Water Management and Agrarian transformation in India

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Introduction

It is well known that agriculture is the main source of livelihood in rural India as about 70 percent of the population depends upon it directly or indirectly. It is also widely recognized that water is the basic input sustaining Indian agriculture and hence the lives of millions of human beings in the country.

Irrigation development and water management played a key role in India during the green revolution started in late 1960s and the subsequent decades in ensuring a modicum of food security to the country. It is now acknowledged that the first phase of green revolution has reached a plateau. The need for a 'Second Green Revolution' (SGR) is being advocated by many as a way out of the on-going agrarian crisis, though the term SGR means different things to different people. However, several water-related issues occupy a prominent place in all these prescriptions for a second green revolution.

Much of the literature on agrarian change in India treats the subject of water management not in an independent and detailed manner but as a small part of the broader enquiries into changes in the agrarian structure (see for instance, Deb 2009, Rao and Nair 2003, and Harris-White and Janakarajan 2004). The present paper, however, addresses primarily the water management issues and its linkages to livelihoods of farmers and overall agrarian change. In this paper we attempt to address the major water issues, their implications for agrarian transformation and the outlook for the future in this context. As mentioned earlier (see foot note1) ,the paper is primarily meant to present results of our resurvey with regard to the role

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[1] The study forms part of a large project on Agrarian change and Social mobility in India initiated in 2005-06 which was affiliated to Lund University, Sweden and South Asian Consortium for Interdisciplinary Studies(SaciWATERs),Hyderabad ,India. The project is a sequel to an earlier project viz Production Relations in Indian Agriculture (PRIA*)* undertaken in 1979 /80 by the same authors from Sweden and India and based on this a book was published (Athreya,et al. 1990). A farm and household economic survey was conducted under this project in 1979-80 in six villages of former Tiruchirapalli district of Tamil Nadu. The same households were resurveyed in 2005-06 (twenty-five years later) under the follow up project (known as PRIA II) basically to understand changes in agrarian structure and rural livelihoods in the six villages as well as macro level developments pertaining to the country, the state of Tamil Nadu and the region. This paper is mainly based on the findings of the resurvey and highlights water management issues and agrarian changes and the overall implication for rural livelihoods. The research project has received financial support from the Swedish Research Council, Sida's Research Council for Developing Countries and the Swedish South Asian Studies Network (SASNET).

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of water in agrarian change.[3] In addition, a review of water issues at the national and Tamilnadu state is presented as a backdrop so that the main theme of the paper can be better understood.

The paper is divided into four sections.Section-1 reviews briefly important water management and agriculture issues at the national level. In Section 2, the issues are discussed in the context of Tamil Nadu. In Section 3, we present the results of our resurvey of over 200 households spread over six villages in Tamil Nadu conducted for the reference year 2004-05 by the present authors. Section 4 is about the study of collective action and participatory irrigation management in the region. In the final section, important conclusions of the study and their policy implications are presented.

1. Irrigation and Agriculture development in India- a brief overview

Expansion of irrigation facilities, along with consolidation of the existing systems, had been one of the main planks of the strategy for increasing production of food grains in independent India. The irrigation potential of the country (through major, medium and minor irrigation projects) has increased from 22.6 million hectares (mha) in 1951, when the process of planning began in India, to about 98.84 mha at the end of 2004-05. Though there is an impressive growth in the development of irrigation potential, a significant proportion of potential created has not been brought under actual use for various reasons. A brief review of irrigation development shows that there is significant achievement in overall agricultural development, not only during the Nehru era (first prime minister's period,1950-64) but also in the green revolution decades (1970-90) in the country. However, during the period of economic liberalization, especially since 1995, irrigation and thereby agricultural development have been affected due to a number of factors, including a decline in public investment in irrigation. Overall, the share of public spending on irrigation to total public expenditure has been declining. The share of capital expenditure has especially declined sharply. The current level of public spending in some states like Tamil Nadu is barely sufficient to meet the operation and maintenance (O&M) costs of existing irrigation infrastructure at the required levels.

As mentioned earlier, the decline in public investment in irrigation and other related sectors like agricultural extension has affected agriculture performance in the country . It is noted from many studies that there is a decline in area and growth of yield under many crops, especially food crops, during the post-liberalization period compared to earlier period (see for e.g., Gadgil, and Gadgil 2006, Chandrasekar 2007 and Ramachandran 2011). Even in the earlier period of more impressive performance, irrigation development was uneven across regions and left vast areas with a large water deficit. Thus a major proportion of area under cultivation in India continues to be rain-fed rather than irrigated. Rain-fed areas in India account for sizable number of farming households, substantial acreage and a considerable part of the overall production. Given that yields are generally much higher under irrigated

[3] The words 'Agrarian Transformation/Change' are interchangeably used in a limited context in this paper to mean broadly the changes that occurred in water resources management and agriculture over a period of twenty five years since 1979-80 .

conditions, there is a pressing need for expansion of irrigation.[4] By the same token, there is a strong case for public investment in research and development aimed at enhancing yields under conditions of scarce water availability (Vaidyanathan 2006 and Kerr 1996). This assumes greater importance in the context of the challenges due to climate change especially from frequent droughts.

Overexploitation and decline of groundwater table is an important water management issue in many states. Groundwater also has a bearing on the public health as it is the major source of domestic water supply in India. In some regions of India, the groundwater table is declining at an alarmingly fast rate of one metre a year, threatening the very prospects of future agriculture. A study has noted that the rate of extraction of groundwater is increasing and that it exceeds the rate of recharge in many blocks, leading to lowered water tables (Government of India, 2007). According to the study, twenty-eight per cent of the blocks are now semi-critical, critical and over-exploited in India. There are also other issues like neglect of micro irrigation that offer great potential for water savings, increasing water use efficiency and profitability of farming. The actual use of micro-irrigation technology like drip-irrigation, and sprinkler systems is noted to be very meagre (2-3 percent) of its potential in India. (Narayanamoorthy,2012).

2. Water Issues and Agrarian Change in Tamil Nadu

The state of Tamil Nadu faces certain specific issues as regards water management and agricultural development. Tamil Nadu has already utilized most of its surface water resources as well as a major share of its groundwater potential for development of irrigation. The share of water resources of the state is only 4 per cent of the total availability in the country though the state accounts for about 7 per cent of the population. The per capita water availability in Tamil Nadu is the lowest among the major states in India.

Agriculture in a semi-arid, sub-tropical region like Tamil Nadu in South India is crucially dependent on water. Monsoon rainfall patterns are erratic and concentrated in short periods of the year. Evapo-transpiration rates are high in most of the year, which makes irrigation crucial for extending the agricultural season. Without irrigation, there would hardly be any agriculture in the state, other than the cultivation of rain-fed, low-yielding, short-duration crops like millets.

The agricultural landscape of Tamil Nadu is shaped by three distinct types of irrigation: large-scale river systems, isolated (“non-system”) tanks and interconnected tank systems, and ground water well irrigation. There are several river-based systems, of which the Cauvery is the biggest. This river is fed by rainfall in the Western Ghats in neighbouring Karnataka state. Its irrigation works include a number of dams built both during the colonial period and after Independence. They are the means by which the Cauvery delta became the rice bowl of the State. An agreement on water-sharing was reached between the riparian states of Karnataka and Tamil Nadu in 1924. After the agreement lapsed in 1974, tail-enders in Tamil Nadu have faced a situation of increasingly unreliable access to water, especially in years of a poor south-west monsoon, the main source of water in the catchment area.

[4] See Dhawan and Satyasai 1988 and Rajagopal and Vaidyanathan 2001. It is not surprising that there is a negative relationship between the proportion of area under irrigation and the incidence of rural poverty (. Narayanamoorthy 2001).

Within smaller watersheds in the "dry eco-type", irrigation depends on rainwater reservoirs called *eris* (tanks), often interconnected by means of seasonal canals that lead surplus water from head-end tanks to tail-end ones. The tank system in Tamil Nadu is unique in many respects. In Karnataka, for instance, tanks are mainly rainwater harvesting devices used to recharge groundwater and not to irrigate paddy crops below the tanks, as in Tamil Nadu. The history of tank irrigation is closely connected to the political history of the state, with the names of kings and local notables linked to the building of the tanks. Their entrepreneurship in irrigation, as well as their means of mobilising both free and unfree labour in the building and maintenance of tanks, were immortalised on stone inscriptions in neighbouring temples (Mosse 2003: 3, 5).

Tank irrigation in Tamil Nadu is often complemented by wells sunk on irrigated land below the tanks (in what is known as the *ayacut* or command area). This system of conjunctive use of wells with tanks has a long history. It makes it possible to draw on recharged groundwater for a much longer period than when there is water in the tanks. Since groundwater flows at a much slower pace than surface water and also avoids evaporation, groundwater recharged from tanks can be drawn upon for a longer time. This traditional system of irrigation through tanks did much to compensate for the highly erratic rainfall (Gunnell and Krishnamurthy 2003).

For many years now, inadequate maintenance by the State of both the river and tank irrigation systems has been an acknowledged problem faced by the farmers .Canals are not properly desilted and mud or cement linings often disintegrate, calling for extensive repair. In the tank system, the main problem is accumulation of silt, and poor upkeep of the walls and bunds of the tanks and of irrigation canals that lead from tanks to fields. Another problem is cultivation in the rain catchment area above tanks, which increases the silt amassed in tanks.[5]

Problem of physical infrastructure are compounded by a policy failure relating to the pricing of irrigation water. Irrigation charges, both for canal- and tank-irrigated land, are bundled with land tax, and the revenue earned covers only a fraction of the cost of operation and maintaining the system.[6] Moreover, and equally important, well irrigation is not charged at all.[7]

In the recent period, an overwhelming share of irrigation expansion in the state has come from groundwater sources like open wells, tube wells and bore-wells, developed mainly through private investment coupled with financial assistance from credit agencies like cooperatives and banks. Overall the percentage of net irrigated area to net sown area which

[5]There is also the problem of encroachment of water courses by, especially, the larger landowners, but we are not looking at this issue here.

[6] This in itself is not an insurmountable problem. Since tank and well irrigation have social benefits extending beyond private benefits that accrue to the users, the State can, in principle, cross-subsidise tank and well irrigation maintenance costs from the general budget. The failure of the State to effectively tax the rich, including the rural rich, is a key constraint in this respect.

