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Full Length Research Paper

Application of integrated pest management (IPM) practices by paddy farmers in Sari county of Mazandaran province, Iran

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The main purpose of this study was to investigate the application of integrated pest management (IPM) practices by paddy farmers. The statistical population consisted of paddy farmers in Sari county of Mazandaran province, Iran. A sample of 260 farmers was selected by using proportional random sampling method. Data were collected by use of a questionnaire. The validity of the instrument was established by agricultural Jihad exports of Sari county and some faculty members at the University of Tehran. Cronbach's alpha was used to estimate the reliability. The reliability was found to be acceptable. The results revealed that educational level, participation in extension-education courses, attitude toward IPM practices and income were some factors correlated with the extent of IPM practices application by paddy farmers. Regression analysis indicated that about 68.5% of the variation in the extent of IPM practices application by paddy farmers could be explained by variables consisting level of knowledge toward IPM practices, farm income from rice production, level of perception toward IPM practices, participation in extension-education courses, level of communication channels usage and production yield.

Key words: Integrated pest management (IPM), paddy farmers, technology, application, attitude.

INTRODUCTION

Concerns about the safety and quality of food, combined with increased environmental awareness, have led to a need for sustainable agricultural production systems (Rasul and Thapa, 2004; Wageningen UR Centre for Development Innovation, 2011). Decreasing crop losses because of pests is a necessary factor to increase food safety and access to sustainable agricultural development (Van Huis and Meerman, 1997), and one of the major goals of sustainable agricultural systems is reducing use of chemical inputs in agriculture. Integrated pest management (IPM) is one approach which deals with these issues (Conway, 1996). Integrated pest management is an effective and environmentally sensitive approach to pest management that relies on a combination of practices (Hoyt, 2001) including biological, chemical, cultural, and other practices (Tette et al., 1987). IPM enables farmers to reduce their reliance on pesticides while maintaining or increasing yields, crop quality and profitability (Mauceri, 2004). Since pesticides can pose serious threats to human health and the environment (WHO, 1990) and IPM is the best mechanism to solve this issue, it is imperative to investigate application of IPM practices by farmers and to find factors influencing application of IPM as well. Attention to studies in the field of factors influencing application of technologies, including IPM, has found different factors. Chaudhary et al. (2001) found that about 90% of farmers accepted the technology in moderate and high levels. Educational level, land size, annual income, utilization patterns and knowledge of farmers were positively and significantly correlated with level of technology adoption.

In contrast, age, household size, agricultural experience, economic stimulation, risk orientation and information sources were not correlated with level of technology adoption. Mauceri (2004) conducted a survey of 109 potato farmers in Carchi, Ecuador that included 30 farmer field school (FFS) participants, 28 farmers who

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had been exposed to FFS-participants, and 51 randomly selected farmers. Using an ordered probit model, the data were analyzed to identify determinants and constraints of adoption. Access to information through FFS was the main determinant of adoption of IPM, followed by field days, pamphlets, and exposure to FFS-participants. The study looked at the relative cost-effectiveness of information dissemination methods and found that field days and pamphlets had strong impacts on adoption considering their low cost of implementation. The only significant household variable was household size, where larger households adopted less IPM. Per capita land holdings were not significant in the model. Reddy and Suryamani (2005) conducted a survey with the objective to study impact of farmer field school (FFS) approach on acquisition of knowledge and skills by farmers. The researchers found that there was a significant difference in knowledge and skills of IPM practices between two groups of farmers, who had participated in FFS planning and who had not participated. Rejaul and Bakshi (2005) found that educational level, age, farm scale and training had positive effect on adoption of IPM technologies. In contrast, agricultural experience and poor health had negative effect on adoption of IPM technologies. Asai and Tokunaga (2007) found that in IPM programs, farmer field schools (FFS), contact with extension agents and familiarity with agricultural service centers had an important role in increasing farmers' skills and reducing the use of pesticides.

