MODERNISATION OF TANK IRRIGATION SYSTEM

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PART I - WORK DONE AND STUDIES CONDUCTED

Introduction

Tanks or small earthen reservoirs, are formed in depressions by constructing earthen embankments across a natural drainage basin to impound water from the monsoon rains. They are an important source of surface irrigation and groundwater recharge in South India. They contribute to about 32 percent of the total irrigated area in the three states of Andhra Pradesh, Karnataka and Tamilnadu. While the major irrigation projects benefit a section of a district or state and are limited by topographical characteristics, tanks have a wider geographic distribution and cater to the irrigation, domestic and live-stock needs of a large percentage of rural population. Investments in tanks tend to be less capital intensive and involve local people in improvement and construction works. Although the efficiency of water use from the tanks is as low as 35 percent at present, the potential to improve it is great, considering the scope for their rehabilitation and better management. It is in this context that a study for modernisation of tank irrigation system has been taken up by the Centre for Water Resources, Anna University, sponsored and funded by the Ford Foundation, New Delhi. Given in the following pages is a resume of the study conducted in a tank irrigation system at Padianallur near Madras.

Objectives of the study

Padianallur tank in Chengalpattu district has been chosen for the study, because the district has a large concentration of irrigation tanks numbering 3746, with 1202 tanks having a command area of more than 40 ha and because tanks command about 75 percent of the net irrigated area in the district. This is a non system tank - one of the majority of such tanks in the district - receiving its water supply through runoff from its own watershed, without any other perennial source of supply to augment its storage. The tank has easy accessibility, being situated adjoining the national highway from Madras to Nellore and Delhi. It is also considered suitable for methodology development and for the establishment of effective linkage with the collaborating organisations. While such a localised study is perhaps limited in its applicability to other tank irrigation systems, nonetheless, it provides valuable information both on the common drawbacks as well as on the site specific problems which one could encounter in many other tanks. It also provides an insight into the prevailing irrigation practices and how they can be improved.

The pilot study is to:

i. investigate the present status of the irrigation system

ii. examine its deficiencies

iii. design measures for improving the system

iv. have the measures carried out by the collaborating organisations and the farmer beneficiaries

v. monitor the progress and co-ordinate the works of the various organisations

vi. evaluate the impact of these measures in the subsequent years and

vii. evolve general policy guidelines for modernisation and management of tank irrigation.

In order to achieve the above objectives, an inter-disciplinary approach has been established with the State Government Departments of Public Works, Agricultural Engineering and Agriculture, as well as the farmer beneficiaries who have the responsibility for the maintenance and improvement of the tank and its appurtenant structures, on-farm development, crop production and water management respectively.

Study Plan and Data collection

The primary concern of this study is to assess the potential and undertake tank modernisation to improve its irrigation efficiency and its productivity. The study has therefore been comprehensive in that it is planned to examine not only the quantity, timing and probability of the storage and the condition of the physical structures of the tank, but also the status of the other parts of the irrigation system, looking up to the watershed which feeds the tank and down to the field channels and wells which provide water to the fields in the command area. With regard to the distribution of water also, the prevailing system of regulation, frequency, quantity and place of application have been taken up for study through a socio-economic survey of the farmer beneficiaries of the tank command and their organisation and through field observations.

The study was commenced during July 1981. The following are the details of the investigations and surveys made and the data collected and computed.

i. Topographic survey of watershed: A topographic survey of the watershed of the tank was made and the ridge line was demarcated in the village map. The drainage area contributing to the tank is computed to be 3.75 Km^2 of free catchment and 3.10 Km^2 of intercepted catchment. Only a part of the runoff from the intercepted catchment limited to 2.8 cumecs is allowed to flow into the Padianallur tank through an inverted syphon, the excess runoff from this catchment flowing out into a feeder channel leading to Redhills lake situated down below and supplying drinking water to Madras city. The entire runoff from the free catchment flows into Padianallur tank.

The data collected from similar surveys made in the water spread and command areas of the Padianallur tank, the analysis of soil and water samples taken and the details of other observations made are furnished in the statement below:

Particulars	Watershed		Waterspread	Command area
	Intercepted	Free		
(1)	(2)	(3)	(4)	(5)
Area	3.10 Sq.Km.	3.75 Sq.Km.	97.28 ha	260 ha
Slope(percent)	3	1.5	0.5	0.05
Soil classification	Red loam	Red loam	Sandy loam	Loamy fine sand
Erosion/ Fertility status of soils	Moderately eroded	Slightly to moderately eroded	-	Low in organic matter content. Poor in available nitrogen and available potash and well

(1)	(2)	(3)	(4)	(5)
				supplied with phosphorous. Free from salinity and alkalinity.
Vegetation	Agricultural crops-15per cent Eucalyptus tree plantation-20per-cent Barren-65per-cent	Agricultural crops-90per cent Barren-10per cent	Weeds like nut grass (Cyperus spp) -40per cent Agri. crops-30percent Barren-30percent	Agricultural crops: Mainly paddy -90 percent Ragi and Vegetables-10percent

The water spread area, storage capacity, command area and the other hydraulic particulars of the tank are as follows:

	As originally designed	As computed now	Reducation (Percent)
Water spread/tank bed area (ha)...	97.70	97.28	0.43
Storage capacity of tank per filling (M.Cu.m.)	0.817	0.721	11.75
No.of fillings	2	1.41	(in 75percent of the years)
Command area(ha)	260	Years - Area	Gap(percent)
Area actually cultivated during different years (ha)		1966-67: 225 1967-68: 214 1969-70: 162 1970-71: 212 1974-75: 221 1975-76: 232 1976-77: 239 1981-82: 240	13.47 17.70 37.70 18.42 15.00 10.77 8.08 7.70

Break up of command area (ha)	Village	Area	Reach	Area
	Padianallur	157	Head	77
	Palavoyal	75	Middle	106
	Theertha karayam pattu	28	Tail end	77

