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The extent and impact of ground water irrigation in Tamil Nadu: Some macro and micro evidences

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The Extent and Impact of Ground Water Irrigation in Tamil Nadu: Some Macro and Micro Evidences.

By

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1. Introduction

The ground water development in the country has been quite impressive (share of ground water irrigation in India is about 40% in 1984). This is more pronounced in the state of Tamilnadu where almost all the possible surface sources have been tapped for irrigation purposes. In fact, over a period of past three decades, area under surface sources of irrigation in the state has declined and it is rather steep in the case of tanks. The percentage share of canals in the total net irrigated area (NIA) of the State registered a small decline from 36% in 1960-61 to 34% in 1984-85; in the case of tanks, the percentage share of NIA dropped sharply from 38% to 27% during the same period. However, there is a sharp increase in the perentage share of NIA by wells from 24% in 1960-61 to little over 38% in 1984-85. Thus, it may be seen that the decline in area irrigated by surface sources is more than compensated by sharp increase in the area irrigated by sub-surface water. This pattern is clearly seen in the case of several districts of Tamil Nadu State. (See Table-1 and Graphs).

The points plotted on the graphs (separately for each district) and information provided in the Table-1 have been the

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*This is a revised version of the paper presented in a workshop on 'Policies and Management Strategies for ground water Development in Low-Rainfall Hard Rock Area, TNAU, Coimbatore, October 4-6, 1989.

outcome of moving average exercise for the years 1950-51 to 1984-85; but the results are recorded in the table only for different points of time. It may be seen from the table and graphs that in all the districts except Thanjavur and Kanyakumari, NIA has gone up atlease by 20 percent if one takes 1952-53 as the base year. In most of the districts at the same time, area under surface sources of irrigation have somewhat steeply come down (see for instance in districts such as Chengalpattu, South Arcot, North Arcot, Madurai, Tiruchi, Tirunelveli and Salem). Thus in all these districts increase in the NIA is basically due to sharp increase in the area irrigated by wells in particular, since mid 1960s. The case of Coimbatore district is quite distinct where well irrigation has been a dominant source right from the beginning of this century. NIA in this district has gone up quite sharply by 50 per cent, but area under well irrigation has come down from 68% of NIA in 1952-53 to 56% in 1983-84. Since area under tank irrigation is insignificant in this district, addition to the NIA is basically due to the new canal irrigation projects started during 1950s and 1960s. The percentage share of canals in this district has gone up from 25% in 1952-53 to 37% in 1983-84.

The case of Ramanathapuram district is quite fascinating, where area under canal irrigation is quite insignificant and the only major source of irrigation has been tanks. In this district one finds only a marginal decline in the area irrigated by tanks (ie., from 82% to 78%) and a small increase in the area irrigted by wells (from 16% to 21%). It is interesting to note that area under well irrigation remains at a low level despite the fact that the stage of ground water development in this district was only 19% as on 1984-85.[1] One possible reason for such a low level of ground water development in this district could be the problem of salinity. The studies carried out by the Central Ground Water Board in this district reveal the fact that the saline aquifers occur in several parts, and in particular coastal tracts upto 80 meters from ground level. In fact, the studies carried out in the south-western parts of the district have revealed the occurrence of saline aquifers upto a depth of 300 meters thereby ruling out the possibility of ground water development. Although the exploratory drilling conducted in this district has revealed the occurrence of fresh water aquifers beneath saline ones, it might be a too expensive proposition for an individual farmer to reach freshwater at that depth.

In the case of Thanjavur and Kanyakumari districts where well irrigation is insignificant, NIA also remains more or less stagnant.

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1. For details on the district wise ground water potential in Tamil Nadu see, 'Report of the Group on the Estimation of Ground Water Resource and Irigation Potential from Ground Water in Tamil Nadu', Chief Engineer (Ground water), PWD., Govt.of Tamil Nadu, 1988.

Table-1

5 Years Moving Averages of NIA by Sources Across Districts of Tamil Nadu, 1950-51 - 1984-85

(Area in '00 hectares)

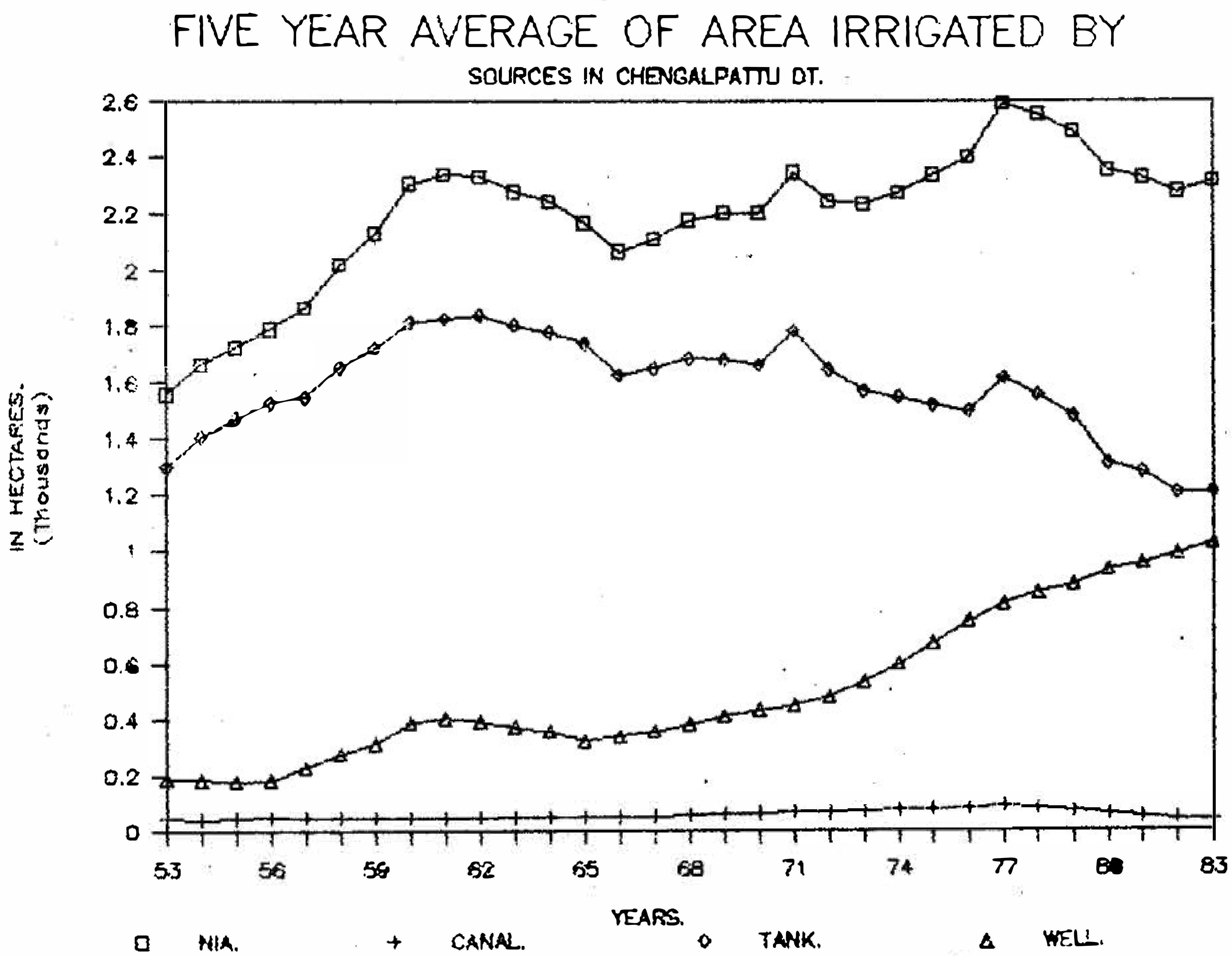
Dist.	Year	NIA	NIA Index	% of area irrigated by Canal	Tank	Well	Other sources	% of surface irrigated area supplemented by well irrigation
Chengal pattu	1952-53	1578	100	2.9	83.3	12.0	1.8	19.4
	1956-57	1797	114	2.5	83.0	12.3	2.2	15.7
	1960-61	2445	155	1.9	78.1	17.2	2.8	13.1
	1964-65	2158	137	2.3	80.3	14.9	2.5	20.0
	1968-69	2256	143	2.7	76.2	18.6	2.5	10.5
	1972-73	2283	145	3.1	70.3	23.8	2.8	11.4
	1976-77	2606	165	3.4	62.4	31.4	2.8	14.7
	1980-81	2300	146	2.1	55.0	41.1	1.8	14.5
	1983-84	2474	157	1.8	52.2	44.3	1.7	15.2
South Arcot	1952-53	2281	100	32.6	45.0	22.3	0.1	5.2
	1956-57	2406	105	31.0	45.0	19.6	4.4	2.5
	1960-61	2709	119	26.4	46.0	21.5	6.1	7.2
	1964-65	2620	115	25.4	49.0	22.4	3.2	7.8
	1968-69	2871	126	27.2	38.0	30.9	3.9	12.7
	1972-73	3087	135	25.7	32.0	38.2	4.1	17.4
	1976-77	3315	145	24.2	28.0	45.0	2.8	13.3
	1980-81	2820	124	24.7	20.0	53.3	2.0	11.0
	1983-84	2761	121	23.7	24.0	50.9	1.4	8.9
North Arcot	1952-53	1682	100	5.7	60.0	31.1	2.9	20.3
	1956-57	1939	115	6.4	57.0	34.6	1.8	18.2
	1960-61	2075	123	7.0	52.0	37.7	3.4	18.6
	1964-65	2564	152	6.0	55.0	35.2	3.7	11.4
	1968-69	2451	146	5.3	48.0	45.3	1.5	20.4
	1972-73	2733	162	5.6	40.0	53.4	0.8	23.9
	1976-77	2636	157	7.2	39.0	52.2	1.5	20.3
	1980-81	2044	122	5.3	29.0	65.0	0.6	17.6
	1983-84	2127	126	3.8	33.0	62.7	0.4	9.8
Coimba-tore	1952-53	2006	100	25.4	4.4	68.4	1.9	0.6
	1956-57	2197	110	38.9	3.2	56.9	1.0	1.3
	1960-61	2583	129	41.1	2.8	55.4	0.8	2.4
	1964-65	2382	119	36.5	2.5	60.0	1.0	4.4
	1968-69	2386	119	45.6	2.0	51.2	0.9	8.4
	1972-73	3117	155	45.2	1.7	52.1	0.9	8.4
	1976-77	3046	152	42.8	1.5	55.5	0.3	7.6
	1980-81	3144	157	42.4	1.8	55.7	0.2	5.6
	1983-84	2991	149	36.7	1.5	56.0	5.8	7.5

Madurai	1952-53	1722	100	32.0	30.1	36.0	1.9	8.1
	1956-57	1826	106	31.0	30.2	37.3	1.5	7.6
	1960-61	1874	109	33.6	28.9	36.0	1.5	6.5
	1964-65	1896	110	35.4	26.3	37.2	1.1	5.7
	1968-69	2031	118	31.5	25.8	41.6	1.1	6.0
	1972-73	2067	120	29.0	23.8	46.3	0.9	5.0
	1976-77	2164	126	24.4	25.6	49.1	0.9	4.6
	1980-81	2275	132	24.1	22.0	53.3	0.6	3.7
	1983-84	2143	124	25.3	19.9	54.2	0.6	2.9
Ramanathapuram	1952-53	1754	100	0.2	82.2	16.2	1.4	1.3
	1956-57	2177	124	0.1	86.6	13.1	0.2	0.3
	1960-61	2433	139	0.1	89.4	10.4	0.1	1.4
	1964-65	2319	132	0.0	88.5	11.3	0.2	0.6
	1968-69	2392	136	0.1	85.5	14.2	0.2	3.0
	1972-73	2249	128	0.2	83.1	16.6	0.1	6.6
	1976-77	2376	135	0.1	82.3	17.5	0.1	6.6
	1980-81	2371	135	0.0	79.9	19.5	0.6	7.0
	1983-84	2219	127	0.0	78.2	21.0	0.8	7.0
Tiruchi	1952-53	1857	100	37.2	39.8	21.0	2.0	3.0
	1956-57	2036	110	35.5	37.5	22.9	4.1	2.6
	1960-61	2076	112	41.3	33.4	23.2	2.1	5.6
	1964-65	2152	116	38.2	35.3	25.0	1.5	9.1
	1968-69	2330	125	34.8	34.0	29.3	1.9	8.5
	1972-73	2656	143	34.1	35.4	28.4	2.1	4.4
	1976-77	2841	153	31.3	38.3	29.4	1.0	2.9
	1980-81	2656	143	32.5	35.1	31.8	0.6	1.9
	1983-84	2341	126	33.6	32.6	33.7	0.4	1.5
Thanjavur	1952-53	4806	100	95.0	4.6	0.4	0.0	0.5
	1956-57	4847	101	95.0	5.0	0.0	0.0	1.3
	1960-61	5009	104	94.0	5.3	0.7	0.0	0.4
	1964-65	5048	105	93.0	5.8	1.2	0.0	0.3
	1968-69	5093	106	93.0	5.8	1.2	0.0	0.9
	1972-73	4824	100	94.0	1.9	1.4	2.7	1.4
	1976-77.	4586	95	96.0	1.4	1.8	0.8	2.4
	1980-81	4861	101	94.0	2.0	1.8	2.2	2.6
	1983-84	4973	103	91.0	5.2	2.2	1.6	2.3
Tirunelveli	1952-53	1284	100	16.6	54.8	27.8	0.8	1.1
	1956-57	1339	104	15.6	52.5	31.2	0.8	1.1
	1960-61	1557	121	14.3	55.7	29.3	0.7	1.3
	1964-65	1572	122	13.4	53.4	32.2	1.0	1.1
	1968-69	1629	127	13.4	48.2	37.2	0.2	3.5
	1972-73	1622	126	14.5	45.2	39.7	0.6	3.4
	1976-77	1591	124	13.6	45.7	39.1	1.5	6.4
	1980-81	1657	129	13.5	48.6	37.3	0.6	4.3
	1983-84	NA	NA	NA	NA	NA	NA	NA

Kanya-kumari	1952-53	NA	NA	NA	NA	NA	NA	NA
	1956-57	297	100	53.8	45.2	0.6	0.4	0.2
	1960-61	286	96	74.7	24.8	0.1	0.4	0.2
	1964-65	302	102	64.1	33.5	0.7	1.7	1.8
	1968-69	320	108	60.9	36.2	0.6	2.3	0.8
	1972-73	315	106	59.7	37.8	0.9	1.6	0.0
	1976-77	286	96	47.7	48.4	1.0	2.9	1.1
	1980-81	286	96	41.7	55.4	1.3	1.6	0.0
	1983-84	273	92	42.6	56.5	1.0	0.0	0.1
Salem	1952-53	1211	100	10.6	27.0	55.8	6.6	16.2
	1956-57	1360	112	13.2	21.0	57.1	8.7	8.7
	1960-61	1435	118	17.7	19.0	60.2	3.1	10.3
	1964-65	1680	139	16.3	17.0	62.2	4.5	19.3
	1968-69	1826	151	16.2	18.0	64.8	1.0	14.3
	1972-73	1980	164	12.3	17.0	69.7	1.0	14.9
	1976-77	1852	153	12.4	12.0	72.7	0.9	19.9
	1980-81	1913	158	11.1	9.0	75.6	4.3	18.8
	1983-84	1680	139	13.4	10.0	75.6	1.0	16.1

