Social and Economic Impacts of water harvesting structures: A synthesis

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Introduction

This theme of social and economic impacts of water harvesting structures consisted of a set of studies conducted at different locations to understand the impact of different types of small water harvesting structures on the lives and livelihoods of men and women in their vicinity. It consisted of six studies[1], sites for which fall in eight districts of four different states. Additionally, collaborators have looked at the revival of minor irrigation tanks in four states (Verma, Shah, & Santhosh, 2018). This paper is an attempt to synthesise these studies across seven states.

Water harvesting programs provide a source of supplementary irrigation, providing a means of achieving income enhancement through agriculture, which is also one of the aims of the central and the state government schemes. Water harvesting structures such as farm ponds have the potential to enable farmers to bring more land under cultivation and achieve greater crop intensification from the same patch of land (Kumar, Ramilan, Ramarao, Rao, & Whitbread, 2016). The multi-location study suggests that NGOs (Non-governmental organisations) as well as the state governments are promoting water harvesting programs across different states including revival as well as construction of new water harvesting structures.

Water harvesting structures result in both tangible as well as intangible gains. However, an essential point of consideration lies in understanding the strength of these impacts; whether they are financially and environmentally sustainable and deserve investment of taxpayers' money. Another important aspect is finding the optimal solution for harvesting rainwater at a particular geographic location. Study sites fall under different agro-climatic and agro-ecological regions with varying annual rainfall. These regions have different geological and water-bearing rock formations as well.

These factors should govern the choice of a water harvesting structure in the region – digging lower order streams may not be as effective a water harvesting measure as a cascade of small ponds

[1] Studies are (Mukharjee & Choudhury, 2018), (Sen, 2018), (Deora, 2018), (Deora & Nanore, 2018), (Guha, 2018)

at the moderate to gently sloping land and good rainfall endowed region of Gumla. This synthesis tries to put the multi-location study into this context.

Water harvesting structures looked at as part of this multi-location study are conceptually also of different types. While some of these structures studied serve the dual purpose of groundwater recharge along with supplementary irrigation, others are only acting only as sources of supplementary irrigation. This paper tries to synthesise all these aspects from the multi-location study and generate a discussion out of these.

Objective

The objective of the multi-location study was to evaluate the social and economic impacts of different small water harvesting structures.

This synthesis explores these impacts across water harvesting structures and different locations.

Method and data gathering

The multi-location study consists of six primary data-based study, and one study by collaborator is itself a synthesis of multiple primary data-based studies carried out from 2015 to 2018. Studies did not strictly follow random sampling procedure; however, no criteria other than the location familiarity and the ease of access has influenced the sample selection. Studies used different data collection techniques to collect quantitative and qualitative data; data collection techniques included questionnaires and focus group discussions. For analysis, study classifies data into a treatment and a control population.

Studies collected data related to changes in the following aspects.

- Agriculture – cropping pattern, yield, income
- Livestock and fisheries
- Availability of water for domestic use
- Groundwater recharge

Studies also attempted to understand the impact of these water harvesting programs on women.

Findings and inferences

Agriculture

- **Irrigated area**

Irrigated area has increased due to the presence of a water harvesting structure at all the locations. Studies record an increase of up to more than 100% in the irrigated area. It has led to benefits for the marginal and small holding farmers.

- **Cropping Intensity**

Cropping intensity is a measure of agricultural intensification. The multi-location study identifies increased cropping intensity as a default outcome of the water harvesting measures. Area under *rabi* crop has increased. It records percentage increase in the cropping intensity ranging from 5% to 125%.

Study sites witnessing relatively higher rainfall show relatively higher percentage increase in the cropping intensity – of close to 100%. It leads to an inference that water harvesting structures at high rainfall sites help in intensifying agriculture by capturing the run-off. Superior water control, brought in through water harvesting structure, has provided irrigation beyond the monsoon months ensuring *rabi* and sometimes *zaid* crops.

- **Crop Diversification**

Study finds that post construction of water harvesting structures, variety of crops on the agricultural plots has increased. Percentage of farmers growing vegetable crops has increased at all locations. Farmers have started cultivating perennial horticulture crops, also mulberry along with other high-value crops requiring assured irrigation.

To determine the magnitude of crop diversification the study calculates the Herfindahl Index (HI) for all locations. The value of HI varies between zero to one. It is one in case of perfect specialisation and approaches zero in case of perfect diversification (Velavan & Balaji, 2012). HI values for five study sites indicate an increased crop diversity post construction of the water harvesting structures. One study site, which shows a reduced diversification has a fraction of farmers turning to commercial seed crop production as the reason behind this reduction (Deora & Nanore, Impact assessment of the Doha Model as a water harvesting structure, 2018).