[7] It may seem odd to complain that well irrigation has not been taxed, since owners have made investments in wells and water-lifting devices. However, to the extent that groundwater can be seen as a common property resource, and well owners have taken subsidised state loans when making well irrigation-related investments, there is a case for ensuring that the external costs of excessive private use of groundwater by a privileged section is appropriately discouraged. The problem of free electricity by the state to all categories of farmers including affluent is also important in this context.

was 41 percent in 1960-61 had increased to 48 per cent in 1980-81 and further to 56 per cent in 2005-06.[8] There has been a drastic change in the relative shares of different sources of irrigation: the area under canal and tank irrigation has declined whereas area under well irrigation has increased sharply. Canal irrigation, which accounted for 34.60 per cent of the total net irrigated area in 1980-81, declined to 27.4 per cent in 2005-06. The decline in tank irrigation is also quite significant, both in absolute area and in its relative share. Tank irrigation accounted for 591,200 ha (22.9 % of total net area irrigated) in 1980-81. This figure declined to 575,000 ha (19.7%) in 2005-06. On the other hand, the area under well irrigation rose from 10,67,000 ha (42.5%) in 1980-81 to 15,36,000 ha (52.6 %) in 2005-06.[9]

Tamil Nadu is rated as one of the most affected regions in India in terms of overexploitation of the groundwater resources. It is reported that out of a total number of 385 blocks in the state, 138 blocks have already over-utilized its groundwater, while 8 suffer from saline water making irrigated agriculture impossible. The problem also assumes added importance as about 80 per cent of this resource has been already utilized in the state. With respect to the groundwater potential available for further use, the remaining blocks are categorized as follows: 97 safe blocks, 105 semi-critical blocks and 37 critical blocks.[10] Recognising the importance of this problem, the government of Tamil Nadu passed an Act (the first of its kind in India) for the regulation of groundwater in the state in 2003 but, for reasons unknown, the Act has not become operational so far.

The net sown area itself is declining in the state: in 1960-61, the net sown area in Tamil Nadu was 59,97,000 ha. This fell to an average of 54,53,000 ha for the triennium ending in 1973. It fell further to an annual average of 50,10,000 ha during the period 2003-06. Similarly the 'total fallows' (defined as land cultivated earlier but not during the last five years) in the state is reported to be quite significant: the triennial average area under 'total fallows' was 24,96,000 ha during 2003-06 out of which the current fallows (defined as not cultivated during the current year but cultivated the previous year) accounted for 8,01,000 ha (32.11 per cent of the total fallows) and other fallows for 16,95,000 ha (67.89 per cent).[11] It would seem that much of these fallows remain uncultivated for want of irrigation, mostly because wells and bore wells, or other sources of irrigation like tanks, have dried up. However, the causal attribution is not clear. Leaving land fallow for longer than normal duration could also be linked to the non-viability of farming on account of adverse price movements, rise in input costs and so on. Agronomists would normally say that it is better to decrease the pressure on this type of marginal land, since it would contribute to less soil erosion. If production levels can be maintained or developed without expansion into marginal lands (as dry lands are), it would normally be considered desirable.

Paddy, jowar, bajra, pulses, sugarcane, banana, groundnut, and cotton are important crops grown in the state. There is a significant change in the area under different crop groups between the two periods of 1979-81 and 2004-06, which roughly coincide with the two survey periods of the study. On the whole, there is a decline in the share of area under food crops from 67 per cent of the gross cropped area (GCA) to 53 per cent between the two

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[8] The years 1980-81 and 2005-06 correspond closely to the years of the two PRIA surveys of 1979-80 and 2005-06 respectively.

[9] Government of Tamil Nadu, *Season and Crop Reports*, various issues

[10] The methodology used here for assessing overexploitation is that of measuring ground water levels at the peak of the dry seasons. This can be criticized: This is rather a measure of withdrawal of water, not necessarily of an indication of overexploitation. A more relevant measure is to see if groundwater is recharged in years with good monsoons. This is not the current practice.

[11] Government of Tamil Nadu, *Season and Crop Reports*, various issues

periods. The decline was contributed by cereals rather than pulses. The area under cereals had diminished from 59 per cent of GCA in the first period to 43 per cent during the second period. However, it should be noted that there is a significant increase (38 per cent) in the yield of food grains, which has partially compensated for the area decrease, thus limiting the decline in food grain production in the state. This has helped moderate the impact of cropping pattern changes on food availability in the state.[12] Overall, the role of agriculture in the growth of the economy of the state has been declining over the last three decades, even while there has been a progressive increase in area under irrigation and a modest rise in land productivity in agriculture. The contribution of agriculture to the state income, which was about 23 per cent in 1980-81, has come down to 13 per cent in 2005-06.[13]

3. Water Management and Agrarian Change in the Resurveyed Villages

In this section, we are dealing with the role of water management in changing agriculture and livelihood over a period of 25 years between two periods of survey (1979-80 to 2005-06). We present the important findings based on analyses of data from the two household surveys. As already mentioned our data is drawn from a 25 year panel study of a sample of 213 agrarian households in six villages in the present Karur and Tiruchirapalli districts of Tamilnadu (see the Maps 1and 2), representing two eco types i.e. 'dry' rainfed tracts and the 'wet 'irrigated areas which are typical of not only of Tamil Nadu but much of South and Central India.[14] In the wet canal-irrigated area, Brahmins used to own the lands farmed by Dalit tenants. Over the period , most of the lands have been taken over by the intermediate Muthuraja Caste and Schedule Castes (who call themselves Dalits today). Caste discrimination has dwindled along with this development. The dry villages rely on tanks and wells for irrigation, but have a large proportion of lands under rain-fed cultivation. In these villages members of the intermediate Castes of Udaiyar, Gounder and Muthuraja still own almost all land, which they farm with the help of Dalit servants. Here discrimination of Dalits is still practiced in several ways.

Irrigation and agriculture

The most important change over the period has been the decrease in Net Sown Area (NSA), with NSA falling from 4421 acres in 1979-80 to 2468 acres in 2004-05 in the wet area, and from 6988 acres to 3204 acres in the dry area in the same period. The most important explanation for this is that there has been a dwindling of the canal water supply in the wet area due to the water dispute with nearby Karnataka state. Farmers could not simply cultivate the same area with the more limited supply of water. In the dry area, the main explanation is on the one hand the more limited groundwater supply due to continuous drought in the period 2002-2005 and on the other hand the increasing concentration on the cultivation of irrigated land leaving more of the rainfed agricultural lands fallow. This is an important background for the changes in irrigation that we have recorded.

[12] See for e.g., Government of India 2005 for more discussion on similar findings on area, production and productivity.

[13] *Tamil Nadu: An Economic Appraisal*, various issues. The decline in the share of agriculture and allied activities in the net state domestic product of the state is not necessarily a matter of concern, and is in fact to be expected when an economy modernizes. However, what is of concern is if this decline is not accompanied by a corresponding decline in the share of the working population dependent on agriculture.

[14] Nangavaram, Poyyamani and Rajendram are sample villages selected under wet eco type which are located in Kulithaleli taluk and Naganur, Kalladai and K. Periapatti are villages selected for the study under dry eco-type located in Manaparei taluk of former Tiruchirappali district in Tamilnadu ,India (See Maps 1 and 2)

About 95 per cent of operated holdings were irrigated in the 'wet' villages of Nangavaram, Poyyamani and Rajendram in 2004-05.About 55 per cent of area operated was irrigated in the dry villages of Naganur, Kalladai and K.Periapatti. The share of area under irrigation in total operated area had decreased slightly i.e., by 2 percentage points, in the wet villages. It had increased by about 10 percentage points in the dry villages over the period between the two surveys (Table 1). The main sources of irrigation were canals in the wet villages and wells in the dry villages during the 1979-80 survey. The same position continued during the resurvey also; however, the relative share of tanks and wells had changed in the dry areas.

Table 1 Percentage of Net Irrigated area to Total Operated Area

Ecotype	**1979-80**	**2004-05**	**Change in percentage points**
Wet	96.5	95.0	-1.5
Dry	44.9	54.7	9.8

Note: No. of cases are 165 in 1979-80 and 147 in 2004.

We have noted earlier that the share of area under irrigation had increased in the dry villages. It is seen that and most of the increase came from wells; i.e., of the total irrigated area, the share of area under well irrigation had increased from 81 per cent to 95 per cent.(Table 2). Accordingly, the share under tank irrigation had come down considerably by 14 percentage points when we consider Nanjai (tank irrigated) and Nanjai using conjunctive wells . This indicates the decline of tank irrigation in the study area, as seen in south Indian states (Vaidyanathan1999)

Table 2 Percentage shares of different sources of Irrigation

Ecotype	1979-80		2004-05	
	Nanjai*****	Thottam (well irrigated)**	Nanjai*****	Thottam(well irrigated)**
Wet	96.0	4.0	95.0	5.0
Dry	19.0	81.0	5.1	94.9

Note: No. of cases is 165 in 1979 and 147 in 2004-05
***** Nanjai – canal irrigated area in wet villages and tank irrigated in dry villages. In dry villages, nanjai includes tank-irrigated lands supplemented by wells.
** Thottam – well irrigated area.

Increased role of well irrigation

Wells remain the predominant source of irrigation in the dry ecotype. In the wet area, the wells earlier served mainly as a supplementary source, canal water being the main source of irrigation. Table 3 shows that the number of wells had more than tripled in the wet villages, whereas it had just about doubled in the dry villages. This underlines the importance of the emergence of wells as a conjunctive source of irrigation in the wet villages in the context of increasing unreliability of canal water from river Cauvery due to the dispute over sharing of water between Karnataka and Tamil Nadu. The same is also true when we consider the density of wells, which has risen from 0.03 wells/acre in 1979-80 to 0.20 wells per acre in 2004-05 in the wet eco-type.

While the rate of expansion of well irrigation both in terms of increase in well density and number of wells is much higher in the case of the wet ecotype villages, the dry ecotype has a much higher well density as well as a much higher number of wells than the wet in both periods.

