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Study of Challenges Faced by Farmers Related to Irrigation Water for Increasing Crop Production

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Authors' contributions

This work was carried out in collaboration among all authors. Author VC designed the study, performed the statistical analysis, wrote the protocol, wrote the first draft of the manuscript, managed the analyses of the study and managed the literature searches. All authors read and approved the final manuscript.

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ABSTRACT

The objective of this study was to evaluate the groundwater scenario in Haveli block of Pune district in Maharashtra, India. An interdisciplinary approach and techniques in both natural and social sciences was used, to unravel how local hydrogeological conditions and institutional arrangements interact and contribute to water problems. The study also attempted to understand the sources of water available for irrigation, methods of irrigation followed by farmers and to suggest how to improve the surface water use for increasing crop yield and area coverage. The study helped to understand the scope for conservation and protection of natural water resources, reduce overexploitation of groundwater and mitigation of water scarcity faced by the community. Fortunately the present government policy encourages the use of micro-irrigation for promoting sustainable agriculture and to cover larger areas under assured irrigation.

Keywords: Irrigation; hydrogeological; conditions; water use.

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1. INTRODUCTION

Water is life as it is needed to ensure food security, feed livestock, undertake industrial production and to conserve the biodiversity and the environment. Although India is not a water-poor country, due to the growing human population, severe neglect and overexploitation, water is becoming a scarce commodity. India's per capita water availability has decreased from 1,816 cu. m in 2001 to 1,545 cu. m in 2011. While this is a growing concern all over the world, India is most vulnerable because of the growing demand and in-disciplined lifestyle. This calls for immediate attention by the stakeholders to make sustainable use of the available water resources to ensure a better quality of life [1]. India is blessed with good rainfall, well distributed over 4-5 months in the year, but the water availability within the state varies widely. Uneven rainfall distribution also affects the groundwater reserves, causing water scarcity condition in certain regions and hampering food security [2]. Groundwater is one of the most vital water resources stored beneath the earth's surface (in saturated, permeable geological formations called aquifers), which has an important role in sustaining aquatic ecosystems and habitat, directly under streams and along the valley bottoms. Streams are constantly exchanging water with the ground, and these exchanges can either augment the stream's flow or recharge the aquifer below. An important feature of these exchanges is that they can vary seasonally, allowing groundwater to keep streams flowing during the warm summer months and to keep water temperatures cool [3]. Farmers rely on a bounty of water to feed their thirsty crops, which demand more water, even by over-exploiting the groundwater. Groundwater resources are further affected by climate variability via precipitation, evapotranspiration and poor recharge. Analyses of USA and India trends reveal that climate-induced pumping indirectly influences groundwater depletion as well [4]. India is facing a dire water crisis, as acknowledged by the NITI Aayog [5] in their report. The major challenges in the irrigation sector in India are erratic rainfall and poor water availability, causing huge regional imbalance and sub-optimal utilization of water. Competing demand for water is increasing rapidly and overexploitation of surface water is leading to drainage problem, coupled with the challenges of climate change. The present study was aimed to understand the sources, volume and quality of water available for irrigation and suggest suitable remedies to ease the water crisis.

1.1 Study Area

The study was carried out around the village Uruli Kanchan, located 33 km east of the Pune city in Maharashtra state in India, adjoining the mountain ranges of Sinhagad - Bhuleshwar. About 2 km north of the village, flows the river, Mula-Mutha. The area around this village receives an average of 600 mm rain per annum. The medium black soil around the village is very fertile and irrigation from the Mutha canal allows the cultivation of cash crops [6].

The area is covered mainly by Deccan Basalts. An interesting feature of the Deccan basalts is the remarkable contrast in the water-bearing properties of different flow units. The porosity of volcanic rocks varies widely from an almost negligible value for dense varieties to over 80 per cent for pumice, tuff and some vesicular varieties, with poor primary porosity. Whatever primary porosity exists is due to gas vesicles (unfilled), lava tubes and lava tunnels. The secondary porosity in basalts is introduced due to weathering, brecciation, shrinkages, cracks and joints, fracture systems developed due to tectonic disturbances. All this primary and secondary porosity together makes basalt a very productive aquifer. Deccan basalts of west-central India are hydro-geologically inhomogeneous rocks. A proper understanding of the physical framework of the basalts within which groundwater resides and moves is a key to the hydrogeology of these rocks [7].

