Analysis of factors influencing the adoption of water conservation practices

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ABSTRACT

Rapid groundwater depletion in the semi-arid Mahendragarh district of Haryana necessitates the urgent adoption of water conservation practices (WCPs) to ensure long-term agricultural sustainability. This study evaluated the key factors influencing farmers' adoption of WCPs using an ex-post facto research design with 80 respondents selected via multistage sampling across four villages during 2025-26. Primary data were analyzed across six constraint dimensions using weighted mean scores (WMS), Pearson correlation and multiple linear regression. Economic factors (WMS 1.74) emerged as the most severe constraint to adoption, followed by production-related (WMS 1.65) and technical factors (WMS 1.57). Key specific barriers identified included high technology setup costs (WMS 1.90), lack of technical guidance (WMS 1.82), operational area reduction (WMS 1.81), fragmented landholdings (1.80) and administrative delays in subsidy disbursement (WMS 1.76). Correlation and regression analyses revealed that landholding size, mass media exposure, risk orientation and extension contact had negative and statistically significant relationships with perceived constraints (R^2 = 0.3298). Overall, accelerating WCP adoption in water-stressed regions requires streamlined administrative procedures, direct financial credit support, decentralized technical training and expanded field demonstration units.

Keywords: Water conservation practices; Groundwater depletion; Semi-arid agriculture; Adoption constraints; Extension services; Weighted mean score

INTRODUCTION

Irrigation water plays a crucial role in driving agricultural productivity and ensuring food security. However, rapidly intensifying freshwater scarcity across many global regions has elevated water security to one of the most pressing concerns for societal survival (Bayart et al 2010, Hoekstra et al 2012). Globally, agriculture accounts for roughly 70 per cent of total freshwater withdrawals, followed by industrial uses at just under 20 per cent and domestic or municipal uses at approximately 12 per cent (Anon 2024).

India extracts around 25 per cent of global extracted groundwater and ranks first in groundwater extraction globally and uses 89 per cent of it for irrigation (Anon 2019). In the northwestern states of India, namely Punjab, Rajasthan and Haryana, the rate of groundwater extraction far exceeds natural recharge rates (Kaur et al 2026). Recent studies emphasize that excessive groundwater extraction for agriculture poses a severe threat to sustainable water management, as withdrawal rates in several regions far exceed natural recharge capacities (Rizvi et al 2025).

Southern Haryana, particularly Mahendragarh district, is exceptionally vulnerable to groundwater depletion due to its semi-arid climate and erratic rainfall patterns. The district come in the zone of over-exploited water resources and due to low rate of groundwater recharge than extraction, there is seen serious change in water quality and water table (Jeet 2010). The district relies almost entirely on groundwater for irrigation because precipitation is sparse and surface water availability remains constrained by a limited canal network. Consequently, the continuous decline of the water table has raised serious concerns regarding the long-term sustainability of local agricultural practices.

Given these environmental constraints, adopting effective water conservation practices (WCPs) is essential to secure sustainable water management in the region. Interventions such as micro-irrigation, laser land leveling, direct-seeded rice, conservation agriculture and rainwater harvesting can substantially enhance water-use efficiency without compromising agricultural productivity (Kaur et al 2026). Nevertheless, the successful adoption of these practices depends on a complex interplay of socioeconomic, institutional, technological and behavioural factors. Liu et al (2018) highlighted that a farmer's education, farm size, income level, agricultural experience, access to credit, irrigation availability and overall awareness of conservation technologies significantly shape adoption decisions. Furthermore, institutional extension support, government subsidies, perceived economic benefits and technical expertise are equally vital in driving behavioural change.

Against this backdrop, the present study was conducted to identify and evaluate the key factors influencing farmers' adoption of WCPs in the Mahendragarh district of Haryana.

METHODOLOGY

The present study was conducted in the state of Haryana, during 2025-26 using an ex-post facto research design. A multistage sampling procedure was employed to select the study area and respondents. At the first stage, Mahendragarh district was selected using a simple random sampling method. Subsequently, two blocks: Mahendragarh and Kanina were purposively selected owing to the active implementation of various water conservation technology initiatives in these regions. At the final sampling stage, two villages were chosen from each selected block using a simple random sampling method, resulting in the selection of Sisoth and Bawania from Mahendragarh block and Karira and Bharaf from Kanina block.

