CHAPTER 11 : SENGANGULAM TANK AREA

CHAPTER 11 SENGANGULAM TANK AREA

11.1 General

11.1.1 Location

Sengangulam Tank with a registered command area of 99.2 ha is located about eight (8) km south to the Madurai - Ramanathapuram road (National Highway 49) as shown in Fig. 11.1.1. The tank is located rather far from the main highway. Paved village road extends from the junction with the National Highway at Tiruppuvanam to Sengangulam Village, of which road distance is measured to be about 16 km. Administratively it belongs to Sengangulam Village in Manamadurai Taluk of Sivaganga District.

The Sengangulam village area is surrounded by Piramanur and Melsorikkulam villages in north side, Palaiyanur Village in east side, Viranendal Village in south side, and the Aruppukkottai Taluk in west side.

11.1.2 Topography

The waterspread area of Sengangulam Tank is measured to be 0.85 km^2 laying from north to south. The ayacut areas of 99.2 ha expand in the eastern area to the tank. The catchment area of the tank expands in the western areas of the tank.

The bund of about 4.2 km runs from northern end to southern end of the tank along the eastern side of the tank. There is a surplus arrangements on the southern end of the bund. Dense social forests are developed in the waterspread area. A supply channel to receive surplus water of upstream tank is provided at the northern end of the tank, and the ayacut area also expands along the supply channel forming a narrow strip.

The residential area of the village is located at the northeastern corner of the waterspread area. A paved village road extends to the village area.

The ayacut areas are generally flat with mild slope toward east, and the earthen channels run generally eastward except for the narrow area along the supply channel where channel flows generally northward. There are 10 wells in the ayacut area to take domestic and irrigation water.

11.1.3 Geology

The archean crystalline rocks mainly granite is overlaid by quaternary formation consisting of sandy clay, clay and sand. The basement granitic rock are intruded by dykes and veins of pegmatite. The thickness of quaternary formation is about 18 - 20 m. This consist of 2 to 3 m of clayeysand at the top followed by sand , sandy clay, sand and gravel. The basement granitic rock are fractured and fissured upto the depth of 70 m.

11.1.4 Soils

The type of soil is mainly black to red sandy loam in the catchment, and black clay to red sandy loam in the ayacut area. Both of them are little alkaline and saline.

11.1.5 Vegetation

There is no obvious forest in the catchment area except some natural shrubs. Tank bed plantation of *Prosopis Juliflora* under the social forestry program is found in the whole waterspread area. Trees are sold after five (5) years growing for charcoal making and 50 % of the gross revenue will go to the Panchayat.

11.1.6 Objectives

Sengangulam Tank is categorized as a SP-3, which belongs to the Southern Study Area (agro-climatic zone III) or annual rainfall less than 1,000 mm, and having an average cultivation area of more than 75 % of registered ayacut area more than 90 ha. But ratio between free catchment area and registered ayacut area is less than 5.0, which is less than the required ratio to cultivate all ayacut under the irrigation efficiency at 60 %. This means water resources is rather poor on its surface and groundwater.

Baseline Survey of tanks in Tiruppuvanam Panchayat Union show that about 65 % of years have surplus water, and average cultivation ratio is about 40 %.

Objectives of Sengangulam Tank rehabilitation program are 1) maximize the tank water instead of groundwater, 2) distribute tank water evenly through the physical tank facility rehabilitation and channel lining.

11.2 Meteo-hydrology

11.2.1 Climate

The climate prevailing over the tank area is sub-tropical. The basic and consolidated climatological data of temperature, relative humidity, sunshine, wind speed and evaporation data are available for Kavalur Meteorological Station located in the Vaippar River basin maintained by the Groundwater Wing of the PWD. Since, the Sengangulam, belongs to the same Southern Agro-climatic Zone, the climatological data of Kavalur Meteorological Station represents Sengangulam Tank also. The coordinates of the Kavalur Station and the monthly average climatological parameters are presented in Section 8.2.1.

11.2.2 Rainfall

The rainfall in the catchment area of the tank varies with the seasons and it receives

considerable rainfall both in Southwest and Northeast monsoon. For all rainfall computations, rainfall recorded at the nearest Manamadurai Rainfall Station, maintained by the Revenue Department is used. The mean monthly rainfall of the last 60 years from 1936 to 1995 are estimated as shown below:

Mean Monthly Rainfall of Sengangulam Tank Catchment Area

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Mean	24.3	19.4	28.7	56.1	58.8	40.5	65.5	97.8	97.2	208.2	190.7	89.8	976.9
Maximum	245.0	209.0	393.7	272.0	404.0	218.2	392.0	306.0	397.0	876.4	634.0	412.7	2,598.1
Minimum	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	38.1	2.5	0.0	273.0

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

- Southwest Monsoon (June-September): 301.0 mm (30.9 %)
- Northeast Monsoon (October-December): 488.7 mm (49.9 %)
- Winter (January - February): 43.7mm (4.5 %)
- Summer (March - May): 144.0 mm (14.7 %)
- Total: 976.9 mm (100 %)

The tank catchment receives its maximum rainfall in Northeast monsoon while the lowest rainfall occurs during the winter months of January and February. The monthly maximum rainfall is 208.2 mm occur in October, and the minimum rainfall is 19.4 mm in Feb. The annual maximum rainfall of 2,598.1 mm occurred during 1947 while the minimum of 370.3 mm occurred in the year 1968.

11.2.3 Catchment Area

Sengangulam tank is a non-system tank located in the lower Gundar River basin. In preparation for the field visits the 1:50,000 map of the tank was obtained which permitted an assessment of catchment and command area. Sengangulam Tank receives its runoff water only from its free basin of 2.49 km^2. As per the PWD norms, the catchment is classified as "average" having gentle slope and moderate vegetation. The registered ayacut of this tank is 99.23 ha, and hence the ratio between free catchment and Registered ayacut is 2.51. More than 80 % of the waterspread area is covered by *juliflora* vegetation.

11.2.4 Hydrological Analysis

The hydrological analysis procedures are similar to that of Echur Tank. Rainfall - runoff computations have been carried out for monsoon (September - December) and annual (January - December) periods for a continuous period of 16 years by using the Strange Tables. No hydrological gauging station exist in the tank catchment and command area.

Yield and Runoff from the Catchment Area of Sengangulam Tank

Year	September-December			January-December		
	Rainfall (cm)	Yield (cm)	Runoff (Mm^3)	Rainfall (cm)	Yield (cm)	Runoff (Mm^3)
1980	71.8	13.3	0.331	106.9	19.8	0.492
1981	128.8	48.7	1.212	191.7	35.5	0.883
1982	69.6	11.7	0.291	88.0	16.3	0.406
1983	68.1	11.9	0.297	151.4	28.0	0.697
1984	59.9	8.8	0.218	99.9	18.5	0.460
1985	59.3	8.6	0.214	104.1	30.7	0.765
1986	59.1	8.6	0.213	72.4	13.8	0.342
1987	25.1	0.8	0.020	62.6	9.7	0.242
1988	66.1	10.8	0.268	117.4	39.9	0.994
1989	93.9	24.0	0.598	157.7	72.5	1.806
1990	81.9	17.9	0.445	138.1	56.3	1.403
1991	115.1	38.1	0.949	154.4	71.0	1.768
1992	131.9	51.4	1.281	190.0	125.4	3.123
1993	100.0	1.0	0.025	139.9	58.8	1.463
1994	53.3	6.1	0.153	108.0	32.9	0.820
1995	58.6	8.3	0.207	97.7	26.9	0.669
Mean	77.6	16.9	0.420	123.8	41.0	1.021
Maximum	131.9	51.4	1.281	191.7	125.4	3.123
Minimum	25.1	0.8	0.020	62.6	9.7	0.242

During 1980 - 1995, the average annual yield was 41.0 cm with a maximum of 125.4 cm in 1992 and a minimum of 9.7 cm in 1987. The corresponding values of estimated annual runoff from the catchment area are 1.021 Mm^3, 3.123 Mm^3 and 0.242 Mm^3 respectively. The monsoonal (September - December) yield and runoff values also have been estimated and are presented in the table. The 16 year average monsoonal yield was 16.9 cm and that of runoff from the catchment was 0.420 Mm^3. In an average the monsoonal yield accounts for nearly 42 % 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 values vary from 0.347 Mm^3 to 2.188 Mm^3. The 10 year average annual runoff is calculated to be 1.111 Mm^3, with a runoff ratio of 54 %. Similarly, the seasonal (September - December) runoff values range from 0.140 Mm^3 to 1.710 Mm^3, with an average value of 1.111 Mm^3. The average runoff ratio for this period is 54 %.

11.3 Social Conditions

11.3.1 Present Social Conditions and Facilities

(1) Available Social Facilities in the Village

Most of the villagers take the groundwater for their domestic use. The quality of groundwater is considered fair. A few public facilities are available in the village such as a primary school (Grade 1 - 5). Electricity supply system is also provided in

the village.

(2) Social Settings of the Ayacut Area

1) Land Holding and Relating Villages or Hamlets

There are 313 farmers in the ayacut areas of Sengangulam Tank, and their average land holding size is calculated to be about 0.32 ha. About 92 % of the farmers are marginal and small farmers. All the farmers in the ayacut areas live in Sengangulam Village. The most prevailing holder type is the marginal farmer representing 80 %.

2) Caste Composition

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

Caste Composition in Sengangulam Tank Ayacut Area

(Unit: %)

Others	BC	MBC	SC	ST	Total
0	95	0	5	0	100

The most predominant caste category is BC composed mainly of the group of Agamudaiyar representing as much as 95 % of the farmers in the ayacut area. The rest is SC composed of the groups of Pallan and Parayan. Both practice Hinduism. The homogeneity of the ayacut farmers is considered quite high in this aspect.

3) Water Distribution and Decision Making Procedure

There is no registered organization for distributing water in the ayacut area. However, there is an informal village society among the villagers. Regular (monthly) meetings are held to discuss villagers' welfare, water distribution, negotiation with the villagers of upstream tank, cleaning of channels and loan arrangement. The present village president takes the leadership role of the society. They collect the membership fee of Rs. 50 - 60 three times a year.

In the irrigation season, some persons are selected among the group of SC families to control the water distribution. They carry out water distribution with the instructions of the village president. The farmers in the ayacut areas pay them with paddy in accordance with their cultivated areas.

4) Maintenance of Irrigation Facilities

Regular simple maintenance activity of the irrigation facilities is conducted in the ayacut area. Maintenance works of the field channels are conducted once a

year as a group. The emergency repair works of tank bund is also carried out by the farmers themselves.

5) Conflicts and Problems

There is no conflict among either the caste groups or the farmers having advantage or disadvantage in receiving irrigation water.

6) Other Employment Opportunity

The nearest town is Tiruppuvanam located about 15 km away from the village, but the farmers usually go to Madurai, 35 km away from the village because more attractive job opportunities are available in Madurai. Most of the farmers work as construction laborers.

11.3.2 Sociological Evaluation

Based on the criteria described in Section 2.5, the sociological conditions of Sengangulam Tank ayacut are evaluated as stated below.

Results of Social Scoring of Sengangulam Tank

Factors	Hamlets	Farm Size	Conflicts	WUA	Leader-ship	Resource Mobilization	Main-tenance	Overall Score
Scores	5	5	15	8	35	20	8	96

This results show that the ayacut is good on social screening and timing of placement of community organizer for formulating WUA shall be at the commencement of the estimate preparation.

11.4 Agriculture

11.4.1 Present Agriculture

(1) Land Use

The registered command area is 99.2 ha of which irrigable area is 40.0 ha (40.3 % of the command area). In 1995-96, paddy, chili, cumbu, cotton and ragi were cropped in the areas of 20.2 ha (20.4 % of the command area), 8.6 ha (8.7 %), 1.0 ha (1.0 %), 6.0 ha (6.0 %) and 4.0 ha (4.0 %), respectively. The total cropped area was 39.8 ha with a crop intensity of 40.1 %. In a normal year, paddy, cotton and ragi are cultivated in the areas of 50.0 ha (50.4 %), 10.0 ha (10.1 %) and 40.0 ha (40.3 %), respectively. The total cropped area is 100.0 ha with the crop intensity of 100.8 %.

(2) Soil and Land Capability

The type of soil in the ayacut area is mainly black clay to red sandy loam which are suitable for wet and dry cultivation. Both of them are a little alkaline and saline. The present cultivation of those soils show that the soils are suitable for irrigation.

(3) Agricultural Production

1) Crop Production

In 1995-96, paddy, chili, cumbu, cotton and ragi were produced at a level of 90.1 tons, 2.6 tons, 0.2 tons, 18.6 tons and 0.8 tons, respectively. The average yields were 4,459 kg/ha, 300 kg/ha, 200 kg/ha, 3,100 kg/ha and 200 kg/ha, respectively. The main varieties used were ADT-36 and CO-43 in paddy, WCO-75 on cumbu, MCU-10 and LRA-5166 in cotton and CO-7 in ragi. In normal year, the production of paddy, cotton and ragi are 237.5 tons, 10.0 tons and 80.0 tons with the average yields of 4,750 kg/ha, 1,000 kg/ha and 2,000 kg/ha, respectively.

2) Irrigation Water

Tank water is available during the period from the middle of September to the middle of December with an irrigable area of 40.0 ha in a normal year. There are 8 wells with an irrigable area of 10.0 ha in the area.

3) Fertilizer Application

According to the data of farmers' interview survey, 83 kg/ha of N and 39 kg/ha of P_2O_5 and 71 kg/ha of K_2O was applied for the paddy in 1995-'96. These amounts applied are nearly the same of the recommendated amounts (N: 120-150 kg/ha, P_2O_5: 38-50 kg/ha, and K_2O: 38-50 kg/ha).

4) Labor Input

According to the farmers' interview survey, the average labor input for paddy cultivation in the 10 pilot atnk areas was about 200 man-day/ha in which 28 % was allotted to harvesting, 24 % to weeding and 21 % to transplanting. While the family agricultural labor in the area is 1.4 men/house and the potential agricultural labor is 2.5 men/house. The necessary staggering period in the area to accomplish the farm works of paddy cultivation by family labor is calculated based on the above data as 1.4 days, at least when the potential labor is used. The labor requirements for vegetable, sugarcane and groundnut cultivation are around 4.3 timers, 2.3 times and 0.6 times of the paddy, respectively.

5) Livestock Breeding

85 heads of cattle, 80 heads of goat, 60 heads of sheep and 400 heads of chicken have been raised in this area.

(4) Farm Size and Land Tenure

The number of farm holders in the area is 313 of which 8 % are farm holders of more than 2 ha, 12 % are farm holders of 1.0 to 2.0 ha and 80 % are farm holders of below 1 ha (marginal). The average farm size is 0.32 ha which is the smallest among the study area, and correspond to 34.1 % of the state average and 20.2 % of the national average.

11.4.2 Agricultural Development Plan

(1) Land Use

As shown in Table 3.4.1, paddy is planned to be grown in an area of 50.0 ha (50.4 % of the command area) in the rainy season, which is the maximum cultivable area in the normal year. The area is only 40 % of the required area for the self-support amount. While, as a high return crop, ladies' finger and chili are grown with well water in the dry season in the total area of 15 ha. In addition to this, ragi is also introduced in the 40.0 ha under rainfed condition in the dry season. The total cropped area amounts to 105.0 ha and the crop intensity came to 105.8 % which increased 5 points than the present one.