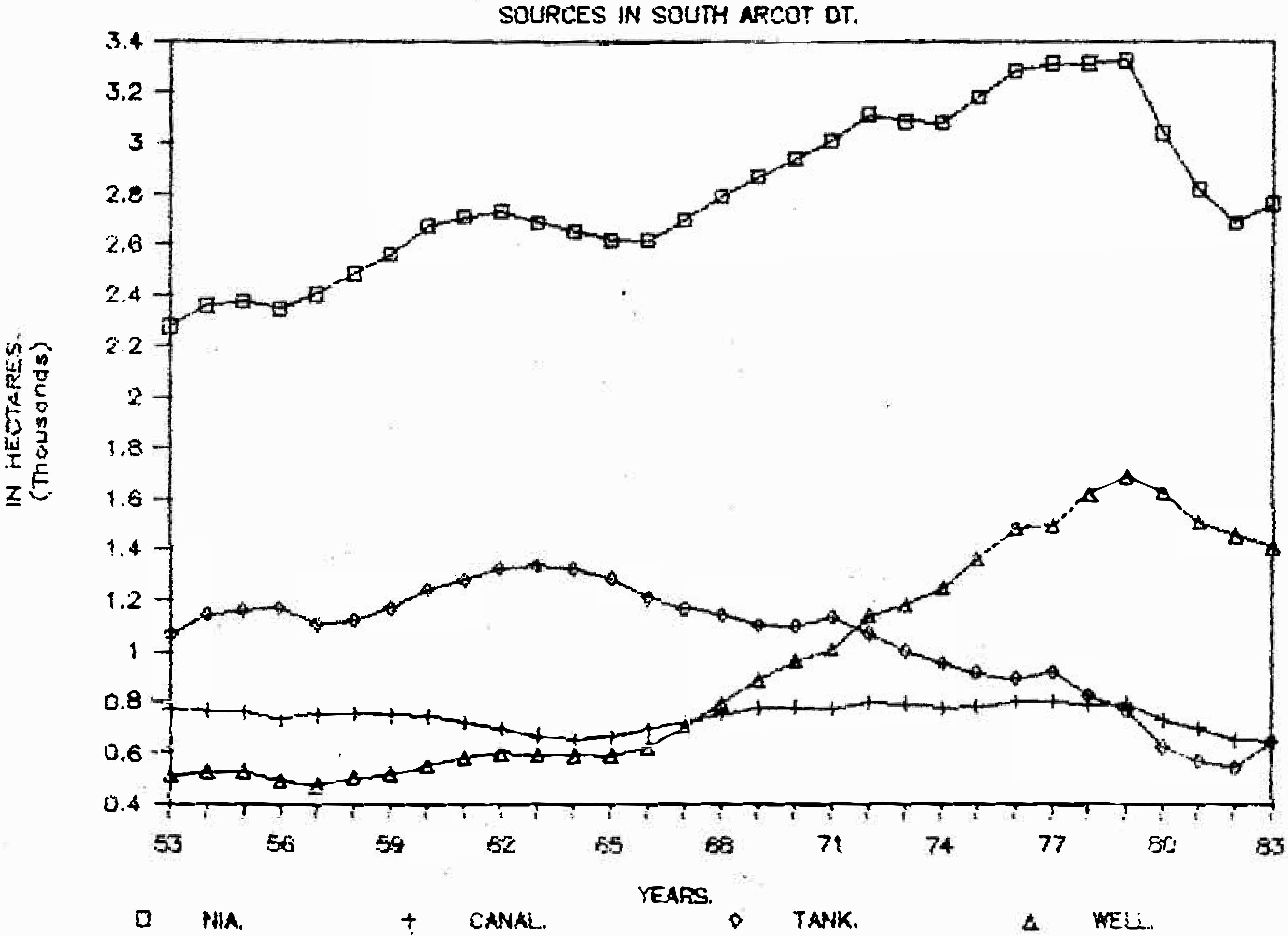
Note: Chengalpattu district is at present called Chengai-Anna district; North Arcot district includes Tiruvannamalai Sambuvarayar and North Arcot Ambedkar districts; Coimbatore includes Periyar district; Madurai includes Quaide-Milleth district; Ramanathapuram includes Pasumpon Muthuramalingam, Kamarajar and Ramanathapuram districts; Thanjavur includes Pudukottai district; Tirunelveli includes Chidambaranar and Nellai Kattabomman districts; Salem includes Dharmapuri district.

NA - Not Available


FIVE YEAR AVERAGE OF AREA IRRIGATED BY
SOURCES IN CHENGALPATTU DT.
IN HECTARES. (Thousands)
2.6
2.4
2.2
2
1.8
1.6
1.4
1.2
1
0.8
0.6
0.4
0.2
0
53
56
59
62
65
68
71
74
77
80
83
YEARS.
NIA.
CANAL.
TANK.
WELL.

FIVE YEAR AVERAGE OF AREA IRRIGATED BY

SOURCES IN SOUTH ARCOT DT.



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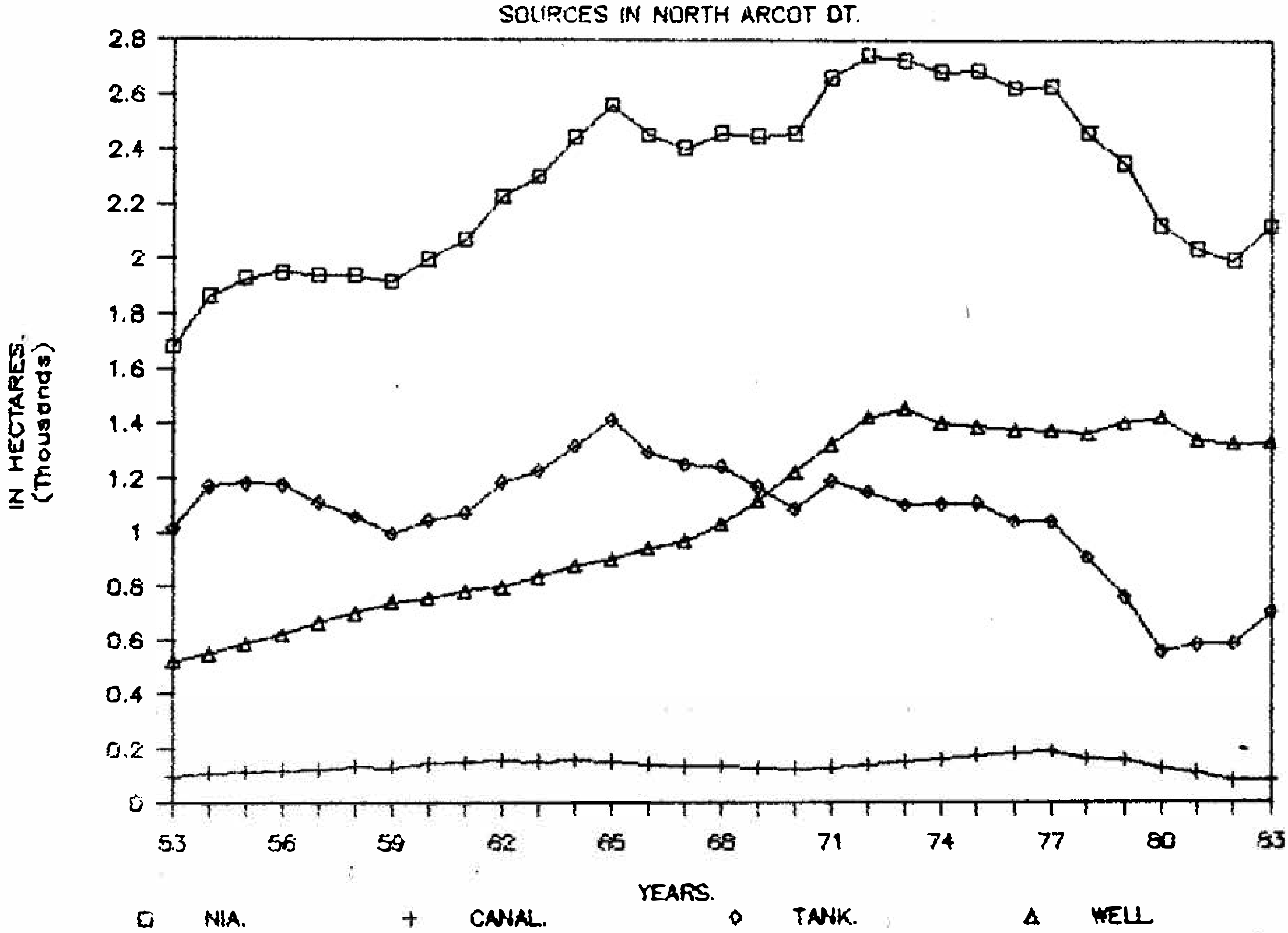
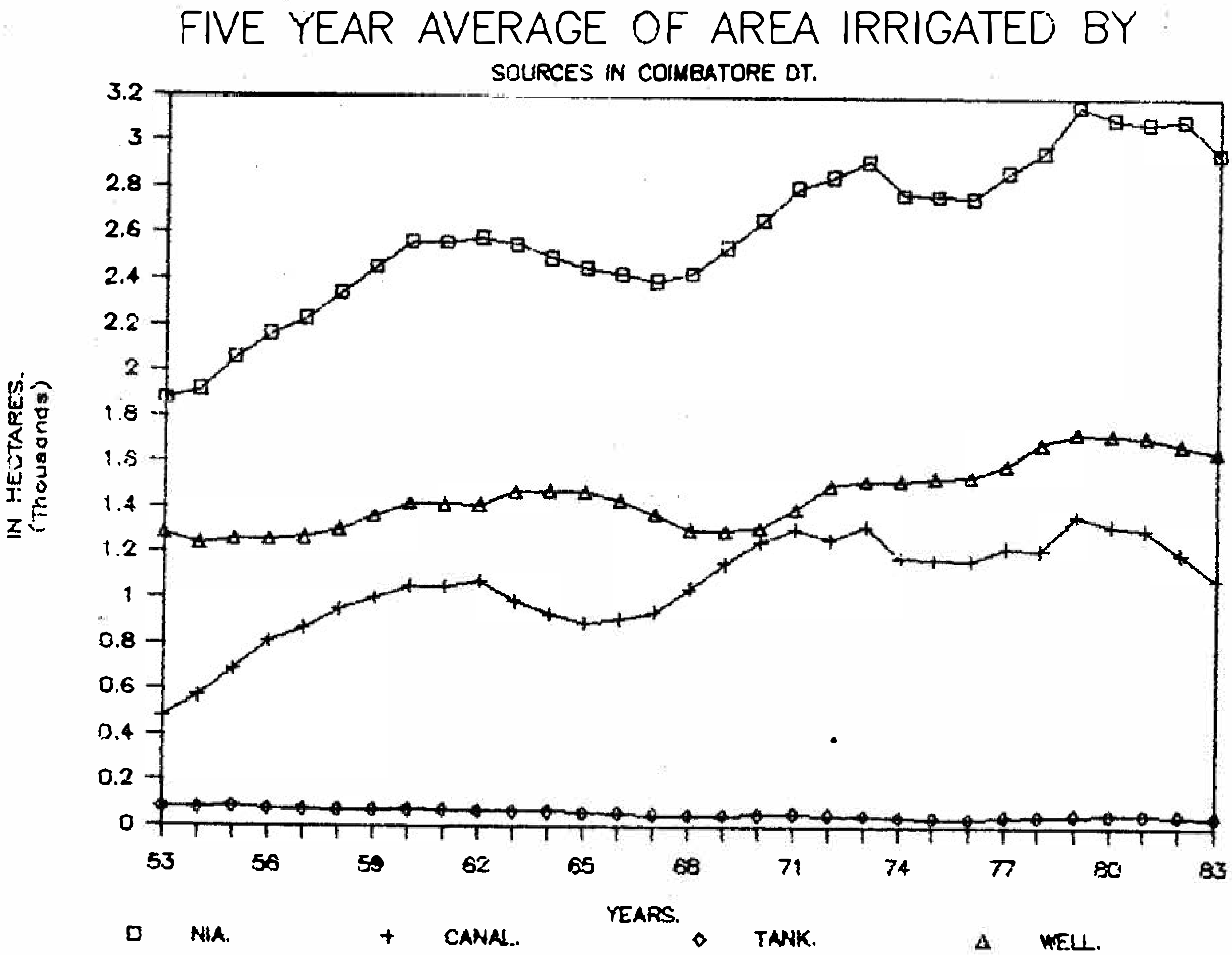
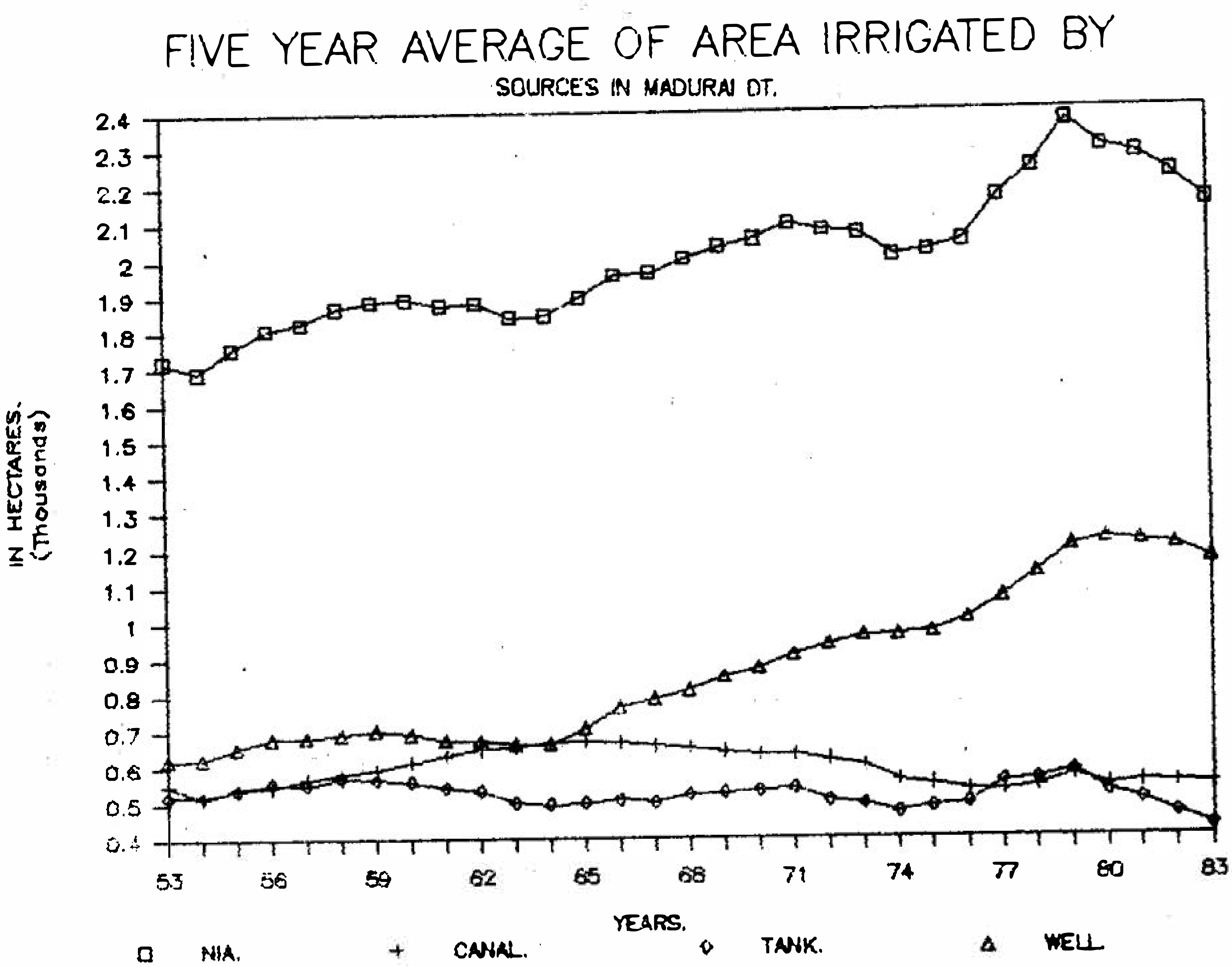



FIVE YEAR AVERAGE OF AREA IRRIGATED BY
SOURCES IN COIMBATORE DT.
IN HECTARES.
(Thousands)
3.2
3
2.8
2.6
2.4
2.2
2
1.8
1.6
1.4
1.2
1
0.8
0.6
0.4
0.2
0
53
56
59
62
65
68
71
74
77
80
83
YEARS.
NIA.
CANAL.
TANK.
WELL.


