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Investigating the Major Barriers to Adoption of IPM Technologies by Paddy Farmers

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Abstract: The main purpose of this study was to investigate the major barriers to adoption of integrated pest management (IPM) technologies by paddy farmers. A sample of 260 farmers was selected by using proportional random sampling method. Data were collected by means of a questionnaire. Data were analyzed using Statistical Package for the Social Sciences (SPSS). The results revealed that lack of knowledge and information for using IPM technologies and lack of equipments and facilities for using IPM technologies were the major barriers to adoption of IPM technologies. Factor analysis showed that infrastructure barriers, management barriers, economics-social barriers, institutional-support barriers and training-skills barriers were the five barriers to adoption of IPM technologies by paddy framers.

Key words: Integrated pest management (IPM) · Barriers · Paddy farmers · Factor analysis · Knowledge

INTRODUCTION

Worldwide, insects and diseases cause billions of dollars in damages to crops every year. Farmers depend mainly on chemical technologies to manage pests and generate profits in their enterprises [1]. However, despite their many benefits, it is now clear that pesticides may also have unfortunate consequences [2]. Pesticides can pose serious threats to human health and the environment [3].

Now, there is the question of how effectively deal with agricultural pests. Integrated Pest Management (IPM) is one approach that deals with these issues. Integrated Pest Management is an effective and environmentally sensitive approach to pest management that relies on a combination of practices [4] including biological, chemical, cultural and other practices [5]. IPM enables farmers to reduce their reliance on pesticides while maintaining or increasing yields, crop quality and profitability [1].

In order to have a more effective impact on promoting wide spread adoption of IPM technologies, concentrating on barriers to adoption can be more fruitful.

Tette *et al.* [5] in their studies concluded that barriers to adoption of IPM technologies included the lack of extension agent understanding and thus reinforcement of IPM principles and practices, the lack of trained personnel and organized opposition from the chemical industry.

Nowak [6] stated that reasons for farmers being unable to adopt new technologies included their inadequate managerial skills, the lack or scarce information regarding economic or technical issues of these technologies, lack of practical knowledge from change agents to help farmers to implement practices, the poor applicability and relevance of the information to the local conditions, the increased risk, the cost and investments and increase on labor requirement. Vanclay [7] found that barriers to adopt new techniques by farmers included complexity, divisibility, congruence-incompatibility with farm and personal objectives, risk and uncertainty, conflicting information and implementation cost - capital outlay.

According to study done by Peshin and Kalra [8], a major constraint in the adoption of IPM practices was the dissemination of conventional, non-IPM technology by state agricultural universities and agricultural development departments. Louise Flint *et al* [9] stated that barriers to IPM adoption included psychological resistance to change, loss of authority, imagined difficulty in learning new technology, fear of IPM program failure, fear that IPM means no access to pesticides, fear that IPM is more expensive than traditional pest control and lack of in-house IPM expertise.

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Muthuraman and Sain [10] stated that the major constraints in the adoption of IPM by farmers were lack of knowledge about recent pest management strategies, non-availability of rice cultivars with good pest resistance; quality; yield and market value, lack of knowledge on predators and natural enemies, non-availability of biological pesticides, lack of community action and the lack of rice cultivars with multiple resistances. Rodriguez Baide [11] indicated that the major barriers in adoption of technologies were economics, education and information, resistance to change, use of technology, social issues, infrastructural, landlessness and personal characteristics.

Mauceri [1] found that economic barriers of IPM technologies adoption were access to capital, credit, land and labor. Truong Thi [12] stated that the main reasons of non-adoption of IPM included weak perceptions of IPM and low education of farmers, weak teaching capacity and limited knowledge of extension staff, not-well organization and management of extension programs, limitation of concrete conditions of local area and fund.

