C SOCIAL ENVIRONMENT AND FARMERS' PARTICIPATION

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C. SOCIAL ENVIRONMENT AND FARMER'S PARTICIPATION

C. 1 General

The active involvement and participation of farmers and beneficiaries are recognized as the most important factor to implement the projects successfully realizing the sustainable operation and management after the completion of the project. In this Study, the sociological approach is considered as one of the most important aspects, and various studies, investigations and surveys have been conducted during the Study period. This part of the report deals with the results of these activities carried out for the Study.

This part consists mainly of two (2) sub-parts;

- one regarding the sociological aspects both in general and particulars of the selected pilot tank areas, and
- the other for organizing the farmers under the project in order to facilitate farmers' active participation in operation and management activities including maintenance of the irrigation facilities.

C.2 Social Environment Survey

C.2.1 Purpose of Survey

Social Environmental Survey is conducted:

- to grasp and obtain the data and information on the actual situation of the rural community in the Study Area such as institution and customs in the village communities, social conditions of villages including socio-economical infrastructures available in rural areas, social problems and constraints in villages as well as present situation of farmers organizations available in the rural villages,

- to obtain the information on farmers' living and their intentions as well as their problems and extent of understanding on the necessity of tank irrigation facilities, and

- to find and identify the constraints in the rural development in the sociological aspect through various studies and analyses on the information and data collected.

C.2.2 Methodology of Survey

The social environment survey consist of two parts, viz a) Rural community survey and b) Farmer's organization survey. These surveys were carried out for the 240 villages selected in the inventory list at random. About 40 villages were selected in each

category. The selected villages are listed in Table C.2.1.

It is observed that in Tiruvallur - Kanchipuram district, about 61 % of the tanks are falling under 100 ha category, about 23 % are under 100 - 200 ha category and about 16 % are having 200 ha command area. In the case of Ramanathapuram district about 65 % are falling under 40 - 100 ha; about 25.6 % are under 100 - 200 ha category and about 9 % are having more than 200 ha command area. In the case of Sivaganga district also, same trend is seen. But in the case of Virudunagar district about 81 % are under 40 - 100 ha category followed by 11.5 % having more than 200 ha command area.

The geographical distribution of the selected tanks are in balance with all tanks in the Inventory List and the sample tanks selected for this survey. Fig. C.2.1 shows the size-wise and area-wise distribution of tanks both in the Northern and the Southern Study Areas. It is considered clear that the distribution of the command area of sample tanks follows that of all the tanks both in the Northern and the Southern Study Areas. The number of tanks in each taluk is also considered almost similar to each other both in the Northern and the Southern Study Areas as shown in the same figure.

The general survey was undertaken during December 1996 to January 1997 covering 240 tanks with 119 tanks in Tiruvallur - Kanchipuram district representing the northern region and 121 tanks in Ramanathapuram, Sivaganga and Virudunagar districts representing the southern region of the State. Total farmer sample was 1,200 with a farm size of less than 1 ha. Further, the socio-economic study included survey of 240 tanks/villages and the farmers' organizations. Data collection was done by interviewing the respondents using the pre-tested questionnaire.

1) Rural Community Survey

Rural community survey was carried out to grasp the present conditions of the marginal farmers in the Study areas and the results will be used for establishing measures to support the effective access and usage of various agricultural development schemes. Especially in the rural areas of India, there exist various peculiar but inherent social characteristics such as village customs, rules, etc., which usually do not come under the preview of government laws. Such peculiarities have to be identified for establishing proper irrigation system through the rehabilitation of tanks.

Interview surveys were made with a Village Administrative Officer (VAO) or a village or Panchayat President of each village. Furthermore, five (5) marginal farmers (landholder less than one (1) ha of farmland) were selected in each particular village, and interview surveys were carried out for them also to grasp their intentions, living conditions, etc.

(2) Farmers' Organization Survey

Tank irrigation system is operated by farmers' organization, but operation system is different from tank to tank because the community structure of each irrigation unit might be different from each other. It is important to confirm the possibility of activities by farmers' organizations and human resources as well as to grasp the present operation and management system. The surveys were conducted with agricultural cooperatives, water users' association covering agricultural extension cooperatives, farmers' associations, organization for farming practice and institutions for agricultural finance as well as informal organizations such as charity organizations. Interview surveys were carried out with a Village Administrative Officer (VAO) or a village or Panchayat President of each village.

The surveys were carried out for the pre-selected 240 villages same as those for the rural community survey at the same time. Since most of the villages do not have any formal farmers' organization in the Study Area, the questions relating to their organization are not responded properly.

The questionnaire forms for the above surveys are presented in Volume VI: Data Book. Since both surveys were carried out at the same time, the questionnaire forms are combined to facilitate the interview to VAO.

The applied questionnaire is composed of two (2) volumes; the volume titled "Questionnaire for Government Officers in the Study Area", and that titled Questionnaire for Farmers in the Study Area". The first volume is further sub-divided into three (3) parts as stated below.

- Part I: General for general information on the target village
- Part II: Rural Community for information on present status of rural community such as institution and customs, social conditions of village, and present social problems and administrative action.
- Part III: Farmers' Organization for the present situation of the farmers' organizations available in the Study Area including the water users' association.

Various discussions were made among JICA Study team, the PWD and the survey company to make the forms suitable for the expected survey as much as possible considering local conditions, etc. Prior to the commencement of actual survey work, its suitability was confirmed at site by carrying out test surveys.

C.2.2 Method of Data Analyses

Data relating to most of the socio-economic aspects were entered in SPSS using data entry software. In the case of village level data, data were entered in master table, as most of the quality information could not be coded for computer data entry program.

(1) Percentage and Tabular Analyses

Percentage and tabular analyses were used in working out the distribution of assets, family composition etc.

(2) Garret Ranking Technique

This technique was employed to find out the position of the individual factor compared to other factors. The respondents were asked to assign a rank to the given set of factors that influence the overall tank performance.

The order of merit thus given by the farmers were converted into ranks using the following formula:

$$percent\ position = 100(Rij-0.5)/Nj$$

where,
Rij= rank given for the ith factor by the jth individual,
Nj = number of factors ranked by jth individual.

The percent position was converted into scores by referring into the Garret table. Then for each factor, the scores of individual respondents were added together and divided by the total number of farmers from whom scores were added upon. The mean score for all the factors were arranged in descending order and ranks were given.

(3) Factor Shares

It is important to analyze the nature of income distribution and factor shares due to tank rehabilitation. Factor shares are the ratio of costs of factor inputs used in the production process to the total value of output. Factor share of current inputs (viz., fertilizer, and other chemicals and irrigation and power charges) and factor share of labour have been worked out as follows:

Factor share of current input = pC/PQ
Factor share of labour = wL/PQ

Where C, L are physical quantities of each input factor used in the production, P is price of output and Q is the quantity of output produced and w is wages and p is the price of input. The operator (farmer's) profit is the value of output minus the payment to current input and labour.

C.2.4 Results of Social Environment Survey

(1) Social Environment Survey for Villages

1) Institutions and Customs

a) Land Use Pattern

It is observed that the average forest area in the villages has ranged from as low as 2 % in Ramanathapuram district to about 7 % in Virudunagar district. In the northern (Tiruvallur - Kanchipuram) district, it accounted for about 4 % of the geographical area. Net area sown also varies from 54 % in northern district to 34 % in the southern (Sivaganga) district. Total cropped area varies from 225 ha in the case of villages in the Sivaganga district to 376 ha in the villages of Ramanathapuram district. Area under non-agricultural uses is high in Sivaganga district (27 %) followed by Ramanathapuram district (20 %). Current fallow which indirectly reflects the water scarcity is comparatively high in Ramanathapuram district(13 %). Area sown more than once is high (89 ha) in Tiruvallur - Kanchipuram district.

Land Use Pattern in the Villages

District	Fores t (%)	Barre n (%)	Non-agrl (%)	Cul. wast (%)	Per past (%)	Mis crop (%)	Curr fall (%)	Aft fall (%)	Net sow (%)	Tot geo (ha)	Sow m.t. (ha)	Tot cro (ha)
Tiruvallur - Kanchipuram	4.0	14.37	7.06	7.06	3.74	2.7	8.12	40.5	54.18	417.2	89.9	335.8
Ramanathapuram	5.7	0.98	26.91	4.89	0.24	1.72	4.63	21.2	34.3	649.9	1.70	224.6
Sivaganga	2.18	1.18	20.33	1.41	0.23	1.36	13.23	8.98	51.5	727.8	2.0	376.7
Virudunagar	7.3	0.92	15.04	1.62	0.23	0.46	10.44	18.09	44.77	635.8	11.0	295.0

Cul.wast = Cultivable waste, Per past = Permanent pasture, Mis crop = Miscellaneous cropped area, Curr fall = Current fallow, Aft fall = After fallow, Net sow = Net sown area, Tot geo = Total geographical, Sow m.t = Sown more than, Tot cro =Total cropped

In general, the low percent of forest area is an indication of the poor status of the catchment area which ultimately affects the run-off to the tanks. Higher percent of after fallow and current fallow are also the indications of the uncertain water supplies from the tanks for crop cultivation both in the tank and non-tank seasons.

The value of land varied from Rs 12,000/ha in remote villages to Rs 65,000/ha in villages close to towns and other Block head quarters.

Number of Farm Households and Area

District	Below 1 ha		1 - 2 ha		More than 2 ha		Landless Farming	
	No.	Area	No.	Area	No.	Area	Tenant	Agri. Lab.
Tiruvallur – Kanchipuram	131	76.79	61	100.69	18	57.6	26	114
Ramanatha-puram	226	141.45	213	306.1	112.91	336.20	69	68
Sivaganga	401	278.88	206	267.1	153	426.8	103	90
Virudunagar	105	65.2	39	69.3	15	67.5	14	166

Average number of farmers in the villages: Tiruvallur-Kanchipuram: 210; Sivaganga: 763; Ramanathapuram: 552; Virudunagar: 159

Average land below 1 ha is possessed by 41 % farmers in Ramanathapuram district to 66 % farmers in Virudunagar district. Land between 1 - 2 ha is accounted from 25 % in Virudunagar district to 38 % in Ramanathapuram district. Percentage of tenants is varying from 8 - 15 % in different villages. Since persons who are cultivating the land for more than 5 years can become the owner of the land as per prevailing laws, the percentage of tenancy has reduced over years. Only informal tenancy is prevailing where no official records are maintained by the tenants and land owners with respect to period of tenancy, details of rent and the mode of payment etc.,

b) Population by Age and Category

Average population of the villages ranges from 772 in Virudunagar district to 2734 in Sivaganga district. The population by age group is more or less equally distributed and the percent of population in the age group of 20-30 years is about 15 % in Tiruvallur-Kanchipuram district to 18 in Ramanathapuram district.

Village Population by Age

District	Below 5	5 - 10	10 - 20	20 – 30	30 - 40	40 - 50	50 - 60	Above 60
Tiruvallur – Kanchipuram	150	153	151	183	170	182	100	65
Ramanathapuram	271	304	464	452	459	351	272	161
Sivaganga	221	261	497	395	309	240	161	81
Virudunagar	79	155	181	95	156	71	22	13

Average population of the villages: Tiruvallur-Kanchipuram: 1,154; Sivaganga: 2,734; Ramanathapuram: 2165; Virudunagar: 772

With respect to the distribution of the population by the size of the households, it is seen that among the village households, number of households with a size of 2-4 is comparatively higher; whereas in the case of farm households, the size range of 5-10 is higher which indicates the possibility of more family labour engaged in the crop production as well as

the subsistence nature of irrigated agriculture under the tank irrigation systems.

Distribution of Village Households and Farm Households Based on Family Size

District	Village Households Family Size				Farm Households Family Size			
	Below 2	2 - 4	5 - 10	Above 10	Below 2	2 - 4	5 - 10	Above 10
Tiruvallur-Kanchipuram	24	146	67	19	29	62	80	39
Ramanathapuram	49	307	172	19	44	264	205	39
Sivaganga	60	317	139	32	80	420	232	31
Virudunagar	27	113	52	7	19	82	50	8

Average population of the villages: Tiruvallur-Kanchipuram: 1,154; Sivaganga: 2,734; Ramanathapuram: 2,165; Virudunagar: 772
Average number of farmers in the villages: Tiruvallur-Kanchipuram: 210; Sivaganga: 763; Ramanathapuram: 552; Virudunagar: 159

In the case of caste distribution, about 50 % belongs to backward community (BC) in Tiruvallur - Kanchipuram and Virudunagar districts, the percentage of population belonging to schedule case/schedule tribe (SC/ST) is ranging from 19 % in Virudunagar to 30 % in Tiruvallur - Kanchipuram district. The forward community (FC) referring the upper class population is only ranging from about 3 % in Tiruvallur - Kanchipuram district to 6 % in Virudunagar district.

Caste and Population in the Villages

District	Caste Population (%)			
	BC	MBC	SC/ST	FC
Tiruvallur-Kanchipuram	49.4	18.7	29.5	2.4
Ramanathapuram	67.3	9.8	19.4	3.5
Sivaganga	48.8	19.5	27.2	4.5
Virudunagar	49.7	25.4	18.7	6.2

One of the major aspects that may constraint the successful operation of the tank systems is the heterogeneity in population represented by different classes and any improvement strategy to improve the tank performance should address on how these groups could be brought together through formal water users associations by appropriate interventions by the Government either directly or indirectly through NGOs.

In Ramanathapuram district, almost all the households are engaged in agriculture and in Virudunagar district about 78% is agriculture based, 9.5% work in industries and 12 % do business. Among the population, about 29 % are engaged in full time farming in Tiruvallur - Kanchipuram district, 59 % in Sivaganga district, 62 % in Ramanathapuram district and 47 % in Virudunagar district and the rest are engaged in part-time farming.

Category of Population

(Value in %)

District	Agriculture	Industry	Commercial	Others
Tiruvallur-Kanchipuram	95.5	0.3	1.1	2.8
Ramanathapuram	81.3	6.3	2.3	1.6
Sivaganga	99.5	-	0.3	-
Virudunagar	78.1	9.5	12.0	-

Number of Farm Households and Working Population

District	Number of Full Time Farm Households	Number of Part Time Farm Households	
		In farm	Non Farm
Tiruvallur-Kanchipuram	62	148	-
Ramanathapuram	452	311	-
Sivaganga	342	190	-
Virudunagar	75	84	-

c) Assets

Most of the farmers own building for their living. It is seen that in the case of Tiruvallur - Kanchipuram district, 33 % of the farmers own their buildings; 44 % in Virudunagar district; 17 % in Sivaganga district and 18 % in Ramanathapuram district. Wells and pumpsets are owned by 26 % farmers in Tiruvallur - Kanchipuram district, 8% in Sivaganga district, 5 % in Ramanathapuram district and 18% in Virudunagar district.

Only one or two farmers in the village own tractors. Power tillers are not common in the tank irrigated areas and this may be due to the uncertainty associated with water supply. Since tanks have untimely filling behaviour and ploughing operations need timely availability of bullocks, the role of power tillers should be much emphasized in the future agricultural extension programs. About 16 - 23 % of the farmers own cattle which include dairy as well as drought animals.

Asset Position in Tank Villages

(Value in 1,000 Rs)

District	Buildings		Machinery						Wells & Pumps		Animals	
			Tractor		Power tiller		Sprayer					
	No.	Value	No.	Value	No.	Value	No	Value	No.	Value	No.	Value
Tiruvallur – Kanchipuram	69	4068	3	660	1	57	10	30	58	1845	892	1264
Ramanatha-puram	132	4044	2	438	-	-	11	5555	63	2520	529	601
Sivaganga	100	1854	1	180	-	-	7	73	25	270	718	404
Virudunagar	70	2969	3	862	-	-	12	16	30	5103	90	315

Average number of farmers in the villages: Tiruvallur-Kanchipuram: 210; Sivaganga: 763; Ramanathapuram: 552; Virudunagar: 159

2) Farming Practices

Since paddy is the main crop in the tank season, transplanting is done by most of the farmers; About 15 - 22 % of the farmers in coastal areas in Ramanathapuram and Tiruvallur-Kanchipuram districts do practice direct sown paddy particularly in locations where the rainfall is highly inadequate and untimely. Mostly the IR20, ADT36 are grown by the farmers extensively. All the land preparation practices are done with bullock labour and transplanting and weeding operations are done by the women labourers only. The crop pattern and irrigation practices are given in the tables.

In the non-tank season, mostly farmers who own wells only cultivate about 70 - 75 % of their lands. Since the wells are shallow dug wells in most cases, wells used to have good recharge when the tanks have good storage and this is the reason why farmers in the non-tank season could not irrigate fully their lands or sell the water to other farmers as they do in the tank irrigation season.

Average area cultivated by the marginal farmers is about 0.72 ha which will also vary between locations. Due to poor water supply in the canals farmers in the tail regions of the canal use to cultivate only about 50 % of the area to avoid crop failure due to water scarcity (Palanisami, 1996). Various scarcity management strategies include, groundwater supplementation (49 % farmers in northern district to 55 - 57 %

Crop Pattern in Tank Command Area (ha/farmer)

Season	Crop	Area (ha)	Variety	Duration
Tank Season	Paddy	0.72	IR 20	135 days
Non-tank Season	Cotton	0.2	-	5 months
	Groundnuts	-	-	-
	Pulses	0.1	-	4 months

Irrigation, Cultivation and Yield Details

	No. of Irrigation		Cost of Well Irrigation (Rs/ha/irri.)	Cost of Cultivation (Rs/ha)	Yield (t/ha)	Price (Rs/t)
	Tank	Well				
1.Tiruvallur-Kanchipuram district:						
Paddy	17 - 23	3 - 6	110/irri	7,200	4.1	3,350
Cotton	-	4 - 7	410/irri	3,260	1.4	2,460
G.nut	-	-	-	-	-	-
Pulses	-	2 - 3	180/irri	330	0.2	3,600
2.Ramanathapuram district						
Paddy	18 - 27	4 - 6	125/irri	6,880	3.9	3,430
Cotton	-	5 - 8	450/irri	3,260	1.0	2,420
G.nut	-	-	-	-	-	-
Pulses	-	-	-	-	-	-
3.Sivaganga district:						
Paddy	16 - 25	3 - 6	118/irri	5,560	3.6	3,330
Cotton	-	4-8	378/irri	2,867	1.1	2,400
G.nut	-	-	-	-	-	-
Pulses	-	2-3	189/irri	246	0.1	3420
4. Virudunagar district:						
Paddy	18 - 24	3 - 6	128/irri	6,580	3.5	3,550
Cotton	-	4 - 6	410/irri	2,960	1.2	2,320
G.nut	-	-	-	-	-	-
Pulses	-	2 - 3	180/irri	243	0.1	3,400

farmers in southern districts). Increased irrigation interval between irrigation from 4 days to 7 days is also reported by many farmers in all the surveyed districts. Other strategies included reducing the depth of irrigation, partial fallowing, and change in crop pattern. Hence it is believed that any rehabilitation investment should aim to bridge the gap in water availability.

Scarcity Water Management Strategies Adopted by Sample Farms

(% of farms adopting)

Strategy	Tiruvallur-Kanchipuram	Ramanatha-puram	Sivaganga	Virudunagar
a) Reduced depth of irrigation	29.00	26.00	32.00	21.00
b) Partial fallowing	7.00	5.00	9.00	14.00
c) Increase irrigation interval	33.00	27.00	17.00	14.00
d) Groundwater supplementation	49.00	45.00	54.00	47.00
g) Changing crop pattern	6.00	5.00	11.00	13.00

Regarding the duration of water supply from tanks and wells, there was no water supply in 5 % of the tanks, about 65 per cent of the tanks had less than three months' water supply; about 30 per cent of the tanks had more than 3 months'

Mean Duration of Water Supply in Tanks

(% Tanks)

District	No Supply	Less Than 3 Months	More Than 3 Months
Tiruvallur - Kanchipuram	5	65	30
Ramanathapuram	7	70	23
Sivaganga	6	74	20
Virudunagar	4	75	21

water supply in the case of northern district and in the case of southern districts, about 70 % of the tanks had water supply for 1 - 2 months only. The mean duration of water supply was comparatively lower (2.2 months). But at the end of the crop season (for one month), farmers rely mostly on supplemental groundwater.

