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Determinants of Farmers' Intention to Use Eco-Friendly Technologies: Pheromone Trap to Control of the Rice Pests in Simorgh County

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تعیین‌کننده‌های قصد کشاورزان برای کاربرد فناوری‌های سازگار با محیط‌زیست: موردمطالعه کاربرد تله‌های فرمونی برای کنترل آفات برنج در شهرستان سیمرغ

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چکیده:

کشاورزی پایدار در گرو کاربرد فناوری‌های سازگار با محیط‌زیست از سوی کشاورزان است. تحقیق حاضر با هدف شناسایی و ارزیابی تعیین‌کننده‌های قصد کشاورزان برای استفاده از تله‌های فرمونی در کنترل آفات برنج در مزارع شهرستان سیمرغ به انجام رسید. به این منظور از روش تحقیق توصیفی مبتنی بر پیمایش پرسشنامه‌ای استفاده شد. جامعه آماری این تحقیق شامل ۱۵۰۰ نفر از شالیکاران ۲۹ روستای شهرستان سیمرغ می شد که با استفاده از فرمول کوکران ۲۰۴ کشاورز به‌عنوان نمونه انتخاب شدند. برای انتخاب نمونه‌ها از روش نمونه‌گیری طبقه‌ای با انتساب متناسب استفاده شد. روایی ظاهری و محتوایی پرسشنامه بر اساس نظر متخصصان و پایایی آن بر اساس محاسبه ضریب آلفای کرونباخ برای متغیرهای تحقیق بین قصد ۰/۷ تا ۸/. به دست آمد. داده‌ها با استفاده از نرم‌افزار SPSS 20 مورد تجزیه‌وتحلیل قرار گرفتند. نتایج نشان داد که ۳۳/۸ درصد و ۱۶/۷ درصد از پاسخگویان به ترتیب قصد نسبتاً قوی و قوی برای استفاده از تله‌های فرمونی دارند. تحلیل مسیر رگرسیونی برای شناسایی اثرات مستقیم و غیرمستقیم متغیرهای مستقل بر متغیر وابسته نهایی قصد استفاده از تله‌های فرمونی مورداستفاده قرار گرفت. نتایج نشان داد که هنجارهای ذهنی بیشترین تأثیر را بر متغیر وابسته (قصد استفاده) دارد (r=۰/۹۴۷). با توجه به اثرات مستقیم و غیرمستقیم، متغیر ادراک از مشکلات با مجموع تأثیر ۱/۳۷۳ در جایگاه اول بود. درمجموع، تأثیرگذاری متغیرهای نگرش، کنترل رفتاری و هنجارهای ذهنی بر قصد استفاده از تله فرمونی بر اساس مقدار ضریب تأثیر کل، به ترتیب برابر با ۰/۳۹۱، ۰/۶۹۰ و ۱/۰۷۶ بود.

واژه‌های کلیدی: فناوری سازگار با محیط‌زیست، کشاورزی پایدار، مبارزه بیولوژیکی، تله‌های فرمونی.

Abstract:

Sustainable agriculture depends on the use of eco-friendly technologies by farmers**.** This research was conducted to identify and evaluate farmers' intent to use pheromone traps for controlling rice pests in paddy farms of Simorgh County, Mazandaran Province. Methodologically, this research was carried out using a questionnaire-based survey. The statistical population of this research included 1,500 farmers in 29 villages of Simorgh County, in which 204 farmers were selected using Cochran formula. Samples were selected using proportionate stratified random sampling. The formal and content validity of the questionnaire was based on experts' opinion and its reliability was calculated based on Cronbach's alpha coefficient. Cronbach's alpha coefficient was calculated between.70 and.80 for the scales of research variables. Data were analyzed using SPSS 20 software. The results showed that 33.8% and 16.7% of the respondents intended to use pheromone traps relatively strongly and strongly, respectively. The regression path analysis method was used to identify the direct and indirect effects of independent variables on the final dependent variable of intention to use the pheromone traps. The results of the path analysis showed that subjective norms had the most direct effect on the dependent variable (intention to use) (r=0.947). In terms of total direct and indirect effects, the perceived barrier to use with a total impact of 1.373 was in the first place. According to beta coefficients, the variables of attitude, behavioral control, and subjective norms had total effects of 0.391, 0.690, and 1.076**,** respectively.

