Reclaiming the Commons:
Community Initiatives of Groundwater Management in the Indian Semi-Arid Tropics

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Introduction

An impressive development that has taken place in Indian agriculture, since independence, is the swift expansion of groundwater irrigation. Over the last 60 years, Indian farmers have pumped massive investment into groundwater structures, which is estimated to be in order of US$ 12 billion[1] (Shah et al., 2003, 2006). The ultimate irrigation potential from groundwater source is 64.05 million ha, as compared to 46 million ha of land currently under groundwater irrigation (Government of India, 2005). Groundwater meets nearly 55 per cent irrigation, 85 per cent rural and 50 per cent of urban industrial needs (Government of India, 2007). In India, the groundwater-irrigated area accounts for about 50 per cent of the total irrigated area and up to 80 per cent of the country's total agricultural production may, in one form or another, be dependent on groundwater (Dains and Pawar, 1987). The gross irrigated area in India in 1960-61 was 28 million ha and in 1998-99 it moved up by 76 million ha with a sharp Compounded Annual Growth Rate (CAGR) of 2.2 per cent (Scott et al., 2003). It is evident from the data that the tanks recoded a reduced growth rate by 1.1 per cent whereas much of the growth is accounted by ground water (Government of India, 2007).

India withdraws an estimated 231 billion cubic meters of water from the ground annually, the largest amount in the world. Considering that groundwater is a critical input for livelihoods, irrigating about 70 per cent of the cropped area and supplying 80 per cent of domestic water, it is clear that the economy is approaching a flashpoint (EPW, 2007). Groundwater overexploitation has been recognized as a serious problem in India since the late 1980s (Moench,1992; Dhawan, 1990, 1995; Macdonald et al. 1995; Bhatia, 1992; Chandrakanth Arun, 1997; Shivakumaraswamy and Chandrakanth, 1997) and the rate of extraction of groundwater far exceeds the rate of replenishment in many blocks leading to progressive lowering of the water table (DebRoy and Shah 2003; Government of India, 2007)[2]. Though the government of India formulated several groundwater rules and regulations to sustainable resource management, concerted efforts have not been forthcoming for several economic and political reasons (Nagaraj *et al* 1999). In addition, technological progress and market forces

[1] 1 billion is equal to 1000 million
[2] The expert group notes that in 2004, an alarming 28 per cent of the blocks in the country were in the category of semi-critical, critical or overexploited, compared to only 7 per cent of the blocks in 1995 (Government of India, 2007).

have not acted to reduce pressures on renewable resources as they have in the stock resource case (Johnson 1975; Dasgupta 1982). Hence, it is imperative to manage the resource by devising institutional and market mechanisms to foster sustainable and equitable use. It is imperative therefore, for resource managers to work together with the combination of formal as well as informal institutions so that appropriate management regimes can be put in place wherever possible. However, it is not always clear what is appropriate when the combination of the above come into picture and the difficulties arise can be even further compounded by the improper system in the decision making-process. Therefore, expansion of interdisciplinary approach needed to deal more effectively with traditional knowledge and to understand how economic and demographic changes impact on natural resources.

This paper explores local groundwater management[3]. Local groundwater management is either advocated as a self-standing solution, or proposed as a complement to external state-initiated regulation and appears to circumvent the enforcement problems of defining rights and entitlements. In this context, this paper explores the scope for local participatory groundwater management and the contribution it can make alongside other interventions. It first explores the legal and regulatory approaches to groundwater management in practice and tries to relate it to larger participatory approach in water resource management such as tank irrigation in South India. Further, it makes a point that these examples of local groundwater management are few and far between and came about unprompted by external support. This paper draws generic lessons to promote local groundwater management and assesses the scope and efficacy of such initiatives in the Indian semi-arid tropics.

Legal and regulatory approaches to groundwater management

Information on dynamics of groundwater resource such as availability, extraction and recharge rate is unavailable for groundwater users in many areas as there are no proper systems to pool the information. Therefore, each user's concern is to maximize their welfare by extracting maximum volume of water by ignoring the effects of aquifer over use on others and the future use (Nagaraj *et al* 1999). This is due to de jure rights to groundwater are not clearly defined. But de facto, groundwater belongs to all those who have land overlying it (Singh, 1995). In addition to this, the electricity subsidy regime supports to increase the extraction level as well as aquifer deterioration. The legal status in terms of *de jure* rights is not transparent. Since groundwater is attached to the land there are no restrictions on its extraction. Thus, only the land owner can own the groundwater right implying that the landless does not have any stake in the resource (Nagaraj *et al* 1999: A 98).