3) Water Management, Input use and Rice Yield

Average number of tank irrigation varied from 17 - 25 and the supplemental well irrigation varied from 4 - 6 in the tank season. and the coefficient of variation in number of tank irrigation was larger ranging from 90 to 110 per cent. reflecting the uncertainty in water availability.

Most of the marginal farmers used to buy the well water from the nearby well owners who sell the water at the rate of Rs 10 - 16/hour depending upon the demand and each supplemental well irrigation costs about Rs 120/ha/irrigation. The mean hours of water purchase by sample farms was found to be ranging from 65 to 82 hours. The mean hours of water sales by the farms also varied

from 50 to 70 hours. Average area irrigated per well ranged from 1.00 to 1.25 ha.

As regards to the inputs other than water, there were not significant differences among the districts. Except human labour, all the other inputs have shown a higher variation among farms with a coefficient of variation ranging from 50 to 135 %.

The total quantum of water applied for rice crop was about 125 cm. However, the total quantum of tank water applied had ranged from 87 to 93 cm and the rest was from well supplementation.

Most of the farmers apply fertilizers below the recommended levels by the Agricultural department, because of uncertain water supplies. It was observed that the average fertilizer use was ranging from about 80 kg/ha of N fertilizer to about 50 kg/ha of P and K fertilizers. Average labour use was about 155 mandays/ha of rice cultivation in northern districts to 141 - 152 mandays/ha in the southern districts.

Comparison of Input Use

Inputs	Tiruvallur-Kanchipuram	Ramanatha-puram	Sivaganga	Virudunagar
1. Labour for rice cultivation (man-days/ha)	155	147	152	141
2. Nitrogen (kg/ha)	92.00	83.00	75.00	89.00
3. Phosphorous (kg/ha)	61.00	56.00	50.00	59.00
4. Potash (kg/ha)	52.00	47.00	45.00	49.00
5. Rice yield (kg/ha)	4,122	3,989	3,682	3,540

Average cost of cultivation of paddy also varies from Rs 5,560 to 7,200/ha depending upon the quantum of fertilizer use and number of supplemental irrigation purchased. Manual threshing is done and farmers sell 50 - 60 % of the produce immediately after harvest to local traders in the village due to demand for money to pay the loans etc., In several cases, farmers incur losses due to non availability of tank and well water at the end of the crop season.

The yield differential between farms with and without well irrigation was significantly different in all the districts. Average yield of 3,989 kg/ha. was recorded in tanks with well irrigation facilities in Ramanathapuram district and the minimum yield of 3,540 kg/ha was observed in Virudunagar district. However, without adequate supplementation with well water (groundwater), the yield was as low as 1,924 kg/ha in most of the locations. This implies that the rice yield in the tanks has shown the maximum response for supplemental well irrigation. Therefore, the policy goals to increase rice yield in tank commands should be concentrated on this aspect.

Major yield constraints encountered by the farmers are water shortage which had a Garret mean score of 76 in northern districts to 86 in Sivaganga district in the south. In all the districts, as per the Garret ranking technique, water shortage was ranked first followed by the financial constraints, and lack of production technologies. Most farmers could not get adequate credit facilities from the commercial banks due to their marginal land holdings. Also many farmers have mortgaged their lands for other loans with the local money lenders. Compared to commercial banks which charge about 14 % interest on the loans, the money lenders charge as high as 30 % interest. Pest and diseases, soils are not reported as major problems by many farmers.

Yield Constraints of Rice Production

Factors	Tiruvallur-Kanchipuram		Ramanatha-puram		Sivaganga		Virudunagar	
	MS	R	MS	R	MS	R	MS	R
1.Water shortage	76	1	72	1	86	1	69	1
2.Weeds	32	7	32	8	41	5	33	8
3.Pest & Diseases	34	6	41	6	23	9	39	6
4.Problem soil	36	5	39	7	31	7	23	9
5.Finance constraints	62	2	69	2	76	2	61	2
6.Ill drainage	32	8	23	9	33	6	41	4
7.Uneven land surface	54	3	42	4	31	8	36	7
8.Poor cultural technology	43	4	51	3	47	3	51	3
9.Other	19	9	45	5	42	4	41	5

MS= Garret mean score; R=Garret rank.

4) Water Rights and Water Distribution

In general though all the tanks with a command area of more than 40 ha are vested with the PWD, the water distribution is the responsibility of the farmers. In several (big) tanks, the *neerkattis* are responsible for the opening and closing of the sluices and water distribution among the farmers and farmers pay in kind for the services of these persons. But the role of *neerkattis* (common watermen) is slowly disappearing in view of the growing conflicts in the village in sharing the available tank water.

In small tanks, farmers themselves open and close the sluices; but in most cases the sluices are always open even though there is no apparent demand for water. Over use of water in the head reaches and non-availability in the tail reaches are common in most of the tanks. This is one of the aspects that may require priority attention in the rehabilitation program.

5) Resource Mobilisation

The major resources that are being mobilized are from social forestry and fishery, as these are the common property resources generating benefits. The foreshore and catchment lands even though form major component of common

property resource in the tanks, they are mismanaged and the resource mobilization is almost zero.

a) Social Forestry

More than 80 % of the social forestry has been established in tank foreshores and bunds and became integral part of tank systems. Consequently new set of rules and regulations were framed by the government for selection, planting, maintenance, harvest and sharing of income thereof.

The social forestry under Tamil Nadu Environment and forests department in its G.O Ms No.117, Agriculture, dated 12.1.1971 orders were issued directing that the revenue realised from the sale of farm forestry plantations be shared between the forest department and panchayats concerned an 50 : 50 basis. Later Tamil Nadu government by its order G.O Ms. No 796, forests & fisheries dated July 7.1983 directed that the revenue realised from the sale of social forestry plantations be shared between the forest department and panchayats on 40 : 60 basis. It is observed that about 35 - 45 % of the income realised from the sale of trees were actually transferred to the panchayats. The plantation is ready for harvest after 10 years of planting. Normally the harvest is allowed for another two rotations of 10 years each.

Thus social forestry in the tank system is a potential source of income for the panchayats. Though 60 % of the total income generated from the social forestry is transferred to panchayats the resources thus mobilised is not fully utilised for improvement or for maintenance of tank systems. This amount goes to the panchayats concerned through regular block development officers.

b) Fishing and Common Land Use Rights in Tanks

Historically, the rights to benefits were rested with the respective local village panchayats as regards the fishery and forestry in the tank systems. There were no organised set up to culture fish or plant trees and enjoy the benefits. But the village panchayats enjoyed the benefits wherever there was available. Only after launching of social forestry project in 1981 and establishment Fish Farmers Development Agency (FFDA) in 1982, there has been an organised way of promotion, maintenance and harvesting and sharing the benefits of fishery and forestry in the tank system.

Fishery is an important water based resource of the tank system. The rights of the people to the artificial tanks is usually customary usufruct rights of the people if the tank is on public land. Rights of the tank are vested in the panchayat or municipality. But if the tanks are on private land, the state or

the people have no rights. If the lakes and tanks are natural thus the people have the customary rights and the state has the absolute rights.

All members of public have a general and common right to take fish from public water. As in the case of natural rights other than light, air and water, no member of public can appropriate a specific area of public water for his own fishing to the exclusion of all others.

The public is bound to exercise their general right to fish in public waters in a fair and reasonable manner in accordance with the established custom of the area and not so as to impede others from doing the same. Right to fish in public water can not form property easement; no one can by contesert or otherwise relinquish, to another has right or any part of it. But an individual who has a right to fish in public water can agree with other who has a similar right to fish in the same that has between themselves they will have separate areas set apart for fishing either because of mutual convenience or because of a desire to avoid conflicts or disputes. In as much as the property in the soil is presumed to rest in the state on behalf of the public were private ownership of the soil is not proved, the right to fish in the water which flow over it can be regulated and restricted by legislature and may be curtained. However, an exclusive rights to fish in public water can be asserted by virtue of grant from the state or by such a degree of exclusive use as in sufficient to raise a presumption that such a grant has been made though not appearing.

Only about 30 % of the tanks in the 4 districts had reported the existence of fishery benefits and most of the income from fish auction was spent for temple repairs and/or celebrating the village festivals. Only less than 2 % tanks the income was also spent for tank repairs including the payment of wages for neerkattis.

The extent of revenue mobilisation was found to be positively correlated with the presence of informal water users' organisation. This could signal the importance of improving resource mobilisation through farmers' cooperation.

c) Tank Catchments and *Poromboke* (Common Property) Land

These lands are generally mismanaged. In several tanks in the sample districts, encroachment of the catchment, waterspread and supply channels and other community land is very common. Even though, the local community has the right to use these lands, because of overuse of the catchment for several activities including construction of huts, making roads etc., it affects the overall tank performance, as the run-off to the tanks are much affected.

d) Labour Contribution

The labour contribution by tank beneficiaries for various tank maintenance works was also observed in about 65 - 75 % tanks particularly during scarcity periods. Average labour mobilization was about 210 mandays/tank/year.

6) Leadership Pattern and Conflicts Solving

In the informal organizational process which prevails in almost all the tanks, as such there is no leadership available; but during scarcity periods as well as during periods of conflicts in water distribution, senior persons in the tank command take a lead and try to settle the matters. Collection of money and labour are also observed in many tanks under these informal leadership for short-run tank management such as cleaning the channels, sluices and surplus weirs. Most of the conflicts are associated with inadequate supplies in the tail end of the canals. In few cases, the well owners come forward to use the well water leaving the scarce tank water to the tail end non well owning farmers. Most of the minor conflicts are however solved within the village itself and major conflicts involving different caste groups are normally settled through police or courts. The heterogenities in the farm size, varying income levels, political and caste groups contribute mainly for the inefficiency in tank related improvement works by the informal organizations in the tank based villages.

7) Employment in Village

It is observed about 70 - 75 % of the people in the village get seasonal employment particularly in the tank season; and in the non-tank (March - August) season, only about 20 - 25 % get the employment. Since the tank as such could not support any non-farm and off-farm activities, the employment level is very low in the tank systems. In certain tanks where the silt is suitable for brick making, about 10 % additional employment is assured. In several tanks, it is observed that people migrate to nearby cities in the off-season and return back during the tank irrigation season.

8) Operation and Maintenance of Irrigation Facilities

The state-level data on operation and maintenance expenditure for tanks show that the total outlay on O&M has increased from about Rs.12.50 to Rs.77.40 million during the period 1978 - 79 to 1994 - 95. It is also clear that though the nominal (at current prices) outlay per ha. of command area has increased by more than six folds from Rs. 26 to Rs. 161, the real (at constant prices) outlay has not shown significant increase which has hovered around Rs. 33 to Rs. 43 per ha.

Operation and Maintenance Expenditure of Tanks (Tamil Nadu)

Year	Maintenance & Repair Outlay (Rs million)	Nominal outlay (Rs/ha)	Real outlay (Rs/ha)
1978-79	124.71	25.98	33.35
1979-80	129.91	27.06	30.17
1980-81	160.05	33.34	33.34
1981-82	152.81	31.83	28.86
1982-83	177.64	37.00	31.09
1983-84	155.67	32.43	25.16
1984-85	159.15	33.15	23.92
1985-86	237.44	49.47	33.13
1986-87	234.65	48.89	30.69
1987-88	354.83	73.92	42.68
1988-89	320.87	66.85	35.82
1989-90	320.73	66.82	33.16
1990-91	324.36	67.58	30.35
1991-92	497.20	103.58	42.27
1992-93	527.80	110.00	-
1993-94	741.65	155.00	-
1994-95	774.30	161.3	-

Source: Notes on the funds required for M & R for minor irrigation works - revised estimate, O/o CE (MI), Chepauk, Madras - 5.

In general, the tanks below 40 ha of command area are under the management of the local panchayats and tanks above 40 ha command are under the PWD control. The PWD attends the major repairs like breaches immediately and the minor repairs like sluice replacement are done in a periodical manner depending upon the fund availability. As such there is no calendar of maintenance activities for the tanks and the maintenance works are attended on first come first served basis. Since about 85 % of the allotted O&M budget by the Government is spent for the salary and other charges, the balance only is spent for the tank maintenance. The average O&M expenses in actual terms could not increase more than 10 % in the past 25 years.

9) Social Condition of Villages

a) Rural Infrastructure

Most of the villages have adequate road facilities. In the tanks surveyed, about 96% of villages in the northern districts and about 87 % of the villages in the southern districts have roads. Only 17 - 22 % of the villages have the processing facilities. More than 88 % of the villages have the postal facilities and in all the villages surveyed, 94 - 97 % of the villages have the electric supply. The electricity connections are provided by the Tamil Nadu Electricity Board (TNEB) and the electricity is supplied free of cost to farmers for irrigation purposes only.

Infrastructure Facilities at Villages (%)

Districts	Road Facility	Processing Facility	Post Office	Electricity Supply
Tiruvallur-Kanchipuram	96	22	96	97
Ramanathapuram	85	20	94	95
Sivaganga	89	17	88	94
Virudunagar	86	19	90	96

b) Domestic Water Supply

Local panchayat is responsible for providing safe drinking water in all the villages through piped system. The piped supply system covers from 40 % in Ramanathapuram district to 70 % in Tiruvallur-Kanchipuram and Virudunagar districts and the rest is from deep (community) wells (20 %) and shallow wells (5 %). The water quality is good to medium. Supply capacity varies from 25 - 40 litters/ head/day in the piped systems and the supply is adequate in the case of shallow and deep well sources. Only in the summer (non-tank) season, the availability is comparatively less as the water table in the wells will be going down.

Domestic Water Supply

District	Piped Supply System				Shallow Well				Deep Well			
	Pop. (%)	Sup. Capa (%)	Wat. Qual.	Prop.	Pop.	Sup. Capa	Wat. Qual (%)	Prop.	Pop. (%)	Sup. Cap. (%)	Wat. Qual.	Prop.
Tiruvallur – Kanchipuram	71	27	good	c.	21	5.5	good	C, P	27	-	good	C, P
Ramanatha-puram	68	53	good	c.	23	77.5	good sal.	C, P	24	7	good sal.	C, P
Sivaganga	40	50	good	c.	40	46	good	C	20	46	good	C
Virudunagar	80	66	med.	c.	30	10	nor.	C	40	28	med.	C, P

C=Community; P=Private; Wat qual = Water quality ; pop(%)= % of population covered.
sup.capa(%)= adequacy of the supply.

c) Housing and Other Support Services

It is observed in all the tanks that about 30 - 35 % of the households only have the tiled houses. Few small shops in the villages cater to the petty needs of the villagers. For major grocery requirement, nearby big villages or towns are approached by the villagers. Primary schools are functioning in about 80 - 85 % of the villages.

Borrowing and Housing

District	Housing (nos.)		Borrowing					
	Thatched	Tiled	Credit 1	Kind	Terms	Credit 2	Kind	Terms
Tiruvallur – Kanchipuram	108	74	Co-op Bank	Crop Others	Short term	LDB Bank	Land Dev Machine	Medium
Ramanatha-puram	101	178	Co-op IRDP	Crop Others	Short term			
Sivaganga	138	221	Co-op IRDP	Crop Others	Short term			
Virudunagar	76	122	Co-op Bank	Crop	Short term	IRDP Thatco	Animal	Short term

Note: Credit1 = Short term crop loan; Credit2 = Medium term loan for land development etc.

Purpose and Name of Subsidy Enjoyed by the Farmers

District	Purpose of the Subsidy and Utilized %					Name of Subsidy	
	Seeds & Fertiliser	Flood Relief	Drip	Animals	Machi-naries	IRDP	THATCO
Tiruvallur – Kanchipuram	28.6	22.2	3.2	9.5	6.3	17.5	3.2
Ramanathapuram	11.0	-	-	4.0	7.4	4.0	-
Sivaganga	-	-	-	-	20.0	3.0	6.0
Virudunagar	15.4	-	-	69.2	15.4	69.2	7.6

For agricultural loans, farmers are approaching the nearby towns and the percentage of marginal farmers availing the institutional loans is negligible. Two types of loans, viz., short term loans are obtained for crop cultivation purposes from cooperatives and commercial banks. About 6 to 8 % of the farmers avail these facilities. In the case of medium term loan for the purchase of machinery and for land development, only less than 3 % of the farmers avail the facilities. Percentage of farmers availing the IRDP facilities is ranging from 18 % in northern district to 16% in southern districts mainly for the purchase of goats, dairy animals and bullocks.

Agricultural extension officers are operating from the block headquarters and many farmers reported that their services are not easily available, as these officials are very rarely visiting the villages.

d) State of Rural Community

It is observed that about 67 % of the population has education upto primary level and about 30 % has no education in the northern district; in the case of southern districts, 57 % to 65 % of the population primary

Educational levels

(Unit: %)

District	Education Level		
	No Education	Primary	Higher Education
Tiruvallur-Kanchipuram	30	67	3
Ramanathapuram	25	65	10
Sivaganga	32	57	11
Virudunagar	36	60	4

education and 25 % to 36 % has no education. Percentage of persons having higher education is 3 - 11 % only in the districts covered. In all the cases, the Hindu religion is dominant accounting for 78 % to 89 % of the total population.

e) Standard of Living

Percentage of food and drink expenses is varying from 52 % in northern districts to even 67 % in southern districts. Most people have radios (49% to 58 %) and TVs (6 % to 9 %). Percentage of farm households having farming successors is ranging from 36 % in northern districts to as high as 65 % in the southern districts.

Standard of Living

(Unit: %)

District	Living Expenses		Spread of Assets		
	(%)	Radio	TV	Motor-cycle	Other
Tiruvallur-Kanchipuram	52	53	6	1	-
Ramanathapuram	67	49	8	2	-
Sivaganga	59	58	7	1	-
Virudunagar	62	61	9	1	-

10) Farmers' Organization

This survey attempts to study the farmers organizational aspects, their resource mobilization, conflicts resolving and other tank improvement aspects. It is observed that in none of the tanks covered for the study, any formal organization exists and mostly the informal organizations are present which are active that too when there is flooding and breaching of the tank bunds or during acute scarcity periods where farmers used to mobilize cash and labour to clean the supply channel and sluices. Only in about 65 % of the tanks in Tiruvallur - Kanchipuram districts the informal organizations are active and in the southern districts, this percentage ranges from 76 % to 82 %. But in all the cases, these organization are active only during scarcity periods.

Farmers Organizations

(Unit: %)

District	Formal	Informal Organizations Active
Tiruvallur-Kanchipuram	-	65
Ramanathapuram	-	76
Sivaganga	-	79
Virudunagar	-	82

(2) Social Environment Survey for Marginal Farmers

1) Land Use Pattern

Land Use Pattern at Farm Level (ha)

Districts	Paddy area	Upland	Others	Total
Tiruvallur – Kanchipuram	0.72	0.13	-	0.85
Ramanathapuram	0.57	0.07	-	0.64
Sivaganga	0.54	0.21	-	0.75
Virudunagar	0.62	0.11	-	0.73

The land use at farm level is dominated by area under paddy crops(about 90 %) followed by upland crops. Since the tanks are the typical gravity irrigation systems, the command area is characterized by gentle slopes facilitating the flow of water from head to tail easily. Since tank irrigation coincides with the north east monsoon (October - December) rains, normally one paddy crop is grown. Crop diversification is followed in few tanks when the water supply is comparatively low; also in the second season, farmers grow non-rice crops using tank as well as groundwater.