In the current period, a market for groundwater has emerged. Interestingly, the incidence of water purchase was significantly higher in the wet villages than in the dry. About one-fourth of the farmers in the wet villages purchased water (for supplementing the canal water), whereas the corresponding figure was only 11 per cent in the dry villages. The overall effect of the intensive use of wells was the lowering of the groundwater table (at the end of the irrigation season and compared to the situation twenty-five years earlier), mainly in the dry area with ground water as the main source of irrigation. The average depth of wells has increased from 35 feet to 45 feet in the dry villages between the two surveys. Many detailed case studies on this also confirmed the problem. In fact, in some villages, the competitive deepening of wells has led to some wells drying up and being abandoned, especially by small farmers who could not afford to invest in further deepening. We found that resource-rich farmers could rob their neighbours of most of their well water through their financial capacity to deepen wells and buy powerful pumps. Thus, the phenomenon of increased exploitation of groundwater, observed in many parts of the state,[15] indirectly affecting the resource base of the poor, seems to have emerged in our study area as well.

Table 3 Total Number of Wells in Use and Well Density 1979 and 2004-05 under Wet and Dry Eco-types (Estimated Number of Wells)

Ecotype	**1979-80**		**2004-05**		**Percentage change (%)**
	No. of wells	Wells/Acre	No. of wells	Wells/Acre	Wells/Acre
Wet	146	0.03	467	0.20	219.8
Dry	750	0.10	1477	0.50	96.9
Total	896	NA	2045	NA	128.2

Note: No of cases 46 during 1979 and 72 in 2005

[15] See Janakarajan and Moench 2006.

Area under well irrigation and mode of lifting of water

There was a clear shift in the mode of lifting of water under well irrigation between 1979-80 and 2004-05(Table 4). In the wet area, the main source of energy for lifting well water was electricity in 1979 and it shifted to diesel in 2004-05. As Cauvery water became unreliable,[16] many farmers have gone for wells as a source of conjunctive use. However, due to problems in getting electricity connections for their pumpsets, they used mostly diesel for their pumps, though the cost was higher. However, it is seen that the benefit of well irrigation in supplementing the unreliable canal water during critical times of crop growth was quite high in the wet area and hence farmers preferred to go in for diesel pumps even at high cost.

In the dry villages, a vast majority of the area was irrigated by electric pumpsets in 2004-05, which had entirely replaced the *'Kavalai'* (Mhote) that was the main method of well irrigation in the earlier period. This was possible due to early obtaining of an electricity service connection and institutional credit provision for investment in wells and pumpsets.

It is also to be noted that overall there is a considerable decrease in the area irrigated by wells in both eco-types. The large decline in area irrigated in both ecotypes may reflect an emerging water crisis, while the elimination of *kavalai* and the relative dominance of electric pumpsets in the dry ecotype may imply a considerable increase in the average efficiency of irrigation.

Table 4 Area under Different Modes of Lift under Wells – Estimated (Acres)

Ecotype	**1979-80**				**2004-05**		
	Electric	Diesel	Kavalai	Total	Electric	Diesel	Total
Wet	434 (49)	288 (33)	158 (18)	880 (100)	93 (38.0)	152 (62.0)	245 (100)
Dry	3242 (50.4)	Nil	3163 (49.6)	6436 (100)	2538 (93.7)	171 (6.3)	2709 (100)
Total	3676	288	3321	7316	2631	323	2954

Note: No. of cases 46 and 72 in 1979 and 2005 respectively.

[16] A study by Tamil Nadu Agricultural University (Ramasamy 2004) has shown reduction in water supply to the state in about half of the years after 1974, when Cauvery water agreement among the riparian states ended. The problem intensified, especially since the middle of the 1980s, which is reported to have affected agriculture in the state in many years.

Cropping Intensity

The cropping intensity refers to the number of times a plot of land is used for cultivation in an agricultural year. It is usually measured as the ratio between gross cultivated area (GCA) and net sown area (NSA). This is useful for understanding the spatial organization of agriculture[17] in a region. Contrary to the trend of decreasing cropping intensity in Tamil Nadu as whole, the cropping intensity (GCA/NSA) has increased in both wet and dry eco-types studied by us between the two points of time (Table 5). The background is, as pointed out above, that the net area sown (NSA) was considerably less in both areas in 2004-05 due to problems with water supply. The extent of increase in cropping intensity (CI) was higher in the wet villages than in the dry villages due to the concentration of cultivation to well endowed areas and a substantial increase in well irrigation as a conjunctive source of water supply. The same factor was also at work in the dry area though to a lesser extent.

Table 5 Changes in Cropping Intensity between 1979-80 and 2004-05

Ecotype	1979-80			2004-05		
	Net Sown area[18] (acres)	Gross Cultivated Area (acres)	Per cent	Net Sown area (acres)	Gross Cultivated Area (acres)	Per cent
Wet	4420.5	5877.8	1.33	2468.1	4233.4	1.73
Dry	6987.9	6099	0.87	3204.2	3451.4	1.08

No. of cases in 2005 is 147

Cropping Pattern

In the wet region**,** though there was no major shift in the cropping pattern, the relative shares of major crops (like paddy, banana and sugarcane) to the total cropped area had changed (Table 6). There was a significant reduction in the share of sugarcane in the total area cultivated to the extent of about 10 percentage points. The share of total cultivated area under banana and paddy had on the other hand increased. Overall, the share of banana went up by 8.4 percentage points and that of paddy by 5.1 percentage points. Another important change was the increase in the area under 'irrigated millets' in wet area, as a method of adaption to water scarcity in the area as the water requirement of millets is very less compared to paddy and banana. In the dry area, there was a significant change in the cropping pattern. The share of total cultivated area under paddy, sugarcane and banana taken together had increased from one-fifth in 1979-80 to about 36 % in 2004-05.While the total area cultivated cannot be compared between 1979-80 and 2004-05, it is clear that there is a decisive shift to irrigated crops in the dry villages over this period, reflected in both the increased share of paddy, sugarcane and that of irrigated millets.

Table 6 Changes in Cropping Pattern by Ecotype between 1979-80 and 2004-05

(area in acres)

[17] For more details, see Dayal 1978.
[18] Net Sown Area refers to area operated by the HH

Crop	1979-80		2004-05		
Eco-Type					
Wet Villages	Area	Percent	Crop	Area	Percent
Paddy	1957.8	33.30	Paddy	1628.7	38.4
Banana	2291.3	38.9	Banana	2004.3	47.3
Sugarcane	1071.1	18.20	Sugarcane	382.1	9.0
Cholam	108.2	1.80	Millet Irri.	172.7	4.1
Cumbu- Millet unirr.	63.1	1.10	Millet unirr.	15.7	0.4
Others	376.3	6.40	Others	30.01	0.7
Dry Villages					
Paddy	1205.9	19.8	Paddy	1127.6	32.7
Banana	10.4	0.17	Banana	-	-
Sugarcane	-	-	Sugarcane	103.7	3.01
Cholam	1603.8	26.3	Millet Irri.	413.13	11.90
Cumbu	886.2	14.5	Millet unirr.	1202.59	34.80
Groundnut	516.2	8.5	Irri. Groundnut	36.3	1.10
			Sunflower	219.64	6.40
			Vegetables	141.20	4.10
Others	664.8	10.9	Others	139.7	4.00

Yield of major Crops

Paddy, which was the main crop in both the eco-types, registered a yield growth of about one per cent per annum between 1979 and 2004. The rate of growth of paddy yield was marginally higher in the dry villages than the wet (Table 7). In the dry areas, apart from paddy, millets and groundnut were the other important crops. Yields of these crops increased significantly over the same period. The yields of sugarcane and banana, which accounted for more than half of the area and which were the important crops in the wet areas, however, did not show an increase, with yields stable or lower than earlier.

The relatively slow growth of yields in the wet villages may partly be on account of the problem of water insecurity due to the dispute between Tamil Nadu and Karnataka over the sharing of Cauvery water resulting in a decline in water from the river for the delta. Another important reason related to this was the 'tail enders' problems in receiving irrigation water, especially during low supply seasons. This was reported during our field survey and attributed mainly due to inadequate maintenance of canals and improper system of water allocation/distribution during scarcity times. Hence, farmers had undertaken some collective actions to find solutions to the problems, especially in the tail reaches.

Table 7 Growth in the Yields of Major Crops in 1979-80 and 2004-05

Crop	**WET**			**DRY**		
	1979	**2004**	**Rate of growth (Annual)**	**1979**	**2004**	**Rate of growth (Annual)**

Paddy (Kg per acre)	1065	1401	0.78	907	1074	0.85
Sugarcane(tonnes per acre)	45	41	-0.09	-	50	Not applicable
Banana (Rastali, number of bunches per acre)	710	733	0.08	-	-	-
Cholam-Kg per acre (Millet Irrigated)	-	85	NA	578	1940	2.54
Cholam-Kg (Millet Unirri)	-	90	NA	152	238	
Groundnut (kg)	-	-	NA	310	709	1.15
Chillies (kg)	-	-	NA	436	350	-0.12

No. of cases for Paddy is 80 in 2005 and 137 during 1979.
NA – Not Applicable

Comparison of productivity of lands under two eco-types

Productivity is considered here in terms of gross value of output (GVO) per acre.[19]The yields of crops as discussed above have differences in values depending upon the net value of the crop output which is a function of prices and quantity of output. Thus, it is difficult to make comparisons across crops and between two ecotypes based on yields alone. Hence, in order to make comparisons of performance of crop production under two ecotypes, we have worked out the gross value of output (GVO) per unit of cultivated land (see foot note no.19). It can be noted from Table 8 that the productivity (GVO/acre) of irrigated lands which constitutes 95% in wet areas had been almost stagnant, whereas the value productivity of irrigated crops had more than doubled in dry ecotype. As a result, the differentials in value productivity of irrigated lands between dry and wet eco-types had narrowed down .That is the ratio of irrigated value productivity between wet and dry eco types which was 6.05 in 1979 has come down to 2.3 in 2004. However, as regards productivity of un-irrigated lands, the differential /ratio between two eco types had increased from 1.56 to 1.91 between two surveys.