Keywords: Eco-Friendly Technology, Sustainable agriculture, Biological control, Pheromone traps.

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Introduction

Rice cultivation is the dominant pattern of agricultural production in the northern region of Iran. A considerable portion of the crop is lost due to pest and disease attacks annually (Salami & Khaledi, 2001). This has led to the widespread use of a variety of chemical pesticides which have caused harmful effects on human health and the environment (Razzaghi Borkhani et al., 2012). Recently, by the intensification of cultivation and the increase in pest outbreak, using pesticides have been increased considerably which requests the need for using diverse strategies to control pest damages. One of these strategies is Integrated Pest Management (IPM). IPM as an alternative concept of pest control suggests a wide range of agricultural, biological, chemical, and mechanical methods for rational pest control. IPM pursues both goals of minimizing the damage to the environment and gaining the maximum economic benefit simultaneously.

Currently using pheromone traps as a new method to control pests was well identified among farmers as the most practical way to control harmful insects. Pheromones transmit chemical messages within species and trigger short-term behavioral responses. Pheromones are messengers that stimulate members of a particular group of plants or animals. Therefore, the increasing emphasis on IPM, especially the use of pheromone traps, is a tangible option to control pests and reduce the use of chemical pesticides in farm fields. In particular, it is estimated that it is possible to reduce dependency on pesticides by 35 to 50 percent without reducing the yield of the product (James et al., 1996).

The aim of promoting IPM practices (such as biological control and pheromone traps) is to identify the natural enemies of each pest in the area and use their ability and function to control the pest. The purpose of this strategy is not to eliminate all harmful pests, but to reduce their population to the point where they cause the least damage to the farm or the environment. While after two decades of effort to promote IPM practice in a farm field, there is still a long road to achieving full adoption by farmers. Moreover, the implementation of IPM methods (including pheromone telephony) faces many institutional, socio-economic, information, and institutional constraints (Abdollahzadeh et al., 2015). Attributes of the biological control method and certain perceptions of farmers, such as compatibility of the technology (i.e., consistency with existing values, prior experiences, and needs of farmers), perceived self-efficacy about the method, facilitating conditions (i.e., technical support), perceived usefulness and ease of use of the technology were significant factors for the adoption (Abdollahzadeh et al., 2017). That is why farmers accept such innovation when they have an accurate assessment of the problems and obstacles to its application according to their conditions. In this regard, barriers and constraints are often considered as a mediating factor that shows the willingness and intention of farmers to accept biological control methods such as pheromone traps (Greiner et al., 2009).

This research aimed to identify the determinants of farmers' intent to use pheromone traps for controlling rice pests in paddy farms of Simorgh County, Mazandaran Province. Currently, 1500 farmers are cultivating rice in Simorgh County and actively involved with biological control. Additionally, 62 extension courses and 395 personal training courses about sex pheromone were provided for farmers in this area. During the same period, 352 pheromone traps were distributed among farmers in the area. Despite the evidence that the use of pheromone traps is not common among farmers on the study site, the question arises as to what factors have led paddy farmers to use pheromone traps in their paddy fields.

Literature review: several studies about the adoption of IPM methods are available in Iran. Veisi et al. (2011) studied the farmer's behavior in the adoption of IPM technologies in rice-growing fields. Findings revealed that 57.5% of adopters practiced the technologies of IPM through execution of biological control practices, however, adaptors were in a better state in terms of knowledge, attitude, planning horizon, the area under cultivation, and free from a need for off-farm income sources in comparison with non-adaptors

adaptors who were of an older age group. Results showed that knowledge, attitude, planning horizon, access to inputs, membership in a local group as well as soil quality influence directly the adoption behavior, while land tenure influence negatively the adoption behavior. Abdollahzadeh et al. (2017) found attributes of the biological control method and certain perceptions of farmers, such as compatibility of the technology (i.e., consistency with existing values, prior experiences, and needs of farmers), perceived self-efficacy about the method, facilitating conditions (i.e., technical support), perceived usefulness and ease of use of the technology were significant factors for the adoption of the use of biological control with *Trichogramma* spp. for the management of the Asiatic rice stem borer in rice fields of Iran. Another study by Abdollahzadeh et al. (2018) revealed farmers who believed in the efficacy of biological control as a pest management method measure were more likely to have a positive attitude towards biological control, while those who perceived more barriers to biological control use were less likely to have a positive attitude towards biological control.

