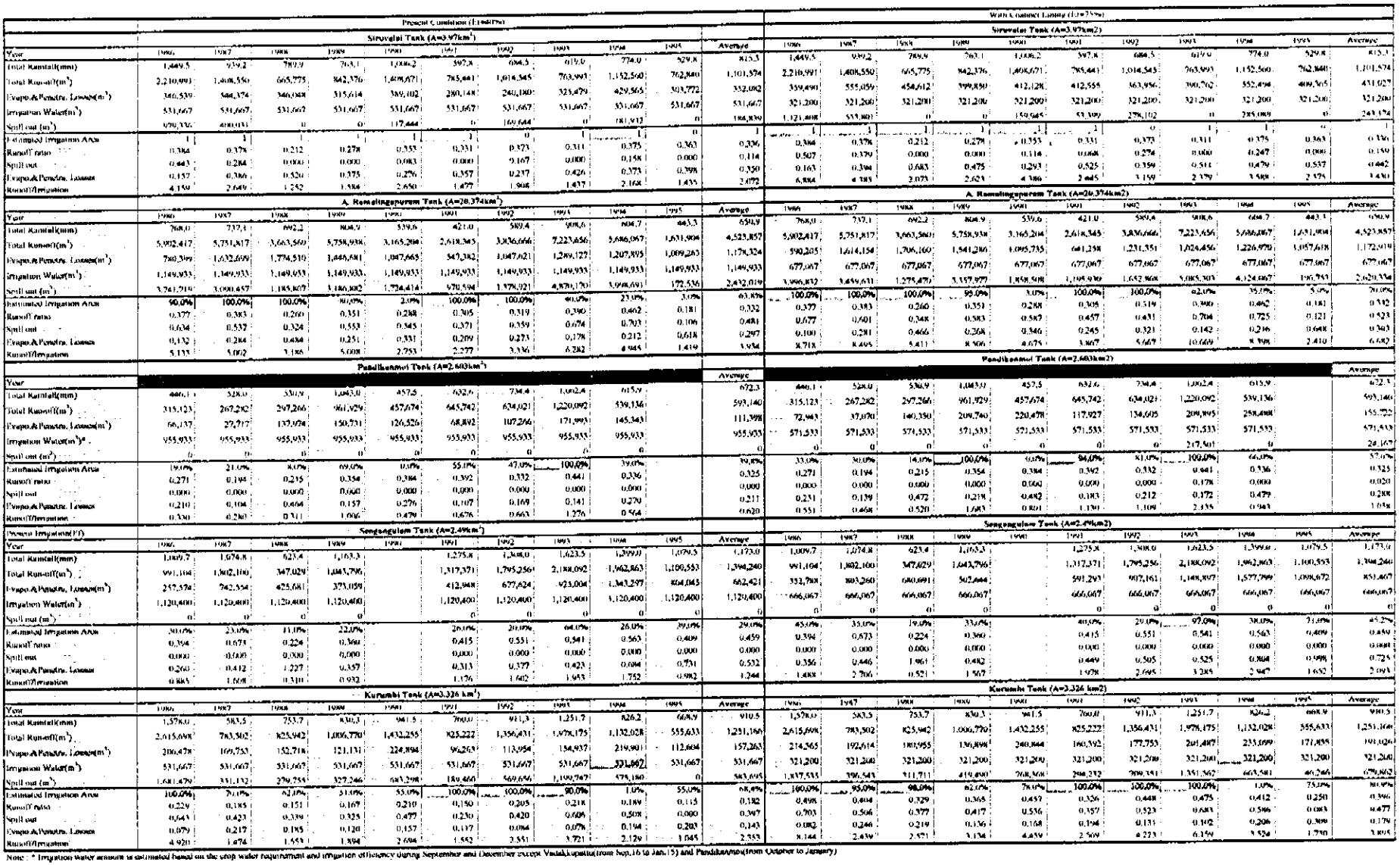
Year	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	Average
Total Rainfall(mm)	932.5	1,133.2	971.3	1,225.6		1,390.0	995.0	1,316.0	1,499.0	1,585.0	1,227.5
Total Runoff(m³)	4,879,267	8,159,199	6,049,557	10,371,576		12,841,194	8,414,588	11,896,314	13,543,429	12,949,863	9,900,554
Evapo.&Percolation Losses(m³)	1,290,328	1,024,845	2,831,626	2,091,533		1,489,259	2,339,201	2,340,488	2,834,265	2,606,175	2,094,413
Irrigation Water(m³)	4,167,467	4,167,467	4,167,467	4,167,467		4,167,467	4,167,467	4,167,467	4,167,467	4,167,467	4,167,467
Spill out (m³)	0	0	0	1,592,752		3,424,665	1,355,053	3,927,573	4,976,713	4,453,389	2,190,012
Estimated Irrigation Area	63.0%	100.0%	100.0%	100.0%		100.0%	100.0%	100.0%	100.0%	100.0%	97.8%
Runoff Ratio	0.308	0.418	0.362	0.491		0.536	0.491	0.525	0.525	0.474	0.459
Spill out	0.000	0.000	0.000	0.154		0.267	0.150	0.330	0.367	0.344	0.159
Evapo.&Percolation Losses	0.264	0.126	0.468	0.202		0.116	0.278	0.197	0.209	0.201	0.229
Runoff/Irrigation	1.171	1.958	1.452	2.489		3.081	2.019	2.855	3.250	3.107	2.376

Vadakkupattu Tank (A=7.25km2)

Year	1986	1987	1988	1989	1990	[redacted]	1992	1993	1994	1995	Average
Total Rainfall(mm)	756.6	1,092.4	1,041.9	1,054.9		1,252.7	714.5	1,379.7	1,602.4	1,563.6	1,137.8
Total Runoff(m³)	2,082,094	3,307,303	3,002,159	3,208,570		4,862,154	2,217,949	4,335,030	5,590,431	7,573,832	4,017,725
Evapo.&Percolation Losses(m³)	1,059,572	1,148,405	1,909,690	1,119,956		1,184,626	2,101,891	502,439	2,498,684	2,786,280	1,574,816
Irrigation Water(m³)	2,974,133	2,974,133	2,974,133	2,974,133		2,974,133	2,974,133	2,974,133	2,974,133	2,974,133	2,974,133
Spill out (m³)	0	0	0	0		0	0	0	348,238	1,627,665	219,545
Estimated Irrigation Area	13.0%	11.0%	41.0%	37.0%		14.0%	15.0%	42.0%	23.0%	82.0%	29.7%
Runoff Ratio	0.381	0.418	0.397	0.429		0.533	0.428	0.433	0.550	0.677	0.471
Spill out	0.000	0.000	0.000	0.000		0.000	0.000	0.000	0.062	0.215	0.031
Evapo.&Percolation Losses	0.509	0.317	0.603	0.349		0.245	0.948	0.180	0.447	0.368	0.435
Runoff/Irrigation	0.701	1.112	1.009	1.079		1.629	0.746	1.456	1.880	2.547	1.551

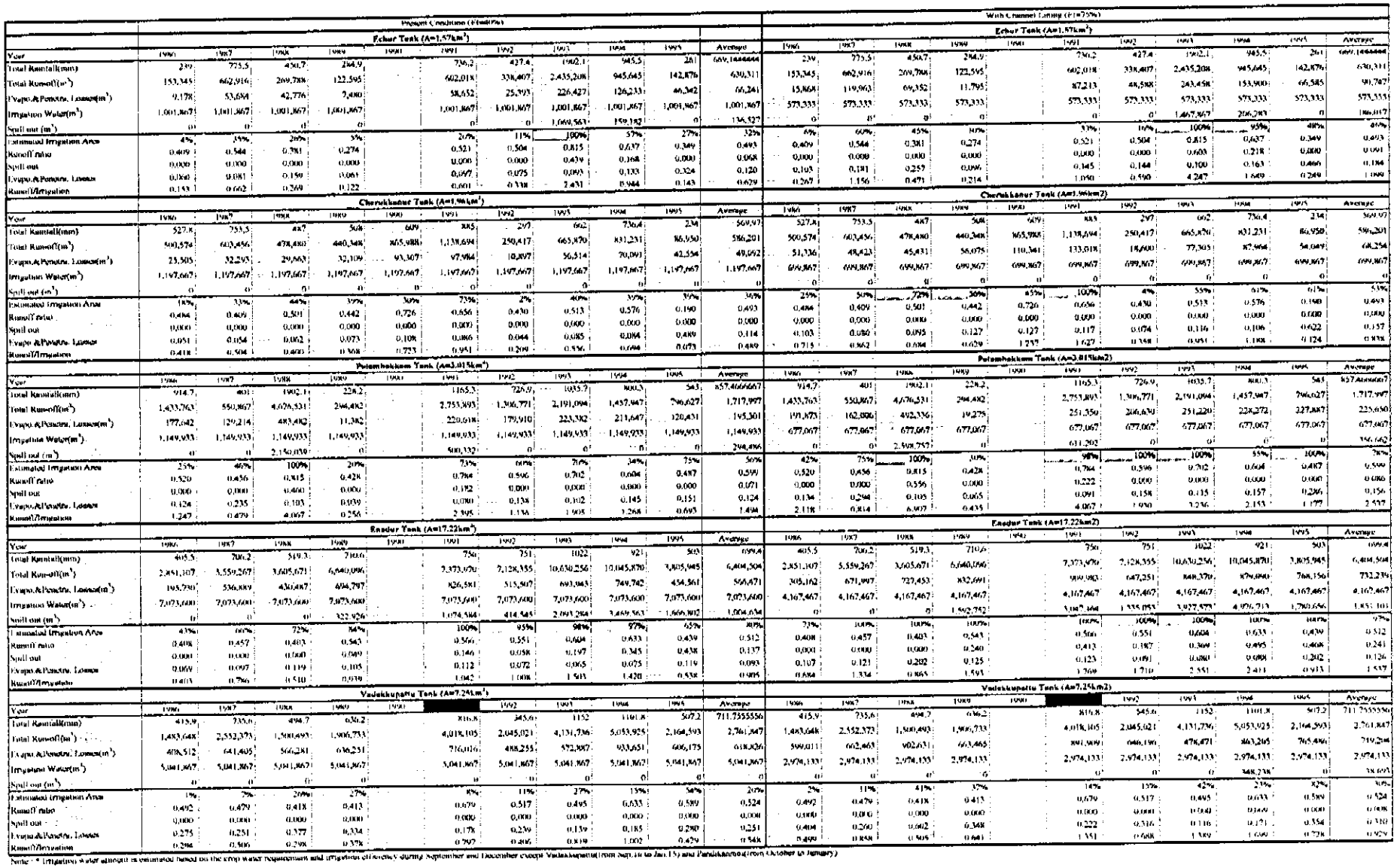
Note : * Irrigation water amount is estimated based on the crop water requirement and irrigation efficiency during September and December except Vadakkupattu(from Sep.16 to Jan.15) and Pudukkanam(from October to January)

Table 3.5.4 Summary of Waster Balance in the Pilot Tank Areas (2/2) (January to December)



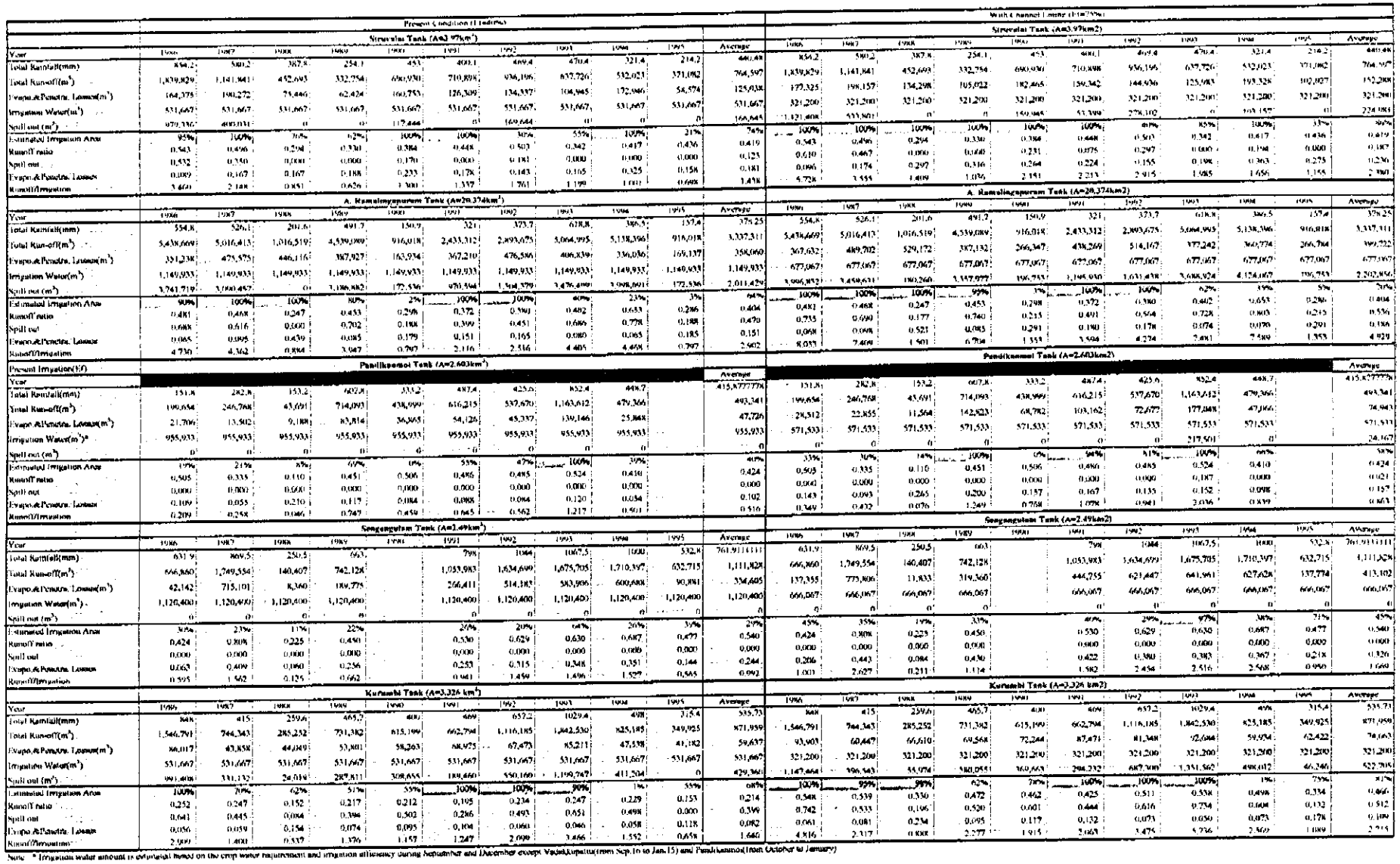
Note: * Irrigation water amount is estimated based on the crop water requirement and irrigation efficiency during September and December except Vadakkupattu(from Sep.16 to Jan.15) and Pandikanna(from October to January)

Table 3.5.5 Summary of Water Balance (1/2) - September to December -



Note : * Irrigation water amount is estimated based on the crop water requirement and irrigation efficiency during September and December except Vadakkupattu(from Sept.16 to Jan.15) and Perukkattu(from October to January)