Specifications and standards of tank structures:

1. Length of tank bund (m)			1845
2. Top width (m)			2
3. Side slopes		Front	1.5:1
		Rear	2.0:1

4.	F.T.L. (m)	M.W.L. (m)	T.B.L. (m)
	99.15	99.60	100.50

5. Sluices/Irrigation outlets:

Sluice No.	Location	Sill level (m)		Size of opening (cm)		Area commended (ha)
		Top (Circular)	Bottom (Rectangular)	Top (Circular)	Bottom (Rectangular)	
1.	L.S.680	97.84	97.24	14.6dia	30x17.5	82
2.	L.S.1166	97.63	96.93	15.0dia	15x17.5	137
3.	L.S.1443	97.70	97.08	20.0dia	30x17.5	33
4.	L.S.1771	98.29	98.14	40x86	10x15	8

Type of sluice openings: Plug and rod for the sluices No. 1, 2 and 3. Sliding wooden shutter for sluice No.4.

The present status of the tank and its components, its deficiencies and the improvements proposed/carried out are as follows:

Present status	Improvements proposed/carried out
1. Catchment area is moderately eroded in about 40per-cent of the area, due to clearance of trees and other vegetation. Some land is used for urban settlement and is levelled up.	Tree planting in the barren lands and adopting appropriate soil conservation measures in cultivated land are proposed. The State Forest Department have been addressed to take up planting of trees of economic value under the Social Forestry Project.
2. Choked up syphon has resulted in preventing the runoff from the intercepted catchment going into the tank.	The debris and silt have been removed by the P.W.Dept. and the conduit is clear to convey the runoff to the tank. The tank got filled up to its full capacity even during the S.W. monsoon rains in August 1983.
3. The supply or feeder channel from the syphon to the tank is meandering, its banks are caving in and its bed is raised due to silt accretion, which impedes free flow of runoff.	Silt clearance was done in the supply channel by the farmer beneficiaries, as a community work during 1983. The State Public Works Department has been requested to restore the supply channel cross section and bed grade to convey the computed runoff from the catchment into the tank and to ease the sharp bends and meanders as well as the side slopes of the channel.

4. Encroachments of channel margins, tank bed and rear slope of tank bund results in silt accretion, seepage loss and breaching of tank bund.	The Survey and Land Records department has been requested to survey the government land reserved for the tank bed and the channel margins and to fix survey stones to demarcate their boundaries. Once this is done, the encroachers will be persuaded to keep clear of these lands so that the further improvements proposed, such as tree planting, restructuring of channels etc. can be carried out by the concerned organisation. The survey work is under progress.
5. Silted up tank bed and weed infestation reduce the storage capacity and increase evapotranspiration loss.	The farmers have requested permission of the P.W.D. authorities to remove tank silt for application to their fields and for brick kilns and building construction. The authorities have expressed their concern, that unless silt clearance is done in a planned manner, it would result in a haphazard excavation of the tank bed and it will also enhance the percolation losses from the tank, due to the exposure of coarser soil particles below the sediment which is currently sealing the pore space and minimising the percolation loss. They were assured that the silt removal would be done as suggested and that we would take further observations on the change in the percolation rate due to silt

removal and the consequent recharge of groundwater in the command area.

As for eradication of the perennial weeds, use of weedicides is discouraged as that would adversely affect fish life in the tank. Burning the weeds, deep ploughing and eradication by excavating the roots during the summer by the farmers are contemplated.

6. Seepage loss of water through the main tank bund.

The top level of the tank bund which has got settled the become uneven, has been restored to the designed standard by the P.W.D. The cross-section of the bund has also been made larger by increasing the top width of the bund from 2 to 3 m and forming it to 2:1 rear slope, so that the saturation gradient falls within the outer toe of the bund and thus the seepage loss is prevented.

Incidentally, the strenthening of the tank bund by enlarging its cross-section and providing stone pitching up to TBL along its entire length has made it possible to use the bund as a cart track also, to transport manures, seeds, fertilizers and produce, thus meeting one of the long felt needs of the farmers,

7. Seepage loss of water from irrigation channels.	The Agricultural Engineering Department has lined all the laterals/sub mains in order to prevent this loss and also to facilitate speedier flow of water, as part of their On-Farm Development works. Restructuring of the main irrigation channels to hydraulically efficient cross-section to carry the peak discharge is planned, as the cost of lining the main channels is prohibitively high. If the problem persists even after the restructuring, lining of the main channels will be considered.
8. Loss of 18 percent of water through sluice leakage	All the sluices have been repaired and the leaks have been arrested with the provision of new shutters and locking arrangements by the P.W.D.
9. Incompatible sluice openings to the area commanded.	The P.W. Department has been requested to alter the sluice openings to match them to the area irrigated by each sluice, based on the approved duty to paddy crop. It requires the concurrence of the District Collector as well as the farmer beneficiaries, for the P.W. Dept. to take up this modification.

10. Some fields in the registered ayacut lie on higher elevation than the sluice command.	There is no scope to level these lands, as the cost will be prohibitive and the less fertile subsoil will be exposed. Hence it is proposed to encourage sinking of wells in such land holdings or lifting water from the channels to irrigate these fields. Such areas are also put to crops other than paddy to minimise their water requirement. An additional high level sluice to command some of these lands has also been constructed by the P.W. Department.
11. Water logging of fields in the upper reaches due to seepage from the tank.	The enlargement and strengthening of the tank bund would minimise this problem. Besides, pipe outlets proposed and being provided by the Ag.Engg.dept. are expected to minimise water logging.
12. Inadequate and delayed supply of water to the field away from the main channels as well as to the fields in the tail end reach.	The provision of additional laterals and field channels being made in the OFD works and the restructuring of the main channels and lining of the laterals are expected to solve this problem considerably.