Maraddi et al. (2007) conducted a research with the objective to study the extent of adoption of IPM practices by sugarcane growers. The expost-facto research design was used for the study. The extent of correlation and multiple regression between the independent variables was ascertained by using suitable statistical tool such as Pearson's and Spearman's correlation coefficient. The researchers found that educational level, farming experience, risk orientation, attitude towards sustainable cultivation practices, management orientation, achievement motivation, innovative proneness and extension contact of farmers had positive and significant correlation with the extent of IPM technologies adoption by farmers. Multiple regression analysis indicated that all the selected independent variables of the respondents put together had contributed to 43.18% variation in extent of adoption of IPM practices. Ofuoku et al. (2008) carried out a study to ascertain the level of IPM adoption among farmers in Central Agro-ecological zone of Delta State, Nigeria. Descriptive statistics and quantitative statistics were employed in the analysis of the data. The findings revealed that the level of adoption of technology was poor because of the poor frequency of extension contact that would have enhanced the adoption of the innovation. Marital status, household size, involvement of every household member was the significant demographic factors influencing the use of the innovation. Truong Thi (2008) studied on factors affecting technology adoption in rice production through the lens of local managers to contribute to the building of strategies and policies for technology adoption. The researcher found that the main factors affecting farmers' adoption of technologies were their perceptions of technologies, knowledge level of extension staff, methods of organization and management of the extension program and local conditions. Low education, low perception, lack of capital, small land, not good infrastructures and limited capacity of extension staff led to low technology adoption. Technologies with complicated components or required more time and labors were difficult for farmers to apply.

Chowdhury and Ray (2010) located the factors that affected the knowledge level as well as the level of adoption of the integrated pest management (IPM) techniques by the selected vegetable growers. The data were collected with the help of a structured schedule/ questionnaire developed for the study and through the personal interview method. The relationship between the selected traits of the respondents and their level of adoption in relation to the IPM techniques in the vegetable under study was examined by using simple correlation co-efficient. The researchers found that a majority of the respondents had low knowledge index and low level of adoption of the IPM techniques. Caste, educational status, total monthly income, type of dwelling and experience of respondents in vegetable cultivation were significantly and positively correlated with the adoption level of the respondents. Also, the knowledge index and adoption level of the respondents regarding the IPM techniques in the selected vegetable cultivation were highly and positively correlated. Totally, attention to the aforementioned studies, farmers had different levels of adoption and application of IPM practices. Also, various factors such as farming characteristics, economic characteristics, education, extension and communicational characteristics, and psychological characteristics affected application of IPM practices by farmers. Rice is the world's most important food crop and a primary source of food for more than half of the world's population (Khush, 2004). More than 90% of the world's rice is grown and consumed in Asia where 60% of the earth's people live (Khush, 2004).

In Iran, rice is, after wheat, the second major source of food for people. In Iran, over 27,000 tonnes of pesticides are used annually, with 60% of this usage occurring in three Northern provinces close to the Caspian Sea (UNDP, 2005). Mazandaran province is one of the Northern provinces close to the Caspian Sea. Rice as the most important strategic product of Mazandaran province, with cultivation size of 201,793 ha, has the highest percentage of rice production in Iran (Ministry of Agricultural Jihad, 2006). Attention to chemical pesticides usage in Iran shows the highest consumption of chemicals in rice fields. Since IPM practices emphasize minimal use of pesticides in controlling pests, their