2) Farm Assets (Animal Population)

Marginal and small farmers account for about 87 % of the total farmers in the tank command, and the animal population is also related to the size of the holdings. Also most farmers live in the villages, away from the tank command, the level of the animal population is also stated to be low. It was observed in all the sample districts, farmers are having only about 1 dairy animal per family, one pair of drought animals (bullocks) for every 3 - 4 farmers and very few farmers are having goats, sheep and poultry. It was also observed that most of the small and marginal farmers used to sell the animals to meet the their family expenses particularly during drought periods when the tanks have lesser storages. The animals are considered as liquid assets in the short-run crop production system.

3) Family composition

Family Composition

Districts	Numbers		Main Job (%)				Annual Income
	M	F	Agrl. Period		Non-Agrl. Period		
Tiruvallur-Kanchipuram	2	2	80	6	20	4	16,559
Ramanathapuram	3	2	85	5	15	7	15,797
Sivaganga	4	3	90	4	10	8	14,970
Virudunagar	3	2	84	6	16	6	16,549

Average family size is about 5 in all the sample tank districts. Main job is agriculture for more than 80 % of the population which lost about 6 months starting from channels cleaning prior to tank season to crop harvest and marketing activities after the tank season. Only 10 - 20 % of the farmers engage themselves in non-farm activities like construction works, transport of materials

and production process in the factories in and around the villages. Normally these farmers spend about 4 - 6 months in the non-agricultural activities. The average annual income per family during 1995 - 96 agricultural years was about Rs 9,800 in northern district, and Rs 9300 to Rs 13500 in the southern districts. The variation in the annual income is due to the variation in paddy production and non-farm activities.

4) Distribution of community assets

Most of the villages have the village common property lands which are normally used for cattle grazing as well as for social forestry programs; availability of these lands range from 78 % in the northern district to 98 % in Virudunagar districts. Over years, the level of urbanization as well as encroachment by the farmers as well as government allotment of land titles (pattas) to landless poor families also to some extent reduced the availability of these lands. Ponds as well as tanks are also common features in almost all the villages, as these sample villages are falling in the tank intensive districts of the state. In the recent years, T.V sets have started entering the villages. It is seen that 46% to 58 % of the villages have this entertainment facility and only the remote villages have no access for it. Community halls and library facilities are comparatively not much developed.

Distribution of Community Assets

(Unit: %)

Districts	Community Hall	TV Set	Village Land	Pond/ Tank	Library
Tiruvallur-Kanchipuram	8	48	78	85	4
Ramanathapuram	9	58	80	94	6
Sivaganga	5	46	96	98	8
Virudunagar	6	54	98	88	5

5) Expenditure pattern

Average annual income during 1995 - 96 year was ranging from Rs 14,970 in Sivaganga district to Rs 17,899 in Tiruvallur - Kanchipuram district. The income level was also varying between districts and tanks due to variation in crop yields, prices of inputs (particularly human labour) and output price. However, in all the cases, the farming and living expenses put together exceeded the income. However, farmers were able to manage through their non farm activities, as well as selling their animals during scarcity periods. The farming expenses was ranging from Rs 8,673 per farm with an average paddy area of 0.72 ha in the tank season and about 1 ha under cotton, groundnut and pulse crops in the non-tank season in Sivaganga district to Rs 10,140 in Ramanathapuram district. The living expenses was ranging from Rs 6,530 per family in Virudunagar district to Rs 6,980 in Sivaganga district.

Expenditure Distribution

(Rs/Family)

Districts	Farming	Non-agrl income	Living	Level H	Living A	(%)L	Income
Tiruvallur – Kanchipuram	10,790	250	6,700	-	10	90	17,899
Ramanathapuram	10,140	840	7,160	-	15	85	15,797
Sivaganga	8,673	370	6,980	-	20	80	14,970
Virudunagar	9,783	620	6,530	-	12	88	15,549

H=high; A=average; L=low

6) Intended changes in livelihood

Most of the farmers have the intentions to change their livelihood, once the condition of the tanks are improved, which are evident from the facts that 34 % to 46 % of the farmers have intended to generate assets by investing in land and animals. Investment in wells is an another attractive activity for 20 % of the farmers in Tiruvallur - Kanchipuram district and 39% of the farmers in Sivaganga districts. It is interesting to note that in tank commands only about 15 % of the farmers who are normally rich are owning the wells at present and the marginal farmers' interest to have their own wells is an indicative of the importance of conjunctive use of tank and well water, as in most of the years (7 out of 10 years) the tank water is to be supplemented with well water to have a reasonable paddy yield. Investment in improved food and living conditions are also indicated by several farmers.

Intend to Change in Livelihood

(Unit: %)

Districts	Improved house	Improved food	Buy assets/ animals	Land Well investment
Tiruvallur – Kanchipuram	13	22	46	20
Ramanathapuram	18	14	34	39
Sivaganga	9	27	38	39
Virudunagar	11	30	37	24

7) Health Aspects

Among the different health hazards, most farmers reported the fever as the most commonly occurring health problem, where 71 % in Virudunagar district to 90 % in Tiruvallur - Kanchipuram district have reported this health problem which is followed by diarrhea and typhoid. It is surprising to note that 68 % to 85 % have preferred private doctors for treatment, as in many villages Primary Health Centers (PHC)/Government Hospitals are not functioning. Even though, such facilities are available, the performance of these health institutions is very poor, as in many cases doctors are not present.

Health Aspects

(Unit: %)

Districts	Fever	Diarrhea	Typhoid	Others	Doctors	
					Govt.	Private
Tiruvallur -- Kanchipuram	90	5	2	8	26	74
Ramanathapuram	82	10	5	10	15	85
Sivaganga	73	12	8	7	20	80
Virudunagar	71	15	10	8	32	68

8) Extension Services

Agricultural extension services are provided by the Agricultural department of the state government, where agricultural extension officers are positioned at block level to provide extension services on various aspects of crop cultivation including seed supply. However, farmers feel these services are either not reachable by the small and marginal farmers nor applicable for their small farm holdings. It is observed that only 7 % of the sample farmers in Tiruvallur - Kanchipuram district to 17 % in Sivaganga district could only visit the block extension offices either for seed or other inputs like pesticides. Many farmers feel that the services of the BDOs and EOS are functionally different and hence they could not substitute each other; however, about 37 % of the farmers in Tiruvallur - Kanchipuram district to 18 % in Sivaganga district obtained timely information from the BDOs and about 24 % in Tiruvallur – Kanchipuram district to 42 % in Ramanathapuram obtained inputs from the EOS. In all the cases, the quality of the services rendered by these agencies has been reported poor by about 82 % of the farmers in Tiruvallur -Kanchipuram district to 90 % in Ramanathapuram and Virudunagar districts.

Extension Service

(Unit: %)

Districts	BDO Office Visit	Officers		Service EOS Seed	Quality of Service		
		BDO Informa-tion	RWO		Good	Average	Poor
Tiruvallur – Kanchipuram	7	37	-	24	-	10	82
Ramanathapuram	11	21	-	42	-	5	90
Sivaganga	17	18	-	31	-	3	85
Virudunagar	9	30	-	37	-	5	90

9) Constraints Encountered in Family

In general, farmers live in a deficit situation both in cash and in kind as the expenses always exceed the receipt. The major constraint is the water scarcity in the tank in most of the years due to erratic rainfall, poor run-off from the

catchment and tank siltation coupled with foreshore encroachment and this constraint was given 1st rank with a Garret mean score of 69 in Sivaganga to 87 in Ramanathapuram district. It has been reported that 25 to 35 % of the storage capacity has been lost in the last 20 years. Lack of money, higher wage rate and high input cost were the other major constraints faced by the small and marginal farmers and ranked 2nd, 3rd and 4th respectively by the farmers. Since low yield is not the direct effect but the cumulative effect of most of the constraints, this was ranked only 5th by the farmers. Labour scarcity, lack of bullock carts and lack of market were not reported as constraints by many farmers, as these farmers do subsistence agriculture, just for the family consumption and not for the market.

Constraints Encounted in Family

(Garret ranking)

Factors	Tiruvallur-Kanchipuram		Ramanatha-puram		Sivaganga		Virudunagar	
	MS	R	MS	R	MS	R	MS	R
High input cost	56	4	64	2	43	5	51	4
Labour scarcity	32	6	43	6	34	6	39	6
Lack of seeds	23	8	31	8	29	7	32	9
Lack of market	32	7	25	9	21	9	21	10
water scarcity	78	1	87	1	69	1	79	1
High wage rate	59	3	61	4	56	3	59	3
Pest & diseases	23	9	31	7	26	8	32	7
Lack of money	63	2	63	3	58	2	61	2
Lack of bullock cart	19	10	21	10	17	10	32	8
Low crop yield	45	5	49	5	51	4	53	5

MS= Garret mean score; R=Garret rank.

10) Constraints in Living

Among the constraints in living, viz., indebtedness, unemployment and high food material cost are ranked 1st, 2nd, 3rd by the farmers. In Virudunagar district, unemployment is ranked 1st compared to other districts where indebtedness is ranked 1st. This is important in the sense that farmers facing shortage of capital to buy input in time, used to borrow from money lenders at higher interest rate which is as high as 30 to 40 % compared to 14 % by the commercial banks. Since, income from the crop production is not even sufficient to meet their regular expenses, they could not repay the loan and again borrow from other money lenders and the vicious cycle is repeated. In the long-run, they are forced to sell the assets or mortgage their properties. Since education is

almost free at the village level and also most of the farmers used to keep their children in the farming itself, educational cost is considered not as a constraint. Farmers manage to live with the rice and other cereals available in the village and the food cost is not considered by many as a growing constraint in living.

Constraints in Living

(Garret ranking)

Factors	Tiruvallur-Kanchipuram		Ramanatha-puram		Sivaganga		Virudunagar	
	MS	R	MS	R	MS	R	MS	R
- High food material cost	61	2	45	3	51	4	49	3
- High education cost	32	5	29	6	21	6	34	5
- Indebtedness	69	1	67	1	71	1	56	2
- Poor health facilities	45	4	34	5	55	3	41	4
- Unemployment	56	3	61	2	65	2	57	1
- Lack of housing	43	5	41	4	38	5	34	6

MS=Garret mean score; R=Garret rank

11) Women Participation

Women participation is particularly noticed in the paddy transplanting operations followed by weeding and harvesting. Role of women in paddy transplanting is reported by 73 % farmers in Ramanathapuram to 84 % in Virudunagar districts and more than 91 % of the farmers have reported women's role in weeding operations. Involvement of women in harvesting operations is reported by 62 % farmers in Tiruvallur - Kanchipuram district to 85 % in Virudunagar district. Marketing is being attended to mostly by the men. The average wage rate has ranged from Rs 20 to 35/day in the tank season to Rs 15 to 20/day in the non-tank season.

Women Participation

(Unit: %)

Districts	Sow / planting	Fertiliz-ing	Weed-ing	Harvest-ing	Proces-sing	Market-ing	Wage rate
Tiruvallur-Kanchipuram	82	10	95	62	42	12	20-40
Ramanathapuram	73	12	93	73	37	8	25-35
Sivaganga	79	8	97	81	59	10	20-30
Virudunagar	84	9	91	85	62	13	22-30

Wage rate=Rs/day

12) Expectations for the Government

It is observed that tank rehabilitation and provision of community wells and increased water storages are the major expectations of the farmers in all the districts for which 1st, 2nd and 3rd Garret ranking was given. Only in Virudunagar district, improving the fishing rights is given as the second priority.

Expectation for the Government

(Garret ranking)

Factors	Tiruvallur-Kanchipuram		Ramanatha-puram		Sivaganga		Virudunagar	
	MS	R	MS	R	MS	R	MS	R
- Rehabilitate the tank in time	87	1	78	1	81	1	76	1
- Increase water storage from other sources	67	3	67	2	61	3	56	3
- Provide good link roads	45	5	41	5	54	4	34	7
- Right to fish and raise forestry in foreshore	51	4	56	4	45	5	61	2
- Community wells	71	2	59	3	72	2	54	4
- More O&M budget to tank	43	6	41	6	38	6	43	5
- Others	21	7	19	7	29	7	36	6

MS=Garret mean score; R=Garret rank

Improved roads, more O&M expenses are given comparatively less priority by the farmers. This has several implications for tank rehabilitation polices, since farmers based on their past experiences have felt by attending these priorities, the government could be able to improve the overall performance of the tanks as well as living standard of the small and marginal farmers. Since O&M expenses are directly handled by the irrigation department, farmers feel that whatever the level of fund allotment, most of these budgets go for meeting the salary increases of the irrigation department staff. Community wells are important as they could be able to supply the supplemental irrigation requirements comparatively at much cheaper rates than the private well owners who normally charge Rs 10 - 15/hr which is only Rs 3 - 4/hr under community wells.

13) Expectation for Project

It is interesting to observe the behavioral expectations of the farmers with respect to tank modernization by foreign agencies. Contrary to our expectations, farmers in southern districts, viz., Ramanathapuram, Sivaganga and Virudunagar districts ranked first the catchment treatment as currently the catchment is mismanaged with higher levels of soil erosion and in northern district , farmers ranked the canal lining as the first choice. Invariably in all the districts, community wells was given the second priority. Even though farmers know well that desilting is highly prohibitive, they prefer this also as the storage capacity will improve and in the drought years, the water storages in the deeper portions will help recharge the wells in the command area. OFD works and sluice

restructuring are not shown much interest by the farmers, as most farmers feel OFD works will disturb their original field boundaries and sluice restructuring will not be much effective, as the slopes of the canals and fields are already fixed.

Expectations for the Project

(Garret ranking)

Factors	Tiruvallur-Kanchipuram		Ramanatha-puram		Sivaganga		Virudunagar	
	MS	R	MS	R	MS	R	MS	R
- More catchment treatment	67	3	71	1	87	1	71	1
- Canal lining	78	1	62	3	56	3	61	3
- Desilting	60	4	59	4	71	2	45	4
- On-farm development	45	3	41	5	45	4	34	5
- Community wells	71	2	68	2	52	5	67	2
- Sluice restructuring	21	5	19	6	32	6	29	6

MS=Garret mean score; R=Garret rank

14) Other Expectations

Even though higher output price and reduced fertilizer price could improve the crop profitability, most farmers are small and marginal farmers with subsistence level and they could not imagine how these interventions could be helpful to them as their marketable surplus of rice is almost zero. Options like provision of regular O&M budgets and making the non-system tanks as system tanks through additional investment for water acquisition are given the first two ranking in all the districts as evidenced from the garret ranking. The small and marginal farmers expect that any improvement that will provide assured tank water supplies only will be useful in the long-run.

Other Expectations

(Garret ranking)

Factors	Tiruvallur-Kanchipuram		Ramanatha-puram		Sivaganga		Virudunagar	
	MS	R	MS	R	MS	R	MS	R
- Increase output price	39	4	45	4	56	3	41	4
- Regular O&M budget	56	2	67	2	69	2	79	2
- Low fertilizer price	45	3	51	3	42	4	61	3
- Invest to system tank	71	1	82	1	79	1	84	1

MS=Garret mean score; R=Garret rank

15) Income distribution: Factor shares

It is important to analyze the nature of income distribution and factor shares due to tank rehabilitation. Factor shares are the ratio of costs of factor inputs used in

the production process to the total value of output. Factor share of current inputs (viz., fertilizer, and other chemicals and irrigation and power charges) and factor share of labour have been worked out.

The details of the factor shares worked out in the case of the selected tanks are given in the table in the section for land use pattern which indicate that the factor shares are high towards current inputs i.e., 0.38 in Tiruvallur - Kanchipuram district and 0.36 to 0.39 in the southern districts. The operator (farmer's) share is high in Virudunagar district (0.30) compared to other districts. It is important to compare these factor shares after tank rehabilitation and any increases in the factor shares of labour as well as farmers is an indicative of the positive impact of rehabilitation.

This survey attempts to study the farmers organizational aspects, their resource mobilization, conflicts resolving and other tank improvement aspects. It is observed that in none of the tanks covered for the study, any formal organization exists and mostly the informal organizations are present which are active that too when there is flooding and breaching of the tank bunds or during acute scarcity periods where farmers used to mobilize cash and labour to clean the supply channel and sluices. Only in about 65 % of the tanks in Tiruvallur - Kanchipuram districts the informal organizations are active and in the southern districts, this percentage ranges from 76 % to 82 %. But in all the cases, these organization are active only during scarcity periods.

Farmers Organizations

(Unit: %)

District	Formal	Informal Organizations Active
Tiruvallur-Kanchipuram	-	65
Ramanathapuram	-	76
Sivaganga	-	79
Virudunagar	-	82

C.3 Farmers Participation and Farmers' Organization

C.3.1 Present Conditions of Farmers' Organization

1) Study Areas

According to the results of the social environment survey conducted during the field survey, none of the villages covered by the survey has formal organization but has informal ones. 65 %, 76 %, 79 % and 82 % of the villages have informal organizations in Tiruvallur - Kanchipuram, Ramanathapuram, Sivaganga and Virudunagar districts, respectively. Those organizations have been maintained as a part of the traditional village system for years, and are considered active only the period when the scarcity of tank water takes place or some conflict occurs in distribution of water among villagers. Usually, there is no leadership available, and only in the case requiring some settlement of such conflicts, senior person in the village such as Panchayat leader and village chief tries to lead and settle the

conflict. However, major conflicts involving different caste groups are usually settled through police or court.

2) Pilot Tank Areas

Among the 10 pilot tanks surveyed for the feasibility study, no tank ayacut has the formal organization for watching water distribution, but some villages have their system for water distribution in an informal form (Table C.3.1). In most areas, they have such system led by either village or Panchayat leader, and some watchers called *Nirukatis* are appointed for watching water distribution. Such watchers are usually paid by farmers with grains during the appointed period according to the cultivated area. In some tanks in the Southern Study Area such as the A. Ramalingapuram and the Sengangulam Tanks, they have some informal society for water management in the ayacut areas collecting some amount of money to maintain the society. These villages are considered to have an advantage to organized farmers as well as to formalize water users' association in the implementation.

C.3.2 Farmers' Participation

It is the most important and essential to facilitate the farmers' participation in the operation and management of the irrigation facilities in order to realize the sustainable operation and management of the project successfully. In the establishment of the organization most suitable for activate the farmers participation in the project, the following items are considered as basic concepts of the farmers' organization.

(1) Importance of Farmer's Participation

The tank irrigation systems are smaller in size and larger in numbers with wider geographic distribution. Water management below the tank can not be viewed as purely technical one, since it encompasses essentially a social phenomenon and in the absence of its adequate understanding, methods of distribution and utilization of water are not going to be very satisfactory. Hence, the tank system has to be managed inevitable by the users themselves, since their management by a government agency will result in huge organizational expenditure, the effective and efficiency of the system depend on the involvement of the users only.

(2)Participation through Activities of Water Users' Association

The following farmers participation are envisaged during the construction and the irrigation management stages.

In construction stage:
- Planning and design of irrigation layout
- Canal testing

- Formation of outlet committees

In irrigation management stage:
- Data collection and operation
- Understanding of operation requirements and procedure
- Formation of association
- Management of entire irrigation system

To facilitate these farmers' participation in the course of the implementation, the water users' association (WUA) is proposed to be established to coordinate the member farmers. The functions and responsibilities of the association are proposed as summarized below.

- To decide whether to take up construction or not and to ensure the members willingness to take up the construction
- To allocate and distribute irrigation water within the scheme on an equitable basis
- To operate and maintain lift pumps and ancillary equipment
- To maintain channels and water courses
- To prepare and agree cropping patterns and schedules for each season
- To resolve minor disagreements in water allocation
- To act on behalf of the members with respect to water use

(3) Sustainability of Association

WUAs need to have reliable income to manage and maintain the water distribution system. If they do not raise their own income, they can hardly be sustainable. The objective in the turnover process is that WUAs will manage operation and maintenance of the system, get enough additional profit from the improved management, and raise their own resources. Basically, a successful WUA is the one that the farmers find profitable above what it costs them in time and money to maintain the society. The following five (5) sources of income to WUAs are considered.