Parsa et al. (2014) studied the opinions of IPM professionals and practitioners from 96 countries and concluded that the lack of adequate training and technical support was the most important factor in farmers' reluctance to use IPM methods. Terano et al. (2015) examined the factors influencing paddy farmers' intention to adopt sustainable agricultural activities in Malaysia and showed that attitude, perceived behavioral control, age, method of storing chemical inputs, knowledge of IPM methods and good agricultural practices impact the intention to use sustainable agricultural activities.

This study aimed to determine the factors affecting farmers' intentions to use the sexual pheromone traps in paddy fields and employed the Theory of Planned Behavior (TPB) (Ajzen, 1991) to accurately explaining the influence of attitude, control of perceived behavior, mental norms in farmers' intention. Perceived barriers to use as external variables (Abdollahzadeh et al., 2018) was added to the main constructs of TPB. The conceptual model of this study and the variables entered into this model are presented in Figure 1.

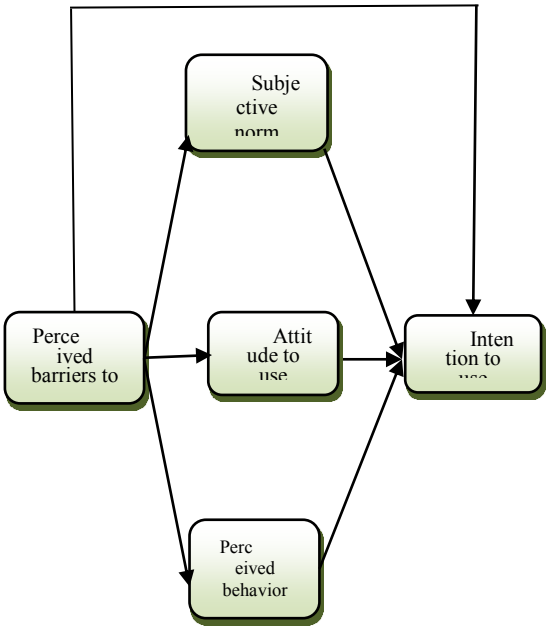

Figure 1: Conceptual model of research

Methodology

This is a survey study and used the researched made questionnaire for data gathering. The questionnaire consisted of two parts. The first part included questions related to farmers and farm characteristics. The second part measured farmers' perceptions of each variable in the conceptual model. This part consisted of 38 items measuring the five latent variables; 1-intention to use (6 items), 2-attitude to use (9 items), 3-subjective norm (6 items), 4-perceived behavior control (7 items) and a 5-perceived barrier to use (10 items). Likert-type scales from 1 to 5 with endpoints of 'strongly agree' and 'strongly disagree' were used for storing all items. We used the mean score of all the items of each construct as a representative variable of that construct into statistical analysis. The face and content validity of the questionnaire was investigated and confirmed by several experts from the Jihad Agricultural Management of the County and members of the research team. To investigate the reliability of constructs, the Cronbach's alpha coefficient was calculated. All of the resulting five constructs achieve a

Cronbach's alpha >0.70 signify the reliability of the research questionnaire.

The target population for this study consisted of 1,500 rice farmers within 29 villages of Simorgh County, Mazandaran province. The area is known for considerable consumption of pesticide inputs, given that insect pests and fungal diseases destroy a considerable proportion of rice produce almost every year (Abdollahzadeh et al., 2015). The main crops grown in the province are Rice, citrus fruits, wheat, soybeans, rapeseed, kiwi, vegetables and summer vegetables, strawberries, corn, and clover. The area under rice cultivation in the study area is about 2908 hectares. 1745 hectares belong to local variety and 1163 hectares belong to high-yielding variety (Mazandaran Agricultural Jihad website, 1397). The samples were calculated to 204 rice farmers using the Cochran equation (Bartlett et al., 2001). Using the random sampling method based on proportional allocation, the samples were chosen from all 29 villages. After excluding questionnaires with missing information, a total of 204 questionnaires met all the required criteria of the survey. Data were analyzed using the statistical software SPSS 20 for Windows. Summary statistics, Mean, standard deviation (SD), coefficient of variation (C.V), frequency distributions, and path analysis were used to describe and interpret data.