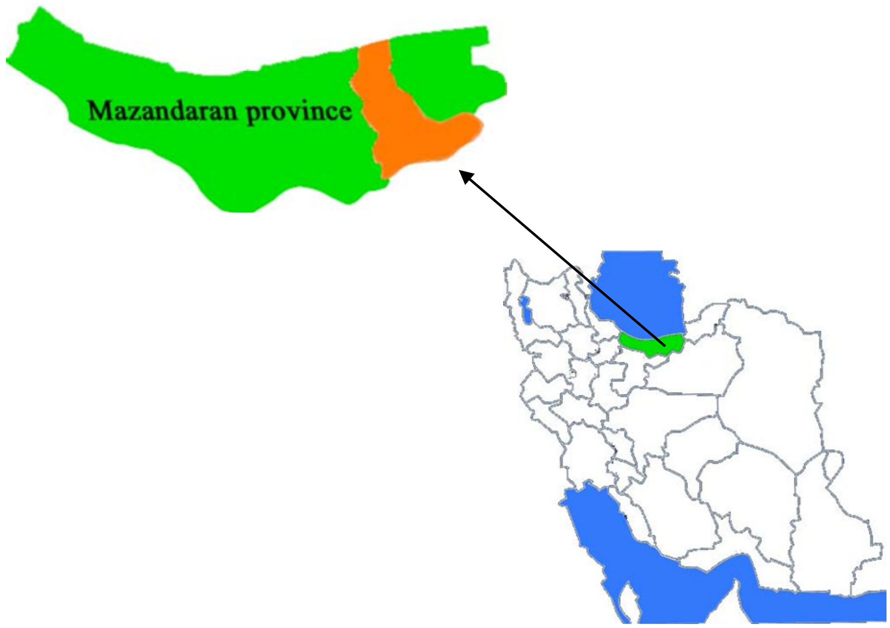

Figure 1. Study site [Mazandaran province (Sari county= Orange county)].

Table 1. Statistical population and sample size of the study.

County	District	No. of paddy farmers per district	Sample size
Sari	Chardangeh	3928	36
	Dodangeh	2121	20
	Markazi	12178	112
	Kelijanrestagh	3815	35
	Miandorod	6125	57
	Total	28170	260

application by farmers can reduce the use of pesticides and their adverse impacts as well. In Iran, application of integrated pest management technologies in rice fields was started from 1990 with emphasis on the use of Trichogramma wasps. Extension agents should be aware of factors affecting application of IPM technologies by farmers, so that the more probable adoption and application of IPM practices will be. Since studies focusing on application of IPM practices for rice production are very limited, this study attempts to investigate application of IPM practices by paddy farmers in Sari County of Mazandaran Province. The specific objectives of the study were:

1. Identifying characteristics of respondents;
2. Identifying the levels of IPM practices application by respondents;
3. Investigating factors associated with application of IPM practices by respondents;
4. Regression analysis to explain variations in the extent of IPM practices application.

MATERIALS AND METHODS

This study was a descriptive-correlation research, carried out in Sari county, which is located in Mazandaran province (Figure 1). In Iran 60% of pesticides usage occurring in three Northern provinces close to the Caspian Sea, including Guilan, Mazandaran and Golestan (UNDP, 2005). Rice as the most important strategic product of Mazandaran province has 37.17% of rice production in Iran, with cultivation size of 201793 ha. The statistical population of the study consisted of paddy farmers (N= 28170) in five districts of Sari county including Chardangeh, Dodangeh, Markazi, Kelijanrestagh, and Miandorod. A sample of 260 farmers was selected by using proportional random sampling method (this value was derived through computing Cochran's formula) (Table 1). From a review of literature, the researchers developed a questionnaire divided into different sections. Table 2 shows variables used in the study. The extent of IPM practices application by paddy farmers was measured in three parts including application of IPM practices for rice pest control (20 questions), application of IPM practices for rice disease control (10 questions), and application of IPM practices for rice weed control (8 questions) in accordance to studies done by Souza et al. (1993), Bonabana-Wabbi (2002), Supriatna (2003), Asai and Tokunaga (2007), and Truong Thi (2008). All these parts were measured on a Likert-type scale ranged from 0 to 5 (0=no, 1=low, 2=very low, 3=intermediate, 4=high and 5=very high).

Table 2. Research variables.

Variables		
Dependent variable	Level of IPM practices application	1) Application for Pest control 2) Application for disease control 3) Application for weed control
Independent variable	Personal characteristics	1) Gender 2) Age 3) Educational level 4) Household size 5) Agricultural experience
	Economic characteristics	1) Number of family work force 2) Production yield 3) Cost of Production yield 4) Cost of pesticides 5) Farm income from rice production (annually) 6) Total income (annually)
	Farming characteristics	1) Cultivation area for agricultural products 2) Cultivation area of rice 3) Extent of pesticides usage
	Education, extension and communicational characteristics	1) Participation in extension - education courses 2) Number of contacts with extension experts 3) Level of communication channels usage
	Psychological characteristics	1) Level of knowledge toward IPM practices 2) Level of attitude toward IPM practices 3) Level of perception toward IPM practices