Diversification towards high-value crops is usually a risk minimisation strategy and an income maximisation strategy at the same time. Findings from the multi-location study are in line with assumption as the high-value crops such as vegetables are more affected by market fluctuations than the traditional food crops. Two of the studies, point out the increased risk with an increased crop diversification – primarily governed by the vegetable price fluctuations (Mukharjee & Choudhury, 2018) (Sen, 2018).

- **Crop Yield**

Crop yield is a potential measure of the land productivity. Therefore, the multi-location study looks at the crop yields of a few crops. It finds an increase in the crop yield due to presence of a water harvesting structure. Synthesis here presents the same for the primary crop at each of these sites.

Crop yield has increased for the major crops – paddy in locations in eastern India, cotton in Maharashtra with the increase ranging from 21% to 92%. At one study site, where the crop yield has reduced study sites a shift in focus to water-intensive cash crops such as mulberry, fruits and flowers as the reason (Sen, 2018).

- **Income from agriculture**

Gross income from agriculture shows an increase for the treatment group farmers, when compared to the same for the control group farmers, over the same period. Cost of cultivation has also reduced as a result of silt application during the process of tank revival (Verma, Shah, & Santhosh, 2018).

Livestock and fisheries

Livestock ownership shows marked increment at four study locations. Two studies find that availability of irrigation for extended period has led to increased fodder production and also indicate a breed improvement. Fishery ownership as well as income from fisheries also shows an increment.

Cost-benefit analysis done for three studies including benefits from agriculture, livestock and fisheries yield an IRR (Internal rate of return) ranging from 21% to 90%.

Groundwater recharge

Groundwater recharge is a significant application of the water harvesting and watershed programs. One study finds it leading to increased groundwater level. Another study (Verma, Shah, &

Santhosh, 2018) finds a reduced depth of tube-wells, increase groundwater level along with a reduction in the number of defunct tube wells and handpumps.

Domestic water use

Men and women from the study sites perceive water harvesting structures to be instrumental in addressing their domestic water availability related issues. As already noted, groundwater level has increased which is usually the source of drinking water also.

Impact on women

In a rural Indian setting, women have the primary responsibility of fetching water. The multi-location study records women complaining of physical drudgery, back pain from travelling long distances to the water sources.

In this context, construction of water harvesting structures in the vicinity of the village habitation area is supposed to benefit women. The multi-location study finds that these structures have benefitted women in cases where they have brought the water sources closer to their homes. Additionally, for women herding cattle to long distance in search of water, close by water reservoirs have brought relief.

One woman from East Singhbhum district of Jharkhand says, *"Earlier I had to go to the stream which is at least two km away from my house. Because of this I used to take bath on alternate days. However, now the farm pond is near my home. I can take bath daily now."*

Equity in benefit distribution

At two locations, where the water harvesting structure is on a common land, study finds the water harvesting structures benefitting a limited population having their agricultural fields on the lowland, leaving those who have their agricultural fields on the upland.

Discussion

Surface area lost for utilisation of water

Water harvesting structures, part of the multi-location study, are of varying dimensions; these range from 15 feet to 150 or 200 feet in length and width, with a depth of 10 to 12 feet from the ground. Efficiency of these structures also varies according to their dimensions. One of the study

(Verma, Shah, & Santhosh, 2018) writes about canal, anicut and tanks also. At one study location, a comparative cost-benefit analysis of the different pond sizes finds the smallest size to be the most efficient. Similar comparisons if done at different locations will yield different results and will help in choosing the best among small water harvesting structures. The study determines this as an essential consideration while planning water harvesting programs.

Geographical suitability of a water harvesting structure

The multi-location study finds that at the study sites with moderate to gentle slopes and a relatively higher rainfall, water harvesting structures are on the upland and the midland; while at the sites with relatively lower slope and lower rainfall, these structures are spread on the midland and the lowland. The topographical location of a water harvesting structure and the extent of rainfall at the site can have an impact on its capacity utilisation.

However, agriculture fields on the upland are usually least productive due to the absence of an irrigation source. In comparison to the midland and lowland, upland has a higher probability of staying fallow. Hence, the opportunity cost of giving up a part of the upland for a water harvesting structure is lower as compared to the midland or lowland. This knowledge, along with the willingness of a farmer to part away with her land, make another critical criteria affecting the planning process of a water harvesting program.

Study also found that the water harvesting structures situated on the upland are not able to retain water at the time of critical irrigation needs for *rabi* crops. Structures on the uplands acted more like percolation structures rather than like irrigation sources. Geohydrological considerations, such as aquifer mapping, were found to be absent from the planning process. Study sites in Maharashtra are dominated by Deccan trap basalt, which has a low primary porosity and a reduced potential for groundwater recharge (Singhal, 1997). Geohydrological features are a determinant of the groundwater recharge capacity and hence need to be considered while planning and implementing water harvesting programs.

