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Attitude of Farmers towards *In-situ* Water Conservation in Semi-Arid Regions of Tamil Nadu

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HIGHLIGHTS

- Farmers who exhibited a heightened awareness of soil erosion problems also held a positive attitude toward ISWC practices.
- Farmers who had access to farm implements displayed a positive attitude toward ISWC practices.
- The accessibility of farm implements had most significant and positive direct impact on attitude.

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Keywords: Dryland, *In-situ* water conservation, Attitude, Pudukkottai and Tamil Nadu.

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ABSTRACT

Water scarcity poses a significant challenge for farmers in dryland regions. The availability of water in these dryland areas greatly impacts crop cultivation and directly affects the livelihoods of farmers. As a result, preserving water resources is crucial for achieving successful crop cultivation. Scientists emphasize that in-situ water conservation is more effective than other methods. However, previous research has indicated that farmers have been reluctant to adopt in-situ water conservation (ISWC) practices Therefore, this study was conducted to analyse dryland farmers' attitude towards ISWC practices in the Pudukkottai district. The data was collected from 120 participants during September-October 2023. Statistical analysis techniques, such as the correlation, regression, and path analysis, were used to analyze the data. The results indicate that a majority of the farmers (53.33%) displayed a highly favourable attitude towards *in-situ* water conservation. Furthermore, variables such as cropping intensity, innovativeness, information seeking behaviour, cosmopoliteness, risk orientation, scientific orientation, awareness of soil erosion problems and accessibility of farm implements were found to have a positive association with the attitude towards in-situ water conservation. The policy implications include providing incentives to farmers who adopt water conservation measures and implementing effective training programs.

INTRODUCTION

In the Indian subcontinent, dryland farming is crucial because it produces 40 per cent of the food grains and provides for two-thirds of the livestock numbers. According to a report by the Central Research Institute for Dryland Agriculture, dryland cultivation accounts for 68 per cent of India's total net sown area, which amounts to 136.8 million hectares. Dryland regions are responsible for producing substantial quantities of sorghum (90%), oilseeds (80%), pulses (75%), and cotton (65%). In Tamil Nadu, approximately two-thirds (66%) of cultivated land is under dryland conditions. This form of agriculture is primarily characterized by

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small landholders who have limited resources to adopt innovative modern technologies.

The predominant challenge encountered in these regions is the issue of water scarcity, particularly during episodes of drought. The rising demand for food production in dryland areas, in the context of climatic changes, has a negative impact on water resources (Oremo et al., 2019). Water scarcity has a significant global impact, affecting approximately 1 to 2 billion individuals, the majority of whom reside in arid regions (Stringer et al., 2021). The escalation of water scarcity, resulting from diverse factors, will pose considerable hurdles in achieving the Sustainable Development Goals (SDGs). Life in drylands is always characterized by droughts, desertification, and water shortages (Singh & Kumar, 2015). The regions most susceptible to climate change are drylands (Lian et al., 2021). It is anticipated that the availability of water in dry areas will be further impacted by climate change (Sharma et al., 2018). Lack of water is negatively affecting livestock production, such as sheep, in addition to crop productivity (Chikwanha et al., 2021).

To address water scarcity, various development schemes have been implemented focusing on soil and water conservation, rainwater harvesting, and drought insulation solutions (Stroosnijder et al., 2012 & Yohannes et al., 2017). While rainwater can be harvested using in-situ or ex-situ methods, scientists believe that the former is more cost-effective and practical, and avoids issues related to water sharing, among other benefits. Studies have shown that the construction of in-situ water conservation structures increases soil moisture content, reduces runoff and soil erosion, slows down water erosion, and replenishes aquifers (Aladenola & Adeboye, 2010). In the district of Pudukkottai, as well as in Tamil Nadu as a whole, the government has recently implemented several programs to promote in-situ water conservation practices. However, despite these efforts, farmers still hesitate to adopt ISWC practices, possibly due to negative perceptions. Research studies have proven that farmers' attitudes have a positive effect on their water conservation behavior (Bagdiand & Kurothe, 2016; Chang et al., 2016; Faridi et al., 2020; Ataei et al., 2022 & Ataei et al., 2024). However, no research has been conducted to investigate the attitudes of dryland farmers in the semi-arid regions of Tamil Nadu. Therefore, this research work aims to investigate the attitude of dryland farmers towards ISWC techniques and the factors influencing these techniques in the dryland regions of Tamil Nadu.