Table 3.5.5 Summary of Water Balance (2/2) - September to December -



Present Condition (Unit:%)

Sirunelai Tank (A=3.97km²)

Year	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	Average
Total Rainfall(mm)	854.2	580.2	387.8	254.1	453	469.4	470.4	321.4	214.2		440.68
Total Run-off(m³)	1,839,829	1,141,841	452,693	332,754	690,930	710,898	936,196	639,726	532,023	371,092	766,597
Evapo.&Penetra. Losses(m³)	164,375	190,272	75,446	62,424	160,753	126,309	134,337	104,985	172,986	58,574	125,038
Irrigation Water(m³)	531,667	531,667	531,667	531,667	531,667	531,667	531,667	531,667	531,667	531,667	531,667
Spill out (m³)	979,396	488,031	0	0	117,666	0	169,644	0	0	0	166,648
Estimated Irrigation Area	95%	100%	76%	62%	100%	100%	80%	55%	100%	21%	76%
Runoff ratio	0.543	0.496	0.294	0.301	0.384	0.448	0.503	0.342	0.417	0.436	0.419
Spill out	0.532	0.350	0.000	0.000	0.170	0.000	0.181	0.000	0.000	0.000	0.123
Evapo.&Penetra. Losses	0.089	0.167	0.167	0.188	0.233	0.178	0.143	0.165	0.325	0.158	0.181
Runoff/Irrigation	3.460	2.148	0.851	0.626	1.300	1.337	1.761	1.199	1.001	0.698	1.458

A. Ramalingapuram Tank (A=20.374km²)

Year	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	Average
Total Rainfall(mm)	554.8	526.1	201.6	491.2	150.9	321	373.7	618.8	386.5	157.4	378.25
Total Run-off(m³)	5,438,669	5,016,413	1,016,519	4,539,089	916,018	2,433,312	2,893,675	5,064,995	5,138,396	916,018	3,337,311
Evapo.&Penetra. Losses(m³)	331,238	475,575	446,116	387,927	163,934	367,210	476,586	406,839	356,036	169,137	358,060
Irrigation Water(m³)	1,149,933	1,149,933	1,149,933	1,149,933	1,149,933	1,149,933	1,149,933	1,149,933	1,149,933	1,149,933	1,149,933
Spill out (m³)	3,761,719	3,060,457	0	3,186,882	172,536	970,544	1,364,379	3,476,499	3,998,601	172,536	2,011,429
Estimated Irrigation Area	90%	100%	100%	80%	2%	100%	100%	60%	23%	3%	64%
Runoff ratio	0.481	0.468	0.247	0.453	0.298	0.372	0.390	0.482	0.653	0.286	0.404
Spill out	0.688	0.616	0.000	0.702	0.188	0.399	0.451	0.686	0.778	0.188	0.470
Evapo.&Penetra. Losses	0.065	0.095	0.439	0.085	0.179	0.151	0.165	0.080	0.069	0.185	0.151
Runoff/Irrigation	4.730	4.362	0.884	3.947	0.797	2.116	2.516	4.405	4.468	0.797	2.902

Paniikennoi Tank (A=2.603km²)

Year	Average
Total Rainfall(mm)	415.8777778
Total Run-off(m³)	493,341
Evapo.&Penetra. Losses(m³)	47,726
Irrigation Water(m³)*	955,933
Spill out (m³)	0
Estimated Irrigation Area	40%
Runoff ratio	0.424
Spill out	0.000
Evapo.&Penetra. Losses	0.102
Runoff/Irrigation	0.516

Paniikennoi Tank (A=2.603km²)

Year	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995
Total Rainfall(mm)	151.8	282.8	153.2	607.8	333.2	487.4	425.6	852.4	448.7	
Total Run-off(m³)	199,654	246,768	43,691	714,093	438,999	616,215	537,670	1,163,612	479,366	
Evapo.&Penetra. Losses(m³)	21,709	13,502	9,188	83,814	36,365	54,126	45,337	139,146	25,868	
Irrigation Water(m³)*	955,933	955,933	955,933	955,933	955,933	955,933	955,933	955,933	955,933	
Spill out (m³)	0	0	0	0	0	0	0	0	0	
Estimated Irrigation Area	19%	21%	8%	69%	0%	55%	47%	100%	39%	
Runoff ratio	0.505	0.335	0.110	0.451	0.506	0.486	0.485	0.524	0.430	
Spill out	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	
Evapo.&Penetra. Losses	0.109	0.055	0.210	0.117	0.084	0.088	0.084	0.120	0.054	
Runoff/Irrigation	0.209	0.258	0.046	0.747	0.459	0.645	0.562	1.217	0.501	

Seegangulam Tank (A=2.49km²)

Year	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	Average
Total Rainfall(mm)	631.9	869.5	250.5	663		799	1064	1067.5	1080	532.8	761.9111111
Total Run-off(m³)	666,860	1,749,554	140,407	742,128		1,053,983	1,634,699	1,675,705	1,710,397	632,715	1,111,928
Evapo.&Penetra. Losses(m³)	42,142	715,101	8,360	189,775		266,411	514,183	583,966	600,688	90,881	354,605
Irrigation Water(m³)	1,120,400	1,120,400	1,120,400	1,120,400		1,120,400	1,120,400	1,120,400	1,120,400	1,120,400	1,120,400
Spill out (m³)	0	0	0	0		0	0	0	0	0	0
Estimated Irrigation Area	30%	23%	11%	22%		26%	20%	68%	26%	35%	29%
Runoff ratio	0.424	0.808	0.225	0.450		0.530	0.629	0.630	0.687	0.477	0.540
Spill out	0.000	0.000	0.000	0.000		0.000	0.000	0.000	0.000	0.000	0.000
Evapo.&Penetra. Losses	0.063	0.409	0.060	0.256		0.253	0.315	0.348	0.351	0.144	0.244
Runoff/Irrigation	0.595	1.562	0.125	0.662		0.941	1.459	1.496	1.527	0.565	0.992

Kurunehi Tank (A=3.326 km²)

Year	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	Average
Total Rainfall(mm)	868	415	259.6	465.7	400	409	657.2	1029.4	498	315.4	535.73
Total Run-off(m³)	1,566,791	744,343	285,252	731,392	615,199	662,794	1,116,185	1,862,530	825,185	349,925	871,959
Evapo.&Penetra. Losses(m³)	86,017	43,858	44,049	53,801	58,263	68,925	67,473	85,211	47,538	41,182	59,637
Irrigation Water(m³)	531,667	531,667	531,667	531,667	531,667	531,667	531,667	531,667	531,667	531,667	531,667
Spill out (m³)	991,408	331,132	26,036	287,811	308,655	188,460	550,160	1,199,747	411,204	0	429,361
Estimated Irrigation Area	100%	70%	62%	51%	55%	100%	100%	90%	1%	55%	68%
Runoff ratio	0.252	0.247	0.152	0.217	0.212	0.195	0.234	0.247	0.229	0.153	0.214
Spill out	0.641	0.445	0.084	0.396	0.502	0.286	0.493	0.651	0.498	0.000	0.399
Evapo.&Penetra. Losses	0.056	0.059	0.154	0.074	0.095	0.104	0.060	0.046	0.058	0.118	0.082
Runoff/Irrigation	2.999	1.400	0.537	1.376	1.157	1.247	2.099	3.466	1.552	0.658	1.660

Note: * Irrigation water amount is potential based on the crop water requirement and irrigation efficiency during September and December except Vadakkupattu(from Sep.1st to Jan.15) and Paniikennoi(from October to January)

Water Conservation Unit (Unit:%)

Sirunelai Tank (A=3.97km2)

Year	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	Average
Total Rainfall(mm)	854.2	580.2	387.8	254.1	453	469.4	470.4	321.4	214.2		440.68
Total Run-off(m³)	1,839,829	1,141,841	452,693	332,754	690,930	710,898	936,196	639,726	532,023	371,092	766,597
Evapo.&Penetra. Losses(m³)	177,325	198,157	134,298	105,022	182,465	159,342	144,936	125,983	193,328	102,027	152,288
Irrigation Water(m³)	321,200	321,200	321,200	321,200	321,200	321,200	321,200	321,200	321,200	321,200	321,200
Spill out (m³)	1,121,408	533,901	0	0	150,985	53,399	279,102	0	103,157	0	224,981
Estimated Irrigation Area	100%	100%	100%	100%	100%	100%	100%	100%	85%	100%	97%
Runoff ratio	0.543	0.496	0.294	0.330	0.388	0.448	0.503	0.342	0.417	0.436	0.419
Spill out	0.610	0.467	0.000	0.000	0.231	0.075	0.297	0.000	0.194	0.000	0.187
Evapo.&Penetra. Losses	0.096	0.174	0.297	0.316	0.264	0.224	0.155	0.198	0.363	0.275	0.236
Runoff/Irrigation	5.728	3.555	1.409	1.036	2.151	2.213	2.915	1.985	1.656	1.155	2.380

A. Ramalingapuram Tank (A=20.374km2)

Year	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	Average
Total Rainfall(mm)	554.8	526.1	201.6	491.2	150.9	321	373.7	618.8	386.5	157.4	378.25
Total Run-off(m³)	5,438,669	5,016,413	1,016,519	4,539,089	916,018	2,433,312	2,893,675	5,064,995	5,138,396	916,018	3,337,311
Evapo.&Penetra. Losses(m³)	367,632	489,702	529,172	387,132	266,367	438,269	514,167	477,242	360,774	266,764	399,222
Irrigation Water(m³)	677,067	677,067	677,067	677,067	677,067	677,067	677,067	677,067	677,067	677,067	677,067
Spill out (m³)	3,996,852	3,459,631	180,260	3,337,977	396,733	1,195,930	1,631,438	3,688,924	4,154,607	396,733	2,202,856
Estimated Irrigation Area	100%	100%	100%	95%	3%	100%	100%	62%	19%	5%	78%
Runoff ratio	0.483	0.468	0.247	0.453	0.298	0.372	0.390	0.482	0.653	0.286	0.404
Spill out	0.735	0.690	0.177	0.740	0.215	0.491	0.564	0.728	0.808	0.215	0.556
Evapo.&Penetra. Losses	0.068	0.098	0.521	0.085	0.291	0.180	0.178	0.074	0.070	0.291	0.198
Runoff/Irrigation	8.033	7.409	1.501	6.731	1.353	3.594	4.274	7.481	7.589	1.353	4.929

Paniikennoi Tank (A=2.603km2)

Year	Average
Total Rainfall(mm)	415.8777778
Total Run-off(m³)	493,341
Evapo.&Penetra. Losses(m³)	74,903
Irrigation Water(m³)	571,533
Spill out (m³)	24,167
Estimated Irrigation Area	58%
Runoff ratio	0.424
Spill out	0.021
Evapo.&Penetra. Losses	0.157
Runoff/Irrigation	0.663

Paniikennoi Tank (A=2.603km2)

Year	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995
Total Rainfall(mm)	151.8	282.8	153.2	607.8	333.2	487.4	425.6	852.4	448.7	
Total Run-off(m³)	199,654	246,768	43,691	714,093	438,999	616,215	537,670	1,163,612	479,366	
Evapo.&Penetra. Losses(m³)	21,709	13,502	9,188	83,814	36,365	54,126	45,337	139,146	25,868	
Irrigation Water(m³)	571,533	571,533	571,533	571,533	571,533	571,533	571,533	571,533	571,533	
Spill out (m³)	0	0	0	0	0	0	0	0	217,501	0
Estimated Irrigation Area	19%	21%	8%	69%	0%	55%	47%	100%	86%	
Runoff ratio	0.505	0.335	0.110	0.451	0.506	0.486	0.485	0.524	0.410	
Spill out	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.167	
Evapo.&Penetra. Losses	0.109	0.055	0.210	0.117	0.084	0.088	0.084	0.120	0.054	
Runoff/Irrigation	0.349	0.432	0.076	1.249	0.768	1.078	0.941	2.036	0.839	

Seegangulam Tank (A=2.49km2)

Year	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	Average
Total Rainfall(mm)	631.9	869.5	250.5	663		799	1064	1067.5	1080	532.8	761.9111111
Total Run-off(m³)	666,860	1,749,554	140,407	742,128		1,053,983	1,634,699	1,675,705	1,710,397	632,715	1,111,928
Evapo.&Penetra. Losses(m³)	444,255	623,447	641,961	627,628	137,774	413,102					
Irrigation Water(m³)	666,067	666,067	666,067	666,067	666,067	666,067	666,067	666,067	666,067	666,067	666,067
Spill out (m³)	0	0	0	0		0	0	0	0	0	0
Estimated Irrigation Area	45%	35%	19%	33%		40%	29%	97%	38%	71%	45%
Runoff ratio	0.424	0.808	0.225	0.450		0.530	0.629	0.630	0.687	0.477	0.540
Spill out	0.000	0.000	0.000	0.000		0.000	0.000	0.000	0.000	0.000	0.000
Evapo.&Penetra. Losses	0.206	0.443	0.084	0.430		0.422	0.380	0.383	0.367	0.218	0.326
Runoff/Irrigation	1.001	2.627	0.211	1.114		1.582	2.454	2.516	2.568	0.959	1.669

Kurunehi Tank (A=3.326 km2)

Year	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	Average
Total Rainfall(mm)	868	415	259.6	465.7	400	409	657.2	1029.4	498	315.4	535.73
Total Run-off(m³)	1,566,791	744,343	285,252	731,392	615,199	662,794	1,116,185	1,862,530	825,185	349,925	871,959
Evapo.&Penetra. Losses(m³)	93,903	60,447	66,610	69,568	72,244	87,471	81,348	92,066	59,954	62,422	74,063
Irrigation Water(m³)	321,200	321,200	321,200	321,200	321,200	321,200	321,200	321,200	321,200	321,200	321,200
Spill out (m³)	1,147,464	596,543	55,074	580,055	369,653	298,232	687,309	1,351,562	498,012	46,246	582,935
Estimated Irrigation Area	100%	95%	98%	62%	70%	100%	100%	100%	1%	79%	81%
Runoff ratio	0.252	0.247	0.152	0.217	0.212	0.195	0.234	0.247	0.229	0.153	0.214
Spill out	0.548	0.539	0.550	0.472	0.462	0.425	0.511	0.558	0.498	0.334	0.466
Evapo.&Penetra. Losses	0.742	0.533	0.196	0.520	0.001	0.444	0.616	0.754	0.608	0.132	0.512
Runoff/Irrigation	0.061	0.081	0.234	0.095	0.119	0.132	0.073	0.050	0.073	0.178	0.109
	4.876	2.317	0.808	2.277	1.915	2.063	3.475	5.796	2.569	1.089	2.715