- Water
- Other common properties and resources
- Farmer's fees and contribution
- Commercial operations
- Contracts for maintenance or repair

(4) Needs of Community Organizer

The community organizer is proposed to be assigned to mitigate and solve the various constraints which are considered to take place in formulating the proper WUAs as well as in operation and maintenance as described below.

1) Constraints in Formulating the Association

The individual irrigation needs are found to be heterogeneous and sometimes conflicting also. Hence, there is no uniform interest among the farmers to form a stable organization of their own to operate and maintain their tank system in a way to achieve maximum production in the individual holdings of all the users with the available water resources. The following shows some examples of such heterogeneous situation of the farmers.

- By traditional water distribution methods practiced in the system, the tail-end farmers are accustomed with the myth that they have lesser rights on water use than the head and middle reach farmers and they are self-convinced by the differential pricing of land in the head and tail reaches. So they are aceptical about the functioning of any farmers' organization for benefit of all the users, through they are interested in it.

- The farmers who own wells and those who are in close proximity to the sluice outlets and main channels are not much interested in equi-distribution of irrigation water.

- Ego of some of the farmers with favorable conditions (having wells and location advantage on the distribution system) to maintain their superiority over the other farmers, especially when the storage is inadequate to meet the needs of all the users.

- Distrust of farmers under high level sluices in having the farmers' organization to achieve equi-distribution of irrigation water.

2) Envisaged Functions of Community Organizer

In view of these facts, water management involves all aspects of allocations, distribution and sharing and this could be achieved only with the active participation of farmers in groups. The community organizers who is expected to take a role of catalyst among the farmers as well as the government agencies in charge are proposed to be fielded for organize the farmers and draw their supports.

The community organizers are proposed to play a vital role in building a situation ideal for the total involvement of the farmers. The following task accomplishments are proposed for the community organizers.

i) Integration and social investigation
   - Gaining social acceptance
   - Understand and analyzing the social, cultural and political dimensions

among and between the communities
- Creating awareness and entry programs

ii) Animation
- Identifying potential leaders
- Conducting formal meetings
- motivating the community to realize their problems

iii) Formalization
- Formulation of By-laws
- Membership enrollment
- Deciding criteria for representation in the executive committee
- Convening general body meeting
- Formal registration under the State Government Act

iv) Mobilizing Financial Resources
- Guiding the community to identify sources and to manage for sustainability

(5)Measures and Process for Community Organization

It is necessary to grasp and analyze the socio-economical characteristics and nature of each community in these aspects to organize such community in the most effective and suitable manners as well as to make the organized community sustainable in all the aspects. It is, therefore, proposed to carry out the social investigation before commencing the implementation to find out the socio-economical constraints of each community in the following manner.

The Participatory Rural Appraisal (PRA) is the method being applied for the Tank Modernization Project by EC to select the tanks suitable for introducing the tank modernization by screening method. RPA is to develop a local perspective by becoming more responsive to local people and existing situation and also it is a must to evolve a methodology for gathering timely and cost effective information. The principles of RPA are stated below.

i) Right attitude:.
ii) Right behavior:
iii) Flexibility:
iv) Seeking diversity:
v) Triangulation:
vi) Critical self-awareness:
vii) Optimal ignorance:
viii)Appropriate imprecision:

The following menu of approach is applied for carrying out the PRA.

i) Semi-structured Interview
ii) Ranking
   - Matrix ranking
   - Wealth ranking/Well-being ranking
iii) Construction of diagram
   a) Mapping (village map, recourse map, mobility map)
   b) Enterprise map
   c) Transect
   d) Seasonality
   e) Trend analyses
   f) Time line
   g) Livelihood analyses
   h) Resource flow analyses
   i) Venn diagram
iv) Case Study

(6) Role of Government Agencies

The following items of support activities are to be provided by the government agencies either directly or through the community organizers.

- Get the WUA on the list of WUAs recognized by government agency.
- Obtain maps or sketches showing all minor canals and control structures, field holdings, channel and water course alignments, sub-blocks, etc.
- Improved field channel alignments as required in view of technical aspects
- Help in preparing *warabandi*, if farmers need the system
- Discuss the water schedule/distribution method including water availability, water allocation, canal scheduling, etc.
- Take administrative arrangements required for getting farmers understood on the determined schedule of water distribution
- Help the WUA collect fees with farmers' confidence issuing receipt etc.
- Allow the WUA to keep a commission on water fees collected for collection work itself, etc. if the member farmers agree it

C.3.3 Farmers' Organization

(1) Proposed Farmers Organization for Water Distribution

The WUA is headed by the President who is selected by election, and is supported by the Treasurer and the Secretary.. Under the President, the Executive Committee is formed to lead the member farmers and to discuss on various subjects during the operation. At least five (5) committee members are selected by election according to the number of member farmers belonging to the association. One (1) committee member is so selected that he represents about 30 member farmers.

The following table shows the number of bearers and committee member of WUA for each tank area.

Proposed Number of Bearer and Member of WUA in Pilot Tanks

	Echur	Cherukkanur Big	Polambakkam	Enadur Big	Vadakkupattu	Siruvalai	A. Ramalinga-puram	Pandikanmoi	Sengangulam	Kurumbi
President	1	1	1	1	1	1	1	1	1	1
Secretary	1	1	1	1	1	1	1	1	1	1
Treasurer	1	1	1	1	1	1	1	1	1	1
E. Com. Mem.	5	9	5	15	12	5	5	5	10	5
Member Farmer	158	256	131	409	340	98	41	102	300	104

(2) Proposed Functions of WUAs

The WUAs are expected to play an important role in management of irrigation facilities, and the following functions are proposed for the WUAs after turning-over of the tanks to WUA.

- Operation and maintenance of irrigation facilities including minor tanks
- Management of irrigation water including distribution schedule and cropping schedule
- Collection of membership fees, penalties, duck feeding and fishing fees, use of social forestry, etc. from the member farmers
- Sustainable and transparent management of operation fund of the association

In addition to the above basic functions, it is proposed to develop the WUAs as the channels for effective delivery of technical services and other assistance toward sustainable agricultural productivity as itemized below.

- 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

Furthermore, WUAs intend to involve only the farmers who own their farm lands in the ayacut areas leaving the other landless farmers out of the association. Therefore, it is recommended to involve such activities that alleviate difficulties of these landless lease farmers as a rural development project as illustrated in the figure.

(3) Formation Procedures of WUAs

The WUAs have to be formulated in a manner that the farmers in the ayacut areas can accept easily so as to fit the present social conditions. The process to formalize the WUAs is that to organize the ayacut community. Therefore, the various activities of the community organizer are essential to carry out the process successfully.

The procedures for formalizing WUAs are divided into the following two (2) stages.

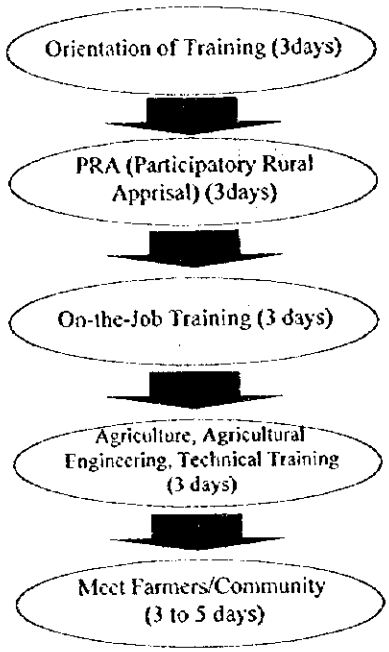
- Preliminary meeting stage to find and organize the potential farmers who are considered interested in formalizing WUA
- General body meeting stage to elect office bearers

(4) Training and Institutional Reinforcement

As described above, the community organizers' contribution to the formation of WUAs are considered indispensable and essential. The community organizers get the training as shown in the figure at present.

The number of community organizers required for implementing the project is roughly estimated at about 30 and the present number seems to be sufficient.

However, considering the works expected for them it is necessary to provide them with more comprehensive knowledge and know-how in order to enable them to act not only as a specialist to organize farmers also as a specialist to extend the water-saving irrigation technology and practices to the farmers even after WUAs' formalization



PRESENT TRAINING FOR COMMUNITY ORGANIZERS

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The sustainable agricultural development is considered to be realized not only by the effort of farmers but also by frequent and timely assistance of the government. The farmers have to understand and practice the farming technologies of various aspects such as water-saving irrigation management, value-added agriculture, crop diversification, marketing development, etc. The government staff is also required to be trained.

The farmers' training is considered to have two (2) aspects; one focuses on the operation and management of the farmers' organization (WUAs) for leading farmers and the other on various farming practices and technologies mainly by the

demonstration of such technologies in the experimental farms.

The training for the government staff is proposed to be conducted mainly on the technical and practical issues relating to introducing the new varieties and technology contributing to water-saving irrigation, crop diversification, marketing, etc. The training includes lectures and study tours held by various national and international organizations and institutes.

It is necessary to set up a organization to coordinate such training agencies to provide comprehensive training traversing various fields in an integrated training system. Therefore, it is proposed to establish "Management Center of Tank Rehabilitation Training" under the coordination among the Public Works Department, the Department Agriculture and the Agriculture Engineering Department. The center is proposed to be attached to the Irrigation Management Training Institute, which functions as a core agency, and act as an important role in various coordination among those training agencies as follows:

- establishment of long and short term training schedules,
- selection of suitable trainees to get training,
- preparation and arrangement of training materials and handouts,
- negotiation and coordination with the international agencies accepting the trainees abroad,
- coordination among the training agencies in arranging lecture rooms, trainer, etc.
- budget allocation to each training agency considering contents, types, duration, number of trainees to be dealt with such agencies, and
- travel and tour arrangements for study tours and attendance to international training course.

Table C.2.1 List of Tanks Selected for Socio Environment Survey (1/2)

(Northern Study Area)

	Name of Taluk	Sl. NO	Name of Tank	Location	Comman Area (ha)	Reservoir Capacity (mcum)	Capacity / Area
1	Ponneri	48	Gudinelvoyal tank	Gudinelvoyal	42.90	0.205	0.478
2	Ponneri	44	Kumaramcheri tank	Kumaramcheri	66.37	0.548	0.826
3	Ponneri	33	Thirupalaivanam tank	Thirupalaivanam	99.96	0.127	0.127
4	Ponneri	8	Kilikodi tank	Kilikodi	118.17	0.504	0.426
5	Ponneri	54	Kummangulam tank	Kummangulam	181.71	0.351	0.193
6	Ponneri	16	Devadanam tank	Devadanam	392.55	0.269	0.068
7	Gummidipoondi	61	Pondavakkam Puderi & Private Thangal	Pondavakkam	40.86	0.143	0.350
8	Gummidipoondi	3	Aramani tank	Aramani	48.22	0.220	0.455
9	Gummidipoondi	5	Annarambedu tank	Annarambedu	67.58	0.031	0.046
10	Gummidipoondi	58	Edur tank	Edur	73.78	0.308	0.417
11	Gummidipoondi	30	Athupakkam Large tank	Athupakkam	199.44	0.202	0.101
12	Gummidipoondi	26	Melkalani Hissa Katteri	Melakalani	280.62	0.986	0.351
13	Chengalpattu	43	Arungal Peria eri	Arungal	39.66	0.386	0.974
14	Chengalpattu	68	Chittamanur tank	Chittamanur	45.73	0.121	0.264
15	Chengalpattu	146	Kurumarapakkam Thangal	Kurumarapakkam	48.56	0.036	0.074
16	Chengalpattu	155	Thirumani tank	Thirumani	51.40	0.532	1.035
17	Chengalpattu	170	Echur eri	Echur	58.68	0.531	0.904
18	Chengalpattu	70	Kondamangalam Peria eri	Kondamangalam	58.68	0.182	0.311
19	Chengalpattu	28	Segundran tank	Senguadran	61.51	0.243	0.395
20	Chengalpattu	72	Vallam tank	Vallam	69.61	0.281	0.404
21	Chengalpattu	50	Kalivanthapattu Attu tank	Kalivanthapattu	74.06	0.217	0.293
22	Chengalpattu	69	Ozalur Puthupakkam tank	Ozalur	79.32	0.112	0.141
23	Chengalpattu	122	Thattalur Peria eri	Thattalur	102.39	0.734	0.717
24	Chengalpattu	10	Karuneeliam tank	Karuneeliam tank	109.67	0.581	0.530
25	Chengalpattu	122	Manapakkam tank	Manapakkam	114.12	0.565	0.495
26	Chengalpattu	35	Villiambakkam tank	Villiambakkam	145.29	0.276	0.190
27	Chengalpattu	145	Kunnathur	Kunnathur	170.36	0.583	0.342
28	Chengalpattu	88	Sirunkundram tank	Sirunkundram	203.16	1.712	0.843
29	Chengalpattu	3	Athur Vadapathy tank	Athur	281.26	0.545	0.194
30	Chengalpattu	109	Thalambur tank	Thalambur	304.73	0.466	0.153
31	Chengalpattu	124	P V Kalathur tank	P V Kalathur	490.49	5.346	1.090
32	Sriperumpudur	46	Kunnam Mukkan Thangal	Kunnam	40.47	0.015	0.036
33	Sriperumpudur	68	Thandalam Mettu eri	Thandalam	41.40	0.269	0.649
34	Sriperumpudur	122	Vandharajapuram Anicut Thangal	Vandharajapuram	53.93	0.091	0.168
35	Sriperumpudur	38	Kunnam Vadagal eri	Kunnam Vadagal	69.20	0.238	0.344
36	Sriperumpudur	41	Kiloy Large tank	Kiloy	80.13	0.253	0.315
37	Sriperumpudur	118	Melaipattu tank	Melaipattu	92.27	0.396	0.429
38	Sriperumpudur	125	Siruvanjur Buderi	Siruvanjur	75.83	0.292	0.386
39	Sriperumpudur	101	Veeranghapuram tank	Veeranghapuram	122.22	0.258	0.211
40	Sriperumpudur	32	Edayarpakkam tank	Edayarpakkam	220.56	1.364	0.618
41	Sriperumpudur	140	Vadakkupattu tank	Vadakkupattu	417.24	2.586	0.620
42	Sriperumpudur	96	Nemam tank	Nemam	804.94	7.271	0.903
43	Uthiramerur	6	Aungunram tank	Aungunram	41.28	0.355	0.859
44	Uthiramerur	78	Ravathanallur tank	Ravathanallur	42.86	0.698	1.628
45	Uthiramerur	36	Edayampudur tank	Edayampudur	56.66	0.400	0.705
46	Uthiramerur	13	Mulaginimeri tank	Mulaginimeri	68.80	0.305	0.443
47	Uthiramerur	39	Kattankulam tank	Kattankulam	86.60	1.154	1.332
48	Uthiramerur	53	Karuveppanpoondi tank	Karuveppanpoondi	106.84	0.725	0.678
49	Uthiramerur	22	Padur Hissa tank	Padur	122.62	0.376	0.306
50	Uthiramerur	25	Thirummukkudal tank	Thirummukkudal	145.69	0.739	0.508
51	Kanchipuram	60	Podavour Kuthangal	Podavour	39.66	0.211	0.532
52	Kanchipuram	128	Vodal tank	Vodal	45.73	1.358	2.970
53	Kanchipuram	26	Athivakkam Reddithangal	Athivakkam	59.89	0.009	0.016
54	Kanchipuram	127	Peramanallur tank	Peramanallur	66.37	0.110	0.165
55	Kanchipuram	119	Erivakkam tank	erivakkam	74.06	0.390	0.526
56	Kanchipuram	33	Siruvodal tank	Siruvodal	76.49	0.462	0.604
57	Kanchipuram	17	Kaliyanoor Peria eri	Kaliyanoor	110.08	0.481	0.437
58	Kanchipuram	55	Nelvoy tank	Nelvoy	178.47	0.947	0.530
59	Kanchipuram	53	Puthupakkam Large tank	Puthupakkam	338.32	0.592	0.175
60	Kanchipuram	3	Valathur tank	Valathur	413.19	1.830	0.443
61	Saidapet	36	Ponmathukulam Big tank	Ponmathukulam	40.87	0.232	0.568
62	Saidapet	12	Kovilampakkam tank & Thangal	Kovilampakkam	46.56	0.123	0.264
63	Saidapet	100	Sembakkam tank	Sembakkam	52.21	0.255	0.488
64	Saidapet	103	Vengaivalasai Peria eri	Vengaivalasai	66.77	0.353	0.528
65	Saidapet	86	Vengappakkam tank	Vengappakkam	92.27	0.157	0.170
66	Saidapet	38	Mittaramalli (Big) tank	Mittaramalli	72.06	0.288	0.400
67	Saidapet	6	Nanmangalkam tank	Nanmangalkam	106.03	0.285	0.269
68	Saidapet	88	Perungalathur tank	Perungalathur	150.95	0.433	0.287
69	Saidapet	77	Madambakkam tank	Madambakkam	259.00	1.415	0.546
70	Thiruvallur	78	Eniyur Chitteri	eniyur	46.76	0.130	0.278
71	Thiruvallur	132	Nayappakkam tank	Nayappakkam	42.90	0.490	1.141
72	Thiruvallur	23	Velleri Thangal Peria eri	Velleri Thangal	47.35	0.182	0.384
73	Thiruvallur	33	Karugavallipuram Kadamberi	Karugavallipuram	53.01	0.114	0.215
74	Thiruvallur	103	Nungambakkam Kadappon	Nungambakkam	61.57	0.820	1.331
75	Thiruvallur	15	Kaliyanoor Peria eri	Kaliyanoor	82.12	0.057	0.069
76	Thiruvallur	44	Ramathandalam tank	Ramathandalam	93.08	0.161	0.173
77	Thiruvallur	7	Vennambudur tank	Vennambudur	103.60	0.200	0.193
78	Thiruvallur	54	Sivanvoyal tank	Sivanvoyal	114.12	0.657	0.576
79	Thiruvallur	20	Polivakkam Putheri	Polivakkam	130.25	0.329	0.252
80	Thiruvallur	2	Pungathur tank	Pungathur	150.55	0.310	0.206
81	Thiruvallur	16	Vladiyur Peria eri	Vladiyur	181.61	0.809	0.445
82	Thiruvallur	81	Mappedu Big tank	Mappedu	242.41	1.528	0.630
83	Thiruvallur	40	Pullarampakkam tank	Pullarampakkam	488.82	1.752	0.361
84	Uthukottai	37	Puduchori tank	Puduchori	44.39	0.248	0.559
85	Uthukottai	40	Srinivasapuram Pudu eri	Srinivasapuram	59.09	0.190	0.321
86	Uthukottai	62	Athivakkam tank	Athivakkam	73.95	0.188	0.254
87	Uthukottai	18	Meyyur Large tank	Meyyur	94.97	0.282	0.297
88	Uthukottai	55	Komagambedu tank	Komagambedu	132.31	0.382	0.289
89	Uthukottai	45	Panapakkam tank	Panapakkam	207.20	0.661	0.319
90	Tiruttani	25	Santhanagopalapuram tank	Thiruvalangadu	41.53	0.355	0.855
91	Tiruttani	35	Buderi	Kalambakkam	48.92	0.099	0.202
92	Tiruttani	51	Thekkalur Chitteri	Thekkalur	55.96	0.268	0.514
93	Tiruttani	42	Thoddur Big & Small tank	Konnangalam	68.17	2.284	3.351
94	Tiruttani	5	Narthawada tank	Narthawada	95.30	0.388	0.407
95	Tiruttani	12	Panappakkam Big & Small tank	Panappakkam	207.51	0.170	0.082
96	Pallipet	13	Peddaramapuram tank	Peddaramapuram	48.92	0.344	0.704
97	Pallipet	25	Perumanallur tank	Perumanallur	92.65	0.650	0.702
98	Pallipet	33	Pallipet tank	Pallipet	276.96	2.208	0.797
99	Maduranthakkam	1	Pulicankottai tank	Pulicankottai	41.28	0.166	0.403
100	Maduranthakkam	104	Punnamai tank	Punnamai	43.88	0.426	0.970
101	Maduranthakkam	76	Chitharkadu tank	Chitharkadu	46.48	0.174	0.374
102	Maduranthakkam	152	Kilmaruvathur tank	Kilmaruvathur	51.35	0.359	0.699
103	Maduranthakkam	140	Nugumbal tank	Nugumbal	52.61	0.816	1.550
104	Maduranthakkam	110	Vizhudamangalam tank	Vizhudamangalam	55.44	0.393	0.756
105	Maduranthakkam	54	Nemandam	Nemandam	56.66	0.622	1.097
106	Maduranthakkam	152	Vinnampoondi Peric eri	Vinnampoondi	62.89	0.507	0.806
107	Maduranthakkam	42	Chinnavennani tank	Chinnavennani	70.34	0.283	0.403
108	Maduranthakkam	18	Kavilthandalam tank	Kavilthandalam	80.53	0.400	0.496
109	Maduranthakkam	33	Polambakkam Peria eri	Polambakkam	91.06	0.835	0.917
110	Maduranthakkam	70	Zamin Budur tank	Zamin Budur	98.64	0.357	0.361
111	Maduranthakkam	113	Ozhavethi tank	Ozhavethi	104.73	0.570	0.544
112	Maduranthakkam	27	Palayanur tank	Palayanur	120.60	0.050	0.046
113	Maduranthakkam	150	Perumbakkam tank	Perumbakkam	197.22	1.135	0.576
114	Maduranthakkam	17	Meyyur tank	Meyyur	400.65	1.116	0.279
115	Acharapakkam	42	Allanur tank	Allanur	54.63	0.534	0.978
116	Acharapakkam	4	Attur Big tank	Attur	104.41	0.588	0.564
117	Acharapakkam	17	Nerkunam tank	Nerkunam	85.96	0.514	0.599
118	Acharapakkam	38	Vilangadu tank	Vilangadu	104.01	0.644	0.620
119	Acharapakkam	20	Orathy Big tank	Orathy	208.59	1.016	0.487