Validity determines whether the research truly measures that which it was intended to measure or how truthful the research results are (Joppe, 2000). Validity of the instrument was obtained by Agricultural Jihad experts of Sari county and some faculty members at University of Tehran, Department of Agricultural Extension and Education. Reliability of the instrument was measured by calculating Cronbach's Alpha coefficient, a measure of internal consistency. Cronbach's alpha reliability coefficient normally ranges between 0 and 1. The closer Cronbach's alpha coefficient is to 1.0 the greater the internal consistency of the items in the scale. George and Mallery (2003) provide the following rules of thumb: "_ > 0.9 – Excellent, _ > 0.8 – Good, _ > 0.7 – Acceptable, _ > 0.6 – Questionable, _ > 0.5 – Poor, and _ < 0.5 – Unacceptable" (p. 231). The reliability for various questions was more than 0.7, found to be acceptable. Data were collected through personal structured interviews (face to face interview) with respondents at their farms.

Data were analyzed using Statistical Package for the Social Sciences (SPSS). Descriptive and inferential statistics were used to analyze the collected data. Descriptive statistics included frequency, percentage, mean, standard deviation, and so forth. Correlation coefficient and multiple regression analysis were used in the inferential analysis section. Pearson's correlation coefficient and Spearman's correlation coefficient was applied to test probabilistic relationship between variables, according to scale of variables. In order to measure the degree of influence of the independent variables on a dependent variable (the extent of IPM practices application by paddy farmers) stepwise multiple regression analysis was conducted. To categorize the extent of IPM practices application by paddy farmers, the following formula was applied (Sadighi and Mohamadzadeh, 2002):

Min<A<Mean-SD: A= Low
Mean- SD <B<Mean: B = Relatively low
Mean <C<Mean+ SD: C= Relatively high
Mean+ SD <D<Max: D = High

RESULTS AND DISCUSSION

Characteristics of the sample

According to the findings, respondents were on average 49 years old. About 26.5.0% of respondents were between the age of 41 and 50 years. While, 12.0, 13.5, 24.2, 21.1 and 2.7% of respondents were <31, 31 to 40, 51 to 60, 61 to 70 and >70 respectively. 71.9% of the respondents were literate and 28.1% were illiterate. Respondents' experience in agricultural activities was 29 years on average. Findings showed that more than half of the respondents (61.9%) had lands less than 2 ha in size for cultivation of rice. While, 25.8, 10.4 and 1.9% of respondents had lands 2 to 4, 4 to 6 and > 6 ha in size respectively. The average income of paddy farmers was 84.96 million Rials annually.

Table 3. Application levels of IPM practices.

Level / Practice	Low		Relatively low		Relatively high		High		Mean	SD
	F	%	F	%	F	%	F	%		
Pests control	51	19.6	77	29.6	82	31.5	50	19.3	51.28	7.66
Diseases control	42	16.2	69	26.5	110	42.3	39	15.0	26.91	5.16
Weeds control	43	16.5	62	23.9	118	45.4	37	14.2	21.99	4.37
Total	52	20.0	64	24.6	101	38.9	43	16.5	100.19	15.16

Table 4. Priority setting of practices for pests control.

Statement	Mean	SD	Priority
Seeding and transplantation in appropriate time	3.965	0.699	1
Putting harvested rice in the sun	3.873	0.778	2
Pesticides use in appropriate time	3.654	0.768	3
Farming alternation in order to control rice pests	3.604	0.781	4
Use of rathe varieties of rice	3.577	0.784	5
Proper management of farm water	3.550	0.791	6
Use plastic for covering	3.492	0.885	7
Deep plowing after harvesting	3.427	1.064	8
Second plowing	3.423	0.799	9
Cutting the bottom of rice stem when harvesting	3.238	1.056	10
Collecting rice straws after threshing	3.138	1.067	11
Using the recommended extent of seed for each of rice varieties	3.100	1.034	12
Collecting and destroying rice stems infected by pests	2.796	1.468	13
Eliminating breeding sites of pests	2.242	1.185	14
Biological control with Trichogramma wasp	1.731	1.071	15
Avoiding spraying during activities of beneficial insects	1.108	0.807	16
Planting of rice varieties resistant to pests	1.020	0.835	17
Using light traps to control pests	0.127	0.442	18
Using pheromone traps to control pest	0.123	0.473	19
Using biological toxins	0.104	0.448	20

Application levels of IPM practices by respondents

Table 3 shows application levels of IPM practices by paddy farmers. As it can be seen, of the farmers, 19.3, 15.0 and 14.2% had high level of IPM practices application for pest control, diseases control and weeds control respectively.