METHODOLOGY

The purpose of this study was to examine attitudes towards practices related to Integrated Soil and Water Conservation (ISWC) in dryland regions. The study focused specifically on the state of Tamil Nadu in India, which has a vast expanse of 3.1 million hectares of dryland. To select participants for the study, a multi-stage random sampling method was used. First, the dryland districts in Tamil Nadu with an annual rainfall of less than 750 mm were identified, and Pudukkottai district was randomly chosen from this group. Then, the Gandarvakottai and Thiruvarankulam blocks were selected using a randomization principle in the second stage. In the third stage, five study villages were randomly chosen from each block. Finally, in the fourth stage, 10 farmers were randomly selected from each village. Overall, a total of 120 farmers were chosen for the study using this multi-stage random sampling approach. The Pudukkottai district covers an area of 4,663 square kilometers and is characterized by red sterile soil and river alluvial soil types. The main crops cultivated in this district include paddy, groundnut, sorghum, maize, pearl millet, finger millet, and gingelly (Muthulakshmi, 2020).

Based on expert opinions, a total of sixteen independent variables were chosen for the study. These variables included age, family size, education, cropping intensity, land holding, occupation, innovativeness, social participation, information seeking behavior, cosmopoliteness, risk orientation, annual income, economic motivation, scientific orientation, awareness of soil erosion problems, and accessibility of farm implements. The dependent variable chosen for the study was the attitude of the dryland farmers towards ISWC practices. The farmers' attitude towards water conservation was assessed using an attitude scale developed by Valizadeh et al., (2023). Respondents were asked to rate their level of agreement with a set of statements. This variable was measured using six items on a 5-point Likert scale, ranging from 1 (strongly disagree) to 5 (strongly agree). The scores of all items were then summed to determine each individual's overall attitude towards ISWC practices. Regression analysis was conducted to examine the relationship between the selected variables and farmers' attitudes towards ISWC practices. Additionally, path analysis was employed to examine the direct, indirect, and significant effects of the selected variables on the level of attitude towards ISWC practices. The test-retest method was used to pre-test the interview schedule on 25 non-sample respondents. The resulting correlation coefficient of 0.75 showed a strong level of significance.

RESULTS

The attitude of dryland farmers towards ISWC practices

It is evident from Figure 1 that 53.33 per cent of dryland farmers exhibited a significantly positive attitude towards in-situ water conservation practices, whereas the remaining farmers demonstrated a moderately favorable attitude (46.67%). Notably, none of the farmers obtained a score of less than 15, indicating that farmers did not hold a negative attitude towards in-situ water conservation practices.

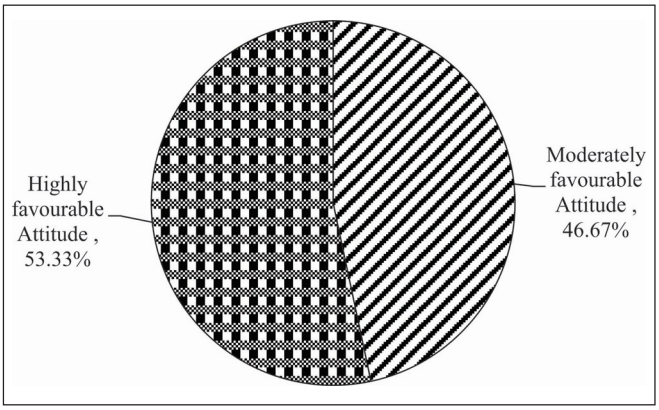

Figure 1. Attitude of dryland towards in-situ water conservation practices

A comprehensive analysis was conducted to investigate the farmers' attitudes towards in-situ water conservation practices concerning their socio-personal characteristics (Table 1). It was observed that middle-aged farmers displayed a significantly favorable attitude towards *in-situ* water conservation practices, which can be attributed to their extensive experience in the agricultural industry. Experienced farmers demonstrate a profound understanding of the pivotal role that water conservation plays in the study area. Similarly, farmers who have completed an undergraduate degree demonstrated a more positive attitude compared to those without such qualifications. Extensive research has consistently highlighted the positive influence of education on farmers' attitudes towards in-situ water conservation. Furthermore, large-scale farmers showed a significantly positive attitude towards in-situ water conservation, as this approach requires substantial capital investment. Additionally, farmers who cultivated crops for multiple seasons displayed a more optimistic attitude. Farmers who demonstrated elevated levels of social participation, information-seeking behavior, and cosmopoliteness exhibited a more favorable attitude toward ISWC practices. These variables are interconnected

