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Water harvesting practices: A way of innovation for supplemental irrigation

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Abstract
Due to causes including climate change, water pollution, and the irresponsible exploitation of water resources, water scarcity has become a more serious global issue. Water is the most important element restricting agricultural production in semi-arid locations during the hot and dry summer months. The effectiveness of soil moisture conservation, either in situ or through harvesting excess runoff and storing it for additional irrigation, is crucial to the sustainable cultivation of rainfed crops. Harvesting rainwater may significantly boost agricultural output, increase food security, and reduce poverty while also helping to more effectively utilize water resources in remote regions. A survey was undertaken to study the level of awareness and adoption of water harvesting practices in the Bhiwani district of Haryana state. From the district, four villages, and from each village 20 farmers were selected randomly. The study revealed that more than 3/4th of farmers in the Bhiwani district were found aware regarding the use of rainwater harvesting practices. A majority (86.25%) of the respondents were aware about 'Rainwater harvesting practices during monsoon', and 'Rainwater harvesting will increase cropping intensity of the farm (85.00%)'; but adoption was found quite low i.e., only 21.36 percent of overall adopted rainwater harvesting practices with a mean adoption score of 5.27. It is also recommended that all agricultural departments launch a campaign to encourage farmers and villagers to adopt water harvesting practices in order to store water for current and future use for various purposes.

Keywords: Rainwater harvesting, awareness, adoption, monsoon, water scarcity

Introduction
Preserving natural resources is crucial to the survival of farm families as well as those who will come after us. An important first step in addressing the sustainability of future agriculture in this setting is to adopt a more comprehensive strategy aimed at agroecological restoration through sustainable land and water management. Because, due to causes including climate change, water pollution, and the irresponsible exploitation of water resources, water scarcity has become a more serious global issue. In several of the dry desert zones, the total rainfall has diminished and dry periods have increased. Water is the most important element restricting agricultural production in semi-arid locations during the hot and dry summer months. India's population is largely dependent on agriculture and related industries, which contribute 18% of India's GDP and plays a significant part in the country's economy. Since roughly 52% of the entire cultivated land is under rainfed agriculture, any change in crop conditions is likely to have an impact on the nation's economy as a whole. Nearly 80% of the country's freshwater is being utilized by small and marginal landholdings in the agricultural sector (Reddy *et al.*, 2020) [6]. The effectiveness of soil moisture conservation, either in situ or through harvesting excess runoff and storing it for additional irrigation, is crucial to the sustainable cultivation of rainfed crops. According to the World Resources Institute, the national supply of water will decline to 50% of demand in 15 years, while the Central Water Commission predicts that demand would rise from 1,093 billion cubic meters in 2025 and 1,447 billion cubic meters in 2050 (Singh *et al.*, 2019) [8]. By 2025, it is predicted that 1 billion more tonnes of grain will be required annually to meet the growing population's food needs. But the development in crop production has slowed down in recent decades, it is because irrigation expansion has also slowed down. To handle this scarcity, numerous strategies have already been created. Rainwater harvesting appears to be an effective strategy for reducing water scarcity in poor nations and serves as a beneficial local adaptation to changes in the environment (Rozaki *et al.*, 2017) [7]. The general public and the government are starting to understand that utilizing this resource calls for a public partnership strategy and a shift in community thinking.

Rainwater harvesting is the concentration, collection, and storage of precipitation for immediate or future use on-site or at other sites. Because surface water cannot satisfy our needs and we must rely on rainwater harvesting, which is crucial in the present scenario. Harnessing the production potential of dryland areas and systems requires careful consideration of rainwater harvesting and use. Harvesting rainwater may significantly boost agricultural output, increase food security, and reduce poverty while also helping to more effectively utilize water resources in remote regions. The use of rainwater harvesting technologies can be used to complement traditional water delivery systems and solve temporary water supply issues when demand rises (Baiyegunhi, 2015) [1]. People must be made aware of rainwater harvesting since efficient execution and usage of any programmes or schemes are the consequence of good awareness. Thus, the current study was done to determine the level of farmers' awareness and adoption of water harvesting practices during monsoons. In order to promote farm-level rainwater gathering for dryland agriculture, various policy and institutional approaches will be presented based on the analysis's broad findings.

