Analysis of farmers’ environmental sustainability behavior: the use of norm activation theory (a sample from Iran)

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Abstract
Human activities are the most effective and significant cause of environmental changes, some of which are destructive and others are beneficial. One of the most effective steps to protect the environment is to assess farmers’ behavior in achieving the goals of environmental sustainability. This study aimed to analyze the environmental sustainability behavior of farmers using the norm activation theory (NAT) in a questionnaire-based survey. The statistical population comprised wheat farmers in Kermanshah province, Iran (N = 126,900). The sample size was determined to be 382 farmers by Krejcie and Morgan’s table. The validity of the questionnaire was verified by experts and its reliability was confirmed by a pilot test and calculating Cronbach’s alpha. Five variables of perceived behavior control, perceived self-efficacy, ascription of responsibility, denial of responsibility, and awareness of consequences had significant effects on personal norms. The variable of personal norms had a significant effect on farmers’ sustainable behavior. By and large, it can be concluded that NAT can adequately account for the environmental sustainability of farmers.

Keywords Environmental sustainability behavior · Norm activation theory · Sustainable agriculture · Farmers’ behavior · Sustainable development

Introduction
The environment in many villages of Iran is posed to severe threats such as desertification, degradation of forests and pastures, land-use changes, the depletion of groundwater aquifers, and landslides (Geravandi et al. 2012). A glance at the environmental situation in recent decades shows that human activities are the most effective and significant cause of environmental change (Panahandeh et al. 2010). If urgent measures are not taken to control unsustainable activities of humans, a catastrophic loss will occur (Smucker and Wisner 2008). Human impact on the environment or anthropogenic impact on the environment includes changes in biophysical environments and ecosystems, biodiversity, and natural resources directly or indirectly caused by humans, including global warming, environmental degradation, mass extinction and biodiversity loss, ecological crisis, and ecological collapse (Ghadermarzi et al. 2020).
aroused environmental concerns so that the conservation and rehabilitation of the environment are the major challenges that societies face such as land loss (Bronfman et al. 2015; Mondéjar-Jiménez et al. 2012), land degradation (Yaghoubi Farani et al. 2016), agricultural expansion, and desertification (Ataei et al. 2018). But, given the emergence of environmental problems at the global level, the UN has set out the sustainable development approach as the topic of the last decade of the twentieth century and placed it at the top of the twenty-first-century agenda at the international, regional, and local levels (Ghadermarzi et al. 2020).

Sustainable development (SD) is a process that organizes the relationship between the human and the environment and manages the exploitation of resources to facilitate achieving ever-increasing production, safe life, food security, justice, social stability, and people’s participation (Pourtaheri and Nemati 2013; Izadi et al. 2019). Environmental sustainability is one of the important pillars of SD, which is important for its various dimensions such as soil conservation, water resource management, climate change, fertilizer, herbicide and pesticide use management, and fossil energy (Es’haghi et al. 2022). SD encompasses three major economic, social, and environmental fields (Roy et al. 2014; Schindler et al. 2015; Yang et al. 2016). In addition to the economic and social dimensions, the environmental dimension should also be considered to achieve SD goals whereas any effort to improve the quality of life and human development is realized in the context of the environment. Therefore, the environment and its resources dictate the sustainability or unsustainability of the development process. Accordingly, any discussion on development will be incomplete if it does not consider the concept of environmental sustainability. However, if SD is considered the ultimate goal, environmental sustainability is a necessary condition to accomplish SD (Bareimani and Asgarei 2010; Ataei et al. 2019).

Environmental sustainability has been a key term for all societies of the world since the beginning of the twenty-first century (Klöckner 2013). All countries need to be ensured about the quality of the natural resources and ecosystems and the diversity of plant and animal species, including the human environment, both in the short and long run (Vlek and Steg 2007). There are many ways to help improve environmental problems, such as government policies, international agreements, participatory leadership, educational programs, and technological innovations. But, the effect of human behavior should not be ignored (Osbaldeston and Schott 2012; Izadi et al. 2017) as humans are often faced with choices that may have positive results for themselves but negative ramifications for the environment, and vice versa (Nordlund et al. 2016) such as burning crop residue; excessive use of plastics; increasing fertilizer, herbicide, and pesticide use; increasing the use of fossil fuels; traffic for agricultural machinery at farms; traditional methods of irrigation; chemical pest management; and changing land use.