Findings

Sociodemographic characteristics of respondents

The basic socio-economic characteristics of the farmers are provided in Table 1. The majority of respondents were men (99%). The average age and the farming experience of respondents were about 52 and 30 years respectively. The education level of most respondents is not very high; 74.8% of the respondents had primary education, 18.62% had secondary education, 16.20% had high school education, 44.14% had a diploma and 13.20% had a college education. Also, the main occupation 74% of respondents was agricultural, and most farmers were not members of any organization. Most farmers were small scale farmers and the average total land area under ownership was slightly more than one hectare. 76% of farmers had second cultivation after rice harvesting and 36.8% cultivated clover. 74.5% of the respondents used local rice variety and 66.2% prepared their required seeds from local Agriculture Jihad Centers. About 46% had three farmworkers. The majority of farmers (86.8%) sell their produced rice to dealers. The majority of respondents (56.4%) have been using biological control for 9 years or more. 81.9% of farmers attend in extension courses and the average number of participation in extension programs was between 5 to 10. Most farmers evaluated the effectiveness of extension programs for promoting pheromone traps at a medium level.

Describe farmers' intentions to use pheromone traps

The overall mean of the intention to use sex pheromone traps was high (average = 3.71), and the average of all items of this variable is more than 3 (Table 1). This suggests that most paddy farmers intend to use pheromone traps. The item ‘I intend to use pheromone trap to produce a healthy product’ had the highest mean score (4.446) and the item ‘I intend to encourage other farmers to use pheromone trap’ had lowest mean score (3.8). About 50% of respondents had a strong and relatively strong intention to use pheromone traps and the other half of the respondents had a weak and relatively weak intention to use such traps in their farm (Table 2).

Describe attitudes toward the use of sex pheromones

The items of respondents' attitudes toward the use of sex pheromones are presented in Table (3). Overall, most of the farmers (65.7%) had a positive and relatively positive attitude towards using sexual pheromone traps, and 34.3% had a negative and relatively negative attitude in this regard (Table 4).

Table 1. Intent of respondents to use pheromone trap

Indicators	Mean	S.D	C.V	Rank
I intend to use a pheromone trap to produce a healthy product	4.44	0.51	0.11	1
Despite the greater influence of chemical pesticides, I tend to use the pheromone trap to control rice pests in the field.	4.19	0.79	0.18	2
I tend to use the pheromone trap to reduce the cost of spraying.	4.03	0.87	0.21	3
I would like to fight with the pheromone trap on the farm.	4	0.89	0.22	4
In the event of government subsidies and easier access to the market, I intend to make a pheromone trap with my wealth.	3.9	0.86	0.22	5
I intend to encourage other farmers to use a pheromone trap.	3.8	0.88	0.23	6

Table 2. Level of respondents' intention in using pheromone trap

Level	frequency	Percentage	Cumulative Percentage
Weak	41	20.1	20.1
Relatively weak	60	29.4	49.5
Fairly strong	69	33.8	83.3
Strong	34	16.7	100

Mean: 3.71 SD: 0.68

Table 3. The attitude of respondents to the use of pheromone trap

Indicators	Mean	S.D	C.V	Rank
The existence of a suitable market for healthy rice increases the incentive to use the pheromone trap.	4.77	0.47	0.09	1
By using a pheromone trap, we respect the rights of consumers in rice pest control.	4.57	0.49	0.10	2
Using the pheromone trap helps protect the environment.	4.55	0.51	0.11	3
Farmers are responsible for reducing the use of chemical pesticides on their farms.	4.45	0.54	0.12	4
By using a pheromone trap, a healthy product is produced.	4.38	0.6	0.13	5
With the spread of various diseases caused by the use of pesticides, the use of a pheromone trap is essential and important.	4.18	0.59	0.14	6
Implementation of the use of the pheromone trap is effective in reducing rice pests.	3.71	0.61	0.16	7
The use of non-chemical countermeasures, despite the slow pace of impact compared with chemical methods, is valuable.	3.71	0.69	0.18	8
The pheromone trap operation is a time consuming and costly process.	2.89	1.1	0.38	9