Table 3.5.6 Estimated Drainage Water Requirements for Pilot Tank Areas

Pilot Tank	Echur	Cherukkanur	Polambakkam	Enadur	Vadakkupattu	Siruvalai	Kurumbi	A. Ramalingapuram	Sengangulam	Pandikanmoi
Free Catchment (Km^2)	1.57	1.96	2.28	14.60	6.32	1.42	2.46	6.34	2.49	2.60
Intercepted Catchment (Km^2)			3.69	13.08	4.66	12.77	4.34	146.34		
Equivalent Catchment (Km^2)	1.57	1.96	3.01	17.22	7.26	3.97	3.33	20.97	2.49	2.60
Combined Catchment (Km^2)	1.57	1.96	5.97	27.68	10.98	14.19	6.80	152.68	2.49	2.60
(1) Rational Method										
$Q = CIA/360$										
Equivalent Catchment (Km^2)	1.57	1.96	3.01	17.22	7.26	4.56	3.33	20.97	2.49	2.60
Equivalent Catchment (ha)	157	196	301	1,722	726	456	333	2,097	249	260
Catchment Coefficient	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5
Rainfall Indensity (mm/h)	90	61	75	60	70	45	55	62	45	60
Discharge (m3/s)	19.63	16.61	31.40	143.47	70.58	28.49	25.41	180.61	15.56	21.67
(1A) Rational Method										
Catchment Area = FC										
Free Catchment (Km^2)	1.570	19.606	2.276	14.600	6.320	1.415	2.459	6.340	2.490	2.600
A (ha)	157	1,961	228	1,460	632	142	246	634	249	260
C	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4
I (mm/hr)	90	83	175	53	60	70	53	120	60	70
Q (m3/sec)	15.70	180.81	44.26	85.98	42.13	11.01	14.48	84.53	16.60	20.22
L (m)	4,396	5,490	8,441	48,205	20,328	12,764	9,313	58,728	6,972	7,280
S (m/m)	2	2	2	2	2	2	1.5	1.5	1.5	1.5
tc(min)	9.8	11.6	16.2	61.8	31.8	22.2	19.5	80.4	15.6	16.1
(2) Empirical Method - Ryve's formula										
$Q = CM^{2/3}\text{-}cm^{2/3}$										
Combined Catchment (sqmiles)	0.606	0.757	2.305	10.687	4.239	5.478	2.624	58.950	0.961	1.004
IC (Sq.miles)	0.000	0.000	1.426	5.050	1.799	4.931	1.674	56.502	0.000	0.000
Q (cfs)	358.07	415.26	745.92	2,133.35	1,162.37	1,264.70	810.40	6,109.27	487.04	501.29
Q m^3/sec	10.14	11.76	21.12	60.42	32.92	35.82	22.95	173.02	13.79	14.20

Table 3.7.1 Calculation of Crop Economic Benefits for Echur Tank

"Without Project":

Crop	Area (ha)	Production				Production Cost		Net Production Value (1000Rs)	Remarks
		Yield (T/ha)	Production (T)	Unit Price (Rs/T)	Value (1000Rs)	Unit Cost (Rs/ha)	Total Cost (1000Rs)		
1. Paddy (1st Crop)	47.0	4.65	218.6	4,736.0	1,035.1	5,008.0	235.4	799.7	Sep-Dec
2. Paddy (2nd Crop)	10.0	4.65	46.5	4,736.0	220.2	7,200.0	72.0	148.2	Jan-May
3. Groundnut (2nd Crop)	2.0	1.50	3.0	7,168.0	21.5	3,900.0	7.8	13.7	Jan-Apr
Total	59.0		268.1		1,276.8		315.2	961.6	

"With Project":

Crop	Area (ha)	Production				Production Cost		Net Production Value (1000Rs)	Remarks
		Yield (T/ha)	Production (T)	Unit Price (Rs/T)	Value (1000Rs)	Unit Cost (Rs/ha)	Total Cost (1000Rs)		
1. Paddy (1st Crop)	47.0	5.00	235.0	4,736.0	1,113.0	5,760.0	270.7	842.2	Sep-Dec
2. Paddy (2nd Crop)	5.0	5.00	25.0	4,736.0	118.4	8,280.0	41.4	77.0	Jan-Jun
3. Ladies Finger (2nd Crop)	7.0	15.00	105.0	3,600.0	378.0	18,800.0	131.6	246.4	Jan-Apri
4 Ladies Finger (3rd Crop)	12.6	15.00	189.0	3,600.0	680.4	18,800.0	236.9	443.5	May-Aug
Total	71.6		554.0		2,289.8		680.6	1,609.2	

Incremental Crop Benefits:

"With Project" NPV:	1,609.2
"Without Project" NPV:	961.6
Incremental Crop Benefits:	647.6
Value Added (5%) :	80.5
	728.0

Table 3.7.2 Price Structure of Paddy (for Evaluation Purpose)

Item	As Economic Price (US$/ton)
1. World Bank Projection Price in 2010 at 1990 Constant Price (5 % Broken White Rice, FOB Bangkok)	266. 80
2. Converted to 1997 Constant Price	292.70
3. Equivalent in Rs. (US $ 1.00 = Rs. 35.50)	10,390.85
4. Grade Differential (less 15 %) Weighted Average Price (as 97% of FOB Price of 5% broken Portion)	8,832.00
5. Freight (Bangkok - Madras) and All Port Charges (US $ 38.00/ton)	1.349.00
6. Exporter's Margin (10% of FOB Price)	883.20
7. Wholesaler's Margin	883.20
8. Shipment-Transportation and Handling Charges	980.00
9. Ex-Mill Price of Rice	4,736.60
10. Ex Mill Price of Paddy (as 68 % of rice conversion rate for average rice-mill in India)	3,220.90
11. Value of Milling By-Products (per ton of paddy)	200.00
12. Milling Cost plus Miller's Margin	400.00
13. Imputed Price of Paddy at Mill	3,020.90
14. Margin for Grain Dealer (per ton of paddy)	250.00
15. Transport Cost from Farm to Miller (for average distance of 100 km)	100.00
16. Farm Gate Price of Paddy	2,670.90 or Rs.2,700/ton

Source: The World Bank, Commodity Markets and the Developing Countries A World Bank Quarterly, August 1996)

Table 3.7.3 Labor Requirement of the Cropping Plan

(man-day)

Tank Area	Crop	Area (ha)	Growing Period	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Echur	Paddy	47.0	Sep-Jan	2,518	571	571	571	571	571	571	571	3,378				9,894
	Paddy	5.0	Jan-Jun	360	106	106	106	106	268							1,052
	Paddy	7.0	Jan-Apr	406	1,993	1,993	1,398									5,789
	L. Finger	12.6	May-Aug					731	3,590	3,590	2,519					10,430
	Total	71.6		3,284	2,670	2,670	2,075	1,408	4,429	4,161	3,090	3,378	0	0	0	27,165
Cherukkanur Big	Paddy	83.0	Jun-Oct						10,337	2,352	2,352	2,352	4,447			21,641
	Paddy	50.0	Nov-Apr				2,679	708	708	708	708	708	708	3,594		10,524
	Sugarcane	20.0	Jun-Jun	412	412	412	412	3,167	2,517	412	412	412	412	412	412	9,803
	Banana	4.0	May-May	68	68	68	633	503	68	68	68	68	68	68	68	1,815
	Total	157.0		480	480	480	3,724	4,378	13,630	3,540	3,540	3,540	5,636	4,074	480	43,783
Polambakkam	Paddy	79.7	Sep-Jan	4,270	968	968	968	968	968	968	968	5,729				16,775
	L. Finger	4.3	Feb-May		249	1,226	1,226	860								3,560
	Black gram	4.3	Jun-Aug						155	181	115					453
	Egg plant	4.3	Feb-Jul		249	613	613	613	613	860						3,560
	Turmeric	5.0	Jun-Mar	285	285	1,000	285	285	290	285	285	285	285	285	285	4,140
	Banana	5.0	May-May	85	85	85	792	629	85	85	85	85	85	85	85	2,268
	Total	102.6		4,640	1,836	3,891	3,893	3,355	2,110	2,380	1,453	6,098	370	370	370	30,756
Enadur Big	Paddy	102.0	Jul-Nov							7,331	2,891	2,891	2,891	5,465		21,468
	Paddy	220.0	Aug-Dec								15,813	6,234	6,234	6,234	11,788	46,304
	Groundnut	10.0	Jan-Apr	275	386	386	773									1,820
	L. Finger	5.0	Jan-Apr	290	1,425	1,425	1,000									4,140
	Chili	50.0	Jan-Aug	2,900	4,750	4,750	4,750	4,750	4,750	4,750	10,000					41,400
	Banana	5.0	May-May	85	85	85	792	629	85	85	85	85	85	85	85	2,268
	Total	392.0		3,550	6,646	6,646	7,314	5,379	4,835	12,166	28,788	9,210	9,210	11,785	11,873	117,401
Vadakkupattu	Paddy	370.0	Aug-Dec								26,594	10,485	10,485	10,485	19,825	77,875
	Paddy	225.0	Jan-Apr	1,617	9,564	9,564	12,056									32,801
	Banana	5.0	May-May	85	85	85	792	629	85	85	85	85	85	85	85	2,268
	Turmeric	5.0	Jun-Mar			1,000	1,425	1,425	290							4,140
	Tomato	4.0	Mar-Jul			232	760	760	760	800						3,312
	L. Finger	4.0	Feb-May		232	760	760	800								2,552
	Tomato	4.0	Mar-Oct			232	380	380	380	380	380	380	800			3,312
	L. Finger	4.0	Aug-Nov								232	1,140	1,140	800		3,312
	Total	621.0		1,702	9,881	11,873	16,173	3,994	1,515	1,265	27,291	12,090	12,510	11,370	19,910	129,573
Siruvalai	Paddy	42.4	Aug-Dec								3,048	1,202	1,202	1,202	2,272	8,924
	L. Finger	6.9	Sep-Dec									400	1,967	1,967	1,380	5,713
																0
	Total	49.3		0	0	0	0	0	0	0	3,048	1,602	3,168	3,168	3,652	14,637
A Ramalinga-puram	Paddy	66.0	Sep-Jan	3,536								4,744	802	802	802	10,685
	L. Finger	14.0	Feb-May		812	3,990	3,990	2,800								11,592
	Greengram	14.0	May-Aug					503	298	298	375					1,473
	Total	94.0		3,536	812	3,990	3,990	3,303	298	298	375	4,744	802	802	802	23,750
Pandikanmoi	Paddy	40.6	Oct-Feb	1,151	2,175								2,918	1,151	1,151	8,546
	Cotton	10.0	Feb-Jun		719	283	283	283	536							2,105
	Blackgram	10.0	Feb-May		359	213	213	268								1,052
	Greengram	10.0	Feb-May		359	213	213	268								1,652
	Total	70.6		1,151	3,613	708	708	819	536	0	0	0	2,918	1,151	1,151	12,755
Sengangulam	Paddy	50.0	Aug-Dec								3,593	1,417	1,417	1,417	2,679	10,524
	L. Finger	5.0	Feb-May		290	1,425	1,425	1,000								4,140
	L. Finger	5.0	May-Aug					290	1,425	1,425	1,000					4,140
	Chili	5.0	Jan-Aug	290	475	475	475	475	475	475	1,000					4,140
	Ragi	40.0	Jan-Apr	1,438	850	850	1,072									4,209
	Total	105.0		1,728	1,615	2,750	2,972	1,765	1,900	1,900	5,593	1,417	1,417	1,417	2,679	27,153
Krumbi	Paddy	52.0	Aug-Dec								3,738	1,474	1,474	1,474	2,786	10,935
	Chili	5.0	Jan-Aug	290	794	794	794	794	794	794	1,000					6,054
	Turmeric	5.0	Jun-Mar	356	356	1,000			290	356	356	356	356	356	356	4,140
	L. Finger	5.0	Feb-May		290	1,425	1,425	1,000								4,140
	L. Finger	5.0	May-Aug					290	1,425	1,425	1,000					4,140
	Egg plant	5.0	Jan-Jun	290	713	713	713	713	1,000							4,140
	Tomato	5.0	Jan-Jun	290	713	713	713	713	1,000							4,140
	Total	82.0		1,226	2,865	4,644	3,644	3,509	4,509	2,575	6,094	1,830	1,830	1,830	3,143	37,699

Source: Farmers interview Survey, JICA

Table 3.8.1 Possible Environmental Impacts for Echur Tank Area

A : Significant environmental impact is unquestionably induced by the Project
B : Significant environmental impact is likely to be induced by the Project
C : There is no environmental impact likely to be induced by the Project
D : Not known or there likely to be no impact

	Categories of Environmental Impact	Evaluation A	B	C	D	Evaluation Base
1.	Planned residential settlement			x		No plan
2.	Involuntary resettlement			x		No plan
3.	Substantial changes in the way of life			x		Not expected
4.	Conflict among communities and people		x			Conflict in water distribution may arise
5.	Negative impact on native people			x		Positive impact by improvement of socio-economic conditions
6.	Population increase			x		Not expected
7.	Drastic change in population composition			x		Not expected
8.	Changes in bases of economic activities			x		Not expected
9.	Occupational change and loss of job opportunities			x		Positive impact by increase of seasonal employment in agriculture
10.	Increase in income disparities			x		Not expected
11.	Adjustment & regulation of water or fishing (repairing) rights		x			Establishment of WUAs needs new water sharing adjustment
12.	Changes in social and institutional structures		x			Establishment of WUAs impacts on traditional community
13.	Changes in existing institutions and customs		x			Traditional water sharing needs to be modernized
14.	Increased use of agrochemicals				x	Agrochamicals application may increase under expansion of irrigated agriculture
15.	Outbreak of endemic diseases			x		Not expected
16.	Spreading of epidemic diseases			x		Not expected
17.	Residual toxicity of agrochemicals			x		Not expected
18.	Increase in domestic and other human wastes			x		Not expected
19.	Impairment of historic remains and cultural assets			x		Not found in the area
20.	Damage to aesthetic sites			x		Not expected
21.	Impairment of buried assets			x		Not found in the area
22.	Changes in vegetation			x		Not expected
23.	Negative impact on important or indigenous fauna and flora			x		Not expected
24.	Degradation of ecosystems with biological diversity			x		Not expected
25.	Proliferation of exotic and/or hazardous species			x		Not expected
26.	Destruction of wetlands and peatlands			x		No wetlands and peatlands in the area
27.	Decrease of tropical rain forests and wildlands			x		No tropical rain forests in the area
28.	Destruction or degradation of mangrove forests			x		No mangrove forests in the area
29.	Degradation of coral reefs			x		No coral reefs in the area
30.	Soil erosion			x		Not expected
31.	Soil salinization			x		Not expected
32.	Deterioration of soil fertility			x		Not expected
33.	Soil contamination by agrochemicals and others				x	Intensive/improper application of agrochemicals may lead to soil contamination
34.	Devastation or desertification of land			x		Not expected
35.	Devastation of hinterland			x		Not expected
36.	Ground subsidence			x		Not expected
37.	Change in surface water hydrology			x		Not expected
38.	Change in ground water hydrology		x			Large scale development may lower the water table
39.	Inundation and flooding			x		Not expected
40.	Sedimentation			x		Not expected
41.	Riverbed degradation			x		Not expected
42.	Impediment of inland navigation			x		Not expected
43.	Water contamination and deterioration of water quality				x	Excess use of agrochemicals may lead to water contamination
44.	Water eutrophication			x		Not expected
45.	Sea water intrusion		x			Over-pumping of groundwater and deep boreholes development may enhance sea water intrusion
46.	Change in temperature of water			x		Not expected
47.	Air pollution			x		Not expected

Table 3.8.2 Environmental Impacts (Irrigation) for Echur Tank Area

	Check Items	Major	Small	None	Not Clear	Problems	Action and Countermeasures Planned	Remarks
Pollution	1. Air Pollution caused by spraying of agricultural chemicals			x		Not expected		
	2. Effect on aquatic organisms, fisheries, and other water utilization of change in the water system resulting from project construction			x		Not expected		
	3. Water pollution caused by effluent from irrigated fields				x	1. Excess and improper use of agrochemicals may lead to soil and water contamination.	1. Farmers training on proper use of agrochemicals is extended.	
			x			2. Large scale groundwater development will lower water table and lead to sea water intrusion.	2. Appropriate development scale is planned with careful hydrological study.	
Natural Environment	1. Effect of construction and operation of the facilities on the ecology			x		Not expected		
	2. Effect on landscape			x		Not expected		
Human Environment	1. Effect of the project on historical and cultural heritage			x		Not found in the project area		
	2. Effect on existing infrastructure			x		Not expected		
	3. Relocation and effect on land-use			x		Not expected		
	4. Effect on other water use				x	1. Introduction of WUA may cause increase of friction and conflict on water sharing in the community.	1. Appropriate procedure is taken in preparation stage through farmers participation.	
Others	1. Effect on the environment during construction period			x		Not expected		
	2. Environmental Monitoring		x			1 Present monitoring activities are not sufficient.	1. Monitoring shall be conducted by relevant agencies.	