Materials and Methods

The present study was conducted in the Bhiwani district of Haryana state. A total of 4 villages were chosen using a random sampling technique *viz*., Bakhtawarpura, Barwa, Budhsaili, and Ghangala from the Siwani block of Bhiwani district. To collect the data 20 farmers from each selected village were also selected randomly. As a result, 80 farmers were chosen as responders in the current study. The farmers' socio-personal (age, education, land holding), socio-economic (irrigation facilities, farming system, cropping pattern, crop rotation followed), and communicational characteristics (mass media exposure, extension contact, social media used, ICT tools used), of the farmers as well as their overall awareness and adoption level of water harvesting practices during monsoon, were considered. The awareness level of farmers about Agri mobile apps for crop production was measured on a 2-point continuum *viz*., 'Aware'- '1' and 'Not aware'- '0'. Similarly, their level of adoption ('Fully adopted'- '2', 'Partially adopted' – '1' and 'Not adopted'- '0') was also measured. A purposefully created interview schedule that had been pretested before being given to the sampled respondents was used to gather data from the respondents who had been selected for the sample. Appropriate statistical measures were used, i.e., mean, frequency, percentage, and rank order, to draw meaningful inferences.

Results and Discussion

Profile of selected respondents

A descriptive analysis of the sampled respondents' socio-personal, socio-economic, and communicational characteristics was conducted. More than half of the respondents (55.00%) belonged to the middle age (31 to 50 years) group, and 27.50 percent of the respondents had educational qualifications up to higher secondary. According to the present study, about one-third (30.00%) of the respondents have land holding above 5 to 10 acres. The majority of the respondents (85.00%), have both sources of irrigation (Canal + Submersible pump/Tube well), were doing livestock with agriculture (87.50%), 67.50 percent of the respondents practicing sole cropping pattern, about two-thirds of the respondents (62.50%) has cotton–wheat cropping system. In the case of communicational characteristics, the newspaper ranked first with a weighted mean score of 2.21 followed by television and Kisan Sewa Kendra ranked second and third with weighted mean scores of 1.92 and 1.60, respectively as mass media, among the extension contact of the farmers, the most popular were the Progressive farmers (WMS=2.69) followed by ADOs/HDOs (WMS=2.54), 85.00 percent of respondents got information through WhatsApp followed by Face book (68.75%), YouTube (52.50%), the ICT tools like website (30.00%) followed by the portal (26.25%) and Kisan Apps i.e. e-Mausam (47.50%) used to get information by the respondents, respectively.

Farmers' awareness towards water harvesting practices

Awareness is a crucial decision-making tool for making farming more profitable and sustainable. Table 1 shows the extent of awareness towards water harvesting practices.

A majority, 86.25 percent of the respondents were aware about rainwater harvesting practices during monsoon season, and 85.00 percent were aware about rainwater harvesting will increase the cropping intensity of the farm. Of the sampled respondents, 83.75 percent of them were aware about rainwater harvesting and storage by different methods like channel tanks, on-farm basins, infiltration channels, check dams, infiltration well, and water harvesting banks, 82.50 percent were aware about the storage of harvested rainwater to cater to demands of water for drinking, domestic & irrigation purpose and harvested rainwater can be stored for future use, 81.25 percent of them were aware about rainwater harvesting practices can increase the area under irrigation and 81.25 percent were aware about harvested rainwater allows for the collection of large amounts of water and mitigates the effects of drought, and 80.00 percent were aware about rainwater harvesting practices can reduces soil erosion, water runoff, flooding, pollution of surface water with fertilizers, pesticides, metals and other sediments as well as harvested rainwater may be the source of drinking water, food security and various needs for crowded millions of the state.

However, 78.75 percent of the sampled respondents were aware that water harvesting improves farm yield and climate change and recharging of groundwater aquifers with runoff from the rooftop, 77.50 percent were aware about different practices of rainwater harvesting methods, and 75.00 percent of respondents were aware that the recharging groundwater aquifers with runoff from ground area. Whereas 73.75 percent of the respondents were aware that harvested rainwater increases available water for irrigation and other uses like domestic, industrial, municipal, etc., 72.50 percent were aware that rainwater harvesting reduces the cost of pumping groundwater and 70.00 percent were aware that harvested water provides very high-quality water, soft & low in minerals. Only 67.50 percent of the sampled respondents were aware about harvested rainwater helps to raise the level of groundwater which then can be easily accessible, and 65.00 percent were only aware that it can be utilized to revitalize the ground level water and improve its quality. It is evident that farmers were more likely to be aware of the advantages of implementing rainwater collection technologies as they were more likely to be aware of the drought and its many socioeconomic and environmental effects. Respondents' overall awareness regarding water harvesting practices was found 77.76 percent.

As depicted in Table 1, the awareness level is found to be better in the case of water harvesting practices at various levels *viz*., rainwater harvesting practices during monsoon season (86.25%), increased cropping intensity of the farm (85.00%), harvesting and storage by different methods (83.75%), to cater to demands of water for drinking, domestic

& irrigation purpose and can be stored for future use (82.50%), can increase the area under irrigation and allows for the collection of large amounts of water and mitigates the effects of drought (81.25%). The overall awareness level is found to be relatively low in the case of, harvested rainwater helps to raise the level of groundwater which then can be easily accessible and can be utilized to revitalize the ground-level water and improve its quality with 67.50% and 65.00%, respectively.