Table 4. Level of respondents' attitude toward using pheromone trap

Level	frequency	Percentage	Cumulative Percentage
Weak	13	6.4	6.4
Relatively weak	57	27.9	34.3
Fairly strong	91	44.6	78.9
Strong	43	21.1	100

Mean: 4.23 SD: 0.24

Describe the items of perceived behavioral control

Perceived behavioral control implies that an individual's perception of the ease or difficulty of performing the desired behavior, and the resources and opportunities required to perform the desired behavior (Table 5). 34.3% of respondents revealed that they have a weak ability to use sexual pheromone traps to combat pests, and they believe that it is difficult to use this technology in paddy fields. About 41% also stated that using this technology in paddy fields is relatively easy and they can use this technology in their paddy fields (Table 6).

Table 5. Respondents' Perceived Behavior Control in using **a** pheromone trap

Indicators	Mean	S.D	C.V	Rank
Learning to use pheromone traps will control more of my rice farm pests**.**	4.69	0.69	0.14	1
I can reduce the use of chemical pesticides by using pheromone traps in my field**.**	4.42	0.76	0.17	2
I have the knowledge and skills to use pheromone traps on my farm**.**	4.28	0.78	0.18	3
It's easy for me to learn how to use and use pheromone traps in the rice field**.**	4.14	0.82	0.19	4
I can help other farmers in the use of pheromone traps in rice**.**	3.90	0.89	0.22	5
The use of pheromone traps does not require much effort**.**	3.62	1.06	0.29	6
I can use pheromone traps on my farm without the help of others**.**	3.59	1.13	0.31	7

Table 6. Level of the Respondents' Perceived Behavior Control in using pheromone trap

Level	frequency	Percentage	Cumulative Percentage
Weak	22	10.8	10.58
Relatively weak	70	34.3	45.1
Fairly strong	83	40.7	85.8
Strong	29	14.2	100

Mean: 3.94 SD: 1.07

Describing the items of mental norms

Perceived subjective norm refers to the perceived social pressure from colleagues and friends to do or not to do the target behavior. According to the results (Table 7); about 66% of respondents did not care much about the mental norms and social pressures exerted by neighbors on the use of pheromone traps in paddy fields. While about 64% of the respondents stated they cared about norms and social pressures exerted by colleagues (Table 8).

Table 7. Description of the subjective norms of respondents regarding the use of pheromone trap

Indicators	Mean	S.D	C.V	Rank
Other farmers will also use the pheromone trap in the future**.**	4.19	0.63	0.15	1
The opinion of the local agricultural experts regarding the use of the pheromone trap is important to me**.**	4.16	0.69	0.18	2
Village council members believe those pheromone traps are very important for the health of the product**.**	4.11	0.88	0.24	3
The people who matter to me think that I should use a pheromone trap on my farm**.**	4.05	1.05	0.32	4
Most family members encourage me to use fennel traps on the field**.**	3.31	1.1	0.33	5
Most farmers have used pheromone traps on their farm**.**	2.65	0.92	0.34	6

Table 8. level of the subjective norms of respondents regarding the use of pheromone trap

Level	frequency	Percentage	Cumulative Percentage
Weak	90	44.1	44.1
Relatively weak	45	22.1	66.2
Fairly strong	54	26.4	92.6
Strong	15	7.4	100

Mean: 3.87 SD: 0.75

Describe items of a perceived barrier to use pheromone traps

The item 'lack of easy access to pheromone trap and difficulty in providing them' had the highest mean score (4.02) and the item 'lack of access to fresh pheromone trap' had lowest mean score (2.73) (Table 9). According to the results of Table 10, about 52% of the respondents perceived the barrier of use pheromone traps as relatively low and low level. 48% of respondents perceived the barrier to the use of pheromone traps in paddy as relatively high or high.

Table 9. Description items of a perceived barrier to using pheromone traps

Indicators	Mean	S.D	C.V	Rank
Lack of easy access to pheromone trap and difficulty in providing them	4.02	0.50	0.12	1
Lack of support of agricultural experts and extension agents in this regard from farmers	3.89	0.55	0.14	2
Lack of timely delivery of pheromone trap to farmers	3.70	0.57	0.15	3
Need to spray with pesticides in some contaminated areas that have been removed from the function of the pheromones.	3.68	0.60	0.16	4
Lack of information and training on the use of pheromone trap	3.35	0.61	0.18	5
There is no extension agent and expert familiar with this issue	3.33	0.68	0.2	6
The problem of identifying the economic threshold of the pest	3.21	0.70	0.21	7
The difficulty of installing and adjusting the distance between the traps in the field (not observing the appropriate distance between the traps)	3.03	0.71	0.23	8
Effectiveness of pheromone trap in eliminating pests	2.83	0.73	0.25	9
Lack of access to fresh pheromone trap	2.73	0.75	0.27	10

Table 10. Level of the respondents' perception of problems in using pheromone trap

Level	frequency	Percentage	Cumulative Percentage
Weak	52	25.5	25.5
Relatively weak	54	26.5	52
Fairly strong	40	19.6	71.6
Strong	58	28.4	100

Mean: 3.18 SD: 0.56

Correlation results

There is a positive and significant relationship between the variables of attitude, behavior control, and subjective norm to use pheromone traps. In contrast, there is a negative and significant relationship between the perceived barrier to use pheromone traps with intention, attitude, behavior control, and subjective norm. Therefore, if the problems perceived by farmers decrease, their intention, attitude, perceived behavior control, and the subjective norm will decrease.

Table 11. Correlation between the intention to use pheromone traps and independent variables

	Intention	Attitude	Behavior control	Subjective norm	Perceived barriers
Intention	1	**0.771	**0.879	*0.926	**-0.701
Attitude		1	**0.824	**0.725	**-0.829
Behavior control			1	**0.993	**-0.825
Subjective norm				1	**-0.768
Perceived barriers					1

* Significant at P < 0.05, ** Significant at P < 0.01.

Path analysis results

To investigate the direct and indirect effect of the independent variables on the dependent variable of farmers' intention use pheromone traps, path analysis has been used. Therefore, we used multiple linear regression analysis to test the research hypotheses (Table 12). The results, including the standardized β coefficient for each independent variable, R-Square, an F-statistic for each regression

model are reported in Table 12. The R square value in the first model (dependent variable: Intention) is 89.6, which shows that 89.6% of the changes in the intention to use are explained by the three variables of attitude, subjective norms, and perceived barriers. β coefficient imply that attitude (β = 0.391), subjective norms (β = 0.947) and perceived barriers (β = 0.253) have a direct and significant effect on the intention to use pheromone traps, while the behavioral control (β = 0.117) has no significant effect on predicting the dependent variable. The Durbin-Watson values all fell in the range from 1.5 to 2.1 (Table 4), which indicated that the residuals were not correlated and autocorrelation was not a problem in our study. Moreover, the presence of multicollinearity was investigated and revealed that the variables did not show severe multicollinearity problems.

Table 12. Regression analysis of factors affecting the intention to use pheromone trap

Variables	B	Variables	Beta value	t value	Sig.
Dependent variable: Intention					
Constant coefficient	4.50	0.651	-	6.91	0.000
Attitude	1.10	0.131	0.391	8.396	0.000
Behavior control	0.075	0.051	0.117	1.476	0.142
Subjective norm	0.864	0.059	0.947	14.624	0.000
Perceived barriers	0.294	0.053	0.253	5.561	0.000
Model summary: R2 = 0.896, F-value =436.93, Sig = 0.000					
Dependent variable: Attitude					
Constant coefficient	4.62	0.125	-	36.92	0.000
Behavior control	0.170	0.024	0.751	6.94	0.000
Subjective norm	0.107	0.031	0.331	3.47	0.001
Perceived barriers	0.190	0.025	0.463	7.60	0.000
Model summary: R2 = 0.821, F-value = 234.29, Sig = 0.000					
Dependent variable: Behavior control					
Constant coefficient	1.397	0.348	-	4.012	0.000
Subjective norm	1.044	0.050	0.729	20.804	0.000
Perceived barriers	0.482	0.064	0.265	7.548	0.000
Model summary: R2 = 0.899, F-value = 892.12, Sig = 0.000					
Dependent variable: Subjective norm					
constant coefficient	6.42	0.185	-	34.65	0.000
Perceived barriers	0.977	0.057	0.798	17.058	0.000
Model summary: R2 = 0.588, F-value = 290.98, Sig = 0.000					

