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Explaining pro-environmental behavior of farmers: A case of rural Iran

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Abstract
The effects of population growth in the world have prompted farmers to excessively use agricultural land to produce the required food. Hence, human activities have been endangering and destroying the environment. Accordingly, the present study was designed based on identifying and introducing the determinants of the application of pro-environmental behaviors among Iranian farmers. The present study was conducted using a questionnaire survey with structural equation modeling and technology acceptance model as the theoretical framework elements of the research. The study population consisted of all wheat farmers living in Khuzestan province (southwest of Iran). The results revealed that about 59.8% of the variance of the farmers' pro-environmental behavior was estimated using the technology acceptance model. The results of structural equation modeling also revealed that variables of attitude and intention, perceived ease of use, and perceived usefulness had significant effects on farmers' pro-environmental behaviors. In general, the results of the present study can be considered as scientific and logical evidence for utilizing the technology acceptance model in applying pro-environmental behaviors. In addition, the results of this study can help national and local policymakers as well as decision -makers to encourage farmers toward using pro-environmental behaviors.

Keywords Ecological behavior · pro-environmental behavior · Sustainable development · Sustainable ecosystem · Technology acceptance model

Introduction

At the moment, food demand for the world's growing population has increased. Despite the global restrictions on water extractions and arable land quality, the indiscriminate use of chemicals to produce sufficient food for meeting the needs of the growing population has increased in developing countries (Bagheri et al., 2021). Producing agricultural products depends on a set of agricultural activities, especially the use of pesticides and chemical fertilizers. These activities increase production through excessive pressure on the land. Meanwhile, this pressure causes water and soil pollution, high depreciation on agricultural land, and quality reduction in soil structure, which consequently will be a threat to food security in the future (Yuan et al., 2020). The application of chemical fertilizers has increased significantly from the last two decades, such that the demand and consumption of chemical fertilizers from 2008 to 2018 rose from 161 million tons to more than 200 million tons (FAO, 2018). In recent years, the consumption of chemical compounds in Iran has been significantly higher than the global average. According to available data, it has been stated that chemical pesticides used in Iranian agricultural farms in 2013 were about 760 g.ha -1, which is five times higher than the global standard (Borkhani & Mohammadi, 2019). According to available information, Iran ranked 53 out of 153 countries in 2006, 105 out of 180 countries in 2016, and 80 out of 180 countries in 2018 regarding the rankings released on chemical consumptions based on 22 environmental factors, such as water resources, air pollution, biodiversity, climate change, and numerous other factors. Therefore, it was concluded that Iran was placed in an unfavorable position in terms of environmental protection (FAO, 2018); the rate of desertification for high -quality lands of Iran was estimated equal to 1.5 million hectares per year.

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Furthermore, more than 7 million hectares of Iran's forests have been destroyed based on human activities over the last 57 years (Savari et al., 2020a, 2020b), which indicates the damage to the environment caused by agricultural sectors and intensive agriculture activities (Husk et al., 2017).

Thus, the contamination induced by these activities has been considered as one of the most critical environmental challenges (Macgregor & Warren, 2006; Kanter, 2018) as such the present era has been called the era of environmental crises. This is because the improper use of natural resources and the lack of self -efficacy in the protection of natural resources have caused irreparable damage to the environment (Mason & Triplett, 2016).

No one can claim that the emergence of pollutants on earth is independent of human activity (Farani et al., 2019). Human exploitation of natural resources has always been one -way and unregulated, and any exploitation of these resources has been based only on short -term benefits and without considering its conservation aspects (Savari & Gharechaee, 2020). Mistakes in human thoughts, attitudes, and behaviors as a result of activities on the planet are one of the main causes of environmental damages (Hirsh, 2014). Indeed, it can be argued that the application of some new technologies in several agricultural sectors, despite the increasing agriculture productions, has been endangering environmental sustainability over the past century (Neo et al., 2017; Knowler & Bradshaw, 2007; Telles et al., 2019; Savari & Shokati Amghani, 2020). Accordingly, increasing global pressures on agricultural sectors toward enhancing agriculture productions and peoples' livelihood resulted in growing environmental concerns by applying new advanced technologies (Hynes & Wilson, 2016).

The loss of biodiversity, reduction of water resources and reserves, destruction of pastures and forest trees, and excessive use of chemical pesticides have been identified as the most dangerous rural agriculture -induced environmental problems (Shafiei & Maleksaeidi, 2020; Rezaei et al., 2020; Dornhoff et al., 2019; Thondhlana & Hlatshwayo, 2018; Maleksaeidi & Keshavarz, 2019). Meanwhile, different challenges of soil erosion, land -use change, and urban wastewater have been considered as the most well -known problems of urban agriculture (Akintunde, 2017; Bleys et al., 2017: Khanpae et al., 2020). It was reported that contamination and environmental degradations are the most important life -threatening factors which could reduce adequate and safe food production capacity for the world's growing population (Kien, 2015).

Long -term survival of human society requires the adoption of environmentally friendly individual and collective behaviors (Steg et al., 2014). Sustainability in an agricultural system is achieved when farmers' activities are in line with environmental conservation as sustainability depends on the choices and behaviors of farmers (Savari & Zhoolideh, 2021). Researchers believe that many environmental problems are caused, partially or completely, by human behavior, and changing this behavior is usually the most fundamental approach to solving environmental problems (Sopha et al., 2011).

In this regard, humans' destructive and irresponsible behaviors toward the environment resulted in many environmental problems in the past decades (Vicente-Molina et al., 2013). Therefore, recognizing and changing people's behaviors has been regarded as the most well -known requirement and precondition of sustainable environmental management programs and sustainable development goals (Janmaimool & Denpaiboon, 2016; Eskandari-Damaneh et al., 2020; Ghorbani et al., 2021). Understanding people's attitudes, understanding ideas on natural resource management, and their desire for protecting the environment plus natural resources are essential issues to solving environmental crises (Savari & Shokati Amghani, 2020; Akter et al., 2018). Some researchers and policymakers believe that farmers can overcome environmental problems and improve them by applying environmentally friendly behaviors (Dornhoff et al., 2019; Thondhlana & Hlatshwayo, 2018; Akintunde, 2017; Bleys et al., 2017).

As mentioned in the introduction, Iran does not have a good position in the world in terms of environmental conservation indicators. Most environmental degradation by farmers is due to their close relationship with the natural environment. In this regard, this study was conducted with the general purpose of examining the factors affecting environmental conservation behavior in southwestern Iran. In this regard, examining the use of environmental conservation behavior and the application of TAM model in predicting farmers' behavior in environmental conservation were done.

Literature Review

The definition of environmentalist discourse was a priority in the 1960s and 1970s, and the importance of the concept of sustainable development in the 1980s and 1990s is a sign of this priority (Fransson & Gärling, 1999). Concerns about human -environmental behaviors have led attitudes and behaviors to become a major topic in environmental psychology and sociology studies (Cottrell, 2003). The two approaches of humanism and environmentalism, which both express a positive tendency to preserve the environment, were proposed. The difference between these two attitudes is in the arguments they cite for the conservation of the environment (Mason & Triplett, 2016). In the human -centered attitude, less effort is made to preserve the environment, but people with an environmentalist attitude protect the environment and are even willing to pay for it (Fransson & Gärling, 1999). Introductory studies were initiated to measure environmental hazards, public concerns about their consequences, and pro-environmental behaviors impacts on people's lives since the mid -1960s (Li et al., 2019). Then, the factors affecting the acceptance of pro-environmental and environmentally friendly behaviors were investigated among farmers following increasing popularity of the mentioned behaviors' studies (Casaló & Escario, 2018; Khanpae et al., 2020).