Table 1. Attitude of farmers according to socio-personal characteristics about *in-situ* water conservation practices

Variables	Categories	Moderately favourable		Highly favourable		χ^2 value
		N=56	Percentage	N=64	Percentage	
Age	Young	16	13.33	10	8.33	2.950^{NS}
	Middle	34	28.34	46	38.33	
	Old	6	5.00	8	6.67	
Education	Illiterate to Primary	16	13.33	8	6.67	3.975^{NS}
	Middle to Higher Secondary	15	12.50	23	19.17	
	Collegiate	15	12.50	43	35.83	
Family size	4 members	33	27.50	33	27.50	0.655^{NS}
	More than 4 members	23	19.17	31	25.83	
Landholding	Small	46	38.33	15	12.50	0.564^{NS}
	High	10	8.33	49	40.84	
Cropping intensity	Single cropping	27	22.50	14	11.66	6.559*
	Double cropping	24	20.00	39	32.50	
	Multiple cropping	5	4.17	11	9.17	
Occupation	Agriculture alone	19	15.83	29	24.17	1.641^{NS}
	Agri + wage earners	25	20.83	23	19.17	
	Agri + Business	12	10.00	12	10.00	
Annual income	Low (upto 80000)	24	20.00	32	26.67	0.612^{NS}
	Medium (80000-1.5 lakh)	26	21.67	26	21.66	
	High above 1.5 lakh)	6	5.00	6	5.00	
Innovativeness	High	16	13.33	7	5.83	7.603*
	Medium	35	29.17	44	36.67	
	Low	5	4.17	13	10.83	
Social participation	Low	41	34.16	32	26.67	6.871*
	Medium	10	8.33	23	19.17	
	High	5	4.17	9	7.50	
Information seeking behaviour	Low (up to 21)	36	30.00	22	18.33	10.70**
	High (more than 21)	20	16.67	42	35.00	
Cosmopoliteness	Low (up to 10)	51	42.50	45	37.50	8.044**
	High (more than 10)	5	4.17	19	15.83	
Risk Orientation	Low (up to 21)	31	25.83	14	11.67	14.28**
	High (above 21)	25	20.83	50	41.67	
Economic motivation	Low (up to 21)	7	5.83	10	8.33	0.240^{NS}
	High (above 21)	49	40.84	54	45.00	
Scientific orientation	Low (up to 21)	42	35.00	13	10.83	35.97**
	High (above 21)	14	11.67	51	42.50	
Awareness of soil erosion problems	Low (up to 5)	33	27.50	23	19.17	6.34**
	High (more than 5)	23	19.17	41	34.16	
Accessibility of farm implements	Low (up to 12)	35	29.17	23	19.16	8.43**
	High (more than 12)	21	17.50	41	34.17	

* Significant at the 0.05 level; ** Significant at the 0.01 level

and can contribute to the broadening of one's perspective. Likewise, farmers who displayed a pronounced inclination for risk-taking, economic motivation, and a scientific orientation showcased a positive attitude toward ISWC practices. Additionally, farmers who exhibited a heightened awareness of soil erosion problems also held a positive attitude toward ISWC practices. Finally, farmers who had access to farm implements displayed a positive attitude toward ISWC practices.

Factors influencing the attitude of dryland farmers towards ISWC practices

Among the variables studied, cropping intensity, innovativeness, social participation, information seeking behavior, cosmopoliteness, risk orientation, scientific orientation, awareness of soil erosion problems, and accessibility of farm implements show statistically significant correlations with the attitude of dryland farmers. The results align with previous studies that have shown a strong correlation between social participation and farmers' attitudes, as demonstrated by Pagaria et al., (2018); Ali & Ghosh (2018); Jha et al., (2019). On the other hand, age, education, land holding, family size, annual income, occupation and economic motivation have non-significant correlations with attitude. Bagdi & Joshi (2018) also discovered no significant relationship between age, landholding, income, and farmers' participation in the soil and water conservation programme. Similarly, Mandal et al., (2022) found that farm size and annual income did not influence the water management practices of the farmers.

Table 2. Correlation analysis between the attitude of the dryland farmers and socio-economic characteristics

S.No.	Independent variables	"r" value
X_1	Age	0.117^{NS}
X_2	Education	-0.006 ^{NS}
X_3	Family size	0.048 ^{NS}
X_4	Land holding	0.140 ^{NS}
X_5	Cropping intensity	0.216**
X_6	Occupation	0.054 ^{NS}
X_7	Annual income	0.071 ^{NS}
X_8	Innovativeness	0.307*
X_9	Social participation	0.197**
X_{10}	Information seeking behaviour	0.280**
X_{11}	Cosmopoliteness	0.238*
X_{12}	Risk Orientation	0.468**
X_{13}	Economic motivation	-0.043 ^{NS}
X_{14}	Scientific orientation	0.609**
X_{15}	Awareness of soil erosion problems	0.387**
X_{16}	Accessibility of farm implements	0.335**

The results of regression analysis (Table 3) revealed that out of the sixteen variables analyzed, nine showed significant and positive associations with attitudes toward in-situ water conservation. These variables include cropping intensity ($b = 0.090$, $p < 0.01$), innovativeness ($b = 0.128$, $p < 0.05$), information seeking behavior ($b = 0.042$, $p < 0.01$), cosmopoliteness ($b = 0.085$, $p < 0.05$), risk orientation ($b = 0.263$, $p < 0.01$), scientific orientation ($b = 0.380$, $p < 0.01$), awareness of soil erosion problems ($b = 0.091$, $p < 0.01$). and accessibility of farm implements ($b = 0.387$, $p < 0.01$). This indicates that higher levels of cropping intensity, innovativeness, information seeking behavior, cosmopoliteness, risk orientation, scientific orientation, awareness of soil erosion problems and accessibility of farm implements are associated with a favourable attitude among dryland farmers. These findings align with a study conducted by Hiwarkar et al., (2012), which also discovered a statistically significant relationship between risk preference and knowledge regarding water productivity practices. Furthermore, Meena et al., (2023) conducted a study that

Table 3. Regression analysis of between the attitude of the dryland farmers and socio-economic characteristics

S.No.	Independent variables	Regression coefficient/ b values	Standard error	't' value
X_1	Age	0.061^{NS}	0.061	0.753
X_2	Education	0.053 ^{NS}	0.053	0.591
X_3	Family size	0.119 ^{NS}	0.119	1.667
X_4	Land holding	0.024 ^{NS}	0.024	0.318
X_5	Cropping intensity	0.090**	0.090	2.626
X_6	Occupation	0.110 ^{NS}	0.110	1.436
X_7	Annual income	-0.088 ^{NS}	-0.088	-1.075
X_8	Innovativeness	0.128*	0.128	1.968
X_9	Social participation	0.095^{NS}	0.095	0.892
X_{10}	Information seeking behaviour	0.042**	0.042	2.895
X_{11}	Cosmopoliteness	0.085*	0.085	2.034
X_{12}	Risk Orientation	0.263**	0.263	3.227
X_{13}	Economic motivation	-0.009 ^{NS}	-0.009	-0.124
X_{14}	Scientific orientation	0.380**	0.380	4.391
X_{15}	Awareness of soil erosion problems	0.091**	0.046	2.732
X_{16}	Accessibility of farm implements	0.387**	0.091	3.567
	Constant	3.415	1.417	1.278

R^2= 61.11 %

$Y_1 = 3.415+0.061\ (X_1)^{NS} +0.053(X_2)^{NS} +0.119(X_3)^{NS} +0.024(X_4)^{NS} +0.090(X_5)^{**} +0.110(X_6)^{NS} -0.088(X_7)^{NS} +0.128(X_8)^{*} +0.095(X_9)^{NS} +0.042(X_{10})^{**} +0.085(X_{11})^{*} +0.263(X_{12})^{**} -0.009(X_{13})^{NS} +0.380(X_{14})^{**} +0.091(X_{15})^{**} +0.387(X_{16})^{**}$

* Significant at the 0.05 level; ** Significant at the 0.01 level

Table 4. The direct, indirect and substantial effect of profile characteristics on attitude level of *in-situ* water conservation practices

