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Risks and farmers' behavior change towards water conservation: a study in the Southeast of Iran

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ABSTRACT

Frequent droughts in Iran have influenced farmers' social and economic lives and have entailed extensive negative consequences. This research aimed to study the process by which farmers adopt water conservation behavior and explore the intervention of perceived risks and risk attitude. This survey was conducted among farmers in the Sistan region in the southeast of Iran ($N = 6{,}000$). A sample of 361 farmers was selected by multistage cluster randomization. The research instrument was a researcher-made questionnaire whose reliability was checked by Cronbach's alpha and composite reliability in a pilot study and whose content validity was confirmed by a panel of agricultural sociologists. The data were analyzed using mean, percentage, and structural equation modeling in the $SPSS_{win26}$ and $AMOS_{24}$ software suites. The results reveal that perceived susceptibility, perceived severity, perceived benefits, perceived barriers, self-efficacy, and cues to action influence farmers' water conservation behavior positively and significantly. Also, most components of the health belief model are influenced by farmers' perceived risks and risk attitude. It can be concluded that it is imperative to focus on socio-psychological components to promote water conservation behavior and use water scarcity-coping strategies in Iran.

Key words: health belief model, risk attitude, sustainable agriculture, sustainable development, water conservation behavior

HIGHLIGHTS

- Frequent droughts in Iran have influenced farmers' social and economic lives.
- Most components of health belief model are influenced by farmers' perceived risks and risk attitude.
- It is imperative to focus on socio-psychological components.

1. INTRODUCTION

In the contemporary world, issues related to the management of water resources, e.g., droughts and water scarcity, have posed increasing challenges for crop production and human life (Mittal *et al.* 2016; Que *et al.* 2022; Karimi & Ataei 2023). These factors, along with economic growth and expansion of agricultural lands, have put much pressure on water resources (Javeline *et al.* 2019; Patra *et al.* 2023), whereas changes in water resources are remarkably influenced by climate change and human activities. Compared to the effects of climate on water cycles and availability, human activities play a more important role in controlling water quality and quantity (Adams 2014; Woldesenbet *et al.* 2017; Hu & Zhang 2022). Recent droughts are accompanied by increased demand, population growth, and agriculture development and have triggered water scarcity in different parts of Iran (Yazdanpanah *et al.* 2014; Yang *et al.* 2022). In agrarian societies, the effects of water scarcity are manifested in socioeconomic aspects (Keshavarz *et al.* 2013; Maleksaeidi & Karami 2013; Panyasing *et al.* 2022). The unwise decisions of governments and officials in charge of resource management (Walter *et al.* 2022; Parwada & Marufu 2023) and inattention to the consumption behaviors of people, especially farmers, have created a lot of problems in the use of water resources. Due to the overuse of water resources, 307 out of 609 plains in Iran have been declared critically endangered, as the groundwater levels or aquifer quality are constantly dropping (Hashmi & Al-Modarressi 2015). The Sistan plain in the southeast of Iran is a relatively vast low area composed of old and new alluviums of the Hirmand, Fararoud, Khasroud, and Nahbandan rivers. A part of this plain is a desert that turns into a wetland, one of the most extensive wetlands in the south of Iran, by hosting a massive volume of flood water annually (Azadeh *et al.* 2010; Karimi & Ataei 2022). The most important river in the region is the Hirmand, which originates from the Hindu Kush Mountains in Afghanistan. The Sistan region is struggling with the most intensive drought in Iran, which originates from the sharp decline in precipitation and its complete reliance on the water supplied by the Hirmand River, while the river is dry most of the time. This region, as an agricultural hub, heavily relies on surface water resources, and the majority of its population lives in rural areas (Mokhtary & Iraj 2008; Hallaj *et al.* 2021).

Research (Bijani & Hayati 2015; Nguyen-Chi *et al.* 2022; Bhakta *et al.* 2023) shows that an average of 70% of water resources are consumed by the agricultural sector (Yazdanpanah *et al.* 2014; Mamani *et al.* 2022; Vasilaky *et al.* 2023; Zuo *et al.* 2023). So, the sound and optimal use of water resources is an urgent necessity in the agricultural sector. Water conservation is the primary strategy in future water planning and management and reflects pro-environmental activities (Gilbertson *et al.* 2011; Adams 2014; Nayar & Patel 2021). It is also the most critical measure to protect water resources by which the interests of future generations can be secured and the demand for sensitive water-dependent ecosystems, such as lakes and rivers, can be reduced. Water conservation includes behaviors for reducing water consumption (Tajri Moghadam *et al.* 2019), and these behaviors are promoted when farmers understand the risks and hazards of water scarcity (Sharafipour & Ahmadvand 2019). Furthermore, the perceived efficiency of the response or the perceived effectiveness of the conservation measures for mitigating risks will play a key role in water conservation behavior. Also, people's belief in their capability or farmers' perceived self-efficiency, as well as the perceived costs of conservation measures, will influence their behavior (Sharafipour & Ahmadvand 2019). It is very important to identify farmers' behavior and actions towards water resources and their conservation. In the environmental behavior literature, there is a wide range of studies on behaviors, and each has somehow concentrated on analyzing the impacts of human behaviors on the natural environment. *Environmental psychology* is a field of study that deals with the interactions between human and their environment, the psychological roots of environmental degradation, and the relationship between environmental attitudes and pro-environmental behaviors such as water conservation behavior (Kollmuss & Agyeman 2002; Aliabadi *et al.* 2022; Ataei *et al.* 2022). The use of behavioral science for understanding water conservation and the use of psychological and anthropological theories and models for understanding behavior-predicting variables are such that their understanding brings about behavior modification (Yazdanpanah *et al.* 2015; Khoshnodifar *et al.* 2023).

So, this research aims to explore farmers' behavioral processes for water conservation in southeast Iran. The novelty of the research is that few studies have addressed the effect of farmers' perceived risk and risk attitudes on their behavioral processes in the context of water conservation. This research can provide a deep and new understanding of farmers' mentality about risk management and their water conservation behavior. This study attempts to fill the gap in the literature on behavior changes by considering farmers' perceived risk and risk attitudes and different dimensions of the health belief model (HBM). Previous studies have mostly dealt with farmers' social dimensions and have less focused on risk dimensions of climate changes. As such, this research can supplement the literature from social, cultural, and psychological perspectives.

2. THEORETICAL FRAMEWORK

The HBM was developed by social psychologists Godfrey H. Hochbaum and Irwin M. Rosenstock in the 1950s (Strecher & Rosenstock 1997). HBM is the most common and popular theoretical model for promoting preventive health behaviors and is used to describe health-related behavior change or persistence (Carley & Stratman 2015). HBM focuses on people's beliefs about their decisions (Tarkang & Zotor 2015) and emphasizes how a person's perception creates motivation and movement and changes their behavior. Generally, HBM focuses on changing beliefs and states that a change in belief triggers a change in behavior (Namdar *et al.* 2012; Yazdanpanah & Mardasi 2017). Other advantages of HBM are that it has a theoretical framework to better understand and create stimuli for the cooperation of deprived people in health education programs and that it reveals the factors that are effective in encouraging or discouraging an individual for engaging in certain health-related measures (Cook 2018). It should, however, be noted that a review of the literature on HBM shows the focus on interpersonal factors, whereas some external factors, e.g., education and economic factors, influence intra-personal factors. Factors like the level of knowledge, attitude, beliefs, motivation, and so on are promoted by education and lead to better decision-making (Vermandere *et al.* 2016; Dodel & Mesch 2017).

HBM predicts two main groups of behavioral beliefs: perceived threats and perceived expectations. Perceived threat is composed of two sub-components: perceived susceptibility (PSu) and perceived severity (PS). Perceived susceptibility refers to people's perception of a hazard or the chance of suffering from health problems. Perceived severity is defined as the extent to which an individual judges the medical and social consequences of the problem (Witte 1992). Perceived benefits (PBe) refer to the effectiveness of certain actions to alleviate the hazard and preserve health, perceived expectations refer to positive results of sound actions, and perceived barriers (PB) refer to the barriers that, in an individual's opinion, prevent the implementation of healthy behavior (Zetu *et al.* 2014).