2. METHODOLOGY

Uruli Kanchan has various water sources and most farmers were entirely dependent on groundwater as they were not in close vicinity of surface water such as a river or canal. Groundwater resources involved were dug wells and bore wells. BAIF Development Research Foundation, a reputed voluntary organisation, has been helping farmers through climate-resilient agriculture, livestock development, watershed development and agri-horti-forestry as major income generation activities. As a result of various water resources development practices, the water scenario has not been dire as of yet but there is room for major improvement through conservation practices. The water levels in this region fluctuated from pre-monsoon to post-monsoon but previous studies suggest that the overall water levels were rising in this area, which explains the water-logging problems faced by the villagers during the monsoon. In many parts of the village, water conservation practices were adapted by the farmers, which included micro-irrigation methods and construction of systems such as roof-water harvesting and farm ponds.

For collection of quantitative data, 60 farmers having irrigation facilities were selected at random, and interviewed by using a schedule, to understand the water sources, status of crop production and irrigation practices followed and to understand their problems. According to Hejase and Hejase [8], descriptive statistics deals with describing a collection of data by condensing the amounts of data into simple representative numerical quantities or plots that can provide a better understanding of the collected data. Therefore, this study analyzed data collected with descriptive statistics such as frequencies and percentages supported with diagrams for clarity. Based on these observations, various conclusions were drown and suitable recommendations were made.

3. RESULTS AND DISCUSSION

3.1 Land Holding and Water Resources

About 50 per cent of farmers have land size ranging from 1-2 ha. 23.3 per cent farmers owned less than 1 ha and 26.7 per cent own more than 2 ha (Table 1). It was observed that with increasing land area, water sources also increased, except for a very few farmers. Farmers tended to create more water resources for their fields, using their surplus income. However, excessive use of water did not increase their income proportionately and it had negative effects on the groundwater aquifer system.

3.2 Water Quality

The quality of water of 51 per cent sources was poor, with high salt content (Fig. 1). Only 28 per cent of the families had access to clean and soft water, while the remaining 21 per cent water sources were highly polluted. Salt content of water has been increasing with depth of bore wells, as reported by the local residents. Water from the river was polluted, as informed by local farmers.

3.3 Methods of Irrigation

About 63.7 per cent of the farmers have opted for furrow irrigation which is an old method of gravity irrigation method, as presented in Fig. 2. The furrow irrigation method was dominant in this area due to assured availability of water in abundance. This condition however, did not persist in the pre and post-monsoon, but the irrigation method remained the same. Drip and sprinkler irrigation systems are still not very popular among farmers and only 36.3 per cent of them, particularly those having access to clean water are willing to invest in drip and sprinkler systems (Fig. 3). Problems of water supply were not very prominent but electricity supply hindered the water use. The crops grown mostly included sugarcane, grains, vegetables and flowers.

Table 1. Relation of water sources and land holding

Land (in hectares)	Number of Farmers (Per cent)	Average no. of water sources
>1	14 (23.3%)	1
1-2	30 (50.0%)	1-3
<2	16 (26.7%)	2-4

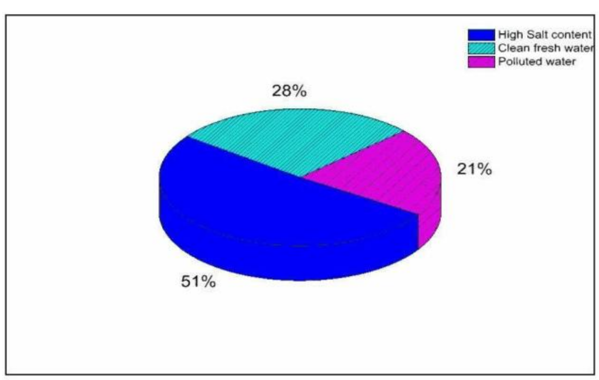

Fig. 1. Pie chart showing quality of water

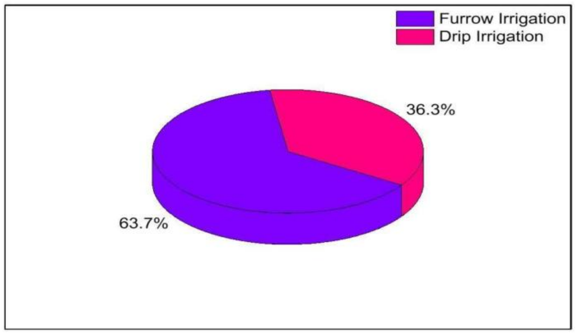

Fig. 2. Percentage of farmers practicing macro and micro-irrigation methods

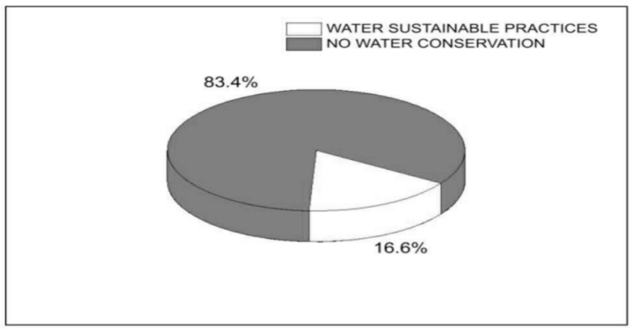

Fig. 3. Percentage of farmers engaging in water conservation practices

Cost of irrigation for farmers ranged from Rs.5,000 to 0.6 million per hectare every year (Table 2). Average annual expenditure per hectare is Rs.32,910. A majority of farmers did not practice any water-saving/sustainable methods other than a few who used field ponds, rain-water harvesting and water tanks.