One of the most effective steps to protect the environment is to evaluate people’s behavior and performance in achieving the basic principles of sustainable life. That is, people must evaluate their behavior in the face of the environment (Muharram Nejad 2007), which does not exclude farmers’ environmental sustainability. It should be noted that any kind of agriculture harms the environment with no exceptions (Paarlberg 2009). However, societies in most countries around the world are heavily concerned about how farmers behave in the agricultural sector (Adnan et al. 2017). Governmental sectors at various levels seek to reduce the environmental problems of agriculture (Seymour and Ridley 2005). Policymakers can present new approaches and technologies to reduce the consequences of environmental problems. The role of government in protecting the environment stretches far beyond designing effective environmental policies since generally ineffective and corrupt government appears to undermine public support for critical environmental policymaking. The translation of normative views into support for government spending on the environment should ultimately rely on whether government institutions that implement and enforce policies are generally effective, fair, and incorrupt (Kulin and Johansson Sevä 2019). Given that agriculture in developing countries is the main source of income and livelihood, the social and economic effects of environmental change are significant in these countries (Rao and Rogers 2006; Yaghoubi Farani et al. 2021).

Therefore, it is significant to pay attention to the environmental sustainability of farmers. Farmers, on the one hand, have a huge impact on the environment on behalf of their activities (such as the use of fertilizers, pesticides, and insecticides; technological mess; and the use of unfavorable farming techniques that directly impact the ecosystem), but on the other hand, they are strongly affected by environmental changes — and this is what makes the situation seem so complex. Psychologists have tried to simplify and define some factors to explain it. Throughout history, many behavioral models have been proposed to examine the social behavior of people. In the field of environmental behavior, there are two general approaches: the traditional economic approach, or the rational human approach, and the ethical approach (Schultz 2000).

The traditional economic approach is based on the untapped use of natural resources and the inattention to the rights of current and future generations. In today’s economic approach, the green economy approach emphasizes the conservation of natural resources and the reduction of greenhouse gas emissions in environmental behavior (Ramazani Ghavamabadi 2016).

The ethical approach considers human behavior as an ethics-oriented position, and it encompasses such theories...
as “norm activation theory” and “theory of value, belief, and norm” (Islami et al. 2014). Given that environmental conservation is considered an ethical problem and it will have many adverse consequences for human beings (Kim 2002). In this study, the norm activation theory (NAT) was used to investigate the environmental sustainability behavior of farmers (Fig. 1).

A review of the literature shows that NAT has long been successfully used to investigate a wide variety of people’s intentions and behaviors such as travelers’ adoption behavior towards electric vehicles (Ashraf Javid et al. 2021), environmentally responsible behavior for tourists and residents (Confente and Scarpi 2021), visitors’ binning behavior (Esfandiar et al. 2021), farmers’ pro-environmental behavior in the face of drought (Hallaj et al. 2021), organic food purchase intention (Le and Nguyen 2022), pro-environmental traveler behavior (O’Connor and Assaker 2021), farmers’ response to water crisis (Savari et al. 2021), and compliance with COVID-19 prevention guidelines (Shanka and Gebremariam Kotecho 2021).

Other scholars have conducted research using NAT, e.g., Han (2014), Menati Zadeh et al. (2015), Rahimi Fayzabad et al. (2016), Zhang et al. (2018), Rezaei et al. (2019), Lopes et al. (2019), and Song et al. (2019). Rahimi Fayzabad et al. (2016) examined the behavior of water conservation using NAT. The results showed that two variables of assignment of responsibility and self-efficacy affected the moral norms of individuals towards water conservation. The water conservation behavior was significantly explained by the moral norms. Menati Zadeh et al. (2015) concluded that among the variables affecting environmental behavior, adherence to individual (moral) norms, the sense of responsibility, and duty for environmental protection by farmers were the most significant factors affecting the environment.

Wan et al. (2014) examined the behavior of individuals concerning waste reduction and recycling. Their results revealed that the recycling intention was affected by mental norms, personal norms, and awareness of the consequences. Also, personal and mental norms could anticipate behavior. Vaske et al. (2015) showed that when the awareness of consequences and accountability increased, norms were enhanced as well. When the components of norms, i.e., awareness of consequences and assignment of responsibility, increased, the respondents were more eager to promote their environmental behavior.

Thus, this study mainly aimed to analyze the environmental sustainability behavior of farmers using NAT. According to NAT, various factors (including perceived behavioral control, perceived self-efficacy, awareness of needs, ascription of responsibility, denial of responsibility, awareness of consequences, and moral norms) can influence farmers’ behavior. Personal norms have a mediating role in NAT. Therefore, the following set of hypotheses was developed and tested on a sample of Iranian farmers:

It was first hypothesized that, in line with NAT, the seven components (perceived behavioral control, perceived self-efficacy, awareness of needs, ascription of responsibility, denial of responsibility, awareness of consequences, and moral norms) were related to the environmental sustainability behavior and that these relationships were mediated by personal norms (hypotheses 1–7). Secondly, according to NAT, personal norms were hypothesized to significantly mediate the influences of the activators on farmers’ behavior (hypothesis 8).