Pro-environmental behaviors include behaviors in which altering the access to elements and energy leads to no changes in the ecosystem structure and its dynamics, reduced environmental problems, and increased benefits (Steg & Vlek, 2009). Pro-environmental behavior has also been defined as individuals' conscious actions toward minimizing the adverse impacts of humans on the environment (Tang et al., 2017). Farmers' pro-environmental behaviors include a wide range of environmentally friendly behaviors, such as application of new advanced irrigation technologies, conservation agriculture, biological inputs, cover crops, protection of pastures and forests neighboring agricultural lands, and reduction of chemical consumption (Veisi, 2012; Kabir et al., 2017; Rezaei et al., 2018; Rezaei et al., 2020; Bagheri et al., 2021; Savari et al., 2013; Savari et al., 2020a).

Thus, foremost, the factors affecting farmers' pro-environmental behaviors should be examined to achieve the previous goals (Milfont & Schultz, 2016; Steg & De Groot, 2010). Meanwhile, with the limitations of a systematic and comprehensive study on the mentioned factors, understanding and developing these behaviors requires a codified theoretical framework (Savari & Gharechaee, 2020). Thus, some researchers have proposed various theories and models to deeply detect abnormal human behaviors in the environment and to solve this problem (Abdul Rashid & Mohammad, 2012). Numerous models and theories, such as the Theory of Planned Behavior (TPB) (Ajzen, 1991), Norm Activation Model (NAM) (Schwartz, 1977), and value -belief -norm (VBN) (Stern et al., 1999), have been investigated in different studies. On the other hand, the latest and most developed model is the Technology Acceptance Model (TAM), which emphasizes the positive features of both theories of TPB and theory of reasoned action (TRA) (Davis, 1989; Davis et al., 1989). The TRA was proposed by Fishbein and Ajzen in 1975. The TRA was one of the first theories to justify the use of computers and the acceptance of a new technology (Fishbein & Ajzen, 1975a, 1975b). Based on TRA theory, the tendency of a behavior is determined based on the attitude and mental norms of a person about that behavior (Davis, 1989; Davis et al., 1989). Attitudes arise from person's deep beliefs, results in behavior and the evaluation of the results (Savari & Gharechaee, 2020) the individual's mental norms are also formed from mental beliefs to the perceived expectations of a reference group (Kabir et al., 2017). Motivation and intention are also formed based on beliefs and expectations (Fishbein & Ajzen, 1975a, 1975b). In general, based on this theory, these beliefs ultimately shape attitudes, intentions, and the performance of a particular behavior (Greaves et al., 2013). But TBP was first developed by Ajzen in 1991 and has been used as an important socio -psychological theory in the study of behavioral tendencies in various contexts (Gao et al., 2017). The TPB was reasonably derived from the TRA and perceived behavioral control variable was added to it to improve the predictive power of the model (Savari & Gharechaee, 2020). TPB declares that attitude, mental norms, and perceived behavioral control together shape an individual's intentions and behaviors (Fishbein & Ajzen, 1975a, 1975b). TRA and TPB are the two basic theories of social psychology that led to the creation of TAM (Silva et al., 2017). The main reason that TAM is better than other models, in addition to its greater generality than other models in technology acceptance, is the existence of important psychological variables in determining behavior in this theory (Jimenez et al., 2021) and provides a framework for the effect of external variables affecting the acceptance of a new behavior (Castiblanco Jimenez et al., 2021). Contrary to the two theories of TPB and TRA, TAM does not include a mental norm, since its psychometric status is uncertain and the effect of attitude decreases over time as people's attitude towards technology becomes habitual over time (Ghorbannezhad et al., 2019). Both theories of TRA and TPB are general patterns of behavior underlying TAM for explaining and adopting different innovations among individuals and organizations (Ducey & Coovert, 2016). According to TRA theory, a person's performance in a particular behavior is determined by that person's behavioral decision to engage in that activity (Venkatesh & Davis, 2000). TPB theory implies that a person's behavioral intention to perform different behaviors can be predicted by the individual's attitude toward that behavior, mental norms, and perceived behavioral control (Alambaigi & Ahangari, 2016). TAM has been created as a compact, predictive, and powerful model for explaining and predicting behavior in decision -making as well as acceptance of using a particular technology (Silva et al., 2017). In general, several researchers have focused on explaining and predicting people's behaviors in accepting new technologies using TAM as one of the most popular theories (Silva et al., 2017; Bagheri et al., 2021). Further, it has also been applied for various purposes in the field of rural extension and development. For example, in a study entitled "Factors affecting farmers' pro-environmental behaviors in Iran using the TAM development model", it was shown that adding the variables of social influence, result demonstrability, compatibility, and self -efficacy to the original model could significantly increase the explanatory power of the model (Rezaei et al., 2020). In a study entitled "Use of biologic inputs among cereal farmers: application of technology acceptance model", the findings showed that TAM could explain 52% of farmers' behavior (Bagheri et al., 2021). In another study on the adoption of renewable energy technologies among farmers using the TAM model, the results revealed that attitude and PU were the most important variables in this field (Ghorbannezhad et al., 2019). Research findings on the factors affecting the application of biological control among farmers using the developed TAM model by adding the variables of self -efficacy, facilitating conditions, and Compatibility, showed that only the effect of PU in this field was not significant; however, other relationships became significant and the developed model was able to predict a significant amount (82%) of farmers' behavior (Sharifzadeh et al., 2017). In a research on factors affecting the acceptance of technology in agriculture in the Netherlands, the results showed that the use of TAM model in this field was very beneficial and could explain a significant part of the variance. In this research, it was found that attitude was the most important factor. In addition, this research found that individual characteristics of farmers such as age and education had a significant effect on technology acceptance (Gebrezgabher et al., 2015).

Technology Acceptance Model (TAM)

Over the last few decades, some researchers have developed various models for understanding the characteristics of users' acceptance of new technologies. However, it has been reported that TAM is recognized as the most important and fundamental model for technology acceptance (Rho et al., 2014; Kamal et al., 2020). It has also been used as the most common model in the fields of sociology, psychology, and agriculture (Cacciamani et al., 2018; Gokcearslan, 2017; Ifenthaler & Schweinbenz, 2016; Kim & Jang, 2015; Sharifzadeh et al., 2017; Bagheri et al., 2021; Rezaei et al., 2020). The principal objectives of TAM are known for predicting factors affecting users' acceptance of new technologies and for identifying the problems of new technologies among different individuals (Nikou & Economides, 2018; Sung et al., 2019). In addition, providing a comprehensive explanation about factors affecting technology acceptance has been introduced as another purpose of the use of TAM (Kamal et al., 2020). TAM was first proposed, designed, and empirically tested by Davis (1986) to explain the acceptance of technology on users and is established (Davis, 1989; Davis et al., 1989). Based on this model, it is assumed that people's behavior tendencies to innovate directly determine the use of an innovation or new activity (Zheng & Li, 2020; Clarke & Abbott, 2016; Dündar & Akçayır, 2014; Ferguson, 2017; Aggelidis & Chatzoglou, 2009).

Davis et al. (1989) introduced the constructs of perceived usefulness (PU) and perceived ease of use (PEOU) in the original TAM. Also, some researchers believed that these constructs are effective on accepting technology, creating an attitude in using technology, intention to use technology, and eventually determining the level of actual system use (Kamal et al., 2020; Bagheri et al., 2021; Rezaei et al., 2020; Sharifzadeh et al., 2017).

Perceived Usefulness (PU) refers to the degree to which people believe that using a particular system would enhance their job performance (Lai, 2018). Individuals' beliefs on technology performances have been recognized as the first factor determining the positive or negative tendencies of people to using technologies. In other words, people shift to use technologies that improve their job (Flett et al., 2004; Bagheri et al., 2021).