[3] Local management defined as "the regulation of groundwater use by local stakeholders, i.e., local governments and groundwater users".

However, the management task is difficult due to differential property rights claimed over groundwater use (Table 1). According to existing property rights for irrigation structure, the state has no control over private irrigation structures as users have absolute ownership and unlimited rights to extract water beneath own land whereas in the case of public irrigation structures, state has power to regulate. Therefore, the regulation of state over groundwater use is very minimal given the current nature of property rights in the country (Singh 1995).[4] The ministry of water resources for the government of India mooted the groundwater (control and regulation) bill in 1970 and revalidated it in 1992 to regulate and control the development of groundwater. The bill was circulated to all the state governments to prepare similar bills to have check on groundwater development since water is a state subject (Singh 1995). However, as on today, only few states have been regularized groundwater bills remaining states have not implemented due to various economic and political reasons.

Control of institutional financing for well development by the NABARD in critical and overexploited taluks was not effective due to a large amount of private financing in the sector. However, neither credit limitations nor distance factor have proven particularly effective in limiting the growth of groundwater extraction. In fact, the decision on institutional finance was heavily affected poor farmers excluding them from resource extraction as wealthy farmers often tap private sources of capital for well construction. In several of the areas, money lenders were predominant in supplying the finance at reasonable interest rate. Moreover, wealthy farmers have never been dependent on the state for the investment.

Therefore, groundwater management with legal and regulatory approaches is most likely to be less effective in the Indian context[5]. There are several reasons for ineffectiveness of top-down legal and regulatory approaches in groundwater management. Firstly, legislation is generally applied to large regions within which significant variations in the characteristics of groundwater exist. It is very unlikely that legislation reflects the local specific problems and the interests of the communities at large and hence could face strong opposition in enforcement. Second, there are millions of wells located in the rural areas, which suffer from poor network and inaccessible. It will be extremely difficult to get a monitoring mechanism established to ensure that a particular regulation is enforced. Third, the farming lobby, which is strong enough to get political patronage, can mobilize rural masses against legislation. Such moves are sufficient to cause political instability (Kumar, 2000: 425).

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[4] The Easement Act (1882) allows private usufructuary rights in groundwater by viewing it as an easement inseparably connected to land. The transfer of property Act 1882 provides that easements can be given to one only if the dominant heritage is also transferred.

[5] For detail discussion on institutional framework, see Kumar, 2000.

Therefore, the present situation demands larger institutional approach towards groundwater management. Watershed approach is one such suitable option for overall management of natural resource as well as to ensure local participation in the process of management. Besides, groundwater management needs to take place at higher geographical scales through external support and providing framework for user-driven management.

Local management of groundwater: Tale of two villages

This section examines two selected examples of local groundwater management characterized by different degrees of community regulation. The examples concern mainly areas with shallow, semi-confined aquifers. The collective community management systems in the examples are homegrown, mostly quite elementary. The cases presented in the paper explore the demand and supply management of groundwater in the form of promotion of recharge and utilization.