Priority setting of practices for pests control

Table 4 shows that seeding and transplantation in appropriate time had first priority because of having the highest mean (mean=3.965). Putting harvested rice in the sun (Mean=3.873), pesticides use in appropriate time (mean=3.654), farming alternation in order to control rice pests (Mean=3.604) and use of rathe varieties of rice (mean=3.577), respectively, had allocated priorities from second to fifth. In addition, using biological toxins with the lowest mean had allocated last priority to itself.

Priority setting of practices for diseases control

Table 5 shows that farming alternation in order to reduce rice diseases (mean=3.555) and using rice varieties resistant to diseases (mean=1.062), respectively had first and last priorities, because of having the highest and the lowest mean. In addition, using chemical fertilizers according to the recommended extent (mean=3.440), using recommended toxins (mean=3.396), paddy land drainage (mean=3.331), and disinfection rice seeds (mean=3.312) had allocated priorities from 2nd to 5th, respectively.

Priority setting of practices for weeds control

Table 6 shows that weeding and eliminating weeds (mean= 4.108), using herbicides in appropriate time and according to the recommended extent (mean=3.692) and getting seeds from healthy part of farm (mean=3.669)

Table 5. Priority setting of practices for diseases control.

Statement	Mean	SD	Priority
Farming alternation in order to reduce rice diseases	3.555	0.819	1
Using chemical fertilizers according to the recommended extent	3.440	0.825	2
Using of recommended toxins	3.396	0.888	3
Paddy land drainage	3.331	0.823	4
Disinfection rice seeds	3.312	1.435	5
Putting appropriate space between rice plants	3.208	1.033	6
Eliminating rice infected with diseases	2.508	0.798	7
Reducing the number of stems in each rice plant	2.150	0.944	8
Using green and manure fertilizers according to the recommended extent	1.178	1.188	9
Using rice varieties resistant to diseases	1.062	0.858	10

Table 6. Priority setting of practices for weeds control.

Statement	Mean	SD	Priority
Weeding and eliminating weeds	4.108	0.603	1
Using herbicides in appropriate time and according to the recommended extent	3.692	0.784	2
Getting seeds from healthy part of farm	3.669	0.941	3
Farming alternation in order to control rice weeds	3.650	0.874	4
Setting the appropriate water depth	3.627	1.015	5
Removing and burning weeds around the farm	2.727	0.957	6
Controlling field water to find whether it is polluted with weed seeds	1.246	0.967	7
Controlling weeds by integrated rice cultivate and duck-culture	0.135	0.498	8

had priorities from 1st to 3rd, respectively. In contrast, controlling weeds by integrated rice cultivate and duck-culture had the last priority to itself.

Correlation analysis

Correlation for independent variables and the extent of IPM practices application by respondents are presented in Table 7. It is recognizable that educational level was positively and significantly ($p<0.01$) correlated with the extent of IPM practices application by paddy farmers. This result is consistent with the results of Chaudhary et al. (2001), Van Duren (2003), Atreya (2007) and Truong Thi (2008). Bonabana-Wabbi (2002) found that educational level was not correlated with the extent of IPM practices application. There was negative and significant correlation ($p<0.01$) between the extent of IPM practices application by paddy farmers and age. This result is accordant to different studies done by Chaves and Riley (2001), Souza et al. (1993), and in contrast with studies done by Chaudhary et al. (2001) and Maraddi et al. (2007). There was negative and significant correlation ($p<0.01$) between the extent of IPM practices application by paddy farmers and agricultural experience. This result is consistent with study done by Rejaul and Bakshi (2005), and in contrast with study done by Maraddi et al. (2007). There was no correlation between the extent of IPM practices application by paddy farmers and household size. This result is consistent with different studies done by Bonabana-Wabbi (2002) and Chaudhary et al. (2001). Bonabana-Wabbi (2002) found that household size was not correlated with the extent of IPM practices application.