FIVE YEAR AVERAGE OF AREA IRRIGATED BY
SOURCES IN MADURAI DT.
IN HECTARES. (Thousands)
2.4
2.3
2.2
2.1
2
1.9
1.8
1.7
1.6
1.5
1.4
1.3
1.2
1.1
1
0.9
0.8
0.7
0.6
0.5
0.4
53
56
59
62
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68
71
74
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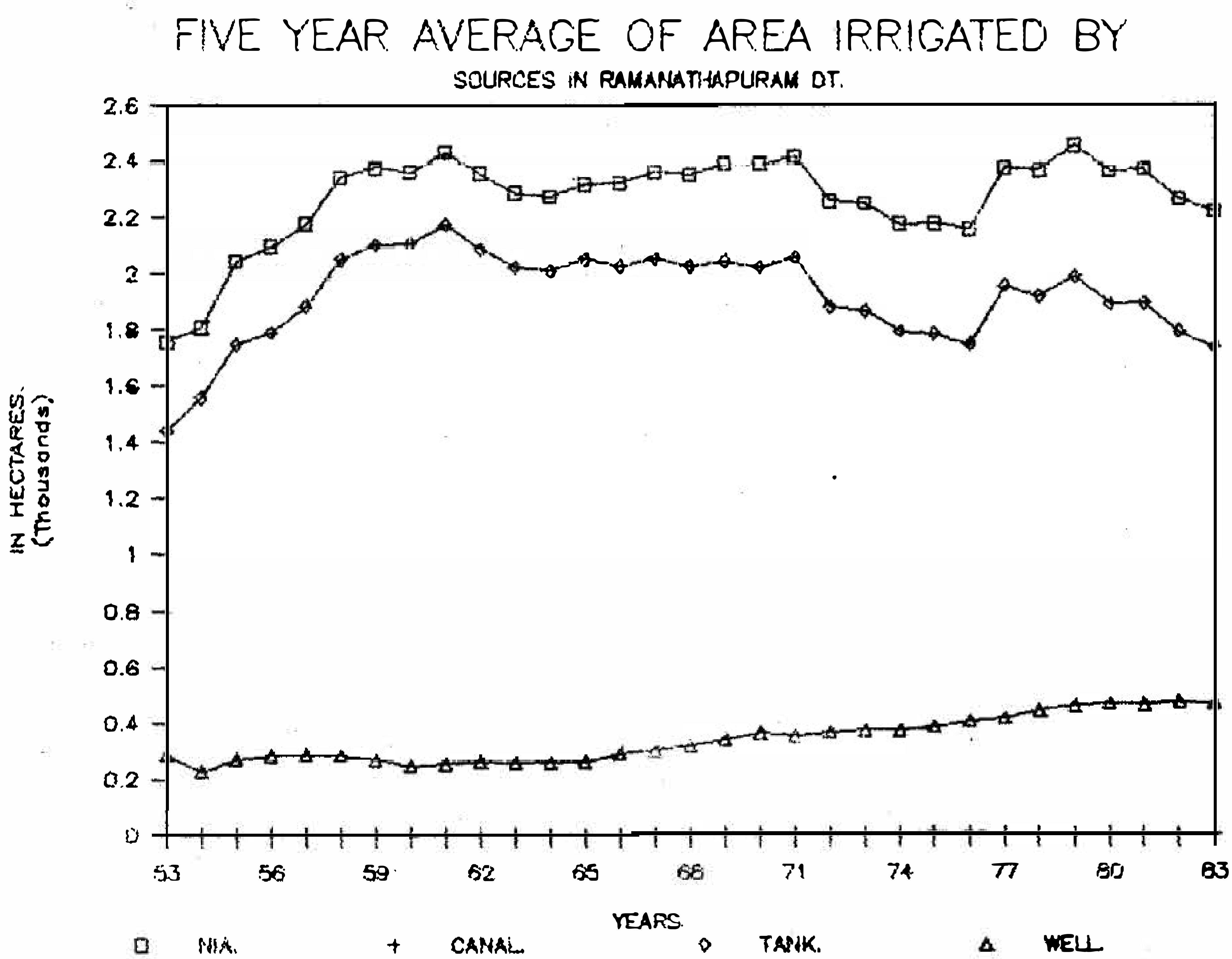
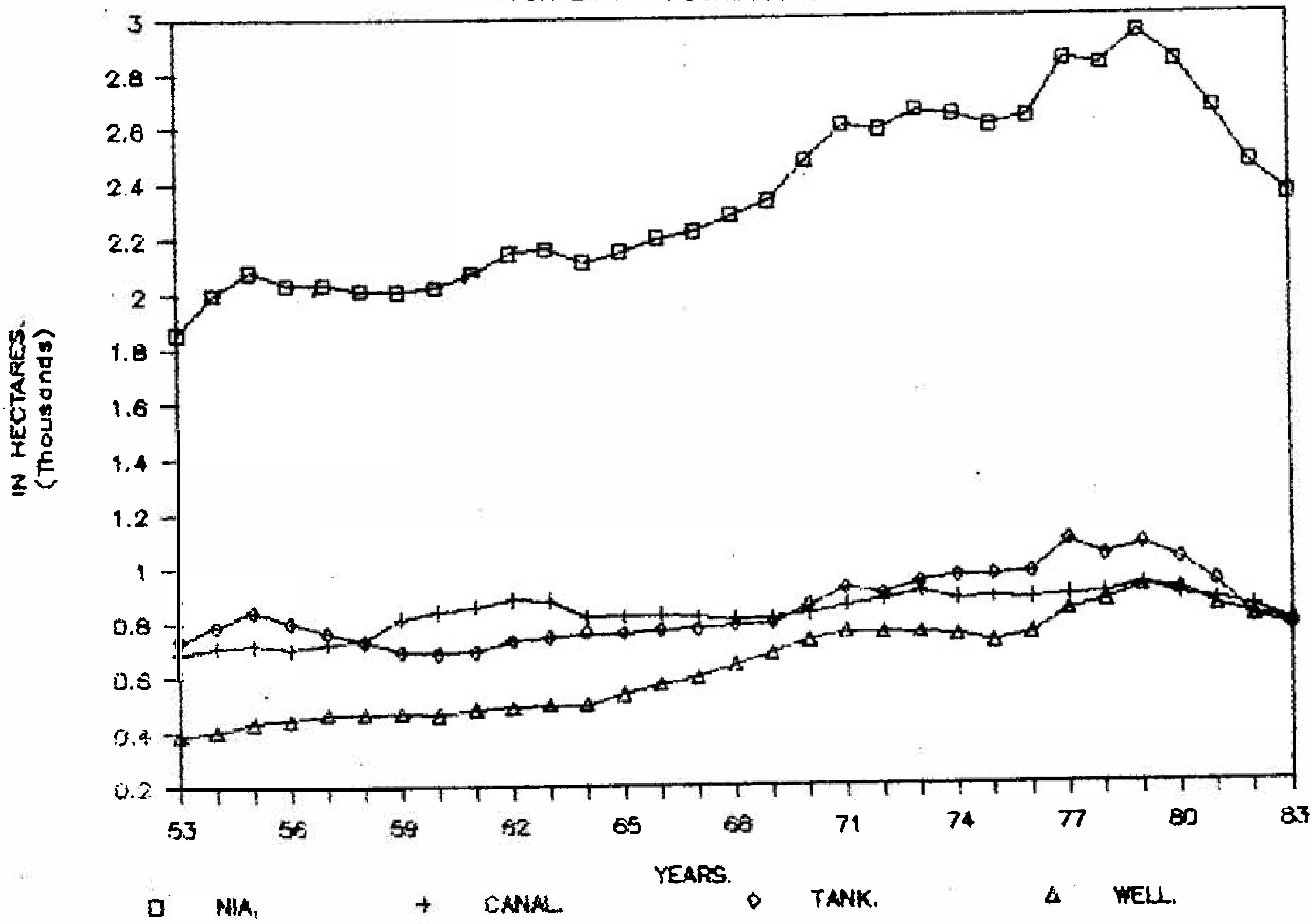
80
83
YEARS.
NIA.
CANAL.
TANK.
WELL



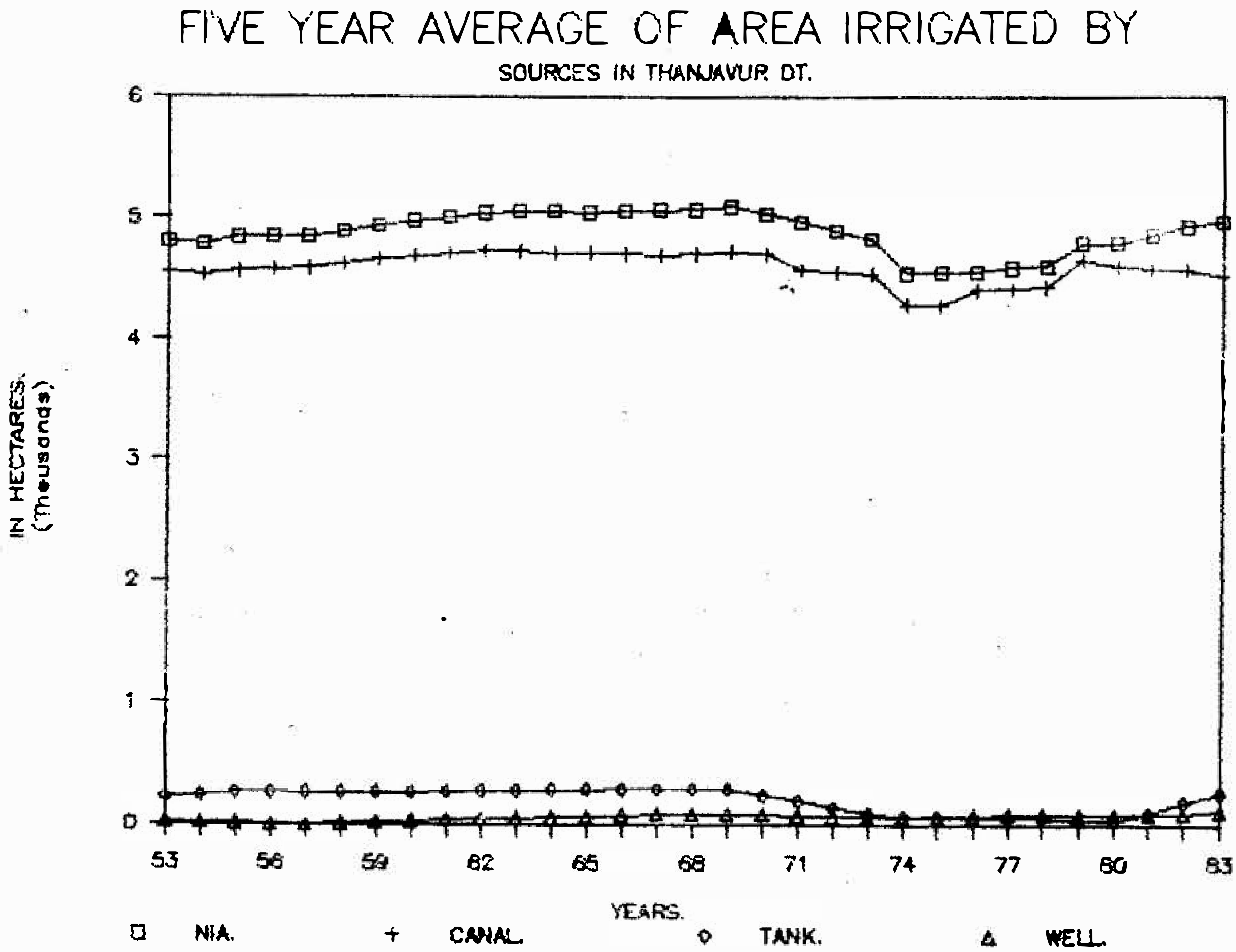
FIVE YEAR AVERAGE OF AREA IRRIGATED BY
SOURCES IN RAMANATHAPURAM DT.
IN HECTARES. (Thousands)
2.6
2.4
2.2
2
1.8
1.6
1.4
1.2
1
0.8
0.6
0.4
0.2
0
53
56
59
62
65
68
71
74
77
80
83
YEARS
NIA.
CANAL
TANK.
WELL

FIVE YEAR AVERAGE OF AREA IRRIGATED BY

SOURCES IN TIRUCHIRAPALLI DT.