Other data collected and analyses made are as follows:

Flow measurements

1. In order to examine whether irrigation water is distributed equitably to all the fields in the command area and to quantify the differences if any, the entire command has been divided into three reaches - the head, the middle and the tail end and the channel flows at the head of each reach are being measured by installing Parshall flumes. Initial analyses of these flow measurements reveal that there is no equity in water distribution, but the precise variations among the reaches are yet to be computed accurately, because the flumes are frequently removed by the farmers who fear that these flumes restrict the quantity of water flowing to their land. Initially 'V' notches were installed to measure the flow, but as they required clear overfall to compute the flow precisely, some heading up of water behind the 'V' notches became necessary. This was resented by the farmers and they attempted to take water by breaching the channel banks, Parshall flumes ~~xx~~ were therefore substituted in their place. In two main channels, the Parshall flumes record the flow under submerged conditions of 96 percent and more when the computations of flow also become unreliable. Other simpler devices which measure the velocities of small flows and used successfully in the Phillippines are proposed to be installed in the tank.

Water analysis:

The water samples collected from the tank, from the wells in the command area and the drainage water at the tail end of the command were analysed and found to have a pH valve ranging from 7.6 to 8.0 and Electrical Conductivity (E.C.) of 0.1 to 0.9, excepting in two wells where the EC was 1.4 and 2.6 respectively and therefore needed treatment with gypsum. The other water samples showed that they are suitable for irrigation as they are.

Soil analysis:

Twentyfive soil samples collected from the different fields in the command were analysed and their pH ranged from 7.2 to 8.2 while their EC was only 0.1 excepting in two cases where the EC was 0.5 and 0.6. They are classified as clay loam and sandy loam and are considered free from salinity and alkalinity.

Groundwater: The water table in the command area as observed during the monsoon period is 0.35m, 0.25m and 0.69m below ground level in the head, middle and tail end reaches respectively. There are 30 open wells and 20 tube wells in the area of which 22 open wells and 16 tube wells are presently in use. Well irrigation is resorted to during the period when the tank is dry, for raising nursery, for land preparation, for transplanting and for irrigating the standing crops. Most of these wells have electric or diesel powered pumps.

The area under the command of these 38 wells in use is 94.50 ha. After meeting their own needs, the farmers who own the wells sell water to the neighbouring land owners. The wells get their recharge mainly from the tank above and from percolation of the irrigation water applied to the lands of the tank command area.

The subsurface lithology is generally as follows:

Top soil	0.90 m thick
Clay and silt	1.20 m thick
Shale	2.40 m thick
Gravel(Red colour)	1.68 m thick
Sand medium	2.90 m thick

From the pump tests conducted, the storage coefficient was found to be 10 percent and the permeability 49.58 m/day. The extent of area in the command which does not have access to groundwater works out to 86.00 hectares. At present, 38 wells are supplementing 94.50 ha, which works out to 2.49 hectares per well. Therefore, an additional 30 wells, preferably tube wells, in the command would be able to provide for supplementary irrigation of the command area. A monthwise water balance study indicated that there is adequate groundwater potential in this area to sink these additional wells.

Command Area Water Users' Committee:

The farmer - beneficiaries of Padianallur tank from the three revenue villages mentioned, have formed a water users' or ayacutdars' committee, for the purpose of regulating and distributing the tank water among themselves. This committee which was not higher-to functioning very effectively, was activated and reconstituted with twleve members in all, with 3 members each from Padianallur, Pannivakkam (hamlet of Padianallur), Palavoyal and Theerthakarayampattu villages. The committee had met six times since June 1982 and have also undertaken the following works:

i. Closing the breaches in tank bund promptly during the heavy rains, to prevent large scale flood damage.

ii. Clearing silt in the supply channel from the catchment to the tank, to facilitate the runoff reaching the tank water-spread area without wastage

iii. Arranging for the opening and closure of shutters in the sluices and monitoring the outflow so as to prevent wastage of tank water

iv. Establishing liaison with the staff of the Anna University, PWD and Agr.Engg.Department connected with the tank modernisation works and giving suggestions for tank improvement works while stressing their felt needs

v. Undertaking the responsibility to use the water most economically on a rotational basis so that the tank storage can be stretched to benefit the second crop for a maximum duration and to make the distribution more equitable than in the past.

This awakening amongst the farmers to manage the water distribution collectively is a major step forward to improve the efficiency of water use from the tank. It is hoped that their interest will be sustained and that they co-operate with the project staff to implement the rotational irrigation by judicious operation of the sluices, outlets and other water control structures efficiently.

Work remaining to be done:

1. Modifications to the sluice openings are to be carried out by the P.W.D.

2. Restructuring of main irrigation channels and construction of control structures are to be done under two of the four sluices by the P.W.D.

3. The tank bund has to be extended in the north from IS 00 to meet the elevated ground in the foreshore and hold water upto F.T.L.

4. On farm development works comprising division of command areas under each sluice and constructing a net work of laterals, field channels, pipe outlets and distribution boxes are to be done by the Ag.Engg.Dept. under sluices 1, 2 and 4.

5. Survey and demarcation of field boundaries of government land are to be made by the Survey and Land Records Department, so as to facilitate eviction or vacation of the prevailing encroachments and to make improvements to the tank structures.

6. After these works are completed, it is proposed to introduce a rotational irrigation system as planned in the tank command, observe the reactions of the farmers and the difficulties, if any, encountered and make such modifications as may be found necessary to improve the system and to ensure equity in water distribution.

7. Appropriate cropping pattern as suggested by the Agricultural staff under the new irrigation plan will be adopted to increase the crop yield and cash return to the farmer.

As the cropping seasons (at present about 180 ha are under second crop) slow down the execution of the improvements contemplated, and as these works can be done only when the fields are fallow, further work will be executed by the Public Works and Agri. Engg. depts. after the harvest of the standing crops.