To investigate the effects of intermediate variables the final effect coefficient has been calculated by multiplying the beta coefficient of variables in each path. Figure 2 shows that the subjective norm, attitude and perceived barriers have a direct and significant effect on the intention to use. Perceived barriers, behavioral control, and subjective norms also have indirect effects through intermediate dependent variables on the dependent variable.

The greatest direct effect on the final dependent variable is related to the effect of the subjective norm (0.947). Regarding total direct (includes indirect and direct effects), perceived barriers with the total effect of 1.373 are in the first rank. Other variables, attitude, behavioral control, and subjective norm have the total effects of 0.391, 0.690, and 1.076, respectively, and the behavior control variable has no direct effect (Table 13).

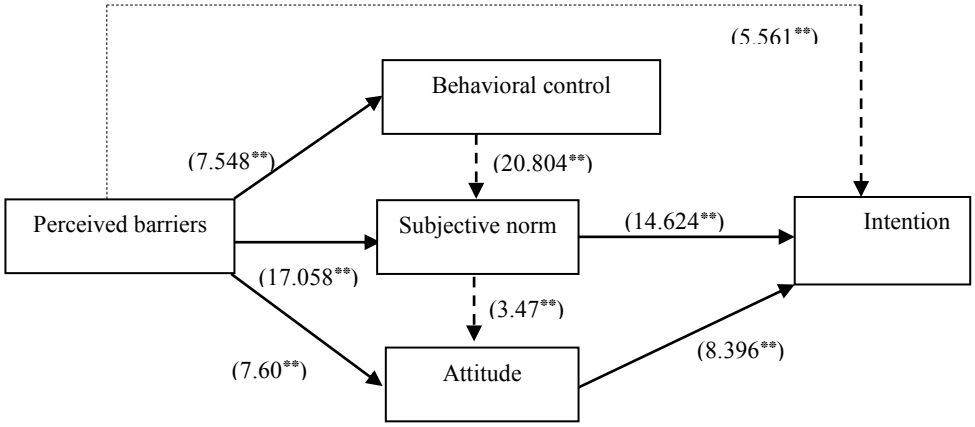

Figure 2. Path analysis for influencing variables on the intention to use pheromone trap (parentheses values indicates the t and the significant level)

Table 13. Total effects of independent variables on the intention to use pheromone trap

Independent variables	Indirect effects	Direct effects	Total effects
Attitude	-	0.391	0.391
Behavior control	0.690	-	0.690
Subjective norm	0.129	0.947	1.076
Perceived barriers	1.120	0.253	1.373
Total	1.939	1.591	3.530

Conclusions and suggestions

The study found that about 35% of farmers used pheromone traps, 30.9% mix of used pheromone traps, and chemical control finally 23.52% used only chemical control to combat rice pests. Results also revealed that there was a positive and significant relationship between all independent variables and dependent variables (intention to use pheromone traps). These results are consistent with the findings of some prior studies (Bond et al., 2009). In line with the results of some studies, including Salari et al. (2015) and Sandoghi and Raheli (2016), the results of this study also indicate that the behavioral control has no direct and significant effect on intention, but has an indirect effect on the dependent variable through the intermediate variable of the subjective norm. The positive and significant relationship between the two variables of perceived barriers intention to use of pheromone trap in paddy fields shows the importance of the effort to mitigate barriers of using pheromone trap such easy, fast, and cheap access when pest outbreak.

Path analysis based on s series of the regression model was used to examine the hypotheses. According to the TPB, this research has the final dependent variable of farmers' intention to use pheromone traps, and the variables of "behavior control", "subjective norm" and "attitude" are dependent. Also, the variables "perceived barrier to using" were added to the basic model because our previous field study revealed that this variable has an important role in constraining the adoption process of new technology among rice farmers.