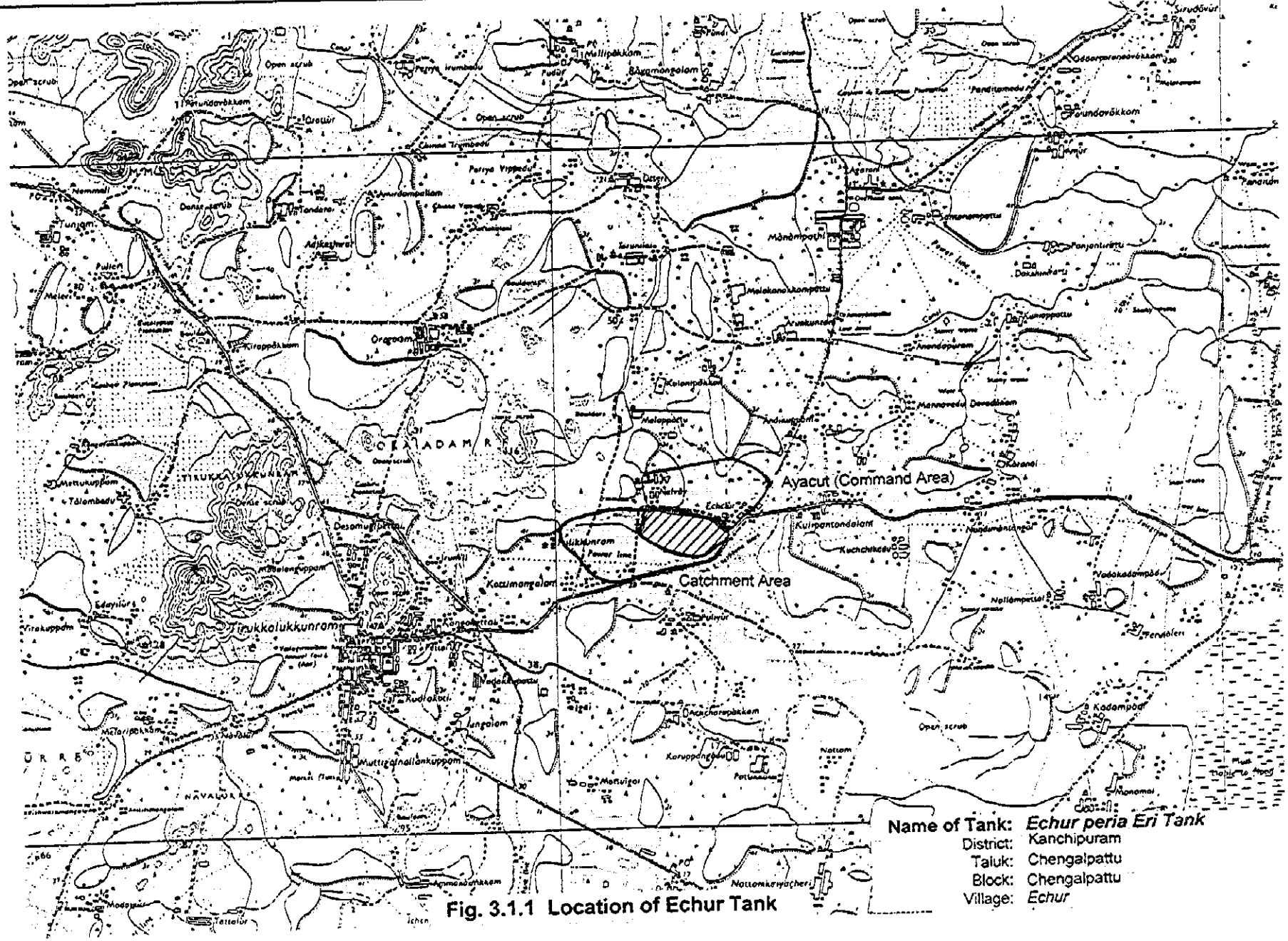


Fig. 3.1.1 Location of Echur Tank

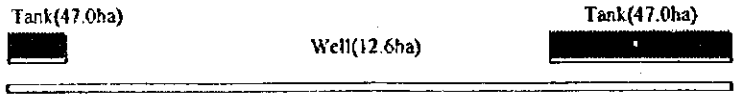
1 Name of Tank	Echur Tank
2 Ayacut Area	58.6 ha
3 Main Soil	Black soil: 88%, Red soil: 8%, Red sandy soil: 4%
4 Water pH, EC	pH: Tank water- 8.8,Groundwater- 7.4 to 8.4, EC: Tank water 0.3 dS/m, Groundwter 0.34 to 0.93 dS/m
5 No. of Farm Households	166 farm households
6 Self-Support Amount of Rice	332 tons (166 x 2,000 kg/Household)
7 Geographical Irrigable Area	Normal year: 47.0 ha
8 Total Irrigable Area and Month by Tan	Normal year: 58.6ha (Oct-Jan)
9 No. of Wells and Irrigable Area	Normal year: 61Wells, 12.6 ha

10 Average Rainfall(mm)

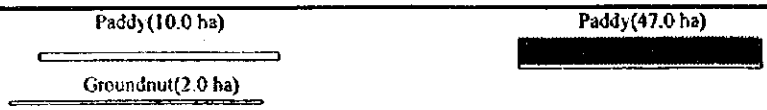
Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
18.3	11.3	8.7	17.1	36.6	54.4	106.3	154.1	143.0	207.3	269.4	131.4	1,157.9

11 Cropping

1) Irrigable Area and Period



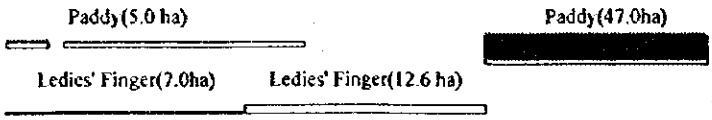
2) Present Cropping Pattern



3) Cropping Plan

a)Paddy Area for Self-Support: 66.4 ha (332t/5t, Expected yield: 5t/ha)

b) Cropping Plan



c) Evaluation

	Crop Intensity(%)	Net Income(1,000 Rs)
Plan	122.2	1,639
Present	100.7	796
Plan/Present	1.21	2.06

Fig. 3.4.1 Cropping Plan in Echur Tank Area

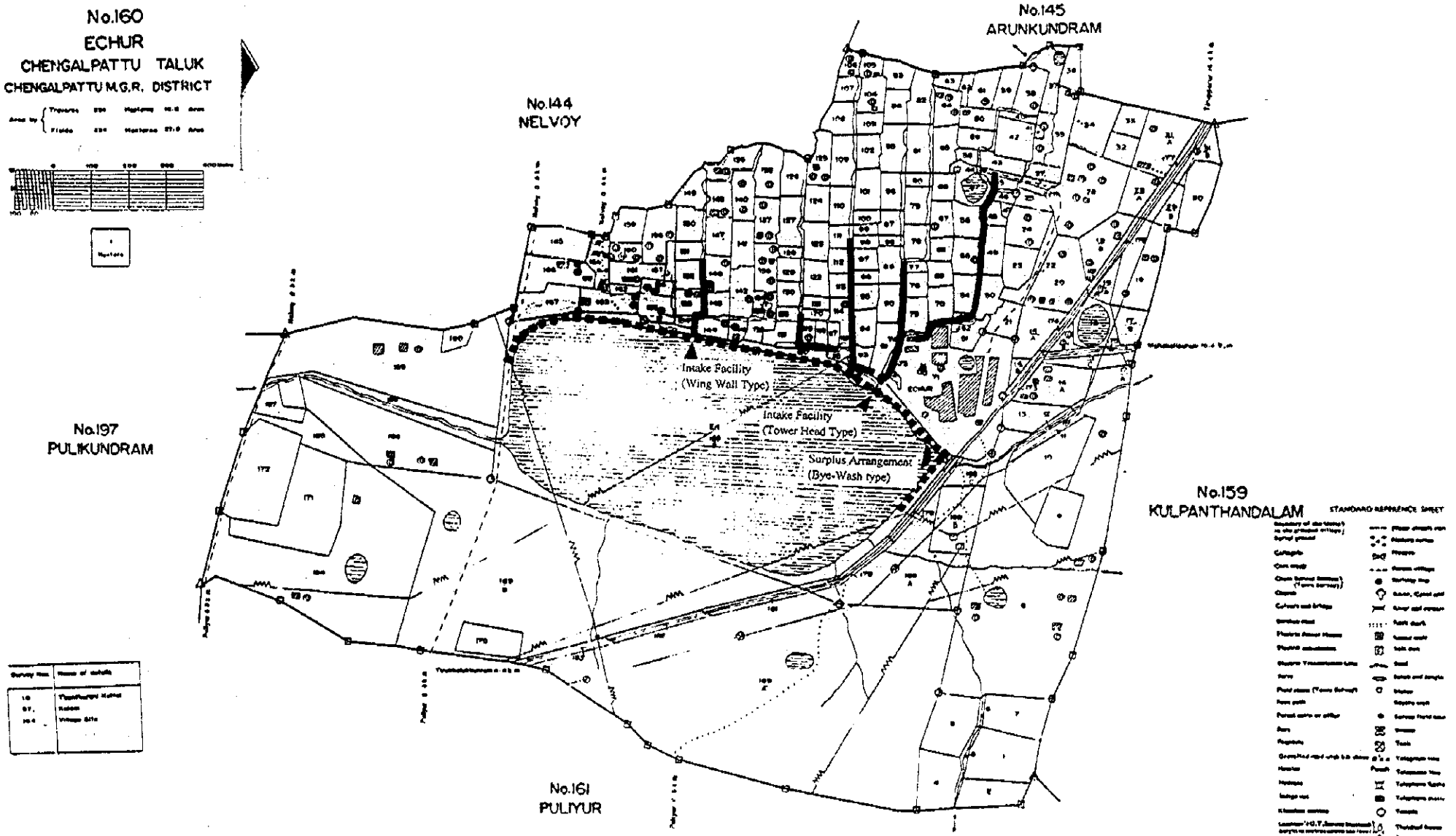


Fig. 3.5.1 General Layout of Irrigation Facilities in Echur Tank

CHAPTER 4 : CHERUKKANUR BIG TANK AREA

CHAPTER 4 CHERUKKANUR BIG TANK AREA

4.1 General

4.1.1 Location

Cherukkanur Big Tank of which registered command area is 91.3 ha is located about nine (9) km west to Tiruttani town along the Tiruttani - Ramakrishina Rajupettai road as shown in Fig. 4.1.1. The tank is located about two (2) km south of the road. Administratively it belongs to Cherukkanur Village in Tiruttani Taluk of Tirvallur District.

The village area is surrounded by Tadur Village, Vellore District, the Koramangalam, and Senagalatturu villages in the north, south, east and west sides, respectively.

4.1.2 Topography

The Cherukkanur Big Tank is located about two (2) km south from the Tiruttani - Ramakrishina Rajupettai road along the unpaved village road, and its waterspread area is measured to be 0.35 km^2. The ayacut areas of 91.3 ha expand in the east of the tank toward the Nandi River (a surplus course of the Ayyaneri Tank). The catchment area of the tank expands in the areas west of the tank.

A supply channel is provided at the southern end of the tank, and it flows from the intake facilities on the Nandi River. The surplus channel flows southeastward from the surplus weir provided at almost southern end of the tank. Although this tank is not a chained tank, it has a surplus arrangement at the northern end of the tank to provide Cherukkanur Small Tank with some extent of surplus water during the flood.

The village territory is topographically divided into two (2) parts by the Nandi river flowing northeastward, and the tank belongs to the northwestern part of the village. The other part of village is called Ramakrishnapuram. There are two (2) residential areas; one is the main village located at the northern end of the tank, and the other is a small area located about 500 m northwest of the main area where the SC villagers live. Public facilities are located in the former area.

An unpaved village road runs from the northern village to southeastern half of the village through the main residential areas of the village crossing the Nandi River. The other unpaved road is branched out at the main village site, and it runs westward to the neighboring Senagalatturu Village.

The bund of about 1.9 km runs from north to south along the eastern edge of the tank. The ayacut areas are generally flat with mild slope toward east, and the earthen irrigation channels runs generally eastward branching many off-take channels. There are

13 wells in the ayacut areas to supply domestic and irrigation water.

4.1.3 Geology

Cherukkanur Big Tank region is primarily made-up of Archean rocks, which are overlaid by a very thin layer of recent soils. The oldest archean crystalline rocks primarily comprise hornblende gneiss, granites and charnockites. The hornblende granites and gneiss generally lies above the charnockites, which is the basement rock in this region. The charnockites are also outcrops at number of places, especially in the northern part Cherukkanur Big Tank. The Thirutani crystalline rocks are also included by dolorite dykes and quartz veins. The boreholes drilled in this area during this study showed that the rocks are weathered up to a depth of about 10 m. Beyond this depth the rocks are fractured and fissured at different depths.

4.1.4 Soils

The type of soil is mainly red clay in the chatchment and black clay in the ayacut area. High alkaline soil exists in a part of the catchment area and causes a high pH value of the tank water.

4.1.5 Vegetation

The catchment area is under casuarina forest, cultivated lands and natural shrubs of *Prosopis Juliflora*. Other trees found in the catchment are *Brassus Flabellifer (Palmyrah)*, *Coconut Palm* and *Eucalyptus Tereticonos*.Tank bed plantation of *Acacia Catatia* under the social forestry program is found in one part of the waterspread area.

4.1.6 Objectives

Cherukkanur Big Tank is categorized as a NR-2, which belongs to the Northern Study Area or annual rainfall more than 1,000 mm, and having the average cultivation area is more than 75 % of registered ayacut area, at a scale between 60 ha and 110 ha. This means water resources is rather rich on its surface and groundwater, and even at present all area of the ayacut might be possible to irrigate, after irrigation efficiency is increased by channel lining. The tank has two supply channels, one diverting the Nandi River water and the other is leading surplus water of the S. Agraharam Tank.