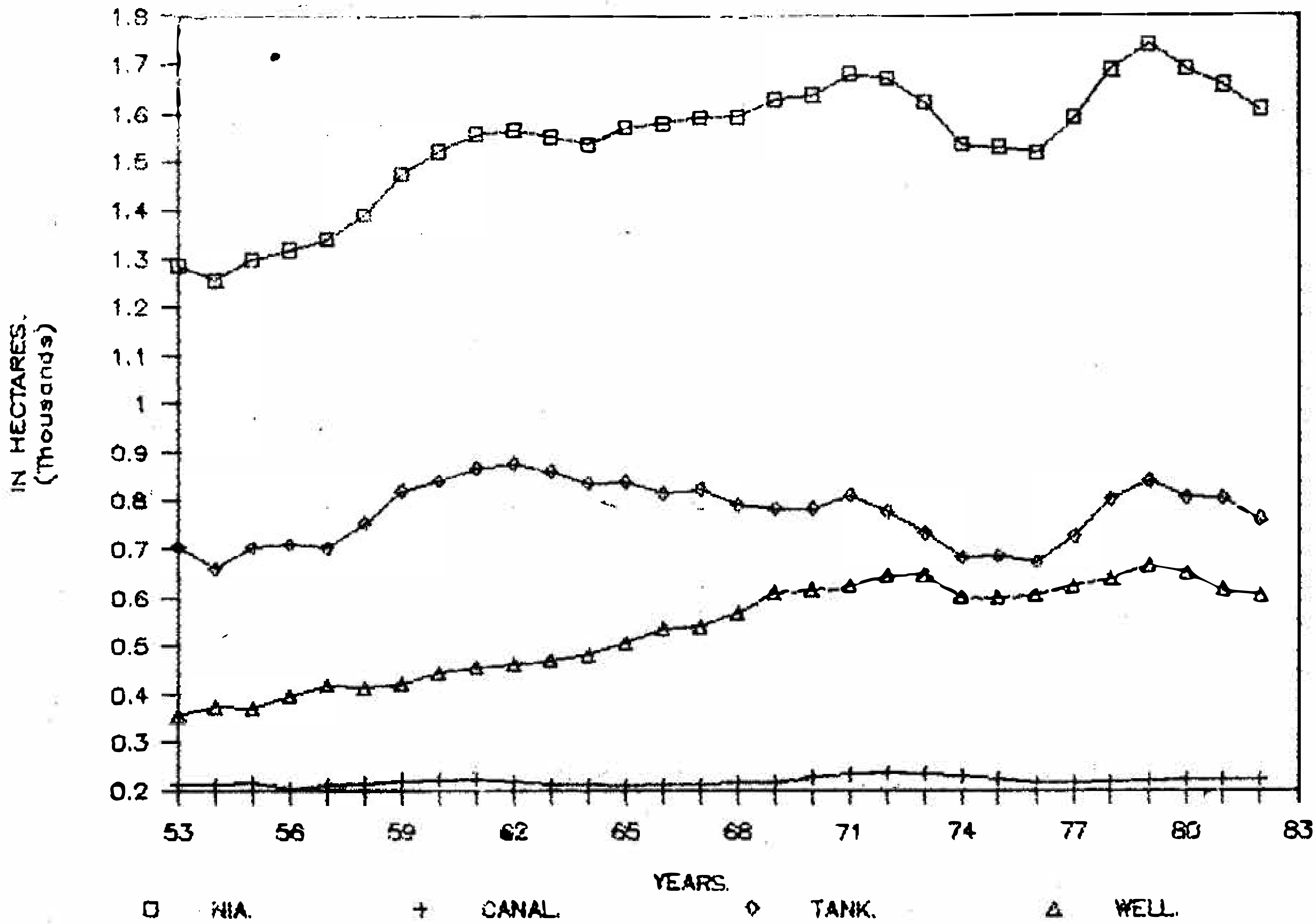
B

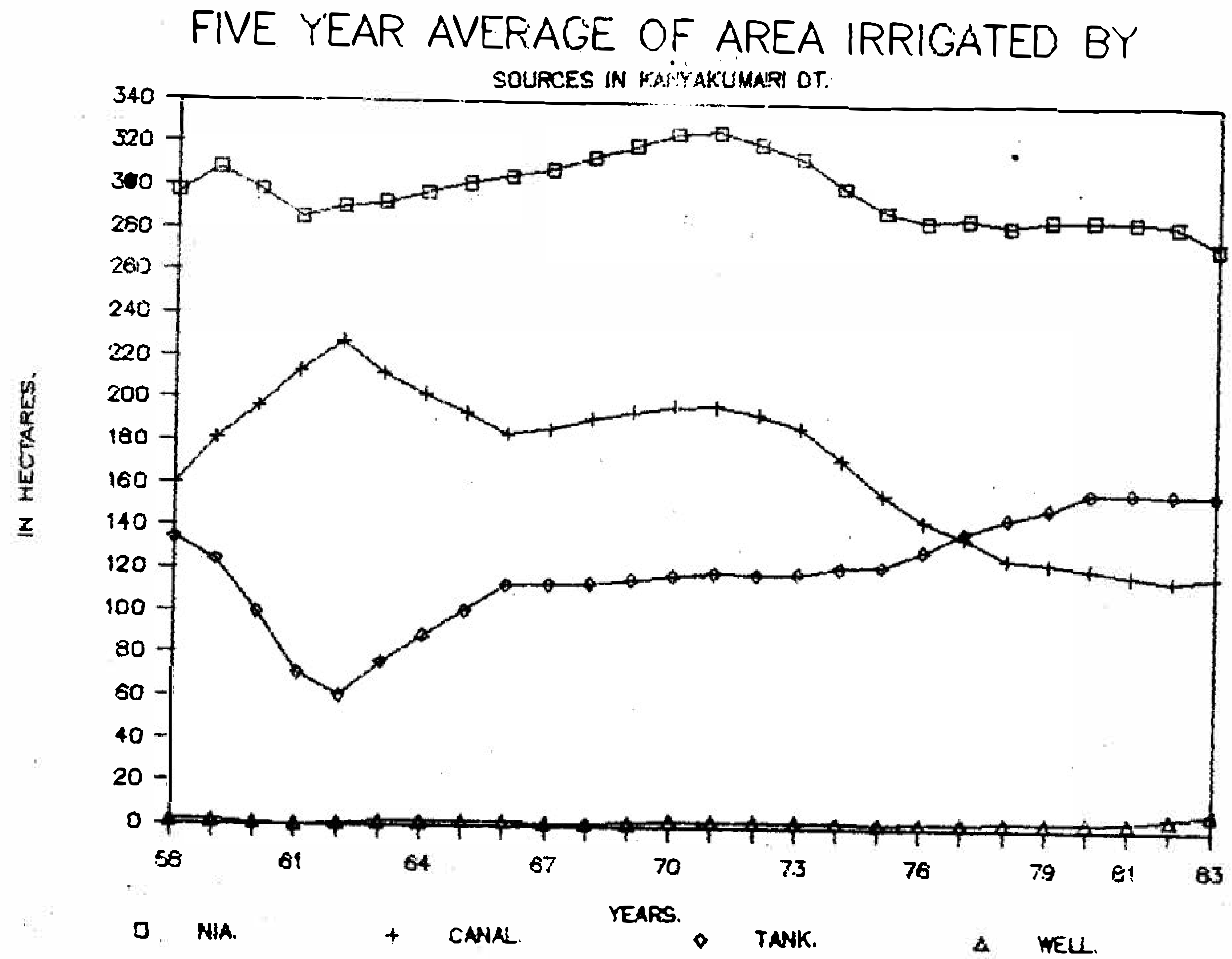

FIVE YEAR AVERAGE OF AREA IRRIGATED BY
SOURCES IN THANJAVUR DT.
IN HECTARES (Thousands)
6
5
4
3
2
1
0
53
56
59
62
65
68
71
74
77
80
83
YEARS.
NIA.
CANAL.
TANK.
WELL.

CB

FIVE YEAR AVERAGE OF AREA IRRIGATED BY

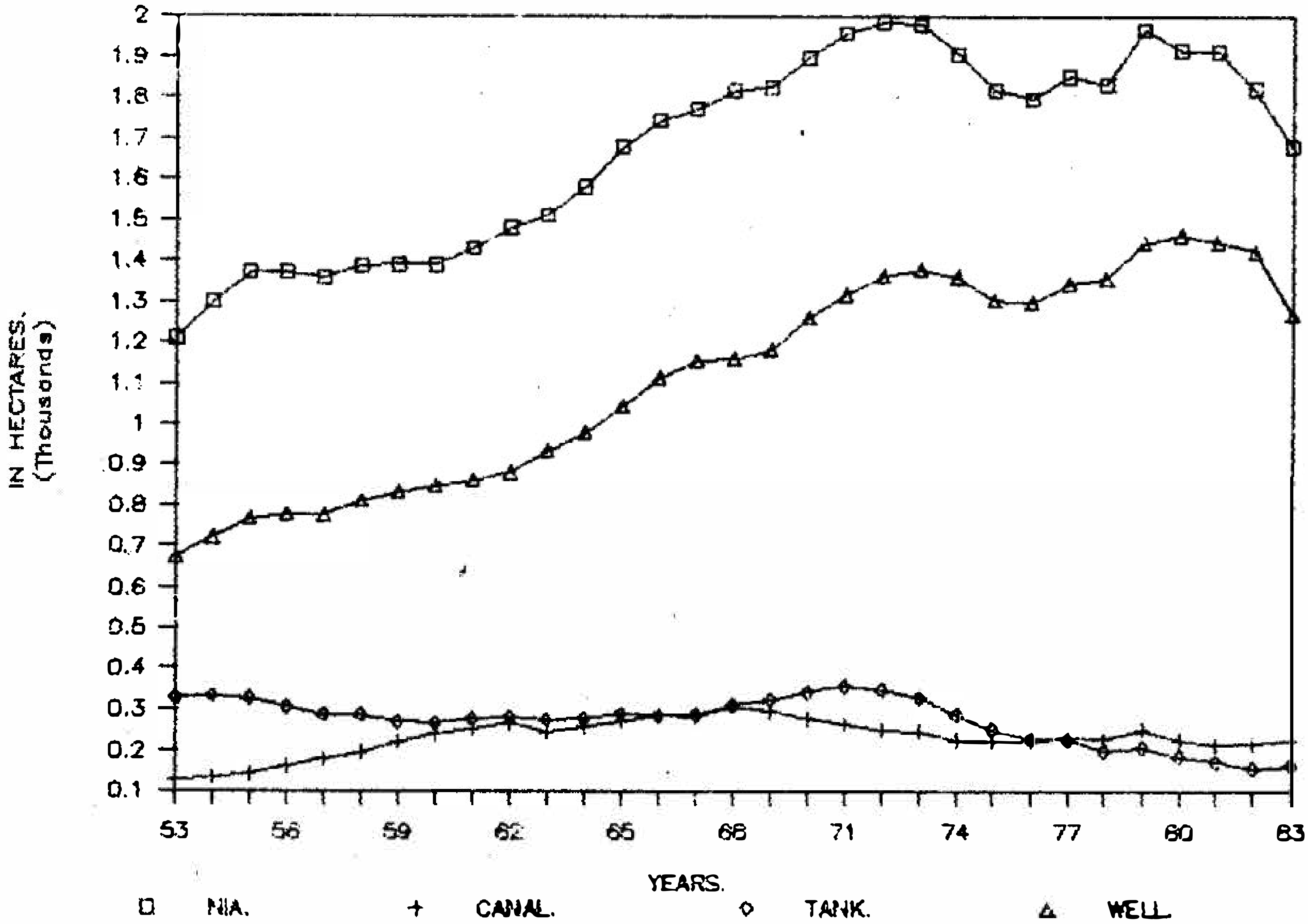
SOURCES IN TIRUNELVELI DT.




FIVE YEAR AVERAGE OF AREA IRRIGATED BY
SOURCES IN KANYAKUMARI DT.
IN HECTARES.
YEARS.
NIA.
CANAL.
TANK.
WELL.

FIVE YEAR AVERAGE OF AREA IRRIGATED BY

SOURCES IN SALEM DT.



Overall, the interesting point that emerges is that wherever area under well irrigation has gone up quite sharply, area under surface irrigation has come down rather steeply which clearly indicates that sub-surface irrigation has become an important source much more than the conventional source like tanks in some parts of the state. This also gives an indication that there is a greater scope for conjunctive use of surface and sub-surface waters in the command areas of tanks and canlas. Data presented in Table-1, relating to wells supplementing surface sources, is grossly understated; but it certainly indicates that conjunctive use of surface and ground water is gaining significance in several parts of the State.

In this context this paper atempts at a modest level a discussion on the pattern of ground water utilisation in the State. In particular, the interest is to examine the phenomenon of conjunctive use of surface and ground water: The extent of its prevalence in the selected command areas of Tamil Nadu and its impact on crop pattern, cropping intensity and productivity. The selected command areas are Palar Anicut System (PAS) and Parambikulam-Aliyar Project (PAP). The PAS is an age old system irrigating an estimated ayacut of 81000 acres through series of tanks (about 317 tanks) mostly in North Arcot and to a small extent in Chengalpattu districts. For the purposes of detailed survey[2]. 15 tanks have been selected somewhat purposively to

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2. The survey was a part of the project funded by the Central Planning Commission, Govt.of India and was carried out in Madras Institute of Development Studies under the overall guidance of Prof.A.Vaidyanathan. The survey was carried out in different phases during 1986-87.

cover various reaches across main/branch channels as well as to capture various characteristics of tanks such as size, sources of supply, and so on.

The PAP is a fairly new canal irrigation system irrigating an ayacut of 240000 acres through the net work of main/branch canals and distributaries. The PAP came into operation during late 1960s and irrigates the dry tracts of Coimbatore and Periyar districts. This Project was designed mainly for raising dry irrigated crops and wet crops (like paddy) were permitted only in low-lying areas or in the areas which pose serious drainage problems. Thus. as per the original design, 80% of the ayacut was devoted to dry irrigated crops and 20% to wet crops. For the purposes of detailed survey 12 distributaries from two main canals have been selected viz., Parambikulam Main Canal (PMC) and Udumalpet Canal (UPC)[3].

The paper is organized in the following manner: Section-2 discusses mainly the concept of conjunctive use, its significance in Indian agriculture and so on; sections 3 & 4 are devoted to analyse the impact of conjunctive use - the evidences from PAS and PAP respectively and section-5 provides the concluding observations.

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3. For details on these two systems and methodology adopted see Vaidyanathan.A, and S.Janakarajan (1989)

2. The Concept of Conjunctive Use

There are two ways of utilising ground water for irrigation: One, as the sole well irrigation, and two, as supplementing surface sources of irrigation. While the former may be seen generally in dry lands (where there are no surface sources of irrigation), the latter may be found in canal or tank commands. The crop pattern and productivity in the areas where wells serve as the only source of irrigation (i.e., in the so called 'dry' lands) will be completely different from canal or tank irrigated areas. Unless and otherwise ground water is available in plenty, the generally observed crop pattern in such dry tracts would be coarse cereals such as ragi, maize, bajra, pulses, etc. and oil seeds such as groundnut and so on. Unless ground water extraction matches recharge, even in the areas where ground water is available in plenty, the constant use of ground water and overcrowding of wells may result in depletion of ground water source. Ultimately, due to over exploitation, ground water table may go down very deep which may result in high cost of ground water extraction. This has infact been the case in several parts of Salem, Periyar, and Coimbatore districts in Tamil nadu, where the extraction rate is much more than the recharge. In Coimbatore district, which has a long history of ground water irrigation, water table during the 40 years preceding 1969 is estimated to be lowered by as much as 16.5 metres.[4]

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4. See for a detailed discussion on this issue Palmgren and Jakobson (1982).

Nevertheless, ground water use in association with adequate recharge may be extremely conducive and desirable for crop production. The natural recharge through rainfall may be helpful, in particular, for those wells located in the dry lands. But due to the frequent failure of monsoon recharge is very often found to be less than the extraction rate. Thus the natural recharge through rainfall is unpredictable. But the recharging through artificial means such as percolation ponds, tanks, canals, etc. may serve a useful purpose, but may be restricted only to respective command areas. However, fast recharging in some canal commands results in waterlogging causing drainage and salinity problems (Dhawan, 1988). Hence a proper management of surface and sub-surface water is needed in the canal and tank commands taking into account the factors such as the availability of ground water potential, pumping rate, extent of recharging desirable and actual extent of recharging, drainage conditions, soil type and so on.

Thus the technique of conjunctive use of surface water and ground water has become a very serious issue in the recent times precisely because of the strong felt need for an integrated approach of water management in the Indian agrarian conditions. The Irrigation Commission (1972) clearly indicated the need for conjunctive use and infact emphasised the importance of taking into account the ground water position while attempting on river basin plans. Thus the Irrigation Commission stated:

"Surface and ground water resources are inter-linked. Therefore, integrated studies are needed to cover both the resources" (p51, vol.I)

Seventh Five Year Plan also emphasised so much on this issue and strongly recommended that the existing irrigation facilities could be put to the best use if ground water irrigation is encouraged in the command areas[5]. The National Water Policy confirms the views of the Planning Commission and the Irrigation Commission.

"Integrated and co-ordinated development of surface water and ground water and their conjunctive use should be envisaged right from the project planning stage and should form an essential part of the project"[6].

What does mean by conjunctive method of irrigation?

The Irrigation Commission interpreted the conjunctive use as follows:

"It can take the form of full utilisation of surface water supplies supplemented by ground water or the direct use of ground water during the periods of low canal supplies or canal closures.

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5. "The conjunctive use programme under the various development sectors would be co-ordinated so that the existing irrigation facilities are put to the best use and the gestation period of irrigation utilisation under major and medium irrigation schemes is reduced". Seventh five Year Plan, 1985-90, Vol.II, p.80.

6. Govt.of India, Ministry of Water Resources, National Water Policy, New Delhi, 1987, P.9.

It can also take the form of irrigating pockets exclusively with ground water in a canal command, especially where the terrain is uneven" (p.96, vol.I). Scholars who have been working in this area look at the conjunctive use in almost similar angle. Tushaar Sha (1988) suggests three ways of conjunctive use: First, supplementing well water when either canal water or tank water is inadequate and/or unreliable; second, pumping the well water into the canal to augment the canal water resources; Third, the canal system itself should be designed in such a way to provide extensive irrigation rather than to provide intensive irrigation and thereby inducing farmers to go in for well irrigation as a supplementary source. Palanisamy (1988) and Venkata Reddy (1988) confirm the superior nature of conjunctive use in crop production in their studies of use of well irrigation in tank commands and canal commands respectively. Dhawan (1988) in fact goes a step ahead to argue that the well irrigation in the command areas protects farmers during drought years also. Thus, he states,

"That ground water availability is substantially enhanced from the seepage of canal/tank water is well known. Consequently, dugwells and tube wells benefitting from such seepage are much less affected by drought than those located outside the commands of canals and tanks .... Farmers can substitute more costly ground water for low cost (from their private angle) surface water whenever surface supplies diminish due to drought. Such conjunctive users of ground and surface waters are best placed to withstand effectively the adverse output impact of a drouhgt" (P.187 Dhawan., 1988).

On the whole, from our foregoing discussion, the following points emerge:

1. The surface and ground waters are interlinked and they complement each other. Precisely for this reason the price of ground water or the cost of water extraction will be more when the surface sources are depleted and vice-versa. Moreover, the use of ground water constantly for a long period of time may prove dangerous and may result in ecological imbalances.

2. The use of surface water along with ground water protects farmers in the command areas to a great extent from the vagaries of uncertainity of surface sources. Ineffect, the conjunctive use helps farmers to overcome the chronic drawbacks of surface irrigation such as irregular and inadequate supply.

3. The constant use of canal or tank water over a period of time in areas where there are inadequate drainage facilities, the problems of water logging and soil salinity will surface. Both salinity and waterlogging may drastically reduce the crop yield. But the proper management of ground water in the command areas may minimise these problems to a great extent.

4. Wasteful use of precious surface water may be conserved if well water is also used along with surface water. Moreover, by the conjunctive method of irrigation, larger area could be brought under cultivation or in other words, extensive rather

than intensive cultivation is possible, if surface irrigation systems are properly designed (right from the project planning stage) taking into account the availability of ground water potential, number of existing wells in the proposed ayacut, number of wells feasible in the proposed command with the available ground water potential and so on[7].