As shown in the Table 7, total income, farm income from rice production, production yield were positively and significantly ($p<0.01$) correlated with the extent of IPM practices application by paddy farmers. These results are consistent with the results of Chaudhary et al. (2001), Bonabana-Wabbi (2002) and Mariyono (2007). According to the findings, cultivation area for agricultural products and cultivation area of rice were positively and significantly ($p<0.01$) correlated with the extent of IPM practices application by paddy farmers. These results are consistent with the results of Chavesand and Riley (2001), Chaudhary et al. (2001) and Truong Thi (2008). Participation in extension - education courses, number of contacts with extension experts, and level of communication channels usage were positively and significantly ($p<0.01$) correlated with the extent of IPM practices application by paddy farmers. These results are consistent with the results of Mauceri (2004), Truong Thi (2008), Ofuoku et al. (2008), Bonabana-Wabbi (2002), Rejaul and Bakshi (2005) and Mariyono (2007).

Table 7. Results of correlation analysis.

Factor	Variable	Pests control practices	Diseases control practices	Weeds control practices	IPM practices (Total)
		r	r	r	r
Personal characteristics	1) Age	-0.443**	-0.449**	-0.414**	-0.381**
	2) Educational level	0.469**	0.435**	0.533**	0.519**
	3) Household size	-0.144*	-0.167**	-0.216**	-0.183**
	4) Agricultural experience	-0.409**	-0.395**	-0.425**	-0.443**
Economics characteristics	1) Number of family work force	-0.144*	-.0167**	-0.216**	-0.183**
	2) Production yield	0.261**	0.317**	0.255**	0.299**
	3) Farm income from rice production	0.358**	0.369**	0.328**	0.383**
	4) Total income	0.422**	0.395**	0.338**	0.425**
	5) Cost of pesticides	-0.151*	-.077	-0.109	-0.128*
Farming characteristics	1) Cultivation area for agricultural products	0.268**	0.304**	0.220**	0.289**
	2) Cultivation area of rice	0.312**	0.354**	0.293**	0.346**
	3) Extent of pesticides usage	-0.398**	-0.418**	-0.429**	-.451**
Education, extension and communicational characteristics	1) Participation in extension - education courses	0.571**	0.523**	0.563**	0.602**
	2) Number of contacts with extension experts	0.394**	0.387**	0.431**	0.435**
	3) Level of communication channels usage	0.632**	0.586**	0.648**	0.675**
Psychological characteristics	1) Level of knowledge toward IPM practices	0.716**	0.660**	0.712**	0.757**
	2) Level of attitude toward IPM practices	0.537**	0.475**	0.504**	0.553**
	3) Level of perception toward IPM practices	0.604**	0.553**	0.598**	0.636**

There was positive and significant correlation ($p<0.01$) between level of paddy farmers' attitude toward IPM practices and the extent of IPM practices application, that Huan et al. (1999), Elsey and Sirichoti (2001) and Maraddi et al. (2007) have confirmed this correlation. There was positive and significant correlation ($p<0.01$) between level of paddy farmers' knowledge toward IPM practices and the extent of IPM practices application that Chaudhary et al. (2001), Peshin and Kalra (2002), Muthuraman and Sain (2002), Nabirye et al. (2003), Mauceri (2004), Atreya (2007), Maraddi et al. (2007) and Truong Thi (2008) have confirmed this correlation. There was positive and significant correlation ($p<0.01$) between level of paddy farmers' perception toward IPM practices and the extent of IPM practices application. This result is consistent with the results of Elsey and Sirichoti (2001) and Truong Thi (2008). Bonabana-Wabbi (2002) found that farmers' perception toward IPM practices was not correlated with the extent of IPM practices application.

Regression analysis

In order to explain variation in the extent of IPM practices application by paddy farmers, a multiple regression analysis was conducted. An overview

Table 8. An overview of stepwise model.