According to the Baseline Survey, the tanks in Tiruttani Development Block show about 70 % of year has surplus water, and cultivation ratio is more 75 %.

Therefore, objectives of Cherukkanur Big Tank rehabilitation are: 1) to maximize the tank water instead of groundwater; and 2) to distribute tank water in equity through the physical tank facility rehabilitation and channel lining.

4.2 Meteo-hydrology

4.2.1 Climate

The climate prevailing over Cherukkanur Big Tank area is sub-tropical. The basic and consolidated climatological data of temperature, relative humidity, sunshine, wind speed and evaporation data are available for Tirutani meteorological station located in the Nandhi river basin maintained by the Ground Water Wing of the PWD. Since, Cherukkanur Big Tank, belongs to the same North-eastern agro-climatic zone, the climatological data of Tirutani Meteorological station is also representative of Cherukkanur Big Tank. The coordinates and the monthly average climatological parameters are already presented in the previous section 3.2.1.

4.2.2 Rainfall

The rainfall in the catchment area of the tank varies with season and it receives considerable rainfall both in South-west and North-east monsoon. For all rainfall computations, monthly rainfall data at the nearest Tirutani Rainfall Station, maintained by the Revenue Department, is used. The mean monthly rainfall of last 54 years are presented below:

Mean Monthly Rainfall of Cherukkanur Big Tank Catchment Area

Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Mean	16.2	10.8	14.4	16.6	48.0	68.5	112.4	130.0	148.5	183.0	194.5	93.9	1023.5
Maximum	137.2	95.0	209.8	106.4	300.1	162.4	288.2	311.0	381.5	554.5	586.5	721.4	2161.8
Minimum	0.0	0.0	0.0	0.0	0.0	0.0	19.0	14.0	8.6	24.0	0.0	0.0	465.0

The entire calendar year can be divided into four seasons with the following rainfall distribution.

- Southwest Monsoon (June-September): 459.4 mm (44.3 %)
- Northeast Monsoon (October-December): 471.4 mm (45.5 %)
- Winter (January - February): 27.0 mm (2.6 %)
- Summer (March - May): 79.1 mm (7.6 %)
- Total: 1036.9 mm (100 %)

The tank catchment receives its maximum rainfall in North-east monsoon while the lowest rainfall occurs during the winter months of January and February. The monthly maximum rainfall is 194.5 mm in November, and the minimum rainfall of 10.8 mm in February. The annual maximum rainfall of 2,161.8 mm occurred during 1947 while the minimum was 465.0 mm occurred in the year 1993.

4.2.3 Catchment Area

Cherukkanur Big tank is a semi non-system tank located in the Nandi River basin. Even though it is located 92.4 km away from Sholingur surplus course, this is linked to the system tank, S Agraharam by a supply channel. The 1:50,000 map of the tank was

obtained which permitted an assessment of catchment and command area. As shown in Table 3.2.1, Cherukkanur Big Tank receives its runoff water from its free basin of 1.906 km^2. As per the PWD norms, the catchment is classified as "average" having gentle slope and moderate vegetation. As per the inventory list provided by the PWD, the average dependable yield for this tank is approved to be 0.1530 Mm^3. The registered ayacut of this tank is 91.26 ha, and hence the ratio between free catchment and registered ayacut is 2.15.

4.2.4 Hydrological Analysis

The hydrological analysis procedures are similar to that of Echur tank. Rainfall - runoff computations have been carried out for monsoonal (September - December) and annual (January - December) for a continuous period of 16 years by the Strange tables. There is no hydrological gauging station in the tank catchment and command area.

Yield and Runoff from the Catchment Area of Cherukkanur Big Tank

Year	September - December			January - December		
	Rainfall (cm)	Yield (cm)	Runoff(Mm^3)	Rainfall (cm)	Yield (cm)	Runoff(Mm^3)
1980	85.9	19.8	0.378	108.9	33.8	0.643
1981	45.3	4.4	0.085	93.7	24.3	0.464
1982	37.4	0.3	0.005	80.9	17.5	0.333
1983	62.7	9.7	0.185	93.4	24.3	0.463
1984	57.8	8.6	0.163	107.1	33.2	0.633
1985	62.4	9.6	0.184	96.5	26.0	0.496
1986	78.2	12.1	0.231	127.6	47.9	0.912
1987	45.6	4.5	0.085	60.3	19.6	0.373
1988	75.8	15.0	0.286	113.4	37.2	0.709
1989	48.4	5.2	0.099	75.0	14.8	0.283
1990	45.0	4.3	0.082	101.0	27.1	0.516
1991	77.3	15.8	0.302	95.3	29.5	0.563
1992	85.8	19.7	0.376	127.7	45.7	0.871
1993	31.2	1.5	0.029	46.5	4.7	0.089
1994	95.8	25.1	0.478	134.1	53.4	1.017
1995	51.8	6.1	0.117	90.0	22.3	0.425
Mean	61.6	10.1	0.193	96.9	28.8	0.549
Maximum	95.8	25.1	0.478	134.1	53.4	1.017
Minimum	31.2	0.3	0.005	46.5	4.7	0.089

During 1980 - 1995, the average annual yield was 28.8 cm with a maximum of 53.4 cm in 1994 and a minimum of 4.7 cm in 1993. The corresponding values of estimated annual runoff are 0.549 Mm^3, 1.017 Mm^3 and 0.089 Mm^3. The monsoonal (September - December) yield and runoff values also have been estimated and are presented in the same table. The 16 year average monsoonal yield was 10.1 cm and that of runoff was 0.193 Mm^3. In average the monsoonal yield accounts for nearly 35% of total annual yield.

The runoff calculated based on the daily rainfall data for the years 1986 - 1995, using the dry-damp-wet method is presented in Table 3.5.4 and 3.5.5. The annual runoff

values vary from 0.295 Mm^3 to 1.419 Mm^3. The average annual runoff for this 10 years period is 0.791 Mm^3, the average runoff ratio being 42 %. Similarly, the runoff values were calculated for the monsoon period, September - December varies between 0.250 Mm^3 and 1.138 Mm^3, with an average annual runoff of 0.586 Mm^3, the runoff ratio being 49 %.

4.3 Social Conditions

4.3.1 Present Social Conditions and Facilities

(1) Available Social Facilities in the Village

The drinking water supply system is provided for all the villagers. About 90 % of villagers use the piped supply system, and the remaining 10 % take the water from deep wells. The water quality of these sources is considered to be fair. However, the electricity supply system is provided for only 90 % of villagers.

There is no communal facilities such as community hall in the village, but there are primary (Grade 1 -5) and middle (Grade 6 - 8) schools. Health and clinic facilities are not available in the village. The village road connecting Cherukkanur Village to Tiruttani - Ramakrishina Rajupettai road is not paved. Its condition is not considered good, but seems to be usable even during the rainy season.

(2) Social Settings of the Ayacut Area

1) Land Holding and Relating Villages or Hamlets

There are 268 farmers in the ayacut areas of Cherukkanur Big Tank, and their average land holding size is calculated to be about 0.34 ha. About 97 % of the farmers are marginal and small farmers. All the farmers in the ayacut areas live in Cherukkanur village. There is no farmer of the other villages and hamlets in the ayacut areas.

2) Caste Composition

The approximate caste composition of the farmers in the ayacut areas are as follows:

Caste Composition in Cherukkanur Big Tank Ayacut Area

(Unit: %)

Others	BC	MBC	SC	ST	Total
0	20	60	18	2	100

The most predominant caste category is MBC composed of the group of Vanniar, and it shares about 60 % of all the farmers in the ayacut. The second predominant caste categories are BC and SC, sharing 20 % and 18 %,

respectively. The BC is composed of mainly Muthrayar and the SC of Adidravida. There is one Scheduled Tribe of Irulla sharing as small as about two (2) % only. Hinduism is considered to be the farmers' religion in the ayacut area.

3) Water Distribution and Decision Making Procedure

There is no registered organization for distributing water in the ayacut area. Farmers nominate a group of three (3) or four (4) farmers, and some discussions are held among them. The irrigation water is distributed in accordance with the decisions of such nominated farmers. The actual operation works are conducted by the *Kanbukuti* who are also assigned by the farmers in the ayacut areas. In Cherukkanur Big Tank ayacut, three (3) *Kanbukutis* are always assigned, and they beeing to the particular group of families (SC) in the village. Recently after the election of Village Panchayat, the Village President takes leadership role in the operation of water distribution.

During the drought year, a traditional water distribution rule is applied. The water distribution is controlled by the *Kanbukutis*, and no cross bund construction is allowed on the irrigation channels. Then, relatively high fields may not be irrigated though the farmers of such high lands are able to get irrigation water once in three (3) days during the normal season.

4) Maintenance of Irrigation Facilities

No regular maintenance activity of the irrigation facilities is conducted in the ayacut area except for the emergency repair works of tank bund and the desilting works done at the initial stage of the every irrigation period. The removal of weeds and the desilting works of the sluice are carried out by the assigned Kanbukutis.

5) Conflicts and Problems

According to the farmers in the ayacut areas, there exists neither conflict nor disparity among either the caste groups in receiving irrigation water. Since the water distribution has been done in accordance with the above-mentioned traditional system, those farmers who are not able to receive water during the drought period do not complain.

6) Other Employment Opportunity

The nearest town is Tiruthani located about 10 km away from the village. However, they are not able to expect high wages in the town. Therefore, some farmers go to Bangalore, about 250 km away from the village, and work as construction laborers there.

4.3.2 Sociological Evaluation

Based on the criteria described in Section 3.3.1, the sociological conditions of Cherukkanur Big Tank ayacut are evaluated as stated below:

Results of Social Scoring of Cherukkanur Big Tank

Factors	Hamlets	Farm Size	Conflicts	WUA	Leader-ship	Resource Mobilization	Main-tenance	Overall Score
Scores	5	5	15	8	35	20	5	93

This results show that the ayacut is good for social scoring and the timing of community organization for formulating WUA shall be at the commencement of the estimate preparation.

4.4 Agriculture

4.4.1 Present Agriculture

(1) Land Use

The registered command area is 91.3 ha of which the irrigable area is 83.0 ha (90.9 % of the command area) in normal year. In 1995-96, paddy was cultivated in the whole irrigable area of 83.0 ha (90.9 %) during the period from July to November and in the area of 50.0 ha (54.76 %) from December to April as a 2nd crop. In addition to this, sugarcane and *casuarina equisetifolia* were cultivated in the areas of 20.0 ha (21.9 %) and 12.0 ha (13.1 %), respectively. Consequently, the total cropped area in the year was 165.0 ha and the crop intensity was 180.7 %. The land use in normal year is the same as for the period 1995-96.

(2) Soil and Land Capability

The type of soil in the ayacut area is generally black clay which is suitable for wet and dry cultivation. However, alkaline saline soils are found at the tail end.

(3) Agricultural Production

1) Crop Production

The main crops cultivated in the area are paddy (133 ha), sugarcane (20 ha) and *casuarina equisetifolia* (12.0 ha).

The paddy is cultivated twice a year in the area. In 1995 - 1996, the 1st crop was grown in an area of 83.0 ha during the period from July to November with tank

water, and the 2nd crop was grown in the area of 50.0 ha during the period from December to April with tank water in December to January and well water in February to April . The main varieties planted are IR36 and ADT39 as the 1st crop and ADT37 in the 2nd crop. The average yields were 3,504 kg/ha in the 1st crop and 2,480 kg/ha as the 2nd crop in 1995 - '96 and are 4,000 kg/ha in both the crops in normal year.

The sugarcane was cultivated in an area of 20.0 ha throughout the year with irrigation by well water in the interval of once a week to 10 days. The average yield was 100 tons/ha. While, *casuarina* is grown throughout 4 to 5 years with occasional irrigation by tank water. The average yield is 113 ton/ha.

2) Irrigation Water

Tank water is available from June to April with an irrigable area of 129.0 ha in normal year. There are 39 wells in the ayacut area with 24 ha irrigable area.

3) Fertilizer Application

According to the data of farmers' interview survey, 73 kg of N and 37 kg of P_2O_5 on average per ha was applied in 1 to 2 split application for the paddy in 1995-96. These amounts applied are less than those recommended by the government; N: 120-150 kg/ha, P_2O_5: 38-50 kg/ha, K_2O: 38-50 kg/ha. Yield increase with an improvement of fertilizer application could be expected.

4) Labor Input

The family agricultural labor in this command area is 2.5 men/house and the potential agricultural labor is 5.1men on average. According to this data, the necessary staggering period in the command area to accomplish the paddy farm works by family labor is enough for 4 days when the potential labor is used. This result shows that there is no shortage of agricultural labor in this command area at present.

(4) Farm Size and Land Tenure

The number of farm holders in the area is 268 of which 3 % are holders of more than 2 ha, 23 % are holders of 1 to 2 ha and 74 % are holders of below 1 ha (marginal). The average farm size is extremely small, that is, 0.34 ha which is only 37 % of that of the State (0.93ha), and 22 % of that of all India (1.57 ha).

4.4.2 Agricultural Development Plan

(1) Land Use

As shown in Table 3.4.1, the crop intensity is planned to be slightly decreased from 180.7 % at present to 172.0 % due to introduction of banana (4.0 ha) in place of casuarina (12.0 ha).

(2) Cropping Plan

As shown in Fig. 4.4.1, 133 ha were allotted to paddy cultivation as self-support production, of which 83 ha are grown during the period June to October as 1st crop and 50 ha are grown from November to April as the 2nd crop. Both the crops are cultivated using tank water. 20.0 ha and 4.0 ha are allotted to sugarcane and banana, respectively. These crops are cultivated using well water.

(3) Crop Budget and Production Plan

The planned production amounts, the production costs and the net incomes are shown in Table 3.4.2. The net incomes for paddy and sugarcane increased by 41 % and 37 % than those of the present, respectively on account of the increased yield. Banana generated a new net income of Rs.235,200 from cultivation of 4.0 ha. The income corresponded to 8.6 % of the present total net income of the command area.

(4) Employment and Working Opportunity

The introduction of banana for 4.0 ha will certainly increase employment and working opportunities, especially for the women in the command area.

(5) Farm Management and Farm Budget

1) Farm Management Plan

For Cherukkanur Big Tank which belongs to a chain tank covering 5 - 6 related villages, the farm management would be largely focused on the item of water management. Due to its basic position in the tank chain, special works on annual cropping scheduling would be considered on alternative cases of water tank supply. Normally this tank has a rather long period of water supply but adjustments on water control should be done in harmony with other related villages. Each individual farm in the tank command area, therefore, should have this situation in mind for a proper and higher profitable cropping schedule.

On the aspect of crops, the cropping diversification has been partly applied in this tank area with sugarcane and *casnarina* as basic cash crops apart from the

main double-cropping of rice. But the integrated agriculture is neglected at the moment.