### Materials and methods

The NAT assumes that the process of norm activation is determined by eight components: perceived behavioral control, perceived self-efficacy, awareness of needs, ascription of responsibility, denial of responsibility, awareness of consequences, moral norms, and personal norms.

This theory has been advocated by various empirical studies (Zhang et al. 2014; Shin et al. 2018; Song et al. 2019; Kim and Hwang 2020; Confente and Scarpi 2021; Arkorful 2022). NAT was initially elaborated in the study of altruistic behavior, but later it was applied successfully in the field of the environment (Lindenberg and Steg 2007). According to this theory, when people feel an ethical commitment to environmental protection, they are more likely to develop environmental behavior. Changing sustainability behavior requires changing personal norms, which are a set of attitudes and beliefs of individuals. Stronger personal norms indicate that people are inherently motivated to protect the environment. It may even be somewhat costly. But, the reason beyond doing this is to feel well. However, when it is a very difficult and costly process, individuals are less likely to follow their personal norms (van der Werff et al. 2013). Researchers argue that the relationships between norms and behaviors become stronger among people when they are more aware of the consequences and feelings of responsibility for the consequences of behavior (De Groot and Steg 2009).

Based on NAT, personal norms have a special contribution in the field of environment in terms of altruism. Moral norms can lead to direct participation in environmental behaviors (Wan et al. 2014). Personal norms are referred to as “moral obligation” to conduct or refrain from a particular action. Personal norms are activated when individuals are aware of the adverse consequences of their behavior on others or on the environment (Lindenberg and Steg 2007). Awareness of the consequences leads to a sense of responsibility in conducting a behavior — or the so-called ascription of responsibility (Wan et al. 2014). The assignment of responsibility is defined as a sense of responsibility for the negative consequences of certain actions (De Groot and Steg 2009). Awareness of needs also tells on an individual’s level of awareness of problems and the need to solve them. On the other hand, in NAT, the idea that people are socially different is determined by denial of responsibility. Denial of responsibility refers to the willingness of individuals to deny their responsibilities and the consequences of their behaviors, which encompasses the welfare of others. Moreover, NAT involves self-efficacy, i.e., perceived ease or difficulty of dealing with a behavior (Rahimi Fayzabad et al. 2016).

This research was an applied study in terms of purpose and a descriptive-correlational study in terms of data collection and generalizability conducted with the survey methodology. The statistical population was composed of wheat farmers in Kermanshah province, Iran ($N = 12,699$). The sample size was determined by Krejcie and Morgan table (Krejcie and Morgan 1970) as 382 farmers who were taken by proportional random sampling. The studied classes were in Kermanshah province (Table 1). A questionnaire was used to collect data. The questionnaire consisted of two sections: the first section was related to the demographic characteristics and the second to the constructs of NAT. The environmental sustainability behavior of farmers was defined as farmers’ activities for water management, pest management, and soil management in their farms (Aliabadi et al. 2020). Therefore, farmers’ environmental sustainability behavior was investigated based on three dimensions: water management, pest management, and soil management. The items used to measure the variables were extracted from previous relevant studies. Farmer behavior was measured with seven items as to water management, with nine items as to integrated pest management (IPM), with 10 items as to soil management, four items as to ascription of responsibility, five items as to denial of responsibility, five items as to awareness of consequence, six items as to personal norm, two items as to moral norms, three items as to perceived self-efficacy, and three items as to awareness of needs. Table 2 lists the items used to measure each of the variables on a 5-point Likert scale. The face and content validity of the questionnaire was confirmed by a panel of experts composed of faculty members from different disciplines such as soil and water management, environmental education, and agricultural education and extension. To confirm the reliability of the questionnaire, a pilot study was conducted with 30

### Table 1 The research population in different counties and the size of the sample taken from them

| Counties            | Research population | Sample |
|---------------------|---------------------|--------|
| Eslam Abadgharb     | 12760               | 39     |
| Paveh               | 30                  | 1      |
| Slababajani         | 3307                | 10     |
| Jvannrodi           | 2033                | 7      |
| Dalahow             | 6707                | 22     |
| Ravansar            | 9554                | 30     |
| Songhor Koliaiee    | 15440               | 46     |
| Sarpol zahab        | 10021               | 30     |
| Sahneh              | 12144               | 37     |
| Kermanshah          | 35230               | 101    |
| Kangavar            | 4418                | 13     |
| Gilangharb          | 6667                | 20     |
| Ghareshirein        | 3434                | 10     |
| Harsien             | 5155                | 16     |
| Total               | 126900              | 382    |

Based on the sample, the demographic characteristics of the farmers are as follows: 12.1% of farmers were aged between 21 and 25 years, 43.2% were between 26 and 30 years, 19.3% were between 31 and 35 years, 16.6% were between 36 and 40 years, and 12.8% were over 40 years. The level of education of farmers was as follows: 51.9% of farmers had a high school diploma or less, 38.5% had a college degree, and 9.6% had a university degree. The occupation of farmers was as follows: 38.5% were farmers, 43.2% were laborers, and 18.3% were business owners. The level of income of farmers was as follows: 35.1% had an annual income of less than 1 million IRD, 31.2% had an annual income of 1 to 2 million IRD, 25.6% had an annual income of 2 to 3 million IRD, and 8.1% had an annual income of more than 3 million IRD.