Table C.2.1 List of Tanks Selected for Socio Environment Survey (2/2)

(Southern Study Area)

	Name of Taluk	SL NO	Name of Tank	Location	Comman Area (ha)	Reservoir Capacity (mcum)	Capacity / Area
1	Thiruvadanai	132	Pottukudi	Pullukudi	40.10	0.031	0,077
2	Thiruvadanai	61	Janaveli tank	Janaveli	45.53	0.260	0,571
3	Thiruvadanai	17	S-Pudukottai tank	Ponnolikottai	48.28	0.190	0.394
4	Thiruvadanai	4	Uthikottai tank	Uthikottai	52.48	0.380	0,724
5	Thiruvadanai	118	Thaniyapper Kanmoi	Mannankudi	53.20	0.005	0.009
6	Thiruvadanai	65	Suthamalli	Suthamalli	58.68	0.320	0,545
7	Thiruvadanai	31	Sirunekudi tank	Sirumakudi	64.04	0.230	0,359
8	Thiruvadanai	59	Melpanaiyur tank	Melpanaiyur	75.40	0.540	0,716
9	Thiruvadanai	26	Neman tank	Neman	85.16	0.510	0.599
10	Thiruvadanai	13	Iraviamangalam tank	Iraviamangalam	105.10	0.880	0,837
11	Thiruvadanai	32	Odakkani tank	Odakkani	92.67	0.440	0,475
12	Thiruvadanai	44	Thurani tank	Thurani	148.64	0,310	0,209
13	Thiruvadanai	77	Mangalam tank	Mangalam	266.00	1.173	0,441
14	Thiruvadanai	87	Thuthiendal tank	Thuthiendal	178.96	0,486	0,272
15	Thiruvadanai	73	Alithikottai tank	Alithikottai	418.19	0.745	0.178
16	Paramakkudi	101	Thevarkuri	Thevarkuri	41.79	0,208	0,498
17	Paramakkudi	17	Pottithatti tank	Pottitheti	52.81	0,085	0,162
18	Paramakkudi	70	Agaram	Agaram	55,91	0.323	0,577
19	Paramakkudi	86	Kondulavi	Sonapiri-yakottai	62.60	0.148	0.236
20	Paramakkudi	104	TM. Kottai	TM. Kottai	87.96	0,373	0,424
21	Paramakkudi	63	P. Kodikulam	P. Kodikulam	106.36	0,921	0,866
22	Paramakkudi	27	Seyalur	Seyalur	125.39	1.705	1,360
23	Paramakkudi	7	Ariyagudy	Ariyagudi	178.78	0.896	0,501
24	Paramakkudi	106	Sonaipriyan	Sonaipriyan	241.52	1.053	0.436
25	Kamuthi	3	Nelammanathi tank	Melammanathi	41.28	1.132	2.742
26	Kamuthi	35	Anaiyur tank	Anaiyur	50.42	0.471	0.835
27	Kamuthi	5	Kamuthi tank	Kamuthi	207.02	1.280	0.618
28	Muthukulathur	5	Kadukusandai	Kadukusandai	44.52		0,000
29	Muthukulathur	75	Melakulam	Melakulam	53.12	0,161	0.303
30	Muthukulathur	83	Posukudi	Posukudi	40.66	0.358	0.880
31	Muthukulathur	71	Keelakulam	Keelakulam	58.30	0.302	0.518
32	Muthukulathur	43	Sadayaneri tank	Sadayaneri	72.42	0,320	0,442
33	Muthukulathur	57	Sellur	Sellur	146.19	0.857	0.586
34	Muthukulathur	47	Ilanjambur tank	Ilanjambur	320.49	1.700	0.530
35	Ramananthcapuram	61	Masaneri	Nalmadur	43.28	0.210	0.485
36	Ramananthcapuram	93	Venkulam	Venkulam	52.65	0.210	0.399
37	Ramananthcapuram	22	Vithanur	Vithanur	62.63	0.280	0.447
38	Ramananthcapuram	44	Uruppuli	Uruppuli	79,97	1,570	1.963
39	Ramananthcapuram	40	Alangulam	Alangulam	93.93	0.470	0.500
40	Ramananthcapuram	16	Deviachanallur	Deviachanallur	110.94	0.299	0.270
41	Ramananthcapuram	30	Perunkarai	Perunkarai	373.94	2.310	0.618
42	Ramananthcapuram	33	Tholur	Tholur	155.00	1.055	0.680
43	Ramananthcapuram	60	Kallikudi	Kallikudi	99.49	0.400	0.402
44	Sivaganga	150	Nattakudi	Nattakudi	41.98	0.241	0,573
45	Sivaganga	38	Srivayal	Srivayal	44.25	0.214	0.483
46	Sivaganga	57	Vitothakudy	Nattarasankottai	46.76	0.261	0.559
47	Sivaganga	112	Pulagini	Arasanur	47.31	0,188	0.398
48	Sivaganga	18	Mavilangai Big and Small	Mavilangai	47.82	0.110	0.231
49	Sivaganga	1	Vanaikudi	Sivaganga	49.31	0.359	0.729
50	Sivaganga	131	Mutharasan	Periakottai	51.25	0.009	0.018
51	Sivaganga	78	Amandy	Andichiurani	53.00	0.317	0,597
52	Sivaganga	75	Pagani	Karungalakkudi	56,94	0.340	0.596
53	Sivaganga	153	Kuruchi	Kovanoor	59.71	0.036	0.060
54	Sivaganga	34	Anjavoyal	Anjavayal	71.46	0.560	0.784
55	Sivaganga	9	Nallandal	Usilangulam	72.93	0.311	0.426
56	Sivaganga	119	Poupatti	Sakkandhi	85.57	0.210	0.245
57	Sivaganga	154	Panaiyur	Panaiyur	121,41	0.666	0.549
58	Sivaganga	35	Sambanoor	Sambanoor	175.94	0.493	0.280
59	Manamadurai	142	Agarampattai	Agarampattai	43.37	0,170	0.391
60	Manamadurai	63	Panyankulam	Payayankualam	47.75	0,189	0,395

	Name of Taluk	SL NO	Name of Tank	Location	Comman Area (ha)	Reservoir Capacity (mcum)	Capacity / Area
61	Manamadurai	5	A. Nedungulam	Athanur	52.19	0.244	0.468
62	Manamadurai	109	Thuvalaikulam	Thuvalaikulam	54.63	0,198	0,363
63	Manamadurai	28	Nadukkanondal	Nadukkanondal	65.20	0.345	0.530
64	Manamadurai	126	Karuvaikudi	Kilathari	73.65	0.155	0.210
65	Manamadurai	72	Vadakkuchandanur	Vadakkuchandanur	81.39	0.860	1.057
66	Manamadurai	100	Sankankulam	Sankankulam	99,33	0,631	0.636
67	Manamadurai	86	Ladanendal	Ladanendal	102.83	0.832	0.809
68	Manamadurai	92	Palayanur	Palayanur	448.62	2.576	0.574
69	Manamadurai	40	Vannikudi Big	Vannikudi	125.72	0,513	0.408
70	Manamadurai	79	Kanakkankudi (North)	Kanakkankudi	132.55	0.775	0.585
71	Manamadurai	1	Annavasal	Annavasal	213.75	0.983	0.460
72	Ilayangudi	51	Udayanur	Udayanur	42.73	0.106	0.248
73	Ilayangudi	26	Nagamugundankudi	Nagamukundankudi	47.34	0.471	0.996
74	Ilayangudi	11	Kodunkulam	Karaikulam	59.03	0.932	1.578
75	Ilayangudi	62	Thiruvallur small	Thiruvallur	76.22	0.240	0.314
76	Ilayangudi	18	Katchathanallur	Katchathanallur	146.82	1.254	0.854
77	Devakottai	51	Udayanasamudram	Udayanasamudram	42.04	0.896	2.131
78	Devakottai	9	Kambini	Kambini	50.38	0.285	0.566
79	Devakottai	19	Kurunthanakottai	Kurunthanakottai	61.64	0.387	0.628
80	Devakottai	27	Chittanur	Chittanur	81.77	0.631	0.772
81	Devakottai	33	Kalathur	Kalathur	126.16	1.539	1.220
82	Karaikudi	22	Muthupattu	Muthupattu	41.50	0.214	0.516
83	Karaikudi	53	Crmbi	S. R. Pattnam	52.61	0.131	0.249
84	Karaikudi	7	Poongudi	Keela Poongudi	47.71	0.194	0.406
85	Karaikudi	78	Idayan	Ariyakudi	48.64	0.450	0.925
86	Karaikudi	8	Mundhan	Kallapettai	62.75	0.313	0.498
87	Karaikudi	87	Andakudi	Mithravayal	80.13	0.660	0.824
88	Karaikudi	54	Visalayankottai	Visalayankottai	103.35	0.643	0.622
89	Thirupattur	76	Erumaipatti	Erumaipatti	40.78	0.317	0.777
90	Thirupattur	60	Kuppathur patti	Kulathur patti	43.10	0.212	0.492
91	Thirupattur	7	Therotti tank	Solanpatti A. Thekkur	52.09	0,083	0.159
92	Thirupattur	21	Villur Thanipatti	Thanipatti	72.48	0,944	1.302
93	Thirupattur	54	Palayanedu vayal	Palayanedu vayal	82.20	0.575	0.699
94	Thirupattur	28	Kilamadam	Kilamadam	97,43	0,679	0.697
95	Thirupattur	49	Mattikanmoi	Singampunari	232.22	0.874	0.377
96	Virudhunagar	12	Kumaralingapuram	Kumaralingapuram	44.00	0.231	0.524
97	Virudhunagar	18	Kammapatti	Kammapatti	68.04	0.438	0.644
98	Sattur	12	Sevalkulam	Nandhukudi	46.15	0.308	0.668
99	Sattur	27	Ammapatti	Ramalingapuram	76.55	0.394	0.514
100	Sattur	9	Koelamarainadu	Koelamarainadu	159.51	1.054	0.661
101	Rajapalayam	2	Appaneri	Appaneri	40.70	0.275	0.674
102	Rajapalayam	27	Koravankulam	Sundarapandiam	57.24	0,192	0.335
103	Rajapalayam	36	Poovaneri	Solaisori	78.67	0.314	0.400
104	Rajapalayam	20	Melapattam Karisalkulam	Melapattam Karisalkulam	96.27	0.570	0.592
105	Rajapalayam	49	Nagarikulam	Devadanam	210.61	1.608	0.764
106	Arupukottai	82	Sottamari	Sottamari	41.16	0,244	0.592
107	Arupukottai	134	Periya Kadambankulam	Kadambankulam	43.22	0.155	0.358
108	Arupukottai	77	Sorikulam	Sorikulam	44.10	0.164	0.373
109	Arupukottai	38	Chettikurichi small tank	Chettikurichi	49.17	0,664	1.350
110	Arupukottai	53	Kokkulam	Kokkulam	53.09	0,906	1.706
111	Arupukottai	88	Narikudi	Narikudi	62.16	0,789	1.270
112	Arupukottai	79	Kottakachiendal	Kottakachiendal	70.00	0.703	1.004
113	Arupukottai	4	Melakallankulam	Malakallankulam	65.34	0.246	0.376
114	Arupukottai	73	Manoor	Manoor	92.19	0.531	0,576
115	Arupukottai	6	Vakkananakundu	Vakkanankundu	128.39	0.314	0.244
116	Arupukottai	51	Tiruchuli	Tiruchuli	198,15	2.798	1.412
117	Srivilliputhur	55	Vadakarai	Acnanthavilthan	41.80	0.702	1.680
118	Srivilliputhur	17	Medankulam	Maharajapuram	54.06	0.092	0.004
119	Srivilliputhur	27	Thirumagalkulam	Thulukkapatti	63.21	0.812	1.285
120	Srivilliputhur	1	Padaranikulam	Khansapuram	97.16	0,240	0.247
121	Srivilliputhur	47	Valaikulam	Valaikulam	229.96	1.432	0.623

Table C.3.1 Socio-economic Conditions of Ayacut Areas

Description	Northern Study Area					Southern Study Area				
	Echur Tank	Cherukkanur Big Tank	Polambakkam Tank	Enadur Big Tank	Vadakkupattu Tank	Siruvalai Tank	A. Ramalinga-puram Tank	Pandikanmoi Tank	Sengangulam Tank	Kurumbi Tank
1. District Name	Kanchipuram	Tiruvallur	Kanchipuram	Kanchipuram	Kanchipuram	Sivaganga	Virudhunagar	R'puram	Sivaganga	Sivaganga
2. Taluk Name	Thirkalikundram	Tiruttani	Madurantakam	Kanchipuram	Sriperumbudur	Sivaganga	Sattur	Paramakudi	Manamadurai	Karaikudi
3. Village Name	Echur	Cherukkanur	Polambakkam	Enadur	Vadakkupattu	Paganeri	A. Ramalinga-puram	Pandikanmoi	Sengangulam	S. R. Patnam
4. Registered Ayacut (ha)	58.6	91.3	94.6	574.7	417.3	53.2	75.6	41.9	99.2	52.7
5. Cropping Intensity (%)										
- Average	166	-	127	124	162	100	100	100	110	100
6. Main Crop	Paddy	Paddy	Paddy	Paddy	Paddy	Paddy	Paddy	Paddy	Paddy	Paddy
7. Farm Size										
- Marginal Farmer (Below 1 ha)	67	198	42	357	284	82	40	75	250	79
- Small Farmer (1-2 ha)	92	61	81	68	54	20	7	30	39	27
- Medium and Large Farmer (Above 2 ha)	7	9	16	23	17	4	2	5	24	6
- Total Farmers	166	268	139	448	355	106	49	110	313	112
- Share of Marginal Farmers (%)	40	74	30	80	80	77	82	68	80	71
- Share of Small Farmers (%)	55	23	58	15	15	19	14	27	12	24
- Total Share of Marg. and Small Farmers (%)	96	97	88	95	95	96	96	95	92	95
- Ave. Farm Size (ha)	0.35	0.34	0.68	1.28	1.18	0.50	1.54	0.38	0.32	0.47
8. Farmers' Organization										
- Water Users' Association	Informal	Informal	Informal	Informal	Informal	Informal	Informal	Informal	Informal	Informal
- Decision Procedure	Group	Group	Group	Group	Group	Group	Group	Group	Group	Group
9. Caste Composition (%)										
- Others	0	0	9	2	10	10	0	0	0	0
- BC	5	20	35	25	28	12	90	65	95	80
- MBC	50	60	5	25	20	73	0	0	0	0
- SC	42	18	50	47	40	5	10	35	5	20
- ST	3	2	1	1	2	0	0	0	0	0
10. Religious Status	Hinduism	Hinduism	Hinduism	Hindu, Muslim,	Hinduism	Hindu, Muslim,	Hinduism	Hinduism	Hinduism	Hindu, Chirist.
11. No. of Hamlets in Ayacut										
- Name of Hamlet 1	Echur	Cherukkanur	Polambakkam	Enadur	Vadakkupattu	Paganeri	A. Ramalinga-puram	Pandikanmoi	Sengangelam	S. R. Patnam
- Name of Hamlet 2	-	-	-	Chettierpet	-	-	-	-	-	Nagavayal
- Name of Hamlet 3	-	-	-	Kattavakkam	-	-	-	-	-	-
12. Social Institutions and Infrastructures										
- Drinking Water (%)	100	100	100	100	100	75	100	50		100
(Water Quality)	(Fair)	(Fair)	(Good)	(Good)	(Good)	(Good)	(Good)	(Saline)	(Fair)	(Good)
- Electricity (%)	78	90	64	90	79	80	85	90		60
- School Institutions	Primary (1-5)	Primary (1-5), Middle (6-8)	Primary (1-5), Higher (6-12)	Primary (1-5), Middle (1-8)	Primary (1-5), High (6-10)	Primary x 2 (1-5), High (6-10), Higher (-	Primary (1-5), Primary (Pvt.) (1-5)	Primary (1-5)	Primary (1-5)	Primary (Pvt.) (1-5), Middle (1-8)
- Clinic and Health Institutions	None	None	PHC	HSC	HSC	PHC, Matanity Hosp	HSC	None	None	None
- Acess Roads	OK	OK	OK	OK	OK	OK	OK	OK		OK
- Cottage Industries Facilities	None	None	None	Champher Factory	None	None	Matches Factory	Charcoal Factory	None	None
- Community Halls,etc	Com. Hall	None	Com. Hall	None	TV Cell (14)	Com. Hall	Com. Hall	Com. Hall	None	Com. Hall
- Wells (Nos.)	70	13	57	55	35	1	2	2	10	?
13. Distance to Towns										
- Main Employment (Distance km)	hirkalikundra (5)	Tiruttani (10)	Madurantakam (9)	Kanchipuram (7)	Chengalpattu (15)	Sivaganga (17)	Sattur (3)	Paramakudi (12)	Thiruppuvaram (15)	Karaikudi (12)
- Main Market (Regulated Market) (Distance km)	Chengalpattu RM (20)	Tiruttani RM (20)	Madurantakam RM (25)	Kanchipuram RM (10)	Kanchipuram RM (22)	Sivaganga RM (20)	Sattur RM (15)	Paramakudi RM (10)	Manamadurai RM (18)	Kavaikudi RM (20)
14. Average Amount Sold (1,000Rs./farm/year)	10-15	10-15	15-20	20-25	20-25	10-15	15-20	5-10	15-20	10-15
15. Social Conflicts/Problems	No	No	No	No	No	No	Yes	No	No	No