From these basic concepts, after confirming the related feasibilities for realization, a proper plan for farm management of each individual farm in this tank area should be further elaborated based on the following elements:

- Existing natural conditions for farming
- Local traditions in agriculture
- Periods of possible water supply from tank, groundwater etc.
- Available capital for investing in agricultural production
- Evaluation of possible crop budgets
- Preparations of farmland, inputs and related techniques
- Selection of crops for planting through the year
- Harvesting and marketing capabilities and proceedings
- Estimates on net farm revenues after all production costs
- Estimates on the balance after all family living expenses

2) Farm Budget Plan

Due to the rather intensive crop diversification application in this tank area, the farm budget for each individual farm corresponding to its annual cropping schedule should be carefully elaborated. Accordingly, the following representative cases are envisaged:

- Two crops of paddy
- Paddy and field crop (groundnut, cotton ragi etc.)
- Two seasons of field crops
- One annual crop only (sugarcane or *casuarina*)

Based on their cultivation capabilities and the marketability of considered crop(s), each farm could make its own proper cropping schedule. And from this cropping schedule with corresponding necessary inputs, the corresponding costs and revenues from envisaged yields will be evaluated for proceeding with the farm budget.

Since integrated agriculture is neglected in this tank area, the application of integrated agriculture should also be considered for increasing farm revenues, particularly on the aspects of raising stock at farm basis and aquaculture in the tank with cooperative scheme.

(6) Marketing Plan

The road from the tank area to the trunk road is recommended to be paved in good

conditions for possible transports to the villages in the rainy season. At the villages near the trunk road, basic post-harvest treatment facilities such as drying yard, godown, basic agro-processing establishments etc. are recommended to be established.

Besides, some transport vans are subjected to be equipped for quick transportation of agricultural produces to district markets.

4.4.3 Agricultural Supporting Services and Institutional Plan

(Same as notified in this part for Echur Tank Area)

4.5 Rehabilitation of Tank Irrigation System

4.5.1 Present Conditions

(1) Irrigation and Drainage System

Cherukkanur Big Tank is a part of the Nandi River irrigation system as shown in Fig. 4.5.1. The origin of system started Sholingur Tank which is the last tank of Sholinghur Branch Channel of Ponnai Canal System. Then the surplus of Sholingur Tank flows into the Ayyaneri Tank (183.4 ha), which has been modernized by EC Project. The surplus of Ayyaneri Tank flows into the Nandi River. From Nandi River, many tanks intake water by simple masonry weirs. They are S. Agrahram (32.85 km), Vengupattu (33.01 km), Paravathur (36.75 km), Cherukkanur Big (39.85 km), Koramangalam (43.33 km), Tekkalur Chitteri (44.21 km), Auckur (44.72 km), Tiruttani (49.10 km), Nasakuppam (50.60 km), Valarpuram (53.13 km), Kurishnapuram (58.65 km) and 9 direct ayacuts, totaling more than 1,000 ha.

As stated above, Cherukkanur Big Tank intake water from the Nandi river at the left bank near Gudjunta village conveyed by a supply channel with 1.5 km length and surplus water from S. Agraharam tank by 2.6 km long channel. One surplus masonry weir drain the surplus water to the Nindi river on the western end of the tank bund, and an uncontrolled surplus channel flows out to Cherukkanur Small Tank at the north end of tank bund.

At present, there are 3 sluices exists. No. 1 sluice is located near to Cherukkanur Village and installed at higher elevation therefore only during high water level it functions. Most of the ayacut area is irrigated by water from No. 2 sluice. No. 3 sluice is located in the southern part of the tank, and installed at higher elevation, commanding about 9 ha, it is possible to irrigate during a high water level period only.

Aqua plants in the waterspread area densely grows near to the bund where there is

deepest water.

Ground in the ayacut gently slopes to the northeastern toward the Nandi River. No. 2 sluice irrigates about 80 ha of paddy field through main feeder channel to the north along the eastern border of Cherukkanur Village with 6.5 km long, and to the south with 4 km long. Both main field channel diverted to 6 secondary field channels on the northern main channel and 5 field channels on the southern channel which lead water toward the Nandi river.

The area between No. 2 and No. 3 sluices is rather elevated, then no water from sluices is available. There are more than 13 open wells used for upland crops, sugarcane and trees by furrow irrigation. Area along the Nandi River at the southeastern edge of the ayacut area is irrigated by the diverted water from the Nandi River by masonry weir crossing the river.

(2) Tank Bund

The existing dimensions of the tank bund are measured and soil mechanics properties are analyzed. The results are shown in Table 3.5.1 and Table 3.5.2. Except natural deterioration due to the long time since its building, there is no damage such as huge cracks or leakage, in this bund. However, weak sections of the provided facilities are noticeable deteriorated.

(3) Spillway (Surplus Arrangement)

1) Location

There are two (2) weirs in this tank. Weir 1 is a natural bye-wash type located at the beginning point of the bund. Another (Weir 2) is a B.C. weir located at the end of the bund.

Besides, Weir 1 is maintenance free and hence not considered in the tank memories and inventory list. Location of these weirs are shown in Fig. 4.5.2.

2) Existing condition

In the Weir 2, there are some broken parts confirmed in the middle of apron by excessive water. It will be occurs that collapsed part of apron are extended against design discharge in the present. It is necessary to urgently repair the apron using cement mortal and stone.

(4) Intake Facilities (Sluices)

1) Location of the Sluice

There are three (3) sluices in this tank. And these sluices are of 2 types: Head and Wall type for Sluices 1 and 3, Head and Tower type for sluice 2 based on the depth of stored water. Location is shown in Fig. 4.5.2.

2) Existing condition

Few cracks and damages are confirmed in the slab and side wall; however, they still functions for intake of stored water and operation of a control device. Concerning the conditions of the materials, these sluices maintain their original condition. Rehabilitation of damages and cracks is not necessary.

3) Water Supply Control Device

Plug and plug rod type are used as water control device, and vent of barrel are installed in these sluices. Under the present conditions, plug and plug rod are removed from each sluice, and it is impossible to control stored water according to the demand discharge.

(5) Groundwater Usage

Groundwater potential in this region is comparatively lower than in other parts of the northern study area. Small diameter bore wells fitted with hand pumps are used to get water for domestic purposes. The irrigation requirements are largely met by the storage in the tank. However during summer season groundwater is being used to meet the irrigation requirements. Because of the hard rocks, the storage of groundwater is mainly due to secondary porosity. Hence the groundwater is generally extracted from large diameter open wells, where possibility of more number of fractures are high. The permeability test carried out at the basement rock below the tank bund gave a very low hydraulic conductivity value. The well drilled to a depth of 50m, was pumped at rate of about 8lts/min failed in about 60 minutes. Thus because of very low transmissivity of the formations, bore wells are not likely to yield large quantity of water.

(6) Operation and Maintenance

No formal water users' association exist in the ayacut area. Traditional irrigation is practiced. No conflicts appears concerning the irrigation water distribution.

4.5.2 Water Resources Development Plan

(1) Liability of Water

The Indian Meteorological Department's classification of drought based on the monsoon rainfall is given in Section 3.5.2. Following the same classification, the probability of the availability of water for Cherukkanur Big Tank is presented in the following table.

Liability of Water Based on Rainfall

Classification	No. of Years	Total No. of Years	Probability (%)
Excess	2	54	3.70
Normal	12	54	22.22
Deficit	21	54	38.88
Scanty	21	54	35.19

Among the 54 years 38.88 % of the years are classified as deficit followed by scanty years 35.19 % and normal years 22.22 %. The excess rainfall occurred only in 2 years accounting for 3.7 %.

Apart from this, another important aspect is the occurrence of drought or flood based on the rain storm. As discussed for Echur Tank, for a five year return period (20 % of probability), the drought monsoon rainfall is estimated as 790 mm which is nearly 85 % of the average monsoon rainfall. Hence, it becomes necessary to develop drought management strategies similar to that of Echur Tank.

(2) Water Quality

The water quality tests for pH and electrical conductivity in the Pilot Study Tank Areas were conducted by the Study Team during the field inspection in this stage. According to these results, the tank stored water and groundwater in the ayacut shows rather high alkalinity (pH 7.2 to 9.7) deferring with other Study Area and EC ranges between 0.75 and 2.17dS/m, which means careful selection of crops for the cultivation is required. This tendency also occurs at adjacent tank.

(3) Irrigation Water Requirement

The major crop in Cherukkanur Tank ayacut is paddy rice with a command area of 91.26 ha. The irrigation water requirements are calculated according to the procedures as outlined for Echur Tank. Present irrigation water requirement for Cherukkanur Big tank command area at 40 % efficiency (storage, conveyance and field application efficiency) is calculated to be 1.182 Mm^3 and with an increased irrigation efficiency of 75 %, 0.489 Mm^3 of water could be saved as post-project water requirement is estimated to be 0.693 Mm^3. The detail estimation are presented in Table 3.5.3. The saved water can be utilized to increase the tank command area or

to supply water for next season crop.

(4) Water Balance

The capacity of Cherukkanur Big Tank is determined as 1.5226 Mm^3, by topographic survey. Based on daily rainfall for the years 1986 - 1995, runoff values were estimated by dry-damp-wet method and presented in Table 3.5.4 and 3.5.5. As per the annual and monsoon (September - December) rainfall data, no surplus occurred during this 10 year period. All the runoff water is stored in the tank, to irrigate a registered ayacut of 91.26 ha. However, due to evaporation losses, insufficient storage capacity and other losses, Cherukkanur Big Tank could not satisfy all the irrigation demand. With present conditions (Ef = 40 %), the estimated irrigated area varies between a minimum of 2 % to a maximum of 73 % (average 36 %) of the registered ayacut, due to insufficient storage. The runoff/irrigation ratio remains as 66 %. This situation could be improved by canal lining, with an increased Ef = 75 %, resulting in decreased irrigation water requirements. By this change, tank water could irrigate in an average 53 % of the registered ayacut. More than 50 % of ayacut area got the irrigation water in 3 of 9 years. Monsoon data also showed the same trend, but with a slight increase in runoff ratio. The above facts point out that not only canal lining but also removal of the silted material from the tank bed is needed to attain the full potentials of tank irrigation.

(5) Drainage Water Requirements

The drainage water requirements of Cherukkanur Big Tank is calculated similar to the procedure outlined for Echur Tank and presented in Table 3.5.6. Using the Ryve's Formula, the estimated maximum flood discharge is 11.76 m^3/s while that using rational formula is 16.61 m^3/s. Hence a safe design discharge of 16.61 m^3/s can be adopted for designing surplus arrangements, after considering the cost-estimate values.

(6) Basin Water Management

Similar to Echur Tank, Cherukkanur Big Tank is also an isolated tank with a free catchment area of 1.9606 km^2. As presented in Table 3.2.1, various ratios calculated for Cherukkanur Big Tank are as follows:

- Free catchment / Command Area : 2.15
- Waterspread Area / Command Area : 0.77
- Storage capacity / Command Area : 0.017 Mm^3/ha
- Waterspread Area / Storage capacity : 0.462 km^2/Mm^3

The surface water resources of Cherukkanur Big Tank basin consists of direct runoff from rainfall and flow in streams. However, irrigation is largely depend on available tank water and ground water. The total ground water recharge of the Tirutani block

to which, Cherukkanur Big Tank belongs was estimated to be 5,613 ha m. Utilizable recharge is 4,771 ha.m, Net groundwater draft is 3,113 ha m and the balance available is 1,658 ha m. This unfilled 34.75 % could be exploited by digging out more ground water wells.

The total surface water resources can not be utilized due to certain limitations as outlined for Echur tank which compels to develop basin water management strategies as outlined in Section 3.5.2 of this Report.

(7) Groundwater Development

In order to meet the irrigation requirement during summer, groundwater potential has to be developed in this region. The unutilized groundwater can be exploited in this area. As the groundwater is stored in the weathered and fractured zones the yield from the bore well is expected to be less. Hence groundwater development has to be carried out by digging large diameter deep wells. In the tank region even bore wells are expected to give reasonable quantity of water because of recharge of water from the tank.

4.5.3 Tank Irrigation Facilities Rehabilitation Works

General layout of irrigation facilities is shown in Fig. 4.5.2, and required item for rehabilitation works are described in the following table.

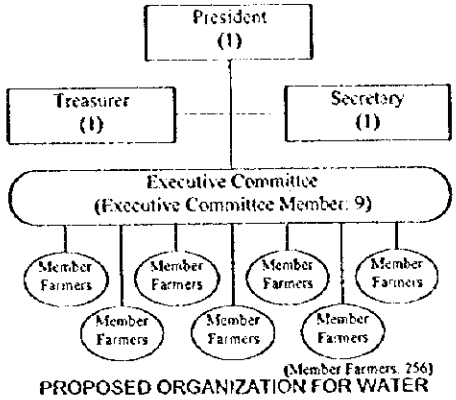
Countermeasures for rehabilitation of Cherukkanur Big Tank

Component	Rehabilitation works	Section for Rehabilitation Works	
Tank Bund Improvement (Total bund length 1605m)	• Strengthening of the bund for reshaping to standard size.	183m	
Intake works (Sluice)	• Modification of intake system using gearing shutter • Protection of back-fill for side slope.	Wing wall type Tower head type	2 units
Surplus arrangement	• Widening as 18.0m of width of B.C type weir. • Provision of rough stone for revetment	B.C. type weir	1 units
Tank supply channel	• Reshaping of cross section	2,006m	
Selective Lining for Field Channel including On-farm development	• Installation of lining canal up to 10ha • Provision of diversion boxes with paddle shutter for equal distribution. • Reshaping of existing canal. • Provision of incidental device such as cart, cattle, and canal/crossing.	830m as main 930m as branch	2 units 1 units
Building for Farmers' Association	• Provision of community hall for WUA, local farmers and inhabitation.	$50m^2$	1 Nos.

4.6 Farmers' Organization

4.6.1 Present Situations of Farmers' Organization

There is no such registered organization as water users' association in the ayacut area as described in the section 4.3.4 of Volume II Report. The farmers have an informal society for water distribution appointing the *Neerkatis* for watching water distributions.



PROPOSED ORGANIZATION FOR WATER USERS' ASSOCIATION OF CHERUKKANUR BIG TANK

4.6.2 Proposed Farmers' Organization

(1) Water Users' Association

Since there are 268 farmers in the ayacut areas, the number of the Executive Committee Member becomes to be nine (9) and the number of member farmers is 259 deducting the number of bearers from the total farmers. The functions of the proposed WUA for the Echur tank are described in the section 4.3.4 of Volume II Report.

(2) Farmers' Organization for Agricultural Production

As explained in Sub-section 4.3.1, the sections which have the following functions are proposed to be attached to the WUA in Cherukkanur Big Tank areas to realize sustainable agricultural development.

- Operation and maintenance technology for water-saving irrigation
- Agricultural technology extension services crop diversification and value-added agriculture, etc.
- Various agricultural supporting services such as supply of agricultural input materials, marketing, including agricultural credit services

4.7 Project Evaluation

4.7.1 Project Costs and Benefits

(1) Project Costs

Unit cost for rehabilitation works are estimated based on *the Standard schedule of Rates for Anna & M.G.R District* issued by P.W.D. At the 1997 price level, direct construction cost is estimated at about Rs. 2,848,000, as shown in the table below.