Rotational Irrigation Plan:

To start with, the rotational irrigation system will be introduced in the command area of one irrigation outlet, viz sluice No. 3, during the first crop season from September 1984 to January 1985. In this part of the tank command which spreads over 80 acres, on farm development works have been executed by the Agricultural Engg. dept. while the restructuring of the main channel and construction of control structures comprising two bed regulators have been done by the Public Works Dept. There are 59 land holders owning these 80 acres.

Rice is the only crop raised is the entire command area. It is sown initially as a rainfed crop in part of the area to be later converted as an irrigated crop when the tank gets the freshes, and as a completely irrigated (transplanted) crop in the remaining extent under this outlet.

The total area of 80 acres has been divided into three blocks A, B and C of about 24 to 28 acres each. Every block is served by a lined lateral taking off the bed regulator constructed across the main channel. These three blocks have again been sub divided into 6 to 7 divisions each with an extent of about 4 acres. Water will be diverted from the main channel to simultaneously irrigate one division of every block daily. The duration of water supply will be twelve hours from 6 AM to 6PM, during which period about 4 acres in each division will receive supply for a depth of 5 cms. The carrying capacity of the lateral being 0.67 cusec, only this much area can be irrigated each day. Thus, it will take six days to cover one block of 24 acres with one application of water and the next irrigation for this area will be on the seventh day in A block. In B and C blocks which are about 28 acres in extent, one water application will take seven days.

The fields which will receive water during each day have been grouped and gmd an irrigation schedule has been worked out. The

sequence in which the individual land holdings will receive water and the timings have been worked out for each division and block. Thus one division in every block A, B and C will receive water daily, irrespective of its location in the head, middle or tail end reach and the frequency of irrigation will range from six to seven days in each of these three blocks. This schedule is expected to result in a more equitable distribution of water than hitherto, when field to field irrigation was the practice adopted.

The practical difficulties of implementing this rotation and the response of the farmers to it will be observed and recorded, and the hardships, if any noticed will be removed then and there to the extent possible by enlisting the co-operation of the farmers involved.

Issues Confronting Modernisation Programme:

This would be an opportune occasion to consider the various issues and problems that are confronted in a modernisation programme of tank irrigation system. While we may not have an answer to all these problems, it would be worth while to discuss the issues and share the experiences of this august assembly, so that we may go in the right direction to reach the goal. The following are some of the issues that we find in our study of the tank irrigation system.

iv. Need for a single organisation to plan and implement the programme:

Again, even in a tank taken up for rehabilitation, part of the works are done by the Public Works Dept. and the rest by the Agri. Engg. Dept. Each department having several types of works in their charge, but with a meagre field staff to attend to the execution, the co-ordination of the efforts of different agencies working in the same area becomes difficult, if not impossible. Getting all the works in a tank irrigation system, planned and executed by a single agency or establishing an organisation like a command area development authority, on a smaller scale, for modernising and operating the tank irrigation system is also worth considering.

v. Conflicts amongst water users:

There is often some conflict among the farmers under a tank command, if they belong to different villages. The villagers where the tank is situated invariably make a preferential claim to its water over the others far away from the tank, although all of them pay the same water rate and have equal right over the water. What can be done to see that all the farmers realize that they are equal partners and are therefore eligible for equitable supply of water is another question that needs to be solved.

While the solutions for technical system deficiencies are easier to find, the need for administrative and organisational policy changes to meet the demands of tank irrigation system has become great and urgent.

