Environmental Technology & Innovation 28 (2022) 102722

Contents lists available at ScienceDirect

Environmental Technology & Innovation

journal homepage: www.elsevier.com/locate/eti

The promotion of biofertilizer application on farms: Farmers' intentional processes

Pouria Ataei [a], Hamid Karimi [b,*], Christian A. Klöckner [c], Seyed Reza Es'haghi [d], Raha Zarei [e]

[a] Department of Agricultural Extension & Education, College of Agriculture, Tarbiat Modares University (TMU), Tehran, Iran
[b] Department of Agricultural Extension and Education, Faculty of Agriculture, University of Zabol, Zabol, Iran
[c] Department of Psychology, Faculty of Social and Educational Sciences, Norwegian University of Science and Technology, Norway[1]
[d] Department of Agricultural Extension and Education, College of Agriculture and Natural Resources, University of Tehran, P.O. Box 14155-6135, Tehran, Iran
[e] Department of Agricultural Extension and Education, School of Agriculture, Shiraz University, Shiraz, Iran

ARTICLE INFO

Article history:
Received 27 April 2022
Received in revised form 30 May 2022
Accepted 31 May 2022
Available online 8 June 2022

Keywords:
Biofertilizers
Comprehensive action determination model
Farmers' behavioral intention
Sustainable agriculture
Sustainable development

ABSTRACT

The present research investigated factors that contribute to the farmer's behavioral intention to use biofertilizers based on a comprehensive model of environmental behavior (CADM). This study was a retrospective design, quantitative, non-experimental, causal-relational, descriptive-correlational, and applied study. This research contributed the new behavioral theory to recognize farmers' intention and it can be useful for policy makers in agriculture sector. From the total population of farmers in the Fars province, Iran, to whom biofertilizers had been introduced ($N = 2200$), a sample of 327 farmers was selected by a stratified random sampling technique. The study was conducted by applying a questionnaire measuring the model variables in a face-to-face interview situation. The results of the model analyses show that the model receives a satisfactory model fit. Intentions to use biofertilizers are strongly determined by normative processes, situational influence, and attitudes. Habits are strongly related to personal norms and objective constraints, whereas the relation to subjective constraints is weaker. It can conclude that all four components proposed in the CADM have a significant direct or indirect relation to farmers' intentions to use biofertilizers and should be addressed when promoting further use.

1. Introduction

Soil nutrients are vital for efficient production of safe crops and food to meet the requirements of a growing population. However, soil quality is a critical component of sustainable agriculture (Kour et al., 2020; Rahimi et al., 2020). Poor soil quality is one of the most important factors that limit production, especially in developing countries (Mohammadi and Sohrabi, 2012). To increase soil fertility, the application of chemical fertilizers was extensively expanded in the 1950s and 1960s, which led to the Green Revolution entailing an increase in food production around the world, but with adverse impacts on the environment (Agegnehu et al., 2016) so that the overuse of chemical fertilizers, which have gradually

* Corresponding author.
E-mail addresses: pouria.ataei@modares.ac.ir (P. Ataei), karimihamid@uoz.ac.ir (H. Karimi), christian.klockner@ntnu.no (C.A. Klöckner), rezaeshaghi@ut.ac.ir (S.R. Es'haghi), raha.zareie660@yahoo.com (R. Zarei).

[1] Faculty of Social and Educational Sciences.

https://doi.org/10.1016/j.eti.2022.102722

polluted soil and water resources over the years, has turned into one of the sustainability challenges of the agricultural sector (Agegnehu et al., 2016; Atieno et al., 2020). Indeed, the current soil management strategies mainly depend on chemical-based fertilizers, which are a threat to human health and the environment (Bhardwaj et al., 2014; Kour et al., 2020; Duan et al., 2021; Es'haghi et al., 2022). The chemical contents of fertilizers adversely influence the soil by reducing its water retention capacity, increasing its salinity, and reducing its natural nutrients. The overuse of chemical fertilizers leads to that they penetrate groundwater tables and contaminate them (Savci, 2012). In addition, the overuse is harmful to the living organisms of soils and reduces soil organic matter and microbial activity (Sujanya and Chandra, 2011; Yadav and Sarkar, 2019; Ezemagu et al., 2021). Furthermore, these chemical fertilizers are also potentially harmful for consumers' health as the accumulation of specific compounds, e.g., nitrates, in crops might have negative health effects (Koocheki et al., 2014; Mahapatra et al., 2022). In Iran, agricultural activities are highly dependent on the application of chemical fertilizers due to the climatic conditions and predominant soil type in the country (Ghaderi et al., 2012). Consequently, the excessive application of these fertilizers has cost several millions of dollars for their purchase and supply, and the government has incurred heavy expenses as subsidies paid to the farmers. Furthermore, these chemical fertilizers are harmful to the environment with such implications as the accumulation of specific compounds, e.g., nitrates, in crops, which has jeopardized consumers' health (Koocheki et al., 2014).

