



Islamic Azad University
Mashhad Branch

Assuring Sustainable Economic Benefit for Farmers by Using Ground Water in Semi-Arid, Hard Rock Areas in India & the Role of UNESCO-IUGS-IGCP Project 523 "GROWNET"

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Received 11 October 2010; accepted 3 February 2012

Abstract

Out of about 1.2 billion people in India, 68% people live on agriculture as their main occupation. Ground water is therefore an important resource which provides over 70% of rural drinking water supply and about 50% of water used for irrigation. Rains in Monsoon season from June to September, provide the main source of water but they last only for four months and the rest of the year is dry in most of the hard rock region. About 67% of India is occupied by hard rock terrain and about 30% of the hard rock area falls within semi-arid, drought-prone zone receiving less than 500 mm rainfall per year. In semi-arid, hard rock terrain in India and in many other low-income countries, the surface water resources are scarce and polluted. Ground water occurs in this area in the shallow weathered zone up to about 15 meters depth and in the deeper fractures and fissures up to about 100 m depth. Bore wells reaching up to 60 to 100 meters depth, installed with hand-pumps, are very common for providing safe drinking water supply to villages. This causes a positive improvement in the health of villagers and an economic advantage by reducing the number of working days lost due to illness.

Agricultural production in these semi-arid areas is just marginal because the rain-fed crops suffer from the vagaries of Monsoon rains. The average farm-size per family of 5 persons is about 2 Ha. There are 3 to 5 drought years within a span of 10 years, which leave the dry-land farmer in perpetual poverty. In the past 3 years, over 4,200 farmers have committed suicide due to continued crop failures. Ground water, therefore, forms a very important and reliable resource which, if available in a farmer's plot of land and if utilized prudently for irrigation by digging or drilling a well, could transform the farmer's lifestyle. Even if the farmers are able to save one rainy season (Monsoon) crop through protective irrigation from dug well, and if possible take winter and summer crops on small plots, they would stabilize in the rural scenario. Otherwise, the farmers would migrate to nearby cities and stay in slums. Many cities in India and other low-income countries are suffering from an ever-increasing flux of rural population thereby choking and polluting the urban environment and putting stress on urban infrastructure. Ground water development for irrigation is the lifeline for rural economy.

However, in many watersheds in semi-arid, hard rock areas, the pumping of ground water is increasing and in some watersheds it is more than the recharge available from rainfall. In these over-exploited watersheds, the yields from the wells are not sustainable. Still, farmers in hard-rock area of peninsular India are taking all risks to develop ground water for irrigational and domestic supply because of the economics underlying its use. This paper discusses the economics of ground water use and gives guidelines for sustainable development, such as availability of soft loans to farmers, insurance for failed wells and people's participation in augmentation of recharge to ground water. Some of these guidelines have been included on the website www.igcp-grownet.org of UNESCO-IUGS-IGCP Project GROWNET, (Ground Water Network for Best Practices in Ground Water Management in Low-Income Countries) for which the Author of this paper is the Project Leader. Reverse migration from cities to villages is possible only if sustainable ground water development is done in these semi-arid areas, through watershed protection and recharge augmentation activities, as advocated by the GROWNET project.

Keywords: Economics, Groundwater use, India, UNESCO Project GROWNET.

1. Introduction

Out of about 1.2 billion people in India, 68% people live on agriculture as their main occupation. Rains in Monsoon season from June to September, provide the main source of water but they last only for four months and the rest of the year is dry in most of the country.

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Ground water is therefore an important resource which provides over 70% of rural drinking water supply and about 50% of water used for irrigation. About 67% of India is occupied by hard rock terrain and about 30% of the hard rock area falls within semi-arid, drought-prone zone receiving less than 500mm rainfall per year. Ground water usage, for drinking purpose and for small scale irrigation, is continuously increasing over the past 40 years or so, especially in the agriculturally advanced, semi-arid, hard rock areas of western India. This is mainly due to the agricultural

revolution in which thousands of small farmers developed their private sources of irrigation by digging wells or drilling bores in their farms.

