SUSTAINABLE MANAGEMENT OF TANK IRRIGATION SYSTEMS IN INDIA

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ABSTRACT

Tank irrigation systems of India are century old. Most of the tanks have, over time, degraded into open access resources due to weak property relations. Encroachment, privatization and government appropriation of the tanks have been the main outcomes of the failure of local authority system to enforce the institutional arrangements under common property resources management regime. About 2% of the tanks in the tank less intensive region and 67% of the tanks in the intensive region have become defunct. Wells that are supposed to be a security against late season tank water scarcity, have, of late become a major threat to the very survival of the tanks. Also taxes from the multiple uses of the tanks if collected by a single agency are sufficient to meet the operation and maintenance expenditure of the tanks both in the short run and in the long run. The modernization options derived from the simulation model indicate that software strategies such as sluice management will have higher pay-off than the hardware strategies such as canal lining and additional wells. Policy interventions include physical investments, management and legal aspects.

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1 Tank Irrigation Systems of India

Tank irrigation contributes significantly to agricultural production in parts of South and Southeast Asia. Especially in South India and Sri Lanka, tank irrigation has a long history and many currently used tanks were constructed in the past centuries. The tanks have existed in India from time immemorial, and have been an important source of irrigation especially in southern India. They account for more than one-third of the total irrigated area in Andhra Pradesh, Karnataka and Tamil Nadu states. The tank irrigation system has a special significance to the marginal and small scale farmers who make a very large number essentially depending on tank irrigation as these systems are less capital-intensive and have wider geographical distribution than large projects (Palanisami, 2000).

An irrigation tank is a small reservoir constructed across the slope of a valley to catch and store water during rainy season and use it for irrigation during dry season. Tank irrigation systems also act as an alternative to pump projects, where energy availability, energy cost or ground-water supplies are constraints for pumping. The distribution of tanks was quite dense in some areas. However, over years the performance of the tanks has been declining.

The share of tank irrigated area in India has declined from 16.51 percent in 1952-53 to 5.18 percent in 1999-2000, whereas the share of groundwater irrigation has increased from 30.17 percent to 55.36 percent during this period. The share of the tank irrigated area to net irrigated area (NIA) had been declining continuously over years (Fig 1)   Among the three major sources of irrigation, tank is the only source, where the irrigated area has been declining continuously since early seventies and many argue that the area under tank irrigation started declining only after the introduction of the green revolution. Further, among the states in India, the area under tank irrigation has declined more drastically in those states where tank irrigated area accounts for relatively a larger share in the net irrigated area and it has increased marginally in certain states where it accounts for very low share in the net irrigated area.

Data from the Agricultural Census of India for five time points namely 1970-71, 1976-77, 1980-81, 1985-86 and 1990-99 indicated that the resource poor farmers (owning less than 2 hectares) still account for major share of tank-irrigated area in India. Marginal (less than 1 ha.) and small farmers (1-2 ha) together accounted for about 40 percent of tank-irrigated area in 1970-71, which further increased to nearly 55 percent in 1990-91 thus accounting for nearly two third of tank irrigated area. On the other hand, the share of tank irrigated area used by large farmers declined from 13.59 percent to 6.02 percent during this period. Since the farmers belonging to marginal and small size group are mostly poor, they couldn't afford for cost-intensive irrigation sources like groundwater as in the case of medium and large farmers and tank irrigation continues to play a crucial role among small and marginal farmers even today. This is also true across different states where tank irrigation has considerable presence even today (Narayanamoorthy, 2004).

2. Management of Tanks

In ancient days, tanks were considered to be the property of rulers. The farmers paid a portion of the produce to the ruler. Farmers also were in charge of the maintenance of the tanks, and supply channels. Zamindars ensured the proper maintenance of the tanks, and channels, since they reaped the benefits of farming in large areas. However, when the British introduced the ryotwari system in 1886, tanks with an ayacut of 40 ha. and above were brought under the control of Public Works Department (PWD) and smaller tanks were under the administrative control of local bodies, or vested with the villagers themselves. Since the local bodies did not have qualified engineers and the duties of the ayacutdars were not clearly mentioned, the system of the farmers themselves taking up maintenance work known as *kudimaramathu* works slowly declined. Tanks were silted up, and supply and distribution channels choked. The deterioration of the tank irrigation system has been a subject of considerable discussion, at least since the middle of the 19th century. The Report of the Public Works Commission of 1852 stated that there was not much of voluntary community labour involved in tank maintenance, and it reported that in all districts labour was more or less forced to work. In fact an act was passed, namely the Madras Compulsory Labour Act of 1858 (or what is known as the *Kudimaramath* Act), with a view to legalising compulsory labour for certain aspects of maintenance, and also to penalize the non-performance of *kudimaramath* labour. The entire administration of the act of levying and collection of fines was left with the irrigation panchayats. The Famine Commission of 1878 brought to light quite forcefully the deteriorating conditions of tanks and advocated a systematic policy of maintenance. However, at present the local village is responsible for water distribution and management of the tanks with a command area of below 40 ha.

3. Performance of tanks over years

In a 10-year period, three years the tank get normal supply, five-years get deficit supply and two years they fail completely (Palanisami,2000). Given the rainfall uncertainties, the tank performance is seen declining over years. There are above-outlet problems such as poorly maintained structures (bunds, surplus weirs). Catchment is mismanaged and forest land adjacent to the catchment are already converted for human settlement by the Government. There are severe encroachment in the tank foreshores. Siltation of the tankbed has reduced the water storage capacity ranging from 20 to 30 percent. In the case of below-outlet problems, channels are not maintained and broken resulting in heavy water losses. Well irrigation has dominated the tank irrigation in several cases where the increase in the number of wells in the tank command had been signaling the inactiveness of the tank systems for providing reliable water supply. In fact, it had been found that large number of tanks have become defunct in less tank intensive districts (i.e., 76% of Panchayat Union tanks and 64% of Public Works Department tanks have become defunct) compared to tank intensive regions, where the percentage of defunct tanks is less[1] (Palanisami, 2000).

Compared to all India level, in Tamilnadu state, the share of tank irrigated area to net irrigated area by marginal farmers has decreased from 39.53 percent in 1970-71 to 35.17 percent in 1990-91, tank irrigated area by small farmers had decreased from 32.02 to 0.23 percent, medium farmers (2-4 ha) has decreased from 30.03 percent to 21.47 percent and large farmers (more than 4 ha) has decreased from 28.46 percent to 19.40 percent during the above periods respectively indicating the poor performance of the tank irrigation systems in the state (Table 1).

The neglect of tanks has meant that most farmers receive inadequate quantities of water from tanks. To offset the decline in tank water supplies, farmers have resorted to supplemental well irrigation to avoid crop losses (Palanisami and Easter,1987, 1991). Since only about 15 % of the farmers in the tank command area own wells and there is a growing demand for well water,

[1] Tank less intensive regions refer the regions where tank irrigation is not the major source of irrigation compared to tank intensive regions, where the tanks are the major source of irrigation.

the well owners in most cases act like local monopolists and are able to charge high prices for well water. However, profit-making through privately owned water source (i.e. wells) within the hydrological boundary of the common property resource (tanks) poses serious threat to the very survival of the tanks, because of the declining interest among well-owners in proper upkeep of tank structures.

Even though several factors have influenced the tank performance, the level of their influences was varying across locations. The major factors influencing the tank performance are given in Table 2**.** The well density had negative influence of the tank performance. It was observed that higher the well density, lesser was the tank performance. Tanks without the well supplementation in the tank season had performed well and this clearly indicated the availability of adequate tank water supplies.

Concerning the O & M expenditure on tanks at state-level, the results of the study had indicated that though outlay per hectare of command area at current prices increased from Rs.26 to Rs. 161 per ha, the outlay at constant (1980-81) prices has increased only marginally from Rs. 33 to Rs.43 per ha. However, the level of O & M amount spent on the sample tanks revealed that the average amount spent was high for PU tanks (Rs 154/ha) compared to PWD tanks (Rs 74/ha). Since the O&M amount was spent mainly depending upon the urgency of the tank repair and the local political pressure, the level of tank performance and the amount of O&M spent could not be directly related (Palanisami et.al, 1995).

4. Multi-uses from tanks

Even though tanks were originally serving irrigation and other village needs such as domestic, livestock, besides fish production, due to change in the village profile over years, tanks are mostly saving the irrigation needs only. However, judging the tank performance using the irrigation component may be inadequate, as it will not reflect the true performance of the tank benefiting the village in several ways. Hence, multi-uses of the tank should be considered in arriving the tank performance. If such uses are in reasonable proportion, then rethinking tank management in terms of multi-use performance may be warranted. Also using the multiple benefits approach will indicate the magnitude of the receipts from all the uses which can be effectively used for tank maintenance.

In absolute terms, as given in Table 3, social forestry raises the most revenue (averaging Rs 170/ha), followed by irrigation (Rs 88/ha) and fisheries (Rs 15/ha). Social forestry collects the highest revenue (100%) as a proportion of total value of output, but irrigation pays a relatively small proportion of the value of output (3.2 %) in various fees. Social forestry appears to perform well in absolute, as well as relative revenue realisation at the tank level. The State Revenue Department, Social Forestry Department, Mines Department, Panchayats, and informal organizations in the village community are all involved in collecting revenue from the tank users. The agency-wise income realised is presented in Table 4. Among the various agencies, Panchayat Unions receive the maximum realised revenue (64.96%), followed by the Social Forestry Department (24.84%), village community (5.18%), and the Revenue Department (4.67%). But if the panchayats generate so much income from the tank uses, why are they not investing more in attending to the maintenance of the tanks? The panchayats feel that it was the responsibility of the state government to pay for the maintenance, and therefore did not put their own resources into tank maintenance. It is not clear what effect the Panchayati Raj Amendment has had on this situation, but it is essential to explore what will happen if the responsibility for tank maintenance as well as the entire revenue collection authority is given to a single institution such as local panchayats or water users association.

It is important to note from the tables that the total revenue realized in terms of taxes, fee etc., ranges from Rs 337.12/ha in PU tanks to Rs 270.29/ha in PWD tanks, with an average realization at the tanks as Rs 275.40 /ha.(Palanisami et.al 1997). This is higher than the government allotment of Rs 140/ha for tank O&M. Hence, instead of receiving heavy small allotments from the government, in fact tanks themselves can generate more resources for maintenance. Present practices do not seem to be even exploiting the full potential of tapping all the uses of tanks for revenue to support them and hence tanks suffer from lack of maintenance funds which is one of the major reasons for poor condition of the tanks. However, further analysis is needed to determine whether the revenue generation will be uniform across tanks, and how different combinations of uses may be competitive and or complimentary in nature.

5. Warning signals

The following are the warning signals to the Government and local community on the declining tank irrigation in the state

- Mostly tanks are reported to be functioning only in normal and excess rainfall years and not so in poor and low rainfall years. The consequences are: many farmers have started abandoning tank agriculture due its continuous uncertainties in water supplies and moving to the nearby towns for other jobs and only the older people are staying back in the tank villages. The lands are not maintained properly and the prosophis trees are growing freely in the cultivated lands thus making the lands unsuitable for cultivation during years when the tank has adequate water. Due to the declining commitment on the maintenance of the tank structures, the upkeep of the structures is a cost affair for the farmers when they really want to use the tank for irrigation during normal supply periods.

- The livestock support activities are also completely gone in the village eco-system thus eroding the livelihood options in the village. Farmers used to take the silt using bullock carts and after the introduction of the social forestry scheme in the 1980s in the water spread area, silt removal from the tanks was prevented thus making the bullock operations limited. Somehow in the recent years, the micro-finance concept has been emerged among the rural women who are managing the families with livestock and credit integration. But livestock also need adequate fodder. Hence, if the tanks are not properly managed then the entire tank-ecosystem based rural economy will be completely collapsed.

- The impact of the social forestry was already felt in terms of increasing silt accumulation in the tank water spread area and it will be difficult to sustain the tanks if the social forestry is allowed to continue. But at the same time, even without social forestry in the tanks, there are possibilities that the prosophis trees will be spreading fast and it will have severe impact than the social forestry with accacia trees which have market (timber) value.

- It is seen in several locations, due to intensification of watershed development programs by the Government, several structures such as small check dams and percolation ponds are developed in the upstream of the tanks thus affecting the inflows into the tanks. Hence a clear demarcation should be done between the watershed programs and tank improvement programs.

- Disappearance of the supply channels is very common. House construction works due to population increases and village development activities such as roads, schools, buildings are concentrated in the government poramboke (common) lands which are the main sources of inflow to the tanks as well as interlinking the tanks in the chain. This is one of the reasons why tanks are not getting adequate storages even though the rainfall is normal.

- The traditional village institutions like needkatti or madayan thotti who looked after the tank catchment and tank structures and facilitated the inflows into the tanks regularly during rainy seasons also disappeared, as they could not be paid by the farmers due to frequent tank failures.

- The growing nexus between castes and politics among the younger generation in the village also played their role in making the traditional leaders in the village (who looked after the tank management) inactive. Several regional political parties are coming up and since the voting percentage is higher in the villages, these parties concentrate on the rural villages for their benefits and in the process, the households are divided among the political and caste related groups.

- The growing self-interest and non-cooperation by the well owners in the routine tank maintenance also make the tank management a difficult task. This is because in several villages, well owners feel that the tanks will not be much useful, as most of the periods they are dry. Also the reliability of the tanks for recharging the wells has also gone down due to siltation and encroachment.

- The rice supplies in the village ration shops to some extent make the poor farmer households to prolong their livelihood with the dried-up tanks . But the major issue is how long the ration shops will sustain the villages and the tanks.

- Many people now raise the question: Do we really need the tank bund which makes 1:2 or 1: 4 water spread : command area?. The 1:2 ratio (i.e., for every one hectare of water spread, only 2 hectares of command area is available) is very attractive for making the rainfed tanks into rainfed land as there is not much differences between the tank irrigation and rainfed agriculture. This aspect is gaining important since in most of the time, the tanks are empty and people think about using the water spread area for rainfed cultivation due to its fertile silt.

6. Policies for improving tank systems

Investment

Tank rehabilitation options that restore the original standards should be given priority. Desilting is an important option. However, it was observed, that in a 10 year cycle, only in 3 years, the tanks get full storage, five years deficit storage and in two years the tanks fail. Hence, desilting the tank fully will not be economical, as the benefits due to desilting will be in three years only, where the tanks get full supply. Also disposal of the entire desilted material is difficult, as the fertile silt is found only in the top (0.4 metre) layer. Therefore, full scale desilting may not be warranted. Considering the high cost of Rs. 120/ m^3 of silt, partial desilting that helps to restore original (10%) dead storage could be attempted as part of tank rehabilitation options as this will help increase non-irrigation benefits of tank water particularly in the non-tank-irrigation season. Also recharging of wells will be improved. Partial desilting can be done nearer to the lower sluice as well as around the periphery of the tank water spread area.

Most of the tanks are not getting adequate water supply and the chain system of tanks has almost broken. Hence, there is an urgent need to revive the tank-chains through appropriate modernization strategies for improving the supply channels connecting different tanks. This highlights the need for taking up modernization works at chain-level i.e. by considering the entire hydrological boundary as a single unit rather than viewing individual tanks as separate entities for new investment. Community wells should be installed in the tank water spread area to provide few supplementary irrigations to the non-well farmers during critical periods.

Management

Farmers in few water scarcity tanks have already been adopting crop diversification strategy involving groundnut, pulses, cotton and other crops and this practice should be extended to tanks whose water storage is 50-60 percent. The water required to produce one kilogram of rice ranges from 4500 - 5000 litres compared to 1500 - 2000 litres in the case of non-rice crops such as groundnut. Hence, using the 50 per cent tank storage, the entire command area can be covered with non-rice crops. Extension efforts and marketing support to farmers should be strengthened to introduce crop diversification particularly in the wet season. Crop demonstrations by the Department of Agriculture should help speed up the process. To complement the above options, tank structures should be repaired for effective water control.

Water losses in the canals are about 30 per cent besides creating inequity in distribution between head and tail farms. Lining the main canals can be followed without disturbing the field boundaries. Tank management strategies such as sluice rotation will help save the tank water by 20 per cent. Instead of continuous water withdrawal from tanks, sluices can be opened and closed on alternate weeks (rotation of sluices).

Legal

More tank have become defunct in the recent years due to encroachment, siltation, choking of supply channels and pollution from industries. Tanks close to the cities should be protected from environmental pollution and further be made as groundwater recharges structures for domestic purposes. Strict regulations and penalty mechanisms should be imposed on the encroachers of catchment, supply channel, and foreshore area.

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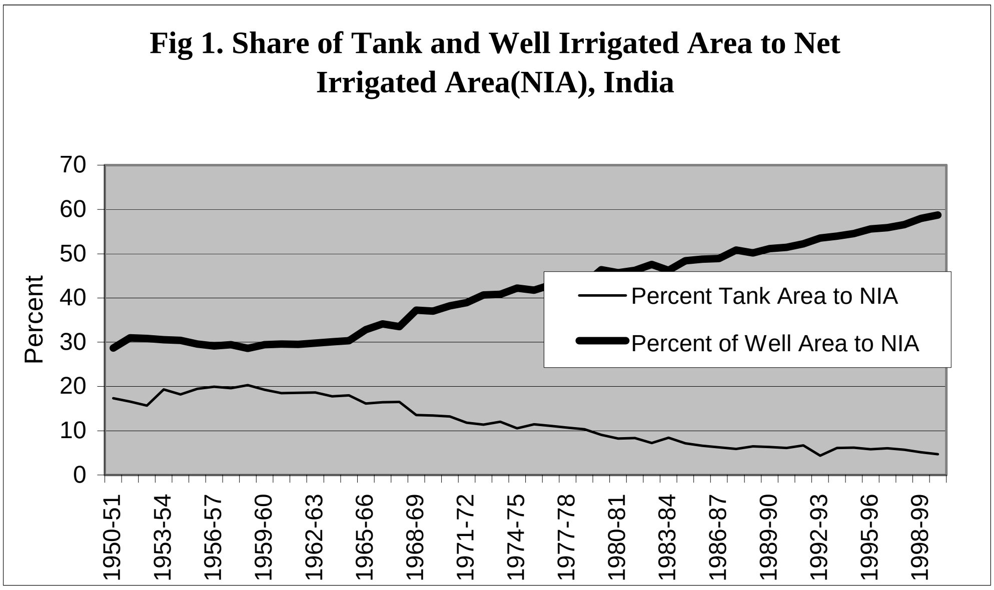
Fig 1. Share of Tank and Well Irrigated Area to Net Irrigated Area(NIA), India
Percent
70
60
50
40
30
20
10
0
Percent Tank Area to NIA
Percent of Well Area to NIA
1950-51
1953-54
1956-57
1959-60
1962-63
1965-66
1968-69
1971-72
1974-75
1977-78
1980-81
1983-84
1986-87
1989-90
1992-93
1995-96
1998-99

Table 1. Share of different sources of irrigation in India and Tamil Nadu (%)

	Source	1960-61	1970-71	1980-81	1990-91	1999-2000
India	Canals	42.05	41.28	39.40	35.63	31.29
	Tanks	18.50	13.22	8.24	6.84	5.18
	Wells	29.56	38.22	45.70	51.04	57.81
	Others	9.89	7.28	6.66	6.49	5.73
	All	100	100	100	100	100
Tamil Nadu	Canals	35.80	33.90	32.70	32.40	27.58
	Tanks	38.00	34.50	32.10	22.38	19.47
	Wells	24.20	29.80	33.80	44.61	52.88
	Others	2.00	1.80	1.40	0.61	0.37
	All	100	100	100	100	100

Source : Tamil Nadu - An Economic Appraisal (Various issues).

Table 2 Parameters influencing tank performance under different levels of adjusted tank performance

Tank Type	Adjusted Tank Performance (%	Well Density (No./ha)	O&M Expen-diture(Rs. /ha/year)	Resource Mobilised (Rs/ha/year)	Encroach-ment (% of water spread area)	Farmers' Participation (mandays/ha year)
PU	<25	1.30	73.80	28.00	34.44	0.28
	25-50	1.00	12.07	0.60	20.26	0.20
	50-100	0.30	154.00	8.25	12.24	0.56
	>100	0.00	24.00	0.00	8.22	0.72
Mean	75.70	0.42	154.00	9.00	16.23	0.54
PWD	<25	1.25	28.50	68.80	19.76	0.09
	25-50	1.00	108.00	61.30	11.66	0.35
	50-100	0.30	73.20	9.45	6.99	0.49
	>100	0.00	No tanks under this category			
Mean	83.30	0.35	74.00	14.00	10.23	0.30

1 US $ = Rs 44

Table 3 Average revenue realization at tank level from multiple tank uses

(Rs/ha)

Tank Type	Irrigation	Fishing	Ducks	Bricks	Social Forestry	Trees	Silt	Total
PU, Head	80.38	6.67	0.24	0.47	228.09	2.55	0.00	318.40
PU, Tail	51.66	17.00	0.41	0.08	284.01	2.70	0.00	355.85
PU	66.02	11.83	0.32	0.28	256.05	2.62	0.00	337.12
PWD, Head	101.04	3.36	0.07	0.21	242.22	0.41	0.00	347.31
PWD,Tail	88.21	20.83	1.42	0.10	49.27	1.07	0.00	160.88
PWD	94.05	14.62	0.60	0.14	160.10	0.77	0.00	270.29
Average	88.00	14.87	0.48	0.15	170.85	1.05	0.00	275.40

1 US $ =Rs 44

Table 4. Average revenue realized by different agencies from various user groups of the tanks

(Rs/ha)

Tank type	Revenue Department	Panchayat Union	Village	Fishery Cooperative societies	Forestry Department	Total
PU, Head	12.96	206.96	6.37	0.00	91.24	317.53
PU, Tail	8.74	215.85	16.75	0.00	113.60	354.94
PU	10.85	211.40	11.56	0.00	102.42	336.24
PWD,Head	14.63	232.62	3.02	0.04	96.89	347.20
PWD,Tail	12.63	105.95	20.82	1.61	19.71	160.72
PWD	13.52	177.43	14.10	1.05	64.04	270.15
Average	12.84	178.75	14.27	0.96	68.34	275.16
Percent to total	4.67	64.96	5.18	0.35	24.84	100.00

1 US $ = Rs 44