5. The degree to which farmers can sustain the drought conditins, depends to a great extent, the access to ground water irrigation in command areas.

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7. See also, Vaidyanathan (1988)

3.Impact of Conjunctive Use -The Case of Palar Anicut System(PAS)

As it has been mentioned earlier, 15 tanks fed by PAS have been selected for the detailed survey. Of these, one is a large tank having an ayacut of 6500 acres irrigating 14 villages. So, for the purpose of our analysis we have selected ayacuts in the deepest sluice and in the elevated sluice. In the deepest sluice again sample plots have been selected separately from the ayacut of a head reach village and from a tail end village. Since most other tanks are single village tanks, sample plos have been selected from the entire tank ayacut. In effect, sample plots have been selected from 17 ayacuts. Size of the sample is 40 plots from each ayacut, of which 5 are plots with wells. Such a sampling procedure was adopted with the expectation that only those plots which have wells would receive well irrigation. However, our survey showed that even the non-well plots have access to well irrigation from the adjacent wells-either own or purchsed.

Table-2 gives informatin on the extent of conjunctive use in the sample non-well plots during 1985-86, which was a normal year. In terms of the extent of conjunctive use in the selected tank ayacuts, one gets quite a varied picture: Firstly, one can observe two extreme situations: (a) there are two tanks (Paranthur and Neervalur) where well irrigation is nil or insignificant and the only source of irrigation is tank. In those two tanks, percentage of area reporting tank irrigation is of the order of 92.0% and 89.0% respectively. (b) On the other

Table 2 Proportion of Area under Conjunctive use (in percentages) in the Sample Non-Well Plots and Well Per Acre, 1985-86

Sl No.	Tanks	T+W	W only	(T+W)+W only	T only	R/ Not culti-vated	Total	Well per acre
1	KVP-LS-H	42.0	0	42.0	24.0	34.0	100.0	0.26*
2	KVP-LS-T	3.0	8.0	11.0	0	89.0	100.0	0.26*
3	KVP-Gafoor	0	50.0	50.0	0	50.0	100.0	0.26*
4	Peruvalayam	37.0	14.0	51.0	42.0	7.0	100.0	0.04
5	Agavalam	70.0	9.0	79.0	13.0	8.0	100.0	0.14
6	Thakkolam	58.0	38.0	96.0	4.0	0	100.0	0.18
7	Karivedu	8.0	10.0	18.0	52.0	30.0	100.0	0.01
8	Perumbuli-pakkam	3.0	66.0	69.0	0	31.0	100.0	0.25
9	Poigai-nallur	0	39.0	39.0	0	61.0	100.0	0.16
10	Tiruppu-kuzhi	0	66.0	66.0	0	34.0	100.0	0.07
11	Pudup-pakkam	30.0	0	30.0	62.0	8.0	100.0	0.02
12	Paranthur	3.0	0	3.0	92.0	5.0	100.0	0.1
13	Neervalur	0	0	0	89.0	11.0	100.0	0.00
14	Velur	18.0	42.0	60.0	5.0	35.0	100.0	0.20
15	Vembi	0	89.0	89.0	0	11.0	100.0	0.28
16	Sirun-gattur	76.0	40	80.0	7.0	13.0	100.0	0.33
17	Kaliyur	21.0	0	21.0	67.0	12.0	100.0	0.21

KVP-LS-H = Kaveripakkam - Lion Sluice - Head
KVP-LS-T = Kaveripakkam - Lion Sluice - Tail
KVP-Gafoor = Kaveripakkam - Gafoor sluice.

Notes:

* For the entire Kaveripakkam tank ayacut

T+W = Atleast once in a year a plot should have received tank plus well irrigation. It also includes Tank only in one season and well only in the second season in the same year.

T only : It will be either tank only and Tank plus Rainfall

W only : It will be either Well only or Well plus Rainfall

R : Rainfall

(Source: Survey)

extreme, there are five tanks (Gafoor sluice, Perumbulipakkam, Poigainallur, Tiruppukkuzhi and Vembi) where it is insignificant or absolutely no tank irrigation. In these tanks, percentage reporting well irrigation is of the order of 50%, 66%, 39%, 66% and 89% respectively. In between, there are 10 tanks where percentage reporting only tank irrigation and only well irrigation varies from 0 to 67%.

Secondly, if one goes by the strict interpretation of the conjunctive use as plots receiving both tank and well waters, it is seen that only in few tanks such reporting of conjunctive use is significant (See Table-2). For instance, T+W in KVP-LH is 42% Peruvalayam 37%, Agavalam 70%, Thakkolam 58% and Sirungathur 76%. In all othe tanks it varies from 0 to 30%. However, it makes a lot of difference if we slightly relax the definition of conjunctive use as the plots reporting well irrigation only' as well as tank plus well irrigation'. The rationale for such relaxation of definition would be that wells in the command area of tanks are recharged from tanks and hence even those plots which received only well water ineffect used the surface water to some extent.[8] We will see from Table-2 that under the changed definition area reporting conjunctive use,(ie., area reporting (t+w) + w) only is quite significant in several tanks such as KVP-LH (42%), KVP-Gafoor (50%), Peruvalayam (51%), Agavalam (79%), Thakkolam (96%), Perumbulipakkam (69%), Poigainallur

8. For a detailed discussion on ground water recharge from surface sources and its impact on productivity see Dhawan (1988)

(39%), Tiruppukkuzhi (66%), Velur (60%), Vembi (89%) and Sirungattur (80%). It is low or insignificant only in tanks such as KVP-L-T, Karivedu, Pudupakkam, Paranthur, Neervalur, and Kaliyur where it ranges from 0 to 30%. This is precisely because in these tanks, well density is very low or nil except in Kaliyur tank, where well per acre is 0.21 but still area reporting (t+w) is only 21%. This is because, this tank receives almost regular and assured supply from two other systems other than PAS, which facilitates farmer to grow wet crops with tank water.

Thirdly, it is interesting to note that in some of these tanks (Perumbulipakkam, Poigainallur, Tiruppukhuzhi and Vembi) tank is used basically as a percolation pond for recharging purposes into wells in the command area. It was in fact specifically mentioned in the case of Vembi tank where sluices have been permanently closed. Moreover in these tanks farmers take absolutely no interest in the maintenance work of inlet channel, distributaries, field channels and so on. In other words,the traditional irrigation institutions are defunct in these tanks; while it reflects on the intensity of conjunctive use, it directly affects those who do not have access to ground water, in particular resource poor farmers.

In Table-3 area benefiting from well irrigation have been estimated for the total ayacut and for the GCA of tank ayacut using the sample well plots. This data very much confirms our sample data analysis reported in Table-2.

Having seen the extent of conjunctive use in the ayacuts of selected tank irrigated areas, I shall now turn to discuss its impact. Table-4 demonstrates differences in cropping intensity among non-well plots reporting own, purchased and no well irrigation. The variation is clearly seen between normal year (1985-86) and drought year (1986-87). The following points emerge from this table.

Table 3 Estimated Area under Total Avacut of Selected Tanks Benefiting from Well Irrigation 1985-86

Tanks	Area of avacut: Total	Area of avacut: % reporting well irrigation	GCA in avacut: Total	GCA in avacut: % reporting well irrigation	Well Per acre in the avacut.
KVP-LS-H	736.6	47.9	NA	NA	0.26*
KVP-LS-T	385.9	9.9	NA	NA	0.26*
KVP-Gafoor	59.0	52.5	81.4	75.2	0.26*
Peruvalayam	NA	NA	NA	NA	0.04
Agavalam	NA	NA	NA	NA	0.14
Thakkolam	411.4	97.2	838.7	64.3	0.18
Karivedu	480.1	18.7	417.4	23.5	0.01
Perumbuli-pakkam	159.5	72.2	332.4	85.6	0.25
Poigainallur	132.9	41.4	149.1	93.5	0.16
Tiruppukuzhi	538.4	67.4	914.0	91.0	0.07
Puduppakkam	709.9	30.8	1418.2	16.2	0.02
Paranthur	759.1	2.8	1430.0	0.0	0.01
Neervalur	730.4	0.0	1457.0	0.0	0.00
Velur	483.3	70.8	933.6	62.0	0.20
Vembi	214.2	89.9	445.4	78.4	0.28
Sirungattur	200.1	83.8	367.9	25.7	0.33
Kalivur	497.9	27.5	899.9	12.9	0.21

*Estimated for the entire Kaveripakkam tank avacut.

Notes:

Estimated total avacut: Estimated avacut of non-well plots + Estimated avacut of well plots

Estimated avacut of non well plots } Total number of sub division without wells in avacut x average size of sample non-well plots.

Estimated avacut of well plots } Total number of sub divisions with wells x average size of sample well plots.

Similar procedure was used to estimate gross cropped area

(Source: Survey)

Table-4 Cropping Intensity in Non-Well Plots by Mode of Access to Well Water, 1985-86, 1986-87

Sl. No.	Tanks	Own Well Water		Purchased Well Water		No well Water	
		1985-86	1986-87	1985-86	1986-87	1985-86	1986-87
1	KVP-LS-H	1.74	2.26	2.15	1.46	0.50	0
2	KVP-LS-T	1.62	2.03	1.61	1.59	0	0
3	KVP-Gafoor	1.91	2.11	2.37	1.00	0.28	0.06
4	Peruvalayam	2.42	1.57	1.58	1.00	0.81	0.55
5	Agavalam	2.60	2.19	1.19	1.35	0.89	0
6	Thakkolam	2.28	1.86	1.07	1.00	1.00	0
7	Karivedu	2.03	1.38	1.00	3.00	0.64	0
8	Perumbuli-pakkam	1.99	1.55	2.12	1.86	0.50	0.19
9	Poigai-nallur	2.47	2.24	1.63	1.70	0	0
10	Tiruppuk-kuzhi	2.37	2.24	1.63	1.70	0	0
11	Velur	2.16	1.96	1.26	1.09	0.67	0.53
12	Vembi	1.72	1.96	2.00	1.00	0.13	0.04
13	Sirungattur	2.09	1.12	Nil	1.00	1.26	0.13
14	Kaliyur	2.19	1.33	Nil	Nil	1.69	0.43

Note: This table excludes three of the selected tanks viz., Pudupakkam, Paranthur and Neervalur where the well irrigation is either insignificant or ni.

Source: (Survey)

Firstly, it can been seen from the table that the cropping intensity is much higher for those plots which receive well irrigation - own or purchased - than those plots which receive no well irrigation.

Secondly, it indicates that the cropping intensity is higher for those plots which received own well irrigtion than those plots which received purchased well irrigation. In 1985-86,in most of the 14 tank ayacuts except three (KVP LS-H, KVP - Gafoor, and Vembi) cropping intensity was higher in those plots which received own well irrigation and in 1986-87, this was seen in all but one tank (KVP-LS-H).

Thirdly, it is clear that those plots which had access to well irrigation in the command area sustained the severe drought of 1986-87. This is amply demonstrated by the fact that cropping intensity in 1986-87 differed very little from 1985-86in those plots which had access to well irrigation; whereas it was very low and infact zero in 7 out of 14 tanks for those plots which received no well irrigation. Thus it reinforces the point that wells in the command area serve a good purpose of insurance against drought conditions.

However, one gets a doubt whether cropping intensity is a correct indicator at all to judge the impact of conjunctive use. Very often it may mislead because mere reporting of crops in a plot for two or even three seasons may not mean much for the simple reason that there are possibilities for either complete crop failure or a farmer would have grown rainfed crops due to inadequate or uncerain water supply conditions. In other words, cropping intensity could be two or even three, but the fact that it does not take into account the crop failure or very poor yield would not reflect on the conditions or quality of irrigation. Productivity may prove to be an useful indicator which overcomes the drawbacks stated above.

Table-5 gives both the indicators of cropping intensity and productivity (in value terms) for all sample non-well plots. It may be seen from the table that in Gafoor sluice cropping intensity is as low as 1.15, but productivity is as high as 3880; but in Pudupakkam cropping intensity is 1.56, but productivity is only 2641; again in velur cropping intensity is 1.44 but productivity is only 1530. Thus it is clear that cropping intensity and productivity need not always go in the same direction. Nevertheless, it is apparent from the table that several of the tank ayacuts which have greater incidence of well irrigation performed better in terms of productivity and to some extent cropping intensity (see for instance, KVP-Gafoor. Peruvalayam, Agavalam, Thakkolam, Perumbulipakkam, Thiruppukkuzhi, Vembi, and Sirungattur). This may be to a large extent the effect of conjunctive use irrigation.

Table-5 Cropping Intensity and Productivity of All Sample Non-Well Plots in the Selected Tanks, 1985-86

Sl. No.	Tanks	CI	GVO/ Sample Plot area	% of Sample Plots getting well irrigation
1	KVP-LS-H	1.23	2115	42
2	KVP-LS-T	0.23	395	11
3	KVP-Gafoor	1.15	3880	50
4	Peruvalayam	1.51	3433	51
5	Agavalam	2.02	5028	79
6	Thakkolam	2.01	5682	96
7	Karivedu	0.86	1647	18
8	Perumbuli-pakkam	1.93	4889	69
9	Poigainallur	1.00	2179	39
10	Tiruppukkuzhi	1.64	4177	66
11	Pudupakkam	1.56	2641	30
12	Paranthur	1.84	3767	3
13	Neervalur	1.89	3290	0
14	Velur	1.44	1530	60
15	Vembi	1.57	2675	89
16	Sirungattur	1.67	3880	80
17	Kaliyur	1.64	2359	21

Notes: GVO - Gross Value of Output
CI - Cropping Intensity

Source: (Survey)

4 Impact of Conjunctive Use -- The Case of Parambikulam - Aiyar Project

It has been already pointed out that 12 distributarites (from two main canals, viz., Parambikulam Main Canal - PMC, and Udumalpet Canal - UPC) have been selected rather purposively with a view to cover various reaches within a main/branch canal. Ultimate sampling unit within a selected distributary was a block (the ayacut of a block or pipe point ranges from 25 to 45 acres) and the entire land falling under each selected block has been surveyed. Altogether 104 blocks from 12 distributaries have been selected randomly for the detailed survey and the total number of sample farmers interviewed was 630. For the sake of analytical convenience sample farmers have been divided into two broad groups, viz., those who have access to ground water (denoted by WW) and those who have not (denoted by NW). Access to ground water represents only own well water (either sole or joint well) and rules out completely purchased well water. The results are quite fascinating and different from that of the tank irrigation system discussed in the previous section.

First of all, it has been noticed that the incidence of well in this area is quite high which is clear from the fact that the proportion of area owned by WW farmers is over 70% in majority of the selected distributaries (ie., in 8 out of 12 distributaries) (See Table-6). Part of the reason for such high incidence of wells in the command area is that many of them were

Table-6 Area owned by NW and WW Farmers and Well Per Acre in the Selected Distributaries

Sl. No.	Zone	Main/ Branch Canal	Distributary (mileage)	Total Plot area of the Dy. (acree)	Proportion of Area owned by NW Farmers	Proportion of Area owned by WW Farmers	Well per acre in the DY
1	I	PMC	2.6.000	153.18	37.2	62.8	0.10
2	I	PMC	13.5.263	129.60	3.0	97.0	0.23
3	I	KPBC	0.2.640	284.60	16.6	83.4	0.19
4	I	KPBC	6.5.600	213.37	26.6	73.4	0.13
5	I	UPC	3.7.330	189.08	17.4	82.6	0.17
6	I	UPC	19.0.15	309.05	34.1	65.9	0.12
7	II	PMC	3.4.500	186.19	31.3	68.7	0.13
8	II	PPBC	0.1.180	178.39	100.0	NIL	NIL
9	II	PPBC	8.0.220	190.20	12.8	87.2	0.19
10	III	PMC	31.4.440	187.48	6.7	93.3	0.28
11	III	PMC	50.4.445	218.37	7.9	92.1	0.28
12	III	PMC	68.0.000	152.49	2.7	97.3	0.26

Note: PMC - Parambikulam Main Canal
KPBC- Kovil Palayam Branch Canal taking off from PMC
PPBC- Pudupalayam Branch Canal taking off from PMC
UPC - Udumalpet Canal

Source: Survey

dug long before the commencement of PAP[9]. However, several of them were deepened in due course, and also new wells have come up since the construction of this project. But as a result of high concentration of wells and due to frequent failure of monsoon, the ground water table has gone down very deep (at-present the depth of wells range from 40 to 100 feet in this area). The yield of water from Wells is also reduced to a great extent. Consequently, only a limited area could be cropped with the available water in several parts of this command area. Thanks to the introduction of the canal irrigation system in this area which has made a big change partly because, several wells in the command area of the system get recharged from canal water. I shall discuss this aspect in detail in the following pages.