### Table 2 The items used to measure each of the variables on a 5-point Likert scale

| Variable                | Description                                                                 |
|-------------------------|-----------------------------------------------------------------------------|
| Farmer behavior         | Measured with seven items as to water management, with nine items as to integrated pest management (IPM), with 10 items as to soil management, four items as to ascription of responsibility, five items as to denial of responsibility, five items as to awareness of consequence, six items as to personal norm, two items as to moral norms, three items as to perceived self-efficacy, and three items as to awareness of needs. |
| Demographic characteristics | 12.1% of farmers were aged between 21 and 25 years, 43.2% were between 26 and 30 years, 19.3% were between 31 and 35 years, 16.6% were between 36 and 40 years, and 12.8% were over 40 years. The level of education of farmers was as follows: 51.9% of farmers had a high school diploma or less, 38.5% had a college degree, and 9.6% had a university degree. The occupation of farmers was as follows: 38.5% were farmers, 43.2% were laborers, and 18.3% were business owners. The level of income of farmers was as follows: 35.1% had an annual income of less than 1 million IRD, 31.2% had an annual income of 1 to 2 million IRD, 25.6% had an annual income of 2 to 3 million IRD, and 8.1% had an annual income of more than 3 million IRD. |
| Percentage of income    | The percentages of income were as follows: 35.1% had an annual income of less than 1 million IRD, 31.2% had an annual income of 1 to 2 million IRD, 25.6% had an annual income of 2 to 3 million IRD, and 8.1% had an annual income of more than 3 million IRD. |
| Percentage of occupation | The percentages of occupation were as follows: 38.5% were farmers, 43.2% were laborers, and 18.3% were business owners. |
| Variable                                | No. | Items                                                                 | Source                                      |
|-----------------------------------------|-----|----------------------------------------------------------------------|---------------------------------------------|
| Water management ($\alpha = 0.71$)      | 1   | I always monitor irrigation closely.                                  | Yazdanpanah et al. (2016)                   |
|                                         | 2   | I rehabilitate and dredge old irrigation canals every year.          | Yazdanpanah et al. (2016)                   |
|                                         | 3   | I destroy the weeds around the water canals.                         | Vaz et al. (2020)                           |
|                                         | 4   | I use modern irrigation methods.                                     | Vaz et al. (2020)                           |
|                                         | 5   | I use drought-resistant seeds.                                       | Self-developed                             |
|                                         | 6   | When irrigating, I use irrigation wastewater.                        | Self-developed                             |
|                                         | 7   | I irrigate when it rains.                                           | Self-developed                             |
| Soil management ($\alpha = 0.70$)       | 1   | I use legumes (chickpea, lentils, etc.) in crop rotation.            | Self-developed                             |
|                                         | 2   | I use green manure.                                                 | Self-developed                             |
|                                         | 3   | In sloped parts, I use a perpendicular plow.                        | Self-developed                             |
|                                         | 4   | I use animal manure alternately.                                     | Self-developed                             |
|                                         | 5   | I use fallow in the crop rotation program.                           | Gholamrezai et al. (2021)                   |
|                                         | 6   | I use low tillage or no tillage.                                     | Gholamrezai et al. (2021)                   |
|                                         | 7   | I level the ground so that the water spreads uniformly.              | Gholamrezai et al. (2021)                   |
|                                         | 8   | In sloped parts, I plant trees to form a dam or put a stone bar to   | Gholamrezai et al. (2021)                   |
|                                         |     | prevent erosion.                                                     |                                             |
|                                         | 9   | I make the minimum use of mixed tillage equipment.                   | Self-developed                             |
|                                         | 10  | After harvesting, I burn the remaining straw.                        | Self-developed                             |
| Integrated pest management ($\alpha = 0.79$) | 1   | I use disinfected seeds.                                             | Vaz et al. (2020)                           |
|                                         | 2   | For weed control, I use mechanical methods (weeding, rooting, etc.). | Vaz et al. (2020)                           |
|                                         | 3   | I use autumn plowing to destroy pest infestations.                   | Self-developed                             |
|                                         | 4   | I remove the contaminated plants.                                    | Self-developed                             |
|                                         | 5   | I avoid spraying in useful periods of beneficial insects.            | Gholamrezai et al. (2021)                   |
|                                         | 6   | I use trap plants to draw harmful insects.                           | Gholamrezai et al. (2021)                   |
|                                         | 7   | I control the animal fertilizers to avoid contamination with weed    | Self-developed                             |
|                                         |     | seeds.                                                               |                                             |
|                                         | 8   | I use winter ice water.                                              | Self-developed                             |
|                                         | 9   | I use lime to control plant diseases.                                 | Self-developed                             |
| Ascription of responsibility ($\alpha = 0.72$) | 1   | All farmers are responsible for protecting the land and the environment. | Self-developed                             |
|                                         | 2   | Farmers are responsible for protecting the land and the environment. | Self-developed                             |
|                                         | 3   | Brokers and policymakers are responsible for protecting the environment and agricultural lands. | Self-developed                             |
|                                         | 4   | Small farmers are paying attention to agricultural and environmental problems | Self-developed                             |
| Denial of responsibility ($\alpha = 0.80$) | 1   | I have no responsibility to preserve natural resources for the future. | Moradhaseli et al. (2017)                  |
|                                         | 2   | Farmers are responsible for protecting themselves and their families, not protecting land and the environment. | Moradhaseli et al. (2017)                  |
|                                         | 3   | Farmers are responsible for protecting themselves and their families, not protecting land and the environment. | Moradhaseli et al. (2017)                  |
|                                         | 4   | I am responsible for increasing the production of products with the maximum use of natural resources. | Self-developed                             |
|                                         | 5   | Small farmers ignore agricultural and environmental problems         | Self-developed                             |
| Awareness of consequences ($\alpha = 0.82$) | 1   | Over the next few decades, thousands of species of animals and plants will be extinct | Gholamrezai et al. (2021)                  |
|                                         | 2   | The balance is sensitive in nature and easily overwhelmed            | Gholamrezai et al. (2021)                   |
|                                         | 3   | Environmental pollution is harmful to the entire community.          | Gholamrezai et al. (2021)                   |
|                                         | 4   | Burning plant remains cannot cause environmental pollution and damage to the soil. | Self-developed                             |
|                                         | 5   | The use of chemical pesticides damages the health of humans and the environment. | Self-developed                             |
people outside the research population. Then, Cronbach’s alpha coefficient was calculated for different sections of the questionnaire at 0.70–0.86, indicating its acceptable reliability (Table 2). One-sample *t*-test and path analysis were applied to compare the mean elements of environmental sustainability behavior and causal relationships among components of NAT. The data were analyzed using the SPSS23 and Amos22 statistical software packages.