Rice is the world's most important food crop and a primary source of food for more than half of the world's population [13]. More than 90% of the world's rice is grown and consumed in Asia where 60% of the earth's people live [13]. 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 [14]. Mazandaran province is one of the Northern provinces close to the Caspian Sea. Rice as the most important strategic product of Mazandaran has the highest percentage of rice production in Iran. Attention to chemical pesticides usage in Iran shows the highest consumption of chemicals in rice fields.

Since chemical pesticides into the water of rice fields cause serious acute health problems and environmental contamination [15] and IPM is the best mechanism to solve this issue, it is important to find factors influence non-adoption of IPM technologies by farmers and to reduce them in order for farmers to benefit. Therefore, the main purpose of the study was to investigate the major barriers to adoption of integrated pest management (IPM) technologies by paddy farmers. The special objectives of the study were:

- Identifying the demographic characteristics of respondents;
- Respondents' attitudes toward effectiveness of IPM technologies;
- Priority setting of respondents' view about barriers to adoption of IPM technologies;
- Factor analysis to indicate barriers to adoption of IPM technologies by respondents.

MATERIALS AND METHODS

This study was a descriptive-correlation research, carried out in Sari County. The population of the study consisted of paddy farmers (N= 28170) in five district of Sari County (Chardangeh, Dodangeh, Markazi, Kelijanrestagh and Miandorod). A sample of 260 farmers was selected by using proportional random sampling method (Table 1).

The survey instrument divided into three parts. Part one (30 items) contained demographic data such as age, educational level, agricultural experience and so forth. Part two (19 items), was assessed barriers to adoption of IPM technologies, using likert-type scale (0 = "none", 1 = "very low", 2 = "low ", 3 = "intermediate ", 4 = "high" and 5 = "very high"). Finally, the third section (38 items) was assessed farmers' attitudes toward effectiveness of IPM technologies using likert-type scale (0 = "none", 1 = "very low", 2 = "low ", 3 = "intermediate ", 4 = "high" and 5 = "very high").

Validity of the instrument was obtained by Agricultural Jihad exports 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. The reliability was found to be acceptable (alpha = 0.76). 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, mean, standard deviation and so forth and inferential statistics included factor analysis.

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

To categorize farmers' attitudes toward effectiveness of IPM technologies the following formula was applied:

Min<A<Mean-SD: A = Negative attitude
Mean- SD <B<Mean: B = Relatively negative attitude
Mean <C<Mean+ SD: C = Relatively positive attitude
Mean+ SD <D<Max: D = Positive attitude

RESULTS AND DISCUSSION

Demographic Information of Respondents: Distributional pattern of demographic information of respondents is shown in Table 2. As it can be seen, respondents were on average 49 years old and the most frequency was between the age of 41 and 50 years. 71.9% of the respondents were literate. Respondents' experience in agricultural activities was 29 years on average and the most frequency was between 21 and 30 years.

Findings showed that more than half of the respondents (61.9%) had lands less than 2 hectares in size for cultivation of rice. The average income of paddy farmers was 84.96 million Rials annually. The average cost of IPM technologies usage was 3.79 million Rials annually.

Table 3 shows paddy farmers' attitudes toward effectiveness of IPM technologies. As it can be seen 53.85% of farmers had negative and relatively negative attitudes toward effectiveness of IPM technologies. In contrast, 46.15% of farmers had positive and relatively positive attitudes toward effectiveness of IPM technologies.

Table 4 shows that lack of knowledge and information for using IPM technologies has first priority of barriers to adoption, because of having the lowest extent of coefficient of variation (CV = 0.150). Lack of equipments and facilities for using IPM technologies

Table 2: Demographic Characteristics Of Respondents

Demographic characteristics	Frequency	%	Mean	SD
Age (year)			49.37	13.12
< 31	31	12		
31-40	35	13.5		
41-50	69	26.5		
51-60	63	24.2		
61-70	55	21.1		
> 70	7	2.7		
Educational level				
Illiterate	73	28.1		
Literate (not primary school)	27	10.4		
Primary school	39	15		
Secondary school	20	7.7		
High school	69	26.5		
Post high school	32	12.3		
Agricultural experience			29.05	14.01
< 11	28	10.8		
20-Nov	40	15.4		
21-30	82	31.5		
31-40	59	22.7		
41-50	36	13.8		
>50	15	5.8		
Cultivation area of rice (ha)			2.31	1.59
< 2	161	61.9		
4-Feb	67	25.8		
6-Apr	27	10.4		
>6	5	1.9		
Farm income from rice production (million Rials/annually)			84.96	56.68