Perceived Ease of Use (PEOU) refers to the degree to which peoples believe that using a particular system would be free from effort (Liu et al., 2010; Nikou & Economides, 2018). The second factor in the acceptance of the technology is the ease of use (Ease of Use factor. It may be assumed that applying new technology is equally useful and overwhelming for people of an area who use it (Bagheri et al., 2021; Rezaei et al., 2020). It means that the ease of use of new technology is essential for people (Davis, 1989; Davis et al., 1989). Davis argues that PEOU has unilateral impacts on PU. Thus, cognitive judgment about the perceived usefulness of a technology depends on the perceived ease to use of technology (Venkatesh & Davis, 2000). Hence, farmers' perceived ease of use in ecological technologies leads to increases in perceived benefits in utilizing that technology and subsequently enhances the feasibility of using pro-environmental behaviors. The easier it is for people to use technology, the more they understand how useful technology is to a person (Kamal et al., 2020; Bagheri et al., 2021). PEOU is a mental possibility formed about the ease of use of a technology. By observing a person's new technology and behavior, PEOU first makes a subjective assessment of how much a person is trying to learn, and the less mentally they try to learn, the more PU will affect a person (Davis, 1989; Davis et al., 1989). For instance, researchers found that farmers who believed that using renewable energy is easy for them, their PU was more affected (Ghorbannezhad et al., 2019). Thus, according to TAM theory, the first research hypothesis is formed as follows.

H1. PEOU has positive and significant effects on PU in terms of using pro-environmental behaviors.

Attitude Attitude reflects the positive and negative tendencies of people to the occurrence of new behaviors. In other words, an attitude is positive and/or negative assessments to people and their ideas/ activities. The more positive a person's attitude is toward behavior norms, the stronger that person will intend to perform the considered behavior (Zhang et al., 2014; Savari & Gharechaee, 2020). According to the words of Fishbein and Ajzen (1975a, 1975b), attitude towards behavior acts as a mediator between both PEOU and PU variables with the intention variable (Davis, 1989; Davis et al., 1989).

Indeed, PEOU and PU variables have been considered as the determinants of an attitude (Cheung & Vogel, 2013; Ducey & Coovert, 2016; Rezaei et al., 2020). Attitudes towards the application of technology are directly influenced by PEOU and PU (Ducey & Coovert, 2016). The attitude will be favorable when farmers have a good understanding of the usefulness and ease of learning a technology (Rezaei et al., 2020). If the use of a technology is very complex for farmers and they believe that the use of technology will not affect their performance, they will certainly not find a positive attitude towards its use (Verma & Sinha, 2018; Rezaei et al., 2020; Webb et al., 2013; Hori et al., 2013; Wang et al., 2016). Farmers' attitudes towards a technology are always influenced by their evaluation (PEOU and PU) towards the technology (Wang et al., 2016). In a research about using ecological inputs by farmers, it was concluded that the attitude of farmers who have PEOU and PU of ecological inputs are more affected towards the use of these inputs (Bagheri et al., 2021). In another study, they also showed that favorable attitude of farmers towards the safe use of chemical fertilizers had a significant relationship with their desire about not using the chemical fertilizers in their farms (Savari & Gharechaee, 2020). Thus, according to the presented materials, the research hypothesis will be presented as follows (Fig. 1):

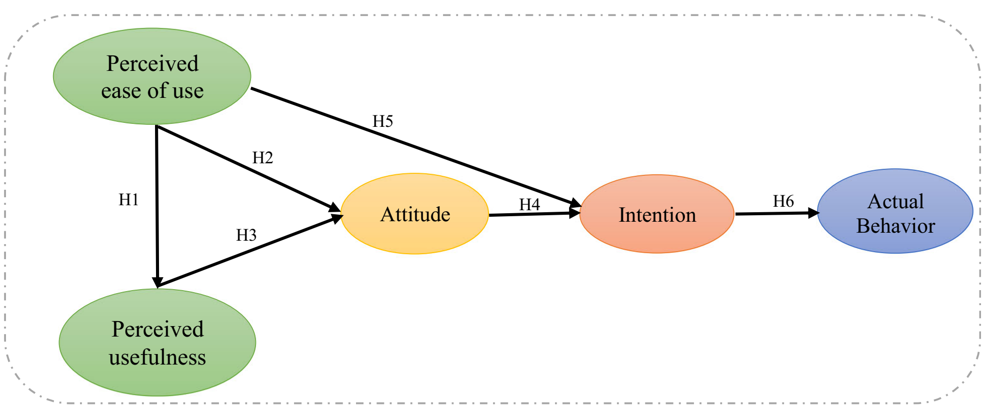
H2. PEOU has positive and significant effects on farmers' attitudes toward using pro-environmental behaviors.
H3. PU has positive and significant effects on farmers' attitudes toward using pro-environmental behaviors.
H4. The farmers' attitudes have positive and significant effects on their intention toward using pro-environmental behaviors.

Intention The intention is a mental motivation that represents a conscious tendency to carrying out an action in the future (Ajzen, 1991). The theory of Fishbein and Ajzen (1975a, 1975b) explains that two major factors determine behavioral intentions where subjective norms, the most important influencing variables, directly describe the actual behavior. On the other hand, the TRA theory restates that PEOU determines farmers' tendencies to use new technologies (Davis et al., 1989; Venkatesh & Davis, 2000; Flett et al., 2004; Bagheri et al., 2021). In other words, farmers use technology when they believe technology is easy to use and has many advantages. The TRA theory posits that attitude directly influences behavioral intentions. Behavioral intentions derive from attitudes towards the application of technology and lead to actual behavior (Venkatesh, 2000). Attitude is regarded as the most decisive variable affecting intention (Hori et al., 2013; Wang et al., 2016) and is the primary key to behavior as well as understanding human desires (Ducey & Coovert, 2016). The farmers' more positive attitudes toward ecological conservation make conservation a feasible action. Further, such positive attitudes make farmers more likely to develop more sustainable intentions (Davis et al., 1989). For example, in a research about using organic fertilizers in rice cultivation in Malaysia, it was resulted that there was a significant relationship between the ease of using organic fertilizers and their willingness to use these fertilizers (Adnan et al., 2020). Another study also showed that farmers who had a good PEOU for using organic fertilizers had an impact on their willingness to do so (Adnan et al., 2019). Hence, the research hypothesis is as follows:

H5. PEOU has positive and significant effects on farmers' intention towards using pro-environmental behaviors.

Actual behavior is the result of all previous constructs. The technology acceptance model (TAM) states that actual behavior is a direct function of behavior intentions (Venkatesh, 2000). Inner tendencies are a determining factor in the individual's behavior, where the perceptions and beliefs associated with a behavior also directly influence the acceptance and rejection of that behavior (Hsu & Lin, 2008). For example, in a research about using water conservation technologies it was shown that farmers who were more inclined to use

Fig. 1 Conceptual framework (Davis et al., 1989; Venkatesh & Davis, 2000)



conservation technology used more water conservation behaviors (Savari et al., 2021). Thus, according to the presented materials, the research hypothesis will be presented as follows:

H6. Farmers' intentions have positive and significant effects on using pro-environmental behaviors.

Methodology

Study Design

The present study was a combination of quantitative, applied research (according to the purpose), descriptive correlation (in terms of data collection), and cross -sectional studies (at a single point in time). In order to calculate the mean rank of adopting pro-environmental behaviors, Friedman test was used to prioritize them because by calculating the mean rank, the level of agreement of groups could be illustrated (Chatfield & Mander, 2009). Friedman test usually has two main uses which include ranking agents and comparing the mean rank of different groups (Kalantari, 2003). In this study, its first use, namely, adopting pro-environmental behaviors was used. Furthermore, in this study, the ISDM[1] index was applied to classify farmers' pro-environmental behaviors (Gangadharappa et al., 2007):

$$Low : A < Mean - \frac{1}{2}\, Sd \tag{1}$$

$$Medium : Mean - \frac{1}{2}\, Sd < B < Mean + \frac{1}{2}\, Sd \tag{2}$$

$$High : C > Mean + \frac{1}{2}\, Sd \tag{3}$$

The ISDM is known as the index of means and standard division and is applied to classify a specific topic (Savari & Shokati Amghani, 2020). The ISDM determines the level of each index or component in the studied groups, such as the use of pro-environmental behaviors, based on the distance of the mentioned index from the mean and standard deviation of the same index across the entire statistical population (Shiri et al., 2014).