It is to be also noted that the value productivity of un-irrigated crops had declined in both the wet and the dry eco-types. The decline is more in the dry villages than in the wet. The decline in income from the un-irrigated crops had an important implication for the livelihoods of farmers, especially the poor in the dry areas, as quite a significant proportion (about 45 %) of area was under un-irrigated crops. This might have been due to many reasons like less attention to dry land cultivation, less soil moisture due to inadequate soil conservation

[19] The GVO/acre is calculated based on the total value production of individual crops (production x prices) per unit area

etc.[20]There is an urgent need for implementation of soil conservation and watershed programmes in dry areas on a large scale for improving the productivity of dry crops. A programme on watershed management has begun in some villages under dry ecotype; however, the impact of such a measure seems to be minimal.

Table 8 Ratio of Irrigated and Un-irrigated Value Productivity (Gross Value of Output in Rupees per Acre) in 1979-80 and 2004-05.

Ecotype	Survey year 2004-05			Survey year 1979-80		
	Irrigated	Un-irrigated	Ratio	Irrigated	Un-irrigated	Ratio
Wet	25966	2486	9.16	25713	2830	9.1
Dry	11224	1296	8.70	4254	1817	2.3
Ratio between wet and dry eco-types	2.3	1.91	-	6.05	1.56	-

No of cases 151 in 1979 and 132 in 2004

Role of irrigation in household incomes across different sizes of holdings

Table 9 shows that a major share of agricultural income of farm households (HHs) (across all categories) in the wet villages had been contributed by irrigation and there was not much difference between the two points of time in this. However, in the case of dry ecotype, the share of income contribution by irrigation had increased substantially (from about 50 per cent to about 90 per cent) across all categories of farmers between the two surveys. The share of increase in income contribution by irrigation had been higher in the case of small and medium HHs than in the case of large. But the share of contribution of unirrigated crops had fallen quite significantly. Thus, it is evident that most of the farm households (especially, small and medium farmers) depended upon irrigation water for their agriculture income.

In this context, it should be noted that the share of agriculture (crop) income to total income was much higher in the case of the wet areas than the dry area during both the survey periods (Table 10). Hence, the unreliability in the availability of Cauvery water, on which major share of income of households depended upon in the wet areas, would have affected their livelihoods, especially of the small and medium farmers. Whereas, in the dry areas, the farm households did not depend so much upon agriculture as their occupations were diversified.

[20] Differences in value productivity reflect both price and quantity differences. If dry land under cultivation in both ecotypes is now devoted to low value crops more than in 1979, that would explain a part of the differential..

Overall, the share of farm income in total income had been reduced in both ecotypes. Thus, the farmers in the dry ecotype did not face uncertainty as their income mostly came from non-farm sources and within agriculture they had diversified the crop pattern, reducing the risks.

Table 9 Percentage of Income Contribution by Irrigated Lands to Total Agricultural Income of Households in 1979-80 and 2004-05, by Ecotype

(Percent)

Ecotype	**1979-80**				
	Category of land	**Small**	**Medium**	**Large**	**Total**
Wet	Irrigated	88.99	100.00	82.75	92.10
	Un-irrigated	11.0	0	17.25	8.0
Dry	Irrigated	49.59	50.00	51.37	50.0
	Unirrigated	50.10	50.0	48.63	50.0
2004-05					
Wet	Irrigated	99.8	100	100	99.94
	Unirrigated	0.1	0	0	0.06
Dry	Irrigated	91.1	90.1	89.1	90.5
	Unirrigated	8.9	9.9	10.9	9.5
	Normal Year				
Wet	Irrigated	100	100	100	100
	Unirrigated				
Dry	Irrigated	89.27	95	83.3	90
	Unirrigated	10.73	5	16.7	10

Note: No of cases in 1979 were 152 and 105 in 2004
Small Farmer HH – 2.5 acres of wet land or 5 acres of dry land
Medium Farmer HH – 5 acres of wet land or 10 acres of dry land
Large Farmers HH – Above 5 acres of wet land or above 10 acres of dry land

Table 10 Share of Agriculture income to Total Household Income – Changes between Two Survey Periods

Ecotype	1979-80 (Average)			2004-05 (Average)		
	Agriculture income (Rs)	Total income (Rs)	%	Agriculture income (Rs)	Total income (Rs)	%
Wet	20891	26776	78.0	27675	45404	60.9
Dry	7118	16135	44.1	14597	47834	30.5
Total	14741	22967	64.2	20991	46378	45.3

Note: No of cases in 1979 were 152 and 105 in 2005.

4. Collective Action and Participatory Irrigation Management [21]

Lack of maintenance of irrigation systems and poor water supply to farmers are key factors that affect water management. Recognising this to be a problem, governments – both Central and State – have sought to "decentralise" water management by handing over the responsibility to the so-called "water users' associations" (WUAs), which consist of farmers. Such responsibility, in some instances, includes the construction and maintenance of local irrigation works, and regulation of water use at the local level.

The fiscal constraints that State governments in India face, given their limited powers to raise resources and their disinclination to do so from the rich, have led them to seek the solution to the problem of water management in what is called participatory irrigation management (PIM) or irrigation management transfer (IMT). This idea is strongly supported by international funding agencies such as the World Bank and the Asian Development Bank (Pant 2008).

In Tamil Nadu the implementation of participatory irrigation management is weak compared, for example, to Maharashtra. In 2000, the State Legislative Assembly in Tamil Nadu passed an Act with the stated objective of involving farmers in the management of irrigation systems. This Act, known as the "Tamil Nadu Farmers' Management of Irrigation Systems Act, 2000," has not been effectively used in empowering farmers' organisations (Rajagopal, Doraiswamy et al 2002).

During our fieldwork in 2005-06 in the Cauvery delta, we interviewed a number of representatives of irrigation associations and watershed committees. These interviews showed that the government had taken steps to involve farmers in water management through the Command Area Development Programme (CADP) and the Watershed Development Programme (WDP). The CADP, though mostly financed by the Central government, relied

[21] This section is an edited version of Lindberg, Staffan, A. Rajagopal, Göran Djurfeldt, Venkatesh B. Athreya, and R. Vidyasagar (2011) 'Designing Collective Action - Problems of Local Water Management in Tiruchi District.' *Review of Agrarian Studies*, 1 (2).

on 10 per cent self-financing by participating farmers. However, while CADP and WDP were thus put into effect, the Tamil Nadu Farmers' Management of Irrigation Systems Act was not extended to the Cauvery delta area because of the water dispute with the co-riparian state of Karnataka.

Water users' associations are an example of voluntary organisations acting as instruments of public policy. In the case of Tamil Nadu, they are linked to the tradition of *kudimaramat* (or community labour for the maintenance of irrigation), which existed during the pre-colonial, colonial and post-colonial periods, and which catered to minor repair work in tank systems and in branch canals of larger canal systems.[22] Water users'associations thus present a rich field of study for political science and other social sciences, and includes issues of democratic functioning, and power relations within and outside the associations.

The central thesis here is that participatory irrigation management is severely hampered by policies in irrigation such as the unregulated use of bore wells with free electricity provided by the State, which benefit mostly the rich farmers.[23] New technologies in irrigation have weakened the incentives, especially for well-to-do farmers, to seek a collective solution to the problem of adequate water for irrigation.

Changes in the irrigation system and the status of collective action

As discussed earlier ,our study of the development of the agrarian economy in the fieldwork area as observed at two points in time, 1979-80 and 2004-05 , revealed that one of the most dramatic changes was the dwindling water supply in the Cauvery river system, as a result of the water dispute with Karnataka. This meant that less land was cultivated in the wet areas over the past five to ten years than earlier. However, farmers had also adapted to scarcity by digging wells to supplement canal irrigation, especially in the second paddy season (from December–January to March–April). The number of wells in the three wet villages had tripled, from 146 in 1979-1980 to 467 in 2004-05.

The water of the Cauvery can be thought of as being one part over the ground and one part underground. Farmers tapped into the latter to protect themselves against the decreasing dependability of canal water. They did complain about the higher costs of using diesel pumps because authorities did not grant them electricity connections. Still, the farmers considered this practice economically viable, especially those who cultivated banana, as it is a capital-intensive cash crop with high rates of return. Farmers did not want to lose income by not paying for one or two spells of irrigation from wells, which could save the crop. We also found a market for water in the area, which allowed access to groundwater by those who did not have tube wells on payment to those who had appropriated the common pool groundwater.

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[22] "Known as *kudimaramat* in the south, it was a widely prevalent practice all over India. Wherever a repair work needed to be attended to, such as cleaning of the supply channel, each family was required to send an able-bodied person to contribute labour for the work. If it was not in a position to do so, it had to send a hired substitute or contribute the money required for it" (Shankari and Shah 1993: 28).

[23] It is another matter that "free electricity" is often something of a misnomer and can be a misleading term in a context characterised by frequent outages and scarce and unreliable supply. These realities often drive farmers to invest in alternative sources of energy, such as diesel-powered pumps. In the context of the agrarian crisis, a one-sided emphasis on the fiscal consequences of 'free electricity' to agriculture would be somewhat misplaced. However, that is not the issue with which we are dealing here.

From a water economy point of view, the aggregate results of these adaptations make a great deal of sense, since farmers moved from an inefficient way of transporting water, i.e. in canals with high rates of evaporation and seepage, to a more efficient way, i.e., to underground transportation where water losses, at least from evaporation, were much lower, and where fluctuations in water yield between years were smoothened. However, the losers were those further downstream, since tapping of water, irrespective of whether it was overground or underground, decreased water availability downstream.

In the dry areas, the number of wells had doubled, from 750 in 1979 to 1,477 in 2004. Though there was also a reduction in the gross cropped area due to three years of drought, the share of net area irrigated to total cultivated area increased from 45 to 55 per cent, and irrigated crops had become more important than rainfed crops. If, in 1979, the income from irrigated crops made up 50 per cent of farm income, in 2004 this proportion was 90 per cent.

Thus, conjunctive use of well water may explain much of our first-hand impression when we returned to the delta and its surroundings in 2005, which was that, agriculturally and landscape-wise not much had changed since 1979, except for the substantial increase in irrigated area in the dry villages.