3.4 Other Observations

From the survey, it can be confirmed that the water scenario of the village Uruli Kanchan is not highly alarming, although the quality of water is poor. Majority of farmers have multiple sources of water which included dug wells, bore wells, irrigation canal, and river water. Very few families have only one source like well, who often face the problem of water in this region.

River and canal water carrying treated sewage from Pune Municipal Corporation were unsuitable for irrigation because of high amounts of pollutants and some wells have salinity higher than desired. Nevertheless farmers who did not have other sources, used this water for irrigation. There was shortage of water in the river for 2-3 months before the monsoon season. During this period, water level in wells dropped, but hardly ever dried out. Farmers located near the canal and river faced less problems during summer, but rain scarcity could worsen the situation. The locals have little knowledge about climate change and its impact on groundwater. They seemed ignorant about the water problems that they will face in the future, if they continue to exploit ground water. It could also be inferred that the farmers were not very seriously concerned about future water stress.

Table 2. Land parameters and annual expenditure

Land parameters	Area (Ha)	Annual cost of irrigation	In Rupees (Rs.)
Total farmers surveyed	60	Total count of survey	60
Average land owned	1.81	Average expenditure/ ha	32,910
Maximum holding	6	Maximum expenditure/ha	600,000
Minimum holding	0.2	Minimum expenditure/ha	5,000

Heavy subsidies on electricity consumed for agriculture has tended to encourage wasteful use of energy and water. However, load-shedding was a serious problem to irrigate regularly in spite of water availability. Hence installation of solar powered pumps is a better option, although farmers are tempted to draw more water by making use of free power and this has to be addressed by extensive awareness on water conservation.

4. CONCLUSION

Village like Uruli Kanchan, located in the Deccan traps is less affected by the water stress conditions, where water for irrigation is available from external sources such as Mula-Mutha river and canal, although the ground water sources are inadequate. These additional sources help in recharging the groundwater table which is efficiently used by the farmers through bore and open wells. However the quality of water has been poor either due to sewage contamination in the river water or absorption of salts from soil from natural and anthropogenic means. The use of groundwater is however restricted to the availability of electricity for pumping. Although farmers are presently not experiencing water scarcity, they are likely to suffer in the near future either from lack of irrigation water or prolonged drought that affects groundwater table. Micro-irrigation is an efficient method for water conservation and sustainable farming but currently only 36.3 per cent farmers had adapted this technique. As these farmers are realising the benefits of micro-irrigation, systematic irrigation extension programmes should be promoted and supported by suitable policies for water conservation.

5. SUGGESTIONS AND RECOMMENDATIONS

Based on the study, the following recommendations were made:

1. Crops demanding less water have to be encouraged, so as to produce food with a minimal amount of water. However, farmers are inclined to grow crops such as sugarcane which requires heavy irrigation, as it guarantees assured income, which is not the case with other crops [9,10]. Hence this scenario should be gradually changed after establishing assured market for new crops.
2. As the study area in Haveli taluka and the adjoining blocks have medium to high yield potential [7], suitable abstraction structures recommended for groundwater development are dug wells and bore wells.
3. There is scope for construction of suitable artificial recharge structures, such as contour bunds, gully plugs, rivulet (*Nala)* bunds and check dams. Percolation tanks are suggested at suitable hydrogeological locations. Some of the existing dug wells may also be used for artificial recharging of groundwater [1].
4. The quality of groundwater is also affected by excessive nitrate content of more than 45 mg/litre [7] which makes water unsuitable for drinking. Hence all wells used for drinking water should be tested for nitrate content.
5. As the groundwater regulation is essential, the Government should introduce suitable policy for groundwater conservation and educate farmers about the need for water conservation [7].
6. Solar energy can be used for pumping water, as it would give farmers more control over their water sources and decrease wastage of water. It is a cost-effective and easily accessible method with very low maintenance cost and a long term benefit with positive results on water source, environment and crop yield [11].
7. For creating awareness among people towards water conservation and augmentation of groundwater resources, Mass Awareness Programmes should be organized involving local public, as suggested by other experts [7]. Farmers should be encouraged to adopt appropriate cropping plans and modern irrigation practices.

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COMPETING INTERESTS

Authors have declared that no competing interests exist.

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