Study Area

Khuzestan province, located in the southwest of Iran (Fig. 2), has been ranked first in wheat production in Iran over the last ten years. Nowadays, the greatest problem in agriculture and related activities is the availability of different chemical fertilizers. Note that the increase in wheat production of the mentioned province has been produced by the excessive use of chemical fertilizers in the past ten years (Agriculture Organization of Khuzestan, 2017). The application of chemical fertilizers in Khuzestan province had increased equal to 56% over the past 20 years. Meanwhile, nitrogen, phosphate, and potassium chemical fertilizers with an average of 69, 24, and 7%, respectively, had the highest fertilizer consumption of all fertilizers used in this province (Agriculture Organization of Khuzestan, 2017). It is annually estimated that agricultural lands of Khuzestan province, known as one of the agriculture hubs of Iran, have been faced with soil erosion and have been taken out of the production cycle. In addition, the excessive use of agricultural lands has resulted in the occurrence of numerous problems of increasing dust and desertification. In recent years, it has been observed that Khuzestan province is known as the main center of dust incurring heavy expenses (Savari & Gharechaee, 2020).

Statistical Population and Sampling Method

The statistical population of the study included all wheat farmers in the study area (Fig. 2). The Krejcie and Morgan Table provides a simple way to calculate the sample size when a given population size is evident. This table is one of the most commonly used methods for calculating statistical sample size, usually applicable in cases with a large population size or undetermined population variance or error percentage (Field, 2013). Hence, considering the large size of the study population and indeterminacy of variance, this study used this table for sample size determination. The stratified multistage sampling method was performed with proportional allocation for this study. At first, the agricultural hubs of five geographical regions such as Ahvaz (center), Shushtar (north), Abadan (south), Ramhormoz (east), and Hoveyzeh (west) were selected for the study. Next, the total sample size was assigned to each city according to the cities' population. In this stage, the study determined the sample size in different counties by comparing farmer populations in those counties and selected larger sample sizes in more densely populated cities. Then, two districts from each city, two rural districts from each district, and two villages from each rural district were selected for the investigation so that a total of 40 villages were selected for the present study (eight villages for each city). At this stage, farmers were divided into two parts. The first part included those people who were able to read and understand the questionnaire themselves, while the second part included those who could not read or write. The items of the questionnaire were explained to them through interviews (in local language), and based on their answers, the questionnaires were filled.

Measurements Instrument

The research tool consisted of a two -part questionnaire, where information related to farmers and their farms was entered in

[1] Integrated science data management

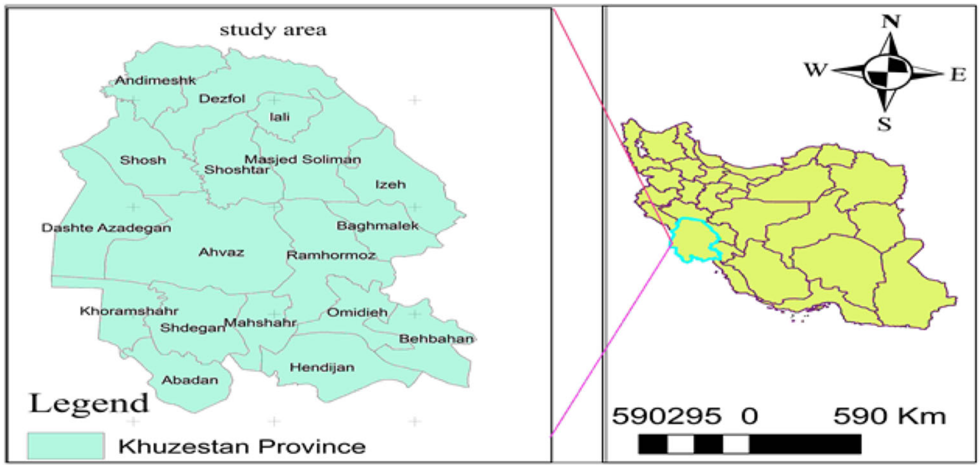


Fig. 2 The study area

the first part. This section included variables concerning age, education level, household size, farming work experience, income, the area of cultivated land, yield, number of cultivated land pieces, knowledge about the standard dose of chemical fertilizers, and participation in related training courses. According to Table 1, the second section of the questionnaire consisted of 26 items with five points of measuring the PEOU (four items), PU (four items), Attitude (five items), Intention (five items), and pro-environmental behaviors (eight items). Farmers' statements were evaluated based on a five -point Likert scale (strongly disagree to strongly agree) following completing the questionnaires. Note that the previous studies were applied to measure the variables of the TAM model in this study.

Operational Definition of Dependent Variable

The dependent variable of this research was adopting pro-environmental behaviors. Eight main behaviors were identified in the literature to measure this variable among farmers (Table 1). A questionnaire was designed based on Likert scale (1 -very low to 5 -very high) which included these behaviors and then, were provided to farmers. Based on their response, the amount of adopting pro0environmental behaviors was determined.

Validity and Reliability

In order to evaluate the indicators examined in the present study, the questionnaire tool was reviewed and modified by an expert staff, including professors of agricultural extension and education, environment, psychology, social sciences, and agricultural sciences before embarking on the interview stage with farmers. In addition, the reliability of the research instrument was evaluated using Cronbach's alpha coefficients and Composite Reliability. The results revealed that farmers' statements had acceptable reliability. The following statistics were obtained for different items: Actual Behavior (AVE = 0.657, CR = 0.922, Cronbach's alpha = 0.866), Perceived Usefulness (AVE = 0.545, CR = 0.802, Cronbach's alpha = 0.741), Perceived Ease of Use (AVE = 0.755, CR = 0.944, Cronbach's alpha = 0.870), Attitude (AVE = 0.652, CR = 0.907, Cronbach's alpha = 0.833) and Intention (AVE = 0.711, CR = 0.911, Cronbach's alpha = 0.844). Thus, the results indicated that the values obtained exceeded the suggested values (AVE ≥ 0.5, CR ≥ 0.6, Cronbach's alpha≥0.7). Hence, the selected items for measuring the variables displayed sufficient accuracy.

Data Analysis

In this research, in order to analyze data in two sections of descriptive and inferential statistics, SPSS and Smart -PLS software were used. Data analysis was performed in two steps. In the first step, the relationship between demographic and adopting pro-environmental behaviors variables was examined. According to the nature of the data, the correlation coefficient tests (Pearson and Spearman), and mean comparison (Mann -Whitney and Kruskal -Wallis) were used. In the next step, structural equation modelling was used to investigate the effect of TAM (Fig. 1) variables on adopting pro-environmental behaviors.

Results

Descriptive Statistics

The average age, agricultural activities, and the number of household members of the participants in the present study were estimated as 49.44, 4.32, and 35.39, respectively, based on the study of personal (identity card) and farm characteristics of farmers. On the other hand, the results indicated that more than one -third of the participants (equivalent to 31.18%)

