

Groundwater Management in North Gujarat:

Sustainable Agriculture Improving Rural Livelihoods and Hydrological Integrity of Groundwater

I. CONTACT INFORMATION

Last Name	Kumar
First Name	Dinesh
Email address:	d.kumar@cgiar.org
Organization Name	IWMI-Tata water policy research program
Organization address	C/O ICRISAT, Pattancheru, PIN 502324, AP
Organization website	www.iwmi-tata.org
Organization type	Research partnership between IWMI and Sir Ratan Tata Trust
Telephone/Fax	0091 40-3071 3735
Organization description and date	Collaboration between IWMI and Sir Ratan Tata Trust, Mumbai

II. PROJECT DETAILS

Title of Proposal	Groundwater Management in North Gujarat: Sustainable Agriculture Improving Rural Livelihoods and Hydrological Integrity of Groundwater
Project Duration using Grant Funds (in months)	18 months
Countries of Implementation	India

III. PRIMARY CGIAR CENTRE PARTNER

Last Name	Samad
First Name	Madar
Email address	m.samad@cgiar.org
CGIAR Centre Name	International Water Management Institute
Position at Centre	Principal Researcher/ Head, India and Nepal Offices
Telephone/Fax	+0091 40 3071 3735
City	Hyderabad
Country	India

IV. OTHER PARTNERS

Name of other Partner Organization (s)	1. M. G. Patel Sarvodaya Trust, Amirgarh, Gujarat. 2. Cohesion Foundation, Ahmedabad. 3. Lokvikas, Sidhpur
Type of Organization	NGOs
Name of partner	Hasmukh Patel, Rajesh Kapoor and Biplav Paul
Email address	1. shamik@icenet.net 2. cohesion@indiatimes.com. 3.lokvikas@rediffmail.com

V. PROJECT QUESTIONS

1) Problem Definition

The semi arid north Gujarat is one of the intensively irrigated regions in India. The agricultural growth in the region was triggered by the explosion in tube well irrigation and introduction of high-yielding varieties. Nearly 92% of the irrigation is from groundwater. Intensive dairying is an integral component of north Gujarat's agriculture. Groundwater irrigation contributes more than 90% the overall livelihoods of the farmers in Banaskantha, a district in north Gujarat. A lion's share of the water used for agriculture in north Gujarat goes to milk production, which uses residues from cereals as input apart from irrigated green fodder. Excessive withdrawal of groundwater for irrigation is causing secular declines in water levels throughout the region. According to Central Ground Water Board data, the rate of decline in water levels ranged from 0.91 m to 6.0 m during a twenty year period from 1978 to 1998. The immediate economic and social consequences of uncontrolled groundwater exploitation are well known. Some of them are:

increase in cost of groundwater pumping¹, deprival of poor farmers of their direct access to groundwater, reduced economic viability of irrigated farming and increased human health hazards due to exposure to water containing fluoride and salinity. A study in Thane village of Banaskantha showed an increase in cost of irrigation of wheat from Rs.1960/ha to Rs.4595/ha during 1970-2003. In another village, Kumbhalmer, the cost of irrigation of mustard went up from Rs.1482/ha to Rs. 2952/ha.

There are major ecological effects of groundwater depletion. Intensive irrigation with water from deep aquifers with high TDS increases soil salinity. While cropping intensity and adoption of high-yielding varieties of rice, wheat, cotton and jowar increased, farmers in this biomass scarce region had to use chemical fertilizers to maintain soil nutrient levels. This causes further deterioration of soil health, and breaking up of soil structure. Poor farmers are the worst hit by this ongoing environmental disaster, as they have to depend on water purchased at prohibitive prices for irrigation² which makes the net return from irrigated production negative for some crops. Recurring droughts, during which natural recharge reduces and groundwater demand increases, aggravate the problems as water markets shrink. Women are worst affected by droughts, with food and nutritional security, increased work burden for fodder collection.

The linkage between land management and water management is more than evident in north Gujarat region. Excessive use of groundwater containing salts and chemical fertilizers increases the irrigation water requirement owing to the additional water requirement for leaching out the salts in the soil, and poor water holding capacity of soils. For instance, in Daskroi taluka of Ahmedabad, the average number of waterings for paddy (kharif) had gone up steadily from 2.5 in 1970 to nearly 3.5 in 1985 to 5.5 in 2000. The average number of waterings for jowar went up steadily from 3.3 in 1970 to 4.75 in 1985 to 6.2 in 2000. Regaining the primary productivity of the soils through nutrient management measures and efficient and controlled use of irrigation water using micro irrigation devices can break this vicious circle.