Fig. No. 1

INDEX PLAN SHOWING PADIYANALLUR TANK

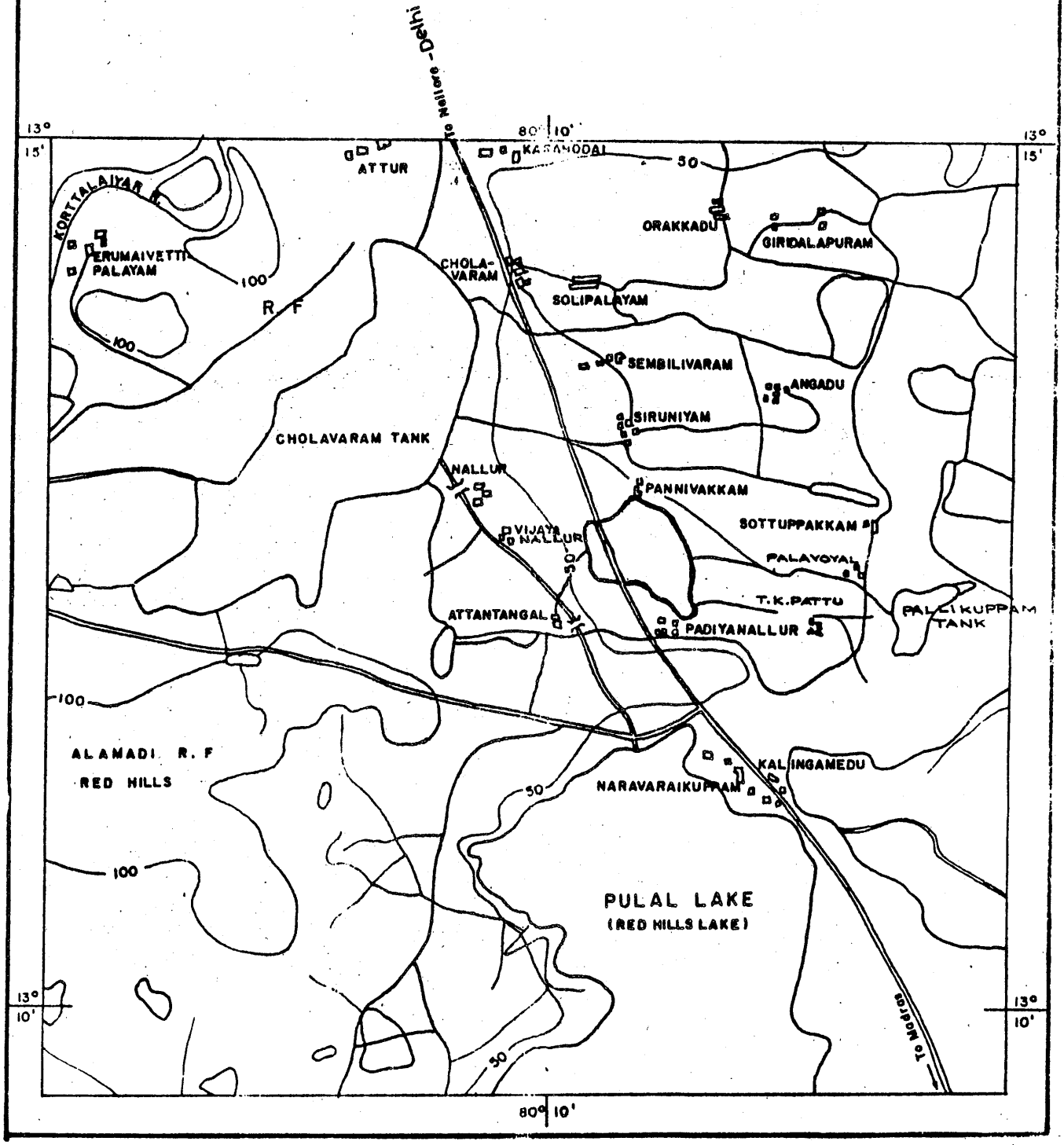
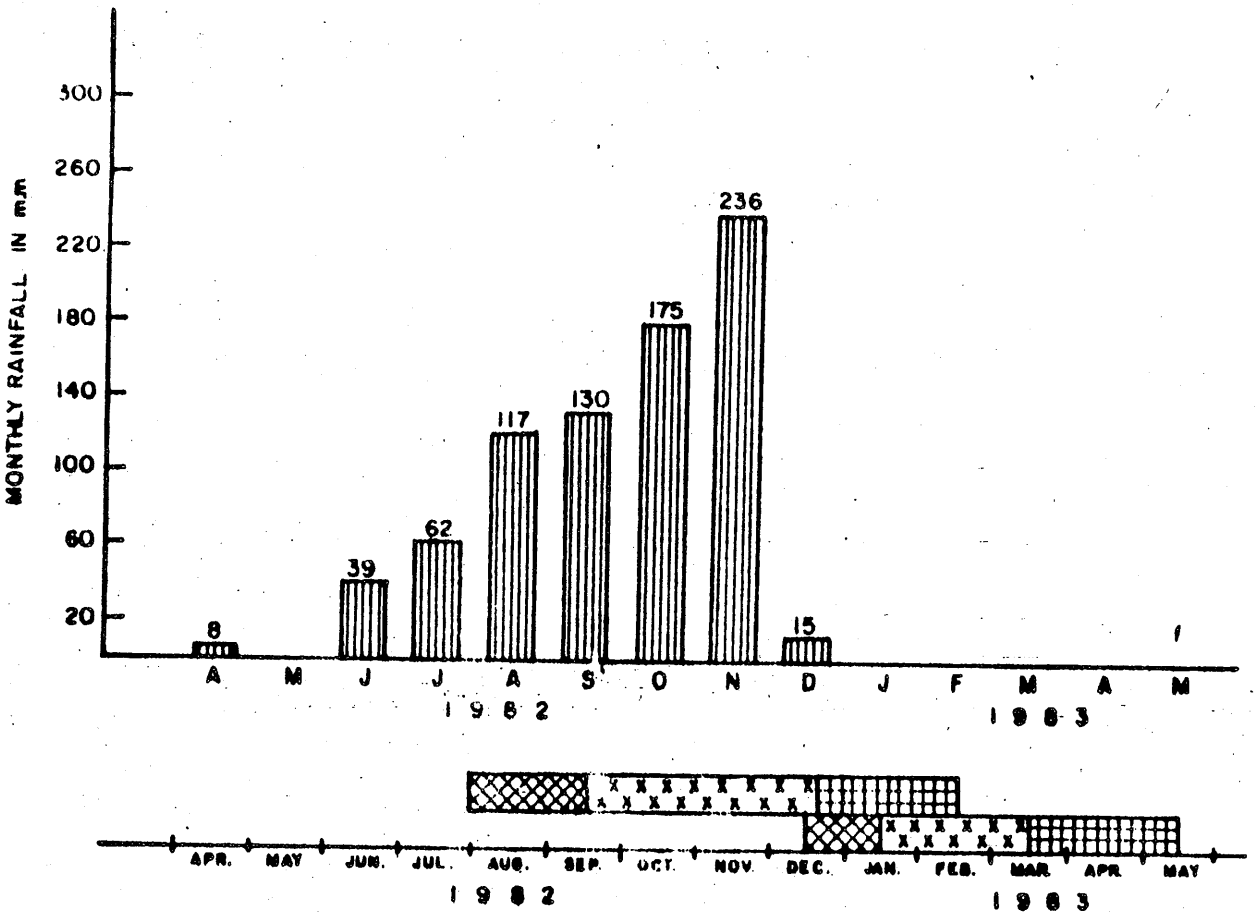


Fig. No. 2

RAINFALL AND CROPPING PATTERN FOR 1982-83.



BROAD CASTING OR TRANSPLANTING PHASE

VEGETATIVE PHASE

HARVEST

AVERAGE ANNUAL R.F. --- 1266 mm

TOTAL R.F. 1982-83 --- 782 mm

FIRST CROP PADDY - July/Aug. - Jan./Feb

SECOND CROP PADDY - Dec./Jan. - Apr./May

M.D = 120-135 days.

L.D = 150-180 days.

S.D = 100-110 days.