Table 1 Research measurement concepts and variables

Construct	Measurement items	Sources
Actual behavior	Applying livestock and organic fertilizers in the farm	Veisi, 2012; Kabir et al., 2017; Rezaei et al., 2020; Bagheri et al., 2021
	Applying of minimum tillage to reduce soil erosion	
	Reducing the use of chemical fertilizers and pesticides	
	Applying new irrigation technologies to prevent water losses	
	Biological control methods of plant pests and diseases	
	Preserving crop residues on the soil and not burning them	
	Planting cover crops in the field	
	Conserving pastures and forests around agricultural lands	
Perceived usefulness	Applying pro-environmental behaviors reduces and facilitates farmers' tasks	Davis et al., 1989; Venkatesh & Davis, 2000; Rezaei et al., 2020; Bagheri et al., 2021
	Applying pro-environmental behaviors increases farm soil fertility	
	Applying pro-environmental behaviors enhances the products' quality and safety	
	Applying pro-environmental behaviors on the farm is an economical approach due to reducing production costs	
Perceived ease of use	Applying pro-environmental behaviors is very easy	Davis et al., 1989; Venkatesh & Davis, 2000; Rezaei et al., 2020; Bagheri et al., 2021
	Pro-environmental behaviors can be easily applied technically	
	Applying pro-environmental behaviors on the farm is clear and understandable for me	
	Learning pro-environmental behaviors is very easy for me	
Attitude	Applying pro-environmental behaviors is a wise thing at all stages of agricultural production	Davis et al., 1989; Venkatesh & Davis, 2000; Ajzen, 1991; Savari & Gharechaee, 2020
	Applying pro-environmental behaviors is a wise thing on the farm toward maintaining community health	
	Applying pro-environmental behaviors is necessary for soil fertility and productivity	
	Applying pro-environmental behaviors is a beneficial strategy for water quality and soil health	
	Environmental protection must be considered in all agricultural practices and operations	
Intention	I like to apply pro-environmental behaviors on my farm	Davis et al., 1989; Venkatesh & Davis, 2000; Ajzen, 1991; Savari & Gharechaee, 2020
	I would like to apply pro-environmental behaviors on my farm to reduce/prevent human diseases	
	I would like to apply pro-environmental behaviors on my farm for the health of manufactured products	
	I would like to apply pro-environmental behaviors on my farm to reduce production costs	
	I would apply biological inputs in agricultural processes and farms even if production will decrease	

were illiterate, about a quarter (24.19%) had primary education, and only a small percentage of them had university educations and graduate degrees (2.01%). In addition, the findings related to household incomes showed that the average monthly income of participants was equal to 36.66 dollars. Also, the average land area under wheat cultivation, average yield, and average share of smallholder lands were recorded equal to 4.46 ha, 2.32 $kg.ha^{-1}$, and 3.43 ha. The results also indicated that a small percentage of farmers (16.09%) were sufficiently knowledgeable about the standards of chemical inputs required for wheat (Table 2).

Investigating the Use of Pro-environmental Behaviors among the Studied Farmers

In the present study, investigating farmers' use of pro-environmental behaviors was performed using the Friedman test (Table 3). The results determined that items of applying new irrigation technologies to prevent water losses and applying livestock and organic fertilizers in the field were recognized as the most used items by farmers, while items of planting cover crops in the farm and preserving crop residues on the soil and not burning those as the lowest items (Table 3).

Table 2 Demographic characteristics of wheat farmers

Variable	Category	Frequency	Percent	Mode
Age (year)	lower than 30	112	27.31	
	30 -50	221	53.90	*
	More than 50	77	18.79	
Education	Illiterate	128	31.20	*
	Elementary	99	24.14	
	Secondary	91	22.18	
	High school	84	20.47	
	College education	8	2.01	
Number of Household (person)	lower than 3	127	30.97	
	3 -4	217	52.92	*
	More than 4	66	16.11	
Monthly Income (dollars)	lower than 20	62	15.12	
	20 -40	268	65.36	*
	More than 40	80	19.52	
work experience (year)	lower than 20	127	30.97	
	20 -40	214	52.19	*
	More than 40	69	16.84	
under cultivation of wheat (Ha)	lower than 2	101	24.63	
	2 -4	217	52.92	*
	More than 4	92	22.45	
Presence in relevant training courses	Yes	66	16.09	
	No	344	83.91	*

Furthermore, TAM variables were also grouped using the ISDM index. The "low" category refers to the number of individuals below the population's average, the "medium" category determines the number of individuals in the average range of the population, and the "high" category involves those who are above the average of the population. The results of TAM variables among the individuals in the study represented that most subjects were in low and medium categories, and the share of the high category in all variables was less than 20% (Table 4).

Inferential Statistics

Investigating the Relationship between Farmers' Demographic Variables and Adopting Pro-environmental Behaviors

According to the data, the Spearman and Pearson correlations were used to investigate the relationships between demographic variables and dependent variable (adopting pro-environmental behaviors). The results showed that there

Table 3 Prioritizing the use of pro-environmental behaviors

Item	Mean	SD	Mean Rank
Applying new irrigation technologies to prevent water losses	3.55	0.601	4.35
Applying livestock and organic fertilizers in the farm	3.35	0.652	4.18
Applying of minimum tillage to reduce soil erosion	2.88	0.587	3.74
Conserving pastures and forests around agricultural lands	2.69	0.621	3.52
Biological control methods of plant pests and diseases	2.55	0.588	3.28
Reducing the use of chemical fertilizers and pesticides	2.55	0.655	3.27
Preserving crop residues on the soil and not burning them	2.22	0.624	3.10
Planting cover crops in the field	2.21	0.677	3.08

Friedman test value: 28.907 Sig: 0.001

Table 4 Investigate status of TAM variables

Variable	Mean	SD	ISDM category					
			Low		Medium		High	
			Frequency	Percent	Frequency	Percent	Frequency	Percent
Actual Behavior	2.75	0.626	133	32.43	201	49.02	76	18.55
Intention	2.96	0.687	132	32.19	231	56.34	47	11.47
Attitude	2.88	0.577	145	35.36	211	51.46	54	13.18
PEOU	2.35	0.702	184	44.87	185	45.12	41	10.01
PU	2.44	0.633	169	41.21	175	42.68	66	16.11

were significant relationships between adopting pro-environmental behaviors and variables such as education level (Spearman correlation: 0.251 Sig: 0.001), income (Pearson correlation: 0.345 Sig: 0.038), and knowledge about the use of chemical fertilizers (Spearman correlation: 0.325 Sig: 0.004). However, based on Pearson correlation, no significant relationship was observed between other demographic characteristics (age, household size, agricultural work experience, cultivation area, yield and number of plots of land) and adopting pro-environmental behaviors.

Furthermore, the study used the compare means Mann -Whitney and Kruskal–Wallis test to compare the participation in related training courses and farmers' areas of residence variables with their adoption of pro-environmental behaviors. It was found that participating in training courses and farmers' areas of residence would lead to a significant difference between the farmers in terms of adopting pro-environmental behaviors. The mean rank indicates that farmers who participated in training courses and lived in Shushtar had a higher tendency toward adopting pro-environmental behaviors (Table 5).

Assessment of the Measurement Model

Assessment of the measurement model with variable of PEOU, PU, attitude, intention, and actual behavior was performed in three stages of unidimensionality, validity reliability, and diagnostic validity (Tables 6 and 7).

Unidimensionality Use of unidimensionality is the first step to study the research measurement model. The optimal way to address unidimensionality is by delving into the scale constructing approaches. The most critical scale constructing approach is the general empirical approach in which the questions (items of the questionnaire) are selected following their contribution to the overall empirical validity based on a particular criterion. Based on this approach, if a test is to be made, the questions are selected to have a high consistency with the criterion (main construct), with minimum internal consistency (Simms, 2008). While this approach judges the questions based on statistical definitions, questions should be selected to determine and share a high degree of variance of a given construct. Researchers have stated that load factor values above 0.5 are acceptable (Gefen, 2003; Raykov, 2001). According to the standardized factor loading values ( ) in Table 7, it can be concluded that these values for selected markers had a value greater than 0.5 and were statistically significant at $P < 0.01$. Further, the above results can be sufficient evidence to confirm the unidimensionality of the studied markers. Hence, it can be stated that the markers examined in the present study have good accuracy and have been selected correctly for measuring research variables.