(2) Farming and Cropping Plan

The cropping plan was made as shown in Fig. 11.4.1. In the plan, paddy is grown in the area of 50 ha during the period from the middle of August to the end of December using well water for the nursery and tank water for the main field. Ladies' finger and chili are grown with well water during the periods from 1st of February to 11th of May and 15th of May to 13th of August in each 5.0 ha on ladies' finger and from 15th of January to 13th of August in 5 ha on chili. Ragi is also grown under rainfed condition during the period from the middle of January to 25th of April in an area of 40.0 ha.

(3) Crop Budget and Production Plan

The planned production amounts, the production costs and the net incomes of the area are shown in Table 3.4.2. The total net income amounts to Rs.1,742,700 of which the paddy, the ladies' finger, the chili and the ragi share 39.5 %, 25.3 %, 21.8 % and 13.3 %, respectively. The total amounts of net income in the area increased 2.2 times of that of the present one.

(4) Employment and Working Opportunity

The introduction of ladies' finger, chili and ragi for an area of 55.0 ha in the dry season will bring certain increase in employment and working opportunity, especially for the women. These labor amounts required are scattered throughout a year.

(5) Farm Management and Farm Budget

1) Farm Management Plan

Regarding farm management in this tank area, the critical conditions of water supply from the tank during the dry season would be largely improved if some structures are made for connecting the tank with the nearby the Kurudumal River. This tank area, therefore, would be in better cropping conditions for cash-crops other than paddy cultivation as at present. The farmland used for cropping paddy will be minimized to limited area only. For the management of present crops, a rather less intensive application will be applied.

The application of integrated agriculture at each farm is recommended to be established. Related documents on the promotion of cash-crops are to be distributed to local farmers for making them understanding the situation on changing to cash-crops and obtaining a proper knowledge on the integrated agriculture.

From these basic concepts, after confirming the related feasibilities for realization, the proper plan for farm management for each individual farm should be further elaborated for each corresponding farm 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 deducting all production costs
- Estimates on the balance after deducting all family living expenses

2) Farm Budget Plan

For further improving the farm income, the integrated agriculture is strongly recommended for increasing farm revenues, particularly on the aspects of

making a home garden for growing vegetables and fruits, and raising livestock such as chicken and goat at farm level (average 3 chickens and 1 goat per farm).

Also for the purpose of improving the farm budgets of small, marginal and landless farmers in this tank area, the introduction of some basic post harvest and agro-processing treatments such as storage, drying, simple processing etc. of agricultural produces are recommended to be promoted at individual farm basis or in a scheme of village cooperative for job creation and , per consequence, for obtaining a higher income.

(6) Marketing Plan

Due to its logistic characteristic of being located relatively nearer to Madurai, the second largest city in Tamil Nadu at a distance of approximately 35 km, and its rather large irrigated area for agricultural production (approx. 100 ha), this tank area has a high commercial position for providing this city with agricultural produces from high-valued cash-crops such as vegetables and fruits. These are also considered as perishable produces which need proper post-harvest treatments to maintain a good state to reach the consumers. The marketing plan, therefore, is recommended for establishing the following items:

i) Temperature controlled godown for mainly vegetables and fruits (1 unit)
ii) Primary treatment facility for mainly fresh and processed vegetables and fruits (1 unit)
iii) Drying yard and vacuum-packing apparatus & facility (1 unit)
iv) Refrigerated van for perishable products (1 unit)
v) Transport lorry (1 unit)

11.4.3 Agricultural Supporting Services and Institutional Plan

(Same as notified in this part for Echur Tank)

11.5 Rehabilitation of Tank Irrigation System

11.5.1 Present Conditions

(1) Irrigation and Drainage System

Sengangulam Tank is connected with the Gridhamai Nadi (river) through a supply/surplus channel at the extension of tank waterspread in the extreme northern part. In the channel, a masonry control structure with gate guide was installed but is not functioning at present.

There are 5 sluices, No. 1, 2, 3, 4 and 5 sluice commanding 9.83, 32.57, 39.46, 20.36 and 13.36 ha, respectively.

One community irrigation well is installed in the waterspread area of the tank between No. 1 and 2 sluices. After the tank water fade out, the groundwater from this well is conveyed by a temporary channel in the waterspread area to the No.2 or 3 sluice, then the water is distributed following same course of tank water distribution.

Irrigation channel connected to small ponds (Segasthu, Amman) in the ayacut and small tanks located at the tail of irrigation channels, such as Vallarendal at the east end, Kurichikulam at the south end.

There was a masonry surplus weir at the northern end of the tank band, but it is abandoned. That means that there was no surplus water during these years.

(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. Some cracks which are characteristic of the presence of Black Cotton Soil occurs around intake facility and top surface of the bund.

(3) Spillway (Surplus Arrangement)

1) Location

One B.C. Calingula type weir was installed at L.S. 28.50 m point, but this arrangement was embanked as a tank bund. Control of excessive water is operated by a regulator; surplus water is well controlled in this arrangement. Location of these arrangement is shown in Fig. 11.5.1.

2) Existing Condition

Due to land subsidence of the foundation, huge cracks are confirmed on the side wall of regulator which controls the surplus water. However, since depth of water is low against the structure of this facility in the rainy season, it will be enough to repair it using cement mortar or concrete.

(4) Intake Facilities (Sluices)

1) Location

There are five (5) sluices, 3 types as head wall type (sluice No. 5), wing wall type (sluice No. 1 and 4) and head tower type (sluice No. 2 and 3) according to depth of stored water. Location of these sluices are shown in Fig. 11.5.1.

2) Existing Condition

In generally, although it is confirmed some deterioration of material is confirmed in each sluice, all of the sluices function properly for intake works except for the height of sill elevation. However, since homogeneous sand around the sluice is black cotton soil, siltation is occurred below sill elevation of plug. Especially, sluice 5 have been replaced recently, and it is not available for irrigation. Regarding the damage, it is confirmed lead channel in sluice No. 2.

3) Water Control Device

Even though, plug and plug rod type devices are supposed to be installed in all sluices, no such things are seen during the field visit.

(5) Groundwater Usage

There are only about 8 wells in command area which are used for irrigation purposes. Of this there are only four wells which extend more than 50 m in depth. Thus groundwater is not exploited heavily in this area. All the wells are of dug cum bore type.

(6) Operation and Maintenance

No formal WUA exist. Traditional water distribution is practiced in the area, but no conflicts on the water distribution occurred.

11.5.2 Water Resources Development Plan

(1) Liability of Water

A classification of drought developed by the Indian Metereological Department is given in Section 3.5.2. This classification is based on the monsoon rainfall. Following the same classification, the probability of the availability of water for Sengangulam Tank is presented in the following table.

Liability of Water Based on Rainfall

Classification	No. of Years	Total No. of Years	Probability (%)
Excess	7	60	11.7
Normal	4	60	6.7
Deficit	24	60	40.0
Scanty	15	60	41.7

Among the 60 years, 41.67 % of the years are classified as having scanty rainfall, followed by deficit rainfall 40.0 %, normal rainfall 6.67 %, and there were only 7 years of excess rainfall years accounting for 11.7 %. Apart from this, as mentioned in Section 3.5.2 another important aspect is the occurrence of drought or flood based

on the rain storm. The current practice is to use a 5 year return period (20% of provability). For a five year return period, the drought monsoon rainfall is estimated as 749.1 mm. Due to the severity of this monsoon rainfall deficiencies, it becomes necessary to develop certain drought management strategies such as developing rain water harvesting techniques, developing crop varieties to suit different probability conditions and to enhance village capability to meet potential changes in rainfall pattern.

(2) Water Quality

The water quality on its pH and electrical conductivity in the Pilot Study Tank Areas were measured by the Study Team. According to these results, the tank stored water and groundwater in the ayacut show weekly alkalinity (pH 8.1 to 8.7). EC of tank remained water shows mostly less than 0.38 dS/m, which means good water quality for cultivation also for drinking while groundwater is concerned, EC value increases 1.62 to 6.97 dS/m, which is not suitable for crop irrigation. Groundwater in the ayacut can not use for irrigation. Groundwater in the village shows EC 0.39 dS/m, which is suitable for drinking also.

(3) Irrigation Water Requirement

In Sengangulam Tank command are of 99.23 ha, paddy rice is the major crop. The gross irrigation water requirements during the main rice growing season (September - December) is presented in Table 3.5.3. The procedures adopted to calculate fortnightly irrigation water requirements are similar to that of Echur Tank, with assumed percolation losses of 1.5 mm/day for block cotton soils which is the dominant soil type in the command area. With the present irrigation efficiency of 40 %, a total irrigation water requirement of 1.106 Mm^3 was calculated. To increase the irrigation efficiency (storage, conveyance and field application) field canal lining is proposed. By this rehabilitation measure, the irrigation efficiency is expected to increase to a level of 75 %. At this level of efficiency, the estimated irrigation water requirements are 0.660 Mm^3. Thus, a water saving to the extent of 0.446 Mm^3 is possible, which can be used to irrigate more command area and also to irrigate less water intensive crops during second cropping period. This will also help to lessen the burden of water supply from ten open wells in the command area.

(4) Water Balance

The capacity of Sengangulam Tank is determined as 2.124 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 3.4.5. 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 irrigated a registered ayacut of 99.23 ha. However, due to evaporation losses, insufficient storage capacity and other losses, Sengangulam Tank could not satisfy all the

irrigation demand. With present conditions (Ef = 40 %), the estimated irrigated area varies between a minimum of 11 % to a maximum of 64 % (average 29 %) of the registered ayacut, due to insufficient storage. The runoff/irrigation ratio remains as 124 %. 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, 45 % of the registered ayacut. Entire command area could also have been irrigated in 1993. 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 along with measures to reduce evaporation losses.

(5) Drainage Water Requirements

The drainage water requirement of Sengangulam Tank is calculated according to the procedure described in Section 3.5.2 and details are given in Table 3.5.6. Using the Ryve's formula, the estimated drainage water requirements for Sengangulam tank is 13.79 m^3/s while that using the rational method is 15.56 m^3/s. Hence a safe design discharge of 15.56 m^3/s, can be adopted in designing the spillway for Sengangulam Tank. However, other considerations such as severity of disaster, adaptability of particular type of weir and cost of rehabilitation need to be considered before deciding on the spill way capacity.

(6) Basin Water Management

As per the tank inventory provided by PWD, Sengangulam Tank is a rainfed tank receiving its tank water from the rainfall occurring over a catchment area of 2.49 m^2. But according to the information provided by the Revenue officials during the field survey, it was understood that the water source for this tank is surplus water from the Piramanur Tank and Sengangulam Tank's surplus water overflow into the Kirudumal River. However, farmers in the tank command area says, Sengangulam tank receives surplus water from Piramanur Tank which is 1.5 km away from Sengangulam Tank and surplus of this tank flows into Vallar Enthal Tank, making them into a chain. These information forces to consider Sengangulam Tank as a chain tank.

As presented in Table 3.2.1, various ratios were calculated and are presented here for quick reference.

- Catchment / command area 2.51
- Waterspread area / Command area 2.09
- Tank storage capacity / command area 0.021 Mm^3/ha
- Waterspread area / Tank storage capacity 0.977 km^2/ha

The surface water resources of Sengangulam Tank basin consists of direct runoff

from rainfall. However, irrigation also depends on ground water wells. The total ground water recharge of Manamadurai Block to which, Sengangulam Tank belongs was estimated to be 4,951 ha-m Utilizable recharge is 4,208 ha m, Net Ground water draft is 818 ha-m and the balance available is 3,390 ha-m (80.5 % of utilizable recharge). So, conjunctive used of ground water need to be promoted. 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 of rehabilitation storage structures.
- The utilizable quantum also depends on the quality of water being suitable for irrigation.

In Sengangulam Tank semi-chain basin management the important aspects are (i) hydrological, (ii) administrative and financial aspects.

1) Hydrological Aspects

Hydrological management activities should include maximizing the utilization of available precipitation, utilization of water to maximum extent so as to get maximum production with high percentage of cropping intensity through which decisions were made for letting out water to the field, raising crops on the basis of availability of water in the chain of tanks, taking up second crop wherever soil moisture was available.

2) Administrative and Financial Aspects

In this 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 with responsibilities as shown below.

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

(7) Groundwater Development

As the groundwater is under utilized in this region more number of deep bore wells

can be drilled. The deep wells have to be located in a region where more prominent fractured zones are present.

11.5.3 Tank Irrigation Facilities Rehabilitation Works

General layout of irrigation facilities is shown in Fig. 11.5.1, and required item for rehabilitation works are described in the table.

Countermeasures for Rehabilitation of Sengangulam Tank

Component	Rehabilitation works	Section for Rehabilitation works	
Tank Bund Improvement (Total bund length 4,230m)	• Strengthening of the bund for reshaping to standard size • Protection of bund using rough stone for preventing irrigation canal along the tank bund..	4,230m	
Intake works (Sluice)	• Modification for intake system using gearing shutter • Protection of back-fill for side slope.	Tower head type Wing wall type	2 units 3 units
Surplus arrangement	-	-	-
Selective Lining for Field Channel including On-farm development	• Installation of lining canal • 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.	1,220m as main	3 units
Building for Farmers' Association	• Provision of community hall for WUA, local farmers and inhabitation.	$50m^2$	1 Nos.
Community well	• Provision for irrigation as supplemental use		2 Nos

11.6 Farmers' Organization

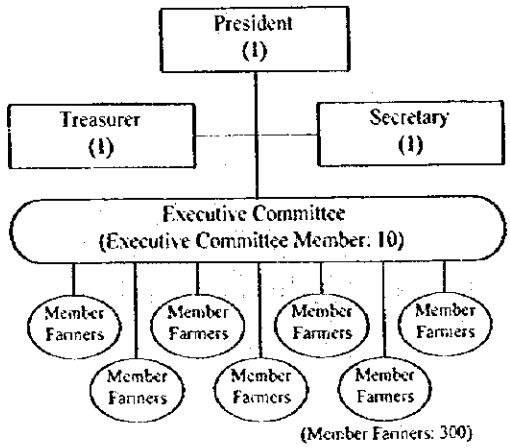
11.6.1 Present Situations of Farmers' Organization

There is no such registered organization as water users' association in the ayacut area as described in Sub-chapter 11.3.1. They have their informal society for water distribution.

11.6.2 Proposed Farmers' Organization

(1) Water Users' Association

Since there are 313 farmers in the ayacut areas, the number of the Executive Committee Member becomes to be 10 and the number of member farmers is 300 deducting the number of office bearers



PROPOSED ORGANIZATION FOR WATER USERS' ASSOCIATION OF SENGANGULAM TANK

from the total farmers. The functions of the proposed WUA for Sengangulam Tank are described in Sub-section 4.3.4 of Volume II of the Report.

(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 Sengangulam Tank area 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

11.7 Project Evaluation

11.7.1 Project Costs and Benefits

(1) Project Costs

Unit cost for rehabilitation works are estimated based on the *Standard schedule of Rates for Kamarajar and Ramanathapuram Districts* issued by PWD. At the 1997 price level, direct construction cost is estimated at about Rs. 2,156,000, as shown in the table.

Direct Construction Cost for Sengangulam Tank

Description	Total Cost (Rs.)	Percentage	Unit Rates (Ayacut 99.23) (Rs./ha)
Tank Bund Improvements	378,000	17.53%	3,809
Sluices Improvement	398,000	18.46%	4,011
Surplus Improvement	-	0.00%	-
Tank Supply Channel Improvement	-	0.00%	-
Selective lining for Field Channel & OFD	850,000	39.42%	8,566
Building for Farmers' Association	130,000	6.03%	1,310
Community Well	400,000	18.55%	4,031
Direct Construction Cost	2,156,000	100.00%	

The financial Project cost consisting of direct cost, supervision charges, contingencies, preparation work cost and overhead charges is estimated at Rs.3,166,000.