### Results

#### Farmers’ demographic characteristics

The distribution of demographic characteristics of the farmers showed that all the farmers were male and their mean age was 45.5 years with a standard deviation of 12.63. The mean experience in agricultural activities was 23.23 years. The survey showed for the educational level that the majority of the farmers had diplomas (34%). Also, 5.8% of the farmers were illiterate while 13.6% had academic degrees.

In terms of agricultural characteristics of the farmers, it was found that the average land size was 8.46 ha and the average yield was 1.73 t ha⁻¹. In terms of land ownership, 49% of the farmers owned land. Also, 81.2% of the farmers did not participate in educational-promotional classes in the environmental perseverance.

The Index of Standard Deviation and Mean (ISDM) (Davis 1971) criterion was used to judge the environmental sustainability of farmers (Formula 1). The environmental sustainability behavior of farmers was defined as farmers’ activities for water management, pest management, and soil management in their farms. In particular, farmers are engaged in a variety of activities for environmental sustainability to manage water resources such as rehabilitation and dredging old irrigation canals, the use of modern irrigation methods and drought-resistant seeds, and destruction of the weeds around the water canals. Furthermore, practices such as using legumes in crop rotation, green manure, and low tillage or no tillage in the farm form soil management by farmers. IPM is one of the major practices for achieving sustainable environment. IPM is carried out in a sustainable manner by combination of biological, cultural, mechanical, physical, and chemical tools in a way that minimizes economic, health, and environmental risks. All of these activities (water management, soil management, and IPM) constitute the environmental sustainability behavior of farmers. The results showed that 26.97% of the farmers had weak environmental behavior, 39% had moderate environmental sustainability behavior, and 34.03% had strong environmental sustainability
behavior. This finding suggests that most farmers display modest environmental sustainability. In other words, farmers display moderate sustainability in irrigation management, soil management, and pest management. Overall, it can be argued that 73.03% of the farmers had appropriate environmental behavior. It may be related to their educational levels. It can be stated that the high educational level of farmers could facilitate understanding, analyzing, and assessing environmental challenges, and this could contribute to their attempts for environmental protection, support, and sustainability. More than 50% of the farmers had educational degrees and they were expected to have appropriate environmental sustainability behavior.