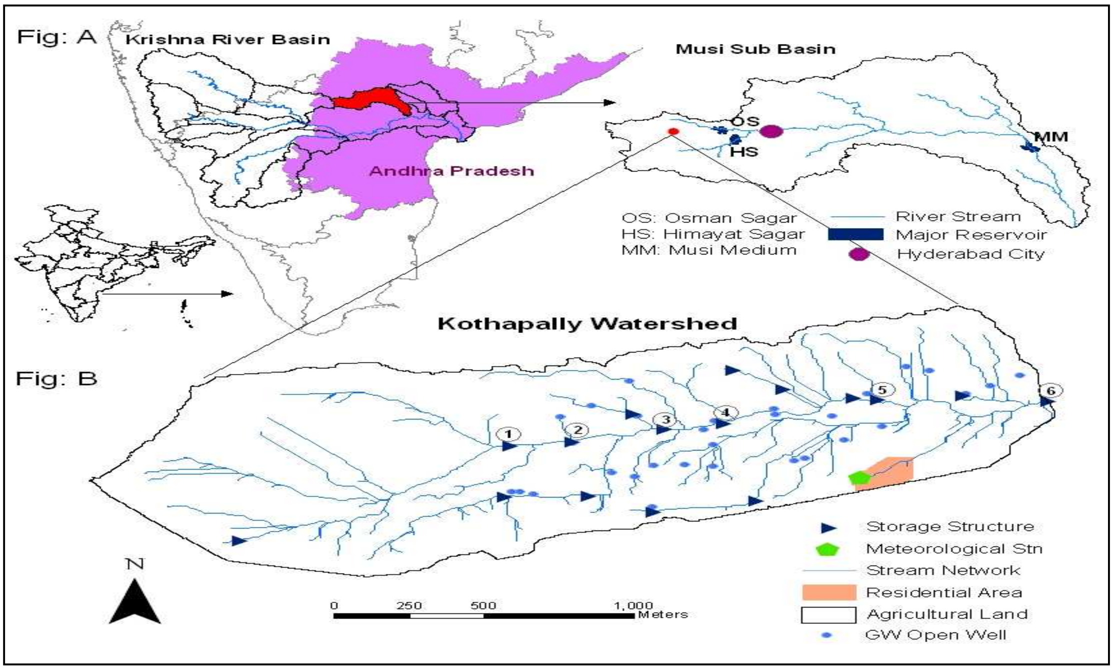
Kothapally, Andhra Pradesh, India

Rangareddy district, like many other parts of Andhra Pradesh state in India, has seen a dramatic change in water use in the last decades. Whereas tanks and shallow dug wells were the prime source of water up to the mid 1980s-1990s, there was a nearly complete transformation in most of the district with borewells becoming the main source of water.

Kothapally village, located in Shankarapalli mandal in Rangareddy district, is one of the examples of this transformation (see Map 1). What is very remarkable is that in Kothapally there are no deep tubewells. Kothapally is a village of nearly 274 families – depending largely on agriculture, either as owner-cultivators or landless labourers. Majority of the farmers (70%) are smallholders having less than 2 ha land. There is also a substantial livestock population – that is equally dependent on safe water supply. Within the village boundaries there are 62 open wells, most of which occur along the main watercourse. These dug wells are limited in depth, a typical well being between 15 and 35 ft deep. There were 15 bore wells before watershed project initiation, and 55 new bore wells were dug during the project. In 1999, watershed project was implemented in the village and it covers about 465 ha and has medium to shallow black soils, with a depth of 30-90 cm.

The groundwater recharge is the major objective of community initiative in Kothapally. What is remarkable is that in Kothapally there is no provision to lift water from checkdams and it is strictly meant for the purpose of groundwater recharge. Since wells and tube wells are major source of irrigation, the community took a decision to restore groundwater by conserving surface water to recharge wells. The community rule (informal norms) was introduced in

2000 at the behest of the watershed committee after consultation with different stakeholders. The ban on lifting water was prompted by the importance of irrigation water during off-season.



Map 1: Adarsha watershed, Kothapally, Andhra Pradesh, India

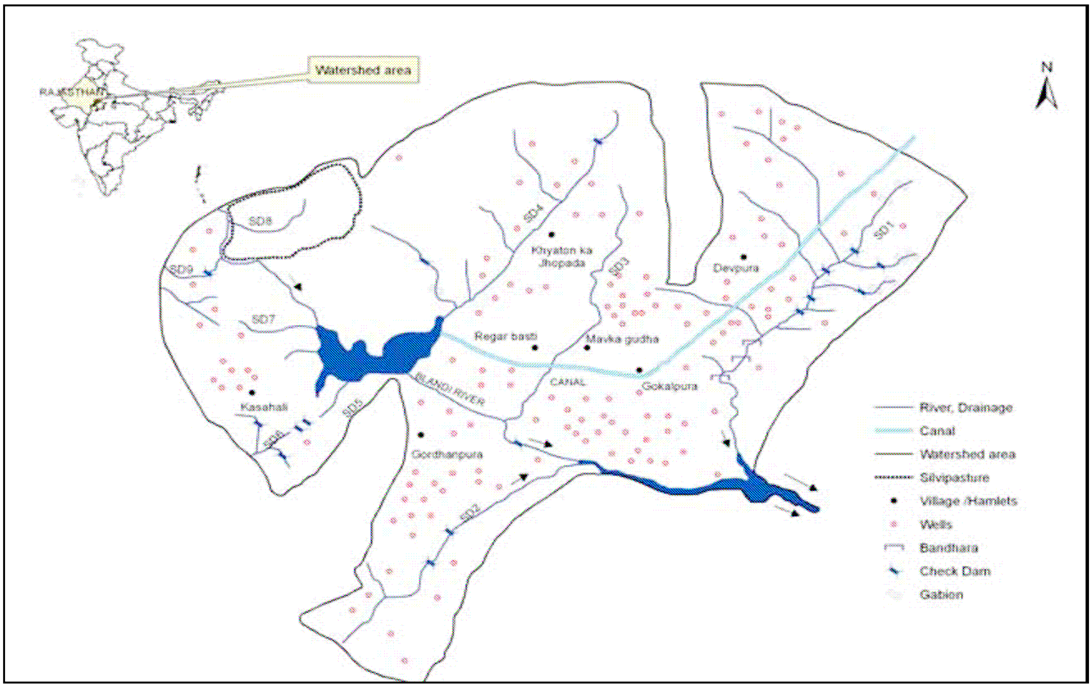
Ever since the rule was put in place it was kept alive by regular follow up by the committee. This effort may be a minimal effort but it is sufficient and effective in enhancing the groundwater recharge thereby ensuring sustainability of groundwater resource in the village. The local groundwater management through banning lifting water from the checkdams has shown remarkable improvement in the groundwater recharge in the watershed area (Figure 1).