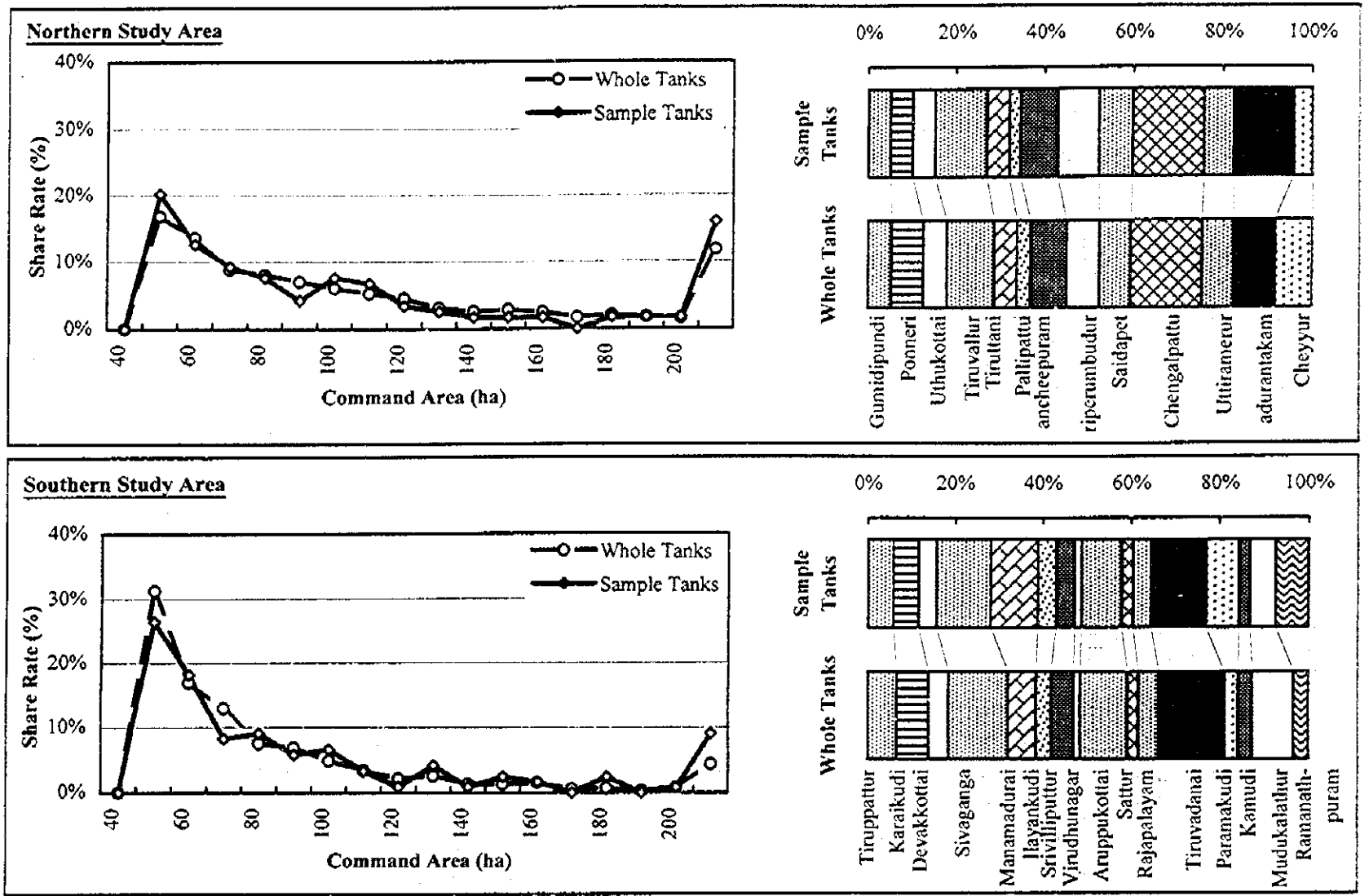

Fig.C.2.1 Size-wise and Area-wise Distribution of Tanks in the Study Area

D IRRIGATION

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D.1 Importance of Irrigation in Indian Agriculture

D.1.1 Irrigation Water Resources of India

The major irrigation water source was canal accounting for 42.1% in 1960s, but in 1970s groundwater replaced it. In 1990, the groundwater, canal and tank water irrigated 51%, 35.6% and 6.8% of total irrigated area respectively. The total number of tanks in India is counted as 510,00, and they are mostly concentrated in the Southern states of Tamil Nadu, Andhra Pradesh, Kerala and Karnataka. Tamil Nadu State shares 7.8% of total tanks in the Nation. But the share of tank irrigated area is 31% in the State 1983-84, the largest among other states in the Nation. However, a continuous decline in the tank irrigated area is observed for past 30 years.

D.1.2 Irrigation Development in India

Since independence in India, expansion of irrigation facilities along with consolidation of the existing systems has been the main strategy for increasing crop production in India. Irrigation support is provided through major, medium and minor irrigation projects through Five Year Plans. With sustained and systematic development of irrigation, the irrigation potential of India has raised from 22.6 million ha in 1951, when the process of planning began, to about 89.42 million ha at the end of 1995-96.

D.1.3 Minor Irrigation Development in India

All surface and groundwater schemes having command area up to 2,000 ha individually are classified as minor irrigation schemes. Generally surface minor irrigation schemes are funded from public sector outlay and development of groundwater individual efforts of farmers. Irrigation potentials created and utilized during the five year plan period are shown below.

Irrigation Potential Created and Utilized Under Minor Irrigation Schemes in India
(in million ha)

Plan	Potential	Utilization
First Plan (1951-56)	14.06	14.06
Second Plan (1956-61)	14.75	14.75
Third Plan (1961-66)	17.00	17.00
Fourth Plan (1969-74)	23.50	23.50
Fifth Plan (1978-80)	27.30	27.30
Sixth Plan (1980-85)	37.52	35.25
Seventh Plan (1985-92)	46.61	43.12
Eighth Plan (1992-97)	10.71	09.36

(Source: India,1996; MI&B)

The Ministry of Water Resources has been operating the centrally sponsored scheme on

rationalization of minor irrigation Statistics since the 7th Five year Plan and the scheme is being continued in the eighth Five Year Plan.

D.2 Irrigation in Tamil Nadu

D.2.1 Agro-climate

Tamil Nadu covers a total area of 130,069 km^2 extending from northern latitude of 8°-5' to 13°-35'N and eastern longitude from 76°-15' to 80°-20'E. Its climate is basically tropical, exposing to both Southwest and Northeast monsoons. Rainfall in the State fluctuates from region to region and year by year. The annual average rainfall recorded is about 900 mm, of which 450 mm and 300 mm occur in Northeast and Southeast monsoon periods respectively. Due to Northeast monsoon, there is more than 1,000 mm of annual rainfall in the Northeast part of State, while it is only 600 to 700 mm in the Southwest area. The incidence of annual rainfall has been grouped into four ranges, viz., less than 600 mm, 600 mm to 800 mm, 800 mm to 1,000 mm and above 1,000 mm.

D.2.2 Irrigation Water Resources and its Development

(1) Water Resources of Tamil Nadu

Basically, Tamil Nadu is deficient in water resources. Per capita water availability in the State is only 600 m^3 which is far less than the national average of 4,000 m^3. Therefore it is necessary to explore the way and means to augment the available supplies and to use them more efficiently and economically. One-third of areas irrigated in the State are by tanks. Therefore, the maintenance and development of these tanks is basically important for agricultural development in the State. Next to the tank irrigation, well irrigation by individually owned farmers dominate the scene. From time immemorial, groundwater is being developed in Tamil Nadu for various purposes, primarily for irrigation. Especially after independence, rapid progress has been made in the development of groundwater resources. In Tamil Nadu the number of dug wells has increased from 790,000 to about more than 1,800,000 and the shallow tube wells from few hundreds to 135,000 in the last four decades. During 1950-51, the irrigation development by groundwater was about 0.5 million hectares only. During 1993-94 it was 1.30 million hectares. Such an overall increase by groundwater was accomplished by means of rapid energisation of pump sets and availability of institutional finance mainly for medium and small scale farmers. The ultimate irrigation potential from groundwater is estimated at 3.144 Million ha, then irrigation potential created is 1.954 million ha and the balance available is 1.19 million ha.

(2) Irrigated Agricultural Development

Tamil Nadu State has exploited almost 83% of the ultimate irrigation potential and has been utilizing the potential to an extent of 98.5%. This means that i) new

irrigation works or project is extremely limited unless new additional water sources become available by inter-basin transfer, which could be secured by inter-state agreement, ii) the plan can only reckon with, sub-marginal potentials and may even be obliged to take into account lowering the period of dependability (50% instead of 70%). For new projects, this will naturally result in high cost per unit irrigated area. To achieve those objectives, the following approaches are envisaged in the 8th Five Year Plan.

- Early completion of the major and medium and minor irrigation projects and accelerating the pace of works, with matching provisions.
- Modernizing the irrigation canal and system, deltas system and also the tank system, securing external assistance whenever it is forthcoming.
- Intensification of groundwater utilization taking cares to see that there is no over extraction.
- Organizing a better water management mission and practices and on-farm management for better water use by farmers and all concerned with irrigation.

D.3 Irrigation in the Study Area

The present status of irrigation in the Study Area, comprising Tiruvallur and Kanchipuram Districts (Northern Study Area) and Ramanathapuram, Sivaganga and Virudhunagar Districts (Southern Study Area) are described below.

D.3.1 Rainfall

In the Northern Study Area, the rainfall is observed generally more than 1,000 mm with the variation from 1,000 mm to 1,200 mm, while it decreases below 1,000 mm in the Southern Study Area. In the Southern Study Area, the rainfall varies from 700 mm to 900 mm. It decreases from north to south in the Southern Study Area, while it increases west to east.

D.3.2 Surface Water Resources

The following river basins are located in and around the Northern and the Southern Study Areas.

(i) Northern Study Area

- Araniyaru basin
- Palar basin
- Coum basin
- Ongur basin
- Adayar basin

(ii) Southern Study Area

- Vellar basin
- Manimuthar basin
- Uttarkosamangaiaru basin
- Vaipparu basin
- Koluvanaru basin
- Kottakaraiaru basin
- Gundar basin
- Pambar basin
- Vaigai basin
- Vembaru basin

The tributaries of the above rivers and their locations are illustrated in Fig.D.4.1 and Fig D.4.2 for the Northern and the Southern Study Areas, respectively.

D.3.3 Groundwater Resources

The block-wise estimation of groundwater resources in the State revealed that, in about 89 blocks, the level of groundwater development is more than 85.1 % (categorized as Dark) of Utilizable groundwater resources; in about 86 blocks the groundwater development varies between 65 percent and 85 percent (categorized as gray) and in the remaining 209 blocks the level of extraction is less than 65 percent (categorized as white).

D.4 Tank Irrigation in the Study Area

(1) PWD Rainfed Tanks

PWD irrigation tanks are the tanks with command area more than 40ha. Command area distribution of PWD rainfed tanks in the Study Area are presented in Fig. D.4.3. Even though, some of them were constructed under the planning and design of PWD, most of them are constructed before the Independence and therefore precise and detailed tank dimensions are not available. There are about 2,600 tanks in the Study Area. Most of rainfed tanks are chained to each other with surplus/supply channels to store the water during flood period.

(2) Conjunctive Use of Water (surface water and groundwater) for Irrigation

There is no data available on the conjunctive use of surface water and groundwater in the tank command area of the Study tanks. But it is clear that farmers who are rich enough to dug wells, use groundwater at free of electricity charge.

(4) Reduction in the Storage Capacity of Tank and Irrigable Area

Most farmers in the tank command area cited the reduction of tank storage capacity and inflow water through supply channel is caused by the sedimentation.

(5) Categorization of PWD Rainfed Tanks for Rehabilitation

In order to evaluate the total project, priority of rehabilitation implementation, the tanks in the Study Area are categorized based on 1) agro-climatic zones as a factor of water availability, 2) cultivated area ratio in the command area as project benefit factor, 3) ratio between free catchment area and command area as a factor of water availability and 4) scale of command area from the efficient O&M and social factors. Also the tanks which do not require rehabilitation are identified as those having cultivation ratio less than 10% and the tanks having marginal farmers' share

less than 10%.

D.4 Master Plan for Rehabilitation Minor Irrigation Tank Systems

D.5.1 Present Constraints for Tank Irrigation System Improvement

Existing constraints for tank irrigation system improvement in the Study Area can be summarized as follows.

(1) Shortage of Stored Water in the Tank
(2) Deterioration of Tank Irrigation Facilities
(3) Poor Irrigation Management
(4) Farmers' Strong Intention for Paddy Cultivation
(5) Poor coordination of Water Distribution among Chained Tanks
(6) Lack of Awareness for Community Property

D.5.2 Basic Concepts and Strategies of the Master Plan

The basic concepts and the strategies of Master Plan can be summarized as follows.

1) Maximization of Water Resources for Minor Tank Irrigation System
2) Establishment of Method for Rehabilitation of Minor Irrigation Tanks
3) Formulate Improvement of Irrigation/drainage Facilities
4) Farmers' Participation in Efficient Operation and Maintenance

D.5.3 Components of Master Plan for Tank Rehabilitation

Based on the basic concepts of the Master Plan, the following irrigation related components are considered to be included in the Project.

(1) Watershed management and total hydrological assessment of basin of tanks in chain
(2) Conjunctive use of surface and groundwater in the catchment and command area including the sinking community wells for irrigation.
(3) Rehabilitation and improvement of tank facilities
(4) Efficient irrigation operation and management through canal lining, on-farm development and establishment of water users' association through the community organizer system,
(5) Crop diversification for the improvement of marginal and small scale farmers through cultivation of water-saving and high beneficial crops instead of paddy in the water scarcity area including the demonstration farms

D.6 Hydrological Survey and Analysis

D.6.1 General Principle

Each crop in the tank command area requires a certain quantity of water after a certain fixed interval, throughout its period of growth. In the Study Area, the rainfall is not sufficient or does not fall after fixed intervals. Therefore, the water has to be stored in the tank and supplied to meet the crop water requirements. Besides, maximum water demands are also required in the design and planning of irrigation systems. All these depends on the amount of seasonal rainfall that occurs over the catchment area of particular tank and the quantity of rainfall that has been converted into runoff for storage in the tank. Further there are certain type of losses, which need to be accounted in calculating the net storage of the tank. Therefore, a holistic approach is needed in developing and utilizing the tank water resources and to increase the efficiency and effectiveness of the tank rehabilitation process through feasibility studies.

As a representative for each tank category, the following ten (10) tanks are selected as pilot tanks for conducting the feasibility study.

Category	Name of the Pilot Tank	Tank Modernization Division	District	Study Area
NR-1	Echur	Chennai	Kanchipuram	Northern Study Area
NR-2	Cherukkanur	Kanchipuram	Tiruvallur	
NR-2	Polambakkam	Chennai	Kanchipuram	
NR-4	Enadur	Kanchipuram	Kanchipuram	
NR-3	Vadakkupattu	Kanchipuram	Kanchipuram	
SP-1	Siruvalai	Sivaganga	Sivaganga	Southern Study Area
SP-2	Kurumbi	Karaikudi	Sivaganga	
SR-1	Ramalingapuram	Virudhunagar	Virudhunagar	
SP-4	Sengangulam	Sivaganga	Sivaganga	
SP-1	Pandikanmai	Paramakudi	Ramanathapuram	

The locations of pilot tank are shown in Fig. D.6.1.

D.6.2 Objectives

The objectives of the hydrological survey in the pilot tanks areas can be summarized as follows:

- To collect reliable rainfall and climate data from representative rainfall/meteorological stations in order to provide an accurate estimate of the catchment runoff using a valid runoff prediction method under different land use and soil conditions prevailing in the catchment.
- To estimate the net irrigation water requirement for principal crops in the command area by calculating the crop water requirements.
- To study the hydrological feasibility of the tank rehabilitation by understanding the relationship between catchment area, tank storage and irrigable area through water

balance studies.

- To quantify the frequency of drought occurrence to develop monsoon management strategies.
- To calculate the drainage flood requirements for designing the surplus arrangements.
- To develop basin management strategies for strengthening the institutional and sociological relationship between the chain tanks.

D.6.3 Method of Hydrological Analysis

To achieve the above objective the following working methods are developed during the course of the Study.

(1) Collection and compilation of long term rainfall - runoff data from the Institute of Water Studies (IWS), Ground Water (GW) wing of PWD and the Statistics Department of the GOTN.

Rainfall and Meteorological Stations for Pilot Tanks

Tank	Rainfall Station	Meteorological Station
Echur	Chengalpattu	Tirutani
Cherukkanur	Tiruthani	Tirutani
Polambakkam	Madurantagam	Tirutani
Enadur Big	Kanchipuram	Tirutani
Vadakkupattu	Sriperumpudur	Tirutani
Siruvalai	Sivaganga	Kavalur
Ramalingapuram	Sattur	Kavalur
Pandikanmoi	Paramakudi	Kavalur
Sengangulam	Manamadurai	Kavalur
Kurumbi	Karaikudi	Kavalur

No rainfall, meteorological, hydrological observation stations exist in the catchment and command areas of the pilot tanks. Therefore, the following rainfall and meteorological stations were identified as the representative of respective pilot tanks, after having a series of discussions with PWD officials. Rainfall pattern in these tank area are presented in Figure D.6.2.

(2) Analysis of climatic features for both short term and long term periods of observation. And estimation of reference evapotranspiration using penman method.

The daily rainfall data and monthly average of the climatological parameters are attached in the data book. In the Northern Study Area, the annual rainfall is observed to be more than 1000 mm, while it was less than 1,000 mm in the southern Study Area.

Reference crop evapotranspiration (ETo) is calculated using the Penman method, which states that:

$$ETo = c[W.Rn+(1-W).f(u).(e_a-e_d)]$$

where, ETo = reference crop evapotranspiration in mm/day
W = temperature-related weighing factor
Rn = net radiation in equivalent evaporation in mm/day
$f(u)$ = wind related function

e_a = saturation vapor pressure
e_d = mean actual vapor pressure
c = adjustment factor

The principles of Penman method and computation procedures are described in detail in the document: FAO 24 - Irrigation & Drainage Paper, "Crop Water Requirements".

(3) Calculation of irrigation water requirements for principal crop(s) in the ayacut

Crop Water Requirement (CWR) = Kc x Eto

where, *Kc* = crop coefficient
Eto = Reference crop evapotranspiration

The *Kc* values were estimated as
0.95 for initial stage (20 days)
1.05 for crop development stage (30 days)
1.10 for mid-season stage (40 days)
0.95 for maturity stage (30 days)

Gross Irrigation Water Requirement (IWR) =
Command area x {(CWR + percolation losses - Effective Rainfall)/ Efficiency}

Predominant irrigated crop in the tank command areas is paddy rice. Apart from this there are some cash crops such as sugar cane grown in the area, reflecting particular hydro-environmental conditions.

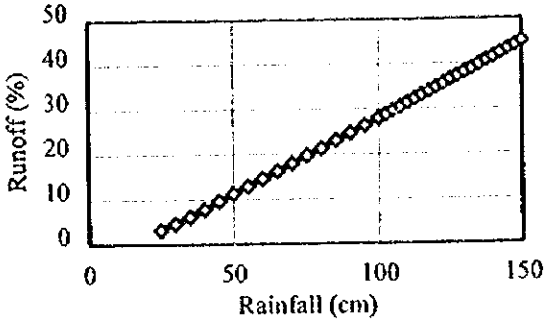
(4) Determination of runoff from the rainfall using Dry - Damp - Wet Method

An estimate of water supply for tanks should be made as a first step in the water resource development plan. Dry - Damp - Wet method which take into consideration, antecedent moisture condition and daily rainfall is widely accepted and commonly used for estimating the runoff in Tamil Nadu. The Strange's table used to calculate runoff from the daily rainfall is given in the adjacent table.

Strange's Table

Daily Rainfall (cm)	Runoff percentage when the original state of ground is:		
	Dry	Damp	Wet
0.64	-	-	8
1.27	-	6	12
1.93	-	8	16
2.54	3	11	18
3.18	5	14	22
3.81	6	16	25
4.45	8	19	30
5.08	10	22	34
6.35	15	29	43
7.62	20	37	55
10.16	30	50	70

A statement of classification of the conditions of the catchment as wet, damp, or dry for purposes of applying the above table is described in the College of Engineering Manual - Irrigation. The curve as shown in the figure developed by Strange is also used to calculate the runoff from the monsoon rainfall, when there is non availability daily rainfall data.