Biofertilizers are discussed as a better alternative to chemical fertilizers for the sake of protecting the environment and human health. Biofertilizers contain living cells of various microorganisms, including bacteria and cyanobacteria, which cover the plant's rhizosphere or internal space when applied to the seeds, plant surface, and/or soil, thereby promoting plant growth by converting key nutrients (mainly nitrogen and phosphorus) from non-absorbable to absorbable forms (Rokhzadi et al., 2008; Malusa and Vassilev, 2014; Yadav and Sarkar, 2019). In fact, the significance of the microorganisms in biofertilizers lies in the capability of producing nitrogen, potassium, phosphorus, and other nutrients required by the plant (Sahoo et al., 2013; Mahmud et al., 2021). These microorganisms can be applied foliar similar to chemical fertilizers, can be directly incorporated into the soil as inoculums, or can even be used as seed cover (Chandler et al., 2011; Asadu et al., 2020). Most biofertilizers also secrete hormones such as auxin, cytokinin, and biotin, as well as vitamins, for plant growth. Furthermore, by secreting antibiotics, which are effective against most plant pathogens, they protect the plant. They can also protect the plant against salinity and drought stresses. The microorganisms of biofertilizers increase plant resistance to biotic and abiotic stress factors and improve plant yields (Sahoo et al., 2013; Bhardwaj et al., 2014; Igiehon and Babalola, 2017; Raimi et al., 2021). The microbes of biofertilizers are environmentally friendly and contribute to soil fertility. Thus, they play a key role in supplying the nutrient requirement of crops and increasing food production and safety (Mohammadi and Sohrabi, 2012; Yadav and Sarkar, 2019). Since, unlike chemical fertilizers, biofertilizers are natural, decomposable, organic, and economical, their application is strongly recommended (Sahoo et al., 2013). In general, it can be acknowledged that biofertilizers are a major component of integrated nutrient management and are a robust instrument to protect the environment and develop sustainable agriculture (Mohammadi and Sohrabi, 2012; Bhardwaj et al., 2014; Mazid and Khan, 2015; Mahanty et al., 2017; Kour et al., 2020).

However, despite the growing pressure on farmers to adopt environmentally-friendly practices, the factors underpinning their pro-environmental behaviors are not well understood (Keshavarz and Karami, 2016; Ataei et al., 2022) whereas emphasis on the drivers of farmers' behaviors facilitates the change in their pro-environmental behaviors (Fleming and Vanclay, 2011; Shojaei-Miandoragh et al., 2020). Therefore, when designing policies fostering the adoption of environmentally-friendly behaviors by farmers, psychological and behavioral factors should be considered along with other factors (Mishra et al., 2018). Given the significance of farmers' pro-environmental behaviors and the need to motivate them to use biofertilizers, it is imperative to analyze the process behind their behavioral decisions in this context in more detail. Thus, the present research analyzes psychological factors that influence farmers' behavioral intention to use biofertilizers in Iran.

2. Theoretical framework

Human behavior change is essential for environmental protection and the long-term survival of the human communities require proper behavior and environmentally compatible institutional policies (Savari and Gharechaee, 2020a,b). Thus, a key goal of sustainable development is to understand drivers of human behavior regarding the environment (Hou et al., 2014), and recent studies have considered pro-environmental behaviors as a key factor underpinning environmental conservation (Rhead et al., 2015; Tang et al., 2017). In this respect, there are various approaches: The theory of planned behavior (Ajzen, 1991) and the norm-activation model (Schwartz, 1977) are especially useful in the context of environmental actions (Klöckner, 2013). However, Klöckner and Blöbaum (2010) argue that none of these approaches can fully reflect pro-environmental behaviors because each emphasizes certain aspects and ignores others. For example, the theory of planned behavior focuses on intention but ignores the role of objective situational constraints, facilitators, habits, and personal norms. On the other hand, the norm-activation model places emphasis on personal norms but underestimates the role of habits, intentions, attitudes, and situations. Similarly, the ipsative theory of behavior (Tanner, 1999) effectively describes the objective and subjective characteristics of situations as behavior predictors but completely overlooks the normative, habitual, and intentional processes. Therefore, combining the existing theories within a model can be a more promising approach so that this hybrid model can use each model in the context in which it has the best efficiency. As such, Klöckner and Blöbaum (2010) proposed such a model as the comprehensive action

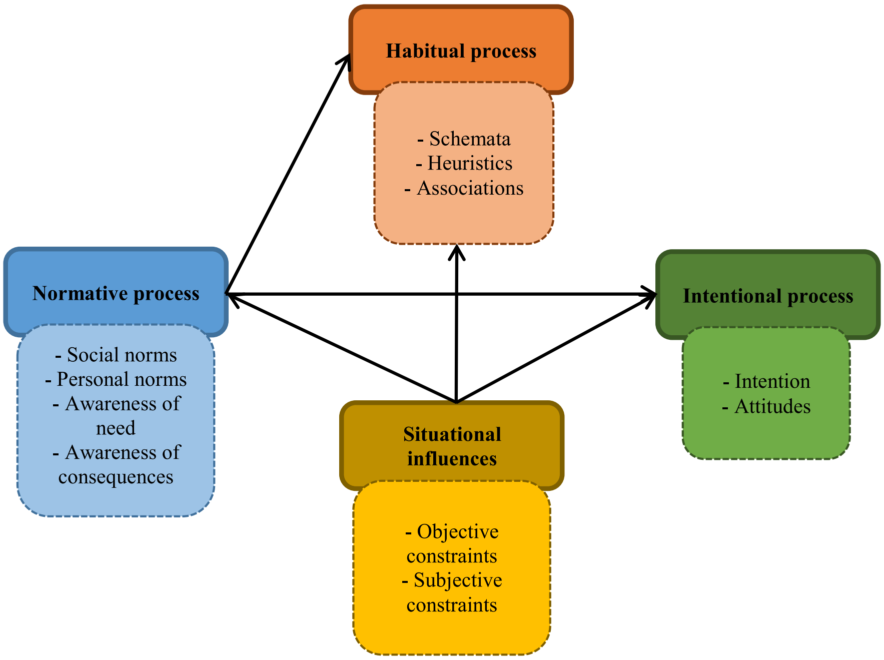

Fig. 1. The theoretical framework of the research.

determination model (CADM). The CADM is composed of intentional, normative, situational, and habitual effects in accounting for pro-environmental behavior. This model is based on the theory of planned behavior (Ajzen, 1991) and the norm-activation model (Schwartz, 1977), but the situational and habitual factors were also included in the framework (Balunde et al., 2020). The first assumption in this model is that an individual's behavior is directly affected by three sources of intentional, situational, and habitual processes. Normative factors influence the exhibition of the behavior indirectly through intentional and habitual factors. Indeed, unlike the norm-activation model, which assumes that personal norms are a direct predictor of behavior, the effect of personal and social norms are indirect in the CADM so that they affect intentional and habitual processes, thereby affecting behavior indirectly (Klöckner and Matthies, 2009). In this model, normative predictors are composed of social and personal norms, awareness of needs, and awareness of consequences. The personal norm reflects a feeling of moral obligation for pro-environmental behavior. Awareness of needs means becoming aware that someone or something one values is suffering negative consequences, and awareness of consequences means that one ascribes the negative consequences seen in AN to one's own behavior (Schwartz, 1977). In this model, the intentional process is the intermediate stage that forms immediately before the behavioral decision. Habit is an automatic reaction that is formed and triggered by frequent prior engagement in similar situations in which a particular behavior has been established (Fishbein and Ajzen, 2011). Finally, situational factors reflect the perceived facilitating or hindering factors in the environment and infrastructure, and function which include objective constraints and subjective constraints.