$D < M - \frac{1}{2}S$D = at weak level

$M - \frac{1}{2}S \leq D \leq M + \frac{1}{2}S$ = at moderate level Formal (1)

$D > M + \frac{1}{2}S$D = at strong level

Comparison of the mean elements of environmental sustainability behavior with the optimal level

The environmental sustainability behavior of the farmers was investigated from three aspects, including water management, pest management, and soil management. The comparison of the mean elements of the environmental sustainability behavior with the hypothetical value shows that only the mean value of soil management significantly differs from the hypothetical value so that the confidence interval of the difference of this variable is negative in the sense that the mean value of the population is significantly lower than the hypothetical value (Table 3). In other words, the mean value of soil management by farmers is significantly lower than the hypothetical value.

Investigating water management by farmers

Seven items were used to study the environmental sustainability of farmers in water management (Table 4). However, the use of drought-tolerant seeds, water canal restorations, the use of new irrigation methods, and the removal of weeds are some principles of water management at farms. The results showed that 43.2% of the farmers were closely monitoring the irrigation of their farms, and 44.5% rehabilitated and dredged irrigation canals every year. Also, 46.6% of the farmers have been continuously removing the weeds around the canals. Among farmers, 28.8% used modern irrigation methods to a great and very great extent. In addition, 42.7% of the farmers used drought-resistant seeds abundantly and very abundantly. Finally, 23.3% of the farmers used wastewater to irrigate their farms and 30.9% irrigated their farms when it rained.

Investigating soil management by farmers

Farmers must adhere to different principles to achieve sustainable land management and improve soil conditions. These principles may include the use of green manure, the use of legumes in crop rotation, perpendicular plowing, tillage/no-tillage, avoiding the burning of plant residuals, and so on. The results showed that 45.8% of the farmers used legumes in crop rotation, 25.4% used green manure in their farms, 29.6% plowed the land perpendicular to the slope, 43.2% used fallow in their agricultural program, and 28.6% performed low tillage and/or no-tillage at a high or

| Table 3 Comparison of means of variables with the hypothetical value |
|-----------------------------|-------|-------|--------|------------|-------|
| Variables                   | Hypothetical value | Mean   | S.D    | t        | Sig    | Confidence interval of the Difference |
| Water management            | 21    | 20.80 | 4.66   | -0.8     | 0.424  | -0.66, 0.27                     |
| Integrated pest management  | 27    | 26.43 | 6      | -1.84    | 0.065  | -1.17, 0.036                    |
| Soil management             | 30    | 29.09 | 6.55   | -2.68    | 0.008  | -1.56, -0.24                   |

| Table 4 Item percentage of water management |
|-------------------------------|-------|-------|-------|-------|-------|
| Items                         | Never | Lowly | Moderately | Highly | Very highly |
| I always monitor irrigation closely. | 5.2   | 19.4  | 32.2     | 32.2   | 11    |
| I rehabilitate and dredge old canals every year. | 4.2   | 12    | 39.3     | 39.5   | 5     |
| I destroy the weeds around the water canals. | 8.1   | 11.8  | 33.5     | 39.3   | 7.3   |
| I use modern irrigation methods. | 15.4  | 21.7  | 34       | 17.3   | 11.5  |
| I use drought-resistant seeds. | 12.6  | 21.2  | 23.6     | 33.5   | 9.2   |
| When irrigating, I use irrigation wastewater. | 11.5  | 32.7  | 32.5     | 15.7   | 7.6   |
| I irrigate when it rains. | 33.5  | 28.8  | 16.8     | 12.8   | 8.1   |
very high level. Also, 28.8%, 24%, and 32.5% of the farmers leveled the soil surface, planted trees in sloped parts, and used mixed tillage equipment at a high or very high level, respectively. Finally, 27.5% asserted a high or very high rate of burning crop residuals after harvesting. Other findings are presented in Table 5.

### Investigation of integrated IPM by farmers

In examining IPM by farmers, it was found that 50% of them used disinfected seeds at a high or very high level and 36.6% reported a high or very high rate of using mechanical methods to control weeds. Also, 49.8, 29, and 25.4% of the farmers applied autumn plowing, eliminated the contaminated plants, and avoided spraying in useful periods of beneficial insects at a high or very high level, respectively. The use of herbaceous plants to attract harmful insects is one of the IPM measures, which was practiced by 30.2% of the farmers highly and very highly (Table 6). Also, 21.7, 24.6, and 21.8% of the farmers controlled the animal fertilizers, used winter ice water, and applied lime to control plant disease at a high or very high level, respectively.