S.No	Independent variables	Direct effect	Indirect effect	Substantial effect		
				I	II	III
X_1	Age	0.261	0.620	0.376 X_2	0.020 X_{12}	0.006 X_9
X_2	Education	-0.041	-0.180	0.052 X_{11}	0.044 X_6	0.026 X_{16}
X_3	Family size	-0.061	0.049	0.047 X_2	0.039 X_9	0.022 X_4
X_4	Land holding	0.087	0.212	0.179 X_{11}	0.058 X_9	0.049 X_{16}
X_5	Cropping intensity	0.078	0.381	0.166 X_{11}	0.119 X_2	0.071 X_9
X_6	Occupation	0.138	0.095	0.129 X_2	0.008 X_{16}	0.005 X_9
X_7	Annual income	-0.282	-0.011	0.121 X_{11}	0.047 X_6	0.031 X_{16}
X_8	Social participation	-0.166	0.140	0.143 X_{11}	0.087 X_9	0.032 X_{10}
X_9	Cosmopoliteness	0.350	0.458	0.050 X_{16}	0.048 X_{10}	0.039 X_{11}
X_{10}	Information seekingbehaviour	0.085	0.431	0.201 X_9	0.176 X_{11}	0.051 X_{16}
X_{11}	Innovativeness	0.141	0.269	0.077 X_9	0.067 X_{16}	0.037 X_1
X_{12}	Risk Orientation	0.086	0.224	0.151 X_{16}	0.058 X_{11}	0.055 X_9
X_{13}	Economic motivation	-0.047	0.111	0.034 X_9	0.031 X_{16}	0.030 X_2
X_{14}	Scientific orientation	-0.304	0.186	0.187 X_{16}	0.140 X_{11}	0.050 X_9
X_{15}	Awareness of soil erosion problems	0.301	0.409	0.111 X_{11}	0.058 X_9	0.043 X_{13}
X_{16}	Accessibility of farm implements	0.426	0.418	0.078 X_{16}	0.036 X_4	0.035 X_{10}

emphasized the importance of awareness in promoting the adoption of soil and water conservation measures. The coefficient of multiple regression, known as the R^2 value, was 0.611, indicating statistical significance at the one percent level. This suggests that the independent variables chosen for the study account for 61.10 per cent of the variation in the attitude of the dryland farmers.

Direct, indirect, and substantial effects of independent variables on the level of attitude

The results revealed that (Table 4) the accessibility of farm implements (0.426) had most significant and positive direct impact on attitude, followed by cosmopolitanism (0.350) and awareness of soil erosion problems (0.301). These results are consistent with the findings of Ali & Ghosh (2018), who observed that the resource position of farmers influences their participation in irrigation management. Additionally, Sathya Gopal et al., (2014) found that farmers who possess knowledge about soil erosion tend to have a favorable attitude toward ISWC practices. On the other hand, education (X_2), family size (X_3), social participation (X_8), annual income (X_7), and economic motivation (X_{13}) had a negative direct effect on this attitude. Additionally, the variables of age (X_1), family size (X_3), land holding (X4), cropping intensity (X_5), occupation (X_6), social participation (X_8), cosmopolitanism (X9), information-seeking behavior (X_{10}), accessibility of farm implements (X_{11}), innovativeness (X_{12}), risk orientation (X_{13}), economic motivation (X_{14}), scientific orientation (X_{15}), and awareness of soil erosion problems (X_{16}) had a positive indirect effect on this attitude. However, education (X_2) and annual income (X_7) had a negative indirect effect on the attitude of dryland farmers. A similar study has revealed that income has the greatest indirect impact (Mandal et al., 2022). Out of the 48 significant substantial effects on attitude level that were examined, fourteen effects were found to be routed through awareness of soil erosion problems (X_{15}), twelve effects were routed through scientific orientation (X_{14}), five effects were routed through risk orientation (X_{12}) and innovativeness (X_8), two were routed through cropping intensity (X_5), occupation (X_6), social participation (X_9), and cosmopolitanism (X_{11}), and one was routed through education (X_2), annual income (X_7), information-seeking behavior (X_{10}), and economic motivation (X_{13}) respectively.