Researchers argue that the structure of HBM is based on constructs that depend on behavior persistence, such as perceived severity, perceived susceptibility, perceived benefits, perceived barriers, self-efficacy, cues to action (CA), and general beliefs. Also, self-efficacy, cues to action, and general beliefs are factors added by researchers to HBM because they argue that these new components can promote the descriptive power of the model (Tashiro 2022). Cues to action encompass a range of incentives, e.g., physical events, social media, and social impact, which activate an individual's readiness by changing through awareness of the negative consequences of unhealthiness (Simsekoglu & Lajunen 2008; Tengecha *et al.* 2022). Self-efficacy is an individual's perceived ability to perform an activity, and general beliefs represent personal values, specific beliefs, and concerns about health problems (Li *et al.* 2015). This model assesses the relationship between health-related beliefs and preventive healthy behaviors (Razmara *et al.* 2018). According to this model, if people feel exposed to a situation (perceived sensitivity), they will engage in preventive actions to hinder the hazard. Furthermore, an individual will most likely engage in the required behavior if they believe that the situation is potentially dangerous and can have significant effects (perceived severity) and that the hazards and side-effects of the situation can be reduced by some measures whose benefits (perceived benefits) outweigh the barriers on the way of adaptation to the behavior (e.g., perceived time and monetary barriers) (Yazdanpanah *et al.* 2015).

The HBM attempts to predict behaviors by accounting for individual differences in beliefs and attitudes. However, it does not account for other factors that influence behaviors. For instance, habitual behaviors may become relatively independent of conscious decision-making processes (Siddiqui *et al.* 2016). Environmental factors outside an individual's control may prevent engagement in desired behaviors (Glanz *et al.* 2008). Furthermore, the HBM does not consider the impact of emotions on behavior. Another limitation of the HBM is that factors other than beliefs also heavily influence behavior practices. These factors may include special influences, cultural factors, socioeconomic status, and previous experiences (Orji *et al.* 2012). Therefore, this research tried to extend the HBM by adding new components: risk attitude and perceived risks. The advantage of HBM is that it well explains the relationship between people's beliefs and their intentional behaviors. Accordingly, if an individual is exposed to a hazard, they will intend to take preventive behaviors provided that the hazard has extensive negative consequences for the individual and the preventive behaviors can effectively alleviate its damages or severity (Gaines & Turner 2009).

Farmers' perceived risk and risk attitudes toward it are among the factors influencing the adoption of risk management tools for water conservation (Sánchez-Cañizares *et al.* 2022) and have a significant impact on their decision based on the strategies adopted for risk management (Rahman *et al.* 2022). In other words, perceived risks and risk attitudes are vital psychological factors that influence water conservation behavior (Wang & Liu 2021). The perception of risk varies among social communities and is mostly shaped by subjective feelings towards various activities, events, and technologies (Wang & Liu 2021). People's perception of risk plays a key role in their decision-making process (Salehi *et al.* 2018). Risk perception guides decision-making regarding the acceptance of risks and fundamentally affects behaviors before, during, and after a disaster (Marshall 2020). As well, perceived risk is a subjective assessment of the likelihood of the occurrence of a certain incident and how to be worried about its consequences (Fierros-González & López-Feldman 2021). Therefore, climate change is intensifying, and local communities, particularly farmers, must adapt and cope with its effects. They also need to conserve water resources for their livelihood sustainability. Thus, we need to understand the risk aspects of farming in these situations and study how perceived risks affect decision-making behavior when investigating people's choices about climate change (Karimi *et al.* 2018). Farmers' perception of risk and management strategies to prevent risk, as well as their socioeconomic characteristics, is important factors in predicting water conservation behavior (Nadhomi *et al.* 2013).

3. LITERATURE REVIEW

Many research studies have studied water conservation by using psychological-cognitive models. Corral-Verdugo *et al.* (2003) studied environmental beliefs and water conservation and modeled general environmental beliefs as a three-factor structure composed of beliefs in (1) the need for protecting balance with nature, (2) the need for limiting human growth, and (3) a human exception model. Based on their results, general environmental beliefs influence the development of specific beliefs about water differently. Water beliefs are positively influenced by this model, whereas ecological water beliefs are positively influenced by beliefs in limitations and are negatively related to the human exception model. Water beliefs, in turn, increase water consumption, whereas their ecological water beliefs restrain their behavior. Bayard & Jolly (2007) adopted the HBM to study the effects of perceived susceptibility, perceived severity, and perceived benefits and barriers on farmers' awareness of and attitude to environmental behavior and environmental degradation. According to the results, perceived benefits of land improvement positively influence farmers' attitudes at a higher economic level. Also, the perceived severity of land erosion positively influences their awareness and attitude.

In a study on self-efficacy and its effect on water conservation behavior, Sharafipour & Ahmadvand (2019) revealed the significant effect of self-efficacy and its non-costliness on water conservation and management behavior. Tajeri Moghadam *et al.* (2020) investigated the barriers to water conservation behavior with grounded theory. They listed wrong beliefs and habits, fatalism, and the lack of understanding and responsibility about water scarcity as the causal conditions, land defragmentation, economic and financial limitations, poor governmental planning and management, lack of cooperation and collective consensus, lack of cultural development and training, and distrust to experts and officials as the contextual factors, and farmers' lack of self-efficacy, poor support plans of the government, and the failure in supplying farmers' livelihoods and benefits as the barriers to conservative behavior. Tajeri Moghadam *et al.* used the HBM to study water conservation behavior and found that perceived susceptibility, perceived benefits, and cues to action accounted for 41% of the variance in farmers' water conservation behavior. Furthermore, perceived benefits were found to be the strongest predictor of water conservation behavior. They concluded that the focus must be on perceived benefits, perceived susceptibility, and cues to action to promote preventive measures in coping with the growing water scarcity in Iran.

Moradhaseli *et al.* (2021) explored the underlying factors of farmers' occupational health behavior using the HBM and revealed that their behavior was influenced by four dimensions: perceived susceptibility, perceived benefits, cues to action, and perceived self-efficacy. These findings confirm the potential of the HBM in describing farmers' behaviors and the relevance of the model's use in studying farmers' protective behaviors. Ataei *et al.* (2021) employed the theory of planned behavior and HBM to investigate farmers' behaviors toward the use of green pesticides. They stated that among the seven constructs of HBM, the four constructs of perceived susceptibility, perceived benefits, cues to action, and health motivation were significantly related to the intention to use green pesticides.

The literature review shows that water conservation behavior is a critical issue investigated by many researchers. However, perceived risks of drought and farmers' risk attitude are two vital components whose role in exhibiting a behavior has been underestimated by researchers. Notably, if farmers have no perception of the risks of drought and water scarcity and have a poor risk attitude toward drought, their water conservation behavior process may change. Accordingly, there is a theoretical and practical gap in the research on water conservation behavior, which needs further research. In an attempt to understand the process of exhibiting water conservation behavior, this research adopts the HBM and includes farmers' risk attitudes and perceived risks in the model. The information collected greatly contributes to understanding how farmers manage water scarcity risks and measuring their knowledge of and attitudes toward water risks and advantages. Despite the importance of farmers' perceived risk of water scarcity and water conservation, no research has ever used the HBM to investigate farmers' water conservation behavior in the Sistan plain.

This study offers several noteworthy contributions to the existing literature. Firstly, it identifies the farmers' risk level in drought. This detailed analysis provides valuable insights into the farmers' decision-making process towards water conservation, contributing to a deeper understanding of the implications for drought mitigation and adaptation. Secondly, the study investigates the components of HBM influencing farmers' behavior. This insight provides valuable guidance for designing effective intervention strategies and promoting behavioral changes among farmers, ultimately facilitating the adoption of water conservation practices. In conclusion, this study bridges a crucial research gap in drought adaptation by evaluating the risk factors and exploring the underlying factors driving farmers' behavior.

As is shown in Figure 1, the model assumes that health-related behavior is based on specific beliefs, perceived susceptibility and severity, cues to action, self-efficacy, perceived benefits of behavior change, and perceived barriers to potential preventive measures. Perceived susceptibility refers to an individual's belief in the likelihood of the occurrence of a certain (negative) event to them. Perceived severity refers to the belief that there is a serious problem that may have serious or even fatal consequences. Perceived benefits refer to an individual's belief in the efficiency of the recommended activities for reducing the risk or in the seriousness of the consequences. Perceived barriers refer to an individual's belief in the subjective and mental costs of the recommended activities. Self-efficacy is an individual's perception of their ability to adhere to a selective behavior.