Table-6 gives information on the proportion of area owned by WW and NW farmers and well per acre. This data certainly helps to get an idea on the magnitude of well irrigation in the selected command area. However, this data may often mislead for the simple reason that higher incidence of well need not necessarily mean that higher proportion of area is irrigated. For instance we found that the average size of holding is larger in the Zone-I, of PMC and it declines in other Zones, in particular Zone-III (see Table-7). In other words, it implies that although the incidence of well is low in Zone-I, area irrigated by each well is larger and vice-versa. Moreover, data

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9. About 70% of the wells located in the command areas of the selected distributaries were dug before PAP came into operation.

Table-7 Average Size of Holding of Sample Farmers in the Selected Distributaries

Sl. No.	Zone	Main/ Branch Canal	Distributary (mileage)	Average Size of holding for NW farmers	WW farmers	All farmers
1	I	PMC	2.6.000	3.35	6.01	4.14
2	I	PMC	13.5.263	0.98	4.19	3.81
3	I	KPBC	0.2.640	2.62	4.48	4.01
4	I	KPBC	6.5.600	4.37	5.59	5.20
5	I	UPC	3.7.330	2.35	4.73	4.02
6	I	UPC	19.0.15	2.70	5.36	4.01
7	II	PMC	3.4.500	2.33	5.12	3.72
8	II	PPBC	0.1.180	3.24	NIL	3.24
9	II	PPBC	8.0.220	2.06	4.60	3.96
10	III	PMC	31.4.440	1.57	3.30	3.07
11	III	PMC	50.4.445	2.47	3.30	3.21
12	III	PMC	68.0.000	1.20	3.66	3.39

Source : Survey

relating to supply of water from wells clearly indicates that only in Zone-I of PMC adequate and regular supply is available and in other zones, in particular Zone-III, supply of water from wells is unreliable and inadequate. In fact many of the wells located in the ayacut of Zone-I of PMC supply water almost throughout both during spell and non-spell years. This is possible mainly because of the fact that constant and adequate recharge is possible from canal supplies to wells in the ayacut of this Zone. Moreover, since Zone-I of PMC is located in the upper reach of the system, even when water is stopped for this Zone, water keeps flowing in the main canal for other zones. This enables several wells to get recharge almost throughout year. This is in fact reflected in higher cropping intensity and productivity in the ayacut of this zone.

Before going into the details on this aspect, let us pay attention to Table-7 to discuss further on the issue of size of holding between irrigated and unirrigated lands. Conventionally one would find that the average size of holding is much smaller in the wet lands (ie.,in the command area of tanks and canals) than in the dry lands. The notion is that greater the intensity of irrigation and cultivation, larger would be the number of cultivators and number of fragmentation. However, during the past three decades area under well irrigation has gone up tremendously both in the so called wet and dry lands. Hence it is necessary to classify the total cultivable area in a more meaningful way, in paticular, the areas where well irrigation is dominant. If classification is done on the basis of access to well irrigation (ie., those who have access to well irrigation and those who have not) one gets entirely a different picture with regard to the aveage size of holding. One can see from Table-7 that the average size of holding is much larger in the WW category (ie., those who have access to well irrigation) than in the NW category (ie., those who have no access to well irrigation)[10]. This has the implication that only those who have greater access to land would be in a position to have private source of irrigation. This perhaps is manifested in the larger average size of holding for those who have wells than those who have not. This leads us to two important conclusions:

(i) The conventional classification of land into wet and dry (particularly in the area where surface source is either inadequate or uncertain) will mislead to a great extent mainly because wells have emerged as an important source of irrigation in the so called wet lands also. And those who own wells in the ayacut are in a better position in terms of having adequate recharge into their wells from surface sources.

(ii) Privitisation of irrigation water is very much linked to the higher degree of land ownership.

With this background I shall now turn to the discussion of extent of conjunctive use in the selected distributaries.

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10. Similar results were found in an another study carried out by the present author in North Arcot District. See for details, Janakarajan, S. (1986).

Extent of Conjunctive use Irrigation in the Selected Distributaries

Table 8,9, and 10 provide information on the proportion of net area irrigated to total plot area, proportion of gross irrigated area to total plot area and area irrigated by different sources, for each selected distributary for three years, viz., 1986-87, 1985-86 and 1984-85 respectively. 1986-87 was a spell year only for Zone - II, 1985-86 was a spell year for all zones except Zone-II, and 1984-85 was a spell year for all zones except Zone-III. We shall analyse data presented in these tables keeping in mind general drought conditions that prevailed during 1986-87. Following points emerge from these tables:

First of all it is generally observed that the performance in terms of proportions of NIA to total plot area (PA) as well as GIA to PA are higher during spell year than in the non-spell year for obvious reasons. For instance, 1986-87 was a spell year for Zone-II (Table-8)[11] where almost 100% of the PA was irrigated in 3.4.500 distributary and about 85% in 8.0.220 distributary. The proportions of GIA to PA was also of the order of 1.44 and 1.26 respectively for these two distributaries which is higher than other distributaries except one in Zone-I. Similarly 1985-86 was a spell year for Zone-I and Zone-III which is reflected in the

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11. In this year (1986-87) farmers of 0.1.180 distributary (of Zone-II) did not utilise canal water for, it was supplied in early September instead of June. In the season starting from September to December farmers of this distributary preferred to grow rainfed red gram crop which requires very less irrigation, in particular this area, where black soil is found.

Table 8 Irrigation Intensity and Sources of Irrigation Across Distributaries, 1986-87

Sl. No.	Zone	Main/ Branch Canals	DY	Total Plot Area (PA)	GIA	NIA	NIA/ PA	GIA/ PA	Area Irrigated by sources C	C+W	W	R	Whether spell (S) or non spell(NS)
1	I	PMC	2.6.000	153.18	114.40	58.65	0.38	0.75	NIL	NIL	114.40	86.37	NS
2	I	PMC	13.5.263	129.60	291.61	111.03	0.66	2.25	NIL	NIL	291.61	6.90	NS
3	I	KPBC	0.2.640	284.60	468.43	165.94	0.58	1.65	NIL	NIL	468.43	82.45	NS
4	I	KPBC	6.5.600	213.37	227.34	90.64	0.42	1.07	NIL	NIL	227.37	46.63	NS
5	I	UPC	3.7.330	189.08	122.83	69.86	0.37	0.65	NIL	NIL	122.83	39.20	NS
6	I	UPC	19.0.15	309.05	195.33	114.67	0.37	0.63	NIL	NIL	195.83	88.73	NS
7	II	PMC	3.4.500	186.19	268.80	184.91	0.99	1.44	65.72 (24.4)	118.90 (44.2)	84.18 (31.3)	3.50	S
8	II	PPBC	0.1.180	178.39	0.90	0.30	NIL	0.04	NIL	NIL	0.90	168.58	S
9	II	PPBC	8.0.220	190.20	238.75	161.58	0.85	1.26	23.25 (9.7)	156.41 (65.5)	59.09 (24.7)	NIL	S
10	III	PMC	31.4.440	187.48	84.47	31.87	0.17	0.45	NIL	NIL	84.47	NIL	NS
11	III	PMC	50.4.445	218.37	183.61	120.68	0.55	0.84	NIL	NIL	183.61	NIL	NS
12	III	PMC	68.0.000	152.49	21.50	7.50	0.05	0.14	NIL	NIL	21.50	5.50	NS

Note: Area in acres
Figures in brackets are percentages to GIA

Source: Survey

Table 9 Irrigation Intensity and Sources of Irrigation Across Distributaries, 1986-87

Sl. No.	Zone	Main/ Branch Canals	DY	Total Plot Area (PA)	GIA	NIA	NIA/ PA	GIA/ PA	Area Irrigated by sources C	C+W	W	R	Whether spell (S) or non spell(NS)
1	I	PMC	2.6.000	153.18	222.00	114.70	0.75	1.45	38.75 (17.5)	75.25 (33.9)	108.00 (48.6)	44.56	S
2	I	PMC	13.5.263	129.60	275.30	125.81	0.97	2.12	5.10 (1.9)	122.74 (44.6)	147.46 (53.6)	4.90	S
3	I	KPBC	0.2.640	284.60	565.33	240.05	0.84	1.99	36.41 (6.4)	211.04 (37.3)	317.88 (56.2)	45.00	S
4	I	KPBC	6.5.600	213.37	347.23	147.62	0.69	1.63	31.49 (9.1)	86.29 (25.0)	228.85 (65.9)	33.27	S
5	I	UPC	3.7.330	189.08	293.73	177.33	0.94	1.55	41.69 (14.2)	136.14 (46.3)	115.90 (39.5)	20.71	S
6	I	UPC	19.0.15	309.05	431.32	272.12	0.88	1.40	94.22 (21.8)	185.69 (43.1)	151.41 (35.1)	77.40	S
7	II	PMC	3.4.500	186.19	114.36	84.42	0.45	0.61	NIL	NIL	114.36	42.48	NS
8	II	PPBC	0.1.180	178.39	NIL	NIL	NIL	NIL	NIL	NIL	NIL	175.49	NS
9	II	PPBC	8.0.220	190.20	38.82	17.94	0.09	0.20	NIL	NIL	38.82	NIL	NS
10	III	PMC	31.4.440	187.48	303.49	3189.21	0.90	1.62	12.44 (4.1)	160.77 (53.0)	130.28 (42.9)	NIL	S
11	III	PMC	50.4.445	218.37	337.43	170.56	0.78	1.55	12.93 (3.8)	165.00 (48.9)	159.50 (47.3)	0.70	S
12	III	PMC	68.0.000	152.49	173.25	130.99	0.86	1.14	5.50 (3.2)	124.89 (72.1)	42.86 (24.7)	3.00	S

Note: Area in acres
Figures in brackets are percentages to GIA

Source: Survey

Table 10 Irrigation Intensity and Sources of Irrigation Across Distributaries, 1986-87

Sl. No.	Zone	Main/ Branch Canals	DY	Total Plot Area (PA)	GIA	NIA	NIA/ PA	GIA/ PA	Area Irrigated by sources C	C+W	W	R	Whether spell (S) or non spell(NS)
1	I	PMC	2.6.000	153.18	139.99	78.24	0.51	0.91	28.49 (20.4)	46.25 (33.0)	65.25 (46.6)	20.34	S
2	I	PMC	13.5.263	129.60	262.39	99.03	0.76	2.02	3.10 (1.2)	93.53 (35.6)	165.76 (63.2)	2.53	S
3	I	KPBC	0.2.640	284.60	562.47	241.89	0.85	1.98	39.15 (7.0)	207.29 (36.9)	316.03 (56.2)	26.46	S
4	I	KPBC	6.5.600	213.37	174.86	115.66	0.54	0.79	24.61 (14.1)	47.25 (27.0)	103.00 (58.9)	19.36	S
5	I	UPC	3.7.330	189.08	302.28	172.51	0.91	1.60	41.19 (13.9)	136.14 (46.0)	118.40 (40.0)	4.00	S
6	I	UPC	19.0.15	309.05	462.08	302.03	0.98	1.50	106.39 (23.0)	194.90 (42.2)	160.79 (34.8)	32.45	S
7	II	PMC	3.4.500	186.19	230.50	176.07	0.95	1.24	68.64 (30.0)	108.53 (47.1)	53.33 (23.1)	NIL	S
8	II	PPBC	0.1.180	178.39	120.31	119.71	0.67	0.04	119.41 (99.20)	NIL	0.90 (0.80)	58.77	S
9	II	PPBC	8.0.220	190.20	167.86	143.98	0.75	0.76	28.15 (16.8)	137.41 (81.9)	2.30 (1.4)	NIL	S
10	III	PMC	31.4.440	187.48	105.77	54.67	0.29	0.56	NIL	NIL	105.77	NIL	NS
11	III	PMC	50.4.445	218.37	147.39	97.41	0.45	0.67	NIL	NIL	147.39	12.63	NS
12	III	PMC	68.0.000	152.49	38.00	21.50	0.14	0.25	NIL	NIL	38.00	7.29	NS

Note: Area in acres
Figures in brackets are percentages to GIA

Source: Survey

higher proportions of NIA to PA and GIA to PA. (See Table-9). In 1984-85 again high proportions of NIA to PA and GIA to PA were seen in the distributaries of Zone I and II for which it was a spell year (see Table-10).

Secondly, while using the same irrigation indices (ie., NIA/PA and GIA/PA) to compare between spell and non-spell years for each zone, one finds that in non-spell years it is very poor except in Zone-I of PMC. In Zone-I of PMC, even in the non-spell year (1986-87), the irrigation intensity was found to be high (ie., 0.75, 2.25, 1.44 and 1.07 respectivey for four distributaries) and the entire area reported was irrigated by wells. This is because, as it has been indicated earlier, wells located in the ayacut of Zone-I of PMC get regular and adequate recharge from canals almost throughout a year. On the other hand, well density is quite high in Zone-III, but supply of water from wells is extremely poor and in fact the supply is almost ceased during non-spell years. This is because no regular recharge is possible in this Zone from canals. Thus it reinforces the point that high well density does not mean much, as wells would serve an useful purpose only when there is regular and sufficient recharge from surface sources.

Thirdly, the distributaries which have distinct locational advantage (viz., 13-5-263 of Zone-I and 50-4-445 of Zone-III) perform better both in spell and non-spell years. The ayacut of 13-5-263 distributary is just adjacent to the main canal; and the ayacut of 50-4-445 distributary is covered by the 'U' shaped main canal. In both these cases, since the main canal is just adjacent to the ayacut, enormous extent of water is recharged into the wells and in fact in the case of former distributary some wells overflow whenever water flows in the main canal.

Fourthly, the extent of conjunctive use of surface and ground water is considerably high in all the distributaries. If one goes by the strict definition of conjunctive use as "canal + well water", then the proportion of area reporting C+W range from 30% to 70%. However, since, wells get recharge basically from surface sources one could relax the definition of conjunctive use as area reporting both (C+W)+W. In which case, in majority of the distributaries, over 80% of gross irrigated area reports conjunctive use. In fact in many distributaries (See Tables 8,9 & 10) area reporting pure canal irrigation is insignificant. This is particularly true in the case of Zone-III, where availability of canal water is irregular and inadequate and hence farmers resort to use well water as a supplementing source to canal water.

Fifthly, one can observe from these tables that area under rainfed crops in the non-spell year is higher than in the spell years. But then, what is puzzling to note is that in the Zone-III, where neither canal water nor well water is assured, area under rainfed crops is insignificant (particularly when soil type is quite suitable under rainfed conditions).

Lastly, while looking across reaches of main/branch canal, at the tail end distributaries, the proportions of NIA to PA and

GIA to PA are lower than what it is for upper reach distributaries within a zone. While looking across Zones also, proportion of area irrigated is lower in the Zone-II and Zone-III than in Zone-I. One can straight away attribute for such low proportion of area irrigated in the tail reach distributaries to the irregular and inadequate supply of canal water, which also implies that wells yield poor supply due to poor recharge from surface sources.

On the whole, it is apparent that the conjunctive use of surface and ground water has emerged as a well recognised and widely prevalent method of irrigation in the PAP command area. Perhaps the rotational system of irriation that is in vogue in this area induces farmers to use well water as a supplementary source to canal water in particular, during the periods of short supply.

Impact of Conjunctive Use

Access to and the quality of irrigation have significant bearing on the crop pattern, cropping intensity and productivity. As it has been mentioned earlier, the type of crops grown and productivity vary a great deal according to sources of irrigation that is available. It is now an established fact that productivity is higher in the area which receives well irrigation for the simple reason that it is more assured and controllable. Let us see in this context what has been the effect of conjunctive use irrigation with particulaar reference to the selected distributaries.