When we arrived in the field in 2005, we found that farmers in the dry areas were rather desperate since it had not rained much in the last three years. We could see that there had been a sharp reduction in tank irrigation and a corresponding increase in well irrigation. The area irrigated by tank water had further dwindled, from 19 per cent of total irrigated area in 1979-80 to a mere 5 per cent in 2004-5, which pointed towards neglect of tank systems.

Tank irrigation crisis

The crisis in tank irrigation was illustrated during our 2005 visit to the medium-sized tank in Kalladai, one of the dry villages. This tank was part of a series of interconnected tanks. The canal connecting it to the upstream tanks was heavily silted and had not been cleaned for years. "In this village, we cannot agree on such matters," someone said. "We agree only when it comes to arranging the yearly festival of the mother goddess!"

The tank itself was also severely silted. As we were standing on the embankment, a person went into the water and said: "In earlier times, I couldn't reach the bottom of the tank here. Now the water is only up to my navel!" The storage capacity of the tank had come down drastically. A graphic illustration, one may think, of the poor cooperative spirit in the village. That, however, could be too rash a conclusion.

Turning around, we looked out over the command area with its intensely green paddy plants and counted the number of wells densely dotting the lush fields. There were a large number of whitewashed pump houses to be seen. Once again, we encountered an instance of individual adaptation to tank siltation. To insure themselves against low water levels in the tank, farmers, with own or borrowed resources, had sunk wells – and they used the water not merely as a conjunctive source of irrigation but as a stand-by system. They thus drew on the underground water recharged from the tank.

It required little reflection to realise why farmers who had their own wells lost much of their interest in maintaining the tank. Their water problems were already taken care of. Thus it was not entirely surprising that the farmers were more interested in organizing the temple festival than in arranging for desiltation of the tank, especially since desiltation, in their view, was the responsibility of the government.

David Mosse's book on the tank irrigation system contains an interesting comparison of two types of villages in the old Ramnad district of Tamil Nadu: one where the tanks have gone into disrepair, and the other in which old forms of communal maintenance systems survive. This, again, has to do with soil types, with one type of soil facilitating the individual adaptation exemplified by Kalladai, and the other type making it more important to maintain the tanks (Mosse 2003). This is also the gist of the argument in the well-known study of collective action in south India written by Robert Wade, where he argues that "corporate organisation is found only in villages where common situations have become common dilemmas" (Wade 1988, p. 184).

From an ecologically conservative point of view, there are grounds to rue this transformation. A historically unique landscape is getting lost, and with every year of siltation, the costs of recovering old systems, which are already phenomenal, are increasing. From a water economy point of view, however, evaluation of this transformation is less clear-cut. One might say that we are moving away from a wasteful way of keeping and using water, which involves huge water losses, to a much more efficient way of storing it underground and drawing it when it is needed. But the distributional consequences may not be benign for farmers who lack the resources to invest in wells and to tackle the challenge of competitive deepening of wells.

Not only landscapes, but also flora and fauna, are changing as a result of such transformation. Tragically, nobody seems to be keeping track of the real changes and thus it is impossible to evaluate the end results. Whatever these may be, the development seems irreversible: tanks are an endangered species!

Participatory irrigation management in action

In the three canal-irrigated villages in our study, we found two functioning associations.[24] One of them (example A) had 30 members in 2005, most of them tail-enders (that is, with land far away from the main canal branch). They had contributed Rs 25,000 and had received a government grant of Rs 200,000. The entire amount was deposited in a local bank and the annual interest was used for maintenance of the canals. They also paid a service fee of Rs 15 per acre once every three months, and had to contribute more cash and labour depending on the nature of the repair work required. However, this arrangement met with limited success. There were about 300 farmers with land under this branch canal system. The reasons for not all of them enlisting for collective action, as stated by our respondents, were as follows: the head-reachers (those having land close to the main canal) did not show much interest in the association since they were getting water anyway; many farmers insisted that the association take up the maintenance of the field *bothies* (channels), which in fact was the responsibility of the farmers themselves; and, as a result, there were problems in collecting service fees on a regular basis from all of them.

We studied another association (example B), which covered three branch canals with an command area of about 2,500 acres of land distributed among 300 farmers. Sixty five of these farmers, again mostly tail-enders, had formed an association in 1999 and jointly contributed Rs 45,000. The government grant was Rs 450,000, so that the association had a

[24] As mentioned already, the scheme came under the ambit of the Command Area Development Programme (CADP) overseen by the Agricultural Engineering Department.

total of almost Rs 500,000 in a local bank. The annual membership fee was Rs 5. The association used the interest of Rs 45,000 received every year from the capital deposited in the bank to desilt the canals. The farmers themselves were not involved in the desilting, as this work was given to a contractor on tender. In terms of the structure of the association, we found that one very big landlord, who was also the president of the association, had contributed 90 per cent of the membership amount. He had done this primarily to avail of the liberal grant from the government for desilting the canal, a large part of whose command area was held by him. Farmers complained that the association was run by a handful of members and that there were no regular general body meetings. There were also complaints about the efficiency of the desilting work being carried out.[25]

In the third village we studied, no farmers' association for irrigation purposes existed in 2005. A reason for this given by the farmers was that the head-reachers were not interested in such a body, especially not at a time when there was hardly any water in the Cauvery river. Another reason stated was that many of them were tenants and did not want to involve themselves in an association. However, farmers, especially in tail-end areas, had voluntarily organised repair work on the irrigation system by collecting money and asking other farmers to contribute labour. Such efforts were generally led by rich farmers who had a strong interest in ensuring maintenance of the irrigation system as they controlled a substantial part of the irrigated land, and also had the necessary resources and influence to carry out the work.

In a nearby town, the headquarters of our fieldwork area, we found a very ambitious attempt being made to form a branch canal association of 500 farmers served by nine branch canals (example C). By July 2005, the leader of this initiative (from a Brahmin landlord family) had managed to enrol 96 farmers with a total deposit of Rs 22,000. However, since the government engineers required a larger enrolment and a deposit of Rs 51,000 before they would release the grant of Rs 450,000, the association existed only on paper and could not carry out any repair work at the time of our study.

We do not know what happened to this particular organisation, but looking at all these attempts at participatory irrigation management in the canal-irrigated villages, one is bound to conclude that they yielded hardly any fruit despite the CADA programme having been functional in the area for a long time. Overall, it appears that the irrigation management organisations were led by big farmers with high stakes in canal maintenance. However, it was observed that small farmers also benefited in the process although they apparently did not take much interest in the work.[26] Presumably, they benefited to a much smaller extent in absolute terms. Their relative lack of interest could also be a reflection of their limited local influence.

It should be noted that as our study area in the Cauvery delta was not covered by the Participatory Irrigation Management Act. Official patronage and recognition in terms of financial and administrative support through World Bank funding, given to similar projects in other parts of Tamil Nadu, was lacking here. This may have been one reason for the less active participatory irrigation management efforts in these wet villages.

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[25] It is interesting to note that already, in 1979–80, an association of tail-enders existed in this area, described in our first book about the Cauvery delta (Athreya *et al.* 1990: 62–63).

[26] This phenomenon of greater interest and efforts in water management among big farmers has been noted in many other studies, see Vaidyanathan 1999, Rajagopal 1991.

Tanks and watershed development

Other than for large irrigation tanks, which were managed by the Public Works Department, the management of irrigation tanks in the dry villages was organised mainly by the leading farming households around a particular tank via traditional caste or village panchayats. As such, this may be seen as a survival of the so-called *kudimaramat* system in south India, which catered to minor repair works in tank systems.

There is evidence to show that the *kudimaramat* system, which was prevalent in the pre-British *zamindari* period, had fallen into disuse during the British period due to the introduction of the ryotwari system. The British tried to reintroduce the *kudimaramat* system in order to protect land revenues, but with little success. As a result, irrigation suffered.[27] According to Mosse (1999, based on a number of authoritative sources) the "re-introduced" *kudimaramat* system propagated local community management of natural resources in a manner that did not exist prior to colonial rule. Severed from their larger political and cultural basis in society for construction and maintenance, these irrigation systems were "decapitated." This, according to Mosse, was the main reason for the gradual decline of tank irrigation systems in the late nineteenth and twentieth centuries.

Rainfed tanks whose command area was less than 100 acres were under the management of local bodies, viz. panchayats. As these local bodies did not have adequate funds, this function was generally neglected and the maintenance of tanks was left to the care of the local farmers. In one of the local tank systems in the study area, a farmers' irrigation society had evolved with more than 300 members, who took care of desilting and bunding its large irrigation tank. It appeared to have been well organised, with an office of its own, a permanent staff of three workers (watermen), and regular membership contributions. There was also a strong connection to a local unit of the Tamil Nadu Farmers Association, whose activities had peaked around the 1980s with an agitation for low electricity tariffs. However, by 2005, because of recurrent monsoon failure and drought for three years, the activities of the society had come to a stop.

Efforts to organise more active watershed development committees were initiated around 2000. Watershed committees formed with the involvement of the village panchayat boards enlisted farmers around rainwater catchment systems. The farmers were asked to pay a membership fee, for example, of Rs 10 per acre, and the remaining funds were provided by the government along the same lines as for the branch canal associations in the wet villages.

The main purpose behind the formation of the watershed development committees in the dry villages was to improve the recharging of groundwater in the catchment area, and of existing ponds and irrigation tanks. A number of works were undertaken or planned to achieve this end, including desilting of tanks and ponds; construction of check dams and weirs across drains; construction of farm ponds; contour bunding; summer ploughing; provision of common threshing fields; and distribution of saplings. In all these efforts, NGO facilitators were often actively involved, working alongside the committees and engineers from government departments.

As with the branch canal associations, there were problems in getting farmers to participate in this voluntary scheme. Not unexpectedly, head-reachers near the tank showed less interest in watershed development than tail-enders. Various sources suggested that some of the work undertaken by the committees, like check dams, soil water conservation through contour

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[27] See the Report of the Committee of Kudimaramat, quoted in Rajagopal 1991).

bunding, and summer ploughing, were beneficial. Some government agricultural engineers informed us that one of the local committees had received a prize from the Government of India for their work.

However, we were not too impressed with some of the works that had been functional for the past three to four years; we found badly engineered schemes designed for water flowing in all directions except downhill![28] Mostly non-functional or dysfunctional, these schemes were not likely to be maintained. In the meantime, they disfigured the landscape and could very well increase erosion and decrease groundwater recharge. The system designs were thus poorly tailored to the task of developing irrigation systems that would be sustainable in the long run.