The validity of CADM was tested in a meta-analytical study (Klöckner, 2013), and several studies have used it to account for pro-environmental behaviors (e.g. (Klöckner and Oppedal, 2011; McDonald, 2014; Izadi and Hayati, 2014; Ofstad et al., 2017a,b; Onokala et al., 2018; van den Broek et al., 2019; Balunde et al., 2020), waste prevention (Balunde et al., 2020), recycling behavior (Fang et al., 2021), personal clothing consumption (Joanes et al., 2020), use of tap water (Poškus et al., 2021), use of consumer electronics recommerce platform (Tang et al., 2017), and Reducing bottled water use (Truskauskaite-Kunevičiene et al., 2021).

Finally, given the theoretical framework of the study (Fig. 1), it was hypothesized that

- H1: normative processes influence farmers' intention to use biofertilizers positively and significantly,
- H2: situational effects influence farmers' intention to use biofertilizers positively and significantly,
- H3: farmers' attitude influences their intention to use biofertilizers positively and significantly.
- H4: personal norms influence farmers' habitual processes positively and significantly,
- H5: situational effects influence farmers' habitual processes positively and significantly,
- H6: objective constraints influence subjective constraints positively and significantly,
- H7: social norms influence farmers' personal norms positively and significantly,
- H8: awareness of consequences influence farmers' personal norms positively and significantly, and
- H9: awareness of need influence farmers' personal norms positively and significantly.

3. Methodology

The research follows a retrospective design because the data collected are related to events that have happened in the past. In terms of objective, it is an applied study since its results can be applied by planners and officials of sustainable agriculture development. The research population was defined as all farmers in the Fars province, Iran, to whom biofertilizers had been introduced. Agriculture extension experts in the public and private sectors introduced biofertilizers by holding briefing courses, distributing advertising brochures, and introducing successful model farmers. Farmers were invited to participate in biofertilizer training courses. In these training courses, the benefits and applications of bio fertilizers were compared with chemical fertilizers. Furthermore, it was trained how to use biofertilizers in the farms. Overall, biofertilizers had been introduced to 2200 farmers. A stratified random sample was drawn from this population. The sample size was determined to be 327 farmers based on Krejcie and Morgan's (1970) table. The study areas were divided into 16 counties (strata were counties where biofertilizers was introduced to farmers). This process involved participation of the population into multiple strata (each county was considered a stratum), out of which samples were taken proportional to the stratum size (the population of each county), and then simple random sampling was applied within each stratum.

Data were collected by the questionnaire composed of two sections — one for the behavioral theory (intentional processes, normative processes, habitual processes, and situational effects) and the other for the farmers' demographic information; social norms (3 items, e.g. 'Farmers whose opinions I value want me to use biofertilizers'), personal norms (3 items, e.g. 'It feels good for me to start using biofertilizers in my own opinion'), awareness of needs (3 items, e.g. 'Fertilizer use is an urgent problem for environmental protection), awareness of consequences (3 items, e.g. 'Reducing fertilizer use will contribute to protecting human health'), habits (3 items, e.g. Using biofertilizers is something I do automatically'), intention (5 items, e.g. 'I intend to use biofertilizer next time I cultivate on the farm'), attitude (3 items, e.g. 'I have a positive attitude towards biofertilizers'), objective constraints (3 items, e.g. 'How much access do you have to biofertilizers?'), and subjective constraints (4 items, e.g. 'Using biofertilizers when I am on the farm is easy for me'). The research variables were measured on Likert's five-point scale (from completely disagree to complete agree). The data were collected through face-to-face interviews. A panel of experts and academic professors was used to confirm the face and content validity of the questionnaire and its diagnostic validity was confirmed by average variance extracted (AVE). To find out the reliability of the research instrument, a pilot study was conducted in which 30 questionnaires were completed by farmers outside the statistical sample and Cronbach's alpha and composite reliability (CR) were calculated. Data were analyzed in the $SPSS_{23}$ and $AMOS_{23}$ software packages in which confirmatory factor analysis was used to validate the theoretical framework of the study and structural equation modeling was used to explore the factors influencing farmers' behavioral intention.

4. Results

4.1. Farmers' demographic characteristics

The frequency distribution of the demographic characteristics among the participants revealed that 85.1% were male and 14.9% were female. Also, 10.7% were single and the remaining 89.3% were married. The farmers were in the age range of 30–77 years with an average age of 48 years. The respondents had, on average, 27 years of experience in agricultural activities. Accordingly, most participants were experienced in agricultural activities. The average number of educational years was 8 years among the farmers. The average family size was 5, the average area of owned land was 10.4 ha, and the average annual earning was 320 million IRR. In terms of the educational level, 61.1% had a diploma or a lower degree, and only 39.9% had a post-diploma educational degree. Also, 89.2% of the respondents had attended less than four educational courses on biofertilizers, while 10.8% had attended more than four courses.