Primary data were gathered to evaluate the factors influencing the adoption of WCPs, which were systematically categorized into six key dimensions: technical, administrative, economic, behavioural, production-related and advisory-related factors. Each factor was evaluated on a two-point continuum scale, categorized as 'Serious' and 'Not so serious,' with assigned numerical scores of 2 and 1 respectively. Following the scoring procedure, the empirical data were analyzed using the statistical package for the social sciences (SPSS). Both descriptive and inferential statistical techniques, specifically weighted mean scores (WMSs), Pearson correlation coefficients and regression analyses, were computed to derive meaningful conclusions.

RESULTS and DISCUSSION

Factors influencing the adoption of WCPs

Table 1 presents the various issues faced by farmers in adopting WCPs, categorized into technical, administrative, economic, behavioural, production and advisory-related factors. Among technical factors, the lack of technical guidance (WMS 1.82) was perceived as the most serious constraint faced by farmers. This was followed by the poor quality of equipment and materials available in the market (WMS 1.52), challenges in maintaining established water conservation technologies (WMS 1.50) and a lack of locally suitable or adaptable technologies (WMS 1.45). The underlying reason for this trend may be inadequate extension support and limited access to timely technical assistance, which leave farmers without proper guidance for selecting, installing and managing water conservation technologies. These issues can be addressed by providing localized training along with assistance in accessing technical advice and context-specific technologies (Rohila 2018).

Among administrative factors, the delay in approval and disbursement of scheme benefits (WMS 1.76) was ranked as the most serious constraint. It was followed by limited awareness about government schemes (WMS 1.46) and complex procedures for availing government benefits (WMS 1.41), whereas, inadequate staff for implementing government schemes (WMS 1.38) was regarded as the least serious administrative factor. These constraints likely stem from bureaucratic delays, cumbersome procedures and insufficient information dissemination, which collectively discourage farmers from accessing government benefits. These findings align with the results of Varadan and Kumar (2012) and Singh et al (2008), who similarly reported that time-consuming procedures and a lack of adequate manpower in state agriculture departments and input agencies significantly impede the adoption of improved agricultural practices.

Under economic factors, the high cost associated with establishing water conservation technologies at the farm level emerged as the primary

Table 1. Ranking of items under factors influencing the adoption of WCPs

Component	Respondents (n = 80)				TCS	WMS	Rank
	Serious		Not so serious				
	f	%	f	%			
Technical factors							
Lack of technical guidance	66	82.50	14	17.50	146	1.82	I
Challenges in maintaining established water conservation technologies	40	50.00	40	50.00	120	1.50	III
Lack of locally suitable or adaptable technologies	36	45.00	44	55.00	116	1.45	IV
Poor quality of equipment and materials available in the market	42	52.50	38	47.50	122	1.52	II
Administrative factors							
Limited awareness about government schemes	37	46.25	43	53.75	117	1.46	II
Inadequate staff for implementation of government schemes	31	38.75	49	61.25	111	1.38	IV
Complex procedures for availing government benefits	33	41.25	47	58.75	113	1.41	III
Delay in approval and disbursement of scheme benefits	61	76.25	19	23.75	141	1.76	I
Economic factors							
High cost associated with establishing water conservation technologies at farmers' level	72	90.00	08	10.00	152	1.90	I
High cost of labour	56	70.00	24	30.00	136	1.70	II
Limited access to institutional credit for investment	51	63.75	29	36.25	131	1.63	III
Behavioural factors							
Risky to practice	12	15.00	68	85.00	92	1.15	III
Non-cooperation of neighbouring farmers	16	20.00	64	80.00	96	1.20	II
Resistance to change from traditional practices	09	11.25	71	88.75	89	1.11	IV
Poor participation in community-based water management programmes	26	32.50	54	67.50	106	1.32	I
Production-related factors							
Reduction in operational area	65	81.25	15	18.75	145	1.81	I
Fragmented landholdings	64	80.00	16	20.00	144	1.80	II
Poor soil condition affecting technology performance	29	36.25	51	63.75	109	1.36	III
Advisory-related factors							
Lack of access to weather information in a timely manner	47	58.75	33	41.25	127	1.58	II
Limited exposure to successful demonstration models	55	68.75	25	31.25	135	1.68	I
Weak extension services and follow-up support	25	31.25	55	68.75	105	1.31	IV
Lack of trainings regarding water conservation	46	57.50	34	42.50	126	1.57	III

Multiple responses, TCS: Total cumulative score, WMS: Weighted mean score

constraint, recording the highest weighted mean score (WMS 1.90). The high cost of labour (WMS 1.70) and limited access to institutional credit for investment (WMS 1.63) ranked second and third respectively. A farmer's financial condition plays a pivotal role in determining their capability to adopt WCPs. These findings are supported by Kumar et al (2014). Similarly, Kuswardhani et al (2014) noted that high capital investment requirements and a lack of affordable labour substantially hinder the adoption of protected cultivation technologies.

Regarding behavioural factors, poor participation in community-based water management

programmes (WMS 1.32) was identified as the most serious issue. This was followed by the non-cooperation of neighbouring farmers (WMS 1.20), perceived risk associated with practicing WCPs (WMS 1.15) and resistance to changing traditional practices (WMS 1.11). This observed trend may be attributed to low awareness, a lack of social cohesion, high risk perception and a strong attachment to conventional farming methods. These challenges can be mitigated through strengthened extension services, farmer group formation and field demonstrations that foster participation and community-wide adoption.

Among production-related factors, the reduction in operational farm area ranked as the top constraint (WMS 1.81). Fragmented landholdings (WMS 1.80) and poor soil conditions affecting technology performance (WMS 1.36) ranked second and third respectively. In a similar vein, Kumar et al (2021) reported that a large proportion of farmers identified land fragmentation as a primary barrier to maintaining soil and water conservation structures within watersheds.

Finally, with respect to advisory-related factors, limited exposure to successful demonstration models (WMS 1.68) was regarded as the most serious constraint. This was followed by a lack of timely access to weather information (WMS 1.58), a lack of training regarding water conservation (WMS 1.57) and weak extension services with poor follow-up support (WMS 1.31).

To overcome these constraints, extension services must be strengthened by establishing more demonstration units and model farms. Furthermore, real-time weather information can be disseminated through ICT tools such as mobile advisories, while regular capacity-building workshops and field-level follow-up support should be institutionalized to accelerate technology adoption. These empirical findings draw strong support from the research of Rajesh et al (2016) and Rohila (2018).

Shubham et al (2023) reported that to boost water conservation in agriculture across the region, extension agencies and the state department of agriculture should leverage a farmer-to-farmer approach by connecting educated, large farmers with small and marginal farmers to share best practices. Concurrently, public awareness should be driven through social media campaigns, community workshops and competitions organized in collaboration with state agricultural universities. Regular outreach by extension personnel is essential to deliver updated farming information and target regions where awareness remains low.

Table 2. Comparative analysis of the different factors influencing the adoption of WCPs (n = 80)

Factor	WMS	Rank
Technical	1.57	III
Administrative	1.50	V
Economic	1.74	I
Behavioural	1.19	VI
Production-related	1.65	II
Advisory-related	1.53	IV