Conditions for success of collective action

Niranjan Pant (2008), in a broad and interesting overview of participatory irrigation management in India, discusses the conditions for the success of participatory canal irrigation management as well as the major impediments thereto. Interestingly, he points out that "the most important factor identified in making farmers come together and work for the common good was the critical necessity of canal water for the survival of crops grown and even the farmers' own survival" (Pant 2008: 31). He also points out that this motivation is strongest among the tail-enders of a collective irrigation system. But he does not really discuss this in detail in his article.[29]

Organisation

Pant emphasises organisational factors in this type of natural resource management. Of these, he finds that administrative commitment on the part of the government officers involved is crucial for the establishment and functioning of a water users' association (WUA). Often, the key persons, that is, the executive engineers, for various reasons, are not at all committed to their work. The rules of the organisation for registration of members, measurement of water utilisation, and accountancy must also be clear. Further, there must be the right type of incentives to motivate farmers to join the association, like grants for the management and maintenance of the irrigation system (*ibid.*). Another crucial set of factors is democratic functioning of the organisation, transparency in transactions, and the type of leadership that is forthcoming. Professional NGOs are also important when it comes to motivating the farmers to join and run the organisation (*ibid.*, pp. 31–3). Pant considers all these important for gaining legitimacy (*ibid.*, p. 33). Hasty, often donor-driven implementation, as well as lack of training of office bearers and members, and the absence of proper systems of monitoring and evaluation, may seriously hamper or even destroy the whole process (*ibid.* pp. 34–5).

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[28] One good example is the settlement where the panchayat president had succeeded in getting a rainwater harvesting device located close to her own farm, presumably a demonstration installation. The only problem was that since the farm was located on a hilltop, water would flow from the tank rather than into it. This was an example of the scheme that had been utilised for the benefit of influential people.

[29] The phenomenon of strong collective action and organisations among tail-enders has been documented for many irrigation systems in Tamil Nadu and Karnataka (Rajagopal ,Doraisamy,et al. 2002).

Our case studies clearly illustrate that both the canal associations and the watershed committees were found wanting in many of these respects. We saw very little active intervention in the functioning of these bodies on the part of government officials. There were few, if any, general body meetings, members were not adequately informed about the projects undertaken; and the leadership, in at least two cases, was highly individualised and person-dependent, rather than being characterised by the kind of "multiple leadership" by self-interested farmers that was necessary to sustain the organisations over time. The most striking example of individual control was the big landlord who had paid up almost the entire membership fees on behalf of the members of the association, mostly small farmers, and was running the whole organisation "out of his own pocket."

Even for committed government officers, interaction with farmers could be rigid and formal. Assistance from NGOs was therefore encouraged, to act as catalysts and facilitators in motivating farmers and building organisations. During our own fieldwork, we saw how this NGO model worked well in some instances (and not so well in others), such as in the building of micro-credit organisations among women (Lindberg, Athreya *et al.* 2011). The model was one in which four, more or less autonomous, social actors interacted: local government officials, an NGO with trained facilitators, the local banks (which are branches of national banks), and self-help groups. This type of arrangement is favoured by some scholars in studies of watershed management (see Farrington *et al.* 1999, Chapter 5). One must note, however, that arguments in favour of such an arrangement are at best a narrative description and a summing-up, and at worst, show a failure to understand the deeper political economy of irrigation under a neoliberal regime which seeks to pass on the costs of social infrastructure to the general user, rather than use fiscal policy to tax the well-to-do and invest in such infrastructure and its maintenance.[30]

As we have noted above, the NGO model was completely absent in the case of the canal associations.[31] In the dry areas, the watershed committees did involve NGOs. However, this turned out to be rather problematic in at least one case. The staff of the NGO that we interacted with included a secretary: a Scheduled Caste person from the village who, after finishing his education, had returned to the village as an employee of the NGO, working on watershed management. Caste discrimination, however, had made his work very difficult. For example, in a meeting with the watershed committee, the Scheduled Caste secretary of the NGO sat on the floor while all the others, including the president, who belonged to the dominant caste in the village, were seated on chairs. When we insisted that the secretary also sit on a chair, there was much discussion before he finally did so. Afterwards, he informed us that this was the first time he had sat on a chair at such a meeting and that he was not likely to do so again. It reminded us of the "two glass system" that was practised in the village. Local teashops still keep two sets of glasses: one for the Scheduled Castes, marked with a red cross on the bottom, and one set for the others.

Caste hierarchy is an example of how a traditional social structure may seriously obstruct efficient and democratic functioning of a body. It is interesting, therefore, to encounter the strongly stated view that historical ways of organising irrigation management in and by the

[30] If nothing further was said than is found in the literature on participatory irrigation management, it would deservedly invite the conclusion that this is an exceptionally uncritical view. This is because it seems to reduce matters to procedures, voluntarism, and good governance. We reiterate the point earlier made that this whole scheme had a reduction of the state's fiscal commitment as its primary intention.

[31] The World Bank programme on participatory irrigation management was extended to the Cauvery delta only in 2009. Prior to this the delta had been excluded from the programme due to the water dispute. Other areas had an NGO component since 1998.

community, viz. the *kudimaramat* system, could potentially support efforts at collective organising. As we have noted above, this notion rests on a false idea of what was historically an "efficient" method of local irrigation management. According to Mosse (1999, 2003), the "efficient" pre-colonial system was managed by the state, not by autonomous village communities.

But there are many more problems with traditional irrigation management methods besides this. In a series of studies, Platteau has pointed out that traditional organisations have two major drawbacks in providing models for participatory management of common-pool resources. First, traditional organisations worked in a situation of abundant natural resources and subsistence production, but tended to fail under conditions of scarce natural resources and rapid commercialisation. Secondly, these organisations were grounded in hierarchical social structures and moral norms of unequal redistribution that are hardly compatible with modern democratic participatory bodies (Platteau 2000, Chapter 5; Abraham and Platteau 2001).[32] What is required, according to Platteau, is strong state intervention to bring about institutional reform at the local level, which can break the power of the elites and of unequal norms of redistribution.[33]

Governing the commons

It is noteworthy that much of the analysis of irrigation management has focused on organisational factors. There is no doubt that an institutional analysis is useful for understanding the functioning of local irrigation associations of various kinds, and for changes in government policy in the future. A very well-known and elaborate such analysis is by the Nobel laureate Elinor Ostrom in her famous book, *Governing the Commons* (1990). In a series of later publications (1990, 2000a, 2000b), she developed a set of characteristics or *design principles* for successful local management of common pool resources, which she summarised in the following way (Lindberg and Pettersson-Löfquist 2001: 9).

When the users of a resource design their own rules (Design Principle 3) that are enforced by local users or accountable to them (Design Principle 4) using graduated sanctions (Design Principle 5) that define who has the rights to withdraw from the resource (Design Principle 1) and that effectively assign costs proportionate to benefits (Design Principle 2), collective action and monitoring problems are solved in a reinforcing manner. (Ostrom 2000b: 19)

The operation of these principles is then bolstered by the sixth principle, which points to the importance of access to rapid, low-cost, local arenas to resolve conflict among users or between users and officials. (*ibid.*, p. 20)

The capability of local users to develop an ever more effective regime over time is affected by whether they have at least minimal recognition of the right to organize by a national or local government (Design Principle 9). (*ibid.*, p. 20)

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[32] The argument that "modern democratic participatory bodies" are devoid of inequality in distribution is difficult to sustain. All that can really be said is that there is at least formal equality in modern bodies that are created by a formally democratic process.

[33] The implicit presumption that the Central/State government is class-neutral or democratic in intent is of course open to question.

When common-pool resources are somewhat larger, an eight-design principle tends to characterize successful systems – the presence of governance activities organized in multiple layers of nested enterprises. (*ibid.*, p. 21)

A key point in this framework is the interplay between local-level management bodies and regional and national governments and administrations, which is discussed in Design Principles 8 and 9. "A polycentric government structure that 'distributes circumscribed but independent rule-making and rule-enforcement authority in numerous jurisdictions' is considered to be the best solution" (Ahmad 2000, p. 4, quoting Ostrom, Schroeder and Wynne 1993). "Polycentric" here entails several levels of decision-making, from the State down to local villages and associations.

Using this framework to understand the organisations in the Cauvery delta, we find that only Design Principles 8 and 9 were really present, albeit in an imperfect way. All the other principles were tampered with. Rules were made by the government bodies, not by the local users, and there was very little of graduated sanctions. There was no clear-cut "rapid, low-cost, local" arena for conflict resolution among users, or between users and officials.

Most crucially, the definition of who had the right to withdraw from the resource and the assignment of costs proportionate to benefits did not cover the entire range of how the natural resource was actually used (Design Principles 1 and 2). As we shall see below, the free use of individual wells dependent on recharge of water from the canal or tank system more or less quashed attempts at organizing comprehensive full coverage.

Free-riding?

Our main argument is as follows. Rapid development of well irrigation without any concomitant change in the legal framework and costing structure, and the lack of an objective basis for all water users to come together in collective action given their different and often conflicting interests, were the major causes for the weak development of water users' associations in the area under study.[34] As long as farmers had the option of digging their own wells and of exploiting groundwater individually, their motivation to come together to manage the overall irrigation system was weak. They simply ignored the fact that even their own wells depended, in the long run, on recharge of the groundwater level – whether through canals or systems of tank irrigation.[35] They did not consider it their problem that tail-enders were robbed of much of the water through the use of wells located upstream or closer to the tanks.

It is important to underline that having his/her own means of lift irrigation gives the farmer far greater control over irrigation, thus making it both more desirable and more efficient from the standpoint of the individual farmer. Hence, the decision to opt for own access to lift irrigation has its own independent rationale, though an unintended consequence of

[34] One may also add that the distributional consequences will not be benign for resource-poor farmers without appropriate state intervention, which in turn requires a struggle in the terrain of the state to force it to undertake pro-poor interventions. The issue is thus not merely one of technical efficiency of irrigation management.