Silting of water harvesting structures

At all the study sites and invariably across all the water harvesting structures under the multi-location study, silting was reported as an issue leading to a reduction in the storage capacity of the structures. It has led to a reduction in the size of the water reservoir, in some cases, to the extent that it has reduced to a mere percolation structure, not supporting the irrigation function. One of the study records government sponsored desilting programs. However, it also flags the non-sustainable nature of desilting done through such programs (Verma, Shah, & Santhosh, 2018). Therefore, a consideration for maintenance, including periodic desilting, right at the time of planning water harvesting structures is crucial in getting the most of the investment.

Community participation

Considering the public nature of the benefits of water harvesting structures and at the same time considering the need for their regular maintenance warrants the need to ensure community participation in the process of planning and implementation of the water harvesting programs. However, the multi-location study finds this as a significant gap across the study sites. All sites have a minimum or no community participation, except one. Community participation can address the issue of silting, if the water harvesting programs address the community needs.

Participation of women

While the study found that the water harvesting structures have helped in reducing physical drudgery for women, there was little evidence of a change in the agency of women as a result of these programs – except at one location where women SHGs (self-help groups) were involved in program implementation. Women at one study site perceive that water harvesting structures were used solely for irrigation and in no way benefitting them. At another study site, women reported having no say in the household decision related to the construction of a water harvesting structure on their farmland. They perceive little control over the household decisions related to the alternate livelihood options facilitated by the water harvesting structures. At the same time, women reported devoting significant time in these alternate livelihoods, owing to the proximity of water harvesting structures from their homes. As a result, women's physical drudgery increases rather than reducing with no say in the decision making. However, in one village in Jharkhand, where women actively participated in planning and implementation of the water harvesting program, they perceived greater say in the decisions related to the alternate livelihood options facilitated by the water harvesting structures.

Conclusion

Findings from the multi-location study show that water harvesting structures result in a variety of benefits related to agriculture, livestock and fisheries. Cropping intensity, crop yield, crop diversity and overall income from agriculture have increased. Cost-benefit analysis also lends credibility to the different water harvesting structures. These structures contribute to groundwater recharge as well which is a significant source of water for domestic use. At certain places they have also contributed to a reduced physical drudgery for women.

However, there are a few challenges related to planning and implementation of a water harvesting program, as highlighted in the discussion. Deciding the optimal location and dimensions for a water harvesting structure; considering all the agro-climatic and geohydrological factors; the subjective availability of privately owned land for these structures; periodic silting of these structures; ensuring participation of (Guha, 2018)community especially women and an equitable distribution of the benefits are few of them. A water harvesting program with these considerations can be more effective than one without these.

References

Deora, S. (2018, August). Exploratory study of Doha Model as a water harvesting structure. *Paper prepared and submitted for the conference on Rural India: Blossoming in neglect?* Pune: Vikasanvesh Foundation.

Deora, S., & Nanore, G. (2018, August). Impact assessment of the Doha Model as a water harvesting structure. *Paper prepared and submitted for the conference on Rural India: Blossoming in neglect?* Pune: Vikasanvesh Foundation.

Guha, R. K. (2018). HAPA: Dreaming with small pond. *Paper prepared and submitted for the conference on Rural India: Blossoming in neglect?* Pune: Vikasanvesh Foundation.

Kumar, S., Ramilan, T., Ramarao, C., Rao, C. S., & Whitbread, A. (2016, October). Farm level rainwater harvesting across different agro climatic regions of India: Assessing performance and its determinants. *Agricultural Water Management, 176*, 55-66.

Mukharjee, M., & Choudhury, N. (2018). Enhancing water, food and income security through Farm Ponds. *Paper prepared and submitted for the conference on Rural India: Blossoming in neglect?* Pune: Vikasanvesh Foundation.

Sen, K. K. (2018, August). Impact of water harvesting structures on lives and livelihoods of farmers in Chikkaballapura District, Karnataka. *Paper prepared and submitted for the conference on Rural India: Blossoming in neglect?* Pune: Vikasanvesh Foundation.

Singhal, B. (1997). Hydrogeological characteristics of Deccan trap formations of India. *Hard Rock Hydrosysteins (Proceedings of Rabat Symposium S2, May 1997). 241*. IAHS.

Velavan, C., & Balaji, P. (2012). Crop diversification in Tamilnadu-A Temporal Analysis. *Agricultural Situation in India*, 655-658.

Verma, S., Shah, M., & Santhosh, H. (2018, August). Reviving India's water harvesting structures to achieve drought resilience. *Paper prepared and submitted for the conference on Rural India: Blossoming in neglect?* Pune: Vikasanvesh Foundation.