Direct Construction Cost for Cherukkanur Big Tank

Rehabilitation Work	Total Cost (Rs.)	Percentage	Unit Rates (Ayacut 91.26ha) (Rs./ha)
Tank Bund Improvements	4,000	0.14%	44
Sluices Improvement	212,000	7.44%	2,323
Surplus Improvement	1,194,000	41.92%	13,083
Tank Supply Channel Improvement	35,000	1.23%	384
Selective lining for Field Channel & OFD	1,273,000	44.69%	13,949
Building for Farmers' Association	130,000	4.56%	1,425
Community Well	-	0.00%	-
Direct Construction Cost	2,848,000	100.00%	

The Project cost consisting of direct cost, supervision charges, contingencies, preparation work cost and overhead charges is Rs. 4,180,000.

Project Cost for Rehabilitation Works in Cherukkanur Big Tank

Description	Cost (Rs.)
Direct Construction Cost)	2,848,000
Petty Supervision Charges & Contingencies	3,303,000
Preparation Cost (Govt. Share)	41,000
Overhead Charges	836,000
Total	4,180,000

Economic price for the economic analysis is estimated using the conversion factor (SCF, 0.8) for the direct construction cost.

(2) Project Benefits

The Project aims mainly at stabilizing the agricultural production through the year in the medium size of command area of about 91.3 ha by introducing proper agricultural production techniques for better farming system for higher farm revenues as well as improving living conditions of small and marginal farms after the rehabilitation works.

At present, though the whole command area is dominantly cropped with paddy for double crops in a year from August to April, but the cultivated area for the second paddy crop starting from January to April has been taken place in more than one half of the command area only. Besides, due to the main factor of unstable water supply in the first crop, the average unit yield of both paddy crops is observed relatively low and at the same level of about 4 ton per ha.

With the Project implementation, major benefits of the Project, therefore, will come from two sources from the economic point of view: 1) increases of crop benefits, and 2) value-added benefits from post-harvest treatments.

For the increases of crop benefits, the cropping pattern, detailed elaboration on water requirements, plan for land use, applied farming system including the cropping

schedule, varieties as well as estimates on inputs and yields for projected crops etc. were carefully evaluated in order to obtain higher farm revenues. This resulted in an increase in the net production value of agriculture from the present level of about Rs.2.7 million to more than Rs.3.44 million (Table 4.7.1).

Besides, with the establishment of various facilities for organizing farm management and improving treatments on storing, marketing etc., an estimated amount of value-added of about Rs.0.163 million as 5 % of the corresponding agricultural production value "with Project" would be obtained accordingly. This is estimated on the basis of results from the Study Team's site surveys that estimates that with the application of some basic post harvest treatments such as storage and selling at markets only, will originate a profit margin of an average of 10 % higher than selling at farm sites during harvesting periods.

4.7.2 Economic Evaluation

The economic evaluation is made to judge the project viability was made in terms of direct contribution to the national economy. The Project covers a command area of 91.3 ha with a total number of 166 farms for a total number of approximately 750 beneficiaries.

For the economic analysis, the related EIRRs for Cherukkanur Big Tank area were basically calculated as follows:

i)	EIRR in basic conditions :	15.9 %
ii)	EIRR at 10% cost-increase:	14.1 %
iii)	EIRR at 10% benefit-decrease:	12.9 %
iv)	EIRR at 3-year benefit delay:	10.0 %

From these figures, the EIRR under basic conditions of 15.9 % shows a relatively low figure. The risk case of 3-year delay of benefits showed the lowest EIRR of 10.0 %.

4.7.3 Financial Evaluation

In this Project, the financial evaluation is made to mainly deal with the analysis of farm budget for the representative farms in both cases of "without project" and "with project" The related results are as follows:

-	"Without Project" Net Income per Farm:	Rs.10,260
-	"With Project" Net Income per Farm:	Rs.13,812
-	"With Project" value-add:	Rs.691
-	Incremental Net Farm Income:	Rs.4,242

With the project implementation, the annual increase in net farm income for an average farm will be about Rs.4,300.

This amount would improve somehow the farm budgets of small and marginal farms in this tank area.

However, in order to achieve these figures, proper supports on technical aspects as well as more investments in farm inputs should be made accordingly. This should be made in a new scheme of financial and technical supports for these farm categories in the newly established Local Farmers' Organization.

4.7.4 Labor Force Requirement

Monthly labor force requirement for the planned cropping schedule are shown in Table 3.7.3. The peak of labor requirement in the area comes in June. The labor force requirement is 13,430 man-day/month. This labor amount can be satisfied by the staggering period of 10 days when the potential family labor is used. The potential family labor in the area is 1,367 man per day.

4.7.5 Farm Household Economy

With the Project implementation, the farm household economy of small and marginal farms will be improved accordingly. From the financial analysis on farm budgets of these farm categories, the agricultural benefits for an average farm in this tank area will be Rs.3,550 for the incremental net production and Rs.690 for the value added from agricultural products for a total amount of about Rs.4,240 per farm per year.

This amount is somehow modest but with better conditions on water supply and supporting institutions for agricultural production, small and marginal farmers would escape from the present deficit situation for improving their basic living standards.

Even for landless farmers, apart from the proposed work scheme for landless people in the farmers' organization as mentioned in the above, they would obtain more labor works from big and medium farms to support their living expenses. A legislative measure to make big and medium farms in the tank areas hiring on annual basis a quota of landless farmers i.e. 2 males or 1 male and 2 females per ha, if permissible, would be promoted for basically supporting their living.

4.8 Environmental Issues

4.8.1 Present Environmental Conditions

(1) Health and Sanitary Conditions

Major diseases in this area are diarrhea/ADD, filariasis and common fever. Diarrhea is a seasonal disease occurred in the wet season. In relation to irrigation and drainage, 11 cases of filariasis were occurred last year in this area. Filariasis, one of

three major mosquito-related diseases in the State, is rarely fatal but difficult to treat.

(2) Natural Environment

The Project Area is gentle sloped land. Catchment area is covered by casuarina forest, cultivated lands and natural shrubs of *Prosopis Juliflora*. No aquatic weeds are found in the tank. Tank bed plantation of *Acacia Catatia* under the social forestry program is found in a part of tank waterspread area. Wildlife seen by the villagers are only natural birds.

(3) Surface Water and Groundwater

Quality of tank water, as measured by the Study Team, is found unsuitable for irrigation due to high pH value of 9.7 and it needs anti-alkali measures in crop cultivation. Groundwater is also utilized for irrigation normally from March in the dry season. There are 13 private open dug wells in the ayacut. From the result of the water quality measurement, it can be stated that the groundwater will have little salinity problems and will cause to decrease crop production

4.8.2 Environmental Impact of the Project

As summarized in Table 4.8.1 and Table 4.8.2, the environmental impact study for Cherukkanur Big Tank area was conducted through the field survey and in consideration of the Project components.

(1) Social Environmental Impact

1) Social Institutions and Customs

In regard to the introduction of a WUA under the Project, almost the same impact as stated in Section 3.8 for Echur tank area will be considered.

2) Health and Sanitary Issues

As to agrochemical aspect, the same situation as stated in Section 3.8 for Echur Tank Area can be expected. That is, the use of agro-chemicals will be increased in the future.

For rural health and diseases, since the area is affected by filariasis, the mosquito-related disease, proper water management and adequate drainage shall be required in the Project. On the contrary, the Project will improve the existing filariasis affected condition by improving drainage and reducing waste water from the canals and seepage water from the tank.

(2) Natural Environmental Impact

1) Soil and Land Resources

As far as the Project activities are concerned, the groundwater development for irrigation may induce soil salinization and damage the crops.

2) Hydrology and Quality of Water

Groundwater with EC value of about 1.3 to 2.2 dS/m is highly saline for irrigation and groundwater development potential will be less. Likely problems induced by the groundwater development will be salinization of soil but it will not be serious. Large scale groundwater extraction will be a cause of lowering water table.

4.8.3 Recommendations

As a result of the environmental impact study described above, it can be concluded that the Project will not induce any serious direct negative environmental impact. But, the development activities may induce some indirect impacts. Details are presented in Appendix G: "Environmental Aspect" of Volume IV.

i) For the establishment of WUAs, it is recommended that an effective procedure involving NGOs with close cooperation among government agencies shall be provided.

ii) For the expansion of the irrigated agriculture, it is recommended that AD shall extend the guidance to the farmers on agrochemical use.

iii) For the expansion of the irrigation practice, it is recommended that proper water management and adequate drainage shall be provided and spread of filariasis be monitored.

iv) For the groundwater development for irrigation, it is recommended that the scale of groundwater development and the selection of crops considering water salinity shall be carefully planned.

Table 4.7.1 Calculation of Crop Economic Benefits for Cherukkanur Big Tank

"Without Project":

Crop	Area (ha)	Production				Production Cost		Net Production Value (1000Rs)	Remarks
		Yield (T/ha)	Production (T)	Unit Price (Rs/T)	Value (1000Rs)	Unit Cost (Rs/ha)	Total Cost (1000Rs)		
1. Paddy (1st Crop)	83.0	4.00	332.0	4,736.0	1,572.4	5,008.0	415.7	1,156.7	
2. Paddy (2nd Crop)	50.0	4.00	200.0	4,736.0	947.2	7,200.0	360.0	587.2	
3. Sugarcane (1 year)	20.0	100.00	2,000.0	560.0	1,120.0	12,000.0	240.0	880.0	
4. Casuarina (4.5 year)	12.0	22.50	270.0	1,120.0	302.4	16,000.0	192.0	110.4	
Total	165.0		2,802.0		3,942.0		1,207.7	2,734.3	

"With Project":

Crop	Area (ha)	Production				Production Cost		Net Production Value (1000Rs)	Remarks
		Yield (T/ha)	Production (T)	Unit Price (Rs/T)	Value (1000Rs)	Unit Cost (Rs/ha)	Total Cost (1000Rs)		
1. Paddy (1st Crop)	83.0	4.80	398.4	4,736.0	1,886.8	5,760.0	478.1	1,408.7	Jun-Oct
2. Paddy (2nd Crop)	50.0	4.80	240.0	4,736.0	1,136.6	8,280.0	414.0	722.6	Nov-Apr
3. Sugarcane (1 year)	20.0	125.00	2,500.0	560.0	1,400.0	13,800.0	276.0	1,124.0	
4. Banana (1 year)	4.0	27.97	111.9	2,400.0	268.5	20,000.0	80.0	188.5	
Total	157.0		3,250.3		4,691.9		1,248.1	3,443.8	

Incremental Crop Benefits:

"With Project" NPV:	3,443.8
"Without Project" NPV:	2,734.3
Incremental Crop Benefits:	709.6
Value Added (5%) :	172.2
Incremental Total	881.8

Table 4.8.1 Possible Environmental Impacts for Cherukkanur Big Tank Area

A : Significant environmental impact is unquestionably induced by the Project
B : Significant environmental impact is likely to be induced by the Project
C : There is no environmental impact likely to be induced by the Project
D : Not known or there likely to be no impact

Categories of Environmental Impact	Evaluation A	B	C	D	Evaluation Base
1. Planned residential settlement			x		No plan
2. Involuntary resettlement			x		No plan
3. Substantial changes in the way of life			x		Not expected
4. Conflict among communities and people		x			Conflict in water distribution may arise
5. Negative impact on native people			x		Positive impact by improvement of socio-economic conditions
6. Population increase			x		Not expected
7. Drastic change in population composition			x		Not expected
8. Changes in bases of economic activities			x		Not expected
9. Occupational change and loss of job opportunities			x		Positive impact by increase of seasonal employment in agriculture
10. Increase in income disparities			x		Not expected
11. Adjustment & regulation of water or fishing (repairing) rights		x			Establishment of WUAs needs new water sharing adjustment
12. Changes in social and institutional structures		x			Establishment of WUAs impacts on traditional community
13. Changes in existing institutions and customs		x			Traditional water sharing needs to be modernized
14. Increased use of agro-chemical				x	Agro-chemical application may increase under expansion of irrigated agriculture
15. Outbreak of endemic diseases			x		Not expected
16. Spreading of epidemic diseases				x	Expansion of irrigation favours spread of filariasis
17. Residual toxicity of agro-chemical			x		Not expected
18. Increase in domestic and other human wastes			x		Not expected
19. Impairment of historic remains and cultural assets			x		Not found in the area
20. Damage to aesthetic sites			x		Not expected
21. Impairment of buried assets			x		Not found in the area
22. Changes in vegetation			x		Not expected
23. Negative impact on important or indigenous fauna and flora			x		Not expected
24. Degradation of ecosystems with biological diversity			x		Not expected
25. Proliferation of exotic and/or hazardous species			x		Not expected
26. Destruction of wetlands and peatlands			x		No wetlands and peatlands in the area
27. Decrease of tropical rain forests and			x		No tropical rain forests in the area
28. Destruction or degradation of mangrove			x		No mangrove forests in the area
29. Degradation of coral reefs			x		No coral reefs in the area
30. Soil erosion			x		Not expected
31. Soil salinization				x	Increase of saline groundwater use may enhance soil salinization
32. Deterioration of soil fertility			x		Not expected
33. Soil contamination by agro-chemical and others				x	Intensive/improper application of agro-chemical may lead to soil contamination
34. Devastation or desertification of land			x		Not expected
35. Devastation of hinterland			x		Not expected
36. Ground subsidence			x		Not expected
37. Change in surface water hydrology			x		Not expected
38. Change in ground water hydrology		x			Large scale development may lower the water table
39. Inundation and flooding			x		Not expected
40. Sedimentation			x		Not expected
41. Riverbed degradation			x		Not expected
42. Impediment of inland navigation			x		Not expected
43. Water contamination and deterioration of water quality				x	Excess use of agro-chemical may lead to water contamination
44. Water eutrophication			x		Not expected
45. Sea water intrusion			x		Not expected
46. Change in temperature of water			x		Not expected
47. Air pollution			x		Not expected

Table 4.8.2 Environmental Impacts (Irrigation) for Cherukkanur Big Tank Area

	Check Items	Major	Small	None	Not Clear	Problems	Action and Countermeasures Planned	Remarks
Pollution	1. Air Pollution caused by spraying of agricultural chemicals			x		Not expected		
	2. Effect on aquatic organisms, fisheries, and other water utilization of change in the water system resulting from project construction			x		Not expected		
	3. Water pollution caused by effluent from irrigated fields		x		x x	1. Excess and improper use of agro-chemical may lead to soil and water contamination. 2. Large scale groundwater development will lower water table. 3. Saline groundwater irrigation will cause soil salinization but not serious.	1. Farmers training on proper use of agro-chemical is extended. 2. Appropriate development scale is planned with careful hydrological study. 3. Cropping pattern is carefully planned.	
Mutual Environment	1. Effect of construction and operation of the facilities on the ecology			x		Not expected		
	2. Effect on landscape			x	Not expected			
Human Environment	1. Effect of the project on historical and cultural heritage			x		Not found in the project area		
	2. Effect on existing infrastructure			x		Not expected		
	3. Relocation and effect on land-use			x		Not expected		
	4. Effect on other water use				x x	1. Introduction of WUA may cause increase of friction and conflict on water sharing in the community. 2. Expansion of irrigation water use may cause increase of filariasis.	1. Appropriate procedure is taken in preparation stage through farmers participation. 2. Proper water management and drainage system are provided.	
Others	1. Effect on the environment during construction period			x		Not expected		
	2. Environmental Monitoring		x			1 Present monitoring activities are not sufficient.	1. Monitoring shall be conducted by relevant agencies.	