Table 1: Awareness of farmers towards water harvesting practices during monsoon (n=80)

S. No.	Statements	Awareness level			
		Aware		Not Aware	
		Frequency	%	Frequency	%
1.	Aware about the rainwater harvesting practices during monsoon	69	86.25	11	13.75
2.	Aware about rainwater harvesting practices that can increase the area under irrigation?	65	81.25	15	18.75
3.	Rainwater harvesting will increase the cropping intensity of your farm?	68	85.00	12	15.00
4.	Harvested rainwater be stored for future use?	66	82.50	14	17.50
5.	Harvested rainwater be utilized to revitalize ground-level water and improve its quality	52	65.00	28	35.00
6.	Harvested rainwater helps to raise the level of groundwater which then can be easily accessible.	54	67.50	26	32.50
7.	Rainwater harvesting reduces the cost for pumping of groundwater	58	72.50	22	27.50
8.	Harvested water provides very high-quality water, soft & low in minerals.	56	70.00	24	30.00
9.	Know about different practices of rainwater harvesting methods?	62	77.50	28	22.50
10.	Rainwater harvesting practices reduce soil erosion, water runoff, flooding, and pollution of surface water with fertilizers, pesticides, metals, and other sediments.	64	80.00	16	20.00
11.	Harvesting rainwater allows for the collection of large amounts of water and mitigates the effects of drought.	65	81.25	15	18.75
12.	Water harvesting improves farm yield and climate change	63	78.75	17	21.25
13.	Aware about rainwater harvesting and storage by different methods like (a) Channel tank, (b) On-farm basin, (c) Infiltration channel, (d) Check dams, (e) Infiltration well, and (f) Water harvesting bank.	67	83.75	13	16.25
14.	Is harvested rainwater increases available water for irrigation and other uses (domestic, industrial, municipal, etc.)?	59	73.75	21	26.25
15.	Storing rainwater for direct use.	61	76.25	19	23.25
16.	Recharging groundwater aquifers with runoff from rooftops.	63	78.75	17	21.25
17.	Recharging groundwater aquifers with runoff from ground area.	60	75.00	20	25.00
18.	Storage of harvested rainwater to cater to demands of water for drinking, domestic & irrigation purposes	66	82.50	14	17.50
19.	Harvested rainwater may be the source of drinking water, food security, and various needs for crowded millions of the state.	64	80.00	16	20.00
Mean awareness score = 14.77					
Overall awareness level (%) = 77.76%					

Farmers' adoption level about water harvesting practices during monsoons

Adoption is the main objective of technology development because it indicates that technology is useful and extensively used. The level of adoption of the sampled farmers was measured with the help of an interview schedule. The extent of the adoption of water harvesting practices is presented in Table 2.

Of the sampled respondents, only 40.00 percent had fully adopted the Laser Land Leveller technology to harvest rainwater uniformly in the field, and among the rest 25.00 percent had partially adopted and 35.00 percent have not adopted it. Only 37.50 percent had fully adopted rainwater harvesting schemes initiated by the Govt. of Haryana, while the remaining 25.00 percent had partially adopted and 37.50 percent have not adopted them. About one-third of the sampled respondents had fully adopted field bunding of farms for rainwater harvesting i.e., 35.00 percent; 32.50 percent had partially adopted and 32.50 percent have not adopted it. Whereas only 33.75 percent of the respondents had fully adopted rooftop rainwater harvesting; 23.75 percent had partially adopted and about 42.50 percent did not adopt it. Only 32.50 percent of the sampled respondents had fully adopted deep ploughing during summer to conserve rainwater; 40.00 percent had partially adopted and 27.50 percent have not adopted it. In the case of recharge pits (water recharge structures) for water harvesting, only 30.00 percent had fully adopted; 27.50 percent had partially adopted. About 42.50 did not adopt the recharge pit for water harvesting.