As a result, the water table level in several watersheds is depleting continuously and the need for reducing the gap between ground water pumpage and recharge from rainfall is being increasingly felt in the semi-arid region. If this gap continues the sustainability of supply of ground water would be affected. Some of the village councils, their enlightened farmer members, and a few NGOs are therefore making efforts for augmenting ground water resources in some of the over-exploited watersheds.

If ground water resources in the village are too poor to supply drinking water, the Government arranges for supply through Water Tankers or pipe line. But if the ground water resources are too scanty to supply irrigational needs, then the farmer is condemned to be a permanent dry-land farmer, totally dependant on rain. If the rains fail, the crop fails and the agro-inputs are wasted. In the past 3 years over 2,500 dry-land farmers have committed suicide in this part of India because they could not repay the Bank's loan taken for purchasing seeds and fertilizers. Against all these odds, plus the risk of a well or bore failing to yield appreciable quantity of water due to the choice of a wrong location for well digging or drilling, why are the farmers interested in using ground water for irrigation? The only answer is a strong motivation towards getting more income from irrigated crops and uplifting their living conditions, including the availability of reliable drinking water supply to protect their health. This paper discusses the best practices followed in this process and the hurdles.

2. Economic Advantages of using ground water for drinking purpose

Surface water in semi-arid regions is scarce and/or polluted. Ground water offers a reliable and safe source for providing drinking water supply. During the past 35 years, the Governments of different States in hard rock areas in India have taken up extensive drilling programs for supplying drinking water to villages. Drinking water supply bores in villages are typically of 150 mm diameter and 60 meters depth. The cost of bore well with hand pump is about US \$400. Getting water supply for domestic use is a basic human need and providing good quality drinking water to citizens has top-priority in the National Water Policy. It is not therefore customary to calculate benefit / cost ratio on this investment by the Government. However, the benefits have been found to be much more than the costs, as given below:

Cost of bore well and hand pump per village:
US \$ 400

Interest & Depreciation 15%: Repairs 10% \$ 100

One Bore well usually provides drinking water for 200 people in 40 families (40 men, 40 women and 120 children). The running cost of the bore well facility is thus about \$0.50 per person per year. If the population is more, say 1000 people, the village gets five bore wells. Before the bore well in the village was drilled either privately or under Government Scheme, 40 women of the village had to spend at least 2 hours per day, for 360 days in the year, to bring water from a distant (often polluted) water source. If one working day for a woman is 8 hours work, this is equivalent to 3600 working days per year.

After drilling the bore well in the village all these working days could be saved and used in gainful employment, which is equivalent to US \$5,400 per year, at the rate of 1.50 Dollars / woman/ day. In addition to this, benefits to health of the villagers are evident from the reduced mortality and morbidity in the village, resulting in more working days and more income per person per year.

Drilling a bore well and installing a hand pump is therefore a low cost, effective solution to the problem of drinking water supply to villages. The only hurdle is to select a proper location for the bore well so as to be successful. The selection is done by trained geologists or geophysicists and the location is then approved by the village council and women. The chances of failure are still up to 30% in hard rock region, but considering the benefits resulting from a successful bore-well, taking a second or third trial is also worthwhile.

3. Economic opportunities from using ground water for irrigation

Rivers originating in the high rainfall, hilly terrain in the western mountain range lying parallel to the western coast, flow south-eastwards through semi-arid regions in peninsular India. Large dams have been built on these rivers and the network of canals extends into semi-arid regions.

However, only 15% of the cultivated area receives canal water. In the remaining farmlands, ground water wherever available, is the only source for irrigation and for domestic use by people and cattle. Even in the area irrigated by canals, farmers dig or drill wells in their own farms because they are not confident about the timely availability of canal water which is controlled by Government officers. Ground water is however owned by farmers and is under full control.