WMS: Weighted mean score

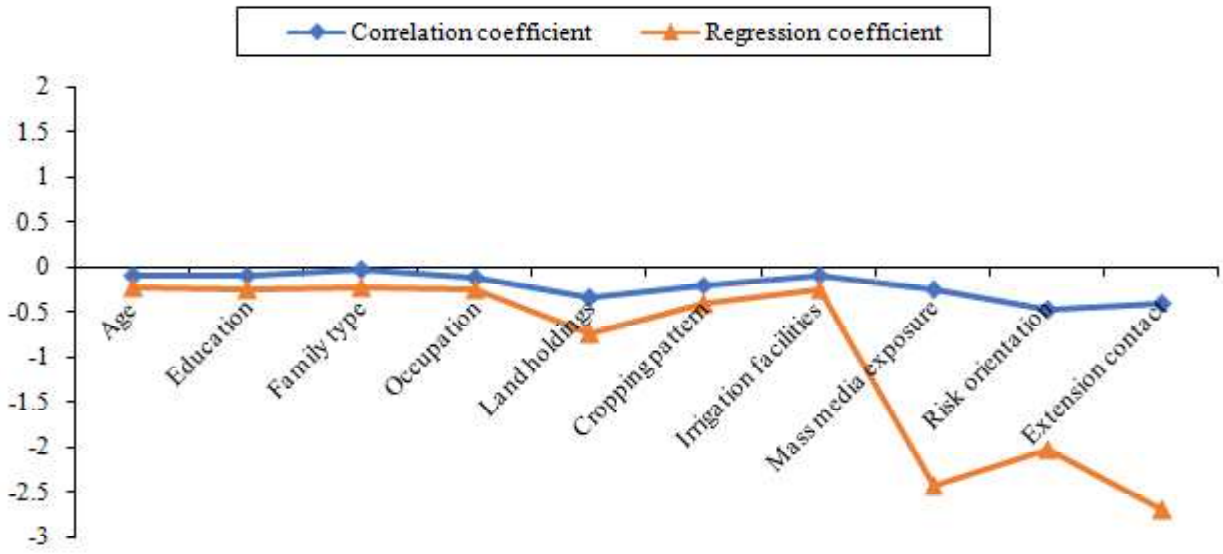
Comparison among different factors

The overall comparison of factors presented in Table 2 illustrates that economic factors were perceived by farmers as the most significant constraint, ranking first with WMS of 1.74. This was followed by production-related factors (WMS 1.65), technical factors (WMS 1.57) and advisory-related factors (WMS 1.53), which ranked second, third and fourth respectively. Conversely, administrative factors (WMS 1.50) and behavioural factors (WMS 1.19) were ranked as the least severe constraints. These empirical findings are strongly supported by the observations of Tekle (2016), who reported that social and financial status were the primary barriers to adopting conservation agriculture. The author further emphasized that technical and infrastructural challenges constituted additional major constraints perceived by farmers.

Association between respondents' personal variables and perceived factors influencing the adoption of WCPs

It is evident from Fig 1 that independent variables such as landholding, mass media exposure, risk orientation and extension contact exhibited a negative and significant correlation with the perceived constraint factors influencing WCP adoption. On the other hand, age, education, family type, occupation, cropping pattern and irrigation facilities also exhibited a negative correlation, but their effect was non-significant at the 0.05 level of probability.

Regarding the partial regression coefficients, landholding, mass media exposure, risk orientation and



Significant at 0.05 level, $R^2 = 0.3298$

Fig 1. Association among respondents' personal variables and perceived factors influencing the adoption of WCPs

extension contact similarly demonstrated a negative and statistically significant effect. The remaining independent variables did not show any significant relationship. The negative relationship observed for landholding, mass media exposure, risk orientation and extension contact with the perceived constraint factors indicates that enhancing access to information and strengthening institutional support significantly reduces the perceived barriers to adopting WCPs.

These findings are partially supported by the reports of Rohila (2018). Furthermore, the multiple regression analysis revealed that all ten independent variables combined contributed 32.98 per cent ($R^2 = 0.3298$) of the total variation in the dependent variable, while the remaining 67.02 per cent of the variation was attributed to other extraneous variables.

CONCLUSION

This study underscores that while farmers in the semi-arid Mahendragarh district of Haryana face critical groundwater scarcity, their transition toward sustainable water conservation practices is substantially constrained by economic, operational and institutional barriers. High initial capital requirements for technology setup, high labour costs, landholding fragmentation and a lack of localized technical guidance serve as the most prominent bottlenecks inhibiting widespread adoption. Administrative delays in scheme disbursements and limited exposure to field demonstration models further impede behavioural change and farm-level technology integration.

However, the study confirms that enhanced exposure to mass media, frequent extension contact, larger operational landholdings and a higher risk orientation significantly mitigate the perceived severity of these constraints.

To address these challenges and ensure long-term water security, targeted policy interventions are necessary to streamline bureaucratic subsidy disbursement pipelines and offer accessible micro-credit to resource-poor farmers. Furthermore, public agriculture departments must strengthen field-level advisory infrastructure by setting up localized demonstration units, offering hands-on technical capacity building and leveraging mobile ICT tools for real-time weather and maintenance advisories to foster sustained community-wide adoption.

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