Project Cost for Rehabilitation Works in Sengangulam Tank

Description	Total Cost (Rs.)
Direct Construction Cost	2,156,000
Petty Supervision Charges & Contingencies	346,000
Preparation Cost (Govt. Share)	31,000
Overhead Charges	633,000
Total	3,166,000

Conversion to the 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 mainly aims at stabilizing the agricultural production through the year in the medium command area of about 99 ha by better water supply and the introduction of proper agricultural production techniques for improving the farming system for higher farm revenues to improve living conditions of small and marginal farms in this tank area after the rehabilitation works.

At present, though the command area is cropped with paddy only for the first crop, but the cultivated area is at a level of about 50 ha. For the second crop starting from January to April ragi cultivation has been occurred largely due to lack of water supply from tank. Besides, due to water management in a limited area aiming mainly at the first crop, the average unit yield of the first paddy crop is observed at a good level .

With the Project implementation, major economical benefits of the Project, therefore, will be 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 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 is resulted in an increase of the net production value from the present Rs. 1.03 million to about Rs. 1.83 million (Table 11.7.1).

Besides, with the establishment of various facilities for organizing farm management and improving treatments on storing, marketing etc., an annual value-added calculated at approximately Rs.0.09 million as 5 % of the corresponding agricultural production value "with Project" would be obtained accordingly. This is estimated on the basis of results from our site surveys that with the application of some basic post harvest treatments such as storage and selling at markets only will make a profit margin of average 10 % higher than selling at farm sites during harvesting periods.

11.7.2 Economic Evaluation

The economic evaluation is made to judge the project viability in terms of direct contribution to the national economy. The Project covers a command area of 99.2 ha with a total number of 313 farms as beneficiaries.

For the economic analysis, the related EIRRs for Sengangulam Tank area are calculated

as follows:

i)	EIRR in basic conditions :	19.7 %
ii)	EIRR at 10% cost-increase:	17.6 %
iii)	EIRR at 10% benefit-decrease:	16.2 %
iv)	EIRR at 3-year benefit delay:	12.3 %

From these figures, the EIRR in basic conditions of 19.7 % shows the Project viability. Meanwhile, the risk case of 3-year delay of benefits showed the lowest EIRR of 12.3 %.

11.7.3 Financial Evaluation

In this Project, the financial evaluation is 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 as follows:

-	"Without Project" Net Income per Farm:	Rs.2,479
-	"With Project" Net Income per Farm:	Rs.5,568
-	"With Project" Net Income per Farm:	Rs.278
-	Incremental Net Farm Income:	Rs.3,367

With the Project implementation, the increase in annual net farm income for an average farm in this tank area will be about Rs.3,400.

This amount would improve their basic living conditions only. Due to the average farm size in this tank area is small (0.32 ha), farmers should engage largely in off-farm economic activities for raising their living standards.

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

11.7.4 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 August with the requirement of 5,594 man-day/month. To meet this labor amount, 7 days in staggering period is needed with the potential family labor of 783 man-day in the area.

11.7.5 Farm Household Economy

With the Project implementation, the farm household economy of small and marginal farms will be largely improved accordingly. From the financial analysis on farm budgets of these farm categories, under the present conditions of inferior production proceedings,

both small and marginal farms are generally faced with a deficit situation resulted from a low on-farm income versus a constant expenditure for family living.

With better conditions on water supply and supporting institutions for agricultural production in the project framework, small and marginal farms would obtain an annual incremental farm benefit of Rs.3,100 and a value added of about Rs.300 for a total amount of about Rs.3,400 per farm 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.

11.8 Environmental Issues

11.8.1 Present Environmental Conditions

(1) Health and Sanitary Conditions

Major diseases in this area are bronchitis, diarrhea/ADD, dysentery, common fever and eye disease. In relation to irrigation and drainage, neither waterborne nor mosquito-related diseases occur.

(2) Natural Environment

The tank area is generally flat land. Catchment area is all cultivated land. Tank bed plantation of *Prosopis Juliflora* under the social forestry program of the Forest Department is found in the waterspread area. Wildlife seen by the villagers is only peacocks.

(3) Surface Water and Groundwater

Groundwater is utilized for irrigation in the dry season. There are 10 wells, one community and nine private wells.

From the result of the water quality measurement, it can be stated that the groundwater will have medium salinity problems for irrigation.

11.8.2 Environmental Impact of the Project

As summarized in Table 11.8.1 and Table 11.8.2, the environmental impact study for Sengangulam 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 the Project will not be a cause of any waterborne or mosquito-related diseases.

(2) Natural Environmental Impact

1) Biological and Ecological Issues

There is no habitat of important fauna and flora in the area except peacocks to be protected. Therefore, almost the same impact and measures to safeguard the wildlife as stated in Section 8.8 for Siruvalai tank area shall be considered.

2) Soil and Land Resources

Since groundwater is saline, the groundwater development for irrigation may induce soil salinization.

3) Hydrology and Quality of Water

Groundwater with EC value of 1.3 to 2.2 dS/m is medium saline for irrigation but groundwater in this area will still have development potential. Likely problems induced by the groundwater development will be the changes of groundwater table, salinization of soil and damage to crops. Large scale groundwater extraction will be a cause of lowering water table.

11.8.3 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) During rehabilitation works in the tank area, it is recommended that the works shall provide safeguard to wildlife particularly for peacocks.

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 11.7.1 Calculation of Crop Economic Benefits for Sengangulam Tank

"Without Project":

Crop	Area	Production				Production Cost		Net Production Value	Remarks
		Yield	Production	Unit Price	Value	Unit Cost	Total Cost		
	(ha)	(T/ha)	(T)	(Rs/T)	(1000Rs)	(Rs/ha)	(1000Rs)	(1000Rs)	
1. Paddy (1st Crop)	50.0	4.75	237.5	4,736.0	1,124.8	5,008.0	250.4	874.4	
2. Cotton (2nd Crop)	10.0	1.00	10.0	12,000.0	120.0	7,400.0	74.0	46.0	
3. Ragi (2nd Crop)	40.0	2.00	80.0	3,400.0	272.0	4,000.0	160.0	112.0	
Total	100.0		327.5		1,516.8		484.4	1,032.4	

"With Project":

Crop	Area	Production				Production Cost		Net Production Value	Remarks
		Yield	Production	Unit Price	Value	Unit Cost	Total Cost		
	(ha)	(T/ha)	(T)	(Rs/T)	(1000Rs)	(Rs/ha)	(1000Rs)	(1000Rs)	
1. Paddy (1st Crop)	50.0	5.00	250.0	4,736.0	1,184.0	5,760.0	288.0	896.0	
2. Ladies Finger (2nd Crop)	5.0	15.00	75.0	3,600.0	270.0	18,800.0	94.0	176.0	
3. Green Chilli (2nd Crop)	5.0	10.00	50.0	8,000.0	400.0	19,200.0	96.0	304.0	
4. Ragi (2nd Crop)	40.0	2.75	110.0	3,400.0	374.0	4,600.0	184.0	190.0	
5. Ladies Finger (3rd Crop)	5.0	15.00	75.0	3,600.0	270.0	18,800.0	94.0	176.0	
Total	105.0		560.0		2,498.0		756.0	1,742.0	

Incremental Crop Benefits:

"With Project" NPV:	1,742.0
"Without Project" NPV:	1,032.4
Incremental Crop Benefits:	709.6
Value Added (5%) :	87.1
Incremental Total:	796.7

Table 11.8.1 Possible Environmental Impacts for Sengangulam 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

gori 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 increase
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	Peacocks may be living in and around tank area
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 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		Not expected
46. Change in temperature of water			x		Not expected
47. Air pollution			x		Not expected

Table 11.8.2 Environmental Impacts (Irrigation) for Sengangulam 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 agrochemicals 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 agrochemicals is extended. 2. Appropriate development scale is planned with careful hydrological study. 3. High saline groundwater will not be utilized.	
Natural Environment	1. Effect on construction and operation of the facilities on the ecology				x	1. Peacocks nests may be destroyed during rehabilitation works.	1. Safeguard shall be provided specially in breeding season during implementation stage.	
	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.	

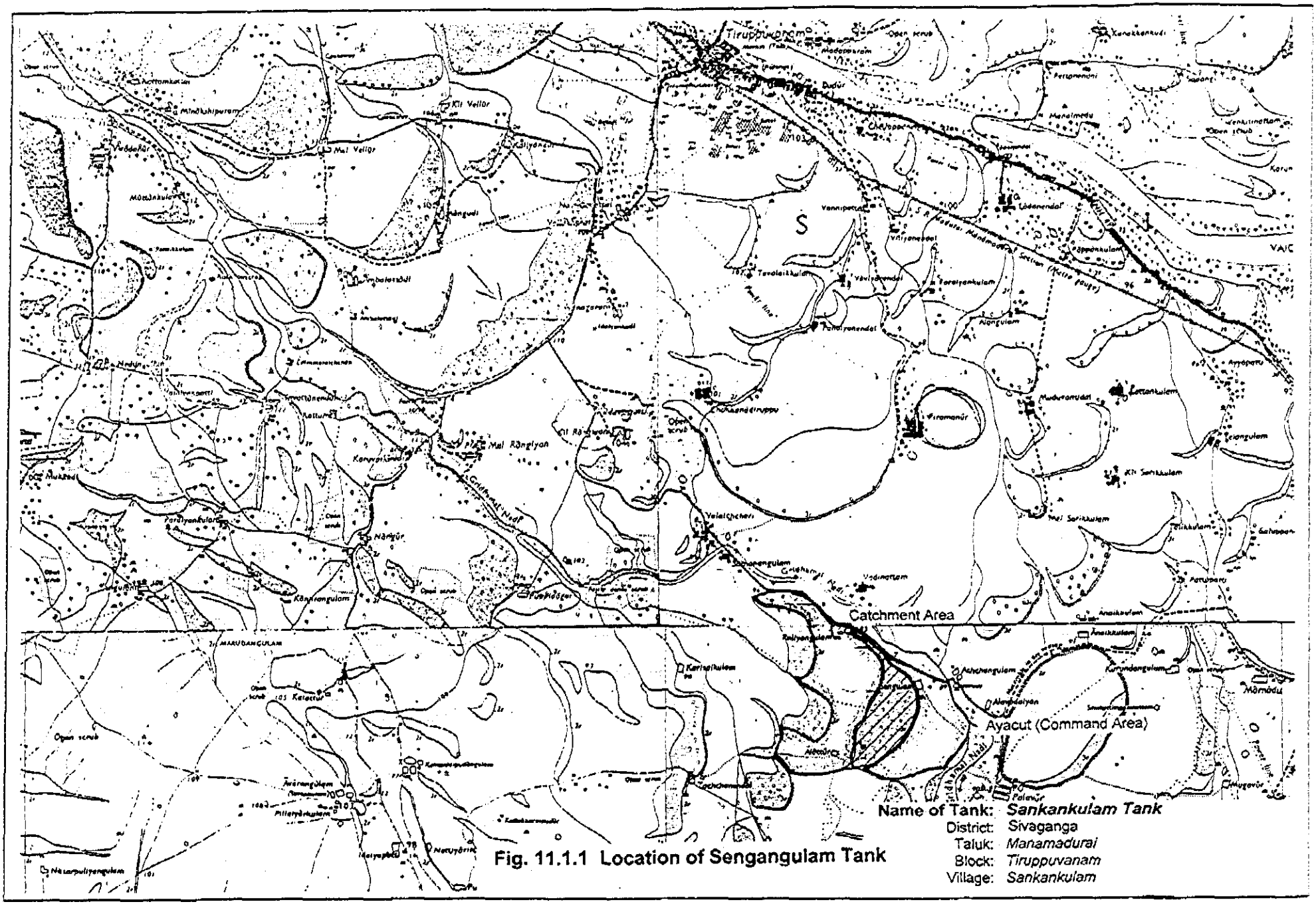


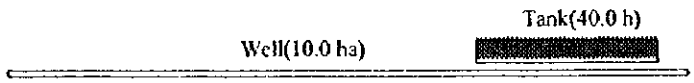
Fig. 11.1.1 Location of Sengangulam Tank

1 Name of Tank	Sengangulam Tank
2 Ayacut Area	99.2 ha
3 Main Soil	Black soil: 100%,
4 Water pH,EC	pH:Tank water- -, Groundwater 7.2 to 7.5, EC: Tank water- -, Groundwater 1.467 to 2.08 dS/m
5 No. of Farm Households	313 farm households
6 Self-Support Amount of Rice	626tons (313 x 2,000 kg/Household)
7 Geographical Irrigable Area	40.0 ha
8 Total Irrigable Area and Month by Tank	40.0 ha(Sep-Dec)
9 No. of Wells and Irrigable Area	8 wells, 10.0 ha
10 Average Rainfall(mm)	

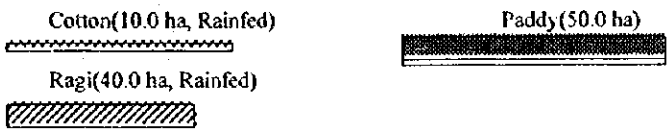
Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
24.7	19.7	28.6	56.4	59.0	41.2	66.4	99.6	96.3	206.9	192.9	89.7	981.3

11 Cropping Plan

1) Irrigable Area and Period



2) Present Cropping Pattern

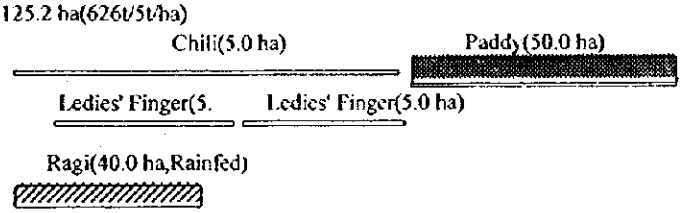


3) Cropping Plan

a) Paddy Area for Sslf-Support

125.2 ha(626t/5t/ha)

b) Cropping Plan



C) Evaluation

	Crop Intensity(%)	Net Income(1000Rs)
Plan	105.8	1,743
Present	100.8	776
Plan/Presen	1.05	2.25

Fig. 11.4.1 Cropping Plan in Sengangulam Tasnk Area

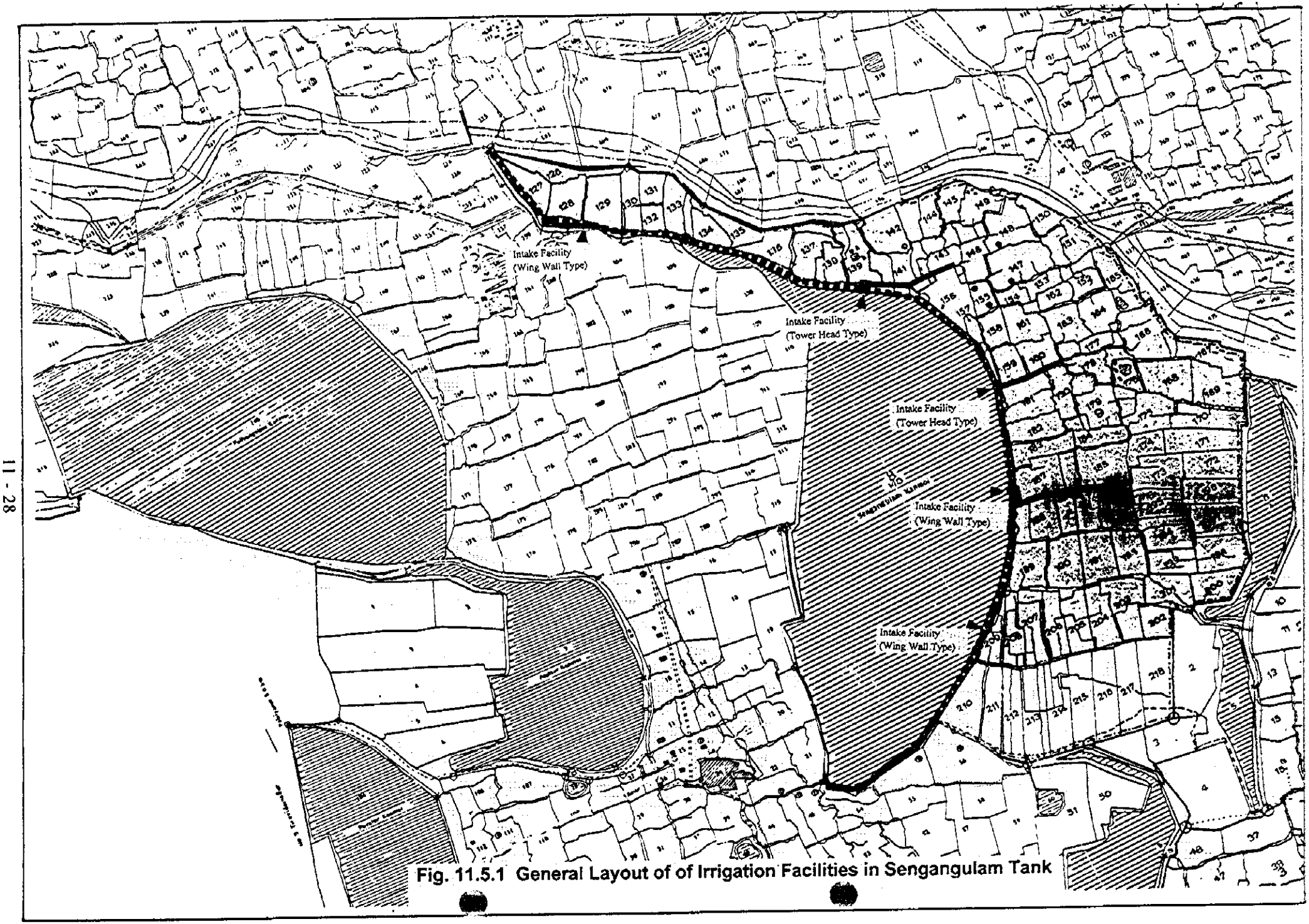


Fig. 11.5.1 General Layout of of Irrigation Facilities in Sengangulam Tank

CHAPTER 12 : KURUMBI TANK AREA

CHAPTER 12 KURUMBI TANK AREA

12.1 General

12.1.1 Location

Kurumbi Tank, with a registered command area of 58.6 ha is located about five (5) km southwest along the Southern Railway Line from the crossing of the Tiruppattur - Devakottai road and the railway as shown in Fig. 12.1.1. Administratively it belongs to the S. R. Patnam Village in the Karaikudi Taluk of the Sivaganga District.

The village area is surrounded by Senjai Village in north and south sides, Amaravati and Kalluppatti villages in its east side, Sannavanam and Kurundampatti villages in its south side, and Pilar, Kuttalur and Variyanvayal villages in its west side.

12.1.2 Topography

Kurumbi Tank is located south of the Southern Railway Line, and its waterspread area is measured to be 0.35 km^2. The ayacut areas of 58.6 ha expand in the south of the tank. The catchment area of the tank expands in the areas north of the tank. The tank is a part of the series of tanks which are chained and located adjacent to each other. Each tank is separated with low bunds. Kurumbi Tank is located at the third positon counting from west.

The residential areas of the village are located at the southeastern corner of the village area, where the VAO's office, primary school, temple, etc. are situated. There exist some houses in the north of the tank called Nagavayal, too. An unpaved village road runs along the railway to the tank, and another road from the crossing near Nagavayal to the residential areas round the tank.

The bund of about 0.9 km runs from east to west along the southern edge of the tank. The tank has two surplus weirs; one located west side for receiving surplus water from the adjacent upstream tank and the other east side for discharging surplus water to the adjacent downstream tank.

The ayacut areas is generally flat with mild slope toward south, and the earthen irrigation channels runs generally southward branching many off-take channels. There are many dug wells scattering in the ayacut areas to take irrigation water during the dry season. There are many open wells are counted in the ayacut areas.

12.1.3 Geology

In Kurumbi Tank region laterite formations occur as a thin cover. The thickness of this formation is generally up to 5 m. In the command area laterite is not seen every where.

This top formation is underlined by white clays, sands, black clays and Karikudi sands. The Karikudi sandy aquifer lies at a depth of 60 m. Thus the basement hard crystalline rocks are expected to be at greater depths. No wells in this tank region penetrates beyond 60 m.

12.1.4 Soils

The type of soil is mainly red sandy loam with a little high infiltration rate both in the catchment and ayacut areas.

12.1.5 Vegetation

A part of the catchment is covered by the agroforestry of cashew and natural shrub of *Prosopis Juliflora*. Other trees found in the catchment area are *Acasia Holoserica, Acasia Nilotica, Azadirachta Indica (Neem), Borassus Flabellifer (Palmyrah), Derris Indica (Pungam)* and *Tamarindus Indica (Tamarind)*. An bed plantation of *Prosopis Juliflora* under the social forestry program is found in the whole waterspread area. 50 % of the gross revenue will go to the Panchayat.

12.1.6 Objectives

Kurumbi Tank is categorized as a SP-1, which belongs to the Southern Study Area (agro-climatic zone III) or annual rainfall less than 1,000 mm, and having an average cultivation area of more than 75 % of registered ayacut area with scale of ayacut less than 55 ha. But ratio between free catchment area and registered ayacut area is less than 5.0, which is less than the required ratio to cultivate all ayacut under the irrigation efficiency at 60 %. This means water resources is rather poor on its surface and groundwater.

Baseline Survey of Kurumbi Tank shows that about 60 % of years have surplus water, and average cultivation ratio is about 75 %. PWD rainfed tanks in the Kallal Panchayat Union are concerned, the surplus year is about 41 % and cultivation ratio is 72 %.

Objectives of Kurumbi Tank rehabilitation program are 1) maximize the tank water instead of groundwater, 2) distribute tank water evenly through the physical tank facility rehabilitation and channel lining.

12.2 Meteo-hydrology

12.2.1 Climate

The climate prevailing over Kurumbi Tank area is sub-tropical. The basic and consolidated climatological data of temperature, relative humidity, sunshine, wind speed and evaporation data are available for Kavalur Meteorological Station located in the Vaippar River basin maintained by the Groundwater Wing of the PWD. Since, Kurumbi

Tank, belongs to the same Southern agro-climatic zone, the climatological data of Kavalur Meteorological station represents Kurumbi Tank also. The monthly average climatological parameters are presented in Section 8.2.1.

12.2.2 Rainfall

The rainfall in the catchment area of the tank varies with the seasons and it receives considerable rainfall both in South-west and North-east monsoon. For all rainfall computations, rainfall recorded at the nearest Karaikudi rainfall station, maintained by the Revenue Department is used. The mean monthly rainfall of this station for the last 15 years are shown as follows:

Mean Monthly Rainfall of Kurumbi Tank Catchment Area

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Mean	35.6	12.1	9.7	36.8	62.5	68.5	124.6	89.3	121.9	207.7	164.2	86.5	921.0
Maximum	240.0	134.0	70.0	162.0	151.0	150.5	395.0	172.2	308.0	331.0	495.2	322.0	1,601.0
Minimum	0.0	0.0	0.0	0.0	7.5	24.0	11.0	32.0	19.0	110.0	0.0	0.0	316.0

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

- South West Monsoon (June-September):	404.2 mm	(39.7 %)
- North East Monsoon (October-December):	458.4 mm	(45.0 %)
- Winter (January - February):	47.7mm	(4.7 %)
- Summer (March - May):	108.9 mm	(10.7 %)
- Total:	1,019.2 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 207.7 mm occur in October, and the minimum rainfall is 9.7 mm in February The annual maximum rainfall of 1,601 mm occurred during 1981 while the minimum was 316.3 mm occurred in the year 1985.

12.2.3 Catchment Area

Kurumbi Tank is a non-system tank located in the Manimuthar basin. In preparation for the field visits the 1:50,000 map of the tank was obtained which permitted an assessment of catchment and command area. Kurumbi Tank receives its runoff water only from its free basin of 2.459 km^2 and an intercepted catchment of 4.336 km^2 and hence the total catchment (free + intercepted) is 6.795 km^2 and the equivalent catchment (free + 1/5th of intercepted) is 3.326 km^2. As per the PWD norms, the catchment is classified as "average" having a gentle slope and moderate vegetation. The registered ayacut of this tank is 52.67 ha, and hence the ratio between free catchment and registered ayacut is 4.67. In the catchment area, a lot of eucalyptus tree plantations were noticed, which survive by extracting large quantity of groundwater through these deep roots.

12.2.4 Hydrological Analysis

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

Yield and Runoff from the Catchment Area of Kurumbi Tank

Year	September-December			January - December		
	Rainfall (cm)	Yield (cm)	Runoff (Mm^3)	Rainfall (cm)	Yield (cm)	Runoff (Mm^3)
1980	50.1	5.6	0.185	105.6	31.7	1.054
1981	84.8	19.5	0.649	160.1	81.7	2.716
1982	38.3	3.0	0.099	62.5	9.7	0.322
1983	73.4	14.3	0.476	117.3	39.6	1.319
1984	42.0	3.7	0.124	113.0	36.2	1.203
1987	48.9	5.4	0.181	65.8	11.5	0.383
1988	26.0	0.9	0.030	75.4	15.1	0.501
1989	43.7	4.2	0.138	79.7	16.9	0.562
1990	71.1	7.9	0.262	106.7	32.2	1.072
1991	42.9	3.8	0.127	78.4	16.3	0.542
1992	71.1	13.2	0.438	103.5	30.2	1.005
1993	105.9	32.0	1.064	133.5	52.7	1.754
1994	49.8	5.5	0.184	81.5	17.9	0.596
1995	31.5	1.7	0.058	66.9	11.2	0.374
Mean	55.7	8.6	0.287	96.4	28.8	0.957
Maximum	105.9	32.0	1.064	160.1	81.7	2.716
Minimum	26.0	0.9	0.030	62.5	9.7	0.322

During 1980 - 1995, the average annual yield was 28.8 cm with a maximum of 81.7 cm in 1981 and a minimum of 9.7 cm in 1982. The corresponding values of estimated annual runoff from the equivalent catchment area are 0.957 Mm^3, 2.716 Mm^3 and 0.322 Mm^3. The monsonal values also have been estimated and are presented in the table. The 16 year average monsoonal yield was 8.6 cm that of runoff from the equivalent catchment area was 0.287 Mm^3 and the monsoon yield accounts for nearly 30 % annual yield, as per the calculations based on the Strange Tables.

The runoff calculated based on the daily rainfall data for the years 1986 - 1995, using dry-damp-wet method are presented in Table 3.5.4 and 3.5.5. The average runoff values vary from 0.553 Mm^3 to 2.615 Mm^3. The ten year average value for this period is 1.251 Mm^3 with a runoff ratio of 18 %. Similarly, the seasonal (September - December), runoff values are calculated and these values range from 0.285 Mm^3 to 1.116 Mm^3, with a 10 year average value of 0.871 Mm^3. The average runoff ratio for this 10 year period is calculated to be 21 %. As per the monsoon rainfall data, surplus from this tank occurred all but one year, when the rainfall is 315.4 mm.

12.3 Social Conditions

12.3.1 Present Social Conditions and Facilities

(1) Available Social Facilities in the Village

The piped drinking water supply system and water wells are available for all the villagers. The water quality of these sources is considered to be good. The electricity supply system is provided for about 60 % of villagers.

There are a primary school (Grade 1 - 5) and a middle school (Grade 1 - 8) in the village, and a community hall, too. However, no health care and clinic facility is available.

(2) Social Settings of the Ayacut Area

1) Land Holding and Relating Villages or Hamlets

There are 112 farmers in the ayacut areas of Kurumbi Tank, and their average land holding size is calculated to be about 0.47 ha. About 95 % of the farmers are marginal and small farmers. All the farmers in the ayacut areas live in the S. R. Patnam or Nagavayal.

2) Caste Composition

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

Caste Composition in Kurumbi Tank Ayacut Area

(Unit: %)

Others	BC	MBC	SC	ST	Total
0	80	0	20	0	100

The farmers in the ayacut areas are composed of the caste categories of BC composed of Vallambar, Mutharaiyar, Vellalar, Yadava, Kammalar, Dhabi, Barbar and Nadar caste and SC composed of Pallar and Parayar. About 80 % is shared by BC category, but the caste groups composing BC category are as many as eight (8).

3) Water Distribution and Decision Making Procedure

There is no such registered organization as water users' association in the ayacut area. The farmers take irrigation water from the tank whenever they feel it is necessary. But during the drought period they discuss and negotiate among themselves. The farmers, who are not able to receive water from the tank, buy groundwater from those who have well and pumping equipment.

4) Maintenance of Irrigation Facilities

Simple regular maintenance activity of the irrigation facilities is conducted by hiring laborers. Laborers' charges are paid by farmers collecting some amount in accordance with their cultivated areas. This maintenance work is carried out twice a year in the ayacut. The emergency repair works such as temporary repair for breach of the tank bund, etc. are conducted by farmers as required.

5) Conflicts and Problems

There is no conflict among either the caste groups or the farmers having advantage or disadvantage in receiving irrigation water.

6) Other Employment Opportunity

Nearest town area is Karaikudi located about 12 km away from the village. Since this area is abundant of groundwater resources, three (3) crops are very common. The farmers do not need to seek other jobs out of the village.

12.3.2 Sociological Evaluation

Based on the criteria described in Section 2.5, the sociological conditions of Kurumbi Tank ayacut area are evaluated as stated below.

Results of Social Scoring of Kurumbi Tank

Factors	Hamlets	Farm Size	Conflicts	WUA	Leader-ship	Resource Mobilization	Main-tenance	Overall Score
Scores	4	5	15	8	35	20	8	95

The results show that the ayacut area is good for the social screening and the timing of the community organizer placement for formulating WUA shall be at the commencement of the estimate preparation.

12.4 Agriculture

12.4.1 Present Agriculture

(1) Land Use

The registered command area is 52.7 ha of which irrigable area is 52.0 ha (98.7 % of the command area). In 1995-96 which was drought year, only paddy was cropped in an area of 24.1 ha (45.7 %). In a normal year, paddy, groundnut and pulses are cropped in the total areas of 84.0 ha sharing 78.5 % by paddy, 11.9 % by groundnut and 7.1 % by pulses. The crop intensity was 45.7 % in 1995 - '96 and 159.4 % in normal year.

(2) Soil and Land Capability

The type of soil in the ayacut area is mainly red sandy loam which requires a little high infiltration rate. No saline soils are found. The present cultivation of those soils show that the soils are suitable for irrigation.

(3) Agricultural Production

1) Crop Production

In 1995-96, only paddy was produced at a level of 104.0 tons in the area of 24.1 ha with an average yield of 4,313 kg/ha using the varieties of ADT-36 and 39 in the rain season. In normal year, 301.2 tons of paddy, 14.0 tons of groundnut and 3.0 tons of pulses are produced from the areas of 68.0 ha, 10.0 ha and 6.0 ha respectively. The average yields were 4,200 kg/ha on the 1st crop of paddy, 4,500 kg/ha on the 2nd crop of paddy, 1,400 kg/ha on groundnut and 500 kg/ha on ragi.

2) Irrigation Water

Tank water is available during the period from September to February with an irrigable area of 50.0 ha in normal year. There are 16 wells with an irrigable area of 35.0 ha in the area.

3) Fertilizer Application

According to the data of farmers' interview survey, 36 kg/ha of N and 50 kg/ha of P_2O_5 was applied for the paddy in 1995-96. These amounts applied are very low compared with the recommendation amounts (N: 120-150 kg/ha, P_2O_5: 38-50 kg/ha, and K_2O: 38-50 kg/ha).

4) Labor Input

According to the farmers' interview survey, the average labor input for paddy cultivation in the 10 pilot tank areas was about 200 man-day/ha in which 28 % was allotted to harvesting, 24 % to weeding and 21 % to transplanting. While the family agricultural labor in the area is 4.9 men/house and the potential agricultural labor is 5.2 men/house. The necessary staggering period in the area to accomplish the farm works of paddy cultivation by family labor is calculated based on the above data as 2.2 days when the potential labor is used. The labor requirements for vegetable, sugarcane and groundnut cultivation are around 4.3 times, 2.3 times and 0.6 times of the paddy, respectively.

5) Livestock Breeding

88 heads of cattle, 21 heads of sheep and 30 heads of chicken have been raised in this area.

(4) Farm Size and Land Tenure

The number of farm holders in this command area is 112 of which 5 % is farm holders of more than 2 ha, 24 % is farm holders of 1.0 to 2.0 ha and 71 % is farm holders below 1 ha (marginal). The average farm size is 0.47 ha which correspond to only 51 % of that of the state (0.93ha), and 30% of that of all India (1.57 ha).

12.4.2 Agricultural Development Plan

(1) Land Use

As shown in Table 3.4.1, paddy is planned to grow in an area of 52.0 ha (98.7 % of the command area) in the rainy season, White, as a high return crop, chili, turmeric, ladies' finger egg plant and tomato are grown using well water in the dry season with an area of 5.0 ha on chili, 5.0 ha on turmeric, 10.0 ha on ladies' finger, 5.0 ha on egg plant and 5.0 ha on tomato. The total cropped area in the area amounts to 82.0 ha and the crop intensity came to 155.6 % which is lower 3.8 points than the present one.

(2) Farming and Cropping Plan

The cropping plan was made as shown in Fig. 12.4.1. In the plan, paddy is grown in an area of 56 ha during the period from 15th of August to 31st of December using well water for the nursery and tank water for the main field. Chili, turmeric, ladies' finger, egg plant and tomato are grown with groundwater to the areas of 5.0 ha, 5.0 ha, 10.0 ha, 5.0 ha and 5.0 ha, respectively, during the periods from 15th of January to 13th of August on chili, 1st of June to 27th of March on turmeric, 1st of February to 11th of May and 20th of May to 28th of August on ladies' finger, 15th of January to 24th of June on egg plant and 15th of January to 14th of June on tomato.

(3) Crop Budget and Production Plan

The planned production amounts, the production costs and the net incomes of the area are shown in Table 3.4.2. The total net income amounts to Rs.2,196,100 of which the paddy, the chili, the turmeric, the ladies' finger, the egg plant and the tomato share 27.7 %, 17.3 %, 17.1 %, 20.1 %, 9.1 % and 8.8 %, respectively. The total amounts of net income in the area is increased to 2.4 times of the present one.

(4) Employment and Working Opportunity

The introduction of the high return crops for the area of 30.0 ha in the dry season will bring certain increase in employment and working opportunity, especially for the women. These labor amounts are required throughout a year.

(5) Farm Management and Farm Budget

1) Farm Management Plan

For this tank area where the conjunctive use of tank and well water as well as the cropping of sugarcane as the main cash-crop have been basically practiced, the farm management would be focused on the aspect of water management in conjunctive use in cooperation with the application of crop diversification for higher farm income for small and marginal farmers.

In order to realize this farm management system, the confirmation on groundwater supply concerning its possible volume, period, and operation cost in each case should be carefully made. Due to the limited groundwater supply and a rather higher water cost in case of well, the conjunctive use of both water sources for expanding maximum cropped areas, therefore, is recommended.

Besides, the application of integrated agriculture at each farm is recommended to be established. Related documents on the promotion of cash-crops are to be distributed to local farmers for making them understanding the situation on changing to cash-crops and obtaining a proper knowledge on the integrated agriculture.

Apart from intensive tank rehabilitation works for collecting water and effectively discharging into subjected farms to be carried out in the Project framework, the management of water and cares on the growing conditions of new cash-crops are to be recommended for a systematic application at each farm.

From these basic concepts, after confirming the related feasibilities for realization, the proper plan for farm management for each individual farm should be further elaborated for each corresponding farm 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 deducting all production costs
- Estimates on the balance after deducting all family living expenses

This will be done on the basis of combining evaluation for balancing the weights of all these elements to determine a proper farm management plan for each farm. For each year also, this work will be renewed as per an annual cycle to check the results from the previous year and to identify the recent changes in each element for making proper measures to the new management plan.

2) Farm Budget Plan

For further improvements of the farm income, integrated agriculture approach is strongly recommended for a proper application for increasing farm revenues, particularly on the aspects of making a home garden for growing vegetables and fruits, and raising livestock such as chicken and goat at farm basis (average 3 chickens and 1 goat per farm).

Also for the purpose of improving the farm budgets of small, marginal and landless farmers in this tank area, the introduction of some basic post-harvest and agro-processing treatments such as storage, drying, simple processing, etc. of agricultural produces is recommended to be promoted on the individual farm basis or in a scheme of village cooperative for creating jobs and, per consequence, for making a higher income for them.

(6) Marketing Plan

For this tank area, the marketing plan is recommended on subjected items as follows:

i) Rehabilitation of the access road from village to tank area for possible use in wet seasons
ii) A small lorry for transporting products
iii) About 2 units of cottage industry for making brown sugar

Besides, due to its rather remote location far from related cities, small shops for selling agricultural inputs and basic materials for the integrated agriculture, are recommended to be established in the village also.

12.4.3 Agricultural Supporting Services and Institutional Plan

(Same as notified in this part for Echur Tank)

12.5 Rehabilitation of Tank Irrigation System

12.5.1 Present Conditions

(1) Irrigation and Drainage System

Kurumbi Tank is located within a cascade of six (6) tanks. However, during the high water level, all 6 tanks is turned to be one. The order of tanks is: 1) Neduvari, 2) Nagavayal, 3)Kurumbi, 4) Kanjirang, 5) Pechide, and 6) Pudu Tanks. Furthermore, upper tanks gets water from Poigai and Mangudi tanks, and the lowest tank surplus flows to the Manimutar River near Devakottai through Kalluppatti Tank.

Registered ayacut is 52.67 ha, irrigated by one sluice. Canal system can be divided into 3 feeder channels, the main channel runs at the center of the ayacut covering almost 30 ha, the second runs along the western border of the ayacut covering about 20 ha, and the third channel runs along the foot of the tank bund and irrigate the eastern part of the ayacut. The first and second channel end in the field and excess water flows into the small pond located in the south-western end of the ayacut. The excess water of the third channel system flows into the Ganapathi Tank located at the eastern border of the ayacut. Field channels are running criss-crossing each other at the tail of ayacut. Also, they are supplied with water from adjacent tank channel such as Neduvari, Nagavayal, and Kanjiran Tanks

Most of the field bunds are embanked highly and planted with tall trees. Irrigation channels are rather fairly maintained up to field channel. There are several private open wells, irrigating summer paddy cultivation.

The ground slope in the ayacut runs in a south-eastward direction. There is no drainage channel in the ayacut, the irrigation channel has dual function. Therefore, during the high water period, the foot of the tank bund shows poor drainage due to seepage water through tank bund, then the yield in the area shows low.

(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. Soil erosion occurs at some parts of the slope of the bund. Especially, this damage occured around irrigation facilities such as weir and head sluice.

(3) Spillway (Surplus Arrangement)

1) Location

One B.C. type weir is located at the end of the bund. Since this arrangement is

connected to Kanjirang Tank, it is important to consider is formation as a chained tank system. Location of this weir is shown in Fig. 12.5.1.

2) Existing Condition

Although there are damage and cracks in this arrangement, it is possible to use for overflowing the excessive water. However, upstream side of this arrangement, is filled with bushes which disturb the overflow of design flood discharge.

(4) Intake Facilities (Sluices)

1) Location of the Sluice

There is only one (1) sluice of tower head type, for this tank. Location of the sluice is shown in Fig. 12.5.1.

2) Existing Condition

This sluice constructed in 1967 as same as the surplus arrangement. Although the material of body is deteriorated in some parts, damages and cracks are not confirmed in the sluice structure.

3) Water Supply Control Device

As same as other tanks, plug and plug rod type devices are installed: these devices were lost in the present sluice. It is necessary to reinstall the control device for effective control of water.

(5) Groundwater Usage

There are 13 wells in the command areas which are used for irrigation purposes. Among the 13 wells, four wells are dug cum bore wells. Depth of these wells ranged from 27 m to 50 m. In recharge area, most of the wells are dug wells and some hand pumps are present which are used for domestic purposes. Depth of these wells ranged between 9 m to 50 m. Thus the groundwater in this region is mainly extracted from the sands and clayey sands present above the Karikudi sands. The quality of the groundwater is good.

(6) Operation and Maintenance

There is no formal WUA at present, and irrigation water distribution including sluice control is run based on the traditional method.

12.5.2 Water Resources Development Plan

(1) Reliability 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 Kurumbi Tank is presented in the following table.

Liability of Water Based on Rainfall

Classification	No. of Years	Total No. of Years	Probability (%)
Excess	1	14	7.14
Normal	1	14	7.14
Deficit	4	14	28.57
Scanty	8	14	57.14

Among the 14 years, 57.14 % of the years are classified as having scanty rainfall, followed by deficit rainfall 28.57 %, normal rainfall 7.14 %, and there were only one year of excess rainfall years accounting for 7.14 %. Apart from this, another important aspect is the occurrence of drought or flood based on the rain storm. For a five year return period (20 % of provability), the monsoon rainfall is estimated as 748.7 mm. Since more than 50 % of the observation period receives scanty rainfall and also five year return period rainfall falls under deficit classification, it becomes necessary to develop monsoon/drought management strategies such as:

- Expansion of minor irrigation system
- Promotion of rain water harvesting techniques such as construction of percolation tanks.
- Conjunctive use of surface and ground water resources
- Developing contingency plans and crops to suit different weather probabilities.
- Supporting the farmers to increase their capability to meet potential changes in rainfall with scientific use of land and water.

(2) Water Quality

The water quality survey on its pH and electric conductivity in Kurumbi Tank area were conducted by the Study Team during the field inspection. According to these results, the tank stored water and groundwater in the ayacut show week acidity (pH 6.4 to 7.1) deferring with other Study Area and EC show mostly less than 0.75 dS/m, which means good water quality for cultivation and also for drinking.

(3) Irrigation Water Requirement

Paddy rice is the dominant crop in the 52.67 ha of Kurumbi Tank command area. The crop water requirement for rice crop in this command area for the crop growing

period of (Sep - Dec) is calculated on fortnightly basis as outlined in Section 3.5.2 and the results are presented in Table 3.5.3. With the present irrigation efficiency (seepage, conveyance and field application) of 40 %, the gross irrigation water requirement was calculated to be 0.526 Mm^3. Most of irrigation water is lost during conveyance due to seepage in earthen canals and leaky diversion structures. By lining the entire length of the canal, the irrigation efficiency could be increased to a level of 75 %. By this rehabilitation measure, the total irrigation water requirement is reduced to 0.319 Mm^3. Thus, 0.207 Mm^3 of water could be saved during the rice crop growing season, which can be used to increase the cropped area, to grow other less intensive crops in the same period and to lessen the dependability on ground water.

(4) Water Balance

The capacity of Kurumbi Tank is determined as 0.151 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, surplus occurred four out of 10 years. All the runoff water stored in the tank is intended to irrigate a registered ayacut of 52.67 ha. With its richness in water resources, Kurumbi Tank could satisfy in an average 68 % of the irrigation demands. With present conditions (Ef = 40 %), the estimated irrigated area varies between a minimum of 1 % to a maximum of 100 % of the registered ayacut, The runoff/irrigation ratio remains as 235 %. This situation could be further improved by canal lining, with an increased Ef = 75 %, resulting in decreased irrigation water requirements. By this change, tank water could able to irrigate in an average 81 % of the registered ayacut. Beside this, the runoff - irrigation ratio is increased to 390 % and more surplus water (average 0.679 Mm^3) is available to the down stream tanks. Monsoon data also showed the same trend, but with a slight increase in runoff ratio. The above facts point out that partial canal lining is desirable as a rehabilitation measure to increase the command area of Kurumbi Tank.

(5) Drainage Water Requirements

The drainage water requirement of Kurumbi Tank is calculated according to the procedure described in Section 3.5.2 and details are given in Table 2.4.4. Using the Ryve's formula, the estimated maximum flood discharge is 22.95 m^3/s, while that using the rational formula is 25.42 m^3/s. Hence a safe design discharge of 25.42 m^3/s, can be adopted for designing surplus arrangements, after considering the seriousness of disaster, local losses, inconveniences, type of surplus arrangement and rehabilitation cost.

(6) Basin Water Management

Kurumbi Tank is located in the Manimuthar River basin. In Kurumbi Tank chain

there are five tanks in a series separated by dykes due to elevation difference. Kurumbi Tank receives its supply from the surplus of Neduvari Tank which inturn receives its supply from Nagamani Tank. The surplus water from Kurumbi Tank flows into Kanjrang Kanmai, which is interlinked to Pechide Kanmai. Very close to these series of tanks is S R Pattinam Peiya Kanmai. The main water source for Kurumbi Tank are rain water from the northern side, forest area, and surplus water from Poyallor Tank. In the intercepted catchment there are more than five small PU tanks. Various ratios calculated for Kurmbi Tank are presented in Table 2.4.2, and are summarized here for quick reference.

- Free catchment / command area 4.67
- Intercepted catchment / command area 8.23
- Waterspread area / command area 0.32
- Tank storage capacity / command area 0.003 Mm^3/ha
- Waterspread area / Tank storage capacity 1.119 km^2/Mm^3

Kurumbi Tank has a free catchment and intercepted catchment which are 4.67 and 8.23 times larger than command area respectively. This indicates that the changes that take place in the free and intercepted catchment as are as a result of encroachment and social forestry station which can drastically cause a reduction in culturalble command area of the tank. The ratio between waterspread area and the command area is 0.32, which implies that for every ha of waterspread the tank irrigates only 0.32 ha. This indicates the shallow storage and suggests for policy implications on deepening the tank by way of desiliting which could increase the command area. The waterspread area capacity ratio is 1.119 km^2/Mm^3, clearly points out the shallowness and depth of water storage. Over the years, as result of siltation, the storage capacity of the tank may lost. Engineering solutions like temporarily store the surplus by storing the surplus by placing wooden or metal shutters in the surplus weirs shall only increase the conflicts between the farmers of Kurumbi Tank and Kanjiram Tank. Kurumbi Tank has 0.008 Mm^3 of storage in 1 ha of waterspread which themselves speak on the low storage. Kurumbi Tank has a water availability of less than 0.003 Mm^3/ha which is far less than the requirement of water for a single crop of rice under the current levels of efficiencies (storage, conveyance, and field application) These figures indicate that tank irrigation potential is under utilized due to lack of tank management. Proper operation and management of tank irrigation is one of the major options to mitigate the severity of droughts.

The surface water resources of Kurumbi Tank basin consists of direct runoff from catchment and surplus flow from the upper tank. However, irrigation depend on available ground water also. The total ground water recharge of Karaikudi Block to which, Kurumbi Tank belongs was estimated to be 5,537 ha-m Utilizable recharge is 4,706 ha m, net Ground water draft is 161 ha m and the balance available is 4,545 ha-m. This balance 96.5 % can be used to supplement the tank water in the tank cascade.

The total surface water resources can not be utilized due to certain limitations, as under topographical (elevation difference is so small that during little overflow conditions, no water level difference was observed), hydrological (complex interdependence of all the five series of tank), sociological (three major caste groups of the tanks get into conflict when there is a water scarcity).

In solving these problems, the important aspect is the participatory and chain basin approach to the tank rehabilitation. This can be achieved by formation of four -tier farmers association as shown in the following table and assigning specific responsibilities to the farmers in tank rehabilitation and maintenance.

Tier	Association	Level	Responsibilities
I	Kurumbi Tank WUA	Tank/village	To identify and suggest need based tank management program
II	Nagamani Tank Series WUA	Village	To attain better irrigation management for the five tanks in the series
III	Manimuthar Basin Farmers Council	Chain basin	To resolve conflicts arising among the chain of tanks
IV	Sivaganga Tank Farmers Federation	District	To identify the opportunities available for inter and intra chain basin water transfer

(7) Groundwater Development

In this area, due to the presence of significant sand thickness (8 to 51 m) large number of wells can be developed to increase the use of groundwater. A large number of dug cum bore wells will satisfy the irrigation need. As the transmissivity of the sands at the top is expected to be less because of the mixture of clays it is recommended to have a open well up to this depth. If more yield is required deep bore well can be drilled from there as the lower part of the formation in predominantly made up of sands.

12.5.3 Tank Irrigation Facilities Rehabilitation Works

General layout of irrigation facilities is shown in Fig. 12.5.1, and required item for rehabilitation works are described in the table.

Countermeasures for Rehabilitation of Kurumbi Tank

Component	Rehabilitation works	Section for Rehabilitation works	
Tank Bund Improvement (Total bund length 1,120m)	• Strengthening of the bund for reshaping to standard size.	1,120m	
Intake works (Sluice)	• Modification of intake system using gearing shutter • Protection of back-fill for side slope.	Head tower type	1 unit
Surplus arrangement	-	-	-
Selective Lining for Field Channel including On-farm development	• Installation of lining canal • 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.	670m as main 470m as branch	1 unit 3 units
Building for Farmers' Association	• Provision of community hall for WUA, local farmers and inhabitation.	$50m^2$	1 No.
Community well	• Provision for irrigation as supplemental use		2 Nos

12.6 Farmers' Organization

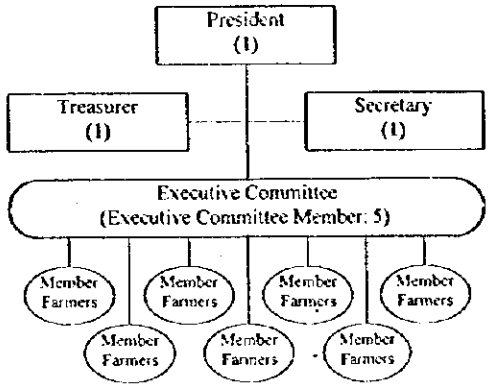
12.6.1 Present Situations of Farmers' Organization

There is no such registered organization as water users' association in the ayacut area as described in Sub-chapter 12.3.1. They have their informal society for water distribution.

12.6.2 Proposed Farmers' Organization

(1) Water Users' Association

Since there are 112 farmers in the ayacut areas, the number of the Executive Committee Member becomes five (5) and the number of member farmers is 104 deducting the number of office bearers from the total farmers. The functions of the proposed WUA for Kurumbi Tank are described in Sub-section 4.3.4 of Volume II of the Report.



PROPOSED ORGANIZATION FOR WATER USERS' ASSOCIATION OF KURUMBI TANK

(2) Farmers' Organization for Agricultural Production

As explained in Sub-section 4.3.4 of Volume II of the Report, the sections which have the following functions are proposed to be attached to the WUA in Kurumbi 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

12.7 Project Evaluation

12.7.1 Project Costs and Benefits

(1) Project Costs

Unit cost for rehabilitation works are estimated based on the *Standard schedule of Rates for Pasumpon Muthuramalinga Thevar District* issued by PWD. At the 1997 price level, direct construction cost is estimated at about Rs. 1,466,000, as shown in the table.

Direct Construction Cost for Kurumbi Tank

Description	Total Cost (Rs.)	Percentage	Unit Rates (Ayacut 52.67ha) (Rs./ha)
Tank Bund Improvements	52,000	3.53%	987
Sluices Improvement	144,000	9.82%	2,734
Surplus Improvement	-	0.00%	-
Tank Supply Channel Improvement	-	0.00%	-
Selective lining for Field Channel & OFD	740,000	50.48%	14,050
Building for Farmers' Association	130,000	8.87%	2,468
Community Well	400,000	27.29%	7,594
Direct Construction Cost	1,466,000	100.00%	

The financial Project cost consisting of direct cost, supervision charges, contingencies, preparation work cost and overhead charges is estimated at Rs.2,153,000.

Project Cost for Rehabilitation Works in Kurumbi Tank

Description	Total Cost (Rs.)
Direct Construction Cost	1,466,000
Petty Supervision Charges & Contingencies	235,000
Preparatio Cost (Govt. Share)	21,000
Overhead Charges	431,000
Total	2,153,000

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 mainly aims at stabilizing the agricultural production throughout the year in the limited command area of about 52.7 ha by improving water supply from tank and the introduction of proper agricultural production techniques for better farming system for higher farm revenues to improve the basic living conditions of

small and marginal farms in this tank area after the rehabilitation works.

At present, though the command area is cropped with paddy for double crops in a year , but the cultivated area for the first paddy crop starting with the rainy season is very limited. Besides, due to main factor of unstable water supply in the first crop, the average unit yield of the first paddy crop (4.2 t/ha) is observed lower than the unit yield in the second crop (4.5 t/ha).

With the Project implementation, major economic benefits of the Project, therefore, will be 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 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 is resulted in an increase of the net production value of agriculture from presently at about Rs.1.04 million to about Rs.2.06 million, or about 2 times (Table 12.7.1).

Besides, with the establishment of various facilities for organizing farm management and improving treatments on storing, marketing etc., an estimate of value-added of 0.1 million Rs. 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 with the application of some basic post harvest treatments such as storage and selling at markets only will provide a profit margin of average 5 % higher than selling at farm sites during harvesting periods.

12.7.2 Economic Evaluation

The economic evaluation is made to judge the project viability in terms of direct contribution to the national economy. The Project covers a command area of 52.7 ha with a total number of 112 farms as beneficiaries.

For the economic analysis, the related EIRRs for Kurumbi Tank area are basically calculated as follows:

i)	EIRR under basic conditions :	40.1 %
ii)	EIRR at 10% cost-increase:	36.8 %
iii)	EIRR at 10% benefit-decrease:	33.3 %
iv)	EIRR at 3-year benefit delay:	22.4 %

From these figures, the EIRR under basic conditions of 40.1 % shows the Project viability. Meanwhile, the risk case of 3-year delay of benefits showed the lowest EIRR of 22.4 %.

12.7.3 Financial Evaluation

In this Project, the financial evaluation is 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 as follows

- "Without Project" Net Income per Farm:	Rs.8,004
- "With Project" Net Income per Farm:	Rs.19,608
- "With Project" Value-add per Farm:	Rs.980
- Incremental Net Farm Income:	Rs.12,584

The incremental net farm income for the representative farm, therefore, will be Rs.12,600 per annum. With the Project implementation, the annual net farm income for an average farm in Kurumbi Tank area will be envisaged at Rs.20,600.

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

12.7.4 Labour 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 August with the requirement of 7,381 man-day/ month. To meet this labor amount, 13 days in staggering period is needed with the potential family labor of 582 man-day in the area.

12.7.5 Farm Household Economy

With the Project implementation, the farm household economy of small and marginal farms will be largely improved accordingly. From the financial analysis on farm budgets of these farm categories, under the present conditions of inferior production proceedings, both small and marginal farms are generally faced with a deficit situation resulted from a low on-farm income versus a constant expenditure for family living

With better conditions on water supply and supporting institutions for agricultural production in the Project framework, the small and marginal farms would adjust their farm budgets from the present deficit situation for improving their basic living standards. An incremental farm benefit of approximately Rs.11,600 and a value added of about Rs.980 for a total amount of about Rs.12,600 would be obtained per year by an average farm accordingly.

However, due to the average small farm size of 0.47 ha in this tank area resulting in a limited on-farm income, farmers should be engaged more in off-farm economic

activities for raising their 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.

12.8 Environmental Issues

12.8.1 Present Environmental Conditions

(1) Health and Sanitary Conditions

Major diseases in this area are influenza, common fever, diarrhea and dysentery. In relation to irrigation and drainage, neither waterborne nor mosquito-related diseases occur.

(2) Natural Environment

The tank area is generally flat land. Catchment area is under cashew forest, waste land, cultivated land and Nagavayal Village. Tank bed plantation of *Prosopis Juliflora* under the social forestry program is found in the whole waterspread area. Wildlife seen by the villagers are peacocks, foxes, rabbits, monkeys, spotted deer and other birds.

(3) Surface Water and Groundwater

Quality of tank water is good and no water contamination by agro-chemicals occurs. Groundwater is also utilized widely for irrigation in dry season. There are several tube wells and open dug wells, all private, in the ayacut. Open wells are dried up in late dry season.

From the result of the water quality measurement, it can be stated that the groundwater will have no salinity problems for irrigation use. The depth of tube well and open well is around 45m and 9m respectively.

12.8.2 Environmental Impact of the Project

As summarized in Table 12.8.1 and table 12.8.2, the environmental impact study for Kurumbi 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, also the same situation as stated in Section 3.8 for Echur Tank area can be expected. That is, the use of agrochemicals will be increased in the future. For rural health and diseases the Project will not be a cause of any waterborne or mosquito-related diseases.

(2) Natural Environmental Impact

1) Biological and Ecological Issues

There is no habitat of important fauna and flora in the area except peacocks to be protected under The Wildlife (Protection) Act. Therefore, almost the same impact and measures to safeguard the wildlife as stated in Section 8.8 for Siruvalai Tank area shall be considered.

2) Hydrology and Quality of Water

Groundwater with EC value of about 0.65 dS/m is suitable for irrigation and groundwater in this area will still have development potential. Likely problems induced by the groundwater development will be the changes of groundwater table. Large scale groundwater extraction will be a cause of lowering water table.

12.8.3 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) During rehabilitation works in the tank area, it is recommended that the works shall provide safeguard to wildlife particularly for peacocks.

iv) For the groundwater development for irrigation, it is recommended that the scale of groundwater development shall be carefully planned.

Table 12.7.1 Calculation of Crop Economic Benefits for Kurumbi 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)	16.0	4.20	67.2	4,736.0	318.3	5,008.0	80.1	238.1	
2. Paddy (2nd Crop)	52.0	4.50	234.0	4,736.0	1,108.2	7,200.0	374.4	733.8	
3. Ground nut (2nd Crop)	10.0	1.40	14.0	7,168.0	100.4	3,848.0	38.5	61.9	
4. Blackgram (2nd Crop)	6.0	0.50	3.0	9,600.0	28.8	3,600.0	21.6	7.2	
Total	84.0		318.2		1,555.6		514.6	1,041.0	

"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)	52.0	4.50	234.0	4,736.0	1,108.2	5,750.0	299.5	808.7	
2. Eggplant (2nd Crop)	5.0	20.00	100.0	2,400.0	240.0	17,600.0	88.0	152.0	
3. Tomato (2nd Crop)	5.0	15.00	75.0	3,200.0	240.0	17,200.0	86.0	154.0	
4. Ladies Finger (2nd Crop)	5.0	15.00	75.0	3,600.0	270.0	18,800.0	94.0	176.0	
5. Ladies Finger (3rd Crop)	5.0	15.00	75.0	3,600.0	270.0	18,800.0	94.0	176.0	
6. Green Chilli (1 year)	5.0	10.00	50.0	8,000.0	400.0	20,400.0	102.0	298.0	
7. Turmeric (1 year)	5.0	25.00	125.0	3,200.0	400.0	20,100.0	100.5	299.5	
Total	82.0		734.0		2,928.2		864.0	2,064.2	

Incremental Crop Benefits:

"With Project" NPV:	2,064.2
"Without Project" NPV:	1,041.0
Incremental Crop Benefits:	1,023.2
Value Added (5%) :	103.2
Incremental Total:	1,126.4

Table 12.8.1 Possible Environmental Impacts for Kurumbi 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 increase
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	Peacocks may be living in and around tank area
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			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
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		Not expected
46. Change in temperature of water			x		Not expected
47. Air pollution			x		Not expected

Table 12.8.2 Environmental Impacts (Irrigation) for Kurumbi 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	1. Excess and improper use of agrochemicals may lead to soil and water contamination. 2. Large scale groundwater development will lower water table.	1. Farmers training on proper use of agrochemicals is extended. 2. Appropriate development scale is planned with careful hydrological study.	
Natural Environment	1. Effect on construction and operation of the facilities on the ecology				x	1. Peacocks nests may be destroyed during rehabilitation works.	1. Safeguard shall be provided specially in breeding season during implementation	
	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.	

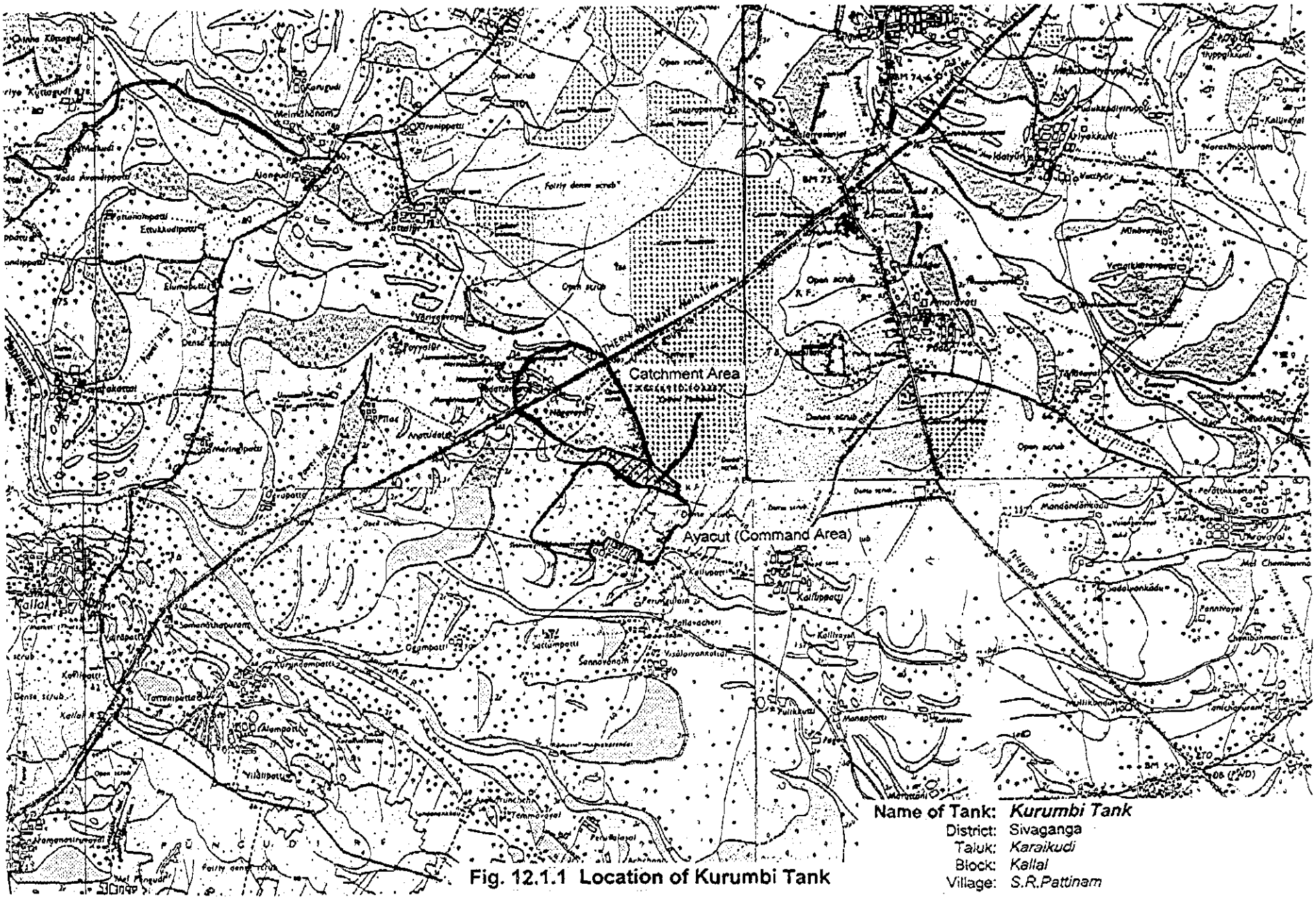


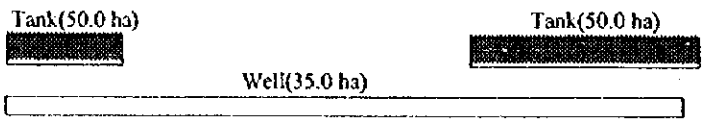
Fig. 12.1.1 Location of Kurumbi Tank

1 Name of Tank	Kurumbi Tank
2 Ayacut Area	52.7 ha
3 Main Soil	Red Sandy Soil(100%)
4 Water pH,EC	pH: Tank water 7.1, Groundwater 6.4 to 7.0, EC: Tank water 0.11 dS/m, Groundwater 0.593 to 0.736 dS/m
5 No. of Farm Households	112 farm households
6 Self-Support Amount of Rice	224tons (112 x 2,000 kg/Household)
7 Geographical Irrigable Area	52.0 ha
8 Total Irrigable Area and Month by Tank	50.0 ha(Sep-Feb)
9 No. of Wells and Irrigable Area	16 wells, 35.0 ha
10 Average Rainfall(mm)	

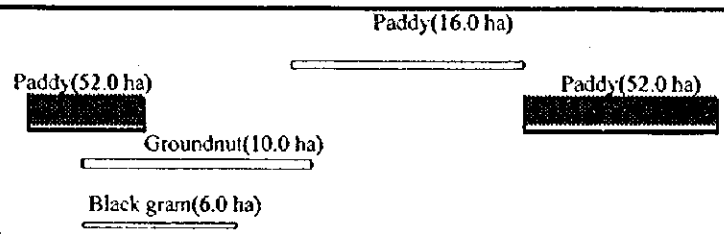
Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
24.4	19.5	24.6	55.5	36.4	19.8	18.9	59.4	63.5	150.8	149.6	80.6	722.9

11 Cropping

1) Irrigable Area and Period



2) Present Cropping Pattern

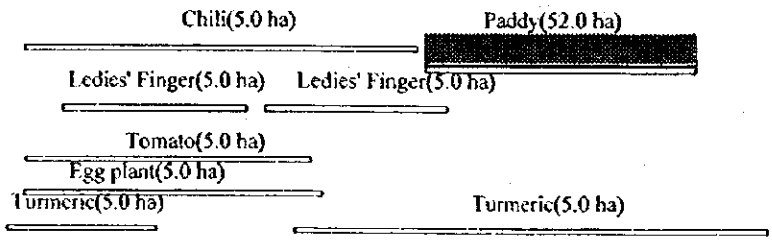


3) Cropping Plan

a) Paddy Area for Sslf-Support

56.0 ha(224 ton/4 ton)

b) Cropping Plan



c) Evaluation

	Crop Intensity(%)	Net Income(1000Rs)
Plan	155.6	2,196
Present	159.4	896
Plan/Presen	0.98	2.45

Fig. 12.4.1 Cropping Plan in Kurumbi Tank Area

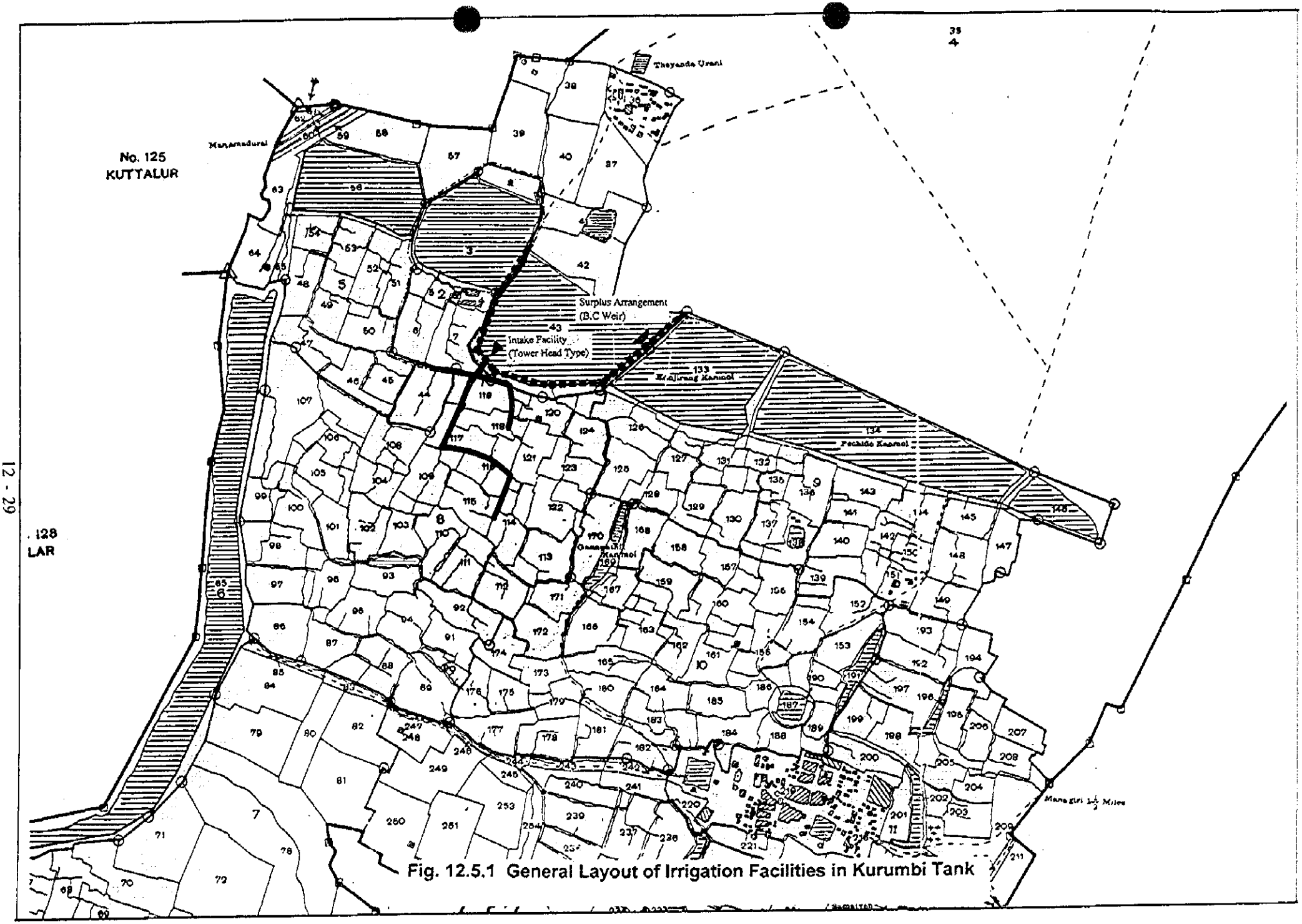


Fig. 12.5.1 General Layout of Irrigation Facilities in Kurumbi Tank

CHAPTER 13 : OVERALL PROJECT JUSTIFICATION

CHAPTER 13 OVERALL PROJECT JUSTIFICATION

13.1 Basic Justification on the Study

In the whole framework of the Study on Rehabilitation of Minor Irrigation Tanks for Rural Development carried out in 5 districts of Tamil Nadu (2 districts - Tiruvallur and Kanchipuram - in the Northern Study Area and 3 districts - Ramanathapuram, Sivaganga and Virudunagar - in the Southern Study Area), approximately 2,100 PWD rainfed tanks (or almost 45 % of total rainfed tanks in this State) were covered by the Master Plan Study of the Project.

This would cover a total command area of about 214,000 or about 75 % of the presently irrigated area in these 5 districts (297,000 ha). In fact, the share of areas irrigated by PWD rainfed tanks in this State has been observed to have been decreasing far below from this figure due to the chronical situation of lacking tank water for efficient irrigation operations, particularly in the Southern Study Area where the average annual rainfall has been found very scarce in some parts.

Of the total population of approximately 8.5 million inhabitants in the 5 subjected districts, approximately 1.5 million persons or 18 % of the total population would be considered as beneficiaries of the whole Project framework for being family-members of about 300,000 farm units living in the Project area.

The PWD rainfed or non-system tanks for minor irrigation subjected to the Study were mostly constructed several centuries ago by local kings or regional chiefs for collecting rainfall and surface water from each regional catchment to irrigate by gravity its nearby farmland for mainly rice cultivation, the traditional staple foodstuff in this State. These rainfed tanks are presently obverted being very deteriorated in structures and functions for efficiently performing the normal irrigation operation.

As being turned over to the control by PWD since 1975 but basically operated by local Panchyat Unions, these rainfed tanks have been gradually faced with the deterioration in structures and functions, mainly caused by encroachment in corresponding catchment areas, siltation of tank-beds, bund-damages, sluice-malfunctions, water conveyance loss in irrigation canals, etc., resulting in the reduction of envisaged agricultural production and hampering the basic living conditions of local inhabitants.

Therefore, in order to regain the potential in irrigation capacities by these tanks, they should be firstly rehabilitated., and, then, subjected to the functioning of effective O&M under a new management organization to be established in this framework accordingly.

For the feasibility study of the Project, 10 Pilot Tank Areas (5 areas in the Northern Study Area and 5 areas in the Southern Study Area) from the total number of approximately 2,100 tank units were selected as the representative tanks from all

subjected categories. The feasibility study is made as a pilot phase for modeling all related proceedings and procedures for the whole Project framework. The total command area of these 10 Pilot Tank Areas is approximately 1,560 ha (1,235 ha in the North and 325 ha in the South) or approximately 0.7 % of the total command area of the whole Project framework. (214,000 ha). This figure is observed somehow higher than the figure of 0.5 % for the share of 10 units in the total number about 2,100 tanks for the whole Project. As for the number of beneficiaries subjected to the feasibility study, the total number of about 2,450. farms or approximately 11,000 persons would be considered as beneficiaries., sharing also a figure of approximately 0.7 % of the total beneficiaries for the whole Project.

13.2 Justification on the Whole Project Framework

Basically the whole Project framework of the Master Plan study is aimed at firstly stabilizing the agricultural production in the main areas of Tamil Nadu which is observed being very unstable throughout the year recently due to the insufficient supply of irrigation water for cropping, particularly in the dry season, and secondly improving the production yields and farm revenues, especially for the small and marginal farm categories, for raising up their basic living conditions. In this connection, the related institutional aspects on O&M and value-added programmes for functioning the Project will be subjected to an intensive elaboration also. These both subjected aspects are considered basically to deal with the major socio-economic issues of food self-sufficiency and rural poverty in this State where an average population growth of 2 % per annum has been constantly taking place.

From the basic issue of chronic lack of irrigation water, the consideration on the development of available surface water and groundwater, hydrological potentials for each area for the joint use, if possible, is also subjected to consideration in the framework of the Project. From the free cost of electricity for using in agricultural purpose at present, the utilization of groundwater with motor pumps, therefore, would be considered as a good opportunity The installation cost for an open well equipped with electric pump is approximately Rs.50,000 - Rs.60,000 at present, which could irrigate 2 - 3 ha of farmland in average. The problems presently confronted from this alternative would be as follows:

i) Scarcity in potentials of groundwater with proper quality in the drought prone areas, particularly in the Southern Study Area.
ii) Cost requirements for searching proper groundwater sources.
iii) Relatively high cost for well installation. Normally small and marginal farms have no financial capability for this investment.
iv) Irrigation cost by well, therefore, is rather higher than the one for tank irrigation.
v) Limited acreage for irrigation by well (2 - 3 ha from one well)

Installation costs and water discharge capacities of various well types for minor irrigation are shown in Table 13.2.1 and Table 13.2.2. At present, only some affluent

farmers can install wells for enjoying the utilization of electricity as free of charge. In the future, if the electricity used for agricultural purpose is charged (the present electric fee is in the range of Rs.1.5 - Rs.3.0 per kVA), the irrigation cost by this means will be largely increased.

For the Project evaluation on concerned aspects of the Project, in the Master Plan Study for the whole Project framework, the items such as the basic Project justification, the costs and benefits, the economic analysis, the sensitivity analysis, the financial analysis, the environmental assessment as well as the gender issue were properly carried out respectively.

From the results of the evaluation on the whole Project framework, the basic justification on the fundamental improvements in socio-economic development for local inhabitants, the incremental benefits from newly implemented cropping patterns and value-added programmes, the EIRRs with 18.8 % in basic case and 12.3 % in the highest risk from the sensitivity-analysis (case of 3-year delay of Project benefits), the double increase in average farm revenues for small and marginal farmers, the overall clearance of environmental impacts as well as the improvement in gender issue were respectively justified in due course.

In the whole, the Project is evaluated with high positive impacts on the basic socio-economic aspects for improving the basic living conditions in rural Tamil Nadu. Due to various imminent factors of uncertain commitments in the society, the implementation proceedings on relative technical and financial aspects, however, should be carefully performed in accord with the respective implementation schedules at each step in order to avoid discrepancies between the implemented works and the Project objective itself. This would requires great efforts and competency from Tamil Nadu to carry out the correct works at each stage for making the Project achieving correctly the envisaged work-scopes.

13.3 Justification on the Feasibility Study Project

13.3.1 Basic Justification

The feasibility study of the Project covers substantially 10 Pilot Tank Areas of PWD rainfed tanks for minor irrigation purpose with the range of ayacuts from 42 ha (Pandikanmoi Tank) to 575 ha (Enadur Big Tank), evenly distributed in both Northern and Southern Study areas of the State (5 tank areas in the Northern Study Area and 5 tank areas in the Southern Study Area of all related categories).These tanks were selected as the representatives from all concerned categories for making as a modeling part for the whole Project frame work covering the total number of approximately 2,100 units of PWD rainfed tanks in the State.

13.3.2 Economic Justification

The Project is aimed mainly at stabilizing the agricultural production through the year and improving the present old agricultural production techniques for a better farming system in the related command areas through the rehabilitation works of corresponding tanks.

With the Project implementation, the higher cropping intensities in both seasons and the higher yields per cropping unit along with the application of some higher valued cash-crops will make a total amount of approximately Rs.2,340 million as the annual incremental crop benefits which are the main source of economic profits for the Project. In average, therefore, one tank would have an annual incremental crop benefit of Rs.1.12 million. The main economic profits resulted from the project implementation are listed up as follows:

Incremental Economic Benefits

Tank Category	Name of Tank	Ayacut (ha)	NPV without Project (Rs.X1000)	NPV with Project (Rs.X1000)	Incremental Benefit (Rs.X1000)	Value Added (Rs.X1000)	Total Incremental Benefit (Rs.X1000)	Average Total Incremental Benefit (Rs./ha)
NR-1	Echur	58.68	961.6	1,609.2	647.6	80.5	728.1	12,408
NR-2	Cherukkanur	91.26	2,734.3	3,443.8	709.5	172.2	881.7	9,661
NR-2	Polambakkam	94.59	1,030.4	2,289.0	1,258.6	114.5	1,373.1	14,516
NR-3	Vadakkupattu	417.21	9,420.8	11,158.9	1,738.1	557.9	2,296.0	5,503
NR-4	Enadur	574.67	5,008.0	7,392.8	2,384.8	369.6	2,754.4	4,793
SR-1	A. Ramalingapuram	76.53	770.5	1,775.2	1,004.7	88.8	1,093.5	14,288
SP-1	Pandikanmoi	41.88	172.9	604.5	431.6	30.2	461.8	11,027
SP-1	Siruvalai	49.25	663.7	1,002.7	339.0	50.1	389.1	7,901
SP-2	Kurumbi	52.67	1,041.0	2,064.2	1,023.2	103.2	1,126.4	21,386
SP-4	Sengangulam	99.23	1,032.4	1,742.0	709.6	87.1	796.7	8,029
Average					1,024.7	165.4	1,190.1	10,951

Note : For the annual value-added benefits from post-harvest treatments, 5 % of the net annual production value would be considered to be the result of treatments such as storage for off-season prices, primary processing etc. from related institutional programmes.

This shows, in a whole, the 10 Pilot tanks would offer an annual incremental benefit of about Rs.10.2 million along with a value addition of about Rs.1.7 million for a total amount of approximately Rs.11.9 million per annum.

The establishment of various institutional facilities for better organizing farm management and the installation of basic post-harvest treatments such as storing, marketing, simple agro-processing of the raw agricultural produces as proposed in the marketing distribution plan for each tank area would contribute an estimated value-addition as 5 % of the corresponding agricultural production in each tank area accordingly. This is estimated on the basis of results from our site surveys that with the application of some basic post harvest treatments such as storage and selling at markets only will make a profit margin of average 10 % higher than selling at farm sites during harvesting periods. With the Project implementation, therefore, a total amount of value addition of Rs.1.7 million as 5 % of the total net agricultural production value per annum of all 10 Pilot tank areas would be obtained accordingly.

The economic justification judges the Project viability in terms of direct contribution to the national economy. From the economic analysis of each tank area, the corresponding EIRRs are notified in the economic justification of each tank area.

The EIRRs for all 10 Pilot tanks subjected to the feasibility studies at basic conditions are listed up as follows:

Economic Internal Rate of Return for Pilot Tank Areas

Tank Category	Name of Tank	Ayacut (ha)	No. of Farm	Average Farm Holding (ha)	EIRR Basic Condition	EIRR Cost +10%	EIRR Benefit -10%	EIRR Benefit Delay 3 Yr.
NR-1	Echur	58.68	166	0.35	22.8%	20.6%	18.9%	14.1%
NR-2	Cherukkanur	91.26	268	0.34	15.9%	14.1%	12.9%	10.0%
NR-2	Polambakkam	94.59	139	0.68	29.6%	27.0%	24.6%	17.6%
NR-3	Vadakkupattu	417.21	355	1.18	7.4%	5.7%	5.1%	4.1%
NR-4	Enadur	574.67	448	1.28	11.7%	9.9%	9.0%	7.1%
SR-1	A. Ramalingapuram	76.53	49	1.56	14.7%	12.9%	12.6%	9.2%
SP-1	Pandikanmoi	41.88	110	0.38	12.3%	10.6%	9.7%	7.7%
SP-1	Siruvalai	49.25	106	0.46	8.7%	4.8%	6.4%	2.4%
SP-2	Kurumbi	52.67	112	0.47	40.1%	36.8%	33.3%	22.4%
SP-4	Sengangulam	99.23	313	0.32	19.7%	17.6%	16.2%	12.3%
Average					18.3%	15.8%	14.7%	10.5%

From these above figures, in a whole, the feasibility analysis of the Project shows the same trend of EIRRs as mentioned in the Master Plan Study. However, for the figures of each individual tank, due to the specific local conditions resulting in differentials of estimated work - costs and envisaged incremental benefits, some tanks such as CVadakkupattu, Enadur and Siruvalai tanks have low figures in the economic evaluation.

13.3.3 Financial Justification

In the financial evaluation for mainly analyzing the farm budgets for the categories of the representative farms in each tank area for both cases of "without project" and "with project", the farm budgets of these farms were proved to be largely improved. With the Project implementation, in average, one farm would obtain an increase of annual net farm income of about Rs.8,600 and an amount of value added of about Rs.850 for a total amount of Rs.9,450.

The results obtained from each tank are listed up as follows:

Tank Category	Name of Tank	Ayacut (ha)	No. of Farm	Average Farm Holding (ha)	NPV without Project (Rs.)	NPV with Project (Rs.)	Value Added (Rs.)	Incremental Benefit (Rs.)
NR-1	Echur	58.68	166	0.35	4,798	9,875	494	5,571
NR-2	Cherukkanur	91.26	268	0.34	10,260	13,812	691	4,242
NR-2	Polambakkam	94.59	139	0.68	6,553	19,727	986	14,160
NR-3	Vadakkupattu	417.21	355	1.18	26,404	34,415	1,721	9,732
NR-4	Enadur	574.67	448	1.28	10,278	19,621	981	10,324
SR-1	A. Ramalingapuram	76.53	49	1.56	8,951	34,773	1,739	27,561
SP-1	Pandikanmoi	41.88	110	0.38	-677	4,391	220	5,288
SP-1	Siruvalai	49.25	106	0.46	3,627	8,187	409	4,969
SP-2	Kurumbi	52.67	112	0.47	8,004	19,608	980	12,585
SP-4	Sengangulam	99.23	313	0.32	2,479	5,568	278	3,367
Average(Total)		(1,555.97)	(2,066)	0.75	(80,678)	(169,977)	8,499	9,780

The lowest increase of annual net farm income (Rs.3,367) is for Sengangulam Tank in the Southern Study Area, and the highest increase of annual net farm income (Rs.27,561) is for A.Ramalingapuram Tank in the Southern Study Area.

For the areas with an average increase of less than Rs.10,000 /farm/annum, other off-farm economic activities, therefore, should be largely promoted in order to improve the basic living standards of farms with low agricultural incomes due to their very small farm sizes and limited conditions for further achievements in farm incomes. This important issue would be elaborated in another project framework.

Besides, for the landless families, their living conditions would be improved to some extent also from more job opportunities would be obtained from the medium and big farms who are also beneficiaries of the Project.

On the aspect of financial procurement for implementing the Project which objectives were clearly justified for improving the basic socio-economic aspects in this State as mentioned in the above, GOI and GOTN, as well as the envisaged implementing agency, PWD, therefore, are recommended to make proper actions on this aspect for implementing the Project at an early stage.

13.4 Environmental Impacts

From the results of the environmental impact examination (Table 13.4.1), it can be judged that basically the Project will not induce any significant negative impact. Some minor impacts can be eliminated through appropriate procedures and countermeasures. The groundwater development, however, shall need rather careful planning works regarding the development scale, groundwater quality and sea water intrusion. Post-project monitoring and supporting services are required for the groundwater development, agrochemical use, water users association (WUA) and preventing the spreading of mosquito-related diseases.

As to the environmental rule in India, the Government of India enacted the Environment (Protection) Act of 1986 under the Constitution. According to the Environment (Protection) Rules of 1986 and the Notification on Environmental Impact Assessment of Development Projects of 1992 and 1994, all the projects are required to obtain environmental clearance from the Central Government or the State Government. Application shall be accompanied by a detailed project report which shall include Environmental Impact Assessment (EIA) and Environment Management Plan (EMP). For the expansion and modernization of existing projects, if the resultant pollution load is not exceed the existing levels, the project will not be required to seek environmental clearance.

In this Project, it is, therefore, considered that, as far as the Project is to be implemented in the existing minor irrigation tanks with providing the appropriate countermeasures for the minor impacts, the clearance on the environmental aspect would be unnecessary.

13.5 Conclusion

The feasibility study of 10 Pilot tank areas is justified in all relative aspects. This would be considered as a pilot phase for modeling all related proceedings and procedures for applying to the whole Project framework elaborated in the Master Plan Study to be applied for the whole state of the State.

With the Project implementation, along with the construction and installation works of related structures and facilities, the institutional development related to each aspect of the Project will be an important factor for functioning the Project in a correct direction to achieve the objectives envisaged by the Project.

In the whole Project framework, apart from an effective management and operation organization, a proper monitoring system, therefore, is recommended to be established in order to check periodically the results from implemented works for proper correction at each implementation stage as well as after the completion of project-works for following-up the results of works for the Project.

Due to the present difficulties in local conditions for implementing related public works, efforts should be largely made by all concerned persons from the Project start until its final stage with intensive checking and corrections at every stage and every period during the Project implementation including the reservation of penalty measures. The management and all organizations related to the Project, therefore, should be properly organized for implementing a correct operation.

Table 13.2.1 Installation Costs and Water discharge capacities of Different Types of Wells for Minor Irrigation

	Type of Well	Details	Approximate cost per unit (Rs.)	Energization required	Water discharge		Crop Area Irrigable
					in cusec	gallon/hour	
1.(a)	Open well 3'x23'x20'	Shallow well depth below 20' revetment and parapet wall	3,000	3 H.P. electric motor pumpset of 5 H.P. oil engine	0.125	4,000	3 to 5 acres according to crops
(b)	Open well 5'x27'x35'	Deep well above 20 ft. depth with revetment.	5,000 to 6,000	5 H.P. electric motor and oil engine	0.125	3,000 to 5,000	5 to 7 acres according to crops
(c)	Open well 0'x15'x30'	Masonry well with pumpset and electric motor (Rs.2,000)	7,000 to 8,000	5 H.P.	0.125	4,000	Up to 7 acres according to crops
(d)	Open well 3'x25'x30'	With Persian wheel	4,000	One bullock one man	0.100	2,200	4 acres
2.	ift irrigation scheme	Cost per acre with Turbine pumps 50 H.P. should not exceed Rs.1,000			Depending on size of delivery pipe and head		
3.	Tube well						
(a)	Filterpoint tube-well	22' depth with electric motor (Rs.1500)	3,000 to 3,500	3 H.P.	0.15	3,000	5 to 7 acres
(b)	Tubewell– shallow size 15 cm to 20 cm)	150' depth with electric motor	10,500	7 to 10 H.P.	0.45 to 1.00	10,000	10 to 15 acres
(c)	Tubewells – deep 20 cm to 25 cm)	250' to 350' depth with electric motor	15,000	7 to 10 H.P.	1.50	25,000 to 30,000	20 acres (3000 hours per year to 5000 hours)
(d)	Tubewells Borewells	Or Up to 250'	12,000 to 15,000 including 2,500 deposit	7 to 10 H.P.	1.00 to 1.60	25,000 to 32,000	20 acres (3,000 hours per year to 5000 hours)
(e)	Artesian well	200' to 350'	3,500 to 5,000	Nil	0.6 to 1. 50	100,000 to 30,000	30 acres (3000 hours per year to 5000 hours)

Note: 1) Costs as per Market prices before 1985. Prices in 1997 would be up to 3 – 5 times

2) Cost per ft. for tubewell or borewell is Rs. 1,120 for the pipe alone

(Source: Water Management and Planning, K.M. Pillai)

Table 13.2.2 Cost and Water Discharge for Different Types of Minor Irrigation

Type of Well	Delivery Pipe Size	Approximate cost per unit (Rs.)	Energization required	Water discharge in cusec gallon/hour	Crop Area Irrigable
(1)	(2)	(3)	(4)	(5)	(6)
1. Shallow well (depth 20 ft.)	0.125	3,000 to 5,000	5 H.P.	4,000 to 6,000 gph	5 to 7 acres
2. Deep wells (depth above 20 ft)	0.120	5,000 to 6,000	5 H.P.	3,000 to 5,000 gph	5 to 7 acres
3. Open wells-masonry with pump and electric motor (20' x15'x35')	0.125	5,000 to 7,000	5 H.P.	3,000 to 4,000 gph	7 acres
4. Masonry well with Persian wheel (25 ft. to 30 ft.)	0.100	3,000	One bullock-one man	2,200 gph	4 to 5 acres
5. Filter point 4" tubewell (22 ft.) 5 H.P. and motor (4"x3")	0.150	3,000	3.5 HP	3,000 gph	5 to 7 acres
6. Tubewell with diesel engine (Diameter 15 to 45 cm)	0.45 to 1.00	10,500	7 to 10 HP	10,000 gph	20 acres
7. Tubewell or Borewell with electric motor (including deposit Rs. 3,000)	0.45 to 1.60	12,00	7 to 10 HP	10,000 gph	20 acres
8. Lift irrigation scheme	Cost per acre should not Turbine pumps 50 H.P. exceed Rs.1,000				Depending on size of delivery pipe and head 30 acres
9. Artesian well	0.60	2,000	Nil	13,500	30 acres

Note: 1) 1 cusec is approximately 1 acre inch = 22,464 gallons 2) 1 gallon = 4.5 litres 3) 0.16 cu.ft. = 1 gallon

3) 1 cusec discharge annual potential = (hours working x g/h x aya) 5) Installation costs at market prices before 1985

(Source: Water Management and Planning, K.M. Pillai)

Table 13.4.1 Summary of Likely Environmental Impacts in Pilot Tank Areas

Environmental Impact	Northern Area					Southern Area				
	Echur	Cheruk. Big	Polambakkam	Enadur Big	Vadakkupattu	Sirvalai	Ramalinguram	Pandikanmoi	Sengangulam	Kurumbi
1. Social Environment										
1) Socio-economic Issues	O	O	O	O	O	O	O	O	O	O
- Conflict/friction on water sharing (By establishment of WUA)										
2) Health and Sanitary Issues	O	O	O	O	O	O	O	O	O	O
- Increase of agrochemical use (By expansion of irrigated agriculture)										
- Spreading of filariasis/malaria (By expansion of irrigation)	—	O	O	—	—	—	—	O	—	—
3) Cultural Asset Issues	—	—	—	—	—	—	—	—	—	—
2. Natural Environment										
1) Biological and Ecological Issues										
- Negative impact on wildlife (peacocks) (During rehabilitation works of tank)	—	—	—	—	—	O	O	O	O	O
2) Soil and Land Resources										
- Soil contamination (By increase of agrochemical use)	O	O	O	O	O	O	O	O	O	O
- Soil salinization & deterioration of soil fertility (By saline groundwater utilization)	—	O	—	O	—	*	*	*	*	—
3) Hydrology and Water Quality										
- Water contamination (By increase of agrochemical use)	O	O	O	O	O	O	O	O	O	O
- Lowering the water table (By large scale groundwater extraction)	*	*	*	*	*	*	*	*	*	*
- Sea water intrusion (By large scale groundwater extraction)	*	—	—	—	—	—	—	O	—	—

Note: ▲ : Significant impact, * : Medium impact, O : Small impact or likely no impact, —: No impact