Policy Interfacing and Irrigation Development in Tamil Nadu*

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Introduction

Irrigation is the lifeblood of agriculture, rural livelihood and food security in Tamil Nadu. Centuries-old tanks, and reservoirs and canals were the dominant features in irrigation till the mid-twentieth century. Irrigation landscape, however, began changing with private investments in minor irrigation, particularly in groundwater. Today, groundwater irrigation is becoming the cornerstone of providing water for agriculture, resulting in an overall exploitation rate of over 85% of the total available resources. Declining rates of tank and canal irrigation and overexploitation of groundwater are so critical that the state needs new policy interventions to tackle a pending water crisis. This policy brief recommends some development and investment options for the irrigated sector in Tamil Nadu.

Physical Features, Climate and Agroclimatic Zones

The state of Tamil Nadu, located at the southeastern extremity of the Indian peninsula, lies between 8° 5' and 13° 35' of the northern latitudes and between 76° 15' and 80° 20' of the eastern longitudes. Tamil Nadu has a coastal boundary of 922 kilometers (km) and a land boundary of 1,200 km, and its land area of 130,069 km^2 is bordered in the north by the states of Karnataka and Andhra Pradesh, in the east by the Bay of Bengal, in the south by the Indian Ocean, and in the west by the state of Kerala.

Geographically, the state has broadly two natural divisions: a) the coastal plains and b) the hilly eastern and western areas. It also extends a little in the Western Ghats in the Kanyakumari District. The Western Ghats, averaging 3,000 to 8,000 feet in height, run along the western part with the hill groups of Nilgiris and Anamalais on either side of them. The Western Ghats form a complete watershed and no river passes through them. The main streams in this side, namely Paraliyar, Vattassery Phazhayar, etc., are of limited length, and end up in the Arabian Sea. All major rivers are east-flowing. The Eastern Ghats are not a complete watershed containing all the watercourses within the state, and certain rivers pass across and

*Based on the synthesis paper on State Irrigation Investment Strategies, presented at the State Planning Commission, Government of Tamil Nadu, Chennai on 12. 12. 2008. This synthesis paper, in turn, is based on the results discussed in the subsequent chapters and other research conducted by the IWMI-TATA water policy program.

beyond, notable among them being the Cauvery River, which is one of the main rivers. The tributaries of the Cauvery are Bhavani, Amaravathi and Noyyal. The other main rivers are Vaigai, Tamaraparani, Palar, Ponniyar and Vellar.

The climate of Tamil Nadu is basically tropical. Due to its proximity to the sea, the summer is less warm and the winter is less cold than other parts of Peninsular India. The maximum daily temperature rarely exceeds 40 °C and the minimum seldom falls below 15 °C. Both southwest and northeast monsoons influence rainfall in the state.

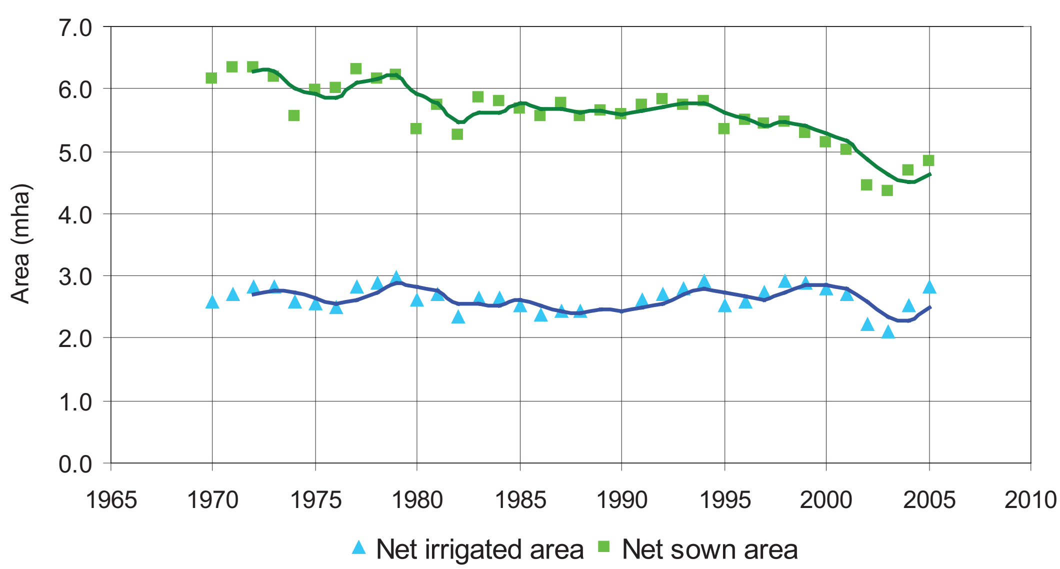
Based on rainfall distribution, soil characteristics and other physical, ecological and social characteristics, Tamil Nadu is classified into seven agroclimatic zones, namely northeastern, northwestern, western, Cauvery Delta, southern, high rainfall and hilly zones. The climate and the agroclimatic zones influence the water availability and use in different regions, in particular in the irrigated areas.

Trends of Irrigation in Tamil Nadu: 1971-2006

Net Sown Area

The net sown area in Tamil Nadu has had three distinct trend patterns over the last three-and-a-half decades (Figure 1). Overall, the total net sown area has declined by 25%, or 1.5 million ha (Mha), from 6.3 Mha in 1971 to 4.8 Mha in 2005. In the 1970s, the net sown area decreased at an annual rate of 0.77%. The declining trend stopped in the early 1980s, and remained steady until the mid-1990s. It started declining again at 2.1% annually after 1995.

Figure 1. Net sown and irrigated area in Tamil Nadu.



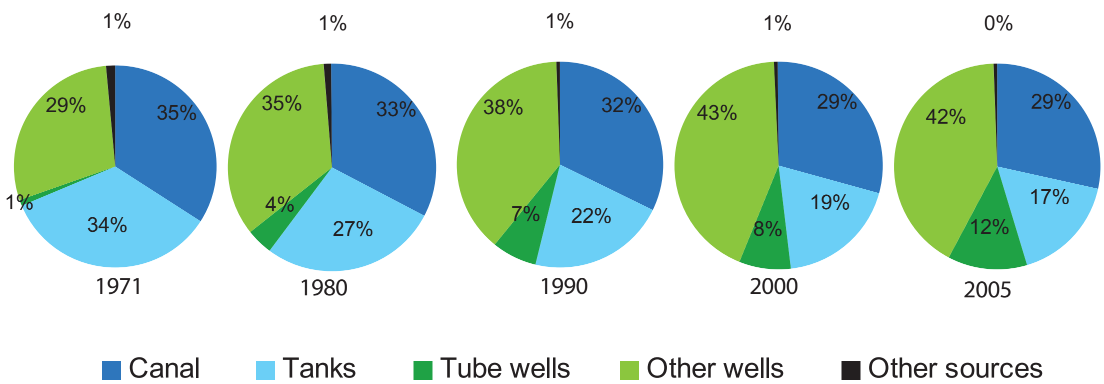
Net Irrigated Area

No significant trend in net irrigated area exists over the same period (1971 to 2005). However, with declining net sown area, the share of net irrigated area steadily increased from 42% in 1970 to 56% in 2005.

Contribution to Net Irrigation Area

The area under different sources of irrigation has changed drastically during the last three-and–a-half decades (Figure 2). Canals and tanks were the main sources of irrigation in the 1970s and 1980s, contributing to two-thirds of the total net irrigated area. But groundwater has dominated irrigation since the mid-1990s, and contributed to more than half the net irrigated area in 2005.

Figure 2. Land-use patterns in Tamil Nadu.



Canal Irrigation

Canal irrigation contributed to 34% of the total net irrigated area in the early 1970s. More than 140,000 ha were lost from the total net irrigated area under canals, and the current canal irrigated area accounts for 29% of the total net irrigated area in 2005.

Tank Irrigation

Tank irrigation contributed to more than one-third of the total net irrigated area in 1971, and had lost more than half of its net irrigated area by 2005. Although rainfall explains a significant part of the annual variation in tank irrigated area, there has been a consistent declining trend in tank irrigated area over the last few decades. Today, tank irrigated areas are only 17% of the total net irrigated area.

Groundwater Irrigation

Groundwater irrigation contributed only 30% to the net irrigated area in 1971. This share had increased to 54% by 2005. Groundwater expansion shows different growth patterns. First, it has replaced the area lost under surface irrigation, especially that under tank commands.

Second, it has spread well outside surface water command areas. Third, groundwater irrigation, especially through dug wells, seemed to be unsustainable in many regions. Dug wells were the main contributors to the growth of groundwater irrigation before the late 1990s. However, this contribution has been decreasing in recent years. Fourth, it is clear that reliance on tube wells in groundwater irrigation is increasing. In 1991, tube wells contributed to only 2% of groundwater irrigation. But this share had increased to 23% by 2005.

Gross Irrigated Area

Gross irrigated area has had a slight declining trend since the 1990s. This is primarily due to declining irrigation intensity. The irrigation intensity decreased from 130% in 1990 to 112% in 2005.

Given the trend in the irrigated area under different sources of irrigation, it is important to provide appropriate strategies to sustain the irrigation sector. Even though a vast array of recommendations is available through several research studies, the following measures could be considered and action initiated to manage the supply-demand gap in Tamil Nadu. The measures are grouped under "Policy Interventions" as follows:

Policy Interventions

Given the projection for 2050, the total water resources of the state including the potential interbasin transfers will be about 46,540 million cubic meters (Mm^3) compared to the total demand of 57,725 Mm^3 (i.e., agricultural demand of 49,978 and nonagricultural demand of 7,747 Mm^3). The projected supply-demand gap will be 11,185 Mm^3 (24%) (GoTN 2003). The gap will be further widened if the agreed interbasin transfers cannot be implemented and also if rainfall variability increases. Hence, it is important to address the needed policy interventions that may help bridge this gap for which the following are suggested.

Policy Interventions in Well Irrigation

The level of groundwater exploitation has been increasing over the years (Table 1). The number of critical blocks increased from 10.8% in 1987 to 46.2% in 1998.

Table 1. Level of groundwater extraction in Tamil Nadu.

Year of assessment	Total no. of blocks	Categorization of blocks (No.)		
		Critical	Semi-critical	Safe
1987	378	41	86	251
1992	384	89	86	200
1998	385	178	70	137

Extraction level: critical = 90-100%; semi-critical = 70-90%; safe = <70%.
Source: Director of Agriculture 2006.

In the case of electricity consumption in Tamil Nadu, out of the total pump sets (9.04 million), about 51.5% are accounted for by 5 HP electricity, followed by 7-10 HP pump sets (23.8%), indicating the need for protecting these regions from well failure due to overexploitation. Hence, it is important to identify appropriate strategies to manage the groundwater resources in the state.

Impact of Watershed Program

The watershed program has been implemented by different project implementing agencies, concentrating mainly on soil and water conservation and development of the rain-fed area. So far, about 4,000 micro-watersheds have been treated out of 19,240 in the state. As such, they account for about 10% of the area under rain-fed conditions and 1% of the area under wastelands. One of the major interventions is recharging the groundwater. According to the research studies conducted, rise in water levels varies from 3 to 7 m over the seasons (Palanisami and Sureshkumar 2005). On the basis of analysis of 358 watersheds, the following recommendations have been made.

Recommendations

- Intensify watershed developmental activities, especially in overexploited and critical blocks on a priority basis so that dysfunctionality of wells will be minimized. The abandoned wells should also be used for groundwater recharge.
- Water saving techniques, such as drip and sprinkler irrigation methods, should be introduced to all the commercial crops, and all the extension officers should be trained who, in turn, can train the farmers in the installation and maintenance of the systems. In addition, capacity building programs at the village level should be initiated to benefit all the farmers in the villages.
- A watershed program with recharging options should be implemented in areas with rainfall ranges of 700-1,000 mm/year.
- In tank-intensive regions, the focus of the program should be on soil and water conservation while in well-intensive regions, the focus should be on groundwater recharge.
- Combining five to six micro-watersheds will enhance the benefits of watershed programs.
- Wells in a zone of influence of 400 m (from the upstream of the water storage structures) should be accounted for while planning the water harvesting structures.
- Agricultural and livestock activities should be combined in all the watershed programs.
- A decision support system (DSS) incorporating the above options can be developed for each district and this DSS should be used for planning the watershed programs.
- Guidelines for post-project management of watershed programs should be developed for better management of watersheds.

Policy Interventions in Tank Irrigation

Tank irrigation systems in South India are centuries-old and they account for over 30% of the total irrigated area. According to the records, there are about 39,200 tanks in Tamil Nadu with varying sizes and types. Most of the tanks are mainly used to irrigate the rice crop from September to December. Several constraints limit the productivity of these tanks. Tank siltation, foreshore encroachment and poor maintenance of structures are major aboveoutlet problems; absence of water user associations (WUAs), a poor distribution system and inadequate groundwater supplies for supplemental irrigation are major below-outlet problems (Palanisami 2005). In three out of 10 years, the tanks get adequate storage (Table 2).

Table 2. Tank irrigation in Tamil Nadu in a 10-year period.

Tank storage	Storage level (%)	Probability[1]
Surplus	> 100	0.1
Full	70-100	0.2
Deficit	50-70	0.5
Very low	<50	0.2

[1]Based on 46 years' rainfall data.

Even though the number of tanks is about 39,200, it is not known how many are still functioning. The results of the study had indicated that in less-tank-intensive regions, about 64% of Public Works Department (PWD) tanks and 76% of the Panchayat Union (PU) tanks are defunct. In tank-intensive regions, about 2.6% of PWD tanks and 1.2% of PU tanks are defunct, showing that there is still a potential to make the tanks a better investment entity (Table 3).

Table 3. Tanks in Tamil Nadu: Functioning and defunct tanks.

Region/Tank type	Number of tanks		Mean command Area (ha)	
	PU	PWD	PU	PWD
Tank-intensive districts				
Total tanks counted	2,064	487		
Functioning tanks	2,039	474	12.67	105.2
(%)	98.8	97.4		
Defunct tanks	25	13	15.81	74.81
(%)	1.2	2.6		
Less-tank-intensive districts				
Total tanks counted	67	90		
Functioning tanks	16	32	22.48	79.75
(%)	23.9	35.6		
Defunct tanks	51	58	18.16	99.46
(%)	76.1	64.4		

Conversion of Tanks to Percolation Ponds

As rainfall has been varying much over the years, several tanks are functioning as percolation ponds, recharging the wells in the tank command. A partial budget was worked out using a 15-tank sample in the southern districts with the aim of comparing the financial gains and losses by cultivating paddy and sugarcane crops. Normally, a farmer with a command area under a tank with well conditions and having 2 ha land prefers to cultivate 1 ha each of paddy and sugarcane. The same farmer in the tank-only situation could cultivate only paddy in the 2 ha. Farmers with wells would be able to get a net income of about Rs 49,000/ha compared to those in other categories (Table 4).

Table 4. Value of production in tanks (using data from 15 tanks in southern Tamil Nadu).

Typology	Total value of production (Rs)	Total income (Rs/ha)	Additional income (Rs/ha)	Cost of cultivation (Rs/ha)	Net income (Rs/ha)	Additional net income (Rs/ha)
Tanks	2,344,490	28,343	0	17,589	10,754	0
Tank+ wells	13,049,154	71,406	43,063	38,719	32,687	21,933
Wells	2,656,928	106,582	78,238	57,505	49,076	38,322

Tank Sluice Rotation and Optimum Well Pumping

Currently, the tank sluices are continuously open and the tank water is exhausted within 6-8 weeks of the release of tank water. Hence, to keep the tank water available for a longer period and for wells to get recharged, tank sluices can be rotated alternately. By doing so, the tank water can be sustained for 10-12 weeks and groundwater supplementation assured to all farmers.

Well owners maximize profits from water sales when the water level is about 5 meters from the surface and this corresponds to about 5.6 hours of pumping per day from the well. Under these conditions, output of well water can best be increased by having farmers install more wells with increased competition. With more wells, the demand for water from each individual well will fall, resulting in a lower price for well water. According to a detailed survey, the number of wells can be increased by 25% in many tank command areas.

Tank Modernization and Its Impact

Tank modernization is one of the key strategies being recommended in all the policy documents. Even though tanks have been modernized through different programs in a small scale, a major program was implemented from 1984-85 to 1994-95, with financial aid from the European Economic Community (EEC). In the first phase (1984-91), 150 nonsystem tanks with a command area of 100-200 ha were selected for modernization with a financial outlay of Rs 450 million. In the second phase (1989-1995), an additional 230 tanks were included and in the same period, considered as Phase II extension, 269 tanks were included at a financial outlay of Rs 500 million. The approximate cost per hectare was Rs 21,000. The project was expected to save about 20% of water over the present use, thus permitting the expansion of cultivation by about 9,000 ha (PWD 1986).

There is no significant difference in the performance between modernized and non-modernized tanks in the region except marginal improvements in terms of water availability in tanks, reduction in encroachment, siltation, presence of WUAs and area covered by wells (Table 5). Since the EEC program was adopted, the package of modernization had the same modernization strategies for all tanks irrespective of their physical conditions. Hence, it is important to identify appropriate selective modernization strategies. Different tank modernization strategies have been examined which include sluice modification, provision of additional wells, sluice management and sluice rotation (Palanisami and Easter 2000).

Table 5. EEC tank modernization: Performance of EEC versus non-EEC tanks.

	Parameter	EEC tanks	Non-EEC tanks
1	Tank performance (%)	81.72	77.63
2	Filling pattern (no. of times)	1.36	1.28
3	Water availability (no. of days)	56.52	52.20
4	Siltation (%)	36.2	46.8
5	Presence of WUAs (%)	36.0	28.0
6	Farmers' participation (%)	40.0	42.0
7	Presence of Neerkatti (%)	68.0	64.0
8	Maintenance of tanks (%)	44.0	36.0
9	Farm income (Rs/acre)	6,240.0	5,975.0
10	Water management (%)	12.0	12.0
11	Equal water distribution (%)	40.0	38.0
12	Employment opportunity (man-days)	40.0	40.0
13	Cooperation among farmers (%)	44.0	40.0
14	Encroachment (%)	36.2	44.5
15	Area covered per well (ha)	9.0	11.0

Note: Based on a study of 50 tanks in the southern districts of Tamil Nadu.

Source: Palanisami et al. 2008.

Recommendations

- Wherever tanks receive less than 40% storages even in normal rainfall periods, they can be examined for their conversion into percolation ponds with encouragement for groundwater development. In other tanks with 40-70% storages, crop diversification should be encouraged with adequate market facilities and crop insurance programs.
- The conversion index of a tank-percolation pond should be developed. IWMI scientists will further work on this. Mostly rain-fed tanks with a lesser number of fillings should be considered while making the decisions on tank conversion.
- Tank farmers' associations should be strengthened and tank sluice management for water distribution practiced using the available groundwater supplies.
- Since the stabilization value of groundwater in tank systems is higher, it is always recommended to have an optimum number of wells in tank commands, such as one well per 2 ha in well-only situations, one well per 4 ha in tank-cum-well situations and one well per 10 ha in tank situations.
- The total number of wells in a tank command can be increased by 25%. Community wells should be encouraged to benefit the small and marginal farmers in the tank command and free electricity supplies should also be available to community wells for individual well owners to irrigate in the tank command.
- Partial desilting of tanks as a modernization option should be introduced and farmers encouraged to use the tank silt in their fields.

- Different revenue-generation options will help the tank management to be sustainable and hence such options in the tanks should be worked out.
- While implementing the watershed programs in tank-intensive regions, watershed structures in the tank foreshore should be avoided.

Policy Interventions in Canal Irrigation

Canal irrigation accounts for about one-third of the total irrigated area in the state. Three major areas of concern are:

1. How can inter-sectoral demand be met in the future?
2. How will water charges help support the subsidy calculations?
3. What are the future investment options?

Inter-sectoral Water Demand

The state water policy highlights the priorities in water allocation starting from the domestic sector onwards. It is expected that, wherever possible, the existing reservoirs have to meet the increasing domestic water demand and if so, then what is the impact of meeting this demand on irrigated agriculture? Keeping this in view, a detailed study was done in the Lower Bhavani Project (LBP) and Amaravathi (Reservoir Project [ARP]) areas to appraise the future water demand. Accordingly, in the LBP, nonagricultural demand will increase by 50% in the next 10 years and in the irrigation sector, water availability will decrease by 50% in dry seasons even though the wet season can manage the water shortages from canals (Table 6). The revenue generation also varies from domestic to irrigation sectors. Revenue from nonagriculture sectors will increase by Rs 319 million (30%) between 2010 and 2015, whereas the revenue from agriculture will decrease by Rs 131 million (9.2%) in the same period.

Table 6. Comparison of agricultural and nonagricultural demand in the Bhavani Basin.

Factors	2005	2010	2015
Water use (28.32 million m^3)			
Nonagriculture sectors	10.48	13.28	16.86
Agriculture sector			
Bhavani River	19.79	19.79	19.79
Lower Bhavani – Odd season	16.88	16.88	16.17
Lower Bhavani – Even season	8.11	4.39	0.62
Revenue generation (Rs million)			
Nonagriculture	819	1,063	1,382
Agriculture	1,522	1,422	1,291

Appropriate Irrigation Investment Options in Canals, Wells and Tanks

The internal rate of return (IRR) clearly indicates the rates of return for different investment types and it will be high for small system tanks (20.6%), followed by large system tanks (20.3%). In general, system tanks offer 19.8% return over the investment. Shallow tube wells within the surface command and dug wells within the surface water command have an IRR of 20.7% and 19.3%, respectively. The IRR to dug wells within the surface command will be 12.2%. Both watercourse and main system improvement will have 14.1 and 13.9% returns, compared to a 6.1% return over the investment on unimproved types. Similarly, improvement of watercourses could yield 13.4% followed by improvement of the main system (13.2 %) and unimproved types (6.2%) (Table 7).

Table 7. Financial evaluation of future investment strategies in Tamil Nadu.

Source	Benefit-cost ratio		IRR
	10%	15%	(%)
Reservoirs	0.77	0.58	6.1
Unimproved	0.77	0.59	6.1
Main system improvement	1.27	0.94	13.9
Water course improvement	1.28	0.95	14.1
Wells			
Dug wells	1.06	0.90	11.7
Within surface systems	1.46	1.10	19.3
Outside surface systems	0.76	0.57	6.0
Deep tube wells	0.96	0.75	8.1
Within surface systems	1.13	0.76	12.2
Outside surface systems	0.81	0.55	6.8
Shallow tube wells	1.37	1.13	18.0
Within surface systems	1.55	1.27	20.7
Outside surface systems	1.39	1.15	18.1
Tanks			
System tanks	1.49	1.22	19.8
Medium/large	1.52	1.25	20.3
Small	1.55	1.27	20.6
Nonsystem tanks	0.76	0.50	5.8
Medium/large	0.78	0.52	6.2
Small	0.80	0.52	6.4

Note: Surface systems refer to the reservoir and tank-irrigated command areas.

Recommendations

- Big reservoir systems have the advantage of new investment in watercourse improvements, and tanks will be benefited by investments in the main system improvements.
- In order to implement the water management strategies, investment in watercourse improvements should be given priority followed by secondary and main system management.
- Water harvesting plans for the Cauvery deltaic zone involving the existing and new tanks both in old and new deltas should be explored.

Water Management

Improved water management is one of the short-term strategies that can help save the irrigation water. About 10% saving in water would result in 14 Mha of additional area under irrigation (GOI 2006).

Current water use efficiency:
Canals: 35-45%; tanks: 30-50%; wells: 40-65%

Given the scope of introducing water management technologies in canals, tanks and wells, it is possible to save about 919 ha.cm, i.e., 20% of the total water supply (Table 8).

Table 8. Possible water savings in major crops.

Crop	Gross area irrigated (000 ha)	Present water use (000 ha.m)	Water reduction possible (%)	Total saving ('000 ha.m)
Rice	2,107	3,160	25	790
Sugarcane	283	566	17	96
Cotton	80	48	15	7
Groundnut	270	121	15	18
With drip/sprinkler	20	32	25	8
Total				0.92 M.ha.m or 325 Bcf

M.ha.m = million hectare meters; Bcf = billion cubic feet; 1 M.ha.m = 353.26 Bcf; 1 Mm^3= 0.0353 Bcf.

The reuse of wastewater is important. The sewage generated from river basins indicates that about 730 Mm^3 can be reused, assuming that 75% of water supplied to the urban population returns as sewage and 90% of it can be reused. This means about 67% of domestic water demand can be reused in the future (GOTN 2003).

Recommendations

- Transfer of water management technology and upkeep options should be given top priority in investment plans. Types of technologies suitable for different crops and regions in the future should be prepared covering the state as a whole. Also capacity-building aspects should be strengthened at various levels.
- Analysis of constraints in technology adoption and the required strategies for upscaling them should be assessed.
- Implement a focused capacity building program involving the drip farmers in further upscaling drip irrigation and other related management strategies.
- The cost of wastewater treatment and transaction cost for delivery to different locations should be worked out and compared with alternative sources of supply.

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