Reliability and Validity The second step to investigate the study's measurement model is to study the validity and reliability of research variables. Validity determines if the selected measurement instrument has the required specifications. Statistically, the AVE value of above 0.5 was seen fit for evaluating the research variables' validity (Khoshmaram et al., 2020). AVE represents the average variance shared between each structure with its own indices. In other words, AVE shows the correlation degree of a structure with its indices which the higher the correlation, the greater the fitness (Henseler & Sarstedt, 2013). On the other hand, reliability refers to the consistency of results in a given questionnaire distributed among a population at different times (Henseler & Sarstedt, 2013). Researchers regard a Cronbach's alpha value of higher than 0.7 and a combined reliability greater than 0.6 as acceptable (Hair et al., 2017). The results indicated that values of the combined reliability (CR) more than 0.60, Cronbach's alpha coefficient higher than 0.70, and average variance extracted (AVE) more than 0.50 were obtained for all variables of the proposed model; thus, it can be stated that all latent variables of the studied model had good reliability and validity (Table 6).

Diagnostic Validity The final and third step for investigating the measurement model is estimating the diagnostic validity of research constructs. Diagnostic validity is established when questions measuring a variable differ from or are

Table 5 Comparison between the rate pro-environmental behaviors and classified variables

Dependent variable	Independent variables	Category	Test	Test value	Mean rank	Sig
Adopting pro-environmental behaviors	Participation in related training courses	Yes	Mann -Whitney	-8.542	158.68	0.001
		No			134.45	
	farmers' area of residence	Ahvaz	Kruskal–Wallis	12.635	175.52	0.008
		Shushtar			185.45	
		Abadan			152.55	
		Romhormoz			159.84	
		Hoveyzeh			169.59	

distinguishable from the questions measuring the other two variables, fully correlating with and corroborating the theory (Hair et al., 2007). However, the construct's validity implies the degree to which the results obtained from applying the statistics are consistent with the theories on which the test was designed (Khoshmaram et al., 2020: Hair et al., 2017). Statistically, if AVE's value is greater than the consistency between the research variables, the variables have a suitable diagnostic validity (Fornell & Larcker, 1981). The results of Table 7 showed that the square root of AVE for the research variables (0.88 < AVE <0.98) was evaluated greater than the correlation between them (0.32 < r < 0.58). So, it can be argued that the proposed model confirmed by the diagnostic validity of the studied variables.

Assessing the Structural Model

In this section, different indicators reported in Table 8 were applied to assess the structural model fit. In general, according to the suggested and estimated values of the indicators presented in this study, it can be concluded that the model has a good fit.

Table 6 The results of fit of measurement models

Constructs	Measurement item		t	Reliability and validity statistics
Actual behavior	Beh1	0.531	4.946	AVE=0.657, CR=0.922, Cronbach's alpha=0.866
	Beh2	0.812	18.066	
	Beh3	0.718	11.607	
	Beh4	0.703	9.887	
	Beh5	0.603	7.075	
	Beh6	0.708	10.733	
	Beh7	0.820	15.820	
	Beh8	0.745	10.384	
Perceived usefulness	RU1	0.559	5.488	AVE=0.545, CR=0.802, Cronbach's alpha=0.741
	RU2	0.568	4.097	
	RU3	0.665	5.387	
	RU4	0.799	15.818	
Perceived ease of use	PEOU1	0.599	8.570	AVE=0.755, CR=0.944, Cronbach's alpha=0.870
	PEOU2	0.819	20.386	
	PEOU3	0.855	20.508	
	PEOU4	0.794	13.744	
Attitude	Att1	0.853	26.928	AVE=0.652, CR=0.907, Cronbach's alpha=0.833
	Att2	0.870	26.285	
	Att3	0.870	22.520	
	Att4	0.843	22.274	
	Att5	0.518	4.171	
Intention	Int1	0.842	25.198	AVE=0.711, CR=0.911, Cronbach's alpha=0.844
	Int2	0.835	21.647	
	Int3	0.798	17.990	
	Int4	0.706	10.607	
	Int5	0.754	12.095	

Table 7 Correlations with Square Roots of the AVEs

Constructs	AVE	Correlation (Pearson)				
		1	2	3	4	5
1 - Actual behavior	0.88	1				
2 - PU	0.94	0.41**	1			
3 - PEOU	0.92	0.37**	0.58**	1		
4 - Attitude	0.96	0.47**	0.47**	0.54**	1	
5 - Intention	0.98	0.48**	0.32**	0.53**	0.51**	1

** Significant at the <0.01 level

The path analysis method (assessing the structural model) was used to test the hypotheses after confirming the measurement models by confirmatory factor analysis. The structural model of standardized factor loadings and the significance between them are shown in Figs. 3 and 4.

Hypothesis Testing

The results related to the final impacts of the variables on applying farmers' pro-environmental behaviors into the farm are outlined in this part. The results showed that all research hypotheses were confirmed based on the predicted equations, as the t value for each coefficient is greater than 1.96. The results also showed that the research variables explained 59.8% of farmers' environmental protection behaviors. The assessment of Stone -Geisser's Q2 value is also critical next R^2. A Q2 value greater than 0 for a construct in the structural model indicates the model's predictive relevance (Hair et al., 2017). The Q2 values presented in Table 9 propose the predictive validity of the structural model.

The study used the bootstrapping method to investigate the path coefficient significance or β, with 100 and 300 samples. The results indicated no difference in the significance of the parameters under each of the two conditions. Also, the results had a strong validity since the significance of the relationships between the variables was not influenced by the sample size, and the size only changed the value of t -statistics. Thus, the assumptions can be tested by the regression model (Table 9).

Table 8 Summary of goodness of fit indices for the measurement model

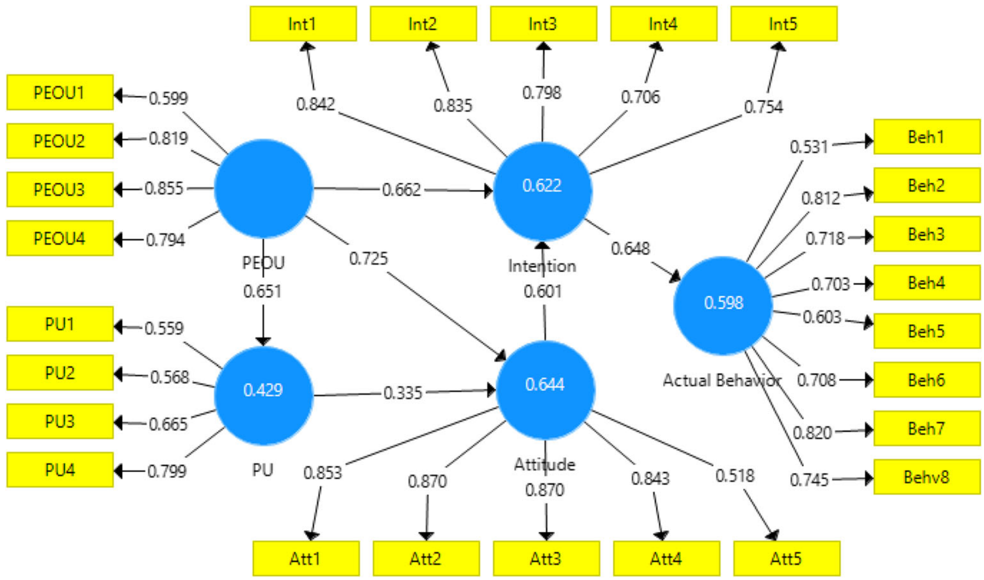
Fit index	SRMR	D -G1	D -G2	NFI	RMS -Theta
Suggested value	<0.1	>0.05	>0.05	>0.90	≤0.12
Estimated value	0.07	0.241	0.341	0.95	0.09

Discussion

According to available information, limited global and Iranian studies have been performed on applying TAM about agriculture issues and farmers' pro-environmental behaviors. Compared to other areas used by TAM, such as the use of ecological inputs (Bagheri et al., 2021), adoption of extension technologies (Zarafshani et al., 2020), and integrated pest management (Rezaei et al., 2020), this result has been far more successful since the rate of explanatory variance in the application of pro-environmental behaviors has been much higher. Thus, TAM is a very valuable theory in explaining the factors affecting the application of pro-environmental behaviors. Therefore, this research can partially overcome the limitations of previous research and offer new approaches to the application of farmers' pro-environmental behaviors. Also, it is expected that the results of this study would be used by national or local policymakers to encourage farmers toward applying pro-environmental behaviors. In addition, the research results can be applied in other Middle Eastern countries with rich environments and offer different approaches to their farmers.