4.2. The status of variables

The variables of the conceptual model were ranked by the coefficient of variations (CV) test. According to the results, the variables of farmers' attitude towards biofertilizers, intention, and subjective constraints were ranked the first to third with the CVs of 0.146, 0.153, and 0.156, respectively. In addition, the variables of awareness of consequences, personal norms, and awareness of needs were ranked the last with the CVs of 0.187, 0.201, and 0.201, respectively (Table 1).

4.3. Correlation between the theoretical model components and the farmers' intention

To have a better understanding of the relationship between the theoretical model components and the farmers' intention, the Spearman correlation test was applied (Table 2). The results of Spearman correlation illustrated a significant correlation between all theoretical model components and the farmers' intention. It was also found that the strongest relationship was between attitude ($r = 0.65$), subjective constraints ($r = 0.50$) and farmers' intention to use biofertilizers.

X_1 = Social norms, X_2 = Personal norms, X_3 = Awareness of needs
X_4 = Objective constraints, X_5 = Attitude, X_6 = Awareness of consequences
X_7 = Habit, X_8 = Subjective constraints, X_9 = Intention

Table 1
Description of the model variables.

Variable	Range	Mean	Std. deviation	CV	Rank
Attitude	3–15	12.44	1.82	0.146	1
Intention	5–25	19.98	3.07	0.153	2
Subjective constraints	4–20	15.56	2.43	0.156	3
Objective constraints	3–15	11.53	1.91	0.166	4
Social norms	3–15	11.01	1.86	0.169	5
Habit	3–15	11.2	2.02	0.180	6
Awareness of consequences	3–15	10.81	2.02	0.187	7
Personal norms	3–15	10.76	2.17	0.201	8
Awareness of needs	3–15	11.19	2.25	0.201	9

Table 2
Correlation matrix between the theoretical model components.

Variables	X_1	X_2	X_3	X_4	X_5	X_6	X_7	X_8	X_9
X_1	1								
X_2	0.66**	1							
X_3	0.64**	0.63**	1						
X_4	0.36**	0.31**	0.38**	1					
X_5	0.13*	0.12*	0.14*	0.30**	1				
X_6	0.48**	0.52**	0.49**	0.36**	0.11*	1			
X_7	0.36**	0.45**	0.38**	0.42**	0.52**	0.45**	1		
X_8	0.16**	0.26**	0.23**	0.51**	0.38**	0.20**	0.34**	1	
X_9	0.34**	0.27**	0.38**	0.43**	0.65**	0.22**	0.45**	0.50**	1

**>0.01.
*>0.05.

4.4. Exploration of the causal model of farmers' intention to use biofertilizers

Structural equation modeling (SEM) was used to analyze the factors underpinning the farmers' intentions to use biofertilizers. Accordingly, the measurement part of the model was assessed to check the validity and reliability of the variables. Also, the general fit of the model was evaluated by various indicators to assess the consistency and conformity of the model with empirical data.

We employed CR and AVE to measure the reliability and validity of the questionnaire. Constructs whose CR is >0.6 are considered reliable enough. The closer this value is to 1, the more reliable the construct will be (Raykov, 1998). Also, constructs whose AVE is >0.5 are valid enough (Iglesias, 2004). To check the validity of a model, the amount and level of significance of paths between the latent variables with their relevant indicators should be studied for which confirmatory factor analysis was used to test whether the indicators considered for accounting for the latent variables or construct really determined them and how accurately the selected indicators determined or fitted the latent variable. Since t-value with values of >1.96 are statistically significant (Bentler and Yuan, 1999), the results show that the indicators used to measure the studied latent traits acceptably matched the factor structure and theoretical framework of the research (Table 3).

The conceptual model of the research was assessed by chi-square/degrees of freedom (χ^2/df), NFI, IFI, GFI, CFI, and RMSEA. Based on the values reported for the model fit indices in Table 4, χ^2/df is equal to 4.9, showing a satisfactory fit of the model. Other indices (NFI, IFI, GFI, and CFI) were estimated at 0.9, 0.93, 0.9, and 0.91, respectively. Finally, RMSEA was used to provide a mechanism for adjusting for sample size where chi-square statistics are used. It was found to be 0.06, showing measurement error in the model was controlled. Accordingly, all reported indices had acceptable values for the general fit of the model. It can, thus, be claimed that the model was generally consistent with the data.