With respect to the adoption of UGPL for the collection of harvested rainwater, only 27.50 percent had fully adopted it; 20.00 percent had partially adopted but the majority 52.50 percent of the respondents have not adopted it. Whereas 25.00 percent had fully adopted the trenching across the slope of the field for water harvesting; while the remaining 15.00 percent had partially adopted and about 60.00 percent have not adopted the trenching for water harvesting. About 75.00 percent have not adopted the Farm Pond for rainwater harvesting; only 15.00 percent had fully adopted and 10.00 percent had partially adopted it. In the case of a community-based water structure for rainwater harvesting, the majority 85.00 percent have not adopted it, only 10.00 percent had fully adopted and 05.00 percent had partially adopted it. And, about 78.75 percent of the sampled respondents have not adopted the check dam/pond across the Nalas/Roadsides for rainwater harvesting. Only 08.75 percent of respondents had fully adopted and 12.50 percent had partially adopted it. The overall adoption level of farmers found as 21.36 percent, with a mean adoption score of 5.27.

As depicted in Table 2, the adoption level is found to be relatively lower in almost all cases i.e., the level of adoption of solar energy was only to the extent of 40.00, 37.50, 35.00, 33.75, 32.50, 27.50, 25.00, 15.00, 10.00, and 08.75 percent, respectively. As for as, the non-adopted category of respondents about water harvesting practices in the sequence as stated above i.e., 27.50, 32.50, 42.50, 37.50, 35.00, 42.50, 52.50, 60.00, 75.00, 85.00 and 78.75 percent, respectively the respondents not adopted any water harvesting practices during monsoon season.

Therefore, the present study revealed overall adoption of water harvesting practices during monsoons is at a low level (21.36%). According to the study of Udmale *et al.*, (2014) [10], despite farmers' accurate assessments of the severity of the effects of drought and their knowledge of the available choices for adaptation including water harvesting, the preference shown for its widespread adoption in farming was insufficient. The study of Singh *et al.*, (2019) [8] revealed that rainwater harvesting has been adopted in several arid and

semi-arid areas of India; nonetheless, the technology's adoption has been slow. The study by Kumar *et al.*, (2016) [4] found poor adoption of rainwater collecting and a wide disparity in RWHS advantages among farms and regions. The study by Singh *et al.*, (2022) [9], it is revealed that the overall adoption level of water harvesting practices was 15.95 percent, which is very low. In many ways, these findings are comparable to those of the current study.

Table 2: Adoption Level of Farmers towards Water Harvesting Practices (n=80)

S. No.	Statements	Adoption level					
		Fully adopted		Partially adopted		Not adopted	
		F	%	F	%	F	%
1.	Laser Land Leveler technology to harvest rainwater uniformly in the field.	32	40.00	20	25.00	28	35.00
2.	Field bunding of farm for rainwater harvesting	28	35.00	26	32.50	26	32.50
3.	Deep ploughing during summer to conserve rainwater	26	32.50	32	40.00	22	27.50
4.	Recharge pit (water recharge structures) for water harvesting	24	30.00	22	27.50	34	42.50
5.	Rainwater harvesting schemes initiated by the Govt. of Haryana	30	37.50	20	25.00	30	37.50
6.	UGPL for collection of harvested rainwater	22	27.50	16	20.00	42	52.50
7.	Rooftops rainwater harvesting	27	33.75	19	23.75	34	42.50
8.	Trenching across the slope of the field	20	25.00	12	15.00	48	60.00
9.	Farm pond for rainwater harvesting	12	15.00	8	10.00	60	75.00
10.	Community-based watershed for rainwater harvesting	8	10.00	4	05.00	68	85.00
11.	Check dam/ Pond across the Nalas/ Roadsides for rainwater harvesting	7	08.75	10	12.50	63	78.75
Mean adoption score = 5.27							
Overall adoption level = 21.36%							

Conclusion

Less productivity, degraded soil, extreme weather variability, and food poverty are serious concerns that must be overcome, and Water Harvesting holds the solution. The present study has revealed an overall gap of about 21 percent between farmers' awareness and adoption level of water harvesting practices during monsoons which needs to be bridged. The awareness of the farmers varied across water harvesting practices adoption. Awareness level was favorable with more than 80 percent level of awareness about rainwater harvesting practices during monsoon season, it increased cropping intensity of the farm, harvesting, and storage by different methods, to cater to demands of water for drinking, domestic & irrigation purposes and can be stored for future use, it can increase the area under irrigation and allows for the collection of large amounts of water and mitigates the effects of drought. However, more effort is needed to increase the adoption level of farmers about water harvesting practices during monsoons, which is very low. In order to encourage adoption, governments and the private sector must focus on young farmers. Higher levels of education among rural farmers can raise the likelihood of this technique's adoption. It can be achieved through increasing exposure to relevant info, education, and training, extension personnel could boost farmers' awareness of and understanding of the advantages of water harvesting practices. Additionally, greater social capital building through network membership is also required for better installation in the farmers' field. It is also recommended that all agricultural departments launch a campaign to encourage farmers and villagers to adopt water harvesting practices in order to store water for current and future use for various purposes.

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