Crop pattern

First let us look at the crop pattern in the selected distributaries for three years viz., 1986-87, 1985-86 and 1984-85 (See Table-11). for the sake of convenience crops have been divided into four categories: Paddy; Fodder, Chillies and Vegetables; irrigated dry crops; and annual and perennial crops. Irrigated dry crops include cotton, onion, groundnut, cholam, maize, bajra, grams, gingilly, tobacco and other coarse cereals and pulses. Annual and perennial crops include sugarcane, turmeric, banana and coconut. Of the categories mentioned above except dry irrigated crops, all others are wet crops and infact annual and perennial crops need year round supply of water. In other words, these wet crops cannot be grown without assured irrigation facilities. It was already indicated that as per the original plan the PAP was intended mainly for dry irrigated crops and wet crop cultivation was allowed only to the extent of about 20% of the total command area of the system; area demarcated for wet crop cultivation was basically low lying areas or areas which have chronic drainage problems. However, the official statistics as well as our own survey confirm the fact that wet crop cultivation is far more than the envisaged and in some areas almost entire area is under wet crop cultivation during spell period. Perhaps, the most crucial factor that determines wet crop cultivation in the command area is the availability of ground water.

Let us now have a close look at Table-11. First of all it is generally found that during spell years WW farmers do better

Table 11

Crop Pattern in the Ayacuts of Selected Distributaries, 1984-85, 1985-86 & 1986-87

(Net Area in acres)

Sl. No.	Zone	Distributary	[illegible]	1986-87 Paddy	1986-87 Fodder chillies and Vegetables	1986-87 Irrigated Dry Crops	1986-87 Annual and Perennial Crops	1986-87 Total	1985-86 Paddy	1985-86 Fodder chillies and Vegetables	1985-86 Irrigated Dry Crops	1985-86 Annual and Perennial Crops	1985-86 Total	1984-85 Paddy	1984-85 Fodder chillies and Vegetables	1984-85 Irrigated Dry Crops	1984-85 Annual and Perennial Crops	1984-85 Total
1	PMC-I	2.6.000	[illegible]	Nil	9.0	78.7	23.0	110.7	11.5	5.8	121.7	17.0	156.0	[illegible]	7.8	19.0	16.5	57.3
			[illegible]	Nil	Nil	64.1	Nil	64.4	5.5	Nil	88.6	Nil	94.1	3.5	Nil	55.2	Nil	58.7
			ALL	Nil	12.3	142.8	23.0	175.1	17.0	5.8	210.3	17.0	250.1	17.5	7.8	74.2	16.5	116.0
2	PMC-I	13.5.263	[illegible]	Nil	12.3	34.3	80.2	126.8	18.2	14.5	43.2	81.7	157.6	19.2	7.0	11.5	79.1	116.8
			[illegible]	Nil	Nil	3.9	Nil	3.9	0.7	Nil	7.1	Nil	7.8	0.7	Nil	3.7	Nil	4.4
			ALL	Nil	12.3	38.2	80.2	130.7	18.9	14.5	50.3	81.7	165.4	19.9	7.0	15.2	79.1	121.2
3	PMC-I	6.2.640	[illegible]	Nil	4.3	36.9	151.9	193.1	8.8	13.5	69.3	155.0	244.6	22.8	12.8	33.3	157.2	226.1
			[illegible]	Nil	Nil	49.9	Nil	49.9	Nil	1.1	72.8	Nil	73.9	Nil	Nil	59.1	Nil	59.1
			ALL	Nil	4.3	86.8	151.9	243.0	6.8	14.6	142.1	155.0	318.5	22.8	12.8	92.4	157.2	285.2
4	PMC-I	6.5.600	[illegible]	0.5	2.5	29.2	69.4	101.1	5.5	10.3	58.1	76.7	150.8	3.5	7.7	20.3	44.3	75.8
			[illegible]	Nil	Nil	41.2	Nil	41.2	Nil	2.5	78.1	Nil	80.6	Nil	Nil	31.0	Nil	31.0
			ALL	0.5	2.5	70.4	69.4	142.3	5.5	12.8	136.2	76.7	231.2	3.5	7.7	51.3	44.3	106,8
5	UPC	3.7.[illegible]	[illegible]	Nil	9.7	60.6	20.9	91.1	[illegible]	4.1	86.2	41.4	192.2	76.8	10.0	37.2	[illegible]	171.9
			[illegible]	Nil	Nil	27.4	Nil	[illegible]	[illegible]	Nil	36.1	Nil	46.3	18.9	Nil	14.9	Nil	33.8
			ALL	Nil	9.7	88.0	20.8	118.5	[illegible]	4.1	[illegible]	41.9	238.5	95.7	10.0	52.1	[illegible]	[illegible]
6	UPC	19.[illegible]	[illegible]	Nil	3.1	114.6	28.2	[illegible]	[illegible]	13.3	139.0	45.7	257.6	88.6	11.6	106.5	[illegible]	[illegible]
			[illegible]	Nil	Nil	74.4	Nil	[illegible]	[illegible]	2.6	143.3	Nil	166.8	60.7	1.1	70.3	Nil	[illegible]
			ALL	Nil	3.1	189.0	28.2	220.3	[illegible]	[illegible]	282.3	45.7	424.4	149.3	12.7	176.8	[illegible]	[illegible]

Contd.....

Table 11 contd.....

Sl. No.	Zone	Distri-butary	MW/ NW	1986-87 Paddy	1986-87 Fodder chillies and Vegetables	1986-87 Irrigated Dry Crops	1986-87 Annual and Perennial Crops	1986-87 Total	1985-86 Paddy	1985-86 Fodder chillies and Vegetables	1985-86 Irrigated Dry Crops	1985-86 Annual and Perennial Crops	1985-86 Total	1984-85 Paddy	1984-85 Fodder chillies and Vegetables	1984-85 Irrigated Dry Crops	1984-85 Annual and Perennial Crops	1984-85 Total
7	PMC-2	3.4.500	MW	45.9	2.9	69.6	32.0	150.4	25.3	2.1	49.1	13.8	90.3	66.8	1.5	31.8	21.3	121.4
			NW	45.9	0.5	15.9	0.1	62.4	4.8	Nil	35.7	0.7	41.2	40.9	0.4	16.1	Nil	57.4
			ALL	91.8	3.4	85.5	32.1	212.8	30.1	2.1	84.8	14.5	131.5	107.7	1.9	47.9	21.3	178.8
8	PMC-2	0.3.100	MW	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil
			NW	Nil	Nil	169.7	0.3	170.0	Nil	Nil	178.4	0.3	178.7	38.8	Nil	109.9	0.3	149.0
			ALL	Nil	Nil	169.7	0.3	170.0	Nil	Nil	178.4	0.3	178.7	38.8	Nil	109.9	0.3	149.0
9	PMC-2	6.0.220	MW	46.4	4.5	123.2	11.4	186.5	Nil	Nil	8.3	9.1	17.4	58.4	Nil	51.7	10.9	121.0
			NW	1.9	Nil	24.5	Nil	25.5	Nil	Nil	Nil	Nil	Nil	Nil	Nil	24.7	Nil	24.7
			ALL	48.4	4.5	146.7	11.4	212.0	Nil	Nil	8.3	9.1	17.4	58.4	Nil	76.4	10.9	145.7
10	PMC-3	31.4.440	MW	Nil	1.5	2.0	26.8	30.3	59.6	10.5	137.1	22.2	229.4	Nil	2.0	34.7	24.0	60.7
			NW	Nil	Nil	Nil	Nil	Nil	0.5	Nil	14.0	Nil	14.5	Nil	Nil	0.9	Nil	0.9
			ALL	Nil	1.5	2.0	26.8	30.3	61.1	10.5	151.1	22.2	243.9	Nil	2.0	35.6	24.0	61.6
11	PMC-3	50.4.44[illegible]	MW	34.4	28.9	116.8	2.5	182.6	176.0	16.0	120.6	2.5	315.1	24.3	27.4	91.8	2.5	146.0
			NW	Nil	Nil	3.1	Nil	3.1	8.3	Nil	0.7	Nil	9.0	Nil	1.5	6.5	Nil	8.0
			ALL	34.4	28.9	119.9	2.5	185.7	184.3	16.0	121.3	2.5	324.1	24.3	28.9	98.3	2.5	154.0
12	PMC-3	66.0.[illegible]	MW	Nil	Nil	6.0	Nil	6.0	53.8	9.6	88.4	7.0	158.8	Nil	Nil	23.4	7.0	30.4
			NW	Nil	Nil	Nil	Nil	Nil	Nil	Nil	5.5	Nil	5.5	Nil	Nil	1.0	Nil	1.0
			ALL	Nil	Nil	6.0	Nil	6.0	53.8	9.6	93.9	7.0	164.3	Nil	Nil	24.4	7.0	31.4

Notes (i) Irrigated dry crops include cotton, onion, groundnut, cholam, maize, bajra, cubu, grass, gingilly, tobacco and others. (ii) Annual and Perennial Crops include sugarcane, turmeric, banana and coconut. Source: Field Survey, 1986-87.

in terms of wet crop cultivation than NW farmers; during non-spell years also WW farmers grow wet crops but to a lesser extent. On the other hand, NW farmers grow wet crops to a limited extent during spell years and it is practically nil during non-spell years. The NW farmers during non-spell periods just go in for unirrigated dry crops and in fact in some distibutaries even area under rainfed cultivation is nil or insignificant (in particular, see 31.4.440 and 68.0.000 distributaries of Zone-III & 8.0.220 distributary of Zone-II).

Secondly, it has been mentioned earlier that wells located in the Zone-I of PMC yield almost year round supply and average area irrigated by each well in that zone is much higher. In fact its impact is clearly seen in the crop pattern. For instancealthough 1986-87 was a non-spell year for Zone-I, wet crop cultivation was widespread and was found in a large extent of area. It was the case in this Zone for WW farmers despite the fact that 1986-87 was a severe drought year. For Zone-III also 1986-87 was a non-spell year but the performance of WW farmers, was extremely poor (except in 50.4.445 distributary, which I shall discuss later) and they have not even ventured for dry irrigated crops. 1985-86 was a non-spell year for Zone-II, but the WW farmers of head distributary (3.4.500) only performed somewhat better and the performacne of tail distributary (8.0.220) was poor and no better than the distributaries of Zone-III. 0.1.180 distributary of this Zone is not taken into account for discussion because of the fact that area receiving well irrigation is practically nil.

Thirdly, while looking across distributaries one finds significant variation. The performance of WW farmers is relatively poor at the tail end of each zone and more so at the tail end system itself. This is basically because of poor recharge from surface to wells. However, this is not always true since the problem is also one of more 'location specific'. For instance, the wells located in the first distributary of Zone-I (2.6.000) which is also the first distributary of Parambikulam Main Canal receives very little recharge from canals probably because of a given geological formations. It is precisely because of this reason area under wet crop cultivation is relatively small in this distributary both during spell and non-spell years. On the other hand, farmers (in particular WW farmers) of 50.4.445 distributary performs much better, despite the fact that it is located at the tail end of the system, precisely because of its favourable location. The command area of this distributary is encompassed with the 'U' shaped main canal. Hence wells located in this ayacut by virtue of its advantageous loation receive abundant recharge from the main canal. Thus wet crop cultivation is quite commonly seen in this distributary, more so during spell years.

Cropping Intensity and Productivity

Table-12 gives information on Cropping Intensity (CI) and Gross Value of Output (GVO) per unit of Plot Area (PA) and Gross Cropped Area (GCA) for each selected distributary for three years, viz., 1986-87, 1985-86, and 1984-85, separately for WW, NW and for 'ALL' farmers.

First of all one finds a glaring difference in the CI and productivity between the area which has access to well irrigation (WW) and which does not have. In particular, the difference is much more striking during the non-spell years than spell years. Let us take for instance, Zone-I, of PMC. We will notice from Table-12 that in the year 1986-87, which was a non-spell year for this Zone, the CI for NW group (for the Zone as a whole) was 0.99, where as for WW group it was 1.95. Similarly, in the same year, one can notice difference in the productivity per acre of GCA between these two groups of farmers. The average productivity per acre of GCA for PMC Zone-I was Rs.184 for NW group, where as for WW group it was as high as Rs.1600, which is little less than 9 times the productivity of NW group. While looking at the individual distributaries also one finds a striking difference in CI and productivity. However, the performance of Udumalpet Canal (3.7.330 and 19.0.15) is not as good as the distributaries of PMC Zone-I despite the fact that both of them fall under the same irrigation spell period. However, the difference in terms of CI and productivity between NW and WW groups is narrowed down to a great extent as one goes down to other zones of the system precisely for the reason that wells located in the ayacut of Zone-II and Zone-III do not get as much recharge (from canals) as they get in the Zone-I. This is the point which was discussed at length in an earlier section. For instance, 1985-86 was a non-spell year for Zone-II, but the

TABLE 12

Cropping Intensity and Productivity, 1986-87, 1985-86 & 1984-85

Sl.No.	Zone	Distributary	Classification of Farmers	1986-87 CI	1986-87 O/GCA	1986-87 O/PA	1985-86 CI	1985-86 O/GCA	1985-86 O/PA	1984-85 CI	1984-85 O/GCA	1984-85 O/PA
1	PMC-1	2.6.000	WW	1.68	878	1477	1.98	1155	2283	0.95	2527	2388
			WN	1.13	168	189	1.65	645	1066	1.03	791	815
			ALL	1.48	676	997	1.86	986	1830	1.51	1841	2784
2	PMC-1	13.5.263	WW	2.37	1982	4701	2.06	2700	5564	2.19	1847	4040
			WN	1.00	265	265	2.00	1294	2588	1.13	2031	2292
			ALL	2.33	1959	4567	2.53	2157	5475	2.60	1850	4817
3	PMC-1	0.6.240	WW	2.03	1846	3861	2.33	2082	4860	2.28	2119	4823
			WN	1.14	114	129	1.57	580	910	1.25	1356	1700
			ALL	1.93	1678	3245	2.21	1905	4206	2.21	2044	4510
4	PMC-1	6.5.600	WW	1.54	1109	1712	1.94	1508	2926	1.05	2882	3029
			WN	0.73	296	215	1.42	362	514	0.55	1604	875
			ALL	1.33	991	1313	1.83	1248	2284	1.13	2679	3034
5	UPC	3.7.330	WW	0.86	982	848	1.77	1364	2411	1.78	2009	3584
			WN	0.83	277	230	1.11	350	388	1.03	2241	2301
			ALL	0.86	863	741	1.65	1246	2059	1.85	2035	3360
6	UPC	19.0.15	WW	0.99	1128	1123	1.71	1307	2241	1.74	1622	2823
			WN	0.71	412	291	1.58	433	687	1.25	2506	3142
			ALL	0.90	936	840	1.67	1024	1711	1.57	1867	2931
7	PMC-2	3.4.500	WW	1.69	3657	2164	0.92	2529	2336	1.28	1754	2251
			WN	1.07	3275	3502	0.66	355	233	0.98	974	960
			ALL	1.50	2412	3608	0.84	1996	1677	1.19	1552	1846
8	PMC-2	0.1.180	WW	NIL	NIL	NIL	NIL	NIL	NIL	NIL	NIL	NIL
			WN	0.96	789	755	1.00	843	847	0.84	543	455
			ALL	0.96	789	755	1.00	843	847	0.84	543	455
9	PMC-2	8.0.220	WW	1.28	2058	2633	0.22	174	37	0.86	751	649
			WN	0.94	1625	1527	NIL	NIL	NIL	1.00	463	463
			ALL	1.23	2018	2489	0.19	174	33	0.88	709	625
10	PMC-3	31.4.440	WW	0.54	40	22	1.57	2473	3886	0.62	714	444
			WN	NIL	NIL	NIL	1.15	19209.	22169	0.07	4245	317
			ALL	0.50	42	21	1.54	3314	5114	0.61	745	462
11	PMC-3	50.4.445	WW	0.93	6039	5630	1.59	5634	8976	0.80	5580	4463
			WN	0.18	310	56	0.52	5386	2805	0.46	3696	1711
			ALL	0.87	5946	5193	1.51	5573	8485	0.95	5491	5207
12	PMC-3	68.0.000	WW	0.04	135	6	1.18	3096	3652	0.30	173	52
			WN	NIL	NIL	NIL	0.92	1877	1720	0.12	NIL	NIL
			ALL	0.04	135	5	1.17	3058	3576	0.30	170	50

Notes: CI-Cropping Intensity; O-Output; GCA-Gross Cropped Area; PA-Plot Area
WW-Sample Farmers with Well; WN-Sample Farmers without Well. Output in Rupees
For the Distributaries 2.6.000, 13.5.263, 0.2.640, 6.5.600, 31.4.440 & 50.4.445 the figures given for WW and WN are subject to correction of non-reporting farmers but, for 'all' farmers, the figures are corrected.