Supply side options to augment groundwater supplies in north Gujarat region are not only extremely limited, but also prohibitively expensive. On the other hand, there are demand side options to cut down groundwater use in agriculture without compromising on the farm economy: simple crop shift towards low water intensive; use water saving technologies for all crops; and introduce new low water-intensive fruit crops which have high water productivity. But, research also shows that the stable household economy provided by milk production, poses a major constraint for introduction of new water productive fruit crops, in spite of milk being low water productive. The reasons for this are two: i] water is not a limiting factor for farmers to maximize their returns; and ii] and also in dairying farmers can maneuver the inputs that require a lot of water for production, through import. The best way to manage the region's groundwater economy is to go for a combination of: 1] water-saving irrigation devices for all crops; and 2] introduction of highly water productive fruit crops.

A project is being implemented in north Gujarat by the IWMI-Tata water policy program, collaboration between IWMI and Sir Ratan Tata Trust (SRTT), Mumbai in partnership with three civil society organizations (CSOs) with support from SRTT, to establish local groundwater management regimes that are based mainly on water demand management in agriculture. Improving productivity of water use in agriculture is a major strategy to manage the demand for water in agriculture. The project evolves sustainable farming system models that are based on technologies and practices which would enhance water productivity in agriculture, through action research, and facilitate their large-scale implementation through a well-designed extension program.

The ideas are already well tested in the ground. The introduction of high valued orchard crops with drip irrigation is found to be raising water productivity at least five times from nearly Rs. 6.88/m³ to Rs. 37 per m³. The use of micro irrigation devices in vegetables, and cash crops is also raising water productivity. The net incremental income from farming due to adoption of orchards with drip irrigation is in the range of US\$ 110 to US\$ 2,400 per acre in a year. The organic vegetable farming increases domestic consumption of green vegetables. Use of vermi-culture and composting is not only improving the availability of quality manure for soil nutrient management, but also giving new opportunities for women farmers to earn income.

The real developmental outcomes of this project depend on the changes in farming system brought out through the introduction of new crop and irrigation technologies. While use of efficient micro irrigation (MI) systems can cut down water use per unit area of crop land and enhance crop yields, farmers might use the saved water to expand the area under irrigation. Also, with MI systems, farmers' preference for high valued crops increases, replacing

¹ The direct cost has increased over the 25-year period from 0.22 rupees per cubic metre in 1975 to 0.33 rupees per cubic metre in 1985 to 0.41 rupees per cubic metre in 1990 to 0.59 rupees per cubic metre in 2000.

² For example, in central Mehsana, where the depth to water level is around 450 feet, the hourly water charge ranges from Rs. 60 to Rs. 90. At the same time, in Daskroi taluka of Ahmedabad, where the depth to water level in tube wells is in the range of 250-270 feet, the hourly water charge ranges from Rs.20 to Rs.50.

wheat and bajra which provides domestic food security. Similarly, the enhanced returns from every unit of water used in orchards may encourage farmers to abstract more water with greater investments for improving their farming fortunes, with undesirable consequences on resource use sustainability, if capital and land availability are not constraints. Extensive orchards may lead to high degree of mechanization, causing negative impacts on landless labourers, and marginal farmers. It can threaten regional food security also. On the other hand, surplus fruit and vegetable production can lead to market failure, bringing miseries to the farming community. Hence, the specific challenge the project addresses is ensuring sustainable groundwater use in the region, without compromising on the economic prospects of farming, food and nutritional security, farming system resilience, and labour absorption in agriculture.

2) Objectives

The overall objective of the project is to design and implement innovative groundwater strategies for semi arid and arid regions of India that strengthens the livelihood systems of the communities dependent on groundwater with reduced risk and vulnerability in farming, without compromising on the hydrological integrity of the aquifer systems and the economic surplus from the region's agriculture and analyze their developmental outcomes. The specific objectives of the project are:

- Study the water demand management interventions being adopted by different categories of farmers such as small/marginal, medium and large farmers in north Gujarat region in response to groundwater depletion and water scarcity;
- Analyze the impact of these interventions on the farming system, livelihood patterns, food and nutritional security, poverty and gender division of labour for different categories of farm households;
- Analyze the potential impact of the combinations of water demand management interventions on agricultural surpluses and groundwater use, and assess their implications for food security, risk and vulnerability of farming communities, and labour absorption for different scales of implementation in north Gujarat;
- Design and implement appropriate strategies in north Gujarat sustainable groundwater management initiative program so as to reduce the stress on groundwater and achieve regional economic prosperity, simultaneously ensuring minimum undesirable consequences such as regional food insecurity, increased farming risks and loss of employment opportunities in agriculture.