### Table 5 Item percentage of soil management

| Items                                                                 | Never | Lowly | Moderately | Highly | Very highly |
|-----------------------------------------------------------------------|-------|-------|------------|--------|-------------|
| I use legumes (chickpea, lentils, etc.) in crop rotation              | 8.9   | 9.9   | 35.3       | 34.8   | 11          |
| I use green manure                                                   | 12.3  | 18.8  | 43.5       | 19.6   | 5.8         |
| In sloped parts, I use a perpendicular plow.                         | 9.4   | 30.6  | 30.4       | 24.6   | 5           |
| I use animal manure alternately.                                     | 10.2  | 30.9  | 34         | 18.6   | 6.3         |
| I use fallow in the crop rotation program.                           | 7.3   | 16.5  | 33         | 32.7   | 10.5        |
| I use low tillage or no tillage.                                     | 8.4   | 25.9  | 37.2       | 22.8   | 5.8         |
| I level the ground so that the water spreads uniformly               | 7.9   | 38.7  | 24.6       | 24.9   | 3.9         |
| In sloped parts, I plant trees to form a dam or put a stone bar to prevent erosion. | 7.3   | 41.1  | 27.5       | 20.9   | 3.1         |
| I make the minimum use of mixed tillage equipment.                   | 6.3   | 24.6  | 36.6       | 26.7   | 5.8         |
| After harvesting, I burn the remaining straw.                        | 16.8  | 40.3  | 15.4       | 17.8   | 9.7         |

### Analysis of the causal model of effective structures for farmers’ environmental sustainability behavior

The path analysis was used to investigate the environmental sustainability behavior of farmers. In this analysis, the effects of a set of variables are measured on each other in which coefficients with the values of less than 0.1 represent weak effects, the values of 0.3 represent moderate effects, and the values of 0.5 or higher reflect the strong effects of variables on one another (Olobatuyi 2006). The goodness of fit of the data model requires that the ratio of chi-square to degrees of freedom (df) be less than 5 and the RFI, CFI, and NFI values be greater than 0.9. Figure 2 shows the causal mechanism of the relationship between different variables and the environmental sustainability behavior of farmers. As can be seen, the proportional values of fitness indices indicate the appropriate compatibility of data and model.

Separating the effects of causal variables showed that the five variables of perceived behavior control ($\beta = 0.128$), perceived self-efficacy ($\beta = 0.408$), ascription of responsibility ($\beta = 0.122$), denial of responsibility ($\beta = -0.437$), and awareness of the consequences ($\beta = 0.298$) had significant effects on personal norms (Table 7), so H1, H2, H4, H5, and H6 were supported. Two variables of awareness of needs and

### Table 6 Item percentage of IPM

| Items                                                                 | Never | Lowly | Moderately | Highly | Very highly |
|-----------------------------------------------------------------------|-------|-------|------------|--------|-------------|
| I use disinfected seeds.                                              | 4.2   | 12.6  | 33.2       | 43.7   | 6.3         |
| For weed control, I use mechanical methods (weeding, rooting, etc.).  | 3.1   | 22.3  | 38         | 27.2   | 9.4         |
| I use autumn plowing to destroy pest infestations.                    | 4.2   | 19.1  | 27         | 38     | 11.8        |
| I remove the contaminated plants.                                     | 5.2   | 23    | 42.7       | 20.4   | 8.6         |
| I avoid spraying in useful periods of beneficial insects.             | 5.2   | 24.9  | 44.5       | 21.5   | 3.9         |
| I use trap plants to draw harmful insects.                            | 10.5  | 35.6  | 23.8       | 22.3   | 7.9         |
| I control the animal fertilizers to avoid contamination with weed seeds. | 10.5  | 34.3  | 33.5       | 17     | 4.7         |
| I use winter ice water.                                               | 13.4  | 32.7  | 29.3       | 20.4   | 4.2         |
| I use lime to control plant diseases.                                 | 30.1  | 29.8  | 18.3       | 17.3   | 4.5         |
moral norms had no significant effects on personal norms. Also, personal norms ($\beta = 0.218$) had a significant effect on farmers’ behavior, supporting H8. This finding suggests that increased control of perceived behavior, perceived self-efficacy, responsibility, and awareness of the consequences will promote farmers’ personal norms concerning environmental sustainability. In other words, the higher the faith the farmers have in their abilities, the higher the sense of moral commitment to the principles of environmental sustainability they will have. Also, if farmers are responsible for the environment, their personal norms will be shaped with respect to environmental sustainability. On the other hand, denying the responsibility to protect the environment and its consequences will lead to the formation of non-environmental norms. Awareness of the consequences of unsustainable environmental behavior also establishes a sense of responsibility for environmental behavior. Also, if farmers understand their sustainable behavior, these behaviors will be institutionalized and will create a personal norm based on environmental sustainability.