Source: Field Survey Data, 1986-87.

productivity per acre of GCA in the WW group was only about 2 1/2 times the productivity of the NW group. For Zone-III, 1986-87 was a non-spell year and one can notice that the CI and in the NW group were Zero for two distributaries (viz., 31.4.440 and 68.0.000) and shows only a marginal improvement in the case of WW group (for these two distributaries). The 50.4.445 is an unique distributary of this zone about which I have already indicated. Since 1985-86 was a spell year for this zone, the wells located in the ayacut of this distributary supplied good water in the year 1986-87 also. For instance, there are 61 wells in the ayacut of this distributary, of which 40 wells supply water upto 9 months (1 of them supplying throughout)during the immediate non-spell year, and during the spell year 50 wells supply water upto 9 months of which 43 wells supply throughout.[12] Whereas, the wells located in the ayacut of other distributaries of this Zone (31.4.440 and 68.0.000) yield very poor supply and most of them remained dry throughout the non-spell year. For instance, there are 93 wells in these 2 distributaries, out of which as many as 88 remain dry throughout; 1 well supplies water upto 6 months; and 4 wells supply upto 3 months during the non-spell year. During the spell year also, 63 wells remain dry throughout; 6 supply upto 6 months and 24 wells supply upto 3 months. (See

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12. Enormous recharge takes place from canals to wells despite the face that canal net work (main/branch canals, distributaies and upto pipe points) of the PAP is a lined one. This is mainly because of extensive damages found in the lining net work of canals which is partly due to deliberate attempts of farmers and aprtly due to tresspassing of cattle. The poor quality of maintenance work undertaken by the PWD has also contributed to this state of condition.

Table-13). Precisely for this reason, one notices a striking difference in the productivity Between NW and WW groups in the 50.4.445 distributary, but not much of a difference in the other two distributaries of this zone. The productivity per acre of GCA for NW group in 50.4.445 distribuary was Rs.310, where as it was as high as Rs.6039 for WW group. At the same time, the productivity per acre of GCA for the other two distributaries of Zone-III (i.e., 31.4.440 and 68.0.000) was 0 for NW group and only Rs.47 for WW group.

In other words the fact of the matter is that there exists a great deal of disparity in the CI and productivity between the areas which has access to well irrigation and which does not have; but the degree at which they vary very much depend upon the yield of water from the wells. It is also necessary here to point out the fact that the general drought conditions prevailed in the state would have contributed for such big difference in the productivty between the NW and WW areas; but one should also acknowledge the fact that wells (with adequate recharge from surface sources) located in the command areas provided a good insurance during the drought year.

It is also a matter of interest to note here that the disparity in productivity and CI between these two areas (NW and WW) get narrowed to a great extent during the spell years (see Tables-12) for the simple reason that the productivity in the NW area makes a substantial improvement due to canal water supply.

Table-13

Frequency Distribution of Wells According to Duration of Water Supply During Spell and Non-Spell Years.

Sl. No.	Zone/ Main/ branch canals	Distri- butary	Duration of Water Supply during spell year — Number of Wells Yielding: 10 mts to 1 year	6to9 months	3to6 months	Less than 3 months	Dry through- out the year	Duration of Water Supply during non-spell year — Number of Wells Yielding: 10 mts to 1 year	6to9 mts.	3to6 mts.	Less than 3 mts.	Dry through- out the year
1	PMC-I	2.6.000	8	4	2	NIL	2	6	4	3	NIL	3
2	PMC-I	13.5.263	28	2	NIL	NIL	NIL	27	3	NIL	NIL	NIL
3	PMC-I	0.2.640	50	3	NIL	NIL	NIL	48	2	3	NIL	NIL
4	PMC-I	6.5.600	20	6	2	NIL	NIL	18	5	3	1	1
	PMC-I	TOTAL	106	15	4	NIL	2	99	14	9	1	4
5	UPC	3.7.330	NIL	6	18	5	4	NIL	NIL	3	20	10
6	UPC	19.0.15	NIL	NIL	7	27	4	NIL	NIL	NIL	14	24
	UPC	TOTAL	NIL	6	25	32	8	NIL	NIL	3	34	34
7	PMC-II	3.4.500	9	10	6	NIL	NIL	2	5	11	7	NIL
8	PMC-II	0.1.180	NIL	NIL	NIL	NIL	NIL	NIL	NIL	NIL	NIL	NIL
9	PMC-II	8.0.220	NIL	3	9	8	16	NIL	NIL	2	5	29
	PMC-II	TOTAL	9	13	15	8	16	2	5	13	12	29
10	PMC-III	31.4.440	NIL	NIL	2	23	28	NIL	NIL	NIL	3	50
	PMC-III	50.4.445	43	7	8	3	NIL	11	29	6	10	5
	PMC-III	68.0.000	NIL	NIL	4	1	35	NIL	NIL	1	1	38
	PMC-III	TOTAL	43	7	14	27	63	11	29	7	14	93

Note: Number of wells reported represent only number of sample farmers denoted by 'WW' in the text; multiple wells (ie., farmers having more than one well) are not included in the table as data for those wells are not available.

Source: Survey.

However, one finds always higher productivity and CI in the WW area than in NW area. The exception again is the case of Zone-III where productivity is found to be even higher in the NW area than WW area in the year 1985-86, which was a spell year for this Zone. This only reinforces the point that has been made earlier that wells serve a good purpose only when there is adequate recharge from surface sources. Otherwise, one finds very little difference between NW and WW areas.

Secondly, it appears in general that the CI and productivity per acre of GCA are higher in Zone-I, in particular during spell years, than in other zones and Udumalpet Canal (except ofcourse, 50.4.445 distributary of Zone-II, which has an unique locational advantage). This is mainly because of the fact that the distributaries of Zone-I have easy access to canal water as they are located in the upper reach of the system. Hence farmers of Zone-I of PMC are in a position to raise one full crop with canal water; after canal water is stopped, large majority of them in this Zone use well water (which are by then sufficiently recharged by canal water) for another 2 or 3 crops. This is possible because even when water is stopped for zone-I, water will keep flowing in the main canal for other two zones and so several wells get recharged in the ayacut of Zone-I. For instance, water was released for Zone-I from 15.2.1986 to 20.6.1986; but after a small gap, again water was let in the main canal for Zone-II from 1-9-1986 to 30-1-1987. The case of abundant recharge from surface sources to wells located in the ayacut of Zone-I is clearly seen from Table-13, which gives details on number of months for which wells yield water during spell and non-spell years for each zone. For instance, out of 127 wells located in the ayacut of Zone-I, 106 yield water (i.e.83%) for 10 months to 1 year during spell year and during non-spell year 99 wells (i.e.80%) yield water for 10 months to 1 year. Most of the remaining wells also supply water upto 6 months. In other zones, the picture is completely different. Most of the wells either remain dry through out or supply only upto 3 months both during spell and non-spell years.

Thirdly, and interestingly too, one finds variation in the productivity across distributaries within a Zone higher in WW area than in NW area during non-spell years, and during spell years, variation is found to be higher in NW area than in WW area. As it has been indicated earlier, during the non-spell years, there is absolutely no scope for any irrigation in the NW area and since crops very much depend upon rainfall, one finds not much of a variation in the productivity across distributaries within a zone. However, in the WW area, since productivity is influenced by the well irrigation, one finds a great deal of variation across distributaries within a zone and the productivity variation is caused by the specific local factors such as well density, locational advantage of wells, availability of water in the wells, extent of recharge possible from surface to sub-surface and so on. During the spell years, however, productivity variation across distributaries (within a zone) is found to be higher in the NW area than WW area for the main reason that the productivity in the former area very much depends upon the vagaries of canal water supply, whereas in the WW area, farmers have the option to supplement well water whenever supply from canas is irrigular and inadequate. In other words, since farmers in the WW area have supplementary source of irrigation (well), productivity variation across distributaries is found to be less during spell years; in contrast, in the NW area, since farmers have to rely entirely upon canal water, (during spell year) which is irregular and inadequate, productivity varies to a great extent across distributaries.

5 Concluding Observations

On the whole while looking at the pattern of ground water utilisation in these two systems, the following issues become clear.

(i) The extent of conjunctive use of ground and surface waters is quite significant in both the systems, which perhaps makes it obvious that the official statistics pertaining to conjunctive use irrigation is in gross understated.

(ii) The extent of area under conjunctive use irrigation in general was found to be higher in the head reach of both the systems precisely because of adequate and regular recharge from surface sources to the wells located in the ayacuts. However no systematic pattern emerges in terms of extent of area under conjunctive use irrigation and it varies across tanks, across zones of PAP and across distributaries. In fact, it very much depends upon specific local conditions such as the occurance of ground water aquifers, suitable geological formations, regular sources for recharge by way of tanks, canals and percolation ponds (in addition to rainfall) and so on.

(iii) Conjunctive use irrigation is prevalent more in the PAP command area, where enormous recharging takes place from canal water. In fact, a large number of wells, in particular zone-I of PMC, heavily depend upon flows in the canals. The rotational method of irrigation that is in vogue in this system induces farmers to use well water as a supplementary source. Moreover, it was widely reported (official statistics on dates of water release also confirm this point) that the dates of water release rarely coincides with agricultural seasons of the area. Therefore, wells located in the command area serves more useful purpose. For instance, those who have wells start their cultivation right at the beginning of a season using well water and use canal water when it is released for the rest of the crop period. Since the first crop is harvested well before the end of a spell period, a large number of those who are favourably placed (in terms of getting access to canal water) raise second crop using canal water atleast for a part of the season, and resort to well water again till the harvest.

Above all, Coimbatore district has a long history of well irrigation and for a long time area irrigated by surface sources was very limited. Hence at the time of introduction of new canal irrigation projects large number of wells were already found in the proposed ayacuts. This was perhaps an initial conducive factor which enabled farmers to adopt conjunctive irrigation management technique.

(iv) The impact of conjunctive use is clearly seen in terms of wet crop cultivation, higher cropping intensity and productivity. But this again varies across tanks/distributaries and also across segments of a particular ayacut. The study shows that the ayacuts closer to the system/distributary/tank (which are likely to have better access to water) performed better than the tail end ayacuts. However, access to ground water has been the main factor which influences the variation in productivity.

(v) While the development of ground water irrigation in the ayacuts of tanks and canals helps conjunctive use irrigation, it also has some negative effects. For instance, over crowding of wells in the head reach of a system, reduces flow of surface water to the tail ends. This is in particular true of PAP. The development of well irrigation on a massive scale in the tank ayacuts (the case of PAS) poses an altogether different problem. Its direct effects are as follows:

The traditional irrigation institutions which hitherto took care of the maintenance and water distribution network, lost interest, and as a result, tanks have been in disuse in several villages. In our survey of 15 tanks in PAS, in six of them traditional irrigation institutions are defunct in six of them and in fact in one village as reported earlier, sluices have been closed permanently. (see, Janakarajan 1989) In effect, the tank merely serves the purpose of a percolation pond. While it is desirable in principle to use the tank water for recharging purposes into sub-surface, there is another dimension to this problem. Who have taken such a decision of closing the sluices of tank? Although we have not probed into this aspect, there is every reason to believe that the decision would have been taken by the leading land owners who have greater access to ground water and who benefit a great deal by way of getting regular recharge of water into their wells. For them, the well irrigation serves better since it is much more assured and controllable. However, in such tanks, the section that is worst hit is that of resource poor farmers who do not have wells or those whose cultivation is entirely depending upon tank water. Such farmers, ultimately resort to purchase of well water from resource rich farmers who have greater access to land and ground water.[13]

(vi) It is interesting to note that while in PAS command water sales is prevalent and absolutely not in prevalence in PAP command area. This is because the conditions are favourable for water sales in PAS and no so in PAP. In the case of PAS command there is a possibility for regular research from tanks: ground water table relatively is not very deep; and holdings are very much fragmented. Whereas in PAP, holdings are large; incidence of wells is high: ground water table has gone down very deep there is no possibility for regular recharge into the wells except in Zone-I and so most of the wells yield poor water supply which may not be adequte even for self cultivation. Although in

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13. For details on the socio-economic implications of operations of grund water market, see, Janakarajan, S 1986).which results in high cost of water extraction;

Zone-I ground water supply is quite adequate water sales does not take place for the reason that about 80% of the area receives own well irrigation.

(vii) While acknowledging the fact that ground water plays a more crucial role in increasing productivity, it is equally important to recognise the fact that a proper regulation is necessary in its utilisation in order to maintain the ground water balance and to avoid any ecological and environmental consequences. The existing legislative measures (for regulating ground water utilisation) are in the nature of stopping institutional finance to those who dig wells in a prohibited area or to those who do not maintain the minimum spacing imposed by the govt. between the existing well and new well or denying the electricity service connection to those who violate government regulations. However, such restrictions imposed by the government affect only resource poor farmers (who depend upon institutional lending agencies for funds) and the well to do self-financing farmers are in no way affected. Such self-financing farmers can still go ahead in digging a new well and instal diesel engine as a water extracting mechanism instead of electric motor. Moreover, such rich farmers, using their political influence, resort to the backdoor method of obtaining necessary funds and licenses from government agencies, violating thereby all the government regulations. Perhaps, quite contrary to ones expectation, such government regulations may result in the emergence of "new inequality" among well owners (Sha, Tushaar, 1985) For instance, as the existing regulations do not pose any threat on rich self-financing farmers, they dig a new well in a restricted area and since they keep on deepening it, extraction rate in the neighbouring wells gets reduced. Consequently, those who are not relatively rich may face problems of depletion and in the long run, due to competition, many such farmers (who have resource constraint) may have to abandon their wells and may join the camp of 'no well group' (Janakarajan, S 1986). Ultimately, a group of rich farmers will emerge with a monopoly control over ground water resource, who, by way of selling water to resource poor farmers would consolidate their own position. In other words, the point which one would like to emphasis here is that the existing legislative measures do not have any desired effect and its effects would only be adverse.

(viii) Finally, it is important to note that the surface irrigation projects in general are always designed with the basic assumption that the entire command area of a system is one homogeneous unit. But as a matter of fact, it is far from reality: There exists a great deal of variations within command area of a system in so far as agro-climatic and soil moisture conditions, the rate of evapotranspiration, the existing practice of crop pattern, the occurrance of ground water aquifers etc. are concerned[14]. Our own survey in the command area showed wide variations in soil types and soil moisture conditions as well as in the availability of ground water even within the

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14. See also, Alogh (1990)

ayacut of a branch canal and distributary (a segment within the PAP command). As a result of such local variations some part of the' system is over flooded and some other parts suffer from chronic problems of inadequate and irregular supply.

The system managers (the PWD) are much vexed about two problems:[15] One, the designed crop pattern has been grossly violated and two, there has been widespread incidents of tampering of structures for illegal use of water. Part of the reason for violations of rules lies in the design of system itself, where the entire command area has been treated as one homogeneous unit. Given the heterogeneous characteristics of agro-climatic and soil moisture conditions, topography and wide variations in the geological formations and occurrance of ground water aquifers, water requirements are not uniform across all parts of the system. Thus, a more realistic system of water supply should be attempted so that, chronic water scarce areas with very little ground water potential get more supply than the one which has good ground water potential and the segment which is how lying area facing serious drainage problems. This type of heterogeneous water supply system could ultimately prove to be a better water management technique in particular the water scarce states like Tamilnadu. This basically calls for a more

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15. The PAP has been designed for dry irrigated crops in 80% of the command area and for wet crops like paddy in 20% of the command area.

imaginative benchmark studies in a proposed command area. The bench mark surveys conducted at the moment in several surface irrigation systems are grossly inadequate and far from the desired needs for which these surveys are proposed.

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