3) Project Implementation

The IWMI-Tata Water policy Program (ITP) has been implementing the project on sustainable groundwater management in three districts of north Gujarat since 2002. The project is expected to impact on a population of nearly 12 million people dependent on agriculture. The project involves: promotion of ecologically sound and efficacious water harvesting to augment groundwater supplies locally; water efficient orchard crops such as pomegranate; large-scale promotion of water-efficient irrigation devices such as drips and sprinklers for a variety of field and row crops, including orchards; and improved land management practices in agriculture to help cut down irrigation water requirement on a sustainable basis. The successful demonstration of pilot project in 30 villages covering four talukas, had led to formulation of a full-fledged field project in 150 villages, covering 13 talukas of three districts in north Gujarat in 2005.

The project is being implemented by ITP's own field team and by three partner organizations (CSOs), located in different parts of north Gujarat region. The strategies are implemented through a well-designed social engineering program. It involves conducting: awareness campaigns at the village level about using a variety of IEC materials; experiments on the techno-economic viability of agricultural water management technologies and practices in experimentation cum documentation farms set up for the purpose, and knowledge sharing; extension activities for promotion of various water-saving and yield enhancing MI systems involving on-farm demonstrations with monitoring; field to field marketing, market demonstrations, and exposure trips for farmers; conducting trainings and workshops to impact knowledge and skills on specific aspects of improved farming.

After 4 years of inception, the program is blowing winds of change in the region's agriculture. More than 2,700 farmers are now using MI devices for alfalfa, vegetables and cash crops covering nearly 11,500 acres. The adopters include small and marginal farmers as well as large farmers. The technology covers both low cost and high end MI systems. More than 500 farmers from the area have already shifted from traditional water intensive crops like summer bajra and alfalfa to low water-intensive, and high valued pomegranate. Farmers are also motivated to adopt vermi culture and scientific composting, leading to increased use of organic manure, which reduces irrigation water

requirement of crops. Nearly 1,100 women from small and marginal farmer households are taking up organic vegetable cultivation using low cost micro irrigation devices; and vermi composting.

But for these changes to sustain and realize positive developmental outcomes, we need to ensure value addition for fruits and vegetables so that the small and marginal farmers continue growing them. The new cropping pattern should be such that it takes care of the domestic food and nutritional security needs, while improving water productivity in physical, economic and social perspective. Resource-poor water buyers, who are not covered by the project in terms of MI technology, need to be benefited by the project. At the regional level, the aggregate groundwater use should drop over a period of time to be in balance with the natural recharge so as to achieve sustainable resource use, which would be determined by the changes individual farmers introduce in their farming systems.

Therefore, the next phase of implementation by ITP will focus on evaluating the developmental outcomes of current level of adoption and future growth apart from analyzing the impact of interventions on regional groundwater use. This would be followed by: 1] designing innovative technological solutions that are economically viable for resource-poor farmers who are dependent on water purchase; 2] evolving farming system models that are socio-economically and ecologically sustainable, and their propagation; and, 3] organizing orchard growers into a producers' company for value addition and marketing. This would involve the following: intensive field-based research to evaluate water productivity in farming and income returns; modeling studies to analyze farm level and regional-level impacts on agricultural surplus, groundwater use, risk and vulnerability of farming system, food and nutritional security and labour absorption; running of experimentation cum demo farms and designing and setting up of on-farm demos of innovative agricultural water management systems for poor farmers; and, rigorous grass root extension services.

4) Innovation

The north Gujarat sustainable groundwater initiative is the first project in Asia that attempts to rescue a regional aquifer that support millions of rural households through interventions that are purely farmer-initiated, and not supported by any subsidies. It explores the possibility of mitigating the imbalance in groundwater use through water demand management in agriculture. The standard approach to address groundwater problems in India during the past couple of decades has been water harvesting and artificial recharge. These interventions, carried out in arid and semi arid regions on a large-scale, not only involve huge public investments with little impact on achieving the desired outcomes, but also create negative consequences for ecology by diverting excess water from "closed" basins, where competition between food security and environment already exist. The project proposes inbuilt mechanisms to induce refinements in its strategies to ensure that the larger developmental goals such as reducing farming risks, reducing vulnerability of landless and marginal farmers to socio-economic and climatic uncertainties, greater employment generation in rural areas, and food and nutritional security are not compromised. They are: continuous monitoring of emerging developmental outcomes of adoption of water management interventions at the household level; and predicting macro level developmental outcomes for different scenarios of scale of adoption, based on current trends.