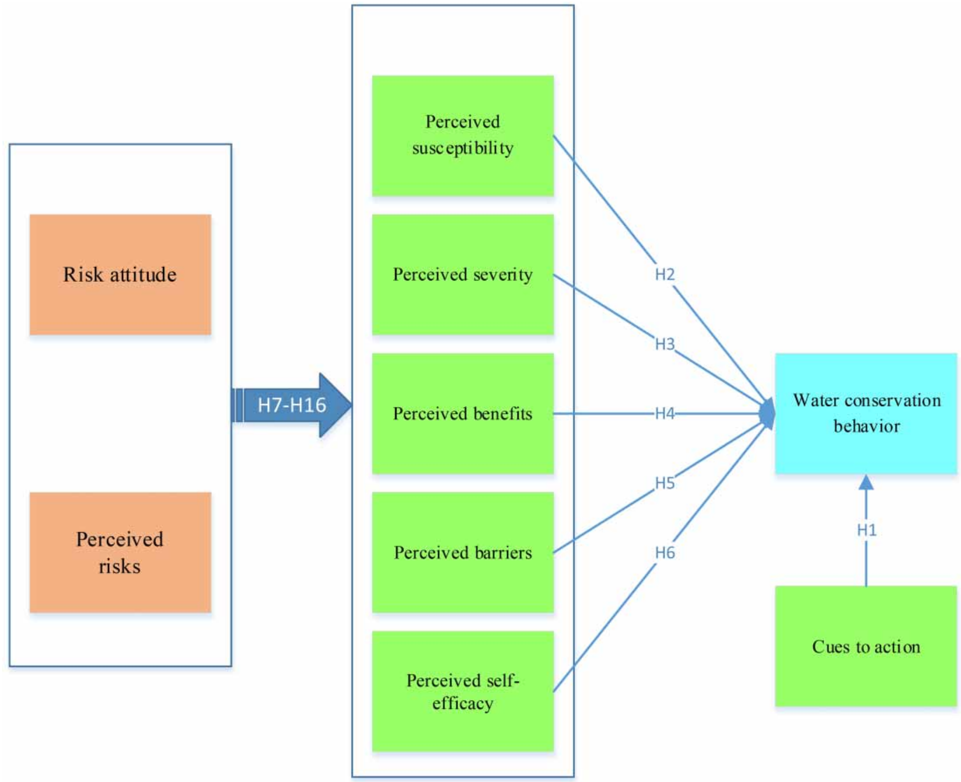

Figure 1 | The theoretical framework of the study.

Cues to actions are specific incentives or events that induce the feeling of need for action in the individual. Finally, given the theoretical framework of the study (Figure 1), the following hypotheses are considered to accomplish the research goals:

- H1: Cues to action influence farmers' water conservation behaviors significantly.
- H2: Perceived susceptibility influences farmers' water conservation behaviors significantly.
- H3: Perceived severity influences farmers' water conservation behaviors significantly.
- H4: Perceived benefits influence farmers' water conservation behaviors significantly.
- H5: Perceived barriers influence farmers' water conservation behaviors significantly.
- H6: Self-efficacy influences farmers' water conservation behaviors significantly.
- H7: Farmers' risk attitude influences their perceived self-efficacy significantly.
- H8: Farmers' risk attitude influences their perceived susceptibility significantly.
- H9: Farmers' risk attitude influences their perceived severity significantly.
- H10: Farmers' risk attitude influences their perceived benefits significantly.
- H11: Farmers' risk attitude influences their perceived barriers significantly.
- H12: Farmers' perceived risks influence their perceived self-efficacy significantly.
- H13: Farmers' perceived risks influence their perceived susceptibility significantly.
- H14: Farmers' perceived risks influence their perceived severity significantly.
- H15: Farmers' perceived risks influence their perceived benefits significantly.
- H16: Farmers' perceived risks influence their perceived barriers significantly.

4. METHODOLOGY

This is a causal-relational research study where the survey methodology was used to identify the factors influencing farmers' water conservation behavior. On the other hand, it is an applied study because its findings can help resolve drought challenges in Iran and learn about farmers' decision process for water conservation. The study site was the villages of the Sistan plain in Sistan and Baluchistan province, Iran. The statistical population was composed of farmers who have been struggling with drought stress in recent years. They amounted to 6,000 farmers as per the statistics provided by the Agriculture Jahad Organization. So, the total number of farmers in the studied area was 6,000. The study sample was selected using the multistage cluster random sampling technique. Multistage cluster random sampling is a sampling method that divides the population into groups (or clusters) for conducting research. During this sampling method, significant clusters of the selected people are split into sub-groups at various stages to simplify primary data collection (Brown 2010). First, two-thirds of the rural districts (12 out of 18 rural districts in the Sistan plain) were selected randomly. Then, 31 villages were chosen from these 12 districts randomly. It should be noted that the samples were assigned to the 31 villages proportionally. The sample was estimated to be 361 farmers, according to Krejcie & Morgan's (1970) table. A self-made questionnaire was used for data collection. The questionnaire had sections for farmers' demographic and professional characteristics, HBM constructs, risk attitude, and perceived risks. The face validity of the research instrument was supported by a panel of agricultural sociologists and based on the optimal construct validity index (AVE = 0.50–0.61). Convergent validity refers to the degree to which a measure is correlated with other measures that it is theoretically predicted to correlate with. Average variance extracted (AVE) is commonly used to assess convergent validity. To calculate the AVE of the latent construct, it takes the loadings of the items on the construct and calculates the average of squared loadings. The reliability of the research instrument was checked by conducting a pilot study and calculating Cronbach's alpha (Formula 1) and composite reliability (CR) (Formula 2). The formula for Cronbach's alpha coefficient is as follows:

$$\alpha = nn - 1\frac{(\sigma X2 - \sum i = 1n\sigma i2)}{\sigma X2} \tag{1}$$

where n is the number of items, σX2 is the total test score variance, and σi2 is the item variance.

The CR measures the internal consistency of indicator variables' loadings on the latent variable. If the CR is greater than 0.7, the indicator variables' loadings on the latent variable have shared variance among them. The formula is as follows (Netemeyer *et al.* 2003):

$$\mathrm{CR} = \frac{\left(\sum_{i=1}^{p} \lambda i\right)^2}{\left(\sum_{i=1}^{p} \lambda i\right)^2 + \sum_{i}^{p} V(\delta i)} \tag{2}$$

where λ_i represents completely standardized loading for the ith indicator, $V(\delta_i)$ is the variance of the error term for the ith indicator, p is the number of indicators.

The results for all constructs ($\alpha = 0.73$–0.94; CR = 0.78–0.89) implied their proper consistency. The variables were all calculated on a 5-point scale from 1 for 'completely disagree' to 5 for 'completely agree' and from 0 for 'none' to 5 for 'very much.' The data were analyzed using mean, percentage, and structural equation modeling in the $\mathrm{SPSS}_{\mathrm{win26}}$ (Field 2017) and AMOS_{24} (Byrne 2016) software suites. The indices of chi-square value/degree of freedom (CMIN/DF) (less than 5), root mean square residual (RMR) (greater than 0.90), Adjusted Goodness of Fit Index (AGFI) (greater than 0.90), comparative fit index (CFI) (greater than 0.90), goodness of fit (GFI) (greater than 0.90), and Root Mean Square Error of Approximation (RMSEA) (less than 0.08) were used to investigate the structural model's goodness of fit (Byrne 2016).

5. RESULTS

5.1. Farmers' demographic-agronomic characteristics

According to the results for the farmers' demographic characteristics, 93.9% were male and 6.1% were female. The farmers of the Sistan plain were, on average, 51.18 years old (with a standard deviation (SD) of 10.77), and they have been working in the field of agriculture for, on average, 29.92 years (SD = 11.64). Most farmers were literate at the basic and middle-school levels (20.5 and 19.4%, respectively). Furthermore, 12.7% were single and 87.3% were married. Regarding land ownership type, most farmers (72.6%) were the owners of their lands, whereas 27.4% were tenants. The mean cultivation area of agricultural and horticultural crops was 13.46 ha (SD = 3.13). The river was the main water resource for most farmers (61.8%), but 30.2% abstracted groundwater tables through water wells. Also, the main sources of the farmers' revenues were horticulture (57.1%), crop farming (36.6%), and animal farming (6.4%) (Table 1).

5.2. Farmers' water conservation behaviors

Confirmatory factor analysis (CFA) is the fundamental first step in running most types of structural equation modeling (SEM) models. It is used to verify the measurement quality of any and all latent constructs used in the structural equation model. The first step is to calculate the factor loadings of the indicators (standardized loadings) that make up the latent construct. The standardized factor loading squared is the estimate of the amount of the variance of the indicator that is accounted for by the latent construct (Cheung *et al.* 2023). Creating this CFA measurement model allows us to check the convergent validity of the construct. Convergent validity is indicated by high indicator loadings, which shows the strength of how well the indicators are theoretically similar.

Table 2 presents the factor loadings of each studied indicator on its corresponding construct. Accordingly, the variable of water conservation behavior is composed of nine indicators. The *t*-value was greater than 1.96 for all of them. So, the factor loadings of the indicators of this variable significantly differed from zero. Also, all *t*-values were greater than 1.96 for the indicators loaded on the variables of *perceived risks*, *risk attitude*, perceived benefits (*PBe*), perceived barriers (*PB*), perceived severity (*PS*), perceived susceptibility (*PSu*), *perceived self-efficacy*, and cues to action (*CA*), implying that the factor loadings corresponding to these indicators were their significant predictors. The research also computed composite reliability (CR) and average variance extracted (AVE). The analysis of these indicators showed that CR was greater than 0.6 for all variables and AVE was greater than 0.5 for all of them.

The structural model's goodness of fit was found to be acceptable based on the fit indices, including CMIN/DF, RMR, AGFI, CFI, GFI, and RMSEA. Furthermore, GFI, an indicator of the relative size of variances and covariances captured by the model, was estimated at 0.91 for the research framework. The CFI was 0.92, meeting the optimal level like other fit indices. χ^2/degrees of freedom was calculated to be 3.25, indicating the proper fit of the model. Also, the values 0.90, 0.94, and 0.06 were calculated for RMSE, AGFI, and RMR, respectively. Given the fit of the structural model of the study, it can be said that this model is generally consistent with the data used.

According to the structural model of the research, the farmers' *perceived risks* and *risk attitude* influenced *perceived benefits, perceived barriers, perceived severity, perceived susceptibility*, and *perceived self-efficacy* directly and their

Table 1 | Farmers' demographic and professional characteristics

Variable		Frequency	Percent	Cumulative percent
Sex	Male	339	93.9	93.9
	Female	22	6.1	100
Education	Illiterate	44	12.2	12.2
	Literate	74	20.5	32.7
	Middle-school	70	19.4	52.1
	Diploma	46	12.7	64.8
	Associate degree	25	6.9	71.7
	Bachelor's degree	63	17.5	89.2
	Master's degree	29	8	97.2
	Ph.D.	10	2.8	100
Marital status	Single	46	12.7	12.7
	Married	315	87.3	100
Land ownership	Owner	262	72.6	72.6
	Tenant	99	27.4	100
Water resource	Well	109	30.2	30.2
	River	223	61.8	92
	Other	29	8	100
Main source of income	Crop farming	132	36.6	36.6
	Horticulture	206	57.1	93.6
	Animal farming	23	6.4	100

Table 2 | Measurement coefficients and the validity and reliability of the variables

Latent variables	Observed variables	Standardized loading	AVE	CR	α	*t*-value
Perceived severity	(PV1) If I don't have water for agriculture, I can hardly survive.	0.65	0.52	0.81	0.75	Fixed
	(PV2) Drought inflicts serious damage to crops.	0.59				5.68
	(PV3) Water scarcity has intensified in recent years.	0.82				8.11
	(PV4) If drought prevention measures are not taken, it will cause serious problems for farmers.	0.81				8.02
Perceived barriers	(PB1) The cost of setting up new irrigation systems is high.	0.75	0.54	0.82	0.73	Fixed
	(PB2) It is time-consuming to use water conservation strategies.	0.81				7.72
	(PB3) The use of water conservation solutions disrupts agricultural activities.	0.71				5.02
	(PB4) The culture of using adaptation methods and dealing with drought has not been established among farmers.	0.68				5.96
Perceived susceptibility	(PS1) It is not necessary to use modern irrigation systems.	0.738	0.54	0.78	0.76	Fixed
	(PS2) Water shortage is not too severe to adopt water conservation strategies.	0.813				9.87
	(PS3) Farmers who have experienced drought use adopt more water conservation strategies.	0.662				8.37
Perceived self-efficacy	(SE1) I can implement water conservation strategies easily.	0.755	0.55	0.78	0.82	Fixed
	(SE2) I can use alternative methods (new irrigation methods) instead of traditional methods.	0.791				10.97
	(SE3) I can produce the current amount of crop by reducing water consumption.	0.677				9.26
Cues to action	(CA1) To what extent do you follow other farmers in applying water conservation strategies?	0.685	0.58	0.80	0.82	Fixed
	(CA2) How effective is the media (e.g., television, radio, internet, etc.) in your use of water conservation strategies?	0.772				9.30
	(CA3) To what extent do you get advice from experts on how to apply water conservation strategies?	0.833				9.76
Perceived benefits	(PF1) The use of water conservation solutions reduces production costs.	0.733	0.54	0.85	0.83	Fixed
	(PF2) The water level of the well will increase if I launch modern irrigation systems.	0.727				9.42
	(PF3) The effects of drought will be reduced by using water conservation strategies.	0.754				9.75
	(PF4) Agricultural water productivity increases by applying water conservation strategies.	0.747				9.67
	(PF5) Production increases by applying water conservation strategies.	0.746				9.65
Risk attitude	(ATT1) I don't like to make risky decisions about my cultivation activities.	0.787	0.61	0.86	0.88	Fixed
	(ATT2) I postpone investments until I really need to make them.	0.794				15.11
	(ATT3) I am usually very careful when deciding to choose a new irrigation method.	0.798				15.202
	(ATT4) I am not afraid of borrowing money to make investments that can increase profitability.	0.75				14.255
Perceived risks	(PR1) Extremely high prices of inputs and agricultural machinery.	0.892	0.51	0.86	0.94	Fixed
	(PR2) Very low income considering long-term expenses.	0.663				4.275
	(PR3) Crop loss due to drought.	0.602				4.275
	(PR4) Reduction of production due to the lack of application of drought adaptation strategies.	0.682				4.481
	(PR5) Unexpected changes in regulations with a negative effect on my land.	0.691				4.797
	(PR6) Cancelation of (an important share of) received subsidies.	0.749				5.197

(*Continued.*)

Table 2 | Continued

Latent variables	Observed variables	Standardized loading	AVE	CR	α	*t*-value
Water conservation behavior	(BEHV1) I divide my land into several plots to reduce water consumption.	0.774	0.50	0.89	0.76	Fixed
	(BEHV2) I irrigate at cold hours of the day, such as in the evening, at night, or at dawn.	0.691				5.55
	(BEHV3) I apply new technologies for growing crops to decrease water consumption.	0.725				5.64
	(BEHV4) I use modified resistant seeds to reduce water consumption and increase crop production.	0.788				10.9
	(BEHV5) I dredge the irrigation canals to prevent water wastage.	0.779				10.77
	(BEHV6) I cement the water channels to prevent water wastage.	0.700				9.69
	(BEHV7) I use a tank or a pool for water storage.	0.680				9.27
	(BEHV8) I consider a suitable slope during land preparation.	0.600				8.18
	(BEHV9) I use furrow for the conservation and agricultural water resources.	0.580				7.94

conservation behavior indirectly. Also, the variables of *perceived benefits, perceived barriers, perceived severity, perceived susceptibility, cues to action,* and *perceived self-efficacy* influenced the farmers' *water conservation behavior* directly. The beta coefficient was used to assess the relationship between independent and dependent variables. The use of the beta coefficient allows direct comparisons between independent variables to determine which has the most influence on the dependent variable. The beta coefficients (regression coefficients) are presented in Figure 2.

The results revealed that *perceived benefits* ($\beta = 0.42$, $P < 0.05$), *perceived barriers* ($\beta = 0.62$, $P < 0.01$), *perceived severity* ($\beta = 0.78$, $P < 0.05$), *perceived susceptibility* ($\beta = 0.62$, $P < 0.01$), *cues to action* ($\beta = 0.42$, $P < 0.01$), and *perceived self-efficacy* ($\beta = 0.61$, $P < 0.01$) influenced the farmers' *water conservation behavior* positively and significantly. So, hypotheses 1–6 are supported.

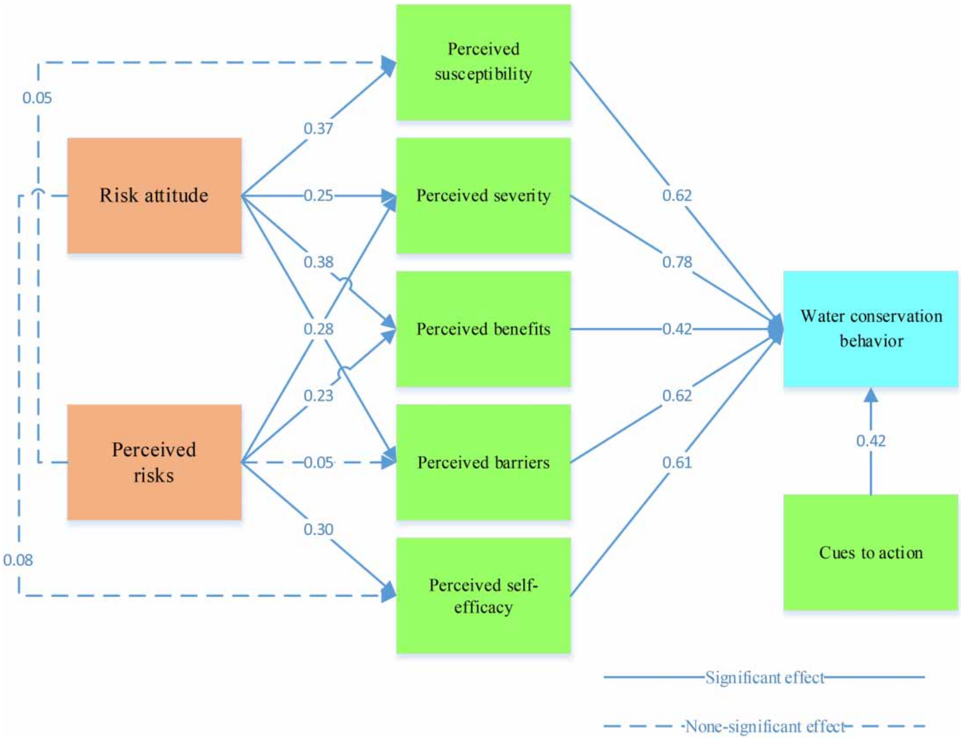

Figure 2 | The results of the causal relationships of the research variables.

Also, the farmers' *risk attitude* was found to influence *perceived benefits* ($\beta = 0.38$, $P < 0.05$), *perceived barriers* ($\beta = 0.19$, $P < 0.05$), *perceived severity* ($\beta = 0.25$, $P < 0.05$), and *perceived susceptibility* ($\beta = 0.37$, $P < 0.01$) positively and significantly. This confirms hypotheses 8–11. However, hypothesis 7 is refuted because the farmers' *risk attitude* had no significant effect on *perceived self-efficacy*.

The positive and significant effect of the farmers' *perceived risks* was revealed on *perceived severity* ($\beta = 0.28$, $P < 0.05$), *perceived self-efficacy* ($\beta = 0.30$, $P < 0.01$), and *perceived barriers* ($\beta = 0.23$, $P < 0.05$). Accordingly, hypotheses 12, 14, and 15 are supported. The farmers' *perceived risks*, however, had no significant influence on *perceived susceptibility* and *perceived barriers*, refuting hypotheses 13 and 16 (Figure 2).

R-squared (R^2) is a statistical measure that represents the proportion of the variance for a dependent variable explained by an independent variable in a regression model. R^2 was found to be 0.15, 0.13, 0.287, 0.133, and 0.08 for *perceived benefits, perceived barriers, perceived severity, perceived susceptibility,* and *perceived self-efficacy*, respectively. This means that 15, 13, 28.7, 13.3, and 8% of the variances in these variables are related to the farmers' *perceived risks* and *risk attitudes*. Also, R^2 was estimated at 0.511 for the farmers' *water conservation behavior*, meaning that 51.1% of the variance in farmers' *water conservation behavior* is predicted by *perceived benefits, perceived barriers, perceived severity, perceived susceptibility, cues to action,* and *perceived self-efficacy* (Table 3).

6. DISCUSSION

This research integrated risk attitude and perceived risks with the components of the HBM to investigate farmers' water conservation behavior. The results proved that the extended HBM was highly successful in predicting farmers' water conservation behavior. This finding has been supported by many research studies in different fields (Li *et al.* 2015; Dodel & Mesch 2017; Cook 2018; Jeong & Ham 2018; Ataei *et al.* 2021). Our results agree with some previous studies on the components of perceived barriers and benefits. Abdollahzadeh & Sharifzadeh (2021) and Abazari *et al.* (2022) established that understanding the barriers and benefits of action would increase the likelihood of its repetition. Some benefits of using water conservation strategies include increasing the water level of wells, enhancing water productivity, escalating production, and reducing production costs.

According to the results, Perceived susceptibility is a strong predictor of water conservation behavior. This has been corroborated by other studies (Ataei *et al.* 2021; Renault *et al.* 2021; Sereenonchai & Arunrat 2022; Tengecha *et al.* 2022).

Table 3 | The results of testing the hypotheses

Relationships between the variables			Beta	*t*-Value	Sig	R^2	Hypothesis
Risk attitude	→	*Perceived susceptibility*	0.37	4.41	0.01	0.133	H8: Confirmed
Perceived risks			0.05	1.48	0.13		H13: Refuted
Risk attitude	→	*Perceived severity*	0.25	2.47	0.013	0.287	H9: Confirmed
Perceived risks			0.28	1.97	0.05		H14: Confirmed
Risk attitude	→	*Perceived benefits*	0.38	2.08	0.03	0.15	H10: Confirmed
Perceived risks			0.23	2.46	0.014		H15: Confirmed
Risk attitude	→	*Perceived barriers*	0.19	2.20	0.02	0.13	H11: Confirmed
Perceived risks			0.05	1.50	0.13		H16: Refuted
Risk attitude	→	*Perceived self-efficacy*	0.08	0.40	0.68	0.08	H7: Refuted
Perceived risks			0.30	2.94	0.01		H12: Confirmed
Perceived susceptibility	→	*Water conservation behavior*	0.62	5.77	0.01	0.511	H2: Confirmed
Perceived severity			0.78	1.97	0.05		H3: Confirmed
Perceived benefits			0.42	2.31	0.02		H4: Confirmed
Perceived barriers			0.62	5.78	0.01		H5: Confirmed
Perceived self-efficacy			0.61	2.78	0.01		H6: Confirmed
Cues to action			0.42	3.09	0.01		H1: Confirmed

According to these scholars, *perceived susceptibility* is a determining factor in people's behavior. Farmers who believe that they are exposed to the risk of drought and water scarcity hinder the occurrence of drought effects or take protective measures to adapt to and alleviate its impacts. So, water conservation behavior is reinforced among them. Also, it was found that *cues to action* would improve the farmers' behavior towards water conservation. This is in agreement with the results of Teshome *et al.* (2021), Win *et al.* (2021), and Yazdanpanah *et al.* (2022), who found that educational messages, collective communications, entrusted people, and entrusted mass media can influence people's behavior. In other words, human and communication accelerating factors induce the need for people to take water conservation measures. So, their measures for fructifying conservation behavior are reinforced. This implies that individuals are affected by knowledge sources. For farmers' water conservation behavior, CA can change the way towards displaying proper behaviors.