DISCUSSION

Research studies have consistently shown that farmers' attitudes towards water conservation practices significantly impact their actual behavior in relation to water conservation (Valizadeh et al., 2023). Therefore, an analysis was done to assess the attitudes of dryland farmers towards in-situ water conservation practices. A substantial proportion of dryland farmers in the study area exhibited a positive attitude towards in-situ water conservation practices. These findings align with the results of Oremo et al., (2019), which revealed that a considerable number of respondents held a favorable attitude towards water resource conservation in the semi-arid agro-ecosystems of Kenya. Similarly, Ashoori (2016) reported that paddy farmers in Iran displayed a moderate to favorable attitude. Likewise, Ataei et al., (2022) also found that farmers had a favourable attitude towards water conservation. Additionally, Rai & Singh (2016) observed that farmers in Madhya Pradesh exhibited a higher percentage of favorable attitudes (43.75%) compared to unfavorable attitudes (31.25%). Varua et al., (2017) also discovered that farmers in rural India exhibited a favorable attitude towards groundwater conservation and the adoption of water-saving practices. However, due to limited resources, these farmers have not yet implemented in-situ water conservation practices in their fields. It is crucial for the government to take appropriate measures to address this issue. Furthermore, a notable observation in was the widespread lack of awareness among respondents regarding contemporary soil and water conservation initiatives.

The regression results indicate that nine variables have a positive influence on farmers' attitude towards ISWC practices. For instance, cropping intensity is found to have a positive association with attitude. Farmers who engage in intensive agricultural practices

tend to prioritize soil moisture management, thereby fostering a more favorable attitude towards ISWC practices. The novelty of most *in-situ* water conservation practices can potentially contribute to a more favorable perception, particularly among highly innovative farmers. It is common for farmers who strive to adopt modern technologies in agriculture to extensively gather information from both local and global sources. This practice has established a positive correlation between the farmers' information-seeking behavior and cosmopoliteness, as well as their attitudes. Furthermore, risk orientation has been found to positively influence the attitudes of dryland farmers. It has been observed that farmers tend to adopt water conservation measures once they understand the implications associated with water scarcity (Sharafipour & Ahmadvand, 2019). Similarly, scientific orientation also shows a positive relationship with attitude. An enhanced understanding of the detrimental effects of soil erosion among farmers is positively correlated with their adoption of ISWC practices. Similarly, individuals who have access to or possess agricultural implements may be better equipped to implement and comprehend the significance of ISWC practices, resulting in a more positive attitude. However, the findings contradict the research conducted by Jara-Rojas et al., (2012) & Yazdanpanah et al., (2015) as well as Varua et al., (2017). A study carried out by Varua et al., (2017) demonstrated a positive correlation between the size of land holdings, educational level, and water conservation behaviors among farmers. Similarly, the findings diverge from the research conducted by Jara-Rojas et al., (2012) & Ashoori et al., (2016), who also reached the conclusion that the size of the farm has a noteworthy impact on the adoption of practices which conserve water. Yazdanpanah et al., (2015) suggested that income could incentivize farmers to adopt measures for soil and water conservation. The multivariate path analysis shown that the accessibility of farm implements, cosmopolitanism, and awareness of soil erosion issues exerted the strongest positive direct effects. Ataei et al., (2024) discovered that perceived susceptibility influences farmers' water conservation behaviors. Furthermore, age, cosmopolitanism, and information-seeking behavior had the most significant positive indirect effects. According to Valizadeh et al., (2018), the biggest indirect effects on farmers' active involvement in water conservation initiatives were found to be related to place attachment and social responsibility toward water conservation.

CONCLUSION

This study aimed to analyse the attitude of dryland farmers towards ISWC practices and factors influencing the same. Farmers in Dryland exhibited a significantly favorable attitude (53.33%) towards in-situ water conservation techniques. Furthermore, the study revealed that various factors, including cropping intensity, innovativeness, cosmopoliteness, risk orientation, information-seeking behavior, scientific orientation, awareness of soil erosion issues and accessibility of farm implements positively influenced this attitude. In addition, accessibility of farm implements, cosmopolitanism and awareness of soil erosion problems had direct effect on the attitude of the dryland farmers. It is recommended that the government take a more proactive approach to water conservation. Farmers who implement effective water-saving practices should be eligible for subsidies, incentives, and awards. Additionally, more training courses should be offered to motivate farmers to adopt cutting-edge in-situ water-saving strategies.

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