The community efforts have assured increase in groundwater recharge nearly about 24 per cent during watershed intervention (Table 2). The *in-situ* and *ex-situ* conservation measures have shown the importance of watershed intervention in improving agriculture in semi-arid tropics. However, the informal rules and norms of the community have improved the capacity of irrigation structures to withstand the pressure even in drought years (Garg et al, forthcoming).

A couple of aspects about the success of groundwater recharge are significant. First is the appropriate innovativeness in water harvesting, conservation and recharge. In Kothapally, watershed intervention has brought water harvesting technology and other conservation technologies to the village. Accordingly, check dams and other water harvesting structures were built to hold the water. What is very significant in this case is that farmers very soon realized that these structures are improving the recharge of dried wells and enhance the water availability in the surrounding areas. Therefore, watershed committee with collective participation of the community took a decision to store the water and banning on lifting water from water harvesting structures. Secondly, people's participation was the keystone elements in this movement and the local leadership played a greater role.

Gokulpura-Govardhanpura, Rajasthan, India

Innovative water efficient land use system of using tank-bed for the cultivation of crops after reducing water in the structures was adopted by the community at Gokulpura-Govardhanapura watershed, Rajasthan (Map 2). The Gokulpura-Goverdhanpura watershed is situated in the very harsh drought prone areas of eastern Rajasthan.



Map 2: Gokulpura-Govardhanapur watershed, Rajasthan, India

The rainfall is characterized as low, erratic and undependable resulting in frequent droughts and often-total crop failures. Generally, severe water scarcity existed both for agriculture and domestic purposes before the watershed program. Poor soils with very low water holding capacity and inherent low fertility resulted in low crop yields. Migration of people in search of employment to nearby towns and cities for livelihood was common feature. The tank was constructed in 2003 with a storage capacity of 14600 m^3 providing irrigation to 57.5 ha mainly through wells in the down stream and benefiting 71 farmers. The submerged area (area under water) is 6.5 ha, which belongs to 15 farmers. These farmers have also their land in the downstream of the tank. These 15 farmers have formed a user group. The user group farmers use the stored water as surface irrigation for about 5 ha in the command area. The surface irrigation charges for other than these 15 user group farmers is Rs 100 per 0.16 ha (1

Bigah[6]) per irrigation. In addition to surface irrigation facility, the tank is benefiting about 18 wells through groundwater recharge. The revenue collected is used for the repair and maintenance of the tank and its irrigation system.

All the farmers involved in this activity belong to one community called 'potters' (pottery makers). The members of the user group have contributed 30 per cent of cost of tank construction in the form of cash, labor and materials. The fields cultivated in the tank bed have significantly increased yield due to the better soil moisture and improved soil fertility attributed mainly to the eroded sediment deposition. Before the construction of the tank, the area in tank bed was severely eroded due to high runoff flow during rainy season and more than 50 per cent of these lands were left fallow. In most years, the rainy season crops were damaged due to heavy runoff flow through this area. After the tank construction, entire 6.5 ha area is cultivated. Crop yields of some of the major crops grown in the area are shown in Table 3. During rainy season only a very small area is generally available for cultivation due to submergence of stored water, where as in post-rainy and summer seasons complete area is cultivated with annual crops and vegetables.

Important benefits accrued due to tank construction are mentioned.

- Reduction in irrigation application has been observed in this system. For example, only one irrigation is given to wheat compared to 4 to 6 irrigations in other areas.
- The fertilizer applied to the crops grown in tank bed is about half compared to other area.
- Before construction of tank, about 50 percent of the area (tank bed) was not cultivated due to heavy runoff flow and now after tank construction the entire area is cultivated.
- Cropping intensity and productivity has increased.
- Earlier, during summer no crops were grown, but now, during summer vegetables are grown in tank bed area. This provides good income to farmers.
- The constructed tank has substantially increased the groundwater recharge for the downstream wells. Majority of the seasonally functional wells have become functional through out the year. Similarly, the mean depth of water column in the wells before the watershed interventions was 4.5 m, compared to 9.5 m after the interventions. There is a huge increase in man depth of water column in wells after the watershed interventions. Particularly during post-rainy season, the depth of water column in wells increased substantially.

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[6] Bigha is the local unit of land measurement used more or less in all parts of India, though the conversion factor of bigha to acre or hectare varies from one place to another. In Rajasthan the conversion factors are 4 bighas = 1 hectare.

In this particular case, a user group has the responsibility of managing water resources in the command area of the tank. The construction of tank and utilizing runoff water for recharging purpose was remarkable. Importantly, community contribution in the construction of tank was significant component of the collective action in the management of water resources. Through tank construction, groundwater recharge has been achieved in the village which enabled agricultural community to expand areas thereby ensuring higher yields and income. The collective action in managing water resource has benefited farmers those who are not in the ambit of irrigation facility. These farmers have been allowed to access excess surface water from the tank with a nominal charge per irrigation. This not only improved the access but also increased the production.

The example show that based on local understanding the local committee effectively regulates groundwater in their own setting and more strict than the formal institutions. These examples exhibits that the implementation of legal and regulatory approaches needs understanding of local knowledge and necessary resources.

Lessons learned

The above discussed cases present examples of self-regulation by groundwater users, triggered by local initiatives. Importantly, these cases reflect the development of local norms to recharge and regulate groundwater. These case studies support the argument that local regulation in groundwater management is possible in several situations. Groundwater is regulated through several legislations existed in law but not in practice. According to legislations a well driller needs to take permission from respective authority and has to maintain inter well distance to ensure sustainability of irrigation structures as well as the resource. However, these legislations are either in practice or were not effective in balancing groundwater demand and supply.

The current practice of water management is not supported by legislative control of the adverse impacts of groundwater overdraft. A need to work towards a groundwater policy that provides an equitable framework and at the same time functions at a decentralized level was long felt. In the country, there is no single law that deals with groundwater ownership and management. All groundwater acts are established in the form of state acts as the sector is in the state list and most of these are benign. The existing regulatory measures are ineffective or not implemented to the extent it needs to be. The National Bank for Agriculture and Rural Development (NABARD) was insisting on minimum distance between wells as a precondition for obtaining institutional credit. However, neither credit limitations nor distance factor have proven particularly effective in limiting the growth of groundwater extraction. In fact, the decision on institutional finance was heavily affected poor farmers excluding them from resource extraction as wealthy farmers often tap private sources of capital for well construction.

In this context, the above case studies have shown directions to move forward to sustain the resource. Following are important issues emerged from case studies.

Firstly, the local management practices which were documented in this paper highlight the importance of universal access of groundwater resources irrespective of strict regulatory norms in the community. It is important to mention that in Kothapally, groundwater recharge has enhanced the drinking water availability. Precisely, the efforts of the community by allowing groundwater recharge have facilitated greater access to water for different uses in the village.

Secondly, there is a greater role for the community to move alongside with other interventions. These cases have proved that communities can take lead in protecting infrastructures that have been built utilizing state led support programs and improve the livelihoods. They are reinforced by local leadership leading by example and by joint local action against those that deviate from the decision.

Thirdly, demand side management through supply side measures were demonstrated in these cases. In Goukulpura-Govardhanapura, tank construction has enhanced the rate of groundwater recharge among downstream wells. Therefore, these wells have managed to withstand pressure of meeting an additional irrigation requirement. This has resulted in increasing the productivity and income among users. In Kothapally, groundwater recharge enhanced the efficiency of wells in supplying water for water intensive crops such as vegetables. However, a caution needs to be noted here that norms and social pressure may not develop everywhere and where groundwater availability simply cannot sustain universal access, it is difficult to see how community norms are behaving.

Fourth, the above presented rules/norms are simple and were all straightforward and easy to monitor by everyone. Once the community decision is through and everybody obliged it, the monitoring of these norms is easy and there would not be any misunderstanding among the members of the community.

Fifth, these experiences have shown that local groundwater management can be taken up at higher geographical scales. However, local leadership and community initiative assumes greater significance in up scaling the management boundary.

Ways forward

The examples discussed above all came about by 'chance' and developed more or less spontaneously. The question, however, is whether and how local regulation can be initiated on larger scale. The rate of groundwater overuse in many areas is alarming and resulting in declining dividends from groundwater dependent sectors (Anantha, 2009). The suggested approaches to reduce the overuse and proper management are less likely to be yielding benefits. Several approaches have been discussed in the literature and more importantly, isolated experiences have been documented to indicate local management is one of the potential options (Kumar, 2000; Steenbergen, 2006).

Institutional shifts – specifically, moving the responsibility for managing groundwater resource from governmental agencies to local users' associations can facilitate the more efficient use of water. In many countries farmers are organizing locally so they can assume this responsibility, and since they have an economic stake in good water management, they tend to do a better job than a distant government agency. There is greater need for strengthening the community roles through capacity building. Thus, the informal way of management needs to be formalized to better mange the scarce resources. As discussed in Steenbergen (2000), capacity building component is very essential and in Andhra Pradesh the Water Conservation Mission was set up as a coordinating mechanism by the Government of Andhra Pradesh to manage the various large scale watershed programs in the state.

People centric approach: People have to take their own initiatives towards resource conservation by regulating groundwater extraction for certain periods. For this purpose, farmers are needs to be provided with awareness regarding water conservation measures as well as dire implications of groundwater scarcity. In watershed programs, capacity building was given priority to ensure higher benefits from the projects.

Possibility of demand and supply management: The holistic approach needs to be developed to include all sections of the community in managing the groundwater. Instead either supply or recharge of groundwater have been improved (Kothapally), water use efficiency enhancing measures may be undertaken and areas where groundwater can still be safely developed can be identified. In areas where groundwater table is declining severely and well failure rate is high, the communities have to be encouraged to enhance water use efficiency by practicing benign cropping pattern. Communities need to be mobilized to undertake recharge activities by developing local regulations, adopting micro irrigations, and improved soil-moisture conservation.

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Tables and Figures

Table 1: Nature of property rights for irrigation structures in India

Type of irrigation structures	Rights structure	State rights
Wells (private)	Absolute ownership	No rights
Wells (public)	Customary rights of groups/communities	State has power to regulate
Borewells (private)	Absolute unlimited rights to extract water beneath own land	No right to own/regulate
Borewells (public)	Usufruct right granted	State has power to regulate

Source: Singh (1995) cited in Nagaraj *et al* (1999).

Table 2: Groundwater recharge before and after watershed development in Kothapally, AP

Year	Rainfall (mm)	GW recharge scenario after watershed development (mm)	GW recharge scenario before watershed development (mm)*
2001	701	114	88
2002	525	79	50
2003	696	231	210
2004	649	128	124
2005	862	359	263
2006	471	114	115
2007	824	108	83
2008	1087	230	170
Average	727	170	138
Ratio of recharge to rainfall		0.23	0.19
Percentage increase in GW recharge (%)			**23.7**

* Simulated scenario results

Table 3: Crop yields, net income and benefit-cost ratio of major crops grown with groundwater management in Gokulpura-Govardhanpura watershed

Crops	Before tank construction		After tank construction	
	Yield (t ha^{-1})	Net Income (Rs ha^{-1})	Yield (t ha^{-1})	Net Income (Rs ha^{-1})
Maize	1.0	-600 (-0.07)*	2.7 [170]**	10750 (1.13)*
Sesame	0.6	-2400 (-0.22)	0.9 [50]	-200 (-0.02)
Wheat	2.7	7100 (0.49)	3.8 [41]	16650 (1.21)
Chickpea	0.9	1350 (0.10)	1.1 [22]	7850 (0.76)

Notes: * figures in parentheses are B:C ratio and ** figures in square brackets are % increase over before tank construction

Figure 1: Water captured and potential storage capacity in Adarsha watershed, Kothapally