PSe is a construct that significantly influences the process of displaying water conservation behavior by farmers. This finding is related to the results of Zobeidi *et al.* (2021), Tashiro (2022), and Abazari *et al.* (2022). It can be asserted that farmers' understanding of their ability to use water conservation strategies can improve their conservation behavior. In other words, water conservation behavior needs farmers' full understanding of their abilities, which can speed up the process of behavior exhibition. As well, the results reveal that risk attitude and perceived risks affect most components of the HBM significantly. Therefore, farmers who perceive greater risk, either due to the fact that they are objectively faced with greater risk or they have a greater subjective perception of various risks, have a significantly greater perception of benefits and barriers of the use of water conservation strategies, drought susceptibilities and severity, and self-efficacy. Hellerstein *et al.* (2013), de Mey *et al.* (2014), and van Winsen *et al.* (2016) have emphasized the role of risk in farmers' agronomic activities, too.

7. CONCLUSIONS

Water scarcity is on the list of environmental challenges and an important factor jeopardizing sustainable socioeconomic development in the world, especially in arid and semi-arid regions like Iran. One way to alleviate the consequences of this global crisis is to change farmers' behavior toward the conservation of water resources. Accordingly, we developed a theoretical model for understanding water conservation behavior based on the HBM and the intervention of risk attitude and perceived risks. Empirical evidence for this model was collected with a survey of farmers in the Sistan region. This model integrates perceived risks and risk attitude as the factors determining the HBM components, whereas water conservation behavior is affected by perceived susceptibility, perceived severity, perceived benefits, perceived barriers, self-efficacy, and cues to action. In conclusion, this study fills a significant research gap by evaluating the risk dimensions of climate change and investigating farmers' water conservation behavior.

The results showed that the theoretical framework of the study was successful in explaining farmers' water conservation behavior. So, the present study supports the theoretical framework as a strong predictor of behavior. Overall, the results reveal that to promote water conservation behavior and use water scarcity-coping strategies in Iran, it is imperative to focus on components like perceived benefits, perceived susceptibility, perceived severity, perceived barriers, cues to action, and self-efficacy while farmers' understanding of the risk will facilitate this process. To motivate farmers to adopt drought adaptation and coping strategies, it is recommended to enhance their awareness of the negative impacts of the degradation of water resources through governmental policy programs on the one hand and to consider the benefits of adopting water scarcity-coping strategies on the other.

As with all studies, this research faced some limitations. One limitation was the difficulty in detecting farmers who applied water conservation practices. On the other hand, it was difficult to gain their trust to complete the questionnaire. To solve this problem, they were informed about the research goals. Also, they were ensured about the confidentiality of their responses and that the data would not be revealed to other organizations. Another limitation was to study farmers' water conservation behavior in detail. In other words, it is impossible to determine the level of the farmers' water conservation behavior, and there is no comprehensive standard to show whether their behavior is optimal. This can be subject matter for future research to develop a framework or guideline for farmers' water conservation behavior level. Another limitation was farmers' self-reporting of the application of water conservation measures. In other words, the metric for assessing their behavior was their self-reports, which can be changed in future research.

DATA AVAILABILITY STATEMENT

Data cannot be made publicly available; readers should contact the corresponding author for details.

CONFLICT OF INTEREST

The authors declare there is no conflict.

REFERENCES

Abazari, M., Adham, D., Saghafipour, A., Taheri-Kharameh, Z., Abbasi-Ghahramanloo, A., Asadollahi, J. & Asl, E. M. 2022 Health beliefs and behaviors of livestock industry workers regarding Crimean-Congo hemorrhagic fever in Northwest of Iran. *BMC Health Services Research* **22** (1). doi:10.1186/s12913-022-07487-4.

Abdollahzadeh, G. & Sharifzadeh, M. S. 2021 Predicting farmers' intention to use PPE for prevent pesticide adverse effects: An examination of the health belief model (HBM). *Journal of the Saudi Society of Agricultural Sciences* **20** (1), 40–47. doi:10.1016/j.jssas.2020.11.001.

Adams, E. A. 2014 Behavioral attitudes towards water conservation and re-use among the United States Public. *Resources and Environment* **4** (3), 162–167.

Aliabadi, V., Ataei, P. & Gholamrezai, S. 2022 Farmers' strategies for drought adaptation based on the indigenous knowledge system: The case of Iran. *Weather, Climate, and Society* **14** (2), 561–568.

Ataei, P., Gholamrezai, S., Movahedi, R. & Aliabadi, V. 2021 An analysis of farmers' intention to use green pesticides: The application of the extended theory of planned behavior and health belief model. *Journal of Rural Studies* **81**, 374–384. doi:10.1016/j.jrurstud.2020.11.003.

Ataei, P., Karimi, H. & Es'haghi, S. R. 2022 Socio-cognitive analysis of farmers' water conservation behavior: The case of the Kavar plain, Iran. *Science Progress* **105** (4), 1–21.

Azadeh, F., Chabokroo, G. & Akbari, S. M. 2010 Negative impacts of drought and solutions to deal with it (case study: Sistan). In *National Conference on Water Crisis Management*. The Islamic Azad University of Marvdasht, Fars, Iran.

Bayard, B. & Jolly, C. 2007 Environmental behavior structure and socio-economic conditions of hillside farmers: A multiple-group structural equation modeling approach. *Ecological Economics* **62** (3), 433–440.

Bhakta, S. S., Rodrigues, L. L. R. & Sriram, K. V. 2023 Assessing water conservation behaviour of India's urban households. *Utilities Policy* **82**, 101547. doi:10.1016/j.jup.2023.101547.

Bijani, M. & Hayati, D. 2015 Farmers' perceptions toward agricultural water conflict: The case of Doroodzan dam irrigation network, Iran. *Journal of Agricultural Science and Technology* **17** (3), 561–575.

Brown, R. S. 2010 Sampling. In: *International Encyclopedia of Education*, 3rd edn (Peterson, P., Baker, E. & McGaw, B., eds). Elsevier, Oxford, pp. 142–146.

Byrne, B. 2016 *Structural Equation Modeling with AMOS: Basic Concepts, Applications, and Programming*, 3nd edn. Taylor and Francis Group, Routledge, New York.

Carley, A. & Stratman, E. 2015 Skin cancer beliefs, knowledge, and prevention practices: A comparison of farmers and nonfarmers in a midwestern population. *Journal of Agromedicine* **20** (2), 85–94. doi:10.1080/1059924X.2015.1010059.

Cheung, G. W., Cooper-Thomas, H. D., Lau, R. S. & Wang, L. C. 2023 Reporting reliability, convergent and discriminant validity with structural equation modeling: A review and best-practice recommendations. *Asia Pacific Journal of Management*. doi:10.1007/s10490-023-09871-y.

Cook, L. A. 2018 Health belief model and healthy consumption: Toward an integrated model. *Journal of Food Products Marketing* **24** (1), 22–38. doi:10.1080/10454446.2017.1244783.

Corral-Verdugo, V., Bechtel, R. B. & Fraijo-Sing, B. 2003 Environmental beliefs and water conservation: An empirical study. *Journal of Environmental Psychology* **23** (3), 247–257. doi:10.1016/S0272-4944(02)00086-5.

de Mey, Y., van Winsen, F., Van Passel, S., Vancauteren, M., Lauwers, L. & Wauters, E. 2014 Farm-level evidence on risk balancing in the EU-15. *Agricultural Finance Review* **74**, 17–37.

Dodel, M. & Mesch, G. 2017 Cyber-victimization preventive behavior: A health belief model approach. *Computers in Human Behavior* **68**, 359–367.

Field, A. 2017 *Discovering Statistics Using IBM SPSS Statistics*. SAGE Publications Ltd, Thousand Oaks, CA.

Fierros-González, I. & López-Feldman, A. 2021 Farmers' perception of climate change: A review of the literature for Latin America. *Frontiers in Environmental Science* **9**, 205. doi:10.3389/fenvs.2021.672399.

Gaines, A. & Turner, L. W. 2009 Improving fruit and vegetable intake among children. *Californian Journal of Health Promotion* **7** (1), 52–66. doi:10.32398/cjhp.v7i1.1320.

Gilbertson, M., Hurlimann, A. & Dolnicar, S. 2011 Does water context influence behavior and attitudes to water conservation? *Australasian Journal of Environmental Management* **18** (1), 47–60.