Ground water occurs as shallow ground water within 12 to 15 meters depth, which is tapped by digging open wells having 4 to 6 m diameter. Bore wells of 150 mm diameter are also drilled up to 100 m depth to obtain water from deeper fractures and fissures in the hard rock. Economics of irrigation from ground water depends upon (1) Obtaining as much supply as possible from the dug well or bore well, because

traditionally the farmer is the owner of whatever quantity of ground water resources occurring in within his farm; (2) Using efficient irrigation methods, like drip or sprinkler system, to obtain more crop per drop of ground water or more value of farm produce per cu.m. of ground water; (3) Selecting suitable high value crops or horticulture depending upon the infrastructure and marketing facilities; (4) Arranging for timely repayment of loan (if any), taken from the Bank either directly or through marketing cooperative society.

The cost of a dug well of about 6 m diameter and of 15 m depth in Deccan traps is around US \$4,000. In the soft, weathered strata met with in the beginning, the excavation is cheaper but a masonry wall has to be built to support the strata. In the underlying hard fractured rock, the excavation is expensive because dynamite blasting is often necessary. But this portion of the dug well does not need a retaining wall. When blasting is conducted in the fractured rock for excavation of well below the water table, it is advisable to blast only one to two holes at a time, as mentioned earlier, instead of simultaneously blasting all the 40 to 50 holes drilled in the bottom of the excavation. If all the holes are simultaneously blasted, the fracture network often receives a heavy shock and the yield of water into the dug well gets reduced. The cost of drilling horizontal bores is around US \$ 2 to 3 per meter while vertical bores cost around US \$ 3 per meter. A bore well of 150 mm diameter and of 100 meters depth costs around US \$500. Submersible pump and control panel cost around \$700.

The loan for a well is a long term loan for 7 to 10 years, with about 12% to 13 % rate of annual interest. The farmer offers his land as collateral and up to 25% of the cost of well and pump as his stake. In case a well yields less than expected supply, the repayment period could be extended up to 15 years. Some Banks active in agricultural financing also provide an 'insurance scheme' for failed wells. Irrigation from ground water is usually on a small scale due to the limitations of land holding and yields of dug wells or bores. Usually in an average farm-size of two hectares, if the loan for a dug well and pump is around US \$ 4,000 to 5,000, protective irrigation in two hectares for the first crop of rainy season (Monsoon season), winter irrigation (October to January) of a high value crop or vegetables in one hectare plot and summer irrigation (February to May) of a high value crop on half hectare plot, is sufficient to generate enough additional income to the farmer for repayment of Bank loan within 7 to 10 years. After the loan is repaid, the farmer enjoys the full additional income and improves his living standard. Repayment of loan for bore well and pump is easier than dug well, but only a small percentage, around 3 %, of bore wells yield adequate water for irrigation [1].

Hydro-fracturing of low yielding bore wells is a relatively new technique and requires expensive equipment for injecting large volumes of water under high pressure into the bore, so as to 'jack up' the existing low permeability fractures met with in the bore well. Some of these fractures get extended and connect the bore well to a network of more permeable fractures, if such a network exists in the vicinity of the low yielding bore well. Hydro-fracturing is more commonly used in USA, Australia and South Africa. In South Africa, flow rates of injection water in a successful operation are more than 15 lit/sec at a pressure of 80 bars [2]. It has been observed that hydro-fracturing is more successful at sites, which are selected on the basis of lineament mapping and geophysical exploration. At such sites the initial low yield is due to the unfortunate fact that the bore well has missed the main fracture network by a few meters or so, and during hydro- fracturing its connection to the main network gets established and the additional yield makes the bore profitable. The equipment is however expensive and in the vast basaltic plateau in India only a few hundred bore wells have been treated by Government Departments.