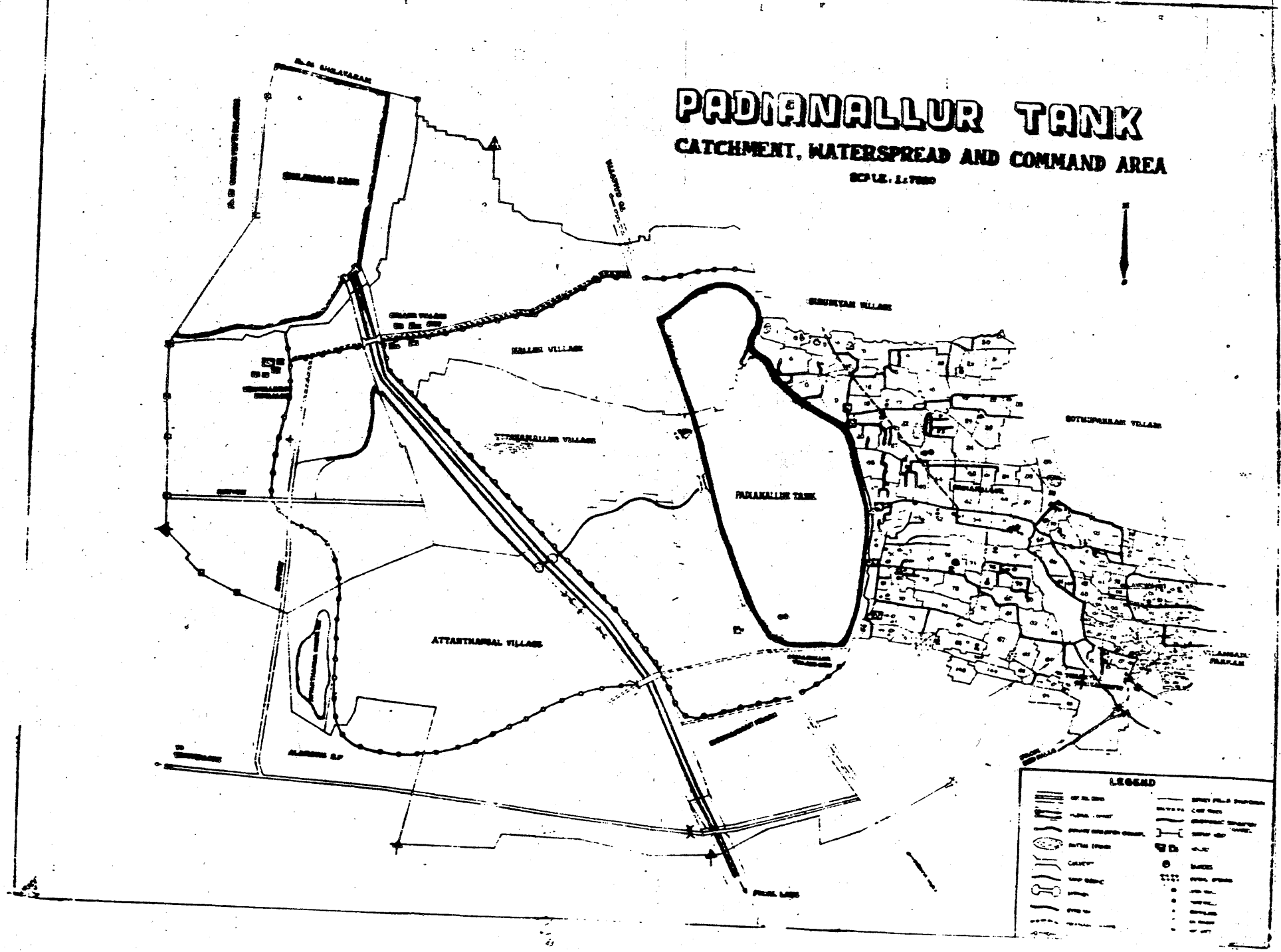
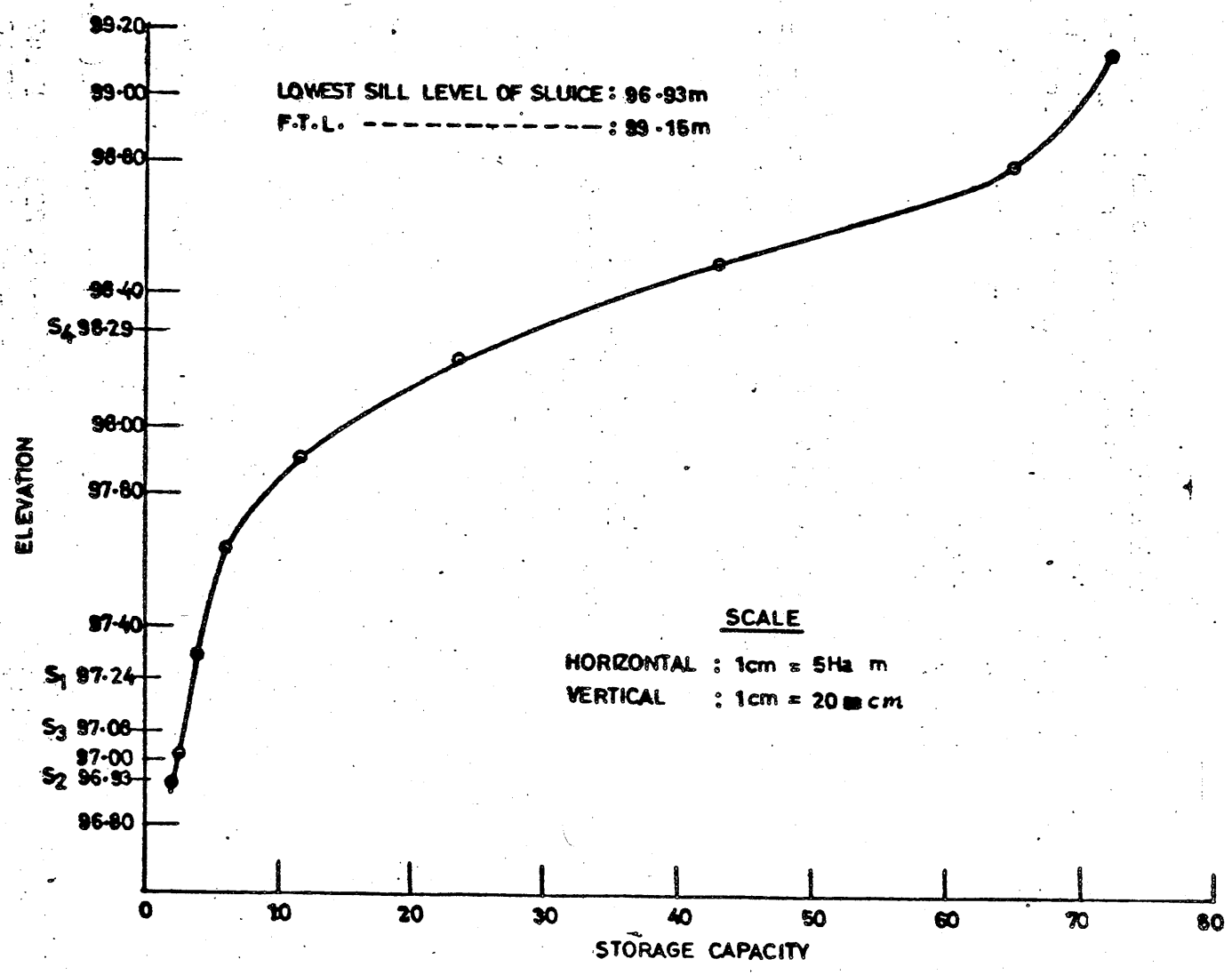