According to the structural model, normative processes have a direct effect on habitual processes and direct and indirect effects on intention to use biofertilizers. Situational influences were found to affect habitual processes, and farmers' intention to use biofertilizers directly and indirectly. Farmers' attitude was also revealed to influence their intention to use biofertilizers directly.

The effects of personal norms ($\beta = 0.44$, $P < 0.01$) and social norms ($\beta = 0.54$, $P < 0.01$) are positive and significant on farmers' intention to use biofertilizers. This supports hypothesis 1 (normative processes influence farmers' intention to use biofertilizers positively and significantly). A positive and significant effects of objective constraints ($\beta = 0.28$, $P < 0.05$) and subjective constraints ($\beta = 0.33$, $P < 0.01$) was found on farmers' intention to use biofertilizers. This supports hypothesis 2 (situational influences affect farmers' intention to use biofertilizers positively and significantly). Furthermore, farmers' attitudes influence their intention to use biofertilizers positively and significantly ($\beta = 0.27$, $P < 0.01$), confirming hypothesis 3 (farmers' attitude influences their intention to use biofertilizers positively and significantly).

The results show that the effect of farmers' personal norms is positive and significant on their habitual processes ($\beta = 0.17$, $P < 0.01$). Accordingly, hypothesis 4 (personal norms influence farmers' habitual processes positively and

Table 3
The measurement coefficients, significance levels of the confirmatory factor analysis, and the validity and reliability of the variables.

	Latent variables	Observed variables	Standardized loading	AVE	CR	α	t-value
Normativeprocess	Socialnorms	SN1	0.766	0.52	0.76	0.72	–
		SN2	0.76				13.08
		SN3	0.643				11.16
	Personalnorms	PN1	0.643	0.54	0.78	0.81	–
		PN2	0.763				11.79
		PN3	0.801				11.79
	Awareness of needs	AN1	0.743	0.58	0.80	0.85	–
		AN2	0.833				13.49
		AN3	0.713				12.13
	Awareness of Consequences	AC1	0.802	0.55	0.78	0.76	10.57
		AC2	0.793				10.48
		AC3	0.617				–
Habitual processes	Habit	HAB1	0.782	0.63	0.83	0.84	13.02
		HAB2	0.884				14.32
		HAB3	0.71				–
Intentional processes	Intention	INT1	0.637	0.50	0.83	0.85	–
		INT2	0.74				10.98
		INT3	0.853				12.11
		INT4	0.633				9.83
		INT5	0.658				10.03
	Attitude	ATT1	0.748	0.58	0.80	0.85	11.45
		ATT2	0.856				12.44
		ATT3	0.674				–
Situationalinfluences	Objective constraints	OC1	0.676	0.50	0.74	0.85	–
		OC2	0.725				6.94
		OC3	0.711				7.15
	Subjective constraints	SC1	0.575	0.50	0.79	0.78	8.95
		SC2	0.843				11.86
		SC3	0.725				10.63
		SC4	0.667				–

Table 4
The fit indices of the research model.

Test	Recommended value[a]	Proposed model
Likelihood ratio Chi-square (χ^2)	Insignificant χ^2 ($p > 0.05$)	<0.001
Normed chi-square (χ^2/df)	χ^2/df < 5	4.9
Root Mean Squared Error	RMSEA<0.08	0.06
Normed fit index	NFI>0.9	0.9
Incremental Fit Index	IFI = Values close to 1	0.93
Comparative Fit Index	CFI > 0.9	0.91
Goodness Fit Index	GFI > 0.9	0.9

[a] Byrne (2016).

significantly) is confirmed. According to the results, the effect of objective constraints is positive and significant on farmers' habitual processes ($\beta = 0.65$, $P < 0.01$). However, the effect of subjective constraints is not significant on farmers' habitual processes. As the results reveal, objective constraints affect subjective constraints to use biofertilizers positively and significantly ($\beta = 0.56$, $P < 0.01$). This is evidence supporting hypothesis 6 (objective constraints influence subjective constraints positively and significantly). The results reveal the positive and significant effect of social norms on farmers' personal norms ($\beta = 0.68$, $P < 0.01$). This supports hypothesis 7 (social norms influence farmers' personal norms positively and significantly). As well, it is found that the effect of awareness of consequences is positive and significant on farmers' personal norms ($\beta = 0.24$, $P < 0.01$). So, hypothesis 8 (awareness of consequences influence farmers' personal norms positively and significantly) is confirmed. However, the effect of awareness of needs on farmers' personal norms is not significant, which refutes hypothesis 9 (Fig. 2).