Hypothesis 1: subjective norms influence the intention of paddy farmers to use pheromone traps. The results showed that among the three main constructs of TPB, the greatest direct effect on the intention to use comes from the subjective norm (total effect = 1.076). This result implies that there is sufficient evidence to support this hypothesis. This result is in line with the findings of Yazdanpanah et al. (2016) who showed that the subjective norms of greenhouse owners are the most important predictor of their intention to use biological control methods.

Also, Bund et al. (2009) showed subjective norms have a positive effect on behavioral control and intention to use biological control technology.

Hypothesis 2: Perceived behavioral control connect positively to the intention to use pheromone traps. The results showed that behavioral control had no direct and significant effect on the dependent variable. But this construct has an indirect effect on the intention to use the pheromone trap through the variable of the subjective norm as an intermediate variable (indirect and total effect = 0.690). This finding is in line with previous research by Salari et al. (2015) which revealed that perceive behavioral control does not affect livestock growers' intention regarding animal welfare. Also, the results of Trano et al.'s (2015) research showed that the variables of attitude, perceived behavioral control, age, storage method of chemical inputs and the amount of knowledge and awareness of integrated pest management methods and good agricultural activities in general 76% of the variable changes explain the intention to use sustainable agricultural activities. Also, the results of Fund and Rachel's (2016) research showed that perceived behavioral control and mental norms did not have a significant effect on the prediction of greenhouse owners. Consistent with this finding Terano et al. (2015) showed that attitude, perceived behavioral control, age, method of storing chemical inputs, knowledge of IPM methods and good agricultural practices impact the intention to use sustainable agricultural activities. Also, the results of Sandoghi and Racheli (2016) showed that perceived behavioral control and subjective norms did not have a significant effect on the greenhouse owners' intention.

Hypothesis 3: perceive barriers to use connect positively to the intention to use pheromone traps.
The results of path analysis showed that the perceived barrier to using (total effect = 1.373) has the greatest total effect on the dependent variable. These results are consistent with the results of a study by Abdollahzadeh et al. (2015), which showed that farmers' willingness to accept biological control methods depends on perceived barriers to use to using biological control methods.

Hypothesis 4: Attitudes affect the intention to use pheromone traps. The results showed that the attitude has a direct and significant effect on the dependent variable (total effect = 0.391) which supports this hypothesis 4. The results of the study of Abdollahzadeh et al. (2018) showed attitude toward and intention to use biological control by citrus farmers indicated that most farmers have a positive attitude towards biological control and intend to use these methods in their farms. Also, Bond et al. (2009) showed that attitude is the most important factor influencing behavioral intention. The results of the study by Sabdoghi and Racheli (2016) showed that the attitude can explain 37% of the changes in greenhouse owners' intentions to adopt organic products. Based on the above results, it can be concluded that the TPB fits for predicts determines of the farmers' intentions to use pheromone traps. The following suggestions can be proposed to promote the use of pheromone traps as an environmentally friendly technology among paddy farmers:
(1) Given the positive attitude and intentions to use more pheromone traps, it is necessary to strengthen institutional, technical, and financial support to promote the use of this technology. Strengthen the skills of local experts and provide specialized training is effective. (2) According to research, the perceive behavioral control due to its relationship with farmers 'skills plays an important role in increasing farmers' willingness and intention to use these traps. Therefore, increasing extension ad training programs about long-term benefits and how to use sex pheromone traps, with an emphasis on improving farmers' skills and demonstrating the effectiveness of these methods and encouraging farmers to attend these courses, can increase perceived behavioral control.
(3) Given the significant effect of subjective norms on farmers' intentions to use pheromone traps, the strategy of encouraging family members and neighboring farmers to use traps can potentially be effective. (4)

Considering the positive effect of attitude, pilot farms, and can be used to ensure the effectiveness of pheromone traps.
Given that the perceived barrier to has a direct and significant impact on the intention, so the problems of farmers in understanding the technical details, time, and conditions of use, should be practically analyzed and solved in technical training programs. (6) Given that intention is an influential factor in the use of pheromone traps, the Agricultural Jihad Organization can seek to strengthen sustainable agriculture and food health by providing financial and technical incentives. Finally, in future research, the relationships between the constructs of our proposed model can be analyzed using structural equation models (SEM).

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