PADIANALLUR TANK
CATCHMENT, WATERSPREAD AND COMMAND AREA
ATTATHARAL VILLAGE
PADIANALLUR TANK
LEGEND

FIG.4



ELEVATION–TANK STORAGE

PART-II: SIMULATION STUDIES OF PADIANALLUR TANK SYSTEM

With the spade work done during the course of modernisation of the Padianallur tank system, it was felt appropriate to initiate a few theoretical investigations using systems approach to give a positive direction towards the achievement of a better water application efficiency, equity of distribution and optimal utilization of the resources available .

The following are the specific objectives of an investigation recently completed at the centre:

i. Assessment of surface and groundwater resources and the extent of acreage that can be raised with permissible irrigation deficiency during I and II cropping seasons by conjunctive use of water resources.

ii. Evolving suitable cropping pattern for the existing and the improved conditions of the system.

iii. Bringing out the quantitative effect of further modernisation work such as lining of channels of the system.

iv. Estimating the effect of exploiting additional groundwater potential

and

v. Study of the effect of any possible change in the watershed resulting in changed runoff characteristics.

Simulation study of the system on a day-to-day basis using the historical data of record of 16 years was undertaken to achieve the

The flow chart of the simulation study PADSIM-I is shown in Fig. . The input data requirement is also given in the same figure.

The operation policy adopted for the simulation study is that the tank water will be released when the storage in the tank goes above the sill level of sluice 2 and whenever the irrigation requirement exceeds the tank release, the defficiency will be met from the groundwater potential. The conjunctive use of surface and groundwater required for the real time operation of the system is incorporated in the model.

The hydrological analysis yielded the daily rainfall expected daily runoff. Based on 3 years data available on the varieties of paddy cultivated in the command area and their extent raised in the tank command, the farmers are found to prefer the following crops for the first season.

1. IR-20 - Medium duration (130-135 days)
2. Ponni - Medium duration (130-135 days)
3. Andhra Sirumani - Long duration (160-180 days)
4. Vadan, Samba, Bayyagondum, Mosanam } - Long duration (160-180 days)
   (Raised either by transplanting or by broadcast sowing)

During the second crop, they raise

1. IET - 4768
2. TKM - 9 } - Short duration variety (100-105days)
3. Kannagi
4. Kanchana

The farmers' preference is given priority in the simulation model, if it is feasible. The crop water requirement data is taken from publications of ICAR and Soil and Water Management Research Institute, Thanjavur.

Though the department of Agriculture, Tamilnadu recommends the raising of pulses, groundnut, Ragi etc during the IInd cropping season in view of their reduced water requirements in the tank commands, a strech of land close to the bund has high seepage making it unsuitable for pulse or groundnut. The remaining area can raise dry crops in the second cropping season.

The effect of sinking of 28 additional wells, the effect of lining of canals and the effect of reduced runoff coefficients are studied in the simulation runs.

The following is the digest of the results obtained from the several simulation runs:

i. The optimal cropping pattern for the first and second crops are obtained for the existing level of groundwater potential and for the condition of sinking of 28 additional wells. Vide Tables 1 and 2

No crop other than paddy can be recommended for Padianallur tank ayacut with the prevailing conditions during the first crop season. From the runs, it is seen that the entire ayacut of 245 Ha can be brought under paddy crop during the first crop season without meeting any irrigation deficiencies during flowering, yield formation

and ripening stages of growth. The deficiencies met during nursery and vegetative stages of growth are present in 5 years out of 16 years considered for simulation, though these deficiencies will not affect the crop yield.

Also, from the results it is seen that no additional improvements such as sinking of additional wells and lining of canals are necessary for raising paddy crop during the first crop season. If additional wells are sunk, the probability of crop production would rise up to 98 percent.

ii. The irrigated dry crops like pulses, groundnut and ragi suggested for the second crop face irrigation deficiency of about 13 percent during their maturity stages though this is well within the permissible limit of 20 percent and hence the crop yield will not be affected much.

iii. The lining of canals has no substantial effect on the system. This is evident from the fact that the channel network is small for a tank system and when conjunctive use of surface and ground water is resorted, the conveyance efficiency is higher.

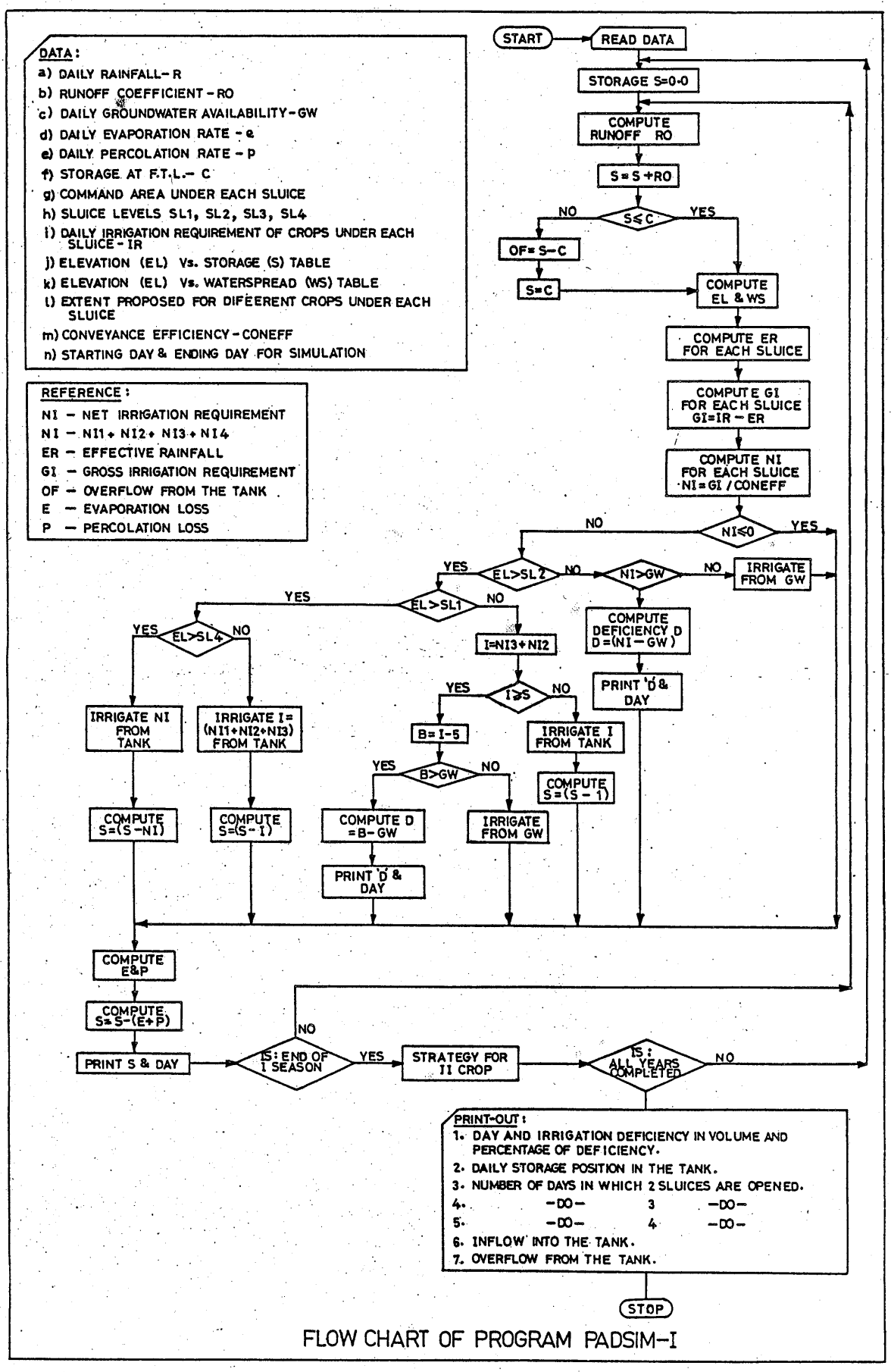
iv. As the deficiency occurs before the tank gets filled due to limitation of groundwater potential, the runoff coefficient has no big effect when reduced even by 10-20 percent.

Further work is required to be done for the day-to-day scheduling under each sluice with the rotational system incorporated in the model.

CROPPING PATTERN SUGGESTED FOR I CROP SEASON

Sl. No.	Variety of Paddy	Crop duration in days	Method of sowing	Area in ha. proposed under each sluice				
				I	II	III	IV	Total
1.	IR-20 (High Yielding Variety)	130-135	Transplanted	10.0	75.0	10.0	5.0	100.0
2.	Ponni (fine variety)	130-135	Transplanted	5.5	34.5	10.0	..	50.0
3.	Andhra Sirumani (fine variety)	160-180	Transplanted	4.5	5.5	..	..	10.0
4.	Andhra Sirumani Mosanam - Vadansamba	160-180	Broadcasting	50.5	17.55	13.75	3.20	85.00
			Total	70.50	132.55	33.75	8.20	245.0

no.	proposed	Area in ha. proposed under each sluice				
		I	II	III	IV	Total
1.	2	3	4	5	6	7
1.	Without lining without addl. wells(i.e exist -ing condition of system)	Rice 2.0 Pul. 10.0 G Nut 15.0 Ragi 20.0	Rice 22.0 Pul. 20.0 G Nut 10.0 Ragi 5.0	Rice 15.0 Pul. 7.0 G Nut 3.0 Ragi 3.0	Rice 1.0 Pul. 3.0 G Nut 2.0 Ragi 2.0	Rice 40 Pul 40 G Nut 30 Ragi 30
	Total	47.0	57.0	28.0	8.0	140 ha
2.	Without lining with 28 addl. wells	Rice 3.0 Pul 35.0 G Nut 7.5 Ragi 25.0	Rice 75.0 Pul. 10.0 G Nut 22.55 Ragi 22.0	Rice 20.0 Pul 10.0 G Nut 4.75 Ragi 2.0	Rice 2.0 Pul 3.0 G Nut 2.2 Ragi 1.0	Rice 100 Pul 55 G Nut 40 Ragi 50
	Total	70.50	132.55	33.75	8.20	2 45 ha



FLOW CHART OF PROGRAM PADSIM-I