RUNOFF AS % OF MONSOON RAINFALL (AFTER STRANG TABLE

(5) Quantification of evaporation and seepage losses from the tank water spread area.

Evaporation losses from tank water surface is a function of water level, capacity and water spread area which is predicted by establishing the Water level (H) - Capacity (Q) and Water level (H) - Water Spread Area (A) Curves (Fig D.6.3) based on the topographic survey and the relationship between Q, H and A. (Table D.6.1).

(6) Water balance calculations for the tank

The water balance of a tank is given by:

Tank storage = [Runoff] - [Irrigation water requirement]
- [Evaporation and seepage losses] -[surplus]

To determine the storage capacity of a tank, water balance of the tank is studied using the seasonal irrigation water requirement, long term yield and runoff from the catchment of more than 10 years which are estimated by hydrological analysis and tank losses of evaporation and seepage.

(7) Estimation of flood water requirements

For estimating maximum flood discharge, Ryve's formula is most commonly used in Tamil Nadu. By this formula the maximum design discharge is given by:

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

where, Q = Flood discharge in cubic feet/sec
M = Area of combined catchment in sq. miles
M = Area of intercepted catchment in sq. miles
C, c = Coefficients

The selection of values for 'C' and 'c' are very important, because improper selection may lead to under estimation of flood discharge values. In Tamil Nadu, the

current practice is to use the value of 500 for 'C' and 1/5th of 'C' i.e. 100 for 'C' which were decided after careful review of past failures. The most justifiable method of flood estimation is using the rational method which states that:

$$Q = CIA/360$$

where Q = Peak rate of runoff in m^3/sec
I = Intensity of rainfall in mm/hr for a duration equal to time of concentration
C = Runoff coefficient
A = Area of equivalent catchment (ha)

From the hydrological point of view, the rational method is preferred over empirical method which was found to underestimate the flood discharge values.

D.6.4 Development of Strategies for Chained Tank Basin Management

In chain tank basin management, the important aspect is the participatory and chain basin approaches to the tank rehabilitation. The following strategies were developed to improve the effectiveness of chain basin management.

(1) Hydrological and Irrigation Aspects

The following tank basin ratios were studied in detail.

i) Ratio of Free and Intercepted Catchment - Command Area
To indicate whether the changes that take place are as a result of encroachment and social forestry which can drastically cause a reduction in actual command area of the tank even during average annual rainfall years.

ii) Ratio of Tank Water Spread Area - Command Area.
To indicate the shallow storage and suggests policy implications on deepening the tank by way of desilting which could increase the command area by:
- Increasing the storage capacity of the tank,
- Vegetative method of soil and water conservation system, and
- Reducing the evaporation losses by larger surface area exposed to sun.
-

iii) Ratio of Tank Water Spread Area to Capacity
To develop engineering solutions like raising the bund height and temporarily store the surplus by storing the surplus by placing wooden or metal shutters in the surplus weirs.

iv) Ratio of Capacity to Command Area
To provide a timely and reliable water supply for modern agriculture based on designs and management procedures and high yielding crops.

(2) Constraints and Potentials in Chain Basin Development

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

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

Nevertheless it is feasible for further chain basin development through better water management, economic utilization of basin water resources and augmentation of the supplies by tapping new water resources of storage under:

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

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

iii) *Command Area Development*: It is to increase the already created irrigation potential to secure optimum crop yield per unit of water, per unit of land and per unit of time.

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

v) *Change in Cropping Pattern*: Emphasis on high water consuming paddy need to be shifted to growing cereals requiring less water like maize, cambu, millets etc.

vi) *Equitable Water System*: Farmers assured of equitable and adequate supplies desist from over-irrigation. Volumetric supply of water needs to be encouraged and water rates charged on volumetric basis rather a present carpet rate.

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

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

ix) *Evaporation Reduction*: Attempts need to be made to reduce evaporation by controlling the rate at which water escapes from water surface of the tank by covering the water surface with a thin mono-molecular film. It was found that hexadeconal or cetyl alcohol is effective. It is considered that evaporation losses may be reduce by one third. A reduction of wind speed by wind breaks is the another method used for controlling evaporation since wind velocity has profound effect on evaporation.

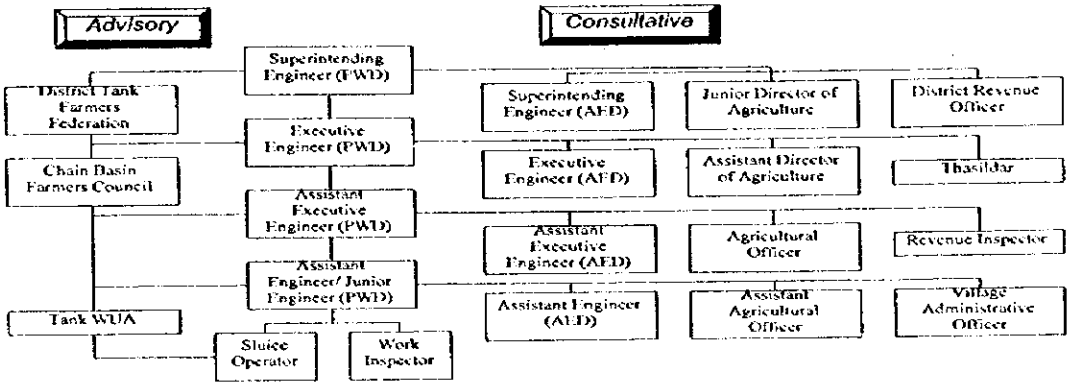
(3) Administrative, Sociological and Financial Aspects

In chain tank basin management, the important aspect is the participatory and chain basin approach to the tank rehabilitation. Moreover, a comprehensive and systematic program for the repair and maintenance of chain of tanks is necessary. This can be achieved by formation of multi-tier farmers association

By this approach, all farmers from catchment to farm level in the chain will form one single association of their own with specific responsibilities as shown below.

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

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



PROPOSED ADVISORY, CONSULTATIVE AND ADMINISTRATIVE SETUP FOR CHAIN BASIN MANAGEMENT

D.7 Rehabilitation of Tank Irrigation Facilities in the Pilot Tank Areas

D.7.1 Echur Tank Area

(1) Rehabilitation Plan

1) Basic concepts in Rehabilitation

Most of the available water resources have been exploited, and it is impossible to increase the volume of water used by the rainfed tanks. On the other hand, according to the PWD, the cost per hectare of the total project cost without overhead charge is proposed to be less than Rs.20,000. Therefore, the cost of rehabilitation minimized as much as possible while considering maximization of the utilization of water resources. Priorities are given to the facilities based on their functions and role played within the system. Required items and works are described below according in a prioritized order.

i) Storage function the Tank Bund

Runoff water from the catchment area must be saved as much as possible using the tank bund. So, the tank bund must be strong enough to bear the stored water up to a full tank level. Since dimensions of tank bund such as height, crest width and slope, are decided considering the stabilization and

phreatic line, reshaping of eroded bunds are necessary.

ii) Supplemental storage function of the tank supply channel

For those tanks which depend on a small scale catchment area as a water resource, it is necessary to secure their water supply by means of a channel feeding water from other tanks.. Generally, a well designed tank supply channel is not easily available; thus, a proper cross sectional flow area must be secured for collecting the water.

iii) Safety function of the surplus arrangement

Excessive water impedes the efficient working of the tank irrigation system; and hence, it must be safely disposed. Three types of surplus arrangements (H.C. type, B.C. type and Natural bye-wash type weir) will have to be provided depending on the site conditions. Regarding the rehabilitation of weirs, the following points are taken into consideration:

- Provision of a drainage channel to discharge excessive water to the downstream side.
- Overflow depth of the weir is set in accordance with standard dimensions considering the stabilization of the bund and extension of apron length.
- In the case of widening of the weir, the same type of structure must be applied.
- Regarding the layout plan of the weir, it is expected to be installed at the upper side of the existing weir because of the reduced height of the crest. This will also secure the existing drainage channel.

iv) Sluices used for distribution of irrigation water

Characteristics of the intake works (sluices) are influenced by the type of control device and site conditions such as depth of water. Although presently plug/plug rod types of water control devices are applied, these types are not inferior to screw gearing shutter type. Revetment for the sluice is necessary since an efficient working of the intake facility is important for regular operation. This will also decrease the risk of collapse of the bund slope due to damages caused by animals. Then, the rehabilitation of sluices must consider the following points:

- Securing stored water for deterrence of excessive water flow.
- Easy operation and accurate sluices operation, especially for those of a Tower head type.

v) Irrigation system as irrigation network

Lining of the field channel is the most effective measure to maximize use of the existing water resources in the ayacut through the reduction of water losses. The lining can reduce the area for the irrigation channel and reduce the maintenance requirements. In the present plan, basically, lining of field (tertiary) channel are proposed with outlets for every 10 ha block. Also, provision of a division box with paddle shutter can evenly distribute in each ayacut.

vi) Community well as a supplemental irrigation facility

In the Study Area, the irrigation periods are determined by the agro-climatic zones. According to the classification, the Southern Study Area, in particular, is estimated to suffer from insufficient irrigation water. To compensate this water deficiency, community wells must be used. In the present rehabilitation plan, 2 community wells with a 2.0 m diameter for supplementing irrigation water use are provided for the ayacut.

(2) Rehabilitation Works

Rehabilitation of tank irrigation system consist of tank bund, intake facilities, surplus arrangement and channel net work. Required items and rehabilitation works are described in Table D.7.1.

(a) Tank Facilities

Rehabilitation plan of the tank irrigation facilities is proposed for each category as follows.

i) Tank Bund
Both longitudinal and cross section leveling were carried out in order to verify the existing conditions of the tank bund. Total bund length of this tank is 1,18 m, and the length of the section requiring strengthening is 298 m.

ii) Intake Facilities (Sluices)
Peak water requirement for the crops is estimated as 36.11 mm/day without considering effective rainfall; the design water requirement for the facilities is calculated as 4.18 litter/sec/ha considering a 24-hours operation. Two sluices are provided in this tank; rehabilitation is carried out by modifying the water control device. Design conditions of these sluices are shown in the table below. The vent size of the barrel is calculated by the following formula.

$$A = Q/[cd\,(2gh)^{1/2}]$$

Where A: Area of vent for the barrel
Q: Discharge (m^3/sec)
Cd: Coefficient of discharge (0.620 for broad crest weir)
h: Hydraulic Head of water
g: Acceleration due to gravity (m/s^2)

Particulars	Sluice 1	Sluice 2
Benefited area (Ayacut)	18.4 ha	40.3 ha
Water requirement	0.077 m^3/sec	0.168 m^3/sec
Required vent size	0.021 m^2 (0.15 x 0.15m)	0.041 m^2 (0.20 x 0.20m)

iii) Spillway (Surplus Arrangement)

Two (2) weirs are served by this tank. The weirs are of B.C. and natural bye-wash types. The results of the computation of drainage water requirements indicates that capacity of the weir is not sufficient for handling the volume of excessive water (10.14 m^3/sec) as shown in Table D.7.2. As the existing capacity of the weir is 6.18 m^3/sec, modification of the weir is necessary to safely manage the excessive water.

B.C. type weir located at beginning of the bund is provided closely to ayacut, so that the volume of the drainage water can not be increased. On the other hand, modification of the crest for both types of weir is not sufficient for handling the expected volume of excessive water as shown in the Table below.

Particulars	Coefficient discharge (Ratio for the crest)	Calculated	Existing (B.C.type)	By Modification	Applicable
Discharge (m^3/sec/m)	-	0.59 (10.14-3.42)/11.40	0.24 (2.76/11.40)	-	x
Modification B.C/Bye-wash	0.625/0.500 (1.25)	-	-	0.30	x
B.C/Bye-wash	0.562/0.500 (1.12)	-	-	0.27	x

Based on the results shown in the Table above, rehabilitation by widening of the weir is carried out by providing a Bye-wash type one since it secures the existing drainage channel at the tank's down stream section. Widening of the weir is estimated to be 16.5m considering the following formula.

$$Q = 2/3\ cd\ L\ H^{2/3}\ (2gh)^{1/2}$$

Where Q: Discharge (m^3/sec)
Cd: Coefficient of discharge (0.500 for rough stone)
L: Width (length) of weir, m

h: Hydraulic Head of water, m
g: Acceleration due to gravity, m^2/s

(b) Canal System (Selective Lining for Field Channel)

Two (2) intake facilities are provided in this tank, and the ayacut is divided into four (4) blocks in accordance with the layout of existing land use (field boundaries) and field channel. Selected field channel for the lining is provided for 10 ha in each block. Besides, in order to maximize water utilization in each field and establish an even water distribution from the upstream section to the tail end of the field, a diversion box with a paddle shutter will be provided every 150 m considering the existing irrigation network system. Layout of selective lining for field channel is shown in Fig. D.7.1.

(3) Implementation Plan

1) Construction Plan

From the experiences of EC Project, the tank rehabilitation works of the tank scale less than 100 ha command area is considered to be implemented within 2 years using the less cultivation season between April to September.

2) Cost estimate

i) Unit Cost Analysis

Both material and unit costs for rehabilitation works are estimated based on *the Standard Schedule of Rates for Anna and MGR Districts 1997-98* issued by the PWD. Material costs are calculated considering the transportation costs from the supply source to the works site; unit costs are estimated based on the material costs. Material and unit cost are shown in Table D.7.3 and D.7.4.

ii) Construction Cost

Quantities for required rehabilitation works are estimated based on Table D.7.1 and unit prices shown in Table D.7.3 and D.7.4. The direct construction cost is estimated at about Rs. 1,717,000 and the details are shown in Table D.7.5.

iii) Project Cost

Project cost consisting of rehabilitation costs, supervision charges, preparation work cost and overhead charges is Rs. 2,523,000, as shown in the table below.

Project Cost for Rehabilitation Works in Echur Tank

Description	Cost (Rs.)
Direct Construction Cost	1,717,000
Contingencies	224,000
Petty Supervision Charges	52,000
Preparation Cost (Govt. Share)	25,000
Overhead Charges	505,000
Total	2,523,000

D.7.2 Cherukkanur Big Tank

(1) Rehabilitation Plan

(a) Tank Facilities

i) Tank Bund

Total bund length of this tank is 1,605 m, and sectional length that require strengthening is 183 m.

ii) Intake Facilities (Sluices)

Peak water requirement and maximum design discharge are estimated as design are estimated 36.11 mm/day, 4.18 litter/sec/ha respectively. Three sluices are provided in this tank; two sluices from the end of L.S. are selected for rehabilitation considering the operational period. Rehabilitation is carried out by modifying the water control device. Design condition of these sluice are shown in the table below.

Particulars	Sluice 1	Sluice 2
Benefited area (Ayacut)	106.5 ha	8.4 ha
Water requirement	0.077 m^3/sec/ha	0.168 m^3/sec/ha
Required vent	0.095 m^2 (0.35 x 0.35m)	0.021 m^2 (0.15 x 0.15m)

iii) Spillway (Surplus Arrangement)

Two (2) weirs of B.C. and Natural Bye-wash type served this tank. Compared to the estimated values of drainage water requirements (11.76m^3/sec), capacity of the weir (6.97m^3/sec) is not sufficient as shown in Table D.7.2. Hence, rehabilitation of the weir is necessary to discharge the

excessive water safely. Width of bye-wash type weir located at L.S.0 can not be extended due to site conditions. Besides, modification of the crest is not sufficient for the volume of excessive water as shown in the table.

	Coefficient discharge (Ratio for the crest)	Calculated	Existing (B.C.type)	by Modification	Appricable
Discharge (m^3/sec/m)	-	0.51 (11.76-1.54) / 19.93	0.27 (5.43/19.93)	-	x
Modification H.C/B.C	0.625/0.562 (1.11)	-	-	0.30	x

Rehabilitation by widening of the weir is carried out by providing a B.C. type weir since it secures the existing drainage channel at the down stream section from the tank. Widened width of the weir is estimated as18.0m.

iv) Tank Supply Channel

Rehabilitation for supply channel ensures proper cross section of flow by excavation.

(b) Canal System (Selective Lining for Field Channel)

Benefited areas are divided into 5 blocks in accordance with the layout of the field channel and existing land use. Layout of selective lining for filed channel is shown in Fig. D.7.2. Diversion boxes with paddle shutter are provided every 150 m for an even distribution of water.

(2) Implementation Plan

1) Construction Plan

From the experiences in EC Project, the tank rehabilitation works of the tank scale less than 100 ha command area is considered to be implemented within 2 years using the less cultivation season between April to September.

2) Cost estimate

i) Unit Cost Analysis

Both of material and unit cost for rehabilitation works are estimated based on *the Standard Schedule of Rates for Anna & M.G.R District 1997-98* issued by PWD. Material and unit costs are estimated considering the site conditions same as the Echur Tank. These costs are shown in the Table D.7.3 and D.7.4.

ii) Construction Cost

Quantities for required rehabilitation works are estimated based on the Table D.7.3 at the 1997 price level. Direct construction cost is estimated at about Rs. 2,848,000, and the details are available in Table D.7.6.

iii) Project Cost

Project cost consisting of rehabilitation costs supervision charges, preparation work cost and overhead charges is Rs. 4,180,000.

Project Cost for rehabilitation works in Cherukkanur Big Tank

Description	Cost (Rs.)
Direct Construction Cost	2,848,000
Contingencies	370,000
Petty Supervision Charges	85,000
Preparation Cost (Govt. Share)	41,000
Overhead Charges	836,000
Total	4,180,000

D.7.3 Polambakkam Tank Area

(1) Rehabilitation Plan

(a) Tank Facilities

i) Tank Bund

Total bund length of this tank is 1,310 m, and section that require strengthening is 1,275 m.

ii) Intake Facilities (Sluices)

Peak water requirement and maximum design discharge are estimated as 36.11mm/day and 4.18 litter/sec/ha respectively. Two sluices are provided in this tank. Rehabilitation is carried out by modifying the water control device. Design condition of these sluices are shown in the Table below.

Particulars	Sluice 1	Sluice 2
Benefited area (Ayacut)	12.2 ha	78.3 ha
Water requirement	0.051 m^3/sec/ha	0.327 m^3/sec/ha
Required vent size	0.013 m^2 (0.15 x 0.15m)	0.060 m^2 (0.25 x 0.25m)

iii) Spillway (Surplus Arrangement)

Two (2) weirs of Natural Bye-wash and B.C. types located close to each other are serving this tank. Compared to the computated drainage water requirements(31.40m^3/sec), present capacity of the weir (25.40m^3/sec) is not sufficient as shown in Table D.7.2. Rehabilitation of the weir is necessary to discharge the excess water safely.

Weirs provided are of bye-wash and B.C. types. Since Bye-wash type weir is installed close to the farm road and B.C. type, widening of these weirs as rehabilitation measure can not be done. Besides, modification of the crest of B.C. type is not sufficient to handle excess water as shown in the table. Hence rehabilitation is carried out by providing an additional B.C. type weir since it secures the existing drainage channel at the down stream section from the tank. Widened length of the weir is estimated as 8.0m.

	Coefficient discharge (Ratio for the crest)	Calculated	Existing (B.C.type)	by Modification	Applicable
Discharge (m^3/sec/m)	-	1.37 (31.40-17.70) / 10.00	0.77 (7.71 / 10.00)	-	x
Modification H.C/B.C	0.625 / 0.562 (1.11)	-	-	0.86	x

(b) Canal System (Selective Lining for Field Channel)

Benefited areas are divided into 4 blocks in accordance with the layout of the field channel and existing land use. Layout of selective lining for filed channel is shown in Fig. D.7.3 Diversion boxes with paddle shutter are provided every 150m for an even distribution of water.

(2) Implementation Plan

1) Construction Plan

Through the experiences in EC Project, the tank having a tank command area less than 100 ha can be implemented the rehabilitation works within 2 years. Every year, the construction will be implemented between April to September which is non cultivation period in the command area.