The results related to the investigation of participants' pro-environmental behaviors showed that farmers perform items of preserving crop residues on the soil, not burning the residues (Beh6), and planting cover crops in the field (Beh7) less than other behaviors. This can be attributed to the ease of agricultural tillage operations and farmers' lack of awareness about the benefits of preserving crop residues (Farani et al., 2019; Bagheri et al., 2021). Crop residues, due to their high nutrient content, can improve the physical, chemical, and biological conditions of the soil (Mahdi et al., 2010). The results of the present study revealed that farmers' PU and PEOU items were lower than the average of 2.5 out of 5 compared to other environmental protection behaviors. The results of the present study were in line with the findings of Abdollahzadeh et al. (2016). These results may be due to farmers' lack of need to apply pro-environmental behaviors, economic inefficiency of these methods in the field (Bagheri et al., 2021), or lack of sufficient awareness of farmers about the exact use of pro-environmental behaviors in the field (Gautam et al., 2017). So, it may take years for farmers to become fully acquainted with these behaviors. In addition, the results showed that farmers had a relatively favorable attitude and willingness to some solutions. In this regard, the results of the present study were consistent with the findings (Savari & Gharechaee, 2020). With regard to this finding, many farmers believe that both soil health and community health should be considered. Also, some researchers have argued that the principles of sustainability should be observed toward preserving benefits for future generations (Maleksaeidi & Keshavarz, 2019).

Fig. 3 Path model with standardized factor loadings



Based on the study of individual and professional characteristics of the respondents, the results revealed that the variables of education, income, knowledge of the standard amount and participation in educational as well as extension courses have a positive and significant effect on applying environmental conservation behavior. This finding is in line with Shamsi Paikiadeh and Shobairi (2019); Gebrezgabher et al. (2015). In interpreting this finding, it can be stated that gaining environmental awareness is the first step towards achieving sustainability and it is also the prerequisite for the future survival of humanity (Frittief, 2015).

Environmental awareness can solve many of the problems facing the environment (Shamsi Paikiadeh & Shobairi, 2019). Environmental awareness includes people's knowledge about the environment, people's responsibility to protect the environment, as well as the relationship between economics and sustainable development (Huang & Shih, 2009; Blessing, 2012). On the other side, lack of knowledge can limit the environmentally friendly behaviors (Vicente-Molina et al., 2013). Concerning income impact, it can be declared that applying environmental conservation behavior in the short term may reduce farmers' incomes because they have to use less chemical fertilizer and they have to protect the surrounding pastures and forests. Thus, it is necessary to reduce the pressure on agricultural lands and natural resources by diversifying economic jobs in rural areas (Savari et al., 2020a).

In addition, the results of SEM indicated that all relationships between constructs of TAM had significant effects on

Fig. 4 Path model with *t* -values

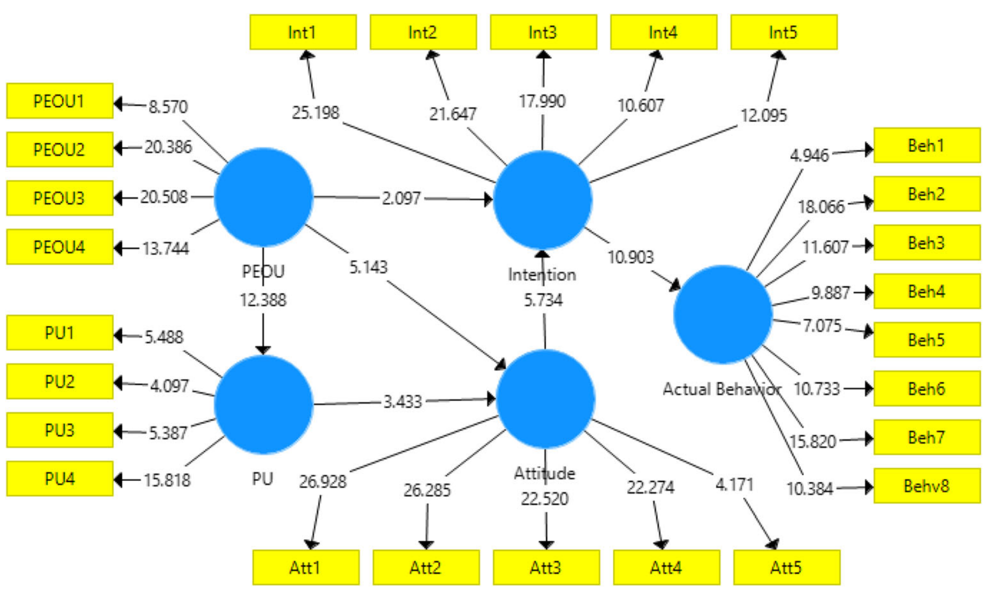


Table 9 Results of research structural models

Hypothesis	Beta	t	STDE	Result	R^2	Q^2
H1: PEOU → PU	0.651	12.388>1.96	0.047	confirm	0.429	0.143
H2: PEOU →Attitude	0.725	5.143>1.96	0.073	confirm	0.644	0.107
H3: PU →Attitude	0.355	3.433>1.96	0.067	confirm		
H4: Attitude →Intention	0.601	5.734>1.96	0.058	confirm	0.622	0.124
H5: PEOU → Intention	0.662	2.097>1.96	0.066	confirm		
H6: Intention →Actual Behavior	0.648	10.903>1.96	0.083	confirm	0.598	0.132

Significant at p -value ($p < 0.05$); Arrows exhibit the direct relationship between the independent and dependent variable

pro-environmental behaviors among farmers, where variables of PU, PEOU, attitude, and intention predicted 59.8% of the variance of farmers' pro-environmental behaviors (Table 3).

In examining the research hypotheses, the results of the effects of PEOU on PU confirmed the hypothesis (1) of the present study which has been approved by numerous researchers (Davis et al., 1989; Sharifzadeh et al., 2017: Kamal et al., 2020, Bagheri et al., 2021; Rezaei et al., 2020). Most traditional farmers do not have the knowledge as well as executive skills and reject technologies that require high skills (Bagheri et al., 2021). Thus, since the complexity level of technology is inversely related to the level of technology acceptance (Kamal et al., 2020), part from the percentage of the usefulness of technology, its complexity level is very important for farmers (Verma & Sinha, 2018). According to diffusion theory, when an innovation is transmitted among farmers, farmers will not easily accept the innovation (new behavior). Many of them, due to their low level of awareness, are always resistant to change and will not easily abandon past behaviors. They only accept a new behavior if they can test it at a low level and see the result (Świtek & Sawinska, 2017: Rogers, 1995). Ease of applying a new behavior allows people with less effort to accept the new behavior and be able to test it on a small scale (Rogers, 1995). In this regards, pro-environmental behaviors should be performed in accordance with the skill level of farmers in each region. Farming seminars and training courses are the most important techniques to enhance the level of farmers' skills, as farmers can recognize pro-environmental behaviors to enjoy their benefits by these methods.

Also, in line with the results of previous researchers (Ajzen, 1991; Venkatesh, 2000; Verma & Sinha, 2018; Webb et al., 2013; Hori et al., 2013; Wang et al., 2016; Yadav & Pathak, 2016), in support of hypothesis (2), our findings indicated that PEOU had a significant effect on farmers' attitudes toward pro-environmental behaviors. In general, some researchers believe that PEOU can create a positive attitude towards applying new technologies. In particular, PEOU is related to the nature of inherent attributes of technologies and tasks, such as ease of use, simplicity, and flexibility (Verma & Sinha, 2018). In this research, by comparing PEOU and PU in terms of the attitude of farmers towards applying pro-environmental behaviors, it could be understood that unlike a few studies (Bagheri et al., 2021), the effect of PEOU on attitude was greater than that of PU. This finding can happen for two reasons. First, farmers have always understood the effects of pro-environmental behaviors and believe that applying this behavior can have positive effects for themselves and future generations. Secondly, the complexity of pro-environmental behaviors for farmers is high because they do not know which of the following behaviors can be most effective or how environmental conservation behaviors should be applied that would not reduce their sources of income in the short term.