The results show that the coefficient of determination (R^2) is 0.738 for farmers' personal norms. This implies that 73.8% of the variance in farmers' personal norms is accounted for by variance in social norms, awareness of consequences, and awareness of needs. Also, R^2 was estimated at 0.716 for farmers' intention to use biofertilizers. So, 71.6% of the variance in farmers' intention to use biofertilizers is predicted by variance in normative processes, attitudes, and situational influences. Furthermore, R^2 is 0.649 for habitual process. This implies that 64.9% of the variance in farmers' habitual process is accounted for by variance in personal norms, objective constraints, and subjective constraints.

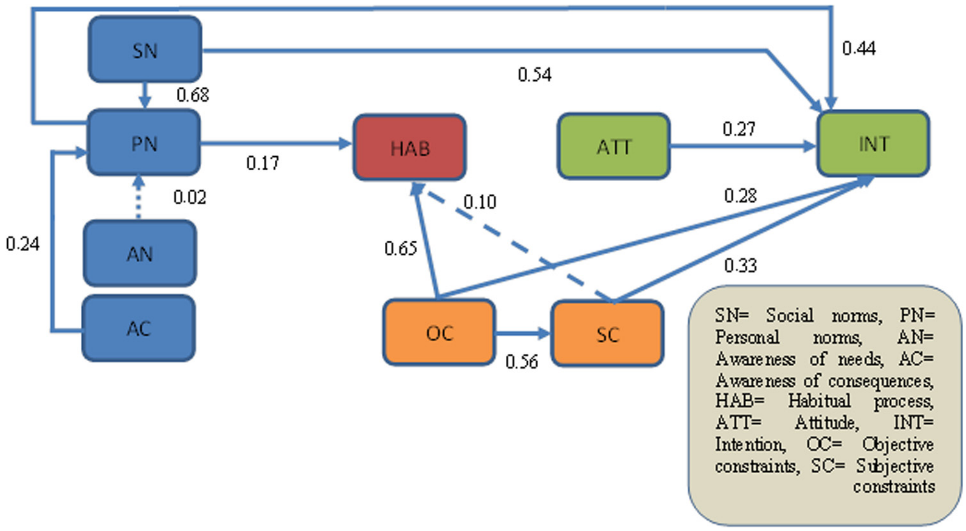

Fig. 2. The structural model of farmers' intention to use biofertilizers.

5. Discussion

The results showed that most psychological factors, which would be expected to predict farmers' intention to use biofertilizers, were significant. Based on the findings, normative processes influence habitual processes and intention to use biofertilizers significantly. In other words, the more the farmers are influenced by others regarding the use of biofertilizers, by perceiving someone or something in need, and by being aware about the negative consequences of their use of chemical and biological fertilizers, the more their intention and habitual processes would be in favour of the use of biofertilizers. Indeed, habits are established with the successful implementation of sustainable behavioral patterns in stable conditions, meaning that prior behavior is a key variable in habit formation. Other researchers (Klöckner and Blöbaum, 2010; Ofstad et al., 2017a,b; van den Broek et al., 2019) have also found an important link between people's norms and habits. They argue that habits are formed on the basis of social norms, personal norms, awareness of needs, and awareness of consequences of behavior in the long run.

The results also show that social norms are a strong predictor of personal norms and farmers' intention to use biofertilizers. It can be argued that stronger social norms increase feelings of moral obligation towards the use of biofertilizers and the likelihood of farmers' intention to apply biofertilizers at their farms increases. In other words, if there is high social pressure for the use of these fertilizers, farmers' intention and their felt moral obligation will increase. Additionally, farmers who are aware of the consequences of the use of biofertilizers can make appropriate decisions on their application. Izadi and Hayati (2014), Chang et al. (2018), Alhama et al. (2020), Dong et al. (2020) and Balunde et al. (2020) confirm this finding. Similarly, they have found that normative processes affect people's intention. Indeed, group compatibility in the social criteria and awareness of needs and consequences makes people act like other members of the group.

