Original Article

The economic and ecological impacts of tank restoration in South India

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Abstract Using 'before and after' and 'with and without' methods, this paper assesses the economic and ecological impacts of tank restoration in three villages in Andhra Pradesh, India. This study finds positive impacts of tank restoration on economic and ecological indicators that unequivocally support the rationale for tank restoration in the drought-prone regions. Moreover, the impact is greater in the case of small and marginal farmers when compared with large farmers, indicating a positive effect/influence on poverty. This study also documents the improvements of the groundwater table in the programme villages and the resultant increase in *rabi* (the second crop in the agricultural season (December–April)) crop acreage and yield rates. Availability of fodder (ecological impact) has strengthened the livestock economy of the programme villages. The economic and ecological impacts of the programme are significant in the case of tanks restored before 1995–1996, indicating the sustainability of the programme.

Cet article évalue les impacts économiques et écologiques de la restauration de réservoirs dans trois villages d'AP' en Inde, en utilisant les méthodes « avant-après » et « avec ou sans ». Les indicateurs positifs obtenus par l'étude justifient la restauration de ces réservoirs dans les régions sujettes à la sécheresse. De plus, l'impact est plus important dans le cas de petits producteurs marginaux que dans le cas de grands producteurs, ce qui indique un effet positif sur la réduction de la pauvreté. L'étude décrit également les améliorations concernant les nappes phréatiques dans les villages du programme et l'augmentation induite des surperficies et rendements des cultures du rabi (seconde saison, de décembre à avril). La disponibilité du fourrage (impact écologique) a renforcé l'activité d'élevage dans les villages du programme. Les impacts économiques et écologiques sont significatifs dans le cas des réservoirs restaurés avant 1995–1996, montrant la durabilité du programme.

European Journal of Development Research (2009) **21,** 112–136. doi:10.1057/ejdr.2008.12

Keywords: tank restoration; impacts; economic; ecological; Andhra Pradesh; India

Background

In India, age-old water harvesting and storage systems such as tanks and ponds are becoming things of the past because of lack of any sort of maintenance by the state or civil society. These traditional systems of resource management have been degenerated over time because of unwarranted interventions by the state and changing socio-economic and political conditions at the village level. As a result, irrigation using these water sources has encountered a growing gap between capacities and the net area irrigated. In fact, by 1999–2000, the net area irrigated by tanks was just 6.52 lakh hectares, almost half of the 13.71 lakh hectares potentially inherited under tanks between 1950 and 1951. This declining capacity of the tanks has led to loss of groundwater recharge in the tank-dominated regions that are relatively dry, drought-prone and dependent on wells (Reddy, 1998). Well irrigation recorded a phenomenal rise after 1950–1951, and moved from the third to the first position in terms of area irrigated by a single source. This has, in turn, created considerable imbalance in the ecological and social systems of the country.

Tanks[1] replenish the groundwater table and help in maintaining ecological balance. Declining tank irrigation and expansion of groundwater development are recipes for disaster, especially in the drought-prone regions such as Rayalaseema in Andhra Pradesh (AP). The literature identifies numerous socio-economic, institutional and physical reasons for the decline of tank irrigation (von Oppen and Rao, 1980a; Reddy, 1990, 1995; Shankari, 1991; Janakarajan, 1993; Reddy *et al*, 1993; Gireesh *et al*, 1997). Historically, the decline in tank irrigation has been linked with increasing population density (von Oppen and Rao, 1980b). It has also been linked to the development of well irrigation, as with the decline in benefits from community-based technology/sources (tanks), people shift toward individual-based technology/sources (wells). This, however, connotes a wrong notion of substitutability between tank and well irrigation, particularly because tanks complement groundwater development in reality. The decline of traditional systems, therefore, is a cumulative effect of policy and institutional neglect.

Institutional arrangements such as *Dasabandam* and *Kudimaramat*, nurtured by benevolent local rulers, were in place to protect these systems from decay.[2] Under *Dasabandam*, tank lands were created and given to a person in the village (*poligars*) for the purpose of maintaining the tank. Under *Kudimaramat*, the community voluntarily participates in maintaining the tank. However, the policy shift towards major and medium irrigation during the British period, coupled with the changes in policy perception of irrigation development, that is, treating it as a productive (revenue-generating source) rather than a protective source, has resulted in the degeneration of these institutions. In addition, overall environmental degradation because of increasing population pressure, especially in drought-prone regions, has led to silting of tanks and shrinking of their capacities. This, in turn, has led to the shift towards private well irrigation. Declining tank irrigation and expansion of well irrigation were stabilized towards the end of the British period, and the stabilization continued until the 1980s.

The second phase of this trend was triggered by the advent of the energization of groundwater lifting mechanisms. The new technologies in pumping systems during the 1980s coupled with the benefits from green revolution technology have resulted in an unprecedented expansion of groundwater development. Further, poor farmers were not in a position to adopt these technologies because of their capital-intensive nature, especially during the initial stages. As a result, a large number of open wells have started drying up in drought-prone regions. In fact, well failure (including borewells) has become a common phenomenon in the recent past, indicating an impending ecological disaster. All the while, unfortunately, the state has been a silent spectator, and party to this ecological mismanagement. The problem lies in treating tanks and groundwater in isolation of one another rather than by following an integrated approach. Even the recent policy changes in water management have been limited to surface irrigation (canal and tank), and do not include groundwater. Although there is every reason to protect and strengthen traditional systems such as tanks, there is also a need to examine their viability and sustainability in the long run. The economic viability of tanks, given their scale, is crucial for the communities to realize their importance in improving their livelihoods. Tanks being common pool resources (CPRs), collective action is a prerequisite to managing them in a sustainable manner. This becomes important in the context of the changing socio-economic and political scenario. This paper is an attempt to explore the economic as well as ecological rationale for strengthening and promoting tank systems in drought-prone regions, and their sustainability in the long run. The analysis assumes policy relevance in the light of the recently initiated tank restoration programme in AP, and the budgetary provisions at the all-India level. AP has embarked on a massive tank restoration programme, with financial support of US$189 million from the World Bank.[3]

Framework

Of late, there has been great emphasis on the judicious management of water at the policy level. Market (pricing) and institutional (user participation) approaches are suggested to overcome the persistent problems. However, these policy measures mostly remain on paper, whereas much need to be carried out at the implementation level. This is mainly because of the absence of balanced development of various resources such as surface versus groundwater and major versus minor. It is now clear that large irrigation projects, though useful, cannot solve the water scarcity problem in all regions. They may ensure food security at the macro level but not at the micro and/or household level. This can be achieved through rainwater harvesting and conservation with the help of water harvesting structures and watershed technologies. Most of the methods of water harvesting and conservation are also cost effective when compared to large irrigation systems. What then stops their implementation? As these programmes are area-based, the involvement and cooperation of local communities are necessary for their success. This requires the development of social capital at the community level. Therefore, the basic approach ought to be fundamentally institutional, though one cannot discard the market approach totally. Ineffective institutional arrangements existing at the operation and maintenance (irrigation department) level and lack of political will have further aggravated the situation. What follows is a brief theoretical discussion on the role of market and institutional approaches in natural resource management.

It is often presumed that market failure is the main reason for the mismanagement of natural resources in most developing countries. On the other hand, local institutions are expected to resolve the problems relating to environmental degradation in rural areas (Hatzius, 1994). In the context of natural resource management, these approaches are expected to be effective when used as complements rather than substitutes. Though markets are expected to lead to efficient allocation of resources in the long run, their role in equitable distribution is questionable, especially in scarcity conditions. Similarly, institutions alone may result in inefficient allocation of resources, and their role in equitable distribution of resources may be rather ambiguous in the context of scarcity and changing socio-political dimensions. Local institutions are inefficient in allocating the resources, as they do not adhere to market principles such as cost-based pricing. Although the importance of institutional and market mechanisms are well recognized at the policy level, their application in an integrated fashion deserves much greater attention. Failing to recognize these linkages has often led to erroneous conclusions such as resource degradation in rural areas of developing countries because of population explosion and poverty (Leach and Mearns, 1991; Vyas, 1991; Reddy, 1995). In the Indian context, although there are studies dealing with agrarian institutions (Bardhan, 1989) and common property resources (Jodha, 1986, 1990), the role of institutions in natural resource management has remained more or less a neglected area. However, there are case studies of a few success stories such as Sukhomajiri (Chopra *et al*, 1990), Panipanchayat (Deshpande and Reddy, 1991) and Ralegao Sidhi (Pagare and Pagare, 1994).

In the context of traditional tank systems, the literature concentrates more on explaining the reasons for their decline than on looking at their revival. It is often assumed that their revival is thwarted by the narrow policy pursuits and self-seeking behaviour of individuals. There are a few studies that have aimed at examining the dynamics of tank management in a collective action framework (Mosse, 2003). The collective action framework is the most appropriate to study and understand CPRs situations such as traditional tank systems. Recent attempts to provide a theoretical framework for collective action have aimed at drawing support from various disciplines and at putting it under the framework of Institutional Analysis and Development (Ostrom, 1990; Bromley, 1992; Ostrom *et al*, 1994). This approach is comprehensive and, in fact, fairly successful in explaining the success stories of the collective action situation, and has led to a shift in focus away from the so-called 'tragedy of the commons'. However, the limited number of successful cases compared to failures makes it a specific rather than a general framework. More importantly, though this approach explains the institutional sustainability part very well, its applicability is limited as far as institutional innovation and changes are concerned. The latter are equally important for understanding institutional success and failure in CPR management.

It has been observed that 'Currently dominant institutional-economic models fail to grasp the cultural specifics of irrigation as social practice and are a poor guide to the meanings and motivations of local institutional development' (Mosse, 2003, p. 287). Historically, local leaders have competed for control over water institutions, as these institutions tend to become financially stronger. The situations do not vary much between resources (irrigation or watershed development) or locations (Tamil Nadu or AP) (Mosse, 2003). As Bardhan (2004) puts it, 'In most poor countries, there are massive costs of collective action in building new economic institutions and political coalitions, and in breaking the deadlock of incumbent interests threatened by new technologies' (p. 481). Therefore, evolving, sustaining and replicating these institutional arrangements is not easy given the socio-cultural and political dynamics in countries such as India. This study analyses the issues at hand in the collective action framework in the context of tank management. The following are some of the important hypotheses that are addressed in the process of this study :

1. Tank restoration is still relevant for improving livelihoods and alleviating poverty in drought-prone regions.
2. Tanks restore the ecological balance between surface and groundwater resources.
3. Collective action is possible in resource management, provided there are incentives for cooperation.
4. Market strategies such as beneficiary contribution are necessary for strengthening and sustaining the collective strategies.

Objectives and Setting

This paper examines the impact of tank restoration on rural livelihoods in drought-prone regions. Some of the important aspects in this regard include viability of tank irrigation practices *vis-à-vis* their size, distribution of water resources across farm size and the role of communities in the process. Specifically, this paper (a) examines the impact of the tank restoration programme on rural livelihoods in terms of changes in cropping pattern, crop intensity, yield rates, employment, equity and so on, and (b) critically evaluates the viability, replicability and sustainability of the programme and suggests further interventions for sustainable water resource management in these regions.

Setting

The tank restoration programme was implemented by the Society for Promotion of Wasteland Development (henceforth SPWD), with the help of local non-governmental organizations (NGOs), in five drought-prone districts of AP (mainly Rayalaseema). These districts include Anantapur, Cuddapah, Kurnool, Chittoor and Prakasam. About 50 tanks have been restored, and some of these have been converted into percolation tanks. SPWD has initiated a network for the 'promotion of people's management of small irrigation schemes in Rayalaseema' with 18 NGOs. The involvement of the people is ensured through a mandatory contribution of 25 per cent of the total costs by all the beneficiaries, either in cash or in labour. Tank management committees (TMCs) have been formed to facilitate people's participation.[4]

About three fourths of Rayalaseema's crops consist of red cotton and the rest of black cotton, with a normal rainfall ranging between 520 and 720 mm, the lowest in the state. The proportion of irrigated area in this region is about 20 per cent of the net sown area. Canals contribute 30 per cent of the area under irrigation, and tanks and wells contribute the rest. Crop failure and drought are common phenomena, especially in Anantapur district. The non-farm sector is also relatively undeveloped, and hence seasonal migration is widespread in most parts of the region. Tanks are lifesaving mechanisms in most parts of these regions. The importance of tanks is, however, on the decline, especially in terms of area irrigated (Table 1). More than 75 per cent of these tanks are small in size (less than 100 hectares of area irrigated). In Chittoor, the proportion of small tanks is more than 90 per cent (Reddy *et al*, 1993).

The majority of the tanks in this region are small, with less than 100 acres of command area (Table 2).[5] In all the districts except Anantapur, the average size of land holding under small tanks is higher than that of large tanks. This may be due to the fact that wider

Table 1: Tank irrigation in the Rayalaseema districts

District	*1955–1956*[a]		*2000–2001*[b]	
	Number	*Area (ha)*	*Number*	*Area (ha)*
1. Anantapur	2237	37 254	2686	10 021
2. Chittoor	6626	72 024	7827	36 527
3. Cuddapah	1187	29 806	2088	7458
4. Kurnool	518	24 472	634	16 585
5. Prakasam	—	—	1126	27 255

[a]Net area irrigated by tanks.
[b]Latest data available from official documents.
Note: These data are generated once in 5 years. The data for 2005–2006 are being compiled at the moment. Presently Prakasam district is not a part of Rayalaseema, but parts of the present Prakasam district are originally from Rayalaseema.
Source: Reddy *et al* (1993)for 1985–1986 and GoAP (2000)for 1999–2000.

Table 2: Structure of the tanks in Rayalaseema

District/tank size	*Average farm size (acres)*	*% of SC/ST*	*% area irrigated*	*Number of crops grown*		*Reasons for decline*	*Suggestions for improvement*
				50 years back	*Present*		
Chittoor							
Big (11)	1.81	18	28	05	07	1, 6, 2	1
Small (287)	2.85	22	29	10	11	6, 1	1
Cuddapah							
Big (10)	5.34	33	16	05	08	1, 14	1, 5
Small (41)	3.94	05	20	07	07	1, 14	1, 5
Kurnool							
Big (6)	1.80	24	37	04	06	5	1
Small (12)	2.75	18	34	04	05	8	1
Anantapur							
Big (112)	5.83	23	25	10	07	1, 8	1, 6
Small (200)	4.06	19	33	15	10	1, 8	1, 5, 6
Prakasam							
Big (16)	3.49	13	21	02	03	2, 1	6, 1, 2
Small (45)	3.50	17	17	03	01	2, 1	6, 1, 2

Note: Big tanks are those having more than 100 acres of command area and small tanks are those having less than 100 acres. Figures in parentheses indicate number of sample tanks. SC/ST = Scheduled Castes and Scheduled Tribes.
Reasons: 1 = silting up because of lack of treatment of the catchment area; 2 = breach; 5 = encroachment of tank bed; 6 = no reason; 8 = low rainfall; 14 = lack of initiative and leadership in the village.
Suggestions: 1 = desilting and treatment of catchment area; 2 = no suggestions; 5 = watershed development; 6 = repairing and clearing the tank bed.
Source: Based on the data collected by local NGOs in 36 Mandals (administrative division below district and above village level). These data are provided by SPWD, Hyderabad.

coverage of large tanks includes all sections of the farmers, whereas small tanks may be specifically serving the medium and large farmers. The proportion of scheduled castes and scheduled tribes (SC/ST households) covered is more than 20 per cent under large tanks in three out of five districts. Therefore, large tanks, by nature, are relatively equitable.

Irrespective of their size, tanks have degraded over the years for various reasons, although there has been little change in the cropping pattern. Only in Anantapur, the number of crops grown has declined compared to the situation 50 years ago. Paddy and groundnut continue to be the most important crops. The most important reason behind the decline of tank systems is the lack of maintenance in terms of desilting or repairing the bunds (1 and 2), followed by low rainfall (8), encroachment of tank bed (5) and lack of initiative or leadership in the community (14) (Table 2). Suggestions for improving the situation are more or less on the same lines, that is, desilting (1) and repairs to the breached bund (6). Watershed development (5) is also seen as an important tool for catchment area treatment and thus checking the tank siltation. There are only marginal differences between small and large tanks as far as reasons for decline and suggestions for improvement are concerned.

Approach

SPWD initiated the tank restoration programme in the early 1990s. A total of six tanks, three tanks each in Adepalli and Venglavaripalli, were restored during 1993–1994 and 1997, respectively, and two in Akkapalli were restored during 1997–1998 (Table 3 and Figure 1). The restored tanks were grouped into those (a) restored before 1995–1996 and (b) after 1995–1996. The reason for this bifurcation is that the tanks fall under the first batch (1993–1994) and the last batch (1997–1998) of the tank restoration programme of SPWD. In addition, this bifurcation helps us to understand the sustainability of the restoration programme, and its impact. For the purpose of our study, we select one of the tanks restored before 1995–1996 and two after 1995–1996, from Anantapur, Chittoor and Prakasam districts. In addition, a matching sample of one village each for the restored tank village, where there is no restoration programme, is selected to compare with and without situations. Thus, a sample of three control villages was selected from the respective districts. Control villages are larger in terms of number of households when compared to the villages where tanks have been restored (Table 3).

Both qualitative and quantitative information was elicited. Group discussions, transect walks and discussions with the local NGOs and SPWD were conducted to obtain an overview of the situation. ‘Before and after’ as well as ‘with and without’ approaches were applied to evaluate the impact of tank restoration (double difference). Both of these methods were used as complementary, as either is fraught with the problem of memory lapse in the case of before and after and estimation problems in the case of with and without approach (for interesting analyses see Ravallion, 2001). Here, the problem of memory lapse in obtaining ‘before’ information is not serious, as the time lag is 7 years in the case of Anantapur and less than 3 years in the case of Chittoor and Prakasam districts.

Three structured questionnaires were prepared in order to elicit information at the NGO (implementing agency), village and household levels. A sample of 25 households was selected from the beneficiaries of each restored tank. These sample farmers were selected by comparing the Probability Proportionate Sample to the size of the land holding after classifying them into four groups, that is, marginal (less than 1 acre), small (1–2 acres),

Table 3: Details of the sample tanks

Tank/village name	*Mandal*	*District*	*Year of restoration*	*Total no. of HH*	*No. of command area farmers*	*Command area (acres)*	*Tank size (acres)*
(I) Restored tanks							
1. *Adepalli*	Chilamathur	Anantapur		73			
Adepalli Cheruvu			1993–1994		(a) 35	(a) 23.96	19
Nallarathi kunta			1993–1994		(b) 14	(b) 12.40	08
Jammala Kunta			1993–1994		(c) 12	(c) 09.18	07
2. *Venglavaripalli*	Emanapalli	Chittoor		54			
Yerrappagari kunta			1997		(a) 03	(a) 0.52	—[a]
Nagannagari kunta			1997		(b) 07	(b) 2.42	—
Tatappagari kunta			1997		(c) 13	(c) 4.50	—
3. *Akkapalli*	Kammarolu	Prakasam		118			
Kannela kunta			1997–1998		(a) 65	62	23
Rekula Kunta			1997–1998		(b) 80	146	60
(II) Unrestored tanks (control)							
1. *Korla kunta*	Chilamattur	Anantapur	—	195	68	70	65
2. *Valasapalli*	Madanapalle	Chittoor		150			
Nagula cheruvu			—		(a) 25	(a) 80	(a) 60
Akkulavani kunta			—		(b) 20	(b) 15	(b) 09
3. *Pottipalli*	Komarole	Prakasam	—	125	40	60	60

[a]These are very small ponds (*kuntas*).
Source: Village schedule and also based on the discussions with the community.

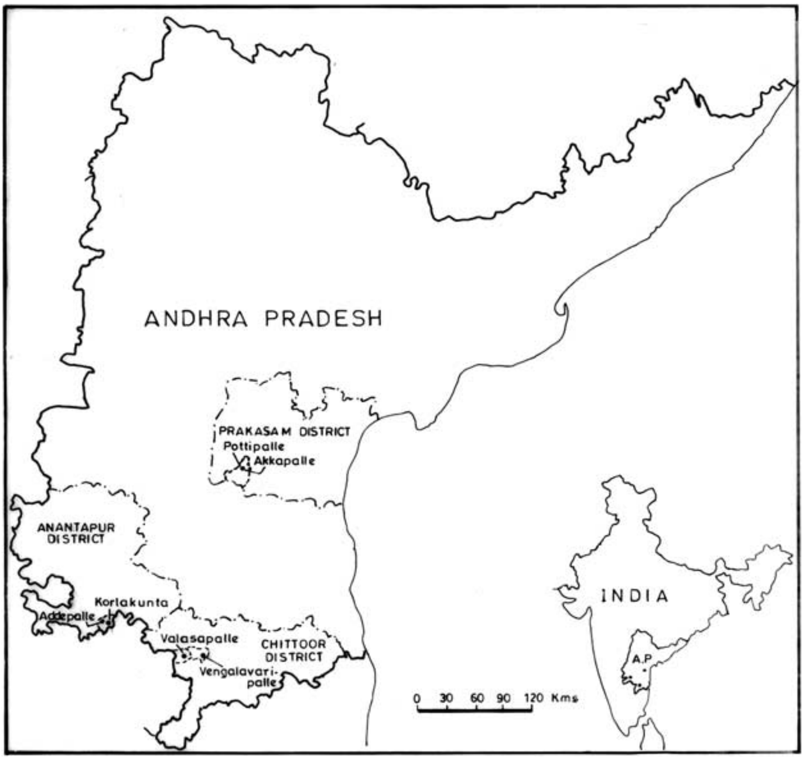

Figure 1: Location of sample tanks in Andhra Pradesh.

medium (2–5 acres) and large (above 5 acres). Another sample of 25 households was selected from the control village, which matches with the restored tank village in terms of various socio-economic attributes, except for the restored tank, using the same method of sampling. On the whole, we have collected detailed information from 150 households, that is, 75 each from the beneficiary and controlled villages (Table 4). Field visits and data collection were organized during the months of March – May 2001.

Profile of the Sample Villages

There are wide variations between the sample villages regarding their socio-economic features (Table 5). The average farm size ranges from 3.25 to 4.48 acres. In two of the districts average farm size is greater in the case of control villages. The selection of beneficiary villages was biased in favour of the villages that have a larger proportion of socially and economically weak sections. This is in line with the criterion adopted by the government while implementing programmes such as watershed development.

All three control villages are well connected with pucca (usually used in the context of concrete road) roads to *Mandal* (second/middle level administrative division within the district) head quarters or nearby towns. All the villages are electrified for both domestic and agricultural purposes. Health facilities are not easily accessible to the villagers; they have to go to nearby towns or *Mandal* headquarters. None of the villages have problems

Table 4: Details of the sample selection

Tank/village name	*Marginal*		*Small*		*Medium*		*Large*		*Total*	
	Act.	*Samp.*	*Act.*	*Samp*	*Act*	*Samp.*	*Act*	*Samp.*	*Act.*	*Samp.*
Restored tanks										
1Adepalli	28	09 (38)	30	10 (41)	13	04 (18)	02	02 (03)	73	25 (34)
2 Venglavaripalli	25	12 (46)	17	07 (31)	08	04 (15)	04	02 (07)	54	25 (46)
3 Akkapalli	21	05 (18)	30	06 (25)	67	14 (57)	00	00 (00)	118	25 (21)
Unrestored tanks (control)										
1. Korla kunta	28	06 (40)	25	03 (13)	72	08 (37)	19	02 (07)	195	25 (13)
2. Valasapalli	79	12 (19)	62	10 (41)	50	08 (33)	10	01 (10)	150	25 (17)
3. Pottipalli	23	05 (18)	63	12 (50)	24	05 (19)	15	03 (12)	125	25 (20)

Note: Act. = actual number of households in the village; Samp. = sample households selected.
Figures in parentheses are respective percentage to the total households. There are no landless households in any of the villages.

accessing drinking water. They have public supply either from overhead tanks (Valasapalle) or hand pumps, which provide drinking water throughout the year. In all three villages, primary education facilities are available. The main activity in these villages is farming and hence agriculture is the main source of livelihood (Table 6). Being a low rainfall region, livelihood is critically linked with the availability of irrigation water. In the programme villages, the proportion of area under irrigation ranges from 22 to 33 per cent of the net cropped area, whereas it ranges from 15 to 36 per cent in the control villages.

Income from agriculture is much higher in the villages where the tank restoration programme was taken up. Agriculture accounts for above 70 per cent of the household income in all the villages, programme as well as control (Table 7). Dependence on agriculture is slightly higher in the programme villages (paddy and groundnut are the important crops). Livestock rearing is the second largest livelihood activity in the sample villages, followed by labour activity. Households with livestock are less dependent on labour. A large proportion of labour income is from farm labour within the village in the case of programme villages, and some migration takes place in the case of control villages.

Status of irrigation

All the sample villages have irrigation tanks of different sizes, and there is more than one tank in some villages (Table 8). In the programme villages, all the existing tanks are restored with repairs to bund, feeder channels, distributory channels and so on. Two tanks in Adepalle are converted into percolation tanks. Tanks are the major source of irrigation in all the sample villages. The extent of irrigated area ranges from 24 to 33 per cent in the programme villages and 15 to 36 per cent in the control villages. The size of the tanks in the programme villages is much smaller compared to the tanks in the control villages. This is mainly because small tanks are given priority in the restoration programme. The first indicator of the impact of tank restoration is reflected in the quality of the tanks. The command area served by each acre of tank bed is higher in the programme villages compared to the control villages, despite the fact that control villages have larger tanks (Table 8).

Table 5: Socio-economic characteristics of the sample villages

Village	*No. of HH*	*% of sample*	*Avg. size of HH*	*Avg. size of land holding (acres)*	*% of households belonging to (farm size)*				*% of HH belonging to SC/ST*	*Avg. income (Rs/HH)*
					Large	*Medium*	*Small*	*Marginal*		
Programme villages										
1. Adepalle	73	34	5.26	3.79	3	18	41	38	56	8820
2. V.V. Palle	54	46	5.35	3.44	7	15	31	47	15	5495
3 Akkapalle	118	21	5.33	3.25	0	57	25	18	17	6837
Control villages										
1. Korlakunta	195	13	4.72	4.48	10	37	13	40	26	6650
2. Valasapalle	150	17	5.64	3.30	7	33	41	19	0	6039
3. Pottipalle	125	20	4.12	3.96	12	19	50	19	3	12 926

Note: HH = households.

Table 6: Economic status of the sample households

Village	*Marginal farmer (% of HH)*	*Small farmer (% of HH)*	*Medium farmer (% of HH)*	*Large farmer (% of HH)*	*Cropping pattern*	*Main occupation*	*% of area irrigated*
Programme villages							
1. Adepalle	36.0	40.0	16.0	8.0	1, 2, 3, 4, 5, 6	Farming	22.52
2. V.V. Palle	48.0	29.0	16.0	7.0	1, 2, 4	Farming	24.00
3 Akkapalle	20.0	23.0	57.0	—	1, 11, 12, 13, 7, 8, 6	Farming	33.44
Control villages							
1. Korlakunta	48.0	12.0	32.0	8.0	7, 2, 4, 6	Farming	18.92
2. Valasapalle	24.0	40.0	32.0	4.0	1, 8, 2, 4, 9, 10	Farming	36.00
3. Pottipalle	20.0	48.0	20.0	12.0	1, 2, 11, 13, 14, 8	Farming	15.00

Note: HH = households; Cropping pattern is given in the order of importance. Crop codes: 1 = paddy; 2 = groundnut; 3 = mulbary; 4 = ragi; 5 = onion; 6 = sunflower; 7 = maize; 8 = tomato; 9 = jowar; 10 = horse gram; 11 = red gram; 12 = castor; 13 = chilly; 14 = cotton.

Table 7: Share of income from various livelihood activities

Village	*Share of various activities in total household income (%)*			
	Agriculture + horticulture	*Livestock*	*Labour*	*Others*
Programme villages				
1. Adepalle	80	14	06	00
2. V.V. Palle	71	09	12	08
3. Akkapalle	76	13	10	01
Control villages				
1. Korlakunta	72	20	08	00
2. Valasapalle	73	12	15	00
3. Pottipalle	71	12	03	14

Note: Others include income from CPRs and so on.

Table 8: Details of tanks in the sample villages

Village name	*No.*	*Tank size (acres)*	*Command area (acres)*	*No. of tanks restored*	*Command area/tank size*	*NGO responsible*
Programme villages						
1. Adepalle	3	34	45.54	3.00	1.34	Chaitanya
2. V.V. Palle	3	6.44	07.44	3.00	1.15	Krushi
3. Akkapalle	2	83	208	2.00	2.51	CAFORD
Control villages						
1. Korlakunta	1	83	70	0.0	0.84	—
2. Valasapalle						
3. Pottipalle	2	69	95	0.0	1.38	—

Note: CAFORD = Collective Action for Rural Development.

Well irrigation complements tank irrigation in most of the sample villages; both open and borewells exist in these villages (Table 9). However, all the open wells have dried up in all the villages. As a result, dependence on borewells is on the rise. The functioning of borewells is critically linked with groundwater recharge in the region. Groundwater, like any other renewable resource, can be exploited indefinitely as long as the extraction rate does not exceed the replenishment rate. The mismatch between these two rates is clearly reflected in the sample villages, where even borewells are drying up, especially in the control villages, this despite the fact that most of these wells are located in the TCA. For instance, in Pottipalle (control village), 52 borewells have come up in recent years, and serve only 10 acres of land, because most of the wells have dried up and well yields are quite low. On the other hand, the situation is not bad in Adepalle (programme village), where borewell density is quite high. Three tanks were restored here, two of which were converted into percolation tanks. This clearly establishes the complementarity between tank and well irrigation, and emphasizes the rationale for tank restoration in this region. Apart from the ecological consequences, well failure imposes severe economic burdens on households (Reddy, 2005).

Table 9: Details of wells in the sample villages

Village	*No. of wells present*		*Density of wells (no./cropped area)*		*Density of wells (no./command area)*		*Area irrigated by wells (acres)*	
	Open	*Bore*	*Open*	*Bore*	*Open*	*Bore*	*Open*	*Bore**
Programme villages								
1. Adepalle	06	27	0.02	0.10	0.16	0.72	Dried	38
2. V.V. Palle	02	02	0.01	0.01	0.27	0.27	Dried	13
3. Akkapalle	08	13	0.02	0.03	0.04	0.06	Dried	70
Control villages								
1. Korlakunta	12	12	0.01	0.01	0.17	0.17	Dried	Dried
2. Valasapalle	05	15	0.01	0.03	0.05	0.16	Dried	45
3. Pottipalle	08	52	0.02	0.11	0.13	0.87	Dried	10

*Bore wells are located in the command area in all the villages except V.V. Palle, hence they serve the command area with assured water supply rather than irrigating extra area.

Institutional process of tank restoration

In the case of the Adepalle tanks, which were restored in 1993, the long-run sustainability of the restored tanks can be examined. The TMC, which was formed at the time of restoration, is working fairly well with the help of the NGOs. Of the three tanks, two are percolation tanks and the other is an irrigation tank. The work carried out in Adepalle includes closing down sluices for percolation tanks, desiltation, treatment of catchment areas and feeding channels, strengthening bunds and so on. All the work took 3 months to complete. The total expenditure incurred for restoration was Rs. 184 000 (US$4600), of which Rs. 95 000 (US$2375) was contributed by SPWD. The remaining amount was contributed by the farmers in the command area (Table 10). The share of beneficiary contribution was quite high (48 per cent) by any standard. Beneficiaries have contributed in terms of labour and materials (cement and so on) voluntarily. In addition, desiltation was carried out by the farmers interested in using the silt, at their own cost. The donor's contribution is used only towards tractor hiring charges, at the rate of Rs. 500 per day for a total of 190 tractor days. Tractors were provided to transport the silt to the farmer's fields.

The TMC was formed with nine members, of which three are women. The TMC is headed by a chairperson and supported by a secretary/treasurer. These members were selected/elected unanimously. So far, no elections were conducted to elect the members and the chairperson. They do not even follow a rotation system to change the members or the office bearers. The Project Implementing Agency (PIA) has left the process of establishing the TMC entirely to the community. In order to manage the limited water in the tank in an equitable manner among all the farmers in the command area, the implementing agency (NGO), with the help of TMC, imposed restrictions on water-intensive cropping patterns and other agricultural practices. At the beginning of each year, the TMC organizes a meeting of the command area farmers where the cropping pattern is determined based on the availability of water in the tank. In the event of water shortage, the TMC requests the farmers to reduce the area under paddy. Farmers growing paddy continuously are asked to rotate their cropping pattern. This arrangement seems to be working satisfactorily so far.

In V.V. Palle, the restoration work was carried out on three small ponds at the cost of Rs. 47 978 (US$1200). Almost all the expenditure was borne by SPWD. Here farmer contribution was in a different form: working at a low wage rate. Those farmers with land in the command area were paid Rs. 20 (US$0.50) per day, and those who did not have land in the command area were paid Rs. 25 per day towards wage. The difference in wage rate (Rs. 5) is the contribution of the farmers. In addition, beneficiary farmers put in extra hours (1–2) of work every day. Moreover, all the households, beneficiary and non-beneficiary, worked at less than market wage rate, indicating the community support for the activity. The main efforts carried out are desilting (78 per cent of the expenditure),

Table 10: Details of costs of tank restoration

Village	*District*	*NGOs*	*Amount spent by the NGO (Rs.)*	*Contribution from the farmers (Rs.)*	*Total costs (Rs.)*
Adepalle	Anantapur	Chaitanya	95 000	89 000 (48)	184 000
V.V Palle	Chittoor	Krushi Samstha	47 978	00	47 978
Akkapalle	Prakasam	CAFORD	200 000	34 000 (17)	234 000

stone revetment (10 per cent), slice (10 per cent) and green cover (2 per cent). Here also TMC was formed with eight members, and two of the members are women. The chairperson of the TMC is also a woman.

The two restored tanks in Akkapalle are large compared to those in Adepalle and V.V. Palle. The nature of work includes strengthening bunds, repairing sluices and so on. Here, the beneficiaries have contributed money (a minimum of Rs. 80/US$2.00 per acre) towards the restoration work. The villagers also took the responsibility to clear the weeds in the tank. However, because of unexpected rains at the time of restoration, they could not complete the work, and cleaning of the tank bed is still pending for various reasons. The tanks are quite large, and are degraded because of long periods of negligence. As a result, more investment and time to bring them back to functional form were required. It was also found that before restoration, the tanks were almost defunct. No TMC was formed, although farmers were keen to form one. Farmers themselves, with the help of contributions, are carrying out the maintenance work.

Beneficiary contribution was not uniform, as it ranged from a negligible amount in V.V. Palle (in monetary terms) to 48 per cent in Adepalle. Although V.V. Palle may be an exception owing to its smallness (and also the nature of people's involvement), the difference between Adepalle and Akkapalle reflects the involvement of the people as well as the role and commitment of the implementing agency.

Impact of Tank Restoration

Impact is measured in terms of changes in various indicators because of the tank restoration programme. It is measured across different size classes of holding in order to examine the distributional aspects of the impact. Impact indicators are grouped under economic and ecological categories. Economic impact is measured in terms of changes in area under irrigation, productivity (yield) of land, livestock holding, income and consumptions. Ecological impact is measured in terms of changes in CPRs, groundwater, fodder and fuelwood.

(a) Economic impact

Changes in area under irrigation is the prime indicator of any impact on rural livelihoods, especially where the major livelihood activity is farming. It was observed that the proportion of area under irrigation has increased, though marginally, among all the households in the programme villages after restoration of the tanks (Table 11). The changes ranged from 5 to 10 per cent in the three programme villages.[6] The increase is more in the case of small and marginal farmers in two of the villages, whereas medium farmers gained more in Adepalle. Distribution of area under irrigation is favourable to small and marginal farmers but this is not because of the programme, as this is true in the case of all the surface irrigation systems. On the other hand, area under irrigation is stagnant in the control villages. Apart from the quantitative changes in the area, qualitative changes in the availability of irrigation in terms of throughout-the-season regular and assured supplies are equally, if not more, important for improving the economic conditions of the farmers. This aspect is reflected in the changes in land productivity.

In all the programme villages, land productivity went up whereas it remained constant in the control villages. Productivity gains ranged from 26 per cent in V.V. Palle to 44 per

Table 11: Impact of tank restoration on area, productivity and land values in the sample households

Village/size-class	*% area irrigated*	*Percentage change in*		
		Area irrigated	*Land productivity yield/acre*	*Land value per acre*
Programme villages				
1. *Adepalle*	10.55	05.26	44.39	37.30
Large	03.94	02.50	36.28	22.95
Medium	06.83	38.10	44.67	25.00
Small	16.93	03.78	41.49	78.57
Marginal	12.02	05.56	61.00	23.15
2. *V.V. Palle*	10.75	08.82	26.57	33.33
Large	04.76	00.00	25.00	33.33
Medium	00.74	00.00	28.33	33.33
Small	19.60	00.00	26.75	33.33
Marginal	14.73	216.67	22.93	33.33
3. *Akkapalle*	29.53	10.34	36.25	28.67
Large	00	00	00	00
Medium	39.06	01.13	27.99	29.35
Small	31.54	11.40	33.30	28.97
Marginal	28.87	21.43	48.98	27.84
Control villages				
1. *Korlakunta*	26.33	00	00	00
Large	11.11	00	00	00
Medium	26.51	−16.67	00	00
Small	12.15	00	00	00
Marginal	16.57	00	00	00
2.*Valasapalle*	45.15	00	00	11.50
Large	45.45	00	00	00
Medium	53.24	00	00	12.00
Small	19.10	00	00	20.59
Marginal	25.00	00	00	15.79
3. *Pottipalle*	35.35	00	00	02.77
Large	29.04	00	00	16.66
Medium	22.81	00	00	00
Small	28.89	00	00	−8.33
Marginal	36.71	00	00	00

cent in Adepalle, which is the first village where tanks were restored (Table 11). Productivity gains are higher in the case of small and marginal farmers. The inverse relation between farm size and productivity indicates that small and marginal farmers are more efficient in terms of land productivity because of the availability of family labour. Along with land productivity, land value has also gone up in all the programme villages, as well as in two of the control villages. The increase in land value is much higher in the programme villages compared to the control villages (Table 11). Although land values have gone up by 28–37 per cent in the programme villages, they have gone up by only 3–12 per cent in the control villages.

Both income and consumption levels have gone up in all the sample villages, and even across all, except one, size classes (Table 12). Between the programme and control villages, two important deviations can be noted. (i) The increases in income and consumption are higher in the programme villages. (ii) Income increases are higher than the increases in consumption expenditure in the programme villages, whereas the reverse is true in the case of control villages. This indicates that net savings are positive in the programme villages. In most cases, small and marginal farmers have recorded higher growth in household income in both control and programme villages. On the other hand, in the case of consumption, the changes were either neutral or biased in favour of large farmers. Therefore,

Table 12: Change of average annual income and consumption of sample households

Village name/size-class	*Average income (Rs/year/household)*			*Average consumption (Rs/year/HH)*		
	Before	*After*	*% change*	*Before*	*After*	*% change*
Programme villages						
1. *Adepalle*	18 230	26 872	47	3839	5339	39
Large	35 833	55 167	54	4768	7224	52
Medium	13 750	18 250	33	4694	6265	33
Small	8586	14 571	70	2952	4015	36
Marginal	8750	8250	−06	2943	3850	31
2. *V.V. Palle*	11 895	16 329	37	3928	5261	34
Large	14 000	19 000	36	6104	7967	31
Medium	10 100	13 332	32	3915	5623	44
Small	8480	11 232	32	3331	4369	31
Marginal	6086	9021	48	2363	3085	31
3. *Akkapalle*	9452	13 999	48	3507	4420	26
Large	0	0	00	0	0	00
Medium	14 657	21 946	50	4388	5488	25
Small	7000	10 000	43	2902	3711	28
Marginal	6700	10 050	50	1804	2349	30
Control villages						
1. *Korlakunta*	17 465	17 810	02	4227	5111	21
Large	23 000	23 000	00	5176	6366	23
Medium	17 625	17 850	01	4221	4874	15
Small	18 400	18 650	01	4566	5558	22
Marginal	10 833	11 741	08	2945	3645	24
2. *Valasapalle*	14 597	16 609	14	4378	5374	23
Large	17 000	17 000	00	4676	5712	22
Medium	16 714	19 786	18	3369	4257	26
Small	12 241	14 942	22	5575	6784	22
Marginal	10 643	12 250	15	3891	4743	22
3. *Pottipalle*	19 454	19 704	01	3121	3785	21
Large	26 667	26 667	00	4262	5354	26
Medium	17 050	18 050	06	3446	4064	18
Small	21 950	21 950	00	2951	3436	16
Marginal	12 150	12 150	00	1825	2286	25

income gains were not converted into consumption benefits for small and marginal farmers, which may be because of the low profitability of farming among these sections (Reddy, 1993).

(b) Ecological impact

The productivity of land and livestock are dependent on the quality of natural resources such as land, water, common grazing lands and so on. Here we examine the linkages between tank restoration and natural resources. Our focus is mainly on the availability of fodder, fuelwood, drinking water and groundwater.

Fodder availability is seen in terms of dependence of cattle on different sources of feed. The main sources of feed are stall-feeding, common grazing lands (CPRs) and own fields (feeding on crop residue and in fodder fields). There is also a dependence on market for fodder (purchase), but on a very limited scale. Stall-feeding is the single most important source, followed by grazing on own lands and CPRs. The availability and quality of CPRs determine the relative shares of CPRs and own lands in the respective villages. Over a period of 3–7 years, the importance of stall-feeding has declined, although it continues to be the most important source in all the villages (Table 13). The decline was more prominent in the programme villages. In most of the villages, the decline in stall-feeding was compensated by both grazing on own fields and CPRs. There was substantial improvement in the availability of CPRs and also in own fields after the programme. Across the size classes, the dependence on CPRs was more in the case of small and marginal farmers. On the whole, the impact of tank restoration on the availability of fodder is positive.

Time spent by the households in collecting fuelwood reflects an improvement in fuelwood availability, especially in CPRs near the village. Own sources such as crop residue and wood from own trees is the single most important source of fuelwood in all the villages. In terms of quantity of fuelwood used, small and marginal farmers use more when compared to large farmers because large farmers have alternative sources of fuel such as coal, dung cakes, kerosene, gas and so on. The data also indicate that dependency on

Table 13: Changes in the availability of fodder

Size-class/village	*Before (cattle using various sources in % of days)*			*After (cattle using various sources in % of days)*			*Percentage change*		
	Stall fed	*CPR*	*Own field*	*Stall fed*	*CPR*	*Own field*	*Stall fed*	*CPR*	*Own field*
Programme villages									
1. Adepalle	77.6	11.9	10.4	46.9	28.9	24.2	−39.5	141.5	132.1
2. V.V. Palle	76.2	9.1	14.6	66.9	11.5	21.6	−12.3	26.0	47.7
3. Akkapalle	68.4	13.4	18.1	61.7	16.1	22.2	−9.8	19.7	22.5
Control villages									
1. Korlakunta	78.1	9.3	12.6	46.9	23.0	30.1	−40.0	146.9	138.9
2.Valasapalle	53.6	23.2	23.2	50.8	24.4	24.8	−5.3	5.4	6.8
3. Pottipalle	62.3	12.3	25.3	70.4	11.2	18.4	12.9	−9.2	−27.2

CPRs is higher in the case of small and marginal farmers. Similarly, small and marginal farmers spend substantially more time collecting fuelwood than large farmers (Table 14).

Over the period, there was a marginal decline in the dependence on CPRs in all the villages, irrespective of the status of the tank. However, the impact of tank restoration can be seen in terms of time spent collecting fuelwood: it has declined in two of the programme villages, whereas it has increased in all the control villages. This indicates improvement in the availability of fuelwood in the vicinity – in good quantity and quality. This could be termed an ecological impact because the increased fuelwood demand is met either by CPRs or own lands, which reduces drudgery in the programme villages, whereas it is met by an increase in the drudgery in the control villages. Purchase of fuelwood is on a very limited scale in the before and after situations in the programme as well as control villages.

The number of irrigation wells has gone up in all the sample villages. Borewells are increasing over time, whereas dug-wells are drying up. All the dug-wells of the sample households in the control villages have dried up. The increase in borewells is much higher in the programme villages (Table 15). More importantly, groundwater depth[7] has declined substantially (above 20 per cent) in the programme villages, whereas it has increased in the control villages. Post-restoration groundwater levels have risen in the programme villages. After the restoration, the difference in the groundwater depth is substantial between programme and control villages.

It may be noted that improvement in the groundwater situation is apparent in Adepalle village. This could be due to two reasons. First, in Adepalle, tank restoration was carried out during 1993–1994 and hence there was sufficient time for recharge. Second, two of the tanks in Adepalle were converted into percolation tanks, which are more effective in terms of groundwater recharge. In fact, improved groundwater availability in Adepalle had a demonstration effect on the neighbouring villages, where villagers came forward to restore their tanks. Another important observation is that there has been a structural change in the ownership of wells in recent years. It may be noted that wells, especially borewells, are no longer only used by large farmers, as more and more small and marginal farmers seem to be investing in borewells. This may be because farmers are forced to invest, often with borrowed money, in borewells owing to the drying up of open-wells (Reddy, 2005). However, availability of groundwater is critically linked with the sustainability of groundwater recharge and the quality of technology that is available at low prices. The average capital cost of a borewell ranges between Rs. 33 000 and Rs. 83 000 across the villages, and these costs tend to be lower in the case of small and marginal farmers, which is because of the use of low cost pumps.

Concluding Remarks

The improvement in all the economic indicators unequivocally supports the relevance and rationale for tank restoration in drought-prone regions. The impact is greater in the case of small and marginal farmers when compared to large farmers, pointing towards a perceptible change in the poverty situation. Ecological impact is evident from the improved groundwater situation and livestock economy in the programme villages. The availability of groundwater has made growing *rabi* crops possible, and has enhanced the yield rates. The economic and ecological impacts of the programme are significant in the case the tanks restored before 1995–1996. This reflects the long-term nature of ecological benefits and the sustainability of the programme.

Table 14: Changes in the availability of fuelwood

Size-class/village	*Before (% quantity from)*		*Time spent for collection (days per year)*	*After (% of quantity from)*		*Time spent for collection (days per year)*	*Percentage change*		
	CPR	*Own*		*CPR*	*Own*		*CPR*	*Own*	*Time spent for collection*
Programme villages									
1. Adepalle	81.25	18.75	21	76.47	23.53	20	−5.88	25.49	−4.76
2. V.V. Palle	84.62	15.38	13	86.67	13.33	13	2.42	−13.33	0
3. Akkapalle	45.45	54.55	18	38.46	61.54	19	−15.4	12.82	5.56
Control villages									
1. Korlakunta	64.71	35.29	18	61.11	38.89	22	−5.56	10.19	22.22
2.Valasapalle	57.14	42.96	27	56.52	43.48	30	−1.09	1.45	11.11
3. Pottipalle	65	35	37	61.92	38.10	39	−4.76	8.84	5.41

Table 15: Details of wells in the sample households

Size-class/village	*No. of wells*		*Depth of wells (ft)*		*% change*	
	Before	*After*	*Before*	*After*	*Number*	*Depth*
Restored villages						
1. Adepalle	08	19	240	178	138	−25.80
2. V.V. Palle	0	01	0	0	—	0
3. Akkapalle	02	10	260	165	400	−36.54
Control villages						
1. Korlakunta	05	07	210 (40)	253	40	20.48
2. Valasapalle	09	10	220 (42)	255	11	15.91
3. Pottipalle	0	11	0	249	—	0

The effectiveness of the programme and its sustainability are reflected in the demand for tank restoration in neighbouring villages. The institutional process of implementation is largely governed by the local PIA's (NGO's) perceptions and commitment to the programme. In some cases, proper institutional arrangements are in place, whereas in others they are not in order. However, our impact analysis clearly brings out the positive impact of the programme, irrespective of the current status of institutional arrangements. In addition, adherence to the user contribution principle has played a major role in some areas in sustaining the programme.

The policy initiatives to restore irrigation tanks are rational as far as achieving the objective of improving rural livelihoods and alleviating poverty in drought-prone regions. Although the immediate benefits of tank restoration are conspicuous, sustaining these benefits in the long run is the crux of the problem. This aspect needs to be given due importance while scaling up the programme, especially by government agencies. The model adopted by SPWD is practical and effective, and could be replicated elsewhere. However, there are certain aspects that need adequate attention in order to sustain the systems in the long run:

1. Communities in these villages need to have a stronger commitment towards protecting these systems in a sustainable manner. The economic benefits can further be enhanced through supporting the community beyond the restoration work in terms of providing irrigation benefits to a larger area, that is, providing more irrigation facilities through community borewells and so on. In this context, converting the small tanks into percolation tanks would provide access to water to more households. Although large tanks can provide both direct irrigation and percolation benefits, small tanks could be more productive as percolation tanks. In this regard, conflict resolution and equity aspects need to be addressed properly.
2. The concept of user charges is not properly followed. Maintenance work was carried out on an *ad hoc* basis. Farmers expect PIAs to have the responsibility of carrying out this repair work. Similarly, the method of user contribution, labour or cash, of 25 per cent of the costs is not followed. Adhering to these concepts in the programme not only ensures the financial sustainability of the systems, but also increases the stakes (responsibility) of the farmers towards maintaining the system.

3. Another important aspect is follow-up action on the part of the funding agency. This is important mainly to ensure equity in water distribution, especially in the case of percolation tanks, through supporting measures to increase access to water to a greater number of households.
4. On the whole, the demand-driven approach needs more emphasis in the entire process. Though this is in-built at the SPWD level, this approach is not taken forward by the local PIAs. In most cases, farmers are enthused, and request that the work be carried out. This is largely because of the demonstration effect. Efforts on the part of PIA to conduct some orientation programmes and educational tours for the communities before selecting the villages and subsequently taking up the programme would be more useful.
5. Although the non-beneficiaries or non-command area farmers are provided a place in TMC, they do not have any right to water. Therefore, they evince little interest in the activities relating to tanks. Though this is a complex issue and requires a great deal of effort directed towards conflict resolution, it may be possible through delinking water from land rights. This is effectively carried out by 'Pani Panchayats' in Maharashtra. That is, rights on water are given to the households, including the landless. All the households in the village contribute equally to the development of irrigation schemes and receive equal rights to water, irrespective of whether the household owns land or not. Every household receives water rights for irrigating 0.5 acres per each household member (adult), and no more. Landless households can exchange or sell these water rights in terms of share-cropping and so on. Even when a household sells its land, water rights are not transferred, and hence there will not be a concentration of irrigated lands in the hands of a few. Private exploitation of groundwater is strictly prohibited (Deshpande and Reddy, 1991). This requires proper and stronger institutional arrangements, and its replicability is rather difficult in the absence of policy support.

Acknowledgement

We thank two anonymous referees and Chief Editor of The European Journal of Development Research for their helpful comments and suggestions. Thanks are also due to Pulak Mishra for his comments on the paper.

Notes

1. Tanks are traditional rainwater harvesting and storage systems consisting of a major embankment across and (along) the line of the drainage, with two side embankments running backward up to the line of the drainage, gradually losing their height. The tank resembles a rectangular (or semi-circle) catchment basin with only three embankments, the fourth side being left open for runoff and drainage water to enter (Rao, 1999).
2. There are numerous examples of institutional arrangements for managing traditional water harvesting systems across the country. For details see Agarwal and Narain (1997).
3. The Andhra Pradesh community-based tank management project aims at improving the physical and operational performance of about 3000 tanks, with a command area of 250 000 hectares.
4. The TMC represents all sections of the village community, though contributions are collected only from the farmers in the tank command area (TCA). The size of the TMC varies from 5 to

20 members, depending on the size of the village. A third of the members are women. To the extent possible, women are recruited (by the NGOs) as organizers, to collect information and interact with village people regarding the tanks. Elections are conducted every year and any person can be a member for a maximum period of two terms. Minimum official wages are paid on the basis of volumetric rates. Contributions are also valued at these rates. The NGOs open bank accounts and operate these jointly with the TMC.
5. We noticed that this data set, collected by the local NGOs, is neither detailed nor consistent.
6. The changes are in terms of effective irrigation, as the command area remains the same before and after restoration.
7. The depth of the borewells was assessed based on the information provided by the sample households on the depth at which groundwater is available before and after restoration of the tank.

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