Table 3: Paddy Farmers' Attitudes Toward Effectiveness Of IPM Technologies

Attitude	Range	Frequency	%
Negative	31.00-47.02	99	38.1
Relatively negative	47.03-54.09	41	15.8
Relatively positive	54.10-61.16	51	19.6
Positive	61.17-67.00	69	26.5
Total	31.00-67.00	260	100.0

Priority setting of paddy framers' view about barriers to adoption of IPM technologies

Table 4: Priority Setting Of Paddy Framers' View About Barriers To Adoption Of IPM Technologies

Statement	Mean	SD	CV	Priority
Lack of knowledge and information for using IPM technologies	4.162	0.625	0.150	1
Lack of equipments and facilities for using IPM technologies	3.992	0.680	0.170	2
Low participation of farmers	4.111	0.760	0.184	3
Lack of experience and technical skills for using IPM technologies	3.958	0.782	0.197	4
Lack of access to extension services	3.808	0.767	0.201	5
Lack of timely delivery of information about pest management	3.650	0.753	0.206	6
Lack of easy access to inputs for IPM practices	3.808	0.820	0.215	7
Lack of plant protection clinics	3.797	0.844	0.222	8
High costs of IPM practices (cost of labor, etc)	3.638	0.856	0.235	9
Inappropriate quality of some biological materials used in previous years	3.915	0.812	0.244	10
The low price of rice products produced with IPM practices	3.388	0.856	0.252	11
Need to better management for IPM practices	3.535	0.927	0.262	12
Lack of government support of IPM products	3.346	0.915	0.273	13
Unsuccessful results of IPM practices in previous years	3.556	0.992	0.278	14
Complexity and difficulty of using IPM technologies	3.565	1.010	0.283	15
Lack of sufficient risk for using IPM technologies	3.315	0.974	0.293	16
Immediate effects of chemical pesticides	3.338	0.986	0.295	17
Lack of government support for paying loan and facilities for using IPM technologies	2.950	0.888	0.301	18
Ease access to chemical pesticides	2.919	1.060	0.363	19

(CV= 0.170), low participation of farmers (CV= 0.184) and lack of experience and technical skills for using IPM technologies (CV= 0.197), respectively, have allocated priorities from second to fourth. In addition, immediate effects of chemical pesticides (CV = 0.295), lack of government support for paying loan and facilities for using IPM technologies (CV = 0.301) and ease access to chemical pesticides (CV = 0.363) with the highest extent of coefficient of variation have allocated last priorities to themselves.

Factor Analysis: In order to indicate barriers to adoption of IPM technologies by paddy framers, factor analysis was conducted. To determine the appropriateness of data and measure the homogeneity of variables entered to the analysis, the Kaiser-Meyer-Olkin (KMO) and Bartlett's Test of Sphericity (BTS) were applied. KMO was 0.703 and BTS was 1647.373 ($p < .01$), indicating that the data were appropriate for factor analysis.

While performing the factor analysis, there are some decisions to be made: the method of factor extraction, the number of factors and the type of factor rotation. There are several factor extraction methods. The methods used for the final solution were chosen primarily on the interpretability of the resulting factors. In this study unweighted least squares factoring was used as the extraction method. Another decision to be made when conducting factor analysis is to determine the number of factors. One rule of thumb is to use an eigenvalue of one as the cut-off value. That is, all factors in a particular solution must have eigenvalues greater than one. Rotation is used to reorient the factor loadings so that the factors are more interