WORKING PAPER

Working Paper No. 49

IRRIGATION IN TAMIL NADU : A SURVEY

by

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IRRIGATION IN TAMIL NADU : A SURVEY

I Introduction

Irrigation : its rationale

Water is a prime requirement for the growth of crops. Its essential functions are to maintain plant temperatures within tolerable limits and to facilitate the absorption of nutrients in the soil. Land under crops is continually losing moisture on account of transpiration by plants and evaporation from the exposed soil. Losses from such evapo-transpiration must be promptly and adequately replenished. The length of crop growth and seasonal variations in climate mainly determine water requirements; in addition, water is consumed for such purposes as land preparation and partial immersion in the case of crops like paddy, and on account of seepage and percolation under field conditions. Direct rainfall, which is the primitive form of irrigation, is in part ineffective on account of losses in run-off and percolation. The quantum and seasonal distribution of effective rainfall, which can be absorbed and retained in the soil, can rarely be relied upon to meet the entire water requirements for crop husbandry. In these circumstances, irrigation - which is the controlled supply of water to land for agriculture-has been practised through a variety of means such as the distribution of water from rivers through channels and canals (either from direct flows or after storage in dams), from tanks fed by rivers and/or rainfall, and through wells which utilise water stored under the ground.

Its long history

2. Irrigation in India has had a history extending to millennia. Tamilnadu can be proud of some of the oldest examples of irrigation works in the country. The Grand Anicut (Kallanai) built in the second century AD across the

Cauvery by Karikala Cholan is considered to be the greatest engineering feat in ancient India; and, it is still operational. We can be equally proud of the ingenious and extensive system of tanks in Tamilnadu which have been designed -- many of them centuries ago- to utilise river and rain waters for agriculture.

Its wide impact

3. Irrigation increases the productivity of land, enables higher intensities of cropping, and the growing of more remunerative crops. In the process, it contributes to growth, diversification, trade and employment. Within a given agrarian structure, the surpluses generated by irrigation can result in asset-formation and concentration. Irrigation also absorbs surpluses, providing a major avenue for public and private investments. It has effects on the demand for, as well as the supply of, labour. The extent and mode of irrigation have implications for population densities and settlement patterns, the commercialisation of agriculture, cultural formations and ecology. The use of waters from common sources - whether rivers, tanks or underground acquifers - on land that is privately and differentially owned or operated leads to a whole set of issues related to distributional equity, ecological conservation and the community management of irrigation works. The societal and economic impact of irrigation is thus wide-ranging and complex. In Tamilnadu, traditional systems of irrigation have been known for centuries and they have existed alongside substantial unirrigated or 'dry' areas. This has enabled a variety of social scientists to use irrigation as a broad frame of reference to analyse differences in the socio-economic characteristics of 'wet' and 'dry' areas in the State.[1/]

Scope of the Working Paper

4. While we have drawn attention to the literature on it, the scope of this Working Paper will not permit us to go into the impact of irrigation in any detail, although we shall touch upon some aspects of it. The focus of this Working Paper is essentially to describe the characteristics of irrigation in Tamilnadu and to identify the principal issues that have a bearing on its future development. The Working Paper is organised as follows. We begin with describing irrigation in Tamilnadu in terms of certain broad features. This is followed by a detailed review of the three principal modes - rivers, tanks and wells - identifying the performance, problems and prospects in each. The financial aspects of irrigation are then discussed. The concluding section touches upon issues involved in the development of irrigation. A note on irrigation statistics is appended.

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Note: Numbers in square brackets indicate the serial number of the reference in the bibliography.

1/ See C.T.Kurien and Josef James Economic Change in Tamil Nadu 1960-1970 Allied Publishers Ltd 1979; C.J. Baker An Indian Rural Economy 1880-1955 : The Tamilnad Countryside Oxford University Press 1984; D.A.Washbrook The Emergence of Provincial Politics : The Madras Presidency 1870-1920 Cambridge University Press 1976. Also, K.C.Alexander 'Some Characteristics of the Agrarian Social Structure of Tamilnadu' in the Economic and Political Weekly November 1, 1975; A.Beteille 'Agrarian Relations in Tanjore District' in Studies in Agrarian Social Structure Oxford University Press 1974; Marshall M.Bouton The Sources of Agrarian Radicalism : A Study of Thanjavur District (forthcoming); Kathleen Gough Rural Society in Southeast India Cambridge University Press 1981; David Ludden 'Ecological Zones and the Cultural Economy of Irrigation in Southern Tamilnadu' in South Asia March 1978; and V.K.Ramachandran 'Agricultural Labour in the Working Population of Tamil Nadu' in the Madras Institute of Development Studies Bulletin March 1980.

II Irrigation in Tamilnadu: The Broad Picture

Rainfall

5. All the sources of irrigation in Tamilnadu - rivers, tanks and wells - depend ultimately on rain for their recharge. The characteristics of rainfall- quantum, seasonal pattern, spatial distribution, variability - have therefore a vital bearing on the extent and reliability of irrigation. The long-term average or 'normal' rainfall in Tamilnadu amounts to 943 mm per annum. Within India, Tamilnadu belongs to a zone of low-to-moderate rainfall (500 to 1000 mm) in comparison with areas of heavy rainfall (more than 2000 mm) such as Assam and parts of the Western Ghats, of moderate-to-high rainfall (1000 to 2000 mm) extending from eastern to north eastern India, and of poor rainfall (less than 500 mm) as in Rajasthan and Kutch. Rain mainly occurs during the two monsoons viz., the south-west (June-September) and the north-east (October-December) which together account for 80 per cent of annual rainfall. The balance is accounted for in the hot months of March to May (15 per cent) and in the winter months of January and February (5 per cent).

6. In the State as a whole, of the two monsoons the north-east monsoon makes the larger contribution : about 450 mm (or 47.6 per cent of the total) as compared to 307 mm (or 32.5 per cent) from the south-west monsoon. However, over the greater part of the State, the heaviest rainfall of the year is brought by the south-west monsoon. It also feeds the catchment areas of the main rivers such as those of the Cauvery, Parambikulam, Periyar and Tamraparni which benefit Tamilnadu. The incidence of the North-east monsoon is concentrated in the coastal districts - Madras, Chengalpattu, S.Arcot and Thanjavur - and it is also higher than average in the Nilgiris, Kanyakumari, Tirunelveli and Ramanathapuram. The north-east monsoon is of particular importance to rain-fed tanks and for dry cultivation in the southern districts.

7. Within this general pattern, there are distinct variations between different regions. As Table 1 will show, districts with rainfall above the State average are the Nilgiris, Kanyakumari, Thanjavur, North Arcot and the north-eastern districts of Madras, Chengalpattu, and South Arcot. The higher incidence of the north-east monsoon in these parts mainly accounts for this. Coimbatore and Periyar districts, which are in the rain-shadow region of the Western Ghats, have the lowest rainfall with an annual level of about 700 mm. Other districts viz., Salem, Dharmapuri, Tiruchirapalli, Pudukottai, Madurai, Ramanathapuram and Tirunelveli have rainfall levels of 800 to 900 mm. Variations from year to year in the seasonal rainfall can also be significant, particularly in the case of the north-east monsoon which is subject to depressions in the Bay of Bengal. In the most recent experience of the 1970s, annual rainfall fell to a minimum of about 650 mm in 1974-75 and went up to about 1100 mm in 1977-78, with the fluctuation being largely on account of the north-east monsoon. In years of very severe drought (e.g. 1876 and 1892), when both monsoons have failed, rainfall levels have been as low as about 400 mm in several districts.

8. The Irrigation Commission (1972) defined 'drought affected' areas as those in which the annual rainfall was less than 75 per cent of the normal in 20 per cent of a sufficiently long span of years and additionally where the irrigated extent was no more than 30 per cent of cultivated area. On this basis, 24 taluks in the districts of Dharmapuri (Hosur, Krishnagiri, Harur and Dharmapuri), Salem (Sankari and Tiruchengode), Coimbatore, (Dharapuram, Palladam and Avinashi), Tiruchirapalli (Perambalur, Karur, Kulathur and Alangudi) Madurai (Dindugal, Palani, and Tirumangalam), Ramanathapuram (Tiruvadanai, Paramakudi, Ramanathapuram, Mudukulathur, Aruppukottai and Sattur) and Tirunelveli

Table 1 : Rainfall in Tamilnadu

(1900-50 annual average in millimetres)

District	South-west (June-Sept)	North-east (Oct-Dec)	Winter (Jan-Feb)	Hot season (March-May)	Total
1. Madras	363.7	795.3	58.0	68.6	1285.6
2. Chengalpattu	397.7	690.1	53.8	68.5	1211.0
3. S.Arcot	391.8	627.8	68.3	101.0	1188.9
4. N.Arcot	440.1	385.5	38.9	106.0	971.1
5. Salem	354.9	303.1	24.8	159.6	842.4
6. Dharmapuri	366.6	290.9	22.0	164.8	844.3
7. Coimbatore/Periyar	199.9	332.1	28.4	158.0	718.4
8. Tiruchirapalli	273.3	419.2	40.5	134.8	867.8
9. Pudukottai	351.0	394.1	52.2	125.5	922.8
10. Thanjavur	288.7	680.6	84.8	114.0	1168.1
11. Madurai	233.2	409.0	48.7	163.9	854.4
12. Ramanathapuram	185.4	455.5	65.7	132.9	839.5
13. Tirunelveli	109.5	485.8	80.4	139.1	814.8
14. Nilgiris	1061.3	513.6	69.7	276.2	1920.8
15. Kanyakumari	546.2	564.0	47.0	312.5	1469.7
Tamilnadu	307.3	449.7	50.9	137.8	945.7

Source: Commissioner of Statistics, Government of Tamilnadu.

(Koilpatti and Nanguneri) were identified as drought affected areas in Tamilnadu. While these are the areas most affected by unreliable rainfall and poor irrigation, there are many other taluks in the State which face acute distress when rains prove inadequate. In comparison to other States, population densities in the drought-prone taluks in Tamilnadu are distinctly higher. They account for as much as 22 per cent of the total population and extend widely across the State.[1/]

9. The spatial pattern of rainfall, in combination with topographical features, sets certain constraints on the utilisation of water. The heavy coastal north-east rain, occurs in Thanjavur and parts of South Arcot at a time when it is not directly usable due to the concurrent availability of river flows; nor do the terrain and availability of land in these areas permit storage through tanks as is possible in eastern Ramanathapuram and Chengalpattu. Out of an average annual availability of 12.32 million hectare metres (MHM) from rainfall in Tamilnadu, it is estimated that surface run-off, evaporation and deep percolation account for 6.25 MHM. Allowing for other constraints relating to time and place of rain, and of storage, the utilisable potential has been estimated at 2.50 MHM or just about 20 per cent of rainfall over the State.[2/]

Extent of Irrigation

10. In relative terms, Tamilnadu compares well with other States in India in regard to the extent of cropped area under irrigation, although as much as about 60 per cent of gross cropped area is unirrigated i.e. under dry cultivation. In the late 1970s, the ratio of gross area irrigated (i.e. including area irrigated for all crops during the year) to gross sown area (i.e. including area sown more than once in a year) was 42.0 per cent in Tamilnadu as compared to the all-India average

of 25.8 per cent. Table 2 will show that among the major States only Punjab (80.8 per cent) and Haryana (51.1 per cent), were ahead of Tamilnadu in this respect.

11. Table 3 reviews the growth in the extent of irrigation in terms of the proportions of net/gross irrigated area to net/gross sown area in 1950-80. The corresponding figures for the intensity of irrigation, i.e. the proportion of gross to net irrigated area, are also given. These proportions vary with seasonal conditions in the reference year or period but certain broad trends are visible. The large increase in the extent of irrigation (gross) has taken place in the 1950s. The ratio has remained more or less stagnant until about the mid-1970s but has moved up somewhat since then. As we shall see later, the first period of growth is associated with an increase in surface irrigation (canals and tanks) while the second, in the later 1970s, is a reflection of growth in groundwater utilisation (wells). The intensity of irrigation also tangibly improved in the 1950s, from 117 per cent at the beginning to about 130 per cent at the end of that decade. Thereafter, it has tended to remain at about the same level.

12. There are variations inter-se among the districts in the extent and intensity of irrigation. These are brought out in Table 4. Chengalpattu is the leading district in the extent of sown area irrigated followed by Thanjavur, S.Arcot and N.Arcot. The driest district is Dharmapuri, ignoring the Nilgiris which is a hill district. Salem, Coimbatore/Periyar, Tiruchirapalli and the southern districts of Madurai, Ramanathapuram and Tirunelveli are also relatively less well endowed. Districts with relatively high intensities of irrigation are Kanyakumari, N.Arcot, Chengalpattu, Salem, Tiruchirapalli and S.Arcot while Ramanathapuram, Pudukottai and Madurai are relatively poor in this respect.

Table 2 : Irrigated cropped area to gross cropped area 1976/77

(Per cent)

State	
1. Andhra Pradesh	35.0
2. Assam	17.3[1/]
3. Bihar	31.8
4. Gujarat	13.5
5. Haryana	51.1
6. Karnataka	14.9
7. Kerala	12.7
8. Madhya Pradesh	9.8
9. Maharashtra	11.2
10. Orissa	19.2
11. Punjab	80.8
12. Rajasthan	17.6
13. Tamilnadu	42.0
14. Uttar Pradesh	42.1
15. W. Bengal	20.2[2/]
All-India	25.8

1/ Refers to 1953/54 2/ Refers to 1967/68

Source: Government of India: Indian Agriculture in Brief 1980.

Table 4: Extent and Intensities of Irrigation District-wise 1976-77

(Per cent)

District	Extent		Intensity[3]
	Gross[1]	Net[2]	
1. Chengalpattu	79.4	77.7	146.1
2. S.Arcot	54.4	53.3	130.6
3. N.Arcot	52.8	45.8	149.5
4. Salem	25.5	22.1	133.4
5. Dharmapuri	14.6	12.9	124.0
6. Coimbatore/Periyar	35.1	31.6	126.1
7. Tiruchirapalli	28.9	24.2	132.0
8. Pudukottai	49.9	47.7	111.9
9. Thanjavur	58.5	70.8	122.8
10. Madurai	33.3	31.3	117.5
11. Ramanathapuram	35.9	34.8	105.4
12. Tirunelveli	33.9	30.0	125.3
13. The Nilgiris	0.5	0.6	100.0
14. Kanyakumari	42.8	33.4	171.4
Tamilnadu	42.0	38.8	128.8

1/ Gross irrigated to gross cropped area.

2/ Net irrigated to net cropped area.

3/ Gross to Net irrigated area.

Source: Government of Tamilnadu Irrigation Statistics 1976-77.

Modes of Irrigation

13. The three main modes or sources of irrigation in Tamilnadu consist of channels and canals (taking off from rivers), tanks, and wells. Streams and spring channels are other sources of minor importance. Rivers are utilised either through channels into which water flows through inundation (i.e. a natural rise in the level) or through canals into which water is made to flow from storage or obstructive constructions such as dams, anicuts and bed regulators. Tanks can be solely rain-fed or they may be supplied in addition by rivers or by flow from other tanks in an upper reach. In many areas, notably in the Periyar-Vaigai system, the additional storage provided by tanks lends support to river-based irrigation. Tanks also function as a source of re-charge for wells located in their ayacut. Wells may supply the sole source of irrigation to a field or they may supplement water available from rivers or tanks. Thus the three modes get inter-linked and re-inforce each other in many situations.

14. In 1979-80, the relative contribution source-wise to net irrigated area was 31 per cent from canals, 30 per cent from tanks, 38 per cent from wells and about one per cent from other sources such as spring channels. During 1950-80 there has been a significant shift in these proportions reflecting differing rates of growth under each source in the three decades. Table 5 brings this out. In the 1950s, surface irrigation registered a better rate of growth than wells. In the 1960s and 1970s, canal-irrigated area has stagnated, tank-irrigation has declined, while there has been a striking increase in ground water development. As a result, wells now contribute to nearly 40 per cent of net irrigated area in Tamilnadu as compared to about 25 per cent throughout the 1950s.

Table 5 : Source-wise Irrigation in Tamilnadu

(million acres of net irrigated area)

	Canals	Tanks	Wells	Others	Total
1951/52	1.96	1.61	1.23	0.13	4.93
	(39.7)	(32.7)	(24.9)	(2.7)	(100.0)
1960/61	2.18	2.31	1.48	0.11	6.08
	(35.8)	(38.0)	(24.3)	(1.9)	(100.0)
1970/71	2.18	2.22	1.91	0.09	6.40
	(34.2)	(34.6)	(29.8)	(1.4)	(100.0)
1979/80	2.30	2.21	2.76	0.09	7.36
	(31.2)	(30.0)	(37.5)	(1.3)	(100.0)

Note: Figures in paranthesis are percentages to total in each year.

Source: Government of Tamilnadu: Irrigation Statistics (Various Issues).

15. In spatial terms, canal irrigation is relatively more concentrated than the other modes. Thanjavur alone accounts for nearly 51 per cent of net canal irrigated area. Five other districts account for a further 38.6 per cent: Coimbatore/Periyar (14.5 per cent), Tiruchirapalli (9.2 per cent), South Arcot (9.0 per cent) and Madurai (5.9 per cent). These are the districts watered by major rivers such as the Cauvery, Parambikulam-Aliyar, Palar, Pennaiyar and Periyar-Vaigai. In the case of tank irrigation, seven districts together account for more than 90 per cent of net irrigated area: Ramanathapuram (23.3 per cent), Chengalpattu (18.6 per cent), South Arcot (12.0 per cent), Pudukottai (9.9 per cent), North Arcot (9.8 per cent), Tirunelveli (9.7 per cent) and Madurai (7.0 per cent). These are the districts which benefit significantly from the north-east monsoon or in which river systems feed a number of tanks (North Arcot, Tirunelveli and Madurai). Well-irrigation is prominent in eight districts: Coimbatore/Periyar (15.9 per cent), South Arcot (14.8 per cent), North Arcot (14.1 per cent), Madurai (11.8 per cent), Salem (9.3 per cent), Chengalpattu (8.2 per cent) and Tiruchirapalli (8.2 per cent).

16. The districts can be classified in five broad groups in terms of the mode of irrigation (vide Table 6). (i) Thanjavur is in a class by itself depending on canal irrigation for over 95 per cent of its cropped area. (ii) Chengalpattu, North Arcot and Dharmapuri depend mainly on tanks and wells although to differing extents. In Ramanathapuram, while tanks account for over 80 per cent of irrigated area, wells dominate in the western taluks. (iii) Coimbatore/Periyar and Salem rely mainly on canals and wells. (iv) Kanyakumari benefits mainly from canals and tanks. (v) The remaining districts - South Arcot, Tiruchirapalli, Madurai and Tirunelveli - depend on all three modes to varying extents.

Table 6 : Modes of Irrigation : District-wise 1978-79

Percentage of net irrigated area

	Canals	Tanks	Wells	Others	Total
1. Chengalpattu	3.3	60.3	32.8	2.6	100.0
2. S.Arcot	23.3	28.6	44.8	3.3	100.0
3. N.Arcot	7.2	32.3	58.8	1.7	100.0
4. Salem	14.3	6.6	77.6	1.5	100.0
5. Dharmapuri	11.0	21.4	63.6	4.0	100.0
6. Coimbatore/ Periyar	43.2	1.6	55.0	0.2	100.0
7. Tiruchirapalli	41.0	15.3	42.2	1.5	100.0
8. Thanjavur	96.4	0.8	2.0	0.8	100.0
9. Madurai	22.6	24.5	52.2	0.7	100.0
10. Ramanathapuram	0.1	80.5	19.2	0.2	100.0
11. Tirunelveli	12.4	46.5	40.5	0.6	100.0
12. Nilgiris	Neg	Neg	Neg	Neg	
13. Kanyakumari	44.7	54.2	0.8	0.3	100.0
Tamilnadu	32.0	29.0	37.2	1.5	100.0

Source: Government of Tamilnadu Irrigation Statistics 1978-79.

Irrigation and the cropping pattern

17. Paddy has remained dominant among irrigated crops in Tamilnadu. It accounted for 67 per cent of gross irrigated area in the late 1970s. In the 1960s and 1970s, additional area brought under irrigation has however been mainly (about 75 per cent) devoted to commercial crops such as sugar cane, cotton, oilseeds, chillies, fruits and vegetables. (See Table 7) This is connected with the fact that in these two decades it is well-irrigation that has been in the vanguard. It is relatively well-intensive districts which are also the ones in which irrigated commercial crops are prominent such as sugarcane (Coimbatore, Periyar, North Arcot, South Arcot, Salem and Tiruchirapalli), groundnut (North Arcot, South Arcot, Coimbatore, Chengalpattu), cotton (Coimbatore and Madurai) and fruits, vegetables and spices (West Ramanathapuram, Madurai, Tirunelveli, Coimbatore, Periyar and Tiruchirapalli).

18. The broad picture of irrigation in Tamilnadu has been outlined. The characteristics of irrigation vary under each mode --- canals, tanks and wells. There are also significant differences as between the three modes of irrigation in terms of past growth, emerging problems and future prospects. We shall discuss them in detail in the following chapters.

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1/ Vide Table 8.1 on p.166 of the Report of the Irrigation Commission 1972 Vol.I /97. The names of the taluks and districts cited relate to the position in 1972.

2/ R.K.Sivanappan and K.Palniswami /287.

Table 7 : Crop-wise gross area irrigated

(million acres)

	1960/61	Per cent	1970/71	Per cent	1978/79	Per cent
1. Paddy	5.69	71.3	5.99	71.1	6.31	67.0
2. Millets	1.06	13.3	0.87	10.4	0.81	8.6
3. Pulses	0.03	0.3	0.02	0.3	0.03	0.3
4. Sugar cane	0.20	2.5	0.28	3.3	0.38	4.0
5. Other food crops[1/]	0.35	4.4	0.45	5.3	0.62	6.6
Total food crops	7.33	91.8	7.61	90.4	8.15	86.5
6. Groundnut	0.24	3.1	0.45	5.3	0.62	6.6
7. Cotton	0.24	3.1	0.21	2.5	0.41	4.3
8. Other non food crops[2/]	0.17	2.0	0.15	1.8	0.25	2.6
Total non-food crops	0.65	8.2	0.81	9.6	1.28	13.5
All crops	7.98	100.0	8.42	100.0	9.43	100.0

1/ mainly chillies and spices and fruits and vegetables.

2/ mainly coconut and gingelly.

Source: Government of Tamilnadu Irrigation Statistics (Various Issues)

III Rivers and Canals

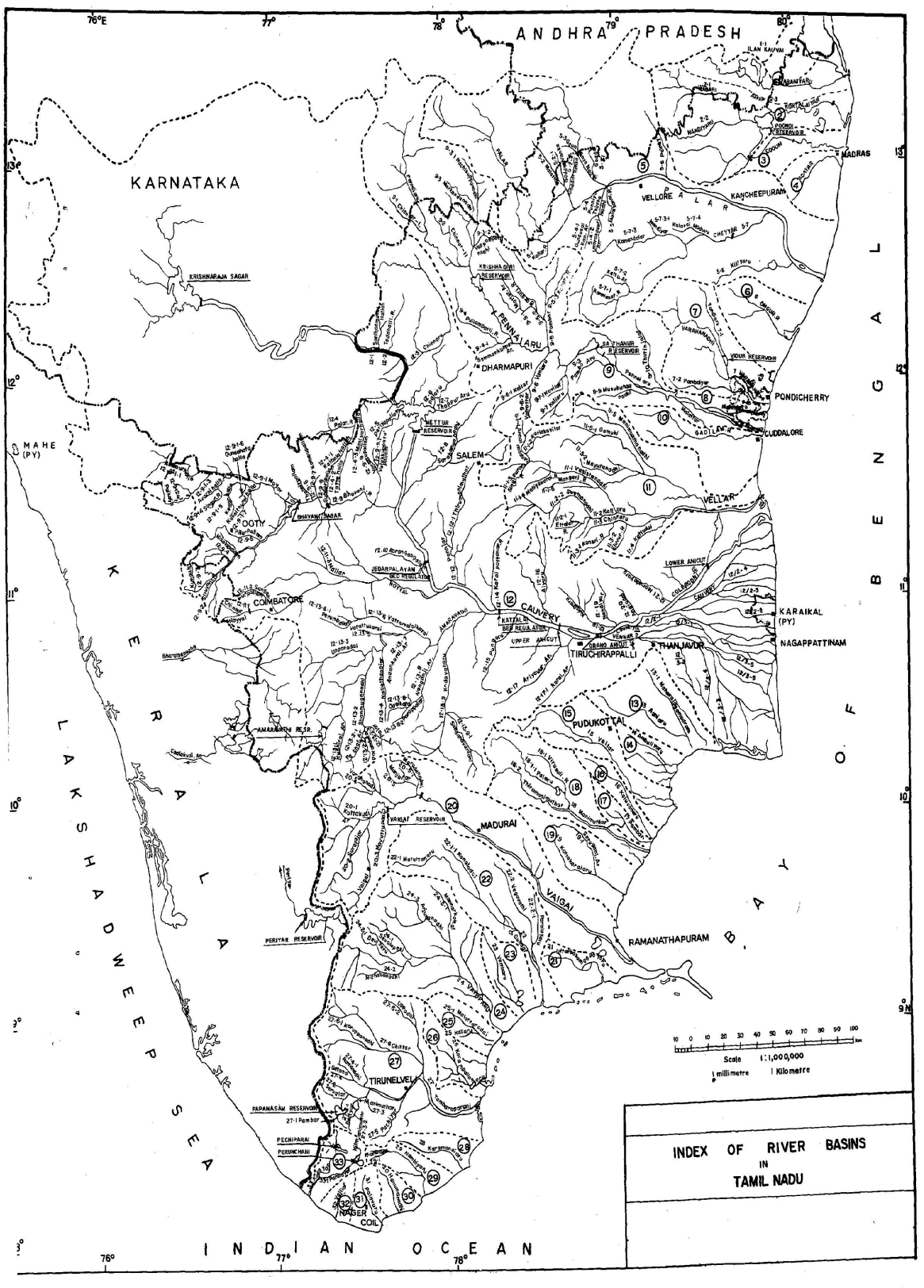
19. Tamilnadu is blessed with a number of rivers, celebrated in legend and poetry, but they, unlike the Himalayan rivers of the North, are rain-fed and relatively small. The Cauvery, which is the only one that can be classed as a major river in all-India terms, is much smaller in its carrying capacity than other major rivers even in peninsular India such as the Mahanadhi, Godavari and the Krishna. Some of the important rivers which flow through Tamilnadu into the Bay of Bengal - the Cauvery itself, the Palar and the Pennaiyar - rise in Karnataka while some others which significantly benefit Tamilnadu - the Periyar and the rivers in the Parambikulam complex - are west-flowing rivers which have been diverted. As far as its river - water irrigation is concerned, Tamilnadu is thus in good measure a lower riparian as well as an importer of water.

Principal River Basins

20. The river systems of Tamilnadu can be conveniently described in terms of three broad groupings viz., those to the north of the Cauvery basin, the Cauvery and its tributaries, and those to the south of them.[1/]

(I) The Araniar and the Kortaliyar are the northernmost rivers. They irrigate mainly Chengalpattu, largely through tanks. The Araniar flows from Andhra Pradesh. The Kortaliyar is also used for water supply to Madras City through the Poondi reservoir which diverts its waters into the Sholavaram and Red Hills tanks. The Cooum and the Adyar are minor rivers in this tract.

The Palar is the first of the relatively bigger rivers in northern Tamilnadu. It rises in the Kolar district of Karnataka and enters Tamilnadu in the North Arcot district. Canals which branch off from the Palar anicut feed a number of tanks apart from providing direct irrigation. The Poini



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and the Cheyyar are tributaries of the Palar which have also been harnessed through anicuts built across them. The Pennaiyar which is the next important river also rises in Karnataka. Entering Tamilnadu through Salem, it is dammed at Krishnagiri in Dharmapuri district, continues via North Arcot where it is dammed at Sathanur, then enters South Arcot where again it is tapped at the Tirukoilur anicut and finally joins the Bay of Bengal after flowing in Pondicherry.

South of the Pennaiyar is the Vellar which rises in Salem and flows mainly in South Arcot district. The Vellar is utilised through a system of anicuts at Tholudur, Pelandurai, and Sethiatope. The Manimuktanadhi, Gomukhi and Kallar are its tributaries.

(II) The Cauvery basin extending over an area of about 88,000 square kilometres is shared between Tamilnadu (49,000 sq. km) Karnataka (36,000 sq.km) and Kerala (3000 sq.km). The Cauvery rises in the Western Ghats in the Coorg district of Karnataka and, after running in Karnataka for 320 kilometres where it is joined by several tributaries, enters Tamilnadu close to the Hogenakal falls in Dharmapuri district. It then flows towards the Mettur reservoir in Salem, where it is dammed, and then on in a south-easterly direction through Coimbatore and Periyar districts where it is joined by the Bhavani, Noyyil and Amaravathi rivers. It then enters the Tiruchirapalli district where it splits into two branches with the northern branch being called the Coleroon (Kollidam) The Upper Anicut has been constructed at this point, Some 16 kms further down, the Cauvery and the Coleroon almost join again to form the island of Srirangam. Below the island is the location of the Grand Anicut which is the head of the irrigation system in the Thanjavur delta. At this point, the Coleroon branches off northward, while the Cauvery or the southern branch splits into two, the other branch being called the

Vennar. These rivers in their further course divide and sub-divide; from them numerous main and subsidiary channels irrigate the delta. The branch which retains the name of Cauvery finally joins the sea as an insignificant stream at Kaveripatnam (or Poompuhar), slightly north of Tranquebar. Altogether, the Cauvery runs in Tamilnadu for 416 kilometres.

The waters of the Cauvery and of its tributaries and branches have been intensively utilised over a long period through a number of dams, anicuts and regulators. The biggest reservoir is at Mettur which, besides stabilising irrigation in the delta, has enabled the extension of irrigation under a new canal-the Grand Anicut canal-to the South-western taluks of Thanjavur district which were previously dry. Below the Mettur dam, the Mettur canals irrigate parts of Salem and Coimbatore districts. The Bhavani and Amaravathi have been dammed to benefit areas in the Coimbatore and Periyar districts. The Kattalai high level canal and the Pullambadi canal consist of bed regulators on the main river from which canal systems irrigate lands in Tiruchirapalli district. The Upper Anicut(now a barrage), while having no direct irrigation under it, safeguards the Thanjavur delta system by diverting the low supplies in the river to the southern branch. It also functions as a flood-moderator. The Grand Anicut enables flood waters to be let into the Coleroon and regulates supplies between the Cauvery and the Vennar. The last of the system of regulators is the Lower Anicut built on the Coleroon towards it tail-end. It benefits areas in the Sirkali taluk of Thanjavur district and in the Chidambaram and Kattumannar Koil taluks of South Arcot in which it feeds the large Veeranam tank. Thus the waters of the Cauvery basin have been harnessed to irrigate areas in a number of districts - Salem, Coimbatore, Periyar, Tiruchirapalli, Thanjavur and South Arcot.

(III) The Periyar is a west flowing river which has been dammed at an altitude of 3000 feet and diverted to the east through a tunnel 5700 feet long. Its waters are let into the Suruliyar, a tributary of the Vaigai. The Vaigai rises in the western slopes of the Varushanad hills in Madurai district and has been dammed downstream of its confluence with the Suruliyar. At the Peranai regulator, the waters of the Periyar-Vaigai are picked up by canals which irrigate lands, directly and through tanks, in Madurai district and supply tanks further down in Ramanathapuram. Two other regulators across the Vaigai (at Virahanur and Parthibanur) feed several tanks in Madurai district. The Gundar and the Vaippar (of which the Arjuna is a tributary) are minor rivers which lie to the south of the Vaigai basin.

The Tamraparni rises in the eastern slopes of the Western Ghats in Tirunelveli district and has several tributaries such as the Chittar, Manimuthar, Gatana, Karuppanadhi and Ramanadhi. Some of the oldest anicuts in Tamilnadu have been built across this river by the Chola and Pandya kings.[2/] Irrigation from the Tamraparni is through canals as well as via tanks. Important constructions are the Papanasam, Manimuthar and Gatana dams and the Marudur and Sri Vaikuntam anicuts.

The southern-most basin in Tamilnadu is that of the Kodayar which has been dammed at Pechiparai and at Perunchani to irrigate areas in Kanyakumari district.

21. We should also note that a major source of irrigation in Tamilnadu is provided by the Parambikulam-Aliyar Project (PAP). In this project, seven rivers, most of whom are west flowing, viz., Nirar, Sholayar, Parambikulam, Tunakadavu, Peruvaripallam, Aliyar and Palar are harnessed through a system of dams, tunnels and canals to irrigate areas in the Coimbatore district. The PAP is a major illustration of inter-state cooperation and, along with Periyar, of the import of water into Tamilnadu.

22. Table 8 shows the relative contributions to the gross irrigated area in Tamilnadu under each of the major basins and their sub-basins. The Cauvery basin (including the Bhavani, Amaravathi and Noyyil sub-basins) accounts for the lion's share of nearly 64 per cent of river-based irrigation. Periyar - Vaigai and PAP come next with contributions of 9 to 10 per cent each. The total share of the smaller basins of the Palar, Pennaiyar, Vellar, Tamraparni, Kodayar and of the minor rivers adds up to the balance of about 18 per cent.

Table 8 : Gross irrigated area under Major basins including their sub-basins

(000 acres)

	Area	Per cent
1. Palar	130	4.6
2. Pennaiyar	84	3.0
3. Vellar	116	4.1
4. Cauvery	1788	63.7
5. Periyar-Vaigai	274	9.7
6. Tamraparni	72	2.5
7. Kodayar	96	3.4
8. Parambikulam-Aliyar	250	9.0
	2810	100.0

Source: Government of Tamilnadu (PWD)
Irrigation in Tamilnadu 1979

Historical development of river irrigation

23. As the above description will indicate, river water resources have come to be very intensively utilised in Tamilnadu over a long period of time, particularly under the Cauvery and the Tamraparni. In the old Madras Presidency, the British encountered a situation in which surface irrigation had been developed to a good extent through storage and other constructions (anicuts, weirs, tanks) but had been allowed to fall into disrepair. They found that the restoration and improvement to existing irrigation works, particularly in Thanjavur, could yield quick and good returns : capital investments on the pre-existing works could be saved and supplementary investments, such as an anicuts and canals, could be made at low cost to enable early utilisation.[3/] The policy paid off and traditionally, there were high returns to irrigation in the Madras Presidency as compared to many other parts of India. By 1882-83, for instance, surplus revenue from the Cauvery delta system had amounted to more than 11 times the total outlay on its development.[4/] The Upper Anicut constructed in 1839 over the Cauvery was the first major project in the British period. Major (later Sir Arthur) Cotton was the brilliant and dynamic engineer responsible for it as also for the Lower Anicut built around the same period. The next phase of growth occurred in the closing decade of the 19th century. The Periyar dam dates to 1897. Several important works such as the Tirukoilur (1895), Sethiatope (1895) and Palar (1896) anicuts also belong to this period. The last major project in the pre-Independence period was the Mettur dam in 1934 which, although conceived of in principle nearly a century earlier, had to await the conclusion of the agreement in 1924 between Madras and Mysore on the utilisation of Cauvery waters.

24. Table 9 gives the growth profile of river-based irrigation in Tamilnadu. About 77.5 per cent of it has taken place in the pre-Independence period. Cauvery basin projects - the old delta, the GA canal and the Lower Anicut account for over 60 per cent; the other important projects of the pre-Independence period being the Palar Anicut, Periyar and Kodayar. Since Independence, the development of canal irrigation has been concentrated, in fact more or less confined, to the first two Plan periods (1951-61). The two most important have been the Lower Bhavani and the Parambikulam-Aliyar projects. The Amaravathi, Krishnagiri, Sathanur Stage I, Vaigai dam, Mettur Canals, Kattalai and Pullambadi canals projects also belong to the 1950s. Table 10 details the projects initiated in each of the Plan periods upto the Fifth Plan (1974-79).[5/]

Table 9 : Growth Profile in Canal Irrigation

(Estimated ayacut in 000 gross acres)

	Ayacut	Per cent
1. Pre-Plan (upto 1951)	2,720	77.6
2. First Plan (1951-56)	353	10.1
3. Second Plan (1956-61)	302	8.6
4. Third Plan (1961-66)	45	1.3
5. Annual Plans (1967-69)	16	0.5
6. Fourth Plan (1969-74)	22	0.6
7. Fifth Plan (1974-79)	49	1.3
	3,507	100.0

Source: Government of Tamilnadu (PWD)
Irrigation in Tamilnadu 1979

Table 10: Canal Irrigation Projects in Plan periods

	Ayacut (000 gross acres) New	Stabilisation	Districts benefited
First Plan (1951-56)			
1. Lower Bhavani	207.0		Coimbatore & Tiruchirapalli
2. Perunchani		64.0	Kanyakumari
3. Mettur Canals	45.0		Coimbatore & Salem
4. Araniar	7.0		Chengalpattu
5. Manimuthar	20.0	83.0	Tirunelveli
6. Amaravathi	21.5	32.0	Coimbatore
7. Sathanur Stage I	21.0		N.Arcot & S.Arcot
8. Vaigai	22.8		Madurai & Ramanathapuram
9. Krishnagiri	9.0		Dharmapuri
Second Plan (1956-61)			
10. Vidur	3.2		S.Arcot
11. New Kattalai High Level Canal	20.6		Tiruchirapalli & Thanjavur
12. Pullambadi Canal	22.1		Tiruchirapalli
13. Neyyar Stage II	5.8		Kanyakumari
14. Parambikulam-Aliyar	250.0		Coimbatore
Third Plan (1961-66)			
15. Gomukhi	5.0		S.Arcot
16. Palar Anicut Improvements	3.3		N.Arcot & Chengalpattu

	Ayacut (000 gross acres) New	Stabilisation	Districts benefited
17. Sathanur Stage II	5.00		S. Arcot
18. Chittar-Patanamkal	32.00	15.00	Kanyakumari & Tirunelveli
Annual Plans (1966-69)			
19. Manimuktanadhi	4.00	0.25	S.Arcot
20. Gatana	1.00	7.12	Tirunelveli
21. Ramanadhi	0.50	1.50	Tirunelveli
22. Modernising Vaigai channels	10.00	95.90	Madurai and Ramanathapuram
23. Ponnaiar	1.83	0.27	Tiruchirapalli
24. Nandan Channel	0.28	4.97	N.Arcot
25. Pilavukkal	2.65	7.89	Ramanathapuram
26. Chinnar	1.87	2.63	Dharmapuri
27. Thandarai	1.40	6.14	N.Arcot
28. Karuppanadhi	2.87	8.66	Tirunelveli
29. Parappalar	1.00	1.32	Madurai
30. Palar-Porandalar	10.00	10.00	Madurai
Fifth Plan (1974-1979)			
31. Periyar modernisation	18.00	28.00	Madurai & Ramanathapuram
32. Varattupallam	3.00	0.60	Coimbatore
33. Sathanur Left Bank Canal	16.40	3.60	N.Arcot & S.Arcot
34. Gunderipallam	2.30		Coimbatore
35. Vattamalaikarai	3.00		Coimbatore
36. Vardhamanadhi	0.50	4.70	Madurai
37. Kodaganar	5.50	0.80	Madurai & Tirunelveli

Source: Government of Tamilnadu (PWD)
Irrigation in Tamilnadu 1979

25. To sum up, Tamilnadu has had an early start and an intensive development of its river water resources. Out of a total estimated potential of 810 TMC (thousand million cubic feet) from all rivers benefitting Tamilnadu, including the Periyar and Parambikulam systems, about 765 TMC or 94.4 per cent is the estimated utilisation.[6] This development has taken place over a long span covering the pre-British, British and early post-Independence periods. By the same token, since the Third Plan, the potential for further development has tapered off.

Efficiency of Irrigation

26. We have so far considered "utilisation" basically in terms of the proportion of river waters that is used for irrigation without being allowed to run into the sea. A high ratio in this regard is one but only a preliminary index of efficiency. The further and more important issue, especially in the Tamilnadu situation where so much of river resources are already being used, is whether the use of water is efficient and economic. The engineering measure of efficiency generally adopted is the 'duty' or the number of acres of a standard crop irrigated per unit of water in terms of M.C.ft (million cubic feet) or cusec (cubic foot per second over a period of supply, usually 140 days).[7] Accordingly, higher the duty the greater is the efficiency of irrigation. The efficiency of river irrigation in Tamilnadu as a whole is low, the aggregate average duty for canal irrigation at channel heads being of the order of 4 to 5 acres per M.C.ft. taking paddy as the standard crop. In some of the old channels, duties are as low as 1.5 to 2.5 acres. The relative efficiencies of the principal systems are given in Table 11. The main contributory causes for low duties are seepage in unlined canals, wastage in channel heads which lack proper regulatory structures, and the over-use of water that takes place in field irrigation.[8]

Table 11: Duties in major canal irrigation systems

	Acres per M.C.ft.
1. Cauvery delta	5.0
2. GA canal	5.3
3. Lower Bhavani	5.6
4. Krishnagiri Reservoir	5.6
5. Sathanur	5.7
6. Periyar-Vaigai	8.2
7. Old Tamraparni Channels	4.0
8. Kodayar	6.5

27. The conditions of field irrigation in the Cauvery delta should be particularly noted in view of its large weight in overall river irrigation. The following is an excellent description of its original rationale.[9/]

> "It is significant that with a river which has mainly a south-west monsoon supply in which the high flow is confined to less than two months in the year and without a reservoir (till one was built in 1933) more than 80 per cent of the waters have been utilised. This feat has been achieved by a successful system under which irrigation and drainage are combined. The old channels in the delta had no head sluices - they were of the inundation type. The channels have been so designed as to take in very much more water than is necessary for the land irrigated under any one of them. The result is that when there is plenty of water in the river these channels take in these waters and distribute them among the various fields under them. Thus instead of the river water being allowed to go to the sea they are distributed amongst millions of fields in the delta. In the fields themselves, an ingenious system has been devised under which the drainage channel of the upper village is the irrigation source for the lower village. The result is that the waters conserved in the upper village are gradually passed on to the villages lower down. In times of flood, these channels, which take

> water from the river, distribute the risk of flood over the entire delta instead of allowing the waters to be concentrated in any particular spot, and when the river level goes down these very channels drain the waters gradually back into the river.... The delta thus utilises the waters of the south-west monsoon brought down by the river in such a way that not only very little of it is wasted into the sea but also its use is spread over as long a period as possible.... The old system of irrigation in Tanjore may be described in one sentence by saying that under this system every field acts as a reservoir and an insurance against floods".

28. The Cauvery delta system described above might have been an optimal one in the original circumstances in which it evolved. These circumstances related to a situation where, on account of poor utilisation in Karnataka, flows to Tamilnadu were larger; prior to Mettur, they were also flood-prone and unregulated. In the current context, however, we can not afford the considerable waste in seepage and percolation entailed by the system of natural conveyance and field-to-field irrigation. Moreover, in the Cauvery system the tail-end taluks in East Thanjavur suffer on many counts. They receive water late; in lean seasons, supply is terminated too soon; and water from the upper reaches carried in the irrigation-cum-drainage channels compounds the drainage problem lower down, especially at times of the heavy coastal rains.

29. It will clearly not be feasible to entirely replace the old delta system with canals in which supplies could be strictly regulated according to requirements. The system could however be "modernised" through measures such as improvements to the headworks, desilting of the rivers and channels, construction of regulators and sluices, lining of selected reaches, and provision of pipe-sluices at open off-takes. Some investments have taken place in the last decade on these lines but, for reasons which will be explained later a comprehensive modernisation of the Cauvery delta system may have to await the settlement of the 'Cauvery dispute'.

30. While historical obsolescence may explain the low duties in the old Cauvery delta, other factors account for relative inefficiencies in newer systems such as the Lower Bhavani (LBP) and Parambikulam-Aliyar (PAP). In the LBP, the canals are not lined. There is considerable loss through seepage and unauthorised paddy cultivation from wells which draw water from seepage. In the PAP, where the canals are lined, wet crops are extensively cultivated in the upper reaches in violation of the cropping pattern originally envisaged. The result is that a much smaller area than the authorised ayacut is actually benefited while the supply is spread over a long reach of the channel system incurring heavy losses in conveyance. The Periyar-Vaigai system is relatively efficient. It is extensively backed up by tanks which provide supplementary storage. Water is also regulated in this system to single and double crop lands which are clearly demarcated.

Water Management

31. In the old Cauvery delta particularly, and in other systems as well, there is much scope for economy in water management at the field level. Essentially, this will require provision of channels for direct supply (inlets) and drainage (outlets) to contiguous blocks in replacement of wasteful field-to-field irrigation through inundation. Within blocks, field channels have to be rationally aligned. The many advantages that can be gained through water management on these lines have been illustrated in an experimental project in an area of about 400 acres in Siddhamalli in Thanjavur district. In this scheme, narrow and straight bunds have been formed to enclose rectangular plots replacing irregular, zig-zagging field boundaries; instead of field-to-field irrigation, water now reaches each field through channels on the boundary of each plot; and embankments have been raised along existing channels and drains to prevent inundation. There have been

tangible benefits in terms of higher output, a higher intensity of cropping, and an increase in the cropped area on account of the straightening of the bunds and the reduction in their width.

32. There is clearly much need and scope for improving efficiency and economy through modernisation and better water management. However, the large investments needed for modernisation will have to be justified on the basis of benefits commensurate with costs.[10/] Not all modernisation projects that are technically promising may be economically viable. Modernisation will also have to be approached on a systemic basis taking into account the hydrological features of the basin or sub-basin as a whole. Prevention of seepage by canal lining, for instance, might reduce groundwater recharge with net saving of water turning out to be much less than *prima facie* gross savings. Similarly, improvements to the upper reaches in the delta might compound the drainage problems in the lower reaches. In the case of field-level water management, as in the Siddhamalli pilot project, a major constraint will be the fragmentation of land under several individual owners whose consent and cooperation will be necessary for the rationalisation of field distributaries and bunds. Thus, for modernisation or water management, socio-economic issues - whether it is cooperative land use in the old delta or the enforcement of prescribed cropping patterns as in the LBP and PAP - will have to be tackled in addition to good engineering and sound economic evaluation.

West flowing rivers

33. In view of its limited internal potential, possibilities for the sharing of waters with neighbouring States is a matter of great interest to Tamilnadu. Surplus waters from rivers that flow into Kerala can benefit arid areas in

Coimbatore, Madurai, Ramanathapuram and Tirunelveli. The Irrigation Commission of 1972 agreed that there was such scope and made the following observation in its report: "There are 41 west-flowing rivers in Kerala with a total annual yield of 72,520 million cubic metres (m.cu.m.). As estimated by the Government of Kerala, a surplus of 40,490 m.cu.m. of water will flow to the sea after meeting the irrigation, power and navigational requirements of Kerala State. A part of this surplus can, in our opinion, be usefully diverted to bring relief to the scarcity areas of Tamilnadu where there is no other source of irrigation."[11/] The Commission also added that the utilisable surplus will be only a part of the estimated total surplus because the diversion of waters will have to be from the upper reaches; the costs of construction of tunnels at lower altitudes will be prohibitive apart from the technical difficulties that might be involved. This consideration will also imply that the higher hydro-electric potential available on the western side of the ghats might get reduced because of the diversion of waters to the east where the drops are less. Any proposed scheme for diversion will have to provide for the existing as well as potential irrigation in the lower reaches on the western side. The costs will have to justify the benefits. Thus, apart from political aspects which will finally decide inter-State cooperation, the techno-economic viability of any further diversion of west-flowing rivers into Tamilnadu will need to be established on the basis of careful studies, an exercise which itself demands the cooperation of the neighbour.

The Cauvery dispute

34. The major inter-State river issue that currently affects Tamilnadu concerns the sharing of Cauvery waters. The utilisation of waters in the Cauvery basin was the

subject of agreements in 1892 and in 1924 between the erstwhile Government of the Madras Presidency and the former princely State of Mysore. The latter agreement, which was negotiated in the context of the construction of the Krishnasagar dam in Mysore, was made subject to review after 50 years (i.e. in 1974) in regard to certain clauses. Meanwhile, Karnataka has proceeded with schemes which utilise waters from important tributaries of the Cauvery such as the Kabbani and the Hemavathi in the face of objections from Tamilnadu. On a legal plane, the present status of the 1924 agreement is a major issue; the more fundamental one being the established rights of the lower riparian State (viz., Tamilnadu) vis-a-vis the rights of the upper riparian (viz., Karnataka) in the present and prospective use of the single river flowing through both. To a limited extent, Kerala and Pondicherry are also interested parties.

35. The two essential issues of interest to Tamilnadu are : (a) an assurance from Karnataka on the quantum of inflows that would be made available at Mettur in "normal" years and (b) the rules of regulation that could be enforced and monitored at Krishnarajasagar in years of "adverse" supply so that there can be an equitable sharing of hardship. Karnataka, in its concern to use as much of Cauvery waters as possible in its own territory, has been insisting that Tamilnadu should seek first to maximise her internal availability by effecting economies in the present use of Cauvery flows and through further groundwater exploitation in the basin. In this way, the modernisation of the Cauvery delta system has become linked to the 'dispute' regarding the sharing and utilisation of Cauvery waters. Karnataka has also objected to any comprehensive investments on modernisation without a prior understanding as to whether the economies to be thereby effected will benefit Tamilnadu alone or could be adjusted wholly or partly against a lesser supply

at Mettur, transferring some benefits to Karnataka as well. Despite several rounds of discussions which have been held since 1974 no agreement is in sight as yet. The early settlement of the dispute, on a mutually satisfactory basis, is very much in the interests of Tamilnadu from the point of view of securing predictable supplies from year to year as well as the long-term gains that can be expected from the modernisation and fuller exploitation of the Cauvery basin.

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1/ For more details, see Chapters IX, X and XI of the Report of the Irrigation Commission 1972 Vol.III (part 2) /11/. Also Government of Tamilnadu (PWD-Irrigation) /15/.

2/ S.Y.Krishnaswamy /19/ and Ludden /22/.

3/ Whitcombe /32/.

4/ Government of Madras /13/.

5/ For histories of the major projects see C.G.Barber /6/ Government of Madras /14/, S.Y.Krishnaswamy /20/ and A.T.Mackenzie /23/.

6/ Ram Chander /26/.

7/ One acre per M.C.ft. is equivalent to 12.1 acres per cusec on a base of 140 days.

8/ For a discussion of duties see State Planning Commission /27/.

9/ S.Y.Krishnaswamy /18/.

10/ The Periyar-Vaigai system is currently being modernised through lining of canals and other improvements with World Bank assistance. At an estimated cost of Rs.104 crores, it is expected to extend irrigation to 17,250 hectares. It is doubtful if the benefits will be commensurate with the high investment cost of about Rs.24,000 per acre.

11/ Report of the Irrigation Commission 1972 Vol.II /10/ page 376.

IV Tank Irrigation

36. We may now turn to the characteristics of tank irrigation in Tamilnadu which is included under, and forms much the most important component of, the general description of 'minor irrigation'.[1] Tamilnadu is one of the States in India in which this mode of irrigation is prominent. The State accounts for about 17 per cent of all tanks in the country coming next only to Andhra Pradesh with 27 per cent. Tanks have had a very long history in Tamilnadu, having been constructed over the ages by kings, regional chieftains and local benefactors. They are mentioned in Sangam literature (300 BC-100 AD) and were extensively developed in the southern districts by the Pandya and Chola kings between the 8th and 14th centuries A.D. The large Kaveripakkam tank in North Arcot district dates back to the 5th century.[2] Some tanks may be natural depressions but most are believed to have been formed or improved by human means reflecting a high degree of skill in using river and rain water taking advantage of natural gradients and heavy coastal rainfall which would have otherwise gone waste.

Some general characteristics

37. There are no exact estimates of the number of tanks in British times in Tamilnadu. A survey in 1882-83 gave a total figure of 32,000 in the old Madras Presidency excluding private tanks and tanks in zamindari areas.[3] In 1950-51, the number reported was about 27,000 in Tamilnadu excluding tanks in the Kanyakumari district and in the ex-zamin areas.[4] In 1978-79, the total number has been taken to be of the order of 38,000 with a total ayacut of 2.2 million acres or 30 per cent of the net irrigated area. There is considerable inter-district variation in the number

of tanks, their sizes in terms of the area irrigated and their relative contribution to the total irrigated area as Table-12 will show. Of the 38,297 tanks in Tamilnadu, 30,895 or over 80 per cent have an ayacut of less than 100 acres. On an average, a tank in Tamilnadu irrigates about 54 acres. However, about 30 per cent of total area under tank irrigation is accounted for by 564 tanks (or 1.5 per cent of the total number) each with an ayacut of 500 acres or more.[5/] Seven districts viz., Ramanathapuram, Chengalpattu, South Arcot, Pudukottai, North Arcot, Tirunelveli and Madurai account for more than 90 per cent of (net) area under tank irrigation and for about 80 per cent of the total number of tanks in the State. Tank irrigation is the predominant or a very important mode of irrigation in Ramanathapuram (80.5 per cent of total net irrigation), Pudukottai (78.6 per cent) Chengalpattu (60.3 per cent), Kanyakumari (54.2 per cent) and Tirunelveli (46.5 per cent).

Typology of tanks

38. Tanks are thus not homogeneous in size nor are they evenly spread. They differ also in terms of their sources and reliability of irrigation. The first distinction is between tanks which receive water from rivers or streams in addition to the yield of their own catchment and those which depend entirely on rainfall and run-off in their catchments. The former are known as "system" tanks and the latter as "non-system" tanks. Both these types can again be divided into (a) tanks which form part of a chain in which the surplus of an upper tank feeds tanks that are lower down or (b) isolated tanks which stand on their own. Tanks have been classified as falling into five categories at the time of revenue settlement having regard to the period for which they can be depended upon for supply: I class (for the entire year) II class (8 to 12 months) III (5 to 8 months) IV (3 to 5 months) and V (less

Table 12 : Tanks in Tamilnadu

District	With ayacut of 100 acres or less (Nos)	With ayacut of more than 100 acres (Nos)	Total tanks (Nos)	Proportion of net irrigated area from tanks per cent 1/	Average area irrigated per tank (acres)
1. Chengalpattu	1362	2291	3653	60.3	105.7
2. S.Arcot	1176	1501	2677	28.6	93.1
3. N.Arcot	927	2262	3189	32.3	64.0
4. Salem	158	664	822	6.6	25.2
5. Dharmapuri	109	2002	2111	21.4	19.3
6. Coimbatore/ Periyar	59	60	119	1.6	102.3
7. Tiruchirapalli	172	2210	2382	15.3	32.9
8. Pudukottai	968	4297	5265	78.6	39.0
9. Thanjavur	130	299	429	0.8	22.0
10. Madurai	422	4600	5022	24.5	29.1
11. Ramanathapuram	1411	5785	7196	80.5	67.2
12. Tirunelveli	466	2329	2795	46.5	73.1
13. Nilgiris	1	3	4	--	--
14. Kanyakumari	41	2592	2633	54.2	147.7
Tamilnadu	7402	30895	38297	29.3	54.3

1/ In 1978-79

Source: Government of Tamilnadu Irrigation Statistics 1978-79.

than 3 months). There are very few tanks in Class I. Unfortunately, data on the number of tanks or the area irrigated by them in each of these categories has not been compiled. Broadly, system tanks are clustered in Chengalpattu, North Arcot and South Arcot (under the Kortaliyar, Palar and Pennaiyar basins), in Madurai (in the Periyar-Vaigai system) and in Tirunelveli (in the Tamraparni basin). They are also the ones with more dependable supply falling in the first three classes. The numerous tanks in Ramanathapuram and Pudukottai are, by and large, rain-fed and less dependable.

British policy

39. Although the importance of tank irrigation in Tamilnadu was recognised in the early British period, no concerted steps were taken for their rehabilitation or improvement until the late 19th century. Tanks were too numerous and scattered; many were in the zamin areas; they were not "spectacular like the reservoir or anicut systems"; and of not much significance in terms of revenue, immediate or prospective. The great famine of 1876-77 however brought the recognition that tanks, which were often located in the arid tracts, were "pockets of insurance" to crops which would otherwise be completely at the mercy of "capricious rainfall" and deserved to be taken more seriously. In view of this "protective function" of tanks, and on the recommendation of the Famine Commission (1878-80), the government introduced the Tank Restoration Scheme (TRS) in 1883. This scheme, which was strongly endorsed by the First Irrigation Commission (1903), involved the investigation of each tank by a TRS party and the preparation of a memoir covering details such as standard levels, flood discharges, storage capacity, sluice specifications and position, and the commandable ayacut. Based on the memoirs, detailed

estimates for repair were prepared for each tank. This was to be followed up by the "execution stage" in which the repairs were carried out and the tank "brought up to standards". Once repaired, the tank was handed over to maintenance to the Public Works Department (system tanks and those with an ayacut of 200 acres or more) or to the Revenue Department (all other tanks).[6]

Post-Independence

40. The government inherited a very unsatisfactory position in regard to tank irrigation at the time of Independence. The TRS divisions did not function continuously having been subjected to reductions and retrenchment from time to time. TRS memoirs were not available at all for tanks in the ex-zamin areas and for about 10 per cent of tanks in the ryotwari areas. In a large number of cases, TRS estimates had not been executed and, meanwhile, the memoir details had become obsolete due to a variety of factors such as changes in rainfall conditions, encroachments, siltation, and damages to bunds and sluices.[7] Tanks taken over from the ex-zamin areas, a large number in eastern Ramanathapuram, were in a particularly neglected condition. Where repairs had been carried out, maintenance had not been adequate. Customary maintenance obligations, or kudimaramath, had broken down. It was not considered feasible, or desirable, to enforce them through punitive action. Although attempts were made in that direction, government did not succeed in evolving a systematic or adequate set of arrangements for the maintenance of tanks.[8] To set right this state of affairs, a number of schemes were taken up in the years following Independence for updating of TRS memoirs, for carrying out special repairs to tanks (AMIP or Accelerated Minor Irrigation Programme), for rehabilitating the ex-zamin tanks(DCS or Desilting-cum-Reclamation) and for the construction of new tanks in suitable locations (SMIP or Special Minor Irrigation Programme).

Present position

41. No detailed evaluation on a comprehensive basis has been made of the present condition of the tank system in Tamilnadu. However, there is evidence from official data and from non-official studies to indicate that the system as a whole has deteriorated. In 1960-80, there has been a secular decline in the gross and net areas under tank irrigation. There is also evidence that the contribution of tank-irrigated areas to increased paddy output in this period has been negligible.9/

42. A number of studies have brought out the factors which have been responsible for the deterioration of tanks.10 These can be summarised as follows. Extensive cultivation has taken place, mainly in the catchment and foreshore areas, but not excluding in many cases the tank bed and the surplus and supply channels. Legally, cultivation of this kind in an "encroachment" but permissive policies have allowed them to continue; and, in some areas they have also been regularised. Such cultivation, along with the lack of timely or regular maintenance, has resulted in siltation on a large scale. Siltation in feeder channels reduces inflow; on the tank-bed it affects storage capacity; in the surplus channel, it may lead to the weakening of bunds; and in front of the sluice, it chokes up the outflow. In the late 1950s, it was estimated that due to siltation, the State had lost about 25 per cent of the capacity under tank irrigation and the fear was expressed that "in course of time the deposit of silt would assume such a high proportion that the tanks would lose their capacity to an extent of 50 to 60 per cent".11/ The second set of problems are the consequences of poor maintenance. Bunds are often weak and liable to breach at heavy rains, so frequently a feature during the north-east monsoon in the coastal, tank-intensive areas. Wrongly-placed, outmoded and leaky sluices are another type of problem resulting in inadequate supply or waste.

Similarly, the excavation of earth around the sluice leads to dead storage. Thirdly, many of the tanks are shallow basins with a large area of water spread relative to the ayacut, estimated in the ratio of 1:1.3.[12] Evaporation losses are consequently significant. The fourth set of problems are administrative. Financial allocations have been inadequate to enable systematic maintenance. Responsibility for maintenance is now divided between the PWD (for system tanks and tanks with an ayacut of 100 acres or more) and Panchayat Unions (in the case of smaller tanks) Finance and technical staff available to the latter are particularly inadequate with the result that the smaller tanks have been relatively neglected. The progress in revising the TRS memoirs has been slow and the gap, noticed in the pre-Independence period, between memoir preparation and execution continues to be yawning.[13]

43. It should be possible to overcome the financial and administrative problems given sufficient will and resources. Some of the technical problems such as the control of evaporation and the removal and deposit of silt, accumulated over decades, will be difficult but may not be impossible of solution. It is the socio-economic issues that will be stubborn. These relate mainly to extensive encroachments over communal land, fragmentation of holdings which constrains the rational alignment of field channels, and lack of institutionalised arrangements for the equitable sharing of water, especially under scarcity conditions.

44. While thus the improvement of tank irrigation is riddled with problems, its necessity and value should also be clear. As already pointed out, tanks are valuable for several reasons. They have a protective function. They under-pin river systems and recharge wells. By conserving water, tanks can support two or even three crops in years

of good supply. It is important that this historic and valuable asset should not continue to be neglected, particularly in view of the limited further potential for irrigation under other sources in Tamilnadu. Even a selective modernisation of a limited number of large tanks could yield good dividends. But to stop with it would be to ignore the protective function of the large number of scattered small tanks which particularly benefit small and marginal farmers in arid tracts. A comprehensive and systematic programme for the repair and maintenance of tanks is therefore necessary. Such a programme will have a large wage payments component since it will mainly involve earthwork. The wide geographical spread of tanks, and the fact that maintenance (including desilting) is a recurring necessity, can make a programme of this kind an ideal avenue for employment generation in rural areas linked to useful activity.

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1/ Most simply defined, tanks are walls of earth, called bunds or embankments, built across routes of drainage, storing water for distribution to fields through channels. The 'catchment area' of a tank is the area run-off from which empties into the tank. The 'tank bed' area is the one over which the water in the tank spreads when it is full and the 'fore-shore' is the area which is exposed when water recedes from its full level. The 'ayacut' is the area commanded by the tank.

Minor irrigation works include constructions across minor streams and river channels costing less than Rs. 25 lakhs.

2/ See S.Y.Krishnaswamy /19/.

3/ M.Von Oppen and K.Subba Rao Part I /31/.

4/ The Statistical Atlas of the Madras State (1950-51), Government of Madras 1952.

5/ Government of Tamilnadu /16/. The largest tanks in Tamilnadu are Veeranam (with an ayacut of 44,856 acres), Chembarambakkam (13,019 acres) and Rajasingamangalam (12,142 acres).

6/ For an account of TRS see B.S.Baliga /5/.

7/ For details of these problems are S.Y.Krishnaswamy /18/. Appendix No.7 containing a note on minor irrigation works.

8/ On problems of maintenance see B.S.Baliga /5/ and Government of India /8/.

9/ Madras Institute of Development Studies /25/.

10/ S.Y.Krishnaswamy /18/; Madras Institute of Development Studies: Structure and Intervention 1980; Madras Institute of Development Studies /25/; and Government of India /8/.

11/ Government of India /8/.

12/ Ibid.

13/ Madras Institute of Development Studies /25/.

V Groundwater

45. Wells, which utilise groundwater, have become the leading mode of irrigation in Tamilnadu. An important difference between surface (river and tank) irrigation and wells is that while the former are public sources in terms of ownership, maintenance and development, wells are largely privately owned and operated, although the underground acquifers on which they draw are part of the commons.

46. Wells can be of different types. They can be deep-bore wells extending to several hundred feet, shallow tube wells, or open wells. The lift mechanism may be operated with human or animal power or it may be energised by means of electric or diesel pumpsets. They can be the sole source of irrigation to a particular field or supplement irrigation from canals and tanks. In Tamilnadu, wells are predominantly open masonary structures, sole-source, and privately owned. On an average, they irrigate between 1.25 to 2.50 acres. This is quite limited compared to wells in the Punjab which have ayacuts of 10 to 15 acres. Over 50 per cent of wells in Tamilnadu had been electrified by 1978-79 with another 5 per cent using diesel pumpsets.

Growth Profile

47. British policy towards well-irrigation was liberal. No water charges were levied on private irrigation and improved productivity achieved thereby was not taken into account in land revenue assessment. Encouragment was given by means of taccavi loans and subsidies for the construction of wells. It was however since Independence that a rapid exploitation of groundwater has occurred directly as the result of government programmes and promotional policies: principally rural electrification and a highly subsidised

agricultural power tariff, medium-term credit for the digging of wells and the purchase of pumpsets, and well subsidies to a limited extent. The exemption from water charges has continued.

48. Wells at present account for about 38 per cent of net irrigated area in Tamilnadu. The growth in ground water development in the last three decades is striking (see Table 13). We have already noted (paragraph (14) that groundwater has almost entirely contributed to the growth in irrigated area in Tamilnadu in the last two decades (1960-80). The number of wells nearly doubled from about 6.3 lakhs at the beginning of the 1950s to 11.9 lakhs at the end of the 1960s, and went up by a further 4.4 lakhs to over 16 lakhs by the late 1970s. Between 1950 and 1970, net area irrigated by wells rose from 12.5 to 19.4 lakh acres i.e., by about 7 lakh acres; and, in the 1970s alone, there was a further increase of 8.6 lakh acres reaching a total of about 28 lakh acres in 1978-79. Electrification of wells has also proceeded at an impressive pace. Prior to Independence only a meagre number of 4,300 wells were connected. The figure rose to about a lakh at the end of the 1950s, went up to 6 lakhs by 1971-72 and over 9 lakh pumpsets had been electrified by 1980-81. Annually, a rate of energisation of 30,000 to 35,000 pumpsets is being maintained. Tamilnadu is the leading State in India in electrified pumpsets and accounted for over a fifth of all such pumpsets in the entire country in the late 1970s.

District-wise position

49. Wells are dispersed fairly widely throughout Tamilnadu, the Nilgiris and Kanyakumari being exceptions. Thanjavur has a relatively small total number, although filter-point tube wells have come up to a large extent in the north-western taluks of the old delta. Eight districts viz., Coimbatore, Periyar,

Table 13 : Growth in groundwater irrigation

	No. of wells (in lakhs)	Net area irrigated (lakh acres)	No. electrified
1951/52	6.34	12.45[1/]	5,000[2/]
1961/62	9.37	14.95	1,00,000[2/]
1970/71	11.86	19.38	5,65,000
1978/79	16.33	26.72	8,41,000

1/ Excluding wells in Kanyakumari district

2/ Estimated

Source: The Statistical Atlas of the Madras State (1950-51) for 1951/52. Season and Crop Reports (various issues) for other years.

South Arcot, North Arcot, Madurai, Salem, Chengalpattu and Tiruchirapalli between them account for 76 per cent of the total number of wells and for over 80 per cent of the net irrigated area under them. It is also these districts which have witnessed a rapid growth in ground water development in the last two decades. In the northern districts - North Arcot, South Arcot and Chengalpattu - wells supplement tank irrigation in good measure.

Future Prospects

50. There is clear indication that the rapid growth in groundwater utilisation which has been a feature of the last three decades can not be sustained in the future. According

to an assessment made in the mid-1970s, groundwater is already being over-exploited with the drawal in many parts of the State being continually more than recharge. This is particularly true in the western districts (Coimbatore, Periyar, North Arcot, Dharmapuri and Salem) but not confined to them. Except in Thanjavur and Kanyakumari, ground water is available only in limited areas for further exploitation, while in these two districts the incentive for its development is limited.[1/] Within this broad assessment, more detailed and refined investigations of water table behaviour, recharge conditions and yield of acquifers may be able to identify some further scope, here and there, for groundwater utilisation. On the other hand, there is likely to be a diminution in present availability on account of the steady lowering of the water table patently noticed in many areas, with progressive electrification accelerating the trend towards intensive exploitation.[2/] The prospects for any significant increase in well-based irrigation in the future are thus not promising.

An Assessment

51. There can be no doubt that groundwater utilisation has literally changed the landscape of irrigation in Tamilnadu. In the early 1960s when the potential for further growth in surface irrigation had very nearly been exhausted, thousands of wells and electric pumpsets have made a notable contribution. This development has helped in increasing output coupled with a higher intensity of cropping, and in the cultivation of remunerative commercial crops. In the process, well-based agriculture has provided more employment to agricultural labour. Pumpsets have led to non-agricultural rural employment for pump operators, mechanics and maintenance personnel. It has spurred the growth of pump manufacturing and repair units. These contributions to output, employment and incomes have been significant and many-sided.

52. The private exploitation by numerous individual farmers of underground water has however taken place in an unplanned and unregulated manner. Although the need for comprehensive groundwater regulation was accepted in principle, it has not been possible to bring forward legislation for this purpose.[3/] In extending institutional credit for wells and pumpsets, distance criteria for the location of new wells have been sought to be enforced. More affluent farmers who have been able to put up wells and pumpsets with their own resources have escaped such regulation. In the process, they have crowded out smaller farmers who were later entrants dependent on institutional finance. As pointed out earlier, the proliferation of wells has resulted in a progressive lowering of the water table in many tracts reducing water availability for all and increasing costs of pumping, of putting up new wells, and the deepening of old ones. Overall ecological damage and the inequitable sharing of a common resource with limited renewability are two important features of the kind of groundwater development that has taken place in Tamilnadu.

53. Groundwater utilisation on Tamilnadu is energy-intensive. The agricultural demand on total power sales is as high as 27 per cent, the highest proportion in any State. The Tamilnadu electricity system is still heavily dependent on hydel sources. In years of poor rainfall, generation gets reduced but the agricultural demand is accentuated. The result has been heavy power cuts on industry and limited and fitful supply to agriculture itself. Furthermore, a heavy social cost of the order of 35 to 38 paise per unit is involved in supplying a unit of power to pumpsets.[4/] The overall burden of this subsidy amounts at present (1980-81) to about Rs. 120 crores per annum which is nearly half the entire sales revenue of the Tamilnadu Electricity Board.

54. Pumpset owners who have water to spare sell it to neighbours in need. In these waters sales, which have been widely reported, they are able to extract "water-rents" in grain and/or cash which are equivalent to 4 to 5 times the cost of water to the seller. This reflects both the monopolistic position of sellers and the real value of water to the buyers.[5/]

55. The extensive use of power for irrigation has many other ramifications. It has rendered the real costs of cultivation (i.e. private costs plus the value of the subsidy) for well-irrigated crops unfavourable vis-a-vis costs under surface irrigation in Tamilnadu and elsewhere. The added costs of irrigation has become a factor in the demand for higher output prices amongst farmers using wells, particularly in areas in Coimbatore, Periyar, Salem and N.Arcot where wells are deep and cash crops are extensively grown. There is also evidence that groundwater irrigation has tended to worsen inequalities in the agrarian structure. In the hands of large farmers with sizable holdings, pumpsets have become valuable surplus-generating assets which have served to further increase their economic power.[6/] Less affluent farmers who have ventured into pumpsets have become increasingly indebted having had to borrow not only for the initial investment but also for periodic repairs and maintenance.[7/] Preliminary studies indicate that rates of growth of agricultural labourers in Tamilnadu in 1961-71 were highest in areas where lift irrigation was a prominent feature suggesting that privatised well-irrigation has tended to push a section of the working population, from among cultivators and others, into the agricultural labour force.[8/]

56. A detailed evaluation of the nature, extent and distribution of costs and benefits in groundwater irrigation will have to await further research. But, in sum, it can

be said that the balance sheet of well-irrigation is at best a mixed one. Its contributions to output and employment are undeniable but these have been won at heavy social costs, financial and ecological. The obverse side of these costs are private benefits which, given the existing structure of asset-concentration in Tamilnadu, have accrued most to the larger farmers.

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1/ Ram Chander /26/

2/ See C.M.Madduma Bandara 'Hydrological Consequences of Agrarian Change' in B.H.Farmer (ed.) Green Revolution? Mac Millan 1977 for a detailed analysis of changes in the water table in N.Arcot district.

3/ A Bill for Groundwater Regulation was proposed by the Tamilnadu Government in 1977 but has not been proceeded with.

4/ The Tamilnadu Electricity Board has estimated the cost of supply at 50 paise per unit while the present (1984) tariff is 12 paise for small farmers and 15 paise for others.

5/ The standard rate for "water-rent" is one-third of the gross output of grain. as reported in village studies in Tamilnadu. See Joan P.Mencher Agriculture and Social Structure in Tamilnadu Allied Publishers 1978 (for Chengalpattu) John Harriss Capitalism and Peasant Farming: Agrarian Structure and Ideology in Northern Tamilnadu Oxford University Press 1982 (for N.Arcot) and S.Guhan and Joan P.Mencher 'Iruvelpattu Revisited' Economic and Political Weekly June 4 and 11. 1983 (for S.Arcot).

6/ See S.Guhan and Joan P.Mencher op.cit. for a case study.

7/ This is well-documented in the field study of a village in N.Arcot by S.Janakarajan of the Madras Institute of Development Studies.

8/ V.K.Ramachandran, 'Agricultural Labour in the Working Population of Tamilnadu' in the Madras Institute of Development Studies Bulletin March 1980.

VI Some financial aspects of irrigation

Social and Private costs and returns

57. In all modes of irrigation, there is a combination of public and private investment. In surface irrigation, budgetary funds have financed dams, canals and tanks in terms of construction, and they are used for expenses on continuing operation and maintenance, while complementary private investments have been on land-levelling, construction of field channels etc. In groundwater, the means of irrigation viz., the well and pumpsets are privately owned but loans and subsidies from the State have provided financial support in large measure for investments on them. The energisation of wells and the functioning of pumpsets depend on the extensive rural electricity net work and on the generation and distribution of electricity which are financed by the State.

58. Returns from irrigation are social and private. For the individual farmer, the availability of water enables extension and/or a higher intensity of cropping, increased productivity, and a shift to more remunerative crops. This becomes possible from the use of water and of inputs such as high yielding seed varieties and fertilisers which depend on water availability. Thus irrigation adds to private incomes in a variety of ways. For the economy as a whole, i.e., by way of "social returns", irrigation leads to increases to output, employment and wider economic growth via linkages with industry, trade, transport etc. The key issues in irrigation finance are to what extent investment criteria should be based on the social returns; and, at the same time, to what extent should a due proportion of private gains be captured as a return to the State on irrigation investments, after the recovery of maintenance costs.

Pre-Independence Irrigation Financing

59. Prior to 1854, all expenditures on irrigation were charged against general revenues. Subsequent to that, maintenance expenditures on existing works and outlays on the construction of smaller works continued to be met from general revenues while separate capital and revenue accounts were opened for larger works. For a period, the experiment was tried in the Madras Presidency to promote a private company - The Madras Irrigation and Canal Company - to undertake irrigation works with money raised in the bond market supported by a guaranteed return of 5 per cent from Government. This policy was abandoned in 1867 and government decided thereafter to meet the investment on irrigation from public funds. For this purpose, irrigation works came to be divided into three categories: productive, protective and minor.[1/] Productive works were those which were anticipated to produce sufficient revenue which, after covering working expenses and interest charges on the capital cost, would yield a prescribed rate of return on capital. Protective works, which came into vogue in 1881 on the recommendation of the Famine Commission, were constructed primarily to insure famine-prone tracts against drought. In calculating returns on them, anticipated savings from the avoidance of land revenue remissions and of famine relief expenditure were taken into consideration. Subsequently, the investment criterion in their case was also brought on par with that for productive works except that the expected rate of return from protective works was fixed at lower levels. During various periods, the normative rates of return on productive works ranged from 3.75 to 6 per cent and on protective works from 2.5 to 4 per cent. No separate capital and revenue accounts were maintained in the case of minor works which included all but a few tanks. At the time of Independence, irrigation works in India yielded a net return of 8 per cent after meeting the costs of maintenance and interest charges.[2/]

The Benefit-cost ratio

60. During the first decade following Independence, it was increasingly felt that the financial productivity criterion was too rigid and tended to ignore several indirect, and largely social, benefits from irrigation. On the basis of a number of studies, it was finally decided in 1964 to adopt instead a revised investment criterion based on the "economic benefit-cost ratio" or "B-C ratio". For the sake of simplicity, the benefit was taken to be equal to the difference between value of output and cultivation costs, before and after the introduction of irrigation. The cost was to comprise the annual interest on capital, depreciation, and expenditure on maintenance and operation. Generally, a benefit-cost ratio of 1.5 was insisted upon before sanctioning a project; at the minimum, a ratio of higher than unity was considered adequate. Neither costs nor benefits were discounted to values at the time of investment. It is important to note that the "costs" taken into account in the B-C ratio were the ones related to public investment. On the "benefit" side, no distinction was made between private and social benefits. The formula also did not provide for weightage to be given to socially desirable benefits (such as for poorer farmers or development of backward areas or increasing output of needed crops) or for any premium to be placed on socially undesirable costs (such as on ecological damage).

61. In terms of investment policy, the shift to the B-C ratio marked an important change since this ratio, unlike the financial productivity criterion, did not take note of the return on investment to the exchequer. The Irrigation Commission in 1972 had to point out that "the application of the benefit-cost ratio criterion in recent years has had certain undesirable effects. It minimises the importance of securing an adequate return from investments on irrigation projects".

Returns on Investment in Tamilnadu

62. The investment criterion for irrigation has seen considerable relaxation in Tamilnadu. In as much as surface irrigation has already been intensively utilised, there has been a tendency to take up newer projects in areas of marginal productivity and with low duties. At the same time, investment costs have progressively increased due to inflation, from around Rs.2500 per acre in the early 1960s to about Rs.7000 in the late 1970s.[3/] As a rule of thumb, annual costs on interest, depreciation and maintenance can be taken at 10 per cent of the investment cost. In some of the marginal projects, the 'benefit' or net additional income due to irrigation is likely to be less than the "cost" at current costs of investment. In such circumstances, where the B-C ratio is depressed below unity, there may be no prima facie case for investing in irrigation at all. If, as a social welfare measure, it is desired to benefit poorer farmers or farmers in backward areas, direct income transfers could be provided on a more reliable and equitable basis.

63. Overall financial returns to the State are far from adequate. In the older projects, irrigation charges are reflected as a part of land revenue i.e., as a wet rate assessment on land. In the newer projects, and for water supplied to "dry" land, specific rates are charged. There has been no practice of revising the wet assessment or the water rates periodically. Furthermore, the wet assessments have been fixed having regard not only to the reliability of the irrigation source but also to the taram assessment of the land. The differentials involved in the latter, while leading to a multiplicity of rates, have over the years ceased to reflect any rational differentiation. The rate structure does not contain any built-in incentives for economising on the use of water; nor is this, in the nature of it, possible as charges are related to the area irrigated and not to the quantum of water used.

64. There is provision in the Madras (Levy of Betterment Contribution) Act 1955 to levy betterment charges on landholders whose lands have benefited from a public work. The annual betterment levy is 1/20th of 1/3rd of the net expenditure on the project per acre of land benefited. The net expenditure is calculated after deducting from the capital cost 20 times the increase in revenue as levied before and after irrigation from the project. The yield from this measure has been quite negligible (about Rs.3 lakhs per annum) owing to delays in the levy and/to poor collection.

65. Altogether, the total annual receipts on "commercial" irrigation (i.e., ignoring non-commercial sources such as tanks and other minor works) from land revenue attributable to irrigation, water rates, betterment levies and other receipts are currently of the order of Rs.3.5 crores. As against this, working expenses alone come to about Rs.6 crores.[4/] There is no question therefore of the recovery covering interest charges or depreciation let alone yielding a net return on the capital cost. The overall investment in 'commercial' (or productive irrigation) in Tamilnadu is about Rs.200 crores in original costs and will be much higher at current prices. This investment involves a recurring liability rather than a return. The net additional income due to irrigation from a gross acre has been estimated at about Rs.1000 pdr acre for the beneficiary in 1979/80 prices.[5/] On an average, recoveries directly related to irrigation (i.e. excluding local cess and local cess surcharge which are credited to Panchayat Unions) capture only about one per cent of this amount. These figures relate to canal irrigation. The subsidy is heaviest in groundwater irrigation where, as pointed out earlier, no water rates are charged and the annual subsidy on the agricultural power tariff alone is of the order of Rs.120 crores. Moreover this subsidy benefits well-using farmers who are able to get relatively better returns from two or three crops

of paddy or from cash crops; among them many are also large farmers.

66. Irrigation is thus heavily subsidised. The Irrigation Commission (1972) and the National Commission on Agriculture (1976) have expressed themselves against irrigation being subsidised at all.[6/] This issue is linked to the larger one of whether, to what extent, and in what manner agriculture or poorer farmers or underdeveloped areas should be subsidised. Regardless of the positions that can be taken on this set of questions, the rationale of indirect subsidies for these purposes via irrigation is open to question. If subsidies are justified, it seems best that they are direct, visible and quantified so that discriminatory benefits can be provided in an explicitly equitable manner. The criticism of irrigation levies in Tamilnadu is that they not only transfer social costs into private benefits but in the process make no distinctions, based on social criteria, as between groundwater and surface irrigation, large and small farmers, crops according to their value, or developed and backward areas.

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1/ Government of Madras /73/

2/ Report of the Irrigation Commission 1972 Vol.I /9/.

3/ Ram Chander /26/

4/ Data obtained from the Finance Department, Government of Tamilnadu.

5/ Leslie Abbie et al /1/. Village Studies conducted in the Madras Institute of Development Studies also confirm this order of magnitude.

6/ Report of the Irrigation Commission 1972 Vol.I pp.264-265 /9/ and Report of the National Commission on Agriculture 1976 Part V p.65 /12/. Referring to the view that "irrigation projects should be undertaken not so

much for the purpose of earning revenue but as a measure of social welfare", the Irrigation Commission felt that it was "highly inequitable" to call upon the general tax-payer to pay for the benefits accruing to a section of the cultivators from irrigation. In this connection, it quoted with approval the following observation of the First Irrigation Commission (1901): "Prima facie, there is no more reason for calling on the State or in other words the general tax payer to bear a permanent charge for the sake of increasing by irrigation the produce of land belonging to a private owner than there would be for calling on it to pay a similar amount for supplying another man's acre with manure".

VII The Issues for the Future

Potential, utilisation and endowment

67. Earlier discussions would have made it clear that unutilised potential in irrigation available for future exploitation is extremely limited in Tamil Nadu.[1/] Estimates of ultimate irrigation potential in the State vary in the order of 3.6 million hectares (Irrigation Commission 1972) to 4.0 million hectares (National Commission on Agriculture 1976) in gross area. The latter estimated that utilisation in 1970-71 was of the order of 3.4 million hectares leaving a balance of 0.1 million hectares under surface irrigation and 0.5 million hectares under groundwater for further exploitation. With rapid development in the 1970s, scope for further expansion in groundwater in the 1980s and beyond will be further limited. Table 14 gives the extent to which the ultimate potential in each of the major States in India had been developed by 1979-80. Along with Punjab, Tamilnadu leads all other States in utilisation already achieved with about 80 per cent of the potential under exploitation. By the same token, the scope for future development relative to past performance is also the least.

68. The same table compares the ultimate potential in hectares of irrigated area per capita as a measure of endowment in irrigation. It shows that irrigation potential in Tamilnadu in per capita terms is the lowest (along with Kerala) among the major States: at only about 0.08 hectares it is less than half of the all-India average of 0.17 hectares. Thus not only are the prospects for further development limited, but the irrigation endowment of Tamilnadu relative to its population is also very poor in comparison to other States. In such a context, the importance of striving for greater economy and efficiency in water use, and greater equity in the sharing of available water resources, can not be over-emphasised. This objective would involve action at different levels - technical, administrative, and socio-economic.

Table 14: Utilisation of ultimate irrigation potential

	Utilisation ratio (per cent)	Per capita ultimate potential[1/] (hectares)
1. Andhra Pradesh	53.5	0.17
2. Assam	14.1	0.13
3. Bihar	38.6	0.18
4. Gujarat	51.8	0.14
5. Haryana	66.5	0.35
6. Karnataka	45.4	0.12
7. Kerala	36.6	0.08
8. Madhya Pradesh	29.3	0.20
9. Maharashtra	39.3	0.12
10. Orissa	35.4	0.22
11. Punjab	79.7	0.39
12. Rajasthan	65.0	0.15
13. Tamilnadu	78.6	0.08
14. Uttar Pradesh	57.9	0.23
15. W.Bengal	48.4	0.11
All-India	50.0	0.17

1/ On the basis of the 1981 population.

Source: Based on Government of India Sixth Five Year Plan 1980-85 pp 162-163.

Planning

69. River basins, or sub-basins in the case of larger rivers, are the natural units of water-shed boundaries in which there is an inter-relationship between surface and groundwater resources. Within them, agro-climatic sub-regions with references to rainfall, land use, and cropping patterns will have to be identified. Detailed planning at the level of river basins, and of agro-climatic zones comprised in them, will be necessary both for locating avenues for possible further utilisation and for the achievement of economies in existing use. A conjunctive use of wells and surface sources can open out possibilities for ground water to supplement surface availablities in achieving higher cropping intensities or for complementing them in the same cropping cycle. The need and scope for improving duties through the modernisation of existing canal systems by means of improved regulatory structures and the lining of canals has already been referred to. The planning of modernisation will have to be in a systemic framework in view of the linkages between different rivers and reaches in the same basin (as in the Cauvery system) and between rivers on one hand and tanks and wells on the other (as in Periyar-Vaigai and the Lower Bhavani.)

70. Crop planning and regulation have an important role both in improving efficiency (in terms of output value for unit of water) and in promoting equity (in terms of the number of farmers who can benefit from a given availability of water). In this connection, it must be noted that paddy is a water-intensive crop requiring nearly three times as much water for the same physical output as wheat or irrigated dry crops. This is because it requires standing water in the field and the percolation loss in most paddy areas is more than double that of evapo-transpiration. Paddy cultivation

should therefore be discouraged in lighter or more permeable soils which lead to excessive percolation. In some of the existing systems, notably the Lower Bhavani and the PAP, the cropping regimes originally envisaged have been allowed to be widely violated with adverse consequences on both efficiency and equity. In other systems as well, more appropriate cropping patterns can enable water to go a longer way.

Water management

71. It is crucial that engineering and agronomic improvements should be followed up in the field by more economic water management. There is much scope for this in surface irrigation but it can happen only if the ayacutdars accept discipline and cooperation in matters such as the operation of turn systems, the formation of bunds, and the rational alignment of field distributaries.[2/] Consolidation of scattered operational holdings can greatly help in this regard. Consolidation is also of importance for soil and moisture conservation in dry areas. In ground water utilisation as well, it has an important efficiency-promoting role. Consolidation has been successfully promoted in a number of northern States but Tamilnadu has not so far been receptive to the idea. Serious re-thinking on this subject will be necessary.

Tanks

72. We have discussed the special problems of tank irrigation at some length. A comprehensive policy will need to be evolved for tanks involving as its elements (a) repairs and standardisation (b) systems for regular maintenance (c) improvements in water-use at the field level and (d) participatory arrangements for local level regulation. The continued neglect of the tank system has

resulted in heavy siltation, the removal and disposal of which has assumed the dimensions of a major problem. It will have to be approached on a tank-by-tank basis. In many cases, it might be possible to use the silt to reclaim foreshore lands; in this way, the water-spread could be reduced and deepened with consequent saving on evaporation losses. In some cases, especially where wells have come up to a substantial extent in the ayacut, the continued utility of the tank in its original form may have to be re-examined. It might be justifiable in such cases to release a part of the water-spread for cultivation, opting for a smaller and deeper tank-bed.[3] We have also drawn attention to the importance of systematic maintenance of tanks. This activity, as pointed out, can result in large-scale employment generation for rural labour, especially in the off-season when the need for it is the greatest. Equally, the periodic desilting of canals and channels under river irrigation can combine gains to efficiency and to employment.

Ground water

73. The problem posed by excessive ground water exploitation admits of no easy solutions. In the context of the unplanned proliferation that has already taken place, efforts to regulate the sinking of wells in the future may largely amount to closing the stable after the horse has been stolen. The closure of existing 'excess' wells, apart from political difficulties, will be infeasible as it can not be determined which the 'excess' ones are. The collective use of wells, either under a cooperative or under a 'nationalised' framework, remains the only solution in these circumstances.[4] It might have to be considered at least in the tracts most seriously affected by over-exploitation and falling water tables.

New technologies

74. Research, development and introduction of new technologies consistent with cost-effectiveness have high priority. In this connection, methods such as sprinkler and drip irrigation have attracted attention. The former, which is extensively practised in Israel, consists of the 'sprinkling' of water through nozzles or perforated pipes eliminating losses in percolation and run-off. In drip irrigation, water is conveyed along furrows through tubes and allowed to drip slowly through nozzles or orifices to keep the soil surface around the plants constantly wet. Both evaporation and percolation losses are eliminated and a steady wetting of the soil is made possible. Other methods that have been suggested include the spraying of cetyl alcohol for reducing evaporation in reservoirs and tanks, artificial rain-making, desalination, and the use of waste and salt water for growing crops.[5/] In particular, the use of solar energy for operating pumpsets, when it becomes economically feasible, can be of enormous significance to Tamilnadu. In many areas, the use of wind power might be feasible. Research on short-duration, less water-intensive seed varieties is another priority area.

Financial aspects

75. In dealing with the financial aspects of irrigation we had discussed investment criteria and drawn attention to the heavy subsidisation of irrigation, particularly in the case of ground water. Since the 1960s, direct public investments on irrigation in Tamilnadu have been relatively limited as major surface projects have been few and far between. In the future, substantial investments are likely to be needed for the renovation and modernisation of existing systems. The economic rationale for such investments will also have

to be rigorously established. Irrigation, despite the high priority it has, can not be justified at any cost. Concurrently, there is no reason why investments in this sector should continue to be heavily and irrationally subsidised. At the barest minimum, the objective will have to be to cover working expenses including depreciation. Given some political will, this should be possible in surface irrigation. It is bound to prove much more difficult, although equally necessary, in respect of the agricultural power tariff.

Administrative aspects

76. Reference should also be made to certain aspects of irrigation administration in Tamilnadu. The Public Works Department (PWD), the irrigation branch of which was established in 1867, is responsible for the investigation and implementation of major, medium and minor irrigation works in respect of canals and tanks. It has a wing for ground water investigations viz., the mapping and assessment of ground water availabilities on a block-wise basis. The PWD also has responsibility for the maintenance and operation of all irrigation works with the exception of non-system tanks with ayacuts of less than 200 acres. The maintenance of the latter has been assigned to Panchayat Unions which function under the supervision of the Department of Rural Development. The Revenue Department is in charge of the levy and collection of land revenue and water charges. It also has the responsibility to protect public and communal lands (porambokes) like canals, channels, tanks etc from encroachments. The Department of Agriculture is concerned with crop planning, soil and moisture conservation, and agricultural engineering works to promote better water management. The Tamilnadu Land Development Bank finances investments on wells and on pumpsets with the Tamilnadu Electricity Board being responsible for electrification. Irrigation statistics (see appendix) are compiled

by the Department of Statistics. Research on various aspects of irrigation, technical and agro-economic, is undertaken principally in the Tamilnadu Agricultural University, Coimbatore and the Perarignar Anna University of Technology at Madras. In the perspective that faces Tamilnadu, it is clear that a comprehensive and integrated approach will be necessary to irrigation planning, modernisation and water use management. It will have to take into account inter-related aspects - engineering, agronomic, land control and financial. In such a context, close interaction and coordination between the several agencies concerned with irrigation will have to be ensured and institutionalised. In particular, planning, research, data and evaluation deserve high priority.

Legislation

77. The body of legislation relating to irrigation in Tamilnadu falls into two broad categories.[6/] Firstly, there are a series of Acts which relate to the levy and collection of irrigation charges: The Tamilnadu Irrigation Cess Act 1895; The Tamilnadu Irrigation Voluntary Cess Act 1942; The Tamilnadu (Levy of Betterment Contribution) Act 1955; The Tamilnadu (Additional Assessment and Additional Water Cess) Act 1965 and its Amendment Act of 1978. The second set of legislation includes laws which give powers to Government to undertake the maintenance and improvement of irrigation works and their appurtenances : The Tamilnadu Compulsory Labour Act 1858; The Tamilnadu Irrigation (Repairs, Improvement and Construction) Act, 1943; The Tamilnadu Irrigation Tanks (Improvement) Act 1949; The Tamilnadu Irrigation (Construction of Field Bothies) Act 1959 and the Tamilnadu Land Improvement Schemes Act.

78. An appropriate and comprehensive legal framework will need to be evolved for the regulation and promotion of irrigation in the specific developmental context of Tamilnadu. In particular, the rights and duties of ayacutdars, of local bodies such as Panchayat Unions and Panchayats and of the State will have to be reviewed and defined in the light of issues such as those relating to an adequate cost recovery on investment, the improvement to tank irrigation, crop planning and regulation, and ground water conservation. From these points of view existing legislation is inadequate, fragmented and in part outmoded.

In Conclusion

79. It deserves to be emphasised that issues relating to irrigation are as much socio-political as technical, financial, administrative and legal. Social organisation and property relations are involved whether it is land consolidation and cooperative use, the clearance and prevention of encroachments, soil and moisture conservation, groundwater regulation, the regular maintenance of irrigation sources, the enforcement of crop planning, or arrangements for equitable water-sharing. This cluster of issues can be tackled only on the basis of an enlightened political process that relies on persuasion and decentralised participatory institutions, underpinned by instruments for legal compulsion.

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1/ In the words of Ram Chander /21/ "A study of irrigation potential in Tamilnadu, if viewed mainly as utilisation of the available water supply, both of surface water and groundwater, would in effect be largely past history rather than future projection".

2/ See in this connection Robert Wade 'Administration and Distribution of Irrigation Benefits' in the Economic and Political Weekly November 1, 1975; Robert Chambers 'Men and Water: the Organisation and Operation of Irrigation' in B.H.Farmer (ed) Green Revolution? Mac Millan 1977; and A.Vaidyanathan /29/.

3/ See Madras Institute of Development Studies /25/ Part D for a discussion of the efficiency of tanks based on the criterion that the total output given its existence would at least be equal to that which would obtain in its absence.

4/ Ian Carruthers and Roy Stoner /7/ point out (p.36) "The role of minimum spacing and/or density regulation through legislation, credit control or other administrative devices; such as electricity connection or diesel fuel rations, merely reinforces existing income distribution patterns. Absence of control will lead eventually to excessive pumping. Thus devices designed to bring about technical efficiency are, in fact, effective in strengthening the position of a richer minority group. The injustice of these indirect effects is compounded, if the credit is subsidised, if it is not repaid in part or in full, if electricity or fuel prices are below social costs, or if rationed resources are not directed to the highest social opportunity cost activity".

5/ These possibilities are discussed in State Planning Commission, Tamilnadu /27/ and in R.K.Sivanappan and K.Palaniswami /28/.

6/ For a discussion of legislation (pre-Independence) see S.Y.Krishnaswamy /18/ and for a comparative discussion State-wise the Report of the Irrigation Commission 1972 Vol.I /5/ Chapter XVI.

APPENDIX

A NOTE ON IRRIGATION STATISTICS IN TAMILNADU

In this note, we shall discuss the availability, sources and limitations of data relating to irrigation in Tamilnadu. We conclude it with some suggestions for improving the data base.

2. The Department of Statistics brings out annually a Brochure on Irrigation Statistics. The Brochure contains the following information:

(i) Figures of net and gross area irrigated at the district level and of net area irrigated at taluk level.[1/]

(ii) Source-wise figures (i.e., canal, tanks, wells sole-source and supplementary, and other sources such as spring channels) at district level for net area irrigated.

(iii) Crop-wise breakdown at district level of the gross area irrigated.

(iv) Physical details at the district level regarding canals (Government/Private: number and kilometres), reservoirs (numbers), wells (Government/Private: tube wells, other wells-masonary and non-masonary) and tanks (broken down into those with an ayacut of 100 acres or more and with ayacut of less than 100 acres).

1/ Net area irrigated is the area irrigated during an agricultural year (July-June) counting the area only once even if two or more crops are irrigated on the same land. Gross area counts the area irrigated under more than one crop during the same year as many times as the number of crops grown.

(v) The irrigation potential created in terms of gross area under individual canal irrigation projects in the pre-Plan period and in each of the Plan periods.

(vi) Area benefited under special minor irrigation programmes.

3. The data in the Brochure is based on that compiled in the annual Season and Crop Reports (SCR) brought out by the Department of Statistics and on data furnished by the Public Works Department (items (v) and (vi) above). In addition to the data reproduced in the Brochure, the SCRs give:

(i) normal and actual figures of rainfall in the year month-wise at the district level.

(ii) detailed information on wells at the district level according to purpose of use (irrigation, industrial, domestic), ownership (Government, private), type (tube wells, filter-point tube wells, dug wells - masonary and non-masonary, dug-cum-bore wells and other types of wells), ayacut (independent or supplementing other sources) and lift mechanism (electrical, diesel, bullock baling, bucket manual and other methods).

(iii) a break down according to I, II and III crop of the gross area irrigated under each crop at the district level. The crop-wise classification is in fuller detail than in the Brochure.

4. The Tamilnadu Economic Appraisal (TNEA) and the Tamilnadu Statistical Handbook (annuals) reproduce a part of the data in the Brochure. The TNEA furnishes a time-series at the State-level for rain-fall season-wise, net

area irrigated source-wise, gross area irrigated under all sources, and gross area irrigated crop-wise. It also gives data on the consumption of electricity for irrigation (in units and value) and the number of pumpsets electrified, both at the State level.

5. The World Agricultural Census (WAC) 1970-71 gives data on net irrigated area source-wise for each of twelve size-classes of operational holdings at the levels of the State, district and Panchayat Union. A similar census has been undertaken in 1980-81.

6. The data in the SCR which is the basic annual compilation is aggregated from statistical returns furnished at the village level by the village revenue establishment (formerly the Karnam and now the Village Administrative Officer). The primary entries are made in the Adangal from which crop/source-wise statements are compiled in the 'G-return'. The quality of the data is therefore a function of the quality of the primary returns on which it is based. In this connection, room is built-in for certain types of errors. In respect of land under canals and tanks classified as "wet", revenue at wet assessment rates is liable to be paid whether or not the area is actually irrigated. The tendency therefore will be to report all wet lands as irrigated resulting in a measure of over-estimation. In the case of land classified as "dry" but which receives water from a government source, water charges are payable. In these cases, irrigated area might get under-estimated for purposes of evasion. No water charges being payable on well-irrigated dry lands, the estimation of area irrigated under wells is likely to be unreliable or under-pitched. In estimating areas irrigated under I, II and III crop and according to the actual crop grown, no detailed measurements are made and the figures are essentially eye-estimates. Much therefore

depends on the accuracy of the village returns and an unspecified margin of error will have to be taken into account. The reporting also does not provide for information on the duration of irrigation: a single wetting or a flow for many months are both treated as 'irrigation'

7. Irrigation statistics could be made more useful for planning and analytical purposes with the following improvements:

(i) Disaggregation to the taluk and block (i.e. Panchayat Union) levels of all available information.

(ii) Inclusion of gross area irrigated source-wise, in addition to net area now furnished.

(iii) Detailed information on tanks according to more disaggregated size-classes of ayacut, giving number and area, reliability/capacity classified as per the Settlement registers and TRS memoirs, and information as to whether they are system, non-system and chain/isolated tanks.[1/]

(iv) Source-wise breakdown of the cropping pattern giving net and gross acreage.

(v) A breakdown according to size-classes of ownership and operational holdings on the lines of the WAC, including gross area irrigated and crop-wise details, at intervals of 5 years.

1/ For a detailed discussion of data relating to tanks see MIDS /25/ Part A.

(vi) Disaggregated data at Panchayat Union level of electrified pumpsets and their horse power and ownership (small farmers and others), data on which is available with the Tamilnadu Electricity Board.

8. It will also be useful if periodical sample surveys could be undertaken, especially of wells, to provide independent estimates and as a check on the accuracy and consistency of village returns.

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