Model	R	R Square	Adjusted R square
1	0.757	0.572	0.571
2	0.789	0.623	0.620
3	0.811	0.658	0.654
4	0.819	0.671	0.665
5	0.823	0.678	0.671
6	0.828	0.685	0.678

Table 9. Regression analysis to explain variation in the extent of IPM practices application by paddy farmers.

Description	Label	B	Beta	t	Sig.
Constant		32.215		6.736	0.000
Level of knowledge toward IPM practices	KIPMP	0.661	0.379	6.078	0.000
Income from rice production	INCOME	1.007	0.360	5.173	0.000
Level of perception toward IPM practices	PIPMP	0.879	0.238	4.919	0.000
Participation in extension- education courses	PEEC	0.519	0.099	2.051	0.041
Level of communication channels usage	CCU	0.330	0.148	2.556**	0.011
Production yield	PY	-0.304	-0.168	-2.467**	0.014

of stepwise model is shown in Table 8. Among independent variables that had significant correlation with dependent variable, level of knowledge toward IPM practices, farm income from rice production, level of perception toward IPM practices, participation in extension - education courses, level of communication channels usage and production yield have entered to regression equation by six steps. The R Square value of 0.685 reveals that 68.5% of variation in the extent of IPM practices application by paddy farmers could be explained by the aforementioned variables. Considering the results shown in Table 9, regression equation in standard situation will be as follows:

$$Y = \text{constant} + B_1X_1 + B_2X_2 + B_3X_3 + B_4X_4 + B_5X_5 + B_6X_6 \quad (1)$$

Equation (1) shows that (Y) is used as dependent variable that representing the extent of IPM practices application, (X_i) is an independent variable and (B_i) is the coefficient of independent variable. Consequently, the final equation of regression is:

Y = 32.215 + 0.661 KIPMP + 1.007 INCOME + 0.879PIPMP + 0.519 PEEC + 0.330 CCU - 0.304 PY

To explain the equation, we infer that while the level of knowledge toward IPM practices, income from rice production, level of perception toward IPM practices, participation in extension- education courses, and level of communication channels usage increased and in contrast, production yield decreased; the extent of IPM practices application by paddy farmers will be more.

RECOMMENDATIONS

Public concern about food safety and the environment has led to increased demands for beneficial agricultural production methods such as IPM. It is obvious that success of agricultural extension in this regard is due, to identify the level of application of IPM practices and to find factors affecting application of IPM technologies by farmers as well. The study's findings revealed that paddy farmers were relatively middle-aged and agricultural experience of most of them was higher than 20 years. Farmers based on experiences and indigenous knowledge, were self-made. They were combined new knowledge with their experiences and use in farm management decisions. Therefore, it is recommended that extension agents use experiences and indigenous knowledge of farmers in educational- extension programs, and with combining indigenous knowledge and modern knowledge, provide more appropriate educational – extension messages.

The findings revealed that farmers' attitude toward IPM practices and the extent of IPM practices application were correlated. For improving farmers' attitude, it is recommended that extension agents state clear advantages of IPM practices. Using delivery methods such as field demonstration and farmer field schools (FFS) are proper methods to achieve this purpose. There were significant correlations between level of paddy farmers' perception toward IPM practices and the extent of IPM practices application. Therefore, perceptions can be an important factor influencing on IPM practices application. Farmers, according to conventional belief about the impact of conventional pesticides, feel they need pesticides usage. Therefore, they consume pesticides and chemical pesticides, even with the high prices. So, reducing pesticide usage and application of IPM practices, requires changing farmers perception. Hence, agricultural extension agent can affect farmers' perceptions and behaviors.

Results of regression analysis showed that level of knowledge toward IPM practices could explain the most variation in the extent of IPM practices application by paddy farmers. Therefore, it is recommended to use FFSs and extension workshops to increase farmers' knowledge toward IPM practices. The findings of regression analysis revealed that income from rice production was the second variable, could explain the variation in the extent of IPM practices application by paddy farmers. Since one of the barriers to adoption and application of technologies, including IPM, is farmers' low risk orientation, it is recommended to provide incentives such as loans and facilities for farmers who have low income. This will increase farmers' application level.

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