In order to increase the number of successful and economically viable bore wells or dug wells for farmers in a watershed, exploration for suitable well-sites assumes great importance. Reconnaissance survey of the watershed or sub-basin is necessary for delineating promising areas for conducting detailed hydrogeological and geophysical surveys. Old river channels, lineaments and fracture orientations observed from satellite imageries or air photographs are also useful for this purpose. Resource assessment in a sub-basin could be done at the input side, by estimating the recharge from rainfall and at the output side, by estimating the dry season flow and underflow of the effluent stream draining the sub-basin. The more the quantity of this outflow, better are the prospects for digging/drilling additional wells.

4. The role of GROWNET

The project "GROWNET – GROund Water NETwork for best practices in ground water management in low income countries" was approved by the UNESCO-IUGS-IGCP in the year 2005, with the Author of this Paper as the Project Leader. The website www.igcp-grownet.org of GROWNET project lists the following best practices which are connected to the economics of using the resource.

1. *Exploration & Assessment of Resource* (This is necessary to ensure that the wells are dug or drilled at suitable spots where ground water would be available and the percentage of failed wells in minimized.)
2. *Institutional financing for wells/bore-wells for small scale irrigation* (Institutional 'soft loans' to farmers

should be made available by Banks, so that the farmers are not cheated by private money-lenders.)

3. *Technology for Digging/Drilling of Wells.* (Appropriate, low-cost technology should be used to cut down the costs of wells and bores.)

4. *Pumping technology* (Pumps should be efficient so as to reduce the electricity charges for pumping water for irrigation.)

5. *Utilization of pumped water for seasonal/perennial irrigation.* (The farmer should aim at getting maximum crop per drop, or maximum income per drop of ground water pumped.)

6. *Marketing of agro-products.* (Marketing of agro products should preferably be arranged through farmers' cooperative societies. Any 'value addition' at farm level brings better returns to the farmer.)

7. *Recovery of Institutional (Bank) Loans.* (The cooperative society for Marketing should pay the loan installment directly to the Bank and then give the remaining amount to the farmer.)

8. *Monitoring of water quality & yields from wells.* (Monitoring is necessary so as to check if the resource is being over-exploited.)

9. *Watershed management.* (This is essential for long-term sustainability of yields from wells)

10. *Artificial Recharge by encouraging participation of beneficiaries* (This is also necessary to safeguard the yields from wells)

11. *Implementing pumping regulations.* (If actions under 9 and 10 above are not enough to control over-exploitation, the village council has to decide on pumpage control.)

12. *Finding amicable solutions for conflicting interests of stakeholders.* (If there is a conflict between stakeholders the village council should try to find an amicable solution.)

13. *Role of Women* (As women are better managers of scarce resource like ground water, active involvement of women should be encouraged at all stages from planning to execution of ground water utilization programs.)

14. *Promoting Role of Ground Water in National Economy & National Water Policy.* (This is necessary to obtain Government funding on priority basis for restoration degraded watersheds.)

15. *Post Evaluation of Ground Water Development Projects* (This is necessary to find out the best practices which were helpful to farmers in getting maximum advantage from resource utilization.)

5. Conclusions

1) In the semi-arid, hard rock region in India, ground water is an important resource for providing drinking water supply and irrigational supply to millions of farmers and villagers.

2) The problem of providing safe drinking water supply to villages has an effective and low-cost

solution in drilling a bore well in the village and installing a hand pump. Village women could then spend more time in gainful employment. The villagers' health also shows improvement by reduction in days lost due to water-related illness.

3) The benefit / cost analysis for using ground water for irrigation is favorable, if (a) The farmers get guidance on selection of location for well drilling/digging; (b) Institutional soft loans are made available to farmers; and (c) Infrastructural development for agro-inputs and marketing of agro products is arranged.

4) UNESCO-IUGS-IGCP project no. 523 "GROWNET" is a humble step in disseminating 'farmer friendly' best practices in ground water development projects, through its website www.igcp-grownet.org

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