2) Cost estimate

i) Unit Cost Analysis

Both of material and unit cost for rehabilitation works are estimated based on the *Standard Schedule of Rates for Anna & M.G.R District 1997-98* issued by PWD. These costs are shown in the Table D.7.3 and D.7.4.

ii) Construction Cost

Quantities for required rehabilitation works are estimated based on the Table D.7.1, at the 1997 price level. Direct construction cost is estimated at about Rs. 2,493,000 and the details are shown in Table D.7.7.

iii) Project Cost

Project cost consisting of direct construction cost, supervision charges, preparation work cost and overhead charges is Rs. 3,659,000.

Project Cost for rehabilitation works in Polambakkam Tank

Description	Total Cost (Rs.)
Direct Construction Cost	2,493,000
Contingencies	324,000
Petty Supervision Charges	75,000
Preparation Cost (Govt. Share)	35,000
Overhead Charges	732,000
Total	3,659,000

D.7.4 Enadur Big Tank Area

(1) Rehabilitation Plan

(a) Tank Facilities

i) Tank Bund

Bund length of this tank is 2,665 m, and the section that require strengthening is 2,512 m.

ii) Intake Facilities (Sluices)

Peak water requirement and design discharge are estimated as 36.11mm/day, and 4.18 litter/sec/ha respectively. Two sluices are provided in this tank. Rehabilitation is carried out by modifying the water control device. Design condition of these sluices are shown in the Table below.

Particulars	Sluice 1	Sluice 2
Benefited area (Ayacut)	499.5 ha	33.2 ha
Water requirement	2.088 m^3/sec/ha	0.154 m^3/sec/ha
Required vent size	0.363 m^2 (0.60 x 0.60m)	0.270 m^2 (0.20 x 0.20m)

iii) Spillway (Surplus Arrangement)

Three (3) B.C. type weirs serve this tank. Estimate drainage water requirements are well below the present capacity of these weirs as shown in Table D.7.2. Hence, rehabilitation of the weir is not necessary.

(b) Canal System (Selective Lining for Field Channel)

The ayacut is divided into 16 blocks in accordance with the layout of existing land use field channel. As a main channel with a total length of 1600m, CH-4-1 has a benefited area of 499.5 ha. The only field channel selected for lining is CH-4-1, as main channel, and the others are left as earthen channels. Diversion boxes with paddle shutters are provided at every 150m. Layout of selective lining for field channel is shown in Fig. D.7.4

(2) Implementation Plan

1) Construction Plan

The tanks having more than 100 ha of command area are planned to be implemented the rehabilitation works with in 3 years, through the past experiences.

2) Cost estimate

i) Unit Cost Analysis

Both of material and unit cost for rehabilitation works are estimated based on *the Standard Schedule of Rates for Anna & M.G.R District 1997-98* issued by PWD. These costs are shown in the Table D.7.3 and D.7.4.

ii) Construction Cost

Quantities for required rehabilitation works are estimated based on the Table D.7.6, at the 1997 price level, direct construction cost is estimated at about Rs. 11,499,000, as detailed in Table D.7.8.

iii) Project Cost

Project cost consisting of rehabilitation costs, supervision charges, preparation work cost and overhead charges is Rs. 16,806,000.

Project Cost for rehabilitation works in Enadur Big Tank

Description	Cost (Rs)
Direct Construction Cost	11,449,000
Contingencies	1,488,000
Petty Supervision Charges	343,000
Preparation Cost (Govt. Share)	165,000
Overhead Charges	3,361,000
Total	16,806,000

6.6.5 Vadakkupattu Tank Area

(1) Rehabilitation Plan

(a) Tank Facilities

i) Tank Bund

Total bund length of this tank is 1,483 m, and the section that requires strengthening of the bund is 1,343 m.

ii) Intake Facilities (Sluices)

The peak water requirement and the design discharge are estimated as 36.11mm/day and 4.18 litter/sec/ha respectively. Three sluices are provided in this tank. Considering the site conditions and operational period, two (2) sluices can be rehabilitated and the rehabilitation is carried out by modifying the water control device. Design condition of these sluice are shown in the Table shown below.

Particulars	Sluice 1	Sluice 2
Benefited area (Ayacut)	309.0 ha	89.4 ha
Water requirement	1.291 m^3/sec/ha	0.374 m^3/sec/ha
Required vent size	0.287 m^2 (0.60 x 0.60m)	0.070 m^2 (0.30 x 0.30m)

iii) Spillway (Surplus Arrangement)

Three (3) B.C. type weirs serve this tank. Present capacity (60.41m^3/sec of these weirs are sufficient to handle the estimated rainage water requirements, as shown in Table D.7.2. However, due to deteriorated condition and collapsed nature of the apron, clogging using cement concrete or random rubble masonry should be for preventing the extension of the damages.

(b) Canal System (Selective Lining for Field Channel)

The ayacut area of this tank is 417.27 ha. There are three (3) main channels serving ayacut. . Selective lining for field channel is applied for all of them. Also, diversion boxes with paddle shutters are provided at every 150m. Layout of selective lining for field channel is shown in Fig.D.7.5.

(2) Implementation Plan

1) Construction Plan

The tanks having more than 100 ha of command area are planned to be implemented the rehabilitation works with in 3 years, through the experiences in EC Project.

2) Cost estimate

i) Unit Cost Analysis

Both of material and unit cost for rehabilitation works are estimated based on *the Standard Schedule of Rates for Anna & M.G.R District 1997-98* issued by PWD. These costs are shown in the Table D.7.3 and D.7.4.

ii) Construction Cost

Quantities for required rehabilitation works are estimated based on the Table D.7.1, at the 1997 price level, Direct construction cost is estimated at about Rs. 12,023,000. The details are given in Table D.7.9.

iii) Project Cost

Project cost consisting of rehabilitation costs, including supervision charges, preparation work cost and overhead charges is Rs. 17,653,000.

Project Cost for rehabilitation works in Vadakkupattu Tank

Description	Total Cost (Rs.)
Direct Construction Cost	12,023,000
Petty Supervision Charges & Contingencies	1,924,000
Preparation Cost (Govt. Share)	175,000
Overhead Charges	3,531,000
Total	17,653,000

D.7.6 Siruvalai Tank Area

(1) Tank Irrigation Facilities Rehabilitation Plan and Works

(a) Tank Facilities

i) Tank Bund

Total bund length of this tank is 2,010 m, and it is required to rehabilitate the entire length of the bund.

ii) Intake Facilities (Sluices)

Peak water requirement for the crops is estimated as 29.53mm/day unconsidered effective rainfall, and the design water requirement for the facilities is calculated 3.41 litter/sec/ha considering 24 hours operation. Ten (10) sluices are provided in this tank. Considering the site conditions such as land use and layout of the channel, six (6) sluice are enough for the efficient rehabilitation works.

Rehabilitation is carried out by modifying the water control device. Design condition of these sluice are shown in the table below.

Particulars	Sluice 1	Sluice 2	Sluice 3	Sluice 4	Sluice 5	Sluice 6
Benefited area (Ayacut)	48.0 ha	14.8 ha	8.8 ha	8.8 ha	9.4 ha	9.0 ha
Water requirement (m^3/sec/ha)	0.164	0.025	0.015	0.015	0.016	0.015
Required vent	0.025 m^2 (0.25 X 0.25m)	0.006 m^2 (0.10 X 0.10m)	0.004 m^2 (0.10x0.10m)	0.005 m^2 (0.10 X 0.10m)	0.004 m^2 (0.10 x 0.10m)	0.005 m^2 (0.10 x 0.10m)

iii) Spillway (Surplus Arrangement)

Two (2) B.C. type weirs are served by this tank. Capacity of these weirs (35.82m^3/sec) is sufficient to meet out the estimated drainage water requirements as shown in Table D.7.2, however, since deterioration and collapse are observed in the water cushion and apron of the No.2 weir, clogging using cement concrete or random rubble masonry is to be done for preventing extension of the damages.

(b) Canal System (Selective Lining for Field Channel)

Most of irrigation blocks benefited are less than 10ha, so that rehabilitation for irrigation network system is emphasized to intake facilities. Selected Field channel for lining is CH-6-1 and others are left as earthen channel.. Layout of the channel is shown in Fig. D.7.6. Also, diversion boxes with paddle shutters are provided for every 150m, in spite of canal lining.

(2) Implementation Plan

1) Construction Plan

The rehabilitation works will be implemented within 2 years. Every years, rehabilitation works will be worked out during the non cultivation period in the command area between March and August.

2) Cost estimate

i) Unit Cost Analysis

Both of material and unit costs for rehabilitation works are estimated based on the *Standard schedule of Rates for Pusumpon Muthuramalinga Thevar District 1997-98* issued by P.W.D. These costs are shown in the Table D.7.3 and D.7.4.

ii) Construction Cost

Quantities for required rehabilitation works are estimated based on the Table D.7.6, at the 1997 price level. Direct construction cost is estimated at about Rs. 1,857,000 as detailed in Table D.7.10.

iii) Project Cost

Project cost consisting of rehabilitation costs, supervision charges, contingencies, preparation work cost and overhead charges is Rs. 2,726,000.

Project Cost for rehabilitation works in Siruvalai Tank

Description	Total Cost (Rs.)
Direct Construction Cost	1,857,000
Contingencies	244,000
Petty Supervision Charges	56,000
Preparation Cost (Govt. Share)	26,000
Overhead Charges	545,000
Total	2,726,000

D.7.7 Ramalingapuram Tank Area

(1) Rehabilitation Plan

(a) Tank Facilities

i) Tank Bund

Total bund length of this tank is 2,016 m, and the section that requires strengthening is 1940 m. Besides, erosion occurred at the bund slope as a characteristic of Black Cotton Soil, so that revetment by rough stone are to be provided to both side of the bund such as water side, ayacut side and top of the bund.

ii) Intake Facilities (Sluices)

Peak water requirement and design design discharge are estimated as 29.53mm/day and 3.41 litter/sec/ha respectively.
Three (3) sluices are provided in this tank. Rehabilitation is carried out by modifying the water control device. Design condition of these sluice are shown in the Table below.

Particulars	Sluice 1	Sluice 2	Sluice 3
Benefited area (Ayacut)	26.3 ha	17.2 ha	28.9 ha
Water requirement	0.090 m^3/sec/ha	0.059 m^3/sec/ha	0.099 m^3/sec/ha
Required vent	0.040 m^2 (0.20 x 0.20m)	0.019 m^2 (0.15 x 0.15m)	0.027 m^2 (0.20 x 0.20m)

iii) Spillway (Surplus Arrangement)

H.C. weir is provided in this tank. As shown in Table D.7.2, estimated drainage water requirements is well below the present capacity (173.02m^3/sec) of these weirs. Hence no rehabilitation works are proposed for this weir.

(b) Canal System (Selective Lining for Field Channel)

Benefited areas are divided into 3 blocks in accordance with the layout of the field channel and existing land use.. Selective lining for filed channel is shown in Fig. D.7.7. Diversion boxes with paddle shutters are provided every 150m for an even distribution of water.

(2) Implementation Plan

1) Construction Plan

Through the past experiences, the tank having less than 100 ha can be rehabilitated within 2 years, implementing the period of non-cultivation in the command area and dry period of the tank water.

2) Cost Estimate

i) Unit Price Analysis

Both of material and unit cost for rehabilitation works are estimated based on the *Standard Schedule of Rates for Kamarajar and Ramanathapuram Districts 1997-98* issued by PWD. Material and unit costs are are shown in the Table D.7.3 and D.7.4.

ii) Construction Cost

Quantities for required rehabilitation works are estimated based on the Table D.7.1, at the 1997 price level. Direct construction cost is estimated at about Rs. 3,759,000 and the details are given in Table D.7.11.

iii) Project Cost

Project cost consisting of rehabilitation costs, supervision charges, preparation work cost, contingencies and overhead charges is Rs.5,520,000.

Project Cost for rehabilitation works in A. Ramalingapuram Tank

Description	Total Cost (Rs.)
Direct Construction Cost	3,759,000
Contingencies	489,000
Petty Supervision Charges	113,000
Preparation Cost (Govt. Share)	55,000
Overhead Charges	1,104,000
Total	5,520,000

D.7.8 Pandikanmoi Tank Area

(1) Tank Irrigation Facilities Rehabilitation Plan and Works

(a) Tank Facilities

i) Tank Bund

Total bund length of this tank is 2,855m, and it is required to rehabilitate the entire length of the bund.

ii) Intake Facilities (Sluices)

Peak water requirement and the design discharge are estimated as 29.53 mm/day and 3.41 litter/sec/ha respectively. Three (3) sluices are provided in this tank. Rehabilitation is carried out by modifying the water control device. Design condition of these sluice are shown in the Table below.

Particulars	Sluice 1	Sluice 2	Sluice 3
Benefited area (Ayacut)	19.2 ha	10.7 ha	12.0 ha
Water requirement	0.066 m^3/sec/ha	0.036 m^3/sec/ha	0.041 m^3/sec/ha
Required vent	0.020 m^2	0.009 m^2	0.011 m^2
	(0.15 x 0.15m)	(0.10 x 0.10m)	(0.10 x 0.10m)

iii) Spillway (Surplus Arrangement)

Natural Bye-wash weir is provided as a surplus arrangement. As shown in Table D.7.2., present capacity (14.20m^3/sec) of these weirs are sufficient to meet the estimated values of drainage water requirements.

(b) Canal System (Selective Lining for Field Channel)

Beneficial area is 3 irrigation blocks on the basis of layout of field channel and existing land use. Layout of selective lining for filed channel is shown in Fig. D.7.8. Diversion boxes with paddle shutter are provided 1unit per 150m.

(2) Implementation Plan

1) Construction Plan

Through the past experiences, the tank having less than 100 ha can be

rehabilitated within 2 years, implementing the period of non-cultivation in the command area and dry period of the tank water.

2) Cost Estimate

i) Unit Price Analysis

Material and unit cost for rehabilitation works are estimated based on the *Standard Schedule of Rates for Kamarajar and Ramanathapuram Districts 1997-98* issued by PWD. These costs are shown in the Table D.7.3 and D.7.4.

ii) Construction Cost

Quantities for required rehabilitation works are estimated based on the Table D.7.1, at the 1997 price level. Direct construction cost is estimated at about Rs. 1,797,000. The details are as shown in Table D.7.12.

iii) Project Cost

Project cost consisting of economic price, supervision charges, preparation work cost and overhead charges is Rs. 2,638,000.

Project Cost for rehabilitation works in Pandikanmoi Tank

Description	Total Cost (Rs.)
Direct Construction Cost	1,380,000
Contingencies	234,000
Petty Supervision Charges	54,000
Preparation Cost (Govt. Share)	25,000
Overhead Charges	528,000
Total	2,638,000

D.7.9 Sengangulam Tank Area

(1) Rehabilitation Plan and Works

(a) Tank Facilities

i) Tank Bund

Total bund length of this tank is 4,230 m, and it is required to rehabilitate the entire length of the bund. Besides, tertiary channel around No.5 sluice constructed along the tank bund is often clogged by the eroded bund

material, i.e Black Cotton Soil. Hence ayacut side of the bund slope are to be provided revetment by rough stone as about 50m.

ii) Intake Facilities (Sluices)

Peak water requirement and the design discharge are estimated as 29.53mm/day and 3.41 litter/sec/ha. Five (5) sluices are provided for this tank. Rehabilitation is carried out by modification of the control device. Design condition of these sluices is shown in the table.

Particulars	Sluice 1	Sluice 2	Sluice 3	Sluice 4	Sluice 5
Beneficially area (Ayacut)	9.7 ha	21.9 ha	24.7 ha	20.9 ha	21.9 ha
Water requirement	0.033 m^3/sec/ha	0.075 m^3/sec/ha	0.084 m^3/sec/ha	0.076 m^3/sec/ha	0.085 m^3/sec/ha
Required vent size	0.009 m^2 (0.10 x 0.10m)	0.020 m^2 (0.15 x 0.15m)	0.022 m^2 (0.15 x 0.15m)	0.020 m^2 (0.15 x 0.15m)	0.027 m^2 (0.20 x 0.20m)

(b) Canal System (Selective Lining for Field Channel)

Beneficially area is divided into 5 blocks on the basis of layout of field channel and existing land use. Layout of selective lining for filed channel is shown in Fig. D.7.9. Diversion boxes with paddle shutter are provided 1unit per 150m.

(2) Implementation Plan

1) Construction Plan

Through the past experiences, the tank having less than 100 ha can be rehabilitated within 2 years, implementing the period of non-cultivation in the command area and dry period of the tank water.

2) Cost estimate

i) Unit Price Analysis

Material and unit cost for rehabilitation works are estimated based on the *Standard Schedule of Rates for Kamarajar and Ramanathapuram Districts 1997-98* issued by PWD. These costs are shown in the Table D.7.3 and D.7.4.

ii) Construction Cost

Quantities for required rehabilitation works are estimated based on the Table D.7.1, at the 1997 price level, direct construction cost is estimated at about

Rs. 2,156,000. The detailed construction cost is shown in Table D.7.13.

iii) Project Cost

Project cost consisting of rehabilitation costs, supervision charges, preparation work cost and overhead charges is Rs. 3,166,000.

Project Cost for rehabilitation works in Sengangulam Tank

Description	Total Cost (Rs.)
Direct Construction Cost	2,156,000
Contingencies	281,000
Petty Supervision Charges	65,000
Preparation Cost (Govt. Share)	31,000
Overhead Charges	633,000
Total	3,166,000

D.7.10 Kurumbi Tank Area

(1) Tank Irrigation Facilities Rehabilitation Works

(a) Tank Facilities

i) Tank Bund

Total bund length of this tank is 1120 m, and it is required to rehabilitate the entire length of the bund.

ii) Intake Facilities (Sluices)

The peak water requirement and the maximum design discharge are estimated as 36.11mm/day and 4.18 litter/sec/ha respectively. A single sluice serves the entire ayacut (command area), so that it is of importance in this ayacut for the irrigation network system. Rehabilitation tried out to modify the control device. Design condition of the sluice are below.

Beneficially area (Ayacut) - 52.67 ha
Water requirement - 0.180 m^3/sec/ha
Required vent size - 0.044 m^2(0.25 x 0.25m)

iii) Spillway (Surplus Arrangement)

There is a B.C. type weir. As shown in Table D.7.2., present capacity (22.95m^3/sec) of the weir is sufficient to meet the estimated drainage requirements. No rehabilitation work is proposed for this weir.

(b) Canal System (Selective Lining for Field Channel)

Single sluice serves 52.67ha, and lining are most importance item of the rehabilitation works. Beneficiary area is divided into 5 blocks on the basis of layout of field channel and existing land use. Layout of selective lining for filed channel is shown in Fig. D.7.10. Diversion boxes with paddle shutter are provided 1unit per 150m as same as other tanks

(2) Implementation Plan

1) Construction Plan

Through the past experiences, the tank having less than 100 ha can be rehabilitated within 2 years, implementing the period of non-cultivation in the command area and dry period of the tank water.

2) Cost estimate

i) Unit Price Analysis

Material and unit cost for rehabilitation works are estimated based on the *Standard Schedule of Rates for Kamarajar and Ramanathapuram Districts 1997-98* issued by PWD. These costs are shown in the Table D.7.3 and D.7.4.

ii) Construction Cost

Quantities for required rehabilitation works are estimated based on the Table D.7.1, at the 1997 price level, direct construction cost is estimated at about Rs. 1,466,000. The detailed construction cost is shown in Table D.7.14.

iii) Project Cost

Project cost consisting of rehabilitation costs, supervision charges, preparation work cost and overhead charges is Rs. 2,153,000.

Project Cost for rehabilitation works in Kurumbi Tank

Description	Total Cost (Rs.)
Direct Construction Cost	1,466,000
Contingencies	191,000
Petty Supervision Charges	44,000
Preparation Cost (Govt. Share)	21,000
Overhead Charges	431,000
Total	2,153,000