[35] Micro-rationality under capitalism is entirely consistent with macro-irrationality!

widespread recourse to lift irrigation may well be to undermine collective welfare by overmining groundwater!

One strong evidence of the importance of the individually owned well as an alternative to joint management of water resources was found in the interview with the president of the water users' association in example B above, who, when asked about wells as an alternative source of irrigation, told us that because of the thick level of clay it was very difficult to bore wells in the area, which is why farmers were so dependent on the irrigation canals. Thus, in his area, there was certainly a need for managing the local canal irrigation system, which may have been absent in other parts.

Our analysis is supported by the field research in Ramanathapuram, Sivagangai, and Virudhunagar districts in Tamil Nadu carried out by Balasubramanian and Selvaraj (2003). With the help of a survey, they showed that ownership of private wells had a strong negative effect on collective tank management (*ibid.*, p. 25). (See also Janakarajan 1991, Vaidyanathan 1999)

Why is this so? After all, traditionally, farmers used to get their water through collective irrigation systems, whether from canals or tanks, which moreover were set up and managed by governments, and provided to farmers at a very low tax-rate. As we have seen, there was also a culture of local collective management of mini-irrigation systems.

The increasing use of tube wells changed all this. Three decisive changes explain this development:

1. The digging of wells was made much cheaper through the use of dynamite for digging and of boring machines to drill tube wells.
2. The method of lifting water from wells shifted from the use of less efficient bullocks and manual labour (the *kavalai* system) to the use of motorised pumps in wells.
3. The cost of electricity to run the pumps, through political decisions, became almost nil. In Tamil Nadu, as in many other Indian states, farmers get electricity more or less free of cost, since there are no tariff costs and only a one-point installation cost.[36]

This is the "infrastructure" of the organisational efforts described above, made up of the ecology and technology of the agricultural system and its changes over time. It is not nature-given but, to a large extent, set by the political economy of the system.

Take the massive proliferation of wells, for example. In Tamil Nadu, the digging of wells is regulated by law in terms of distance rules, in order to protect groundwater and its sustainable use. This rule has been followed in the case of wells financed under institutional loans for construction or deepening. However, state control is defunct in the sense that many more wells have been dug and deepened with non-institutional loans than is allowed by the regulation. Surveillance and punitive actions are nowhere in sight. The main issue here is the involvement of the local community in the management of the whole aquifer. The State

[36] That power supply is erratic and often available only in the early hours of the morning is another story.

government passed an Act in 2003, but has done nothing to see to its implementation (Kulkarni and Vijayashankar 2009).[37]

Another indication of the ambivalent attitude of the state is the pricing of electricity. Since the breakthrough of the green revolution, farmers have organised themselves as an interest group to reap the greatest possible benefits from state intervention and support of agricultural production. In Tamil Nadu, the first state to get a powerful farmers' association (TNFA), the struggle was mainly about the cost of electricity, since the use of motorised pumps in bore wells had developed relatively early in the State. In 1989, after a massive and successful mobilisation in the 1970s and political competition to attract farmers, the newly elected DMK State government gave in to these demands (Lindberg 1999: 278).

Technological development, the lack of legal rules to define the right to withdraw water resources (especially groundwater) and their firm enforcement, and the lack of proper taxation and pricing of water due in part to successful farmer mobilisation, undermine the incentive for farmers to come together for local collective action. Individual farmers with adequate resources can go it alone by boring their own wells and drawing as much water as they can find. The recharge of the aquifer is left to others to care for. This is the real "free-riding" problem of collective management of local irrigation systems that we have seen in the Cauvery delta.

Perhaps the only solution to the problem, besides properly enforced rules for well-digging (distance, etc.) and a proper costing structure, is to make membership in local water users' associations a precondition for the use of water resources, and to provide legal and administrative backing for such a system.

Conclusions

Studies focusing on water management and agrarian transformation over a long period of time are not many. The importance of this study lies in it being precisely such a study. Declining public investment on irrigation that has affected the maintenance of water control systems and performance of agriculture, inadequacies in timeliness and quantum of water availability which affect the access to irrigation water especially by tail-enders and poor farmers, potential overexploitation of groundwater -these are all important macro-level water management issues at the national and state levels. Lack of proper water management policy and institutions is also a problem affecting efficiency and equity in water utilisation. All these issues have a direct bearing on access to water, crop production, farm income and food security. It needs to be recognized that study of water management issues form an important part of studies of agrarian change.

We have studied the impact of some key aspects of water management in the villages covered in our resurvey, the larger purpose of which is to understand social mobility and agrarian transformation over a period of twenty five years under two different eco-types, viz. wet and dry. The study reveals the following:

In the wet villages, there has been a substantial decline in net area sown, but an increased cropping intensity. At the same time there has been a stagnation in the value productivity of

[37] Tamil Nadu Groundwater (Development and Management) Act-2003.

crops. This suggests that crop production with existing technique has reached a plateau in wet areas in terms of both output and yield. The Cauvery water problem due to the inter-state water dispute between Tamil Nadu and Karnataka has contributed to the problems in agriculture in this region. However, farmers have started to use conjunctive sources like shallow tube wells to supplement the canal water. Thus, farmers have already adapted, to some extent, to the problem as it has been prevailing for a long period, especially since the middle of the 1980s. As a result, the incomes of the farmers have not been much affected.[38]

In the dry villages, the share of irrigated area has increased (by about 10 percentage points). There is a sizeable decline in tank irrigation (by about 14 percentage points). This has been compensated by an increase in well-irrigated area. The number of wells used for irrigation has doubled in the dry area.

In the wet areas, diesel pumps have been introduced due to difficulties in getting electricity connection. Though costlier compared to electricity, farmers have gone for diesel pumps due to water scarcity and the fear of loss from the cultivation of high value crops like banana and sugarcane in this area. In other words, the incremental income from such efforts seems to be more than the costs involved in diesel pumping. However, in dry villages farmers got electricity connections already in the 1960s as part of the green revolution package. *Kavalai* irrigation, which was the main source of lift (50%) has completely disappeared.

Cropping intensity has increased in both ecotypes between 1979-80 and 2004-05. In the wet area the cropping pattern has shifted towards the less thirsty banana and millets crops at the expense of sugarcane. In the dry area, there was an increase of paddy cultivation from 20 % to 33%, and to some extent introduction of sugarcane. Output of paddy, the main crop in both eco-types, has grown, between 1979-80 and 2004-05, at a modest rate of 0.78 per cent per annum in the wet area and 0.85 per cent in the dry areas. There was a higher rate of growth in the case of other crops like cholam (maize) and groundnut in dry areas, but a sharp reduction in cultivated area for these crops.. The value productivity (gross value of output per acre) of irrigated crops was stagnant in the wet area but tripled in dry area. However, the value productivity of un-irrigated crops had declined in both eco-types, the decline being greater in dry areas.

As for income from agriculture, a majority of farm households (especially small and medium farmers) depended upon irrigation water in both eco-types. In wet area, almost all income was derived from irrigated crops in both surveys, while in the dry area the share of farm income from irrigated agriculture had increased from 50% to 90% of total farm income. At the same time, the overall share of farm income to the total income of the households had come down in both eco-types. In dry villages, non-farm income accounted for the major share of household income in both the periods but stood higher during the resurvey. However, in wet villages, farmers mostly depended upon farm income and hence irrigation water management assumed more importance there.

Overall, as at the national and state levels, there is stagnation in agriculture in the wet region as the area and yield have reached what seems to be a plateau. It is important to note that this

[38] The practice of Adaptive Water Management has been also discussed in the study of another irrigation system (Bhavani Project) in Tamilnadu which is part of Cauvery basin (Lannerstad 2009).It is observed that the farmers in the project area have adapted to water shortage by conjunctive use of wells and also growing less water intensive crops as happened in our study area. It is to be further understood that irrigation systems are not static and they tend to adapt to changes in water availability, rainfall, topography, land tenure systems, policy of the state, etc

may not be an absolute agro-ecological constraint, but rather one related to changes in the policy regime which is now less supportive of agriculture. However, the paradox is that still agriculture is the main source of livelihood, in which the role of irrigation is very significant.

Basic requirements for 'Second Green Revolution'

Based on our analysis it is now possible to define some important requirements of a second green revolution. It must focus on improving water use efficiency for cultivation of other high value crops and provision of additional sources of employment based on agriculture like processing and marketing of value-added agricultural produce . Rehabilitation and modernisation of old irrigation systems in wet region is an important aspect for increasing water use efficiency .In the dry areas, there is still vast scope for development of agriculture. This can be brought about through investments in irrigation, water harvesting and improved methods of water use like micro irrigation. Also relevant would be research in dryland farming. However, land use management in the dry ecotype should take into account alternative uses of land such as cattle grazing or tree planting, which may be preferable both from an ecological and from an economic point of view.

In the case of irrigated agriculture, scope for further development exists, but there are also some signs of overexploitation of groundwater which is the major source of irrigation in dry areas. Regulation of ground water use through community participation is required for preventing over exploitation of the resource. There is scope here for undertaking more efficient watershed programmes in the dry eco-type to conserve soil moisture and for recharging groundwater, which helps both dry and irrigated agriculture. Greater attention to improving yield levels in dry areas and better water management in both wet and dry ecotypes are essential to stabilize and enhance productivity in agriculture. All of this requires an appropriate change in neo economic policies that have entailed higher input costs, lower and volatile output prices, more expensive credit and a decline in the support for agriculture by way of public investments in irrigation, extension services, research and development and infrastructure for storage, transport and processing of agricultural produce.

Understanding the logic of collective action

As we have seen above, a fair amount of research into participatory water management has focused on organisational factors like internal democracy and administrative efficiency, and not much on institutional dynamics and the political economy within which it is operating.

This paper shows that irrigation institutions and collective action are shaped by a number of factors, such as the distribution – both spatial and across size classes -- of land in an irrigation system, the land tenure system, relative access to new technology like bore wells, the availability and cost of electricity and other energy sources for lifting ground water, and above all, the state policies related to them. In both dry and wet areas, the head-reach farmers showed less interest than tail-enders in collective action, as head-reachers generally had better access to water than others. Among them, big farmers were in the lead in establishing irrigation organisations and undertaking related functions, such as the maintenance of systems and the management of water allocation, as they stood to benefit the most. However, in the process, the benefits also reached small farmers, though to a lesser extent.

Wells as a conjunctive source of water use in both canal irrigation in wet areas and tank irrigation in dry areas have played an important role in reducing the incentive for collective action. The ownership of wells and modern water lifting devices enabled, for their owners, a cost-effective solution to the problem of access to irrigation water.

In dry areas, liberal credit, both for digging or deepening wells as well as for purchase of pump sets, helped the expansion of area irrigated by wells during the green revolution. In wet areas, there was no necessity for the conjunctive use of wells until recently, as water was adequate. However, due to the Cauvery water dispute, the need for well irrigation has increased as canal water supply is less reliable. As a result, farmers have opted for the conjunctive use of wells; however, only a few big farmers could benefit from this, as state policies relating to agriculture and the shrinkage of institutional credit made it difficult for small farmers to undertake the necessary investments. Also, while electricity was free, only a few could benefit from electrification and free electricity, again due to state policy on sanctioning electricity connections. Tenant farmers, who are significant in wet areas, lacked the incentive to invest in wells or other forms of land improvement, the benefits of which would ultimately accrue to the landowner. Most of them, therefore, did not benefit from the use of wells as a conjunctive source.

In sum, the rapid and mostly unregulated development of well irrigation without any concomitant change in the legal framework and costing structure, and the lack of an objective basis for all water users to come together in collective action, given their different and often potentially conflicting interests, are the major causes of the weak development of water users' associations in the area.

The unregulated use of groundwater, especially in dry areas, has resulted in an ecological crisis, due to competitive deepening, that has affected mainly poor farmers. Watershed programmes undertaken in dry areas to prevent this problem have not been very effective, for reasons discussed earlier. Overall, state policy and the political economy of the system play an important role in the functioning of irrigation institutions and the possibility and the efficacy of collective action in water management.

A water management organisation functions in a social and material context, from which it derives its basic features. These, in turn, relate to the ownership and control of productive assets as well as to the distribution of power to make or influence decisions, which itself is not entirely independent of asset-ownership patterns. Any analysis of the success or failure of "participatory irrigation management" that ignores these key aspects, and takes a simplistic "new institutional economics" approach, is unlikely to be of much use..

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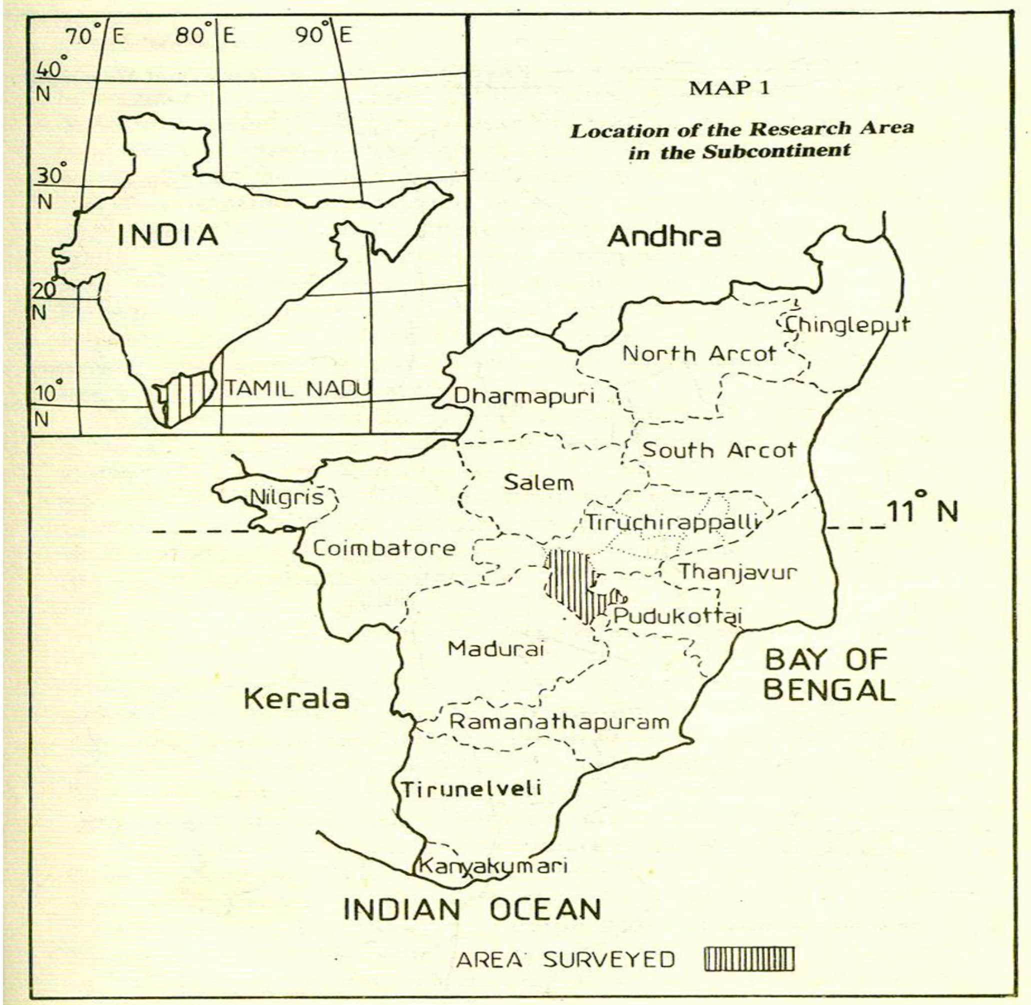
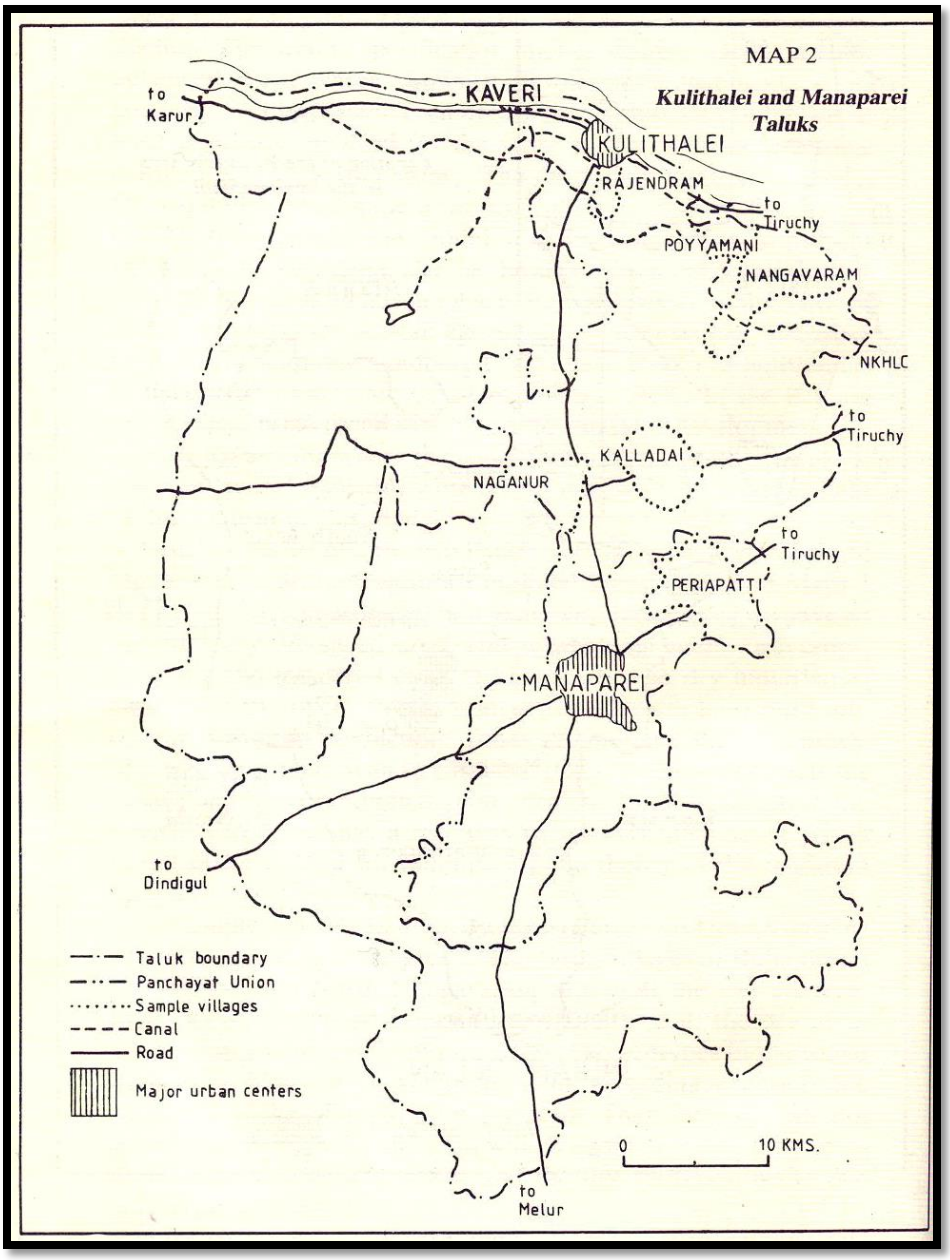

MAP 1
Location of the Research Area in the Subcontinent
70° E
80° E
90° E
40° N
30° N
20° N
10° N
INDIA
TAMIL NADU
Andhra
Chingleput
North Arcot
Dharmapuri
South Arcot
Salem
Nilgris
Tiruchirappalli
11° N
Coimbatore
Thanjavur
Pudukottai
Madurai
BAY OF BENGAL
Kerala
Ramanathapuram
Tirunelveli
Kanyakumari
INDIAN OCEAN
AREA SURVEYED


MAP 2
Kulithalei and Manaparei Taluks
to Karur
KAVERI
KULITHALEI
RAJENDRAM
to Tiruchy
POYYAMANI
NANGAVARAM
NKHLC
to Tiruchy
KALLADAI
NAGANUR
to Tiruchy
PERIAPATTI
MANAPAREI
to Dindigul
Taluk boundary
Panchayat Union
Sample villages
Canal
Road
Major urban centers
0
10 KMS.
to Melur