Obviously, the favorable attitude of farmers to the application of new technologies is directly related to the simplicity of pro-environmental behaviors (Verma & Sinha, 2018: Rezaei et al., 2020). In general, people who are familiar with how to use new technologies or easily learn how to use technologies have a more favorable attitude towards those technologies. In addition, the results showed that PU also had a significant effect on farmers' attitudes toward pro-environmental behaviors, with the findings of some experimental studies confirming the above results (Ajzen, 1991; Venkatesh, 2000; Sharifzadeh et al., 2017; Verma & Sinha, 2018; Rezaei et al., 2020; Webb et al., 2013; Hori et al., 2013; Wang et al., 2016; Yadav & Pathak, 2016). Our findings also indicated that the studied farmers had fully understood the benefits of pro-environmental behaviors on human communities and the environment.

Farmers' perception of the usefulness of new technologies can have great impacts on the use of technology (Hori et al., 2013). Given that pro-environmental behaviors have different benefits, such as reducing production costs, boosting crop health as well as environmental health, reducing the application of chemical pesticides, reducing soil erosion, and other benefits (Rezaei et al., 2020; Wang et al., 2016), the familiarity of farmers with the above benefits can lead to their increased favorable attitude towards the use of pro-environmental behaviors (Bagheri et al., 2021). As a result, employing pro-environmental behaviors can directly lead to increasing crop yields. Given the significance of hypotheses

2 and 3, NGOs must help farmers by explaining the benefits and methods of applying pro-environmental behaviors to improve their attitude towards new technologies.

The positive effects of attitude were proved on farmers' intention towards applying pro-environmental behaviors (Rezaei et al., 2020; Savari & Gharechaee, 2020). Our findings also revealed that attitude had significant and positive effects on farmers' tendencies. Ajzen theory (1991) stated that attitude, as the main factor of TPB, can play a key role in farmers' health -safety behaviors (Damalas & Koutroubas, 2018). Meanwhile, the TRA theory also states that farmers' attitudes directly affect their tendencies to use ecological technologies (Verma & Sinha, 2018; Rezaei et al., 2020). Most previous studies have also introduced attitude as the principal determinant of farmers' behavioral intention (Ajzen, 1991; Venkatesh, 2000; Verma & Sinha, 2018; Webb et al., 2013; Hori et al., 2013; Wang et al., 2016; Yadav & Pathak, 2016). Environmental attitudes are a set of pleasant and unpleasant feelings about the characteristics of the physical environment or related issues (Damalas & Koutroubas, 2018). Although such attitudes may affect people's behavior, in most cases, certain circumstances affect people's environmental behavior, and prevent forming a strong relationship between environmental attitudes and environmental behavior (Ajzen, 1991). Farmers with sustainable and positive attitudes towards the environment benefit from sustainable operations (Gao et al., 2017). Thus, farmers' favorable attitudes toward technology have increased the acceptability of technology and can respond to it correctly. Higher mental fitness can also have direct associations with a person's level of desire (Savari & Gharechaee, 2020). Attitudes express value judgments about technology. In other words, helpful judgments about technologies lead to an increase in peoples' desire level. It was reported that attitudes act as determining factors in the early stages of technology acceptance (Yadav & Pathak, 2016) whereby more expected attitudes towards a behavior resulted in increasing behavior acceptance.

The effect of PEOU on the intention confirmed the hypothesis (5) which was in line with the findings of Schenk et al. (2007): Kamal et al. (2020): Bagheri et al., (2021). As mentioned earlier, the more flexible a technology is and the more it matches the structure of farmers' farms, and the less effort is required to try to learn technology among farmers, the more inclined farmers will be to adopt environmental conservation behaviors (Rogers, 1995) This is because understanding the ease of using after the benefits of a technology is the most important factor in applying a new innovation (Webb et al., 2013).

Finally, the last research hypothesis (Hypothesis 6), the effect of intention on behavior, was confirmed (Ajzen, 1991; Schenk et al., 2007: Kamal et al., 2020, Bagheri et al., 2021; Rezaei et al., 2020). According to the TPB model, the strongest predictor of actual behavior is the intention variable (Ajzen, 1991) as intention is a sign of a person's readiness to perform certain behaviors that directly affect actual behavior (Blok et al., 2015). Intention determines an individual's will to perform a behavior, and behavior is completely influenced by the individual's will as well as intention (Conner & Armitage, 1998). If a person does not have a desire for a particular behavior, it is almost impossible to perform the behavior (Schenk et al., 2007). If farmers are willing to use environmentally friendly inputs, they are more likely to engage in real behavior.

According to the TAM model, our findings showed that perceived benefits and ease of farmers' pro-environmental behaviors play key roles in choosing eco -behaviors by farmers. Concerning the crucial roles of these factors in enhancing farmers' attitudes and tendencies to choose eco -behaviors, they can be promoted by increasing farmers' awareness about the benefits and how to use green as well as environmentally friendly technologies. In recent years, increasing the cost of chemical inputs has been considered as one of the most common strategies of Iran and developing countries to improve pro-environmental behaviors. On the other hand, the available data determined that this strategy did not act as a successful and sustainable policy due to the lack of sufficient awareness of farmers about the benefits of pro-environmental behaviors and techniques, use of cover crops, and the preservation of residues on the farm. So, the lack of farmers' sufficient knowledge led to increased environmental degradation and soil erosion. Thus, regarding Iran's unfavorable positions for adopting sustainable and long -term policies (due to Iran's economic sanctions), holding training workshops can be an effective strategy to improve food health, food security, and productivity of agricultural lands. Another strategy to encourage pro-environmental behaviors is influencing the farmers' attitudes to increase their tendencies toward accepting pro-environmental behaviors by showing short -term and long -term adverse impacts of chemical fertilizers on the environment and on human health. Various advantages of this strategy include the lack of direct supervision, no spending government, and increases farmers' adherence to eco -behaviors. In addition, public sectors in developing countries can provide low -cost ecological inputs and free consulting services to increase farmers' acceptance of pro-environmental behaviors.

Conclusion

This study aimed to investigate factors affecting the acceptance of Iranian farmers' pro-environmental behaviors using the TAM model. Also, the present study tried to mitigate the gap of studies on the application of TAM in agriculture. The results showed that farmers were applied items of applying new irrigation technologies to prevent water losses and the application of livestock and organic fertilizers more than other pro-environmental behaviors. On the other hand, items of "planting cover crops and preserving crop residues on the soil and not burning those" were less used than other pro-environmental behaviors. Also, the obtained results indicated that pro-environmental behaviors were not usable for farmers into farms. Plus, the results related to SEM showed that the TAM model predicted 59.8% of the factors affecting the acceptance of pro-environmental behaviors. The results of the present study can provide new approaches to the development of pro-environmental behaviors by policymakers.

Despite the useful results, the present study had several limitations. The first limitation was related to the spatial limitation. The present study was conducted in southwestern Iran (Khuzestan province) and caution is thus required in extending it to other places (Savari et al., 2020). The predictive power of the model can be improved by developing the model or combining TAM with other psychological models. The third limitation of the research is for people with environmentally friendly behaviors who have a strong desire to participate in the present study (Yadav & Pathak, 2016).

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Data Availability The datasets generated during and/or analyzed during the current study are available from the corresponding author on reasonable request.

Declarations

Ethical Approval All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional research committee and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards.

Informed Consent Informed consent was obtained from all individual participants included in the study.

Conflict of Interest The authors declared that they had no conflicts of interest with respect to their authorship or the publication of this article.

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