Situational influences were also found to have a positive and significant effect on habitual processes, and farmers' intention to use biofertilizers. So, when farms are in situation where access to biofertilizers is less limited, intentions to use them are reinforced and habits can be formed around the use of biofertilizers over time. Furthermore, if a farmer perceives that biofertilizers are easy to use and their application is under their control, they will have a stronger intention to use them. This corroborates with the results of Klöckner and Matthies (2009), Klöckner and Oppedal (2011), Izadi and Hayati (2014), and Varela-Candamio et al. (2018), who have reported that situational influences are a fundamental factor in the formation of intentional process in people. According to these researchers, a major factor determining people's intention to use innovation is their situation, their access to the innovation, and their awareness of its advantages.

The results regarding the significant effect of attitude on farmers' intention to use biofertilizers mean that if farmers have a positive attitude towards biofertilizers and their advantages, their intention to use them will increase. In other words, a person who believes that the use of biofertilizers will have positive consequences will more likely form an intention to use this technology. This is consistent with the results of Ofstad et al. (2017a,b), Varela-Candamio et al. (2018), van den Broek et al. (2019), and Wang et al. (2020). They have, also, concluded that more positive attitudes towards a behavior increase the probability of its exhibition by people.

6. Conclusions

This research contributed a better understanding of the mechanisms that change farmers' intention to use biofertilizers. Recognizing these mechanisms also determines the process of formation of farmers' intentions in decision making. By strengthening behavior change mechanisms, we can help farmers make the right decisions. The results revealed that normative processes, habitual processes, situational influences, and attitude are the most important predictors of farmers' behavioral intention to use biofertilizers. The results imply that to increase farmers' intention to use biofertilizers, they need to understand that the use of biofertilizers is under their own control and they are capable of their application at their farms. Also, social and personal norms should form, and norms should be towards the use of biofertilizers. These findings support the conceptual framework adopted and show that CADM matches the data and provides a good description of the factors underpinning farmers' intention to use biofertilizers. In other words, as a model for the study of behavioral intention, CADM could specify the determinants and inhibitors to help the officials of sustainable agriculture development find ways to improve farmers' intention to use biofertilizers.

Based on the results, it is recommended to hold training courses and workshops and resort to the proper advertisement of biofertilizers to improve farmers' attitude. The agricultural extension service uses demonstration farms or farm schools with the this goal. In this regard, demonstration farms can be developed to execute the application of biofertilizers. Another determinant of farmers' intention to use biofertilizers was found to be situational influences. In this respect, agriculture extension agents are recommended to hold regular meetings with farmers to learn about their problems in the use of biofertilizers and help them resolve their problems. Based on the results, normative processes are another factor involved in farmers' intention to use biofertilizers. Since social norms form within a community through the relationship with others, extension agents can focus on groups in which farmers are active and which form farmers' information sources in order to identify and strengthen farmers' communicational channels in the region. Habitual processes were revealed to be another determinant of farmers' attitudes towards biofertilizers. It was pointed out that habitual processes are an automatic response created by performing the same behavior again and again in stable circumstances, this making them triggered automatically without thinking. So, by enhancing farmers' knowledge and awareness of the nature of biofertilizers and expressing the environmental and crop safety challenges, their perception can be prepared for the use of biofertilizers. Introducing successful domestic and international experiences can be effective in improving farmers' subjective image. Also, farmers should be fully aware of the characteristics of biofertilizers and the ease of their application so that they start to use them after examining their situation.

Albeit the research broadened our comprehension of farmers' intention to use biofertilizer, it has some specific impediments that should be spotted in ongoing researches. This study was only investigated in one province of Iran. Subsequently, what is presently required is a cross-public research study on samples from different provinces so that it can assist with announcing summed-up outcomes. One of the most important limitations of this study was the extent to which farmers' intentions to use biofertilizers became a behavior. It is not possible to argue exactly that all farmers who have a strong intention to use biofertilizers apply them in practice.

CRediT authorship contribution statement

Pouria Ataei: Conceptualisation, Investigation, Methodology, Supervision, Formal analysis, Visualisation, Writing – original draft. **Hamid Karimi:** Experimentation, Writing – review & editing. **Christian A. Klöckner:** Writing – review & editing. **Seyed Reza Es'haghi:** Experimentation, Formal analysis. **Raha Zarei:** Formal analysis, Visualization.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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