### Discussion and conclusions

Environmental sociologists believe that the interaction between humans and the environment is influenced by various socio-cultural factors. One of the ways to avoid harming the environment and preventing its destruction is to shift the behavior of humans towards environmentalist behavior. In this study, we used norm activation theory (NAT) to analyze farmers’ environmental sustainability in three dimensions of water management, soil management, and IPM. The results showed that 65.97% of the farmers had weak or moderate environmental sustainability behavior. Therefore, in each of the three dimensions of water management, soil management, and pest management, farmers’ behavior was under-optimal. However, as the population grows, water use in the agricultural sector is expected to increase, which, together with the development of industries and the rapid increase in the population, will create competition and conflict over access to water resources. In addition, farmers do not use available water wells (Yazdanpanah et al. 2012). Therefore, the water crisis in the
agricultural sector on the one hand and the supply of food requirements on the other hand are sources of serious challenges for water management. In soil management, the problem of soil erosion is far more severe in developing countries than in developed countries (Dehshiri 2015; Bijani et al. 2017).

Pest management is also a sustainable approach to pest control through biological, agronomic, mechanical, and chemical methods that minimizes the risk to the environment, human health, and human economy (Adipala et al. 2003). However, its implementation, especially in developing countries, has turned out to be difficult, perhaps due to its complex nature (Whitehouse 2011). Therefore, it can be concluded that farmers’ environmental sustainability behavior is affected by various factors so that the three personality trait activators (ascription of responsibility, awareness of consequences, and denial of responsibility) and internal factors (perceived behavioral control and perceived self-efficacy) were related to farmers’ environmental sustainability behavior and that these relationships were mediated by personal norms. Also, it can be argued that farmers’ environmental sustainability behavior was determined by the degree of their personal responsibility for soil management, water management, and pest management, which was reflected in personal norms. Thus, it can be inferred that the process of farmers’ norm activation was determined by five factors — denial of responsibility, perceived behavioral control, perceived self-efficacy, awareness of consequences, and ascription of responsibility. In other words, personal norms mediated the impacts of these factors on farmers’ behavior towards soil management, water management, and pest management.

The findings revealed that the control of perceived behavior had a direct and significant effect on personal norms. In other words, controlling perceived behavior can indirectly affect farmers’ sustainable behavior (Adnan et al. 2017; Andow et al. 2017; Arunrat et al. 2017; Nastis et al. 2019). Researchers have also considered the effect of perceived behavioral control on the acceptance of sustainable agriculture and significant sustainability measures that would have a lasting effect on farmers’ behavior (Wauters et al. 2017). Perceived self-efficacy has also been a significant predictor of NAT. Farmers, believing in their ability to protect the environment, will create a living environment and sustainability behavior. In this regard, researchers also believe that perceived self-efficacy contributes to environmental protection (Sharifzadeh et al. 2017), adaptation to climate change (Zhao and Xue 2016; Burnham and Ma 2017), and the display of sustainable behavior (Keshavarz and Karami 2016; Moradihaseli et al. 2017; Karasmanaki et al. 2021). Responsibility and awareness of consequences also had a significant effect on the establishment of environmental norms. When farmers are aware of the harmful consequences for themselves, others, and the environment, responsibility is created in them for the environment, and a responsible personal norm is formed in them (Schultz et al. 2005; Steg et al. 2005; Zorbas et al. 2017). Thus, researchers (Tong et al. 2016; Gao et al. 2017; Börger and Hattam 2017; Paswan et al. 2017) suggest that awareness of the consequences and responsibility are the bases for activating environmental norms. Also, personal norms had a significant effect on farmers’ environmental sustainability behavior. Furthermore, if personal norms are in line with environmental sustainability, farmers’ environmental sustainability behavior will be strengthened. However, several scholars (Dwyer et al. 2015; Koklic et al. 2019; Kim and Seock 2019) have pointed out that values and norms can hardly change or influence behavior. Finally, it can be concluded that NAT is an appropriate explanation for the environmental sustainability behavior of farmers.

Given the positive effect of assigning responsibility to personal norms, this is a strong point among farmers, who feel committed to protecting the environment, and this option can be considered a precondition for the effectiveness of training. Therefore, it is recommended to consider this dimension in designing training courses for environmental protection. Using religious teachings with respect to the conservation of the environment and natural resources in educational programs is possible as well. Also, considering the significant effect of personal norms on the sustainable environmental performance of farmers, it is evident that people are inherently motivated to sustain the environment, even if it is somewhat costly. Therefore, it is suggested that relevant institutions, such as Agricultural Jihad and Natural Resources Institution, facilitate the provision of the abovementioned practices for farmers through the provision of facilities because when behavior is difficult and costly for people, they will be unwilling to pursue their personal norms. Due to the lack of a significant relationship between awareness of needs and personal norms, it is necessary to increase farmers’ awareness of environmental problems and the need to resolve environmental problems because the lack of awareness of the needs originates from the lack of farmers’ awareness of the environmental problems and the need to solve them.

Declarations

Ethics approval This article does not contain any studies with human participants performed by any of the authors beyond that which is described in the text.

Conflict of interest The authors declare no competing interests.

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