5) Relevance and Innovativeness of Partnership

The project has three different kinds of partners: 1] the local NGOs; 2] the farmers themselves; and, 3] SRTT. The project is first of its kind in India where a CGIAR centre has entered into partnership with local civil society organizations (NGOs) to design, test, implement and monitor the outcomes of an agricultural development programme which has significant positive implications for natural resource management in a vast region. Given the strong grass root presence of ITP and these NGOs, the project is likely to succeed. With IWMI involvement, the project can achieve the triple goals of "more crop per drop", "more cash per drop" and "more jobs per drop" through sound scientific inputs from IWMI's on research on water productivity in agriculture, thereby improving the food security, livelihoods and nature. The project has already built regional capacities in dealing with groundwater management issues differently from the conventional approaches. The partnership with the farming community is unique as it does not involve any financial commitments from the implementing agencies. Finally, the relevance of SRTT's involvement is that it has long term interest in India's rural development issues. What is innovative is that the funds from donor are used only in awareness generation, knowledge sharing, training and capacity building and establishing resource centres like experimentation cum documentation farms on AWM. Hence, it is used to create social capital.

6) Expected Results

Some of the expected results of the project are large-scale adoption of: a] water-saving and yield enhancing micro irrigation devices for a variety of crops grown in the region; b] wealth-creating high valued cash crops, including fruit and vegetable crops leading to reduced stress on groundwater, leaving it for future generations. From a socio-

economic perspective, there would be greater wealth generated from lesser use of groundwater in the region. From an equity point of view, the resource poor farmers would have greater opportunities to generate economic surplus from farming. The landless would be able to generate income from cultivation using low cost drip systems, apart from meeting their own domestic consumption needs. The major social impact would be improved livelihood opportunities for poor farmer, as they would be able to generate more income from farming from limited land and water. Another impact is improved health of rural people, especially women and children. The biggest impact on ecosystem and environment would be improvement in primary productivity of soils, and soil ecology.

The physical impacts of interventions would be measured using data on incremental crops yields, applied water, ET estimates and water productivity for different crops, and aggregate groundwater use. The socio-economic impacts would be measured using analysis of data on changes in cropped area and irrigated area, change in cropping pattern, incremental costs and benefits of different interventions such as horticulture and micro irrigation, changes in farm income and overall household income; number of small and marginal farmers accessing groundwater; domestic cereal & milk production. Social impact would be measured by analyzing data on food consumption pattern of households. The environmental impact would be measured using analysis of soils in the cropland for micro nutrients and soil biota.

7) **Replicability**

The very fact the interventions are farmer-initiated without any external support, and that technology adoption is happening on its own in the region is a testimony to the fact that the different models of farming are economically viable, in spite of the zero income benefit they get from water saving. The viability comes from incremental crop returns, which offsets the additional investments. What the project had done is to contribute to the knowledge systems that are accessible to the farmers, through rigorous extension services. There are many arid and semi regions in the world, especially some countries of South America such as Chile and Mexico, North African countries, the Middle East, especially Jordan and Yemen, hard rock areas of peninsular India, central Asia and north China plains where water resources are depleting fast due to excessive diversion for agriculture. These regions also depend heavily on groundwater resources for irrigation.

8) **Sustainability**

This project is the first development project of its kind in India where farmers are investing their resources for water conservation and management in agriculture without any subsidy support either from government or from donor funds. Therefore, it would be self-sustaining. The farmers had already invested 600 million rupees towards a range of agricultural water management practices, against a total investment of nearly 15 million rupees by the project implementing agency. There are two components of the project that would ensure long term sustainability of the project strategies and interventions. *First:* the NGO partners are now fully equipped to design and implement appropriate water management strategies in their own socio-economic settings on a large scale. For instance, MG Patel Sarvodaya Trust designs irrigation systems for poor tribal farmers of Banaskantha. *Second:* the fruit and vegetable producers' company, promoted by farmer leaders with support from NGI project, is expected to provide extension services to farmers to adopt WSTs, high valued orchards, produce marketing and get value addition for their produce.

VI. **PROPOSED BUDGET**

Item	Proposed budget (US \$)
Personnel	79,000.00
Research supplies and services	10,000.00
Equipment	10,000.00
Training and other knowledge-sharing activities	20,000.00
Travel	16,000.00
Communication	10,000.00
General Administrative Expenses	15,000.00
TOTAL Project Cost	1,60,000.00
Co-financing and Funding	48,000.00
GRANT Funding Request	1,12,000.00
Details of co-financing and funding sources	Co-financing would be done from SRTT funds for North Gujarat Initiative project