Glanz, K., Rimer, B. K. & Viswanath, K. 2008 *Health Behavior and Health Education: Theory, Research, and Practice*, 4th edn. Jossey-Bass, San Francisco, CA, pp. 45–51.

Hallaj, Z., Sadighi, H., Farhadian, H. & Bijani, M. 2021 Human ecological analysis of farmers' pro environmental behaviour in the face of drought: Application of norm activation theory. *Water and Environment Journal*. doi:10.1111/wej.12733.

Hashmi, S. & Al-Modarressi, A. 2015 Modeling of subsidence of Neishabour plain using time series and DINSAR technique. *Journal of Geography and Environmental Planning* **26** (1), 84–67. (in Persian).

Hellerstein, D., Higgins, N. & Horowitz, J. 2013 The predictive power of risk preference measures for farming decisions. *European Review of Agricultural Economics* **40**, 807–833.

Hu, B. & Zhang, Z. 2022 Evaluation of big data analytics and cognitive computing in smart health systems. *Journal of Commercial Biotechnology* **27** (2), 1–12.

Javeline, D., Dolsak, N. & Prakash, A. 2019 Adapting to water impacts of climate change introduction to special *issue of Climatic Change*. *Climatic Change* **152** (2), 209–213. doi:10.1007/s10584-018-2349-1.

Jeong, J.-Y. & Ham, S. 2018 Application of the Health Belief Model to customers' use of menu labels in restaurants. *Appetite* **123**, 208–215. doi:10.1016/j. appet.2017.12.012.

Karimi, H. & Ataei, P. 2022 Farmers' cultural biases and adaptation behavior towards drought. *Journal of Agricultural Science and Technology* **24** (4), 791–807.

Karimi, H. & Ataei, P. 2023 Perceived social risks and farmers' behavior in using urban wastewater in their farms. *Environmental and Sustainability Indicators* **20**, 100301.

Karimi, V., Karami, E. & Keshavarz, M. 2018 Climate change and agriculture: Impacts and adaptive responses in Iran. *Journal of Integrative Agriculture* **17** (1), 1–15.

Keshavarz, M., Karami, E. & Vanclay, F. 2013 The social experience of drought in rural Iran. *Land Use Policy* **30** (1), 120–129. doi:10.1016/j.landusepol.2012.03.003.

Khoshnodifar, Z., Karimi, H. & Ataei, P. 2023 Mechanisms to change farmers' drought adaptation behaviors in Sistan and Baluchistan province, Iran. *Frontiers in Sustainable Food Systems* **7**, 1121254.

Kollmuss, A. & Agyeman, J. 2002 Mind the gap: Why do people act environmentally and what are the barriers to pro-environmental behavior? *Environmental Education Research* **8** (3), 239–260.

Krejcie, R. V. & Morgan, D. W. 1970 Determining sample size for research activities. *Educational and Psychological Measurement* **30**, 607–610.

Li, Z. T., Yang, S. S., Zhang, X. X., Fisher, E. B., Tian, B. C. & Sun, X. Y. 2015 Complex relation among Health Belief Model components in TB prevention and care. *Public Health* **129** (7), 907–915. doi:10.1016/j.puhe.2015.04.008.

Maleksaeidi, H. & Karami, E. 2013 Social-ecological resilience and sustainable agriculture under water scarcity. *Agroecology and Sustainable Food Systems* **37** (3), 262–290. doi:10.1080/10440046.2012.746767.

Mamani, W. C., Manrique, G. M. L., Madrid, S. D. P. C., Herrera, E. E., Acosta, D. B., Rivas-Diaz, R. R., Arias-Gonzáles, J. L., Maquera, Y. M. & Ramos, F. S. S. 2022 The role of entrepreneurship and green innovation intention on sustainable development: moderating impact of inclusive leadership. *AgBioForum* **24** (1), 134–143.

Marshall, T. M. 2020 Risk perception and safety culture: Tools for improving the implementation of disaster risk reduction strategies. *International Journal of Disaster Risk Reduction* **47**, 101557. doi:10.1016/j.ijdrr.2020.101557.

Mittal, N., Bhave, A. G., Mishra, A. & Singh, R. 2016 Impact of human intervention and climate change on natural flow regime. *Water Resources Management* **30** (2), 685–699.

Mokhtary, D. & Iraj, S. 2008 *Analysis of Drought and Domestic SocioEconomic Dimensions and its Impact on Rural Households in Sistan, Sixth Iranian Agriculture Economics Conference*.

Moradhaseli, S., Ataei, P., Van den Broucke, S. & Karimi, H. 2021 The process of farmers' occupational health behavior by health belief model: Evidence from Iran. *Journal of Agromedicine* **26** (2), 231–244. doi:10.1080/1059924X.2020.1837316.

Nadhomi, D. L., Tenywa, J. S., Musali, P. & Nakileza, B. R. 2013 Farmers' perception of erosion risk and its implication on the adoption of soil and water conservation practices. *International Journal of Advance Agricultural Science and Technology* **2** (1), 28–44.

Namdar, A., Bigizadeh, S. & Naghizadeh, M. M. 2012 Measuring health belief model components in adopting preventive behaviors of cervical cancer. *Journal of Fasa University of Medical Sciences* **2** (1), 34–44.

Nayar, R. & Patel, R. 2021 Rural water quality monitoring and exploring low-cost treatment technology with water Hyacinth. *Edelweiss Applied Science and Technology* **5** (1). doi:10.33805/2576-8484.188.

Netemeyer, R. G., Bearden, W. O. & Sharma, S. 2003 *Scaling Procedures: Issues and Applications*. California: SAGE Publications.

Nguyen-Chi, H., Chuong, H. N., Pham-My, D., Nguyen-Anh, T. & Tra-Van, T. 2022 Spatial clustering of manufacturing firms in Vietnam. *International Journal of Economics and Finance Studies* **14** (1), 116–137.

Orji, R., Vassileva, J. & Mandryk, R. 2012 Towards an effective health interventions design: An extension of the health belief model. *Online Journal of Public Health Informatics* **4** (3). doi:10.5210/ojphi.v4i3.4321.

Panyasing, S., Yongvanit, S., Purnomo, E. P., Tham, I. & Aim, S. 2022 The government policy on the organic rice farming groups embracing sustainable agricultural production: Evidence in Thailand. *AgBioForum* **24** (1), 83–94.

Parwada, C. & Marufu, H. 2023 Digitalisation of agriculture in Zimbabwe: Challenges and opportunities. *International Journal of Sustainable Agricultural Research* **10** (1), 32–41. doi:10.18488/ijsar.v10i1.3280.

Patra, K., Parihar, C. M., Nayak, H. S., Rana, B., Sena, D. R., Anand, A., Reddy, K. S., Chowdhury, M., Pandey, R., Kumar, A., Singh, L. K., Ghatala, M. K., Sidhu, H. S. & Jat, M. L. 2023 Appraisal of complementarity of subsurface drip fertigation and conservation agriculture for physiological performance and water economy of maize. *Agricultural Water Management* **283**, 108308. doi:10.1016/j.agwat.2023.108308.

Que, N. D., Van Song, N., Mai, T. T. H., Phuong, N. T. M., Huong, N. T. X., Tiep, N. C. & Uan, T. B. 2022 Rice farmers' perception and determinants of climate change adaptation measures: A case study in Vietnam. *AgBioForum* **24** (1), 13–22.

Rahman, A., Zhu, N., Islam, M. D. I., Anny, S. A., Afroj, M., Sarker, M. N. I. & Islam, M. W. 2022 Factors influencing farmers' awareness and risk perception of environmental degradation in Bangladesh. *Polish Journal of Environmental Studies* **31** (2), 1293–1304.

Razmara, A., Aghamolaei, T., Madani, A., Hosseini, Z. & Zare, S. 2018 Prediction of safe driving behaviours based on health belief model: The case of taxi drivers in Bandar Abbas, Iran. *BMC Publ. Health* **18**, 380. doi:10.1186/s12889-018-5300- 5.

Renault, V., Damiaans, B., Humblet, M. F., Jiménez Ruiz, S., García Bocanegra, I., Brennan, M. L., Casal, J., Petit, E., Pieper, L., Simoneit, C., Tourette, I., van Wuyckhuise, L., Sarrazin, S., Dewulf, J. & Saegerman, C. 2021 Cattle farmers' perception of biosecurity measures and the main predictors of behaviour change: The first European-wide pilot study. *Transboundary and Emerging Diseases* **68** (6), 3305–3319. doi:10.1111/tbed.13935.

Salehi, S., Chizari, M., Sadighi, H. & Bijani, M. 2018 Assessment of agricultural groundwater users in Iran: A cultural environmental bias. *Hydrogeology Journal* **26** (1), 285–295. doi:10.1007/s10040-017-1634-9.

Sánchez-Cañizares, S. M., Dolores Guerrero-Baena, M. & Gómez-Limón, J. A. 2022 Factors influencing the simultaneous adoption of risk management instruments in Mediterranean irrigated agriculture. *Journal of Environmental Planning and Management* **65** (6), 1088–1109.

Sereenonchai, S. & Arunrat, N. 2022 Farmers' perceptions, insight behavior and communication strategies for rice straw and stubble management in Thailand. *Agronomy* **12** (1). doi:10.3390/agronomy12010200.

Sharafipour, L. & Ahmadvand, M. 2019 Determinants of water conservation behavior of wheat farmers in Arzooieh city using the theory of conservation motivation. *Irrigation and Water Engineering of Iran* **10** (38), 259–275. (in Persian).

Siddiqui, T. R., Ghazal, S., Bibi, S., Ahmed, W. & Sajjad, S. F. 2016 Use of the health belief model for the assessment of public knowledge and household preventive practices in Karachi, Pakistan, a Dengue-Endemic City. *PLOS Neglected Tropical Diseases* **10** (11), e0005129. doi:10.1371/journal.pntd.0005129.

Simsekoglu, O. & Lajunen, T. 2008 Social psychology of seat belt use: A comparison of theory of planned behavior and health belief model. *Transportation Research Part F: Traffic Psychology and Behaviour* **11** (3), 181–191. doi:10.1016/j.trf.2007.10.001.

Stretcher, V. & Rosenstock, I. M. 1997 The health belief model. In: *Health Behavior and Health Education: Theory, Research and Practice* (Glanz, K., Lewis, F. M. & Rimer, B. K., (Eds.)). San Francisco: Jossey-Bass.

Tajeri Moghadam, M., Raheli, H., Zarifian, S. & Yazdanpanah, M. 2020 The power of the health belief model (HBM) to predict water demand management: a case study of farmers' water conservation in Iran. *Journal of Environmental Management* **263**, 110388. doi:10.1016/j.jenvman.2020.110388.

Tajri Moghaddam, M., Raheli, H., Zarifian, S. & Yazdanpanah, M. 2019 Discovering barriers to agricultural water conservation behavior and related factors using data theory (Case study of Neishabour Plain, Khorasan Razavi Province). *Iranian Agricultural Economics and Development Research* **2** (2), 287–308. doi:10.22059/IJAEDR.2020.296345.668873.

Tarkang, E. E. & Zotor, F. B. 2015 Application of the health belief model (HBM) in HIV prevention: A literature review. *Central African Journal of Public Health* **1** (1), 1–8. doi:10.11648/j.cajph.20150101.11.

Tashiro, A. 2022 Assessing green management in health belief model: An analysis of a post-disaster rural context. *Journal of Environmental Management* **302**, 114025. doi:10.1016/j.jenvman.2021.114025.

Tengecha, N. A., Alimo, P. K., Agyeman, S., Akintunde, T. Y., Lartey-Young, G. & Zhang, X. 2022 Schoolchildren's inland water transport adoption barriers in Tanzania: Health belief model application. *Journal of Transport Geography* **104**, 103444. doi:10.1016/j.jtrangeo.2022.103444.

Teshome, D. F., Balcha, S. A., Ayele, T. A., Atnafu, A. & Gelaye, K. A. 2021 Development and psychometric validation of the hypertension beliefs assessment tool among adult population in northwest Ethiopia. *Patient Preference and Adherence* **15**, 2659–2671. doi:10.2147/PPA.S335070.

van Winsen, F., de Mey, Y., Lauwers, L., Van Passel, S., Vancauteren, M. & Wauters, E. 2016 Determinants of risk behaviour: Effects of perceived risks and risk attitude on farmer's adoption of risk management strategies. *Journal of Risk Research* **19** (1), 56–78. doi:10.1080/13669877.2014.940597.

Vasilaky, K., Harou, A., Alfredo, K. & Kapur, I. 2023 What works for water conservation? Evidence from a field experiment in India. *Journal of Environmental Economics and Management* **119**, 102802. doi:10.1016/j.jeem.2023.102802.

Vermandere, H., van Stam, M. A., Naanyu, V., Michielsen, K., Degomme, O. & Oort, F. 2016 Uptake of the human papillomavirus vaccine in Kenya: Testing the health belief model through pathway modeling on cohort data. *Globalization and Health* **12** (1), 1–13. doi:10.1186/s12992-016-0211-7.

Walter, S., Boden, B., Günter, K., Paul, B., Lukas, F. & Lea, H. 2022 Analyze the relationship among information technology, precision agriculture, and sustainability. *Journal of Commercial Biotechnology* **27** (3), 158–171.

Wang, R. Y. & Liu, X. 2021 How trust and risk perception affect household water use. In: *Oxford Research Encyclopedia of Global Public Health*. doi:10.1093/acrefore/9780190632366.013.164.

Win, T. T. Z., Campbell, A., Soares Magalhaes, R. J., Oo, K. N. & Henning, J. 2021 What drives small-scale farmers to vaccinate their multiple livestock species animals against common infectious diseases in Myanmar? *PLoS ONE* **16** (10). doi:10.1371/journal.pone.0258765.

Witte, K. 1992 Putting the fear back into fear appeals: The extended parallel process model. *Communication Monographs* **59**, 329–349. doi:10.1080/ 03637759209376276.

Woldesenbet, T. A., Elagib, N. A., Ribbe, L. & Heinrich, J. 2017 Hydrological responses to land use/cover changes in the source region of the Upper Blue Nile Basin, Ethiopia. *Science of the Total Environment* **575**, 724–741.

Yang, W., Zhang, X. & Yang, X. 2022 Analysis of health informatics and bioinformatics connectivity modeling. *Journal of Commercial Biotechnology* **27** (3), 54–66.

Yazdanpanah, M. & Mardasi, G. 2017 Predicting the use of helmets among motorcycle farmers using psychological models in Shushtar city. *Rural Research* **8** (4), 675–688.

Yazdanpanah, M., Hayati, D., Hochrainer-Stigler, S. & Zamani, G. H. 2014 Understanding farmers' intention and behavior regarding water conservation in the Middle-East and North Africa: A case study in Iran. *Journal of Environmental Management* **135**, 63–72. doi:10.1016/j.jenvman.2014.01.016.

Yazdanpanah, M., RahimiFeyzabad, F., Forouzani, M., Mohammadzadeh, S. & Burton, R. 2015 Predicting farmers' water conservation goals and behavior in Iran: A test of social cognitive theory. *Land Use Policy* **47**, 401–407.

Yazdanpanah, M., Komendantova, N. & Zobeidi, T. 2022 Explaining intention to apply renewable energy in agriculture: the case of broiler farms in Southwest Iran. *International Journal of Green Energy* **19** (8), 836–846. doi:10.1080/15435075.2021.1966792.

Zetu, L., Zetu, I., Dogaru, C. B., Duta, C. & Dumitrescu, A. L. 2014 Gender variations in the psychological factors as defined by the extended health belief model of oral hygiene behaviors. *Procedia – Social and Behavioral Sciences* **127** (22), 358–362. doi:10.1016/j.sbspro.2014.03.271.

Zobeidi, T., Yazdanpanah, M., Komendantova, N., Sieber, S. & Löhr, K. 2021 Factors affecting smallholder farmers' technical and non-technical adaptation responses to drought in Iran. *Journal of Environmental Management* **298**. doi:10.1016/j.jenvman.2021.113552.

Zuo, D., Chen, G., Wang, G., Xu, Z., Han, Y., Peng, B., Abbaspour, K. C. & Yang, H. 2023 Assessment of changes in water conservation capacity under land degradation neutrality effects in a typical watershed of Yellow River Basin, China. *Ecological Indicators* **148**, 110145. doi:10.1016/j.ecolind.2023.110145.

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