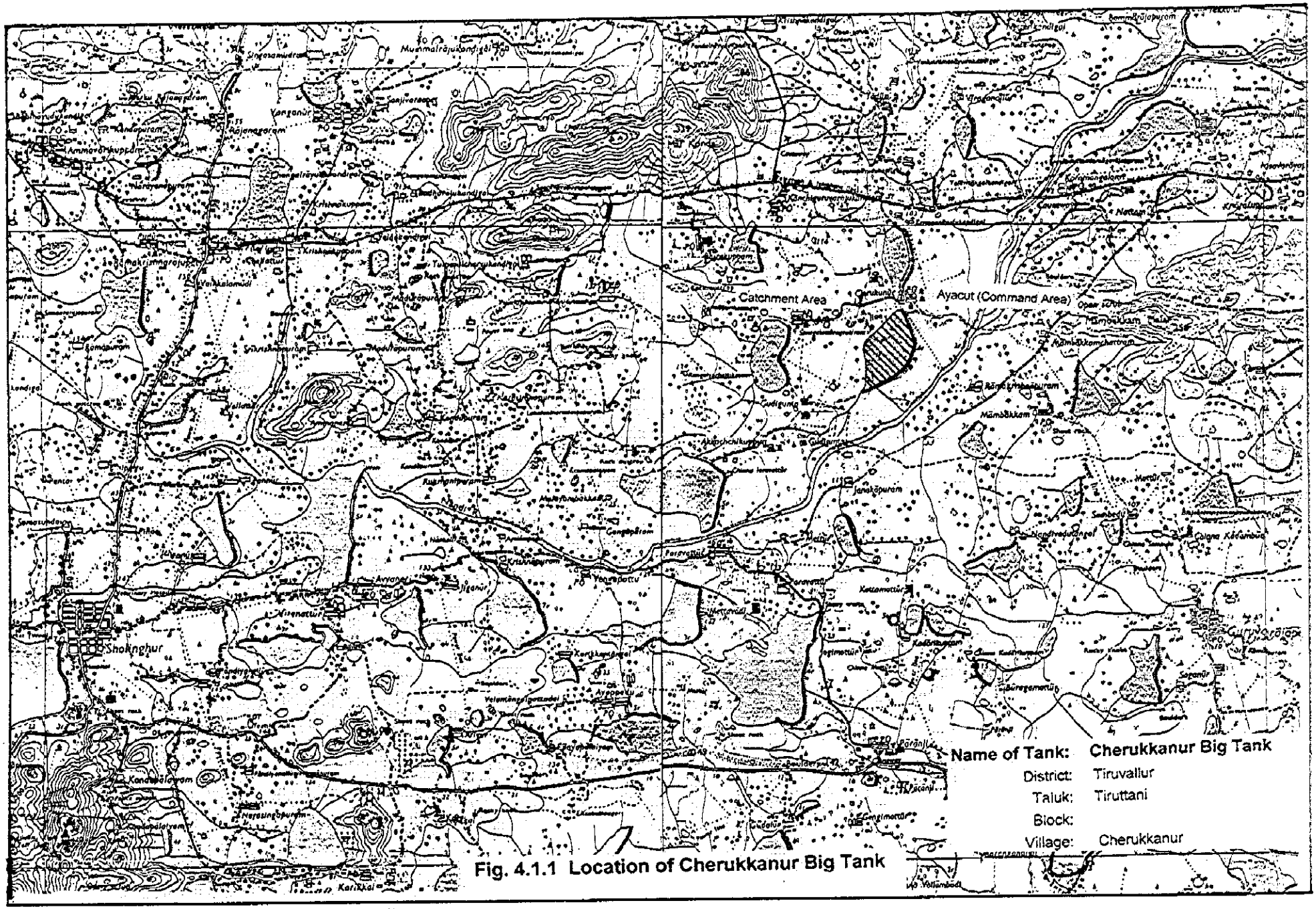


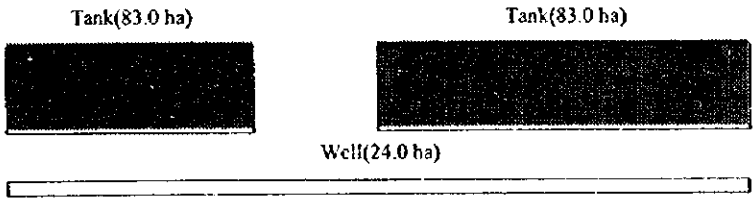
Fig. 4.1.1 Location of Cherukkanur Big Tank

1 Name of Tank	Cherukkanur Big Tank
2 Ayacut Area	114.9 ha
3 Main Soil	Black soil: 88%, Red soil: 8%, Red sandy soil: 4%
4 Water pH,EC	pH:Tank water 9.7, Groundwater 7.2 to 8.4, EC:Tank 0.90 dS/mm, Groundwater 1.27 to 2.17 dS/cm
5 No. of Farm Households	268 farm households
6 Self-Support Amount of Rice	536 tons (268 x 2,000 kg/Household)
7 Geographical Irrigable Area	Normal year: 83.0 ha
8 Total Irrigable Area and Month by Tank	Normal year: 129.0 ha (Jun-Apr.)
9 No. of Wells and Irrigable Area	Normal year: 39wells, 24.0 ha
10 Average Rainfall(mm)	

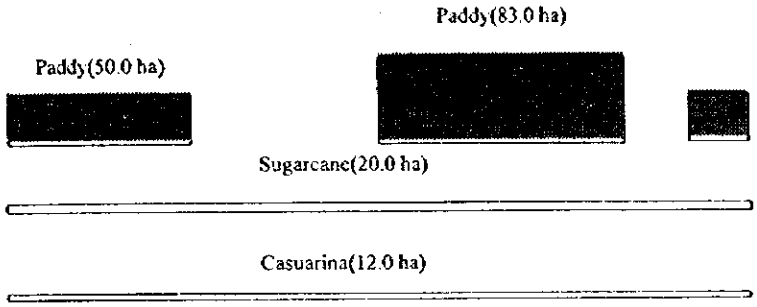
Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
16.2	10.8	14.4	16.6	48.0	68.5	112.4	130.0	148.5	183.0	194.5	93.9	1,023.5

11 Cropping

1)Irrigable Area and Period



2) Present Cropping Pattern

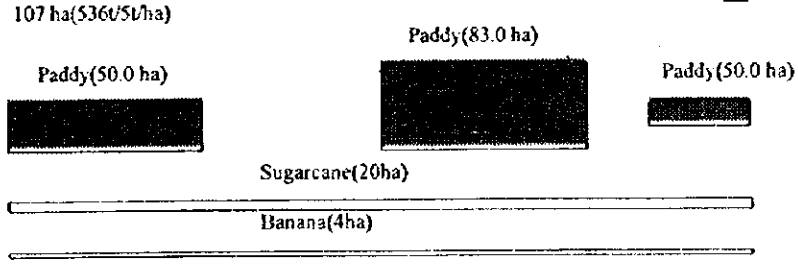


3)Cropping Plan

a) Paddy Area for Self-Support

107 ha(536t/5t/ha)

b) Cropping Plan



c) Evaluation

	Crop Intensity(%)	Net Income(1000Rs)
Plan	172.0	3,702
Present	180.7	2,750
Plan/Present	0.95	1.35

Fig. 4.4.1 Cropping Plan in Cherukkanur Big Tank Area

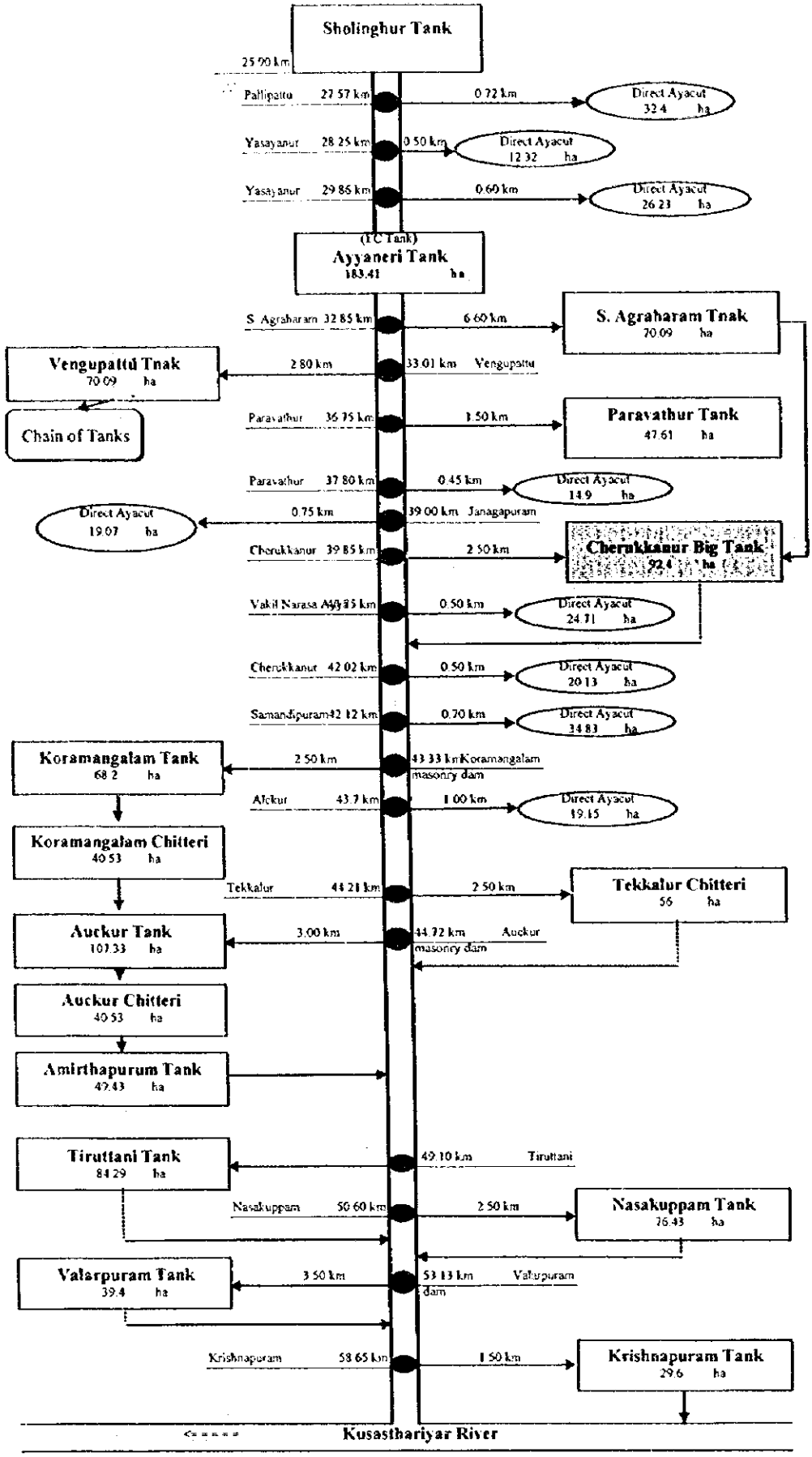


Fig. 4.5.1 FLOW DAIAGRAM OF SHOLINGUR SURPLUS COURSE

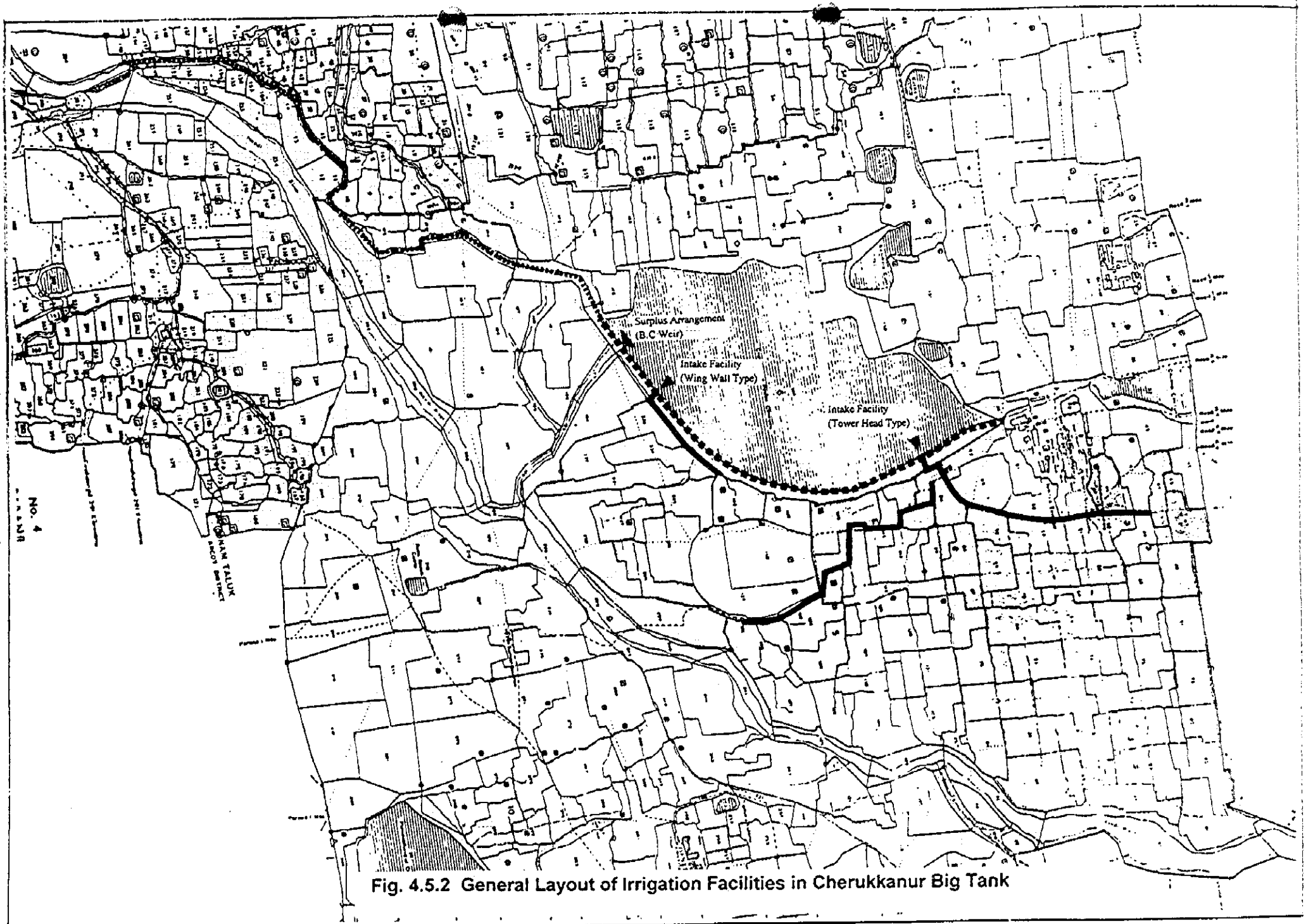


Fig. 4.5.2 General Layout of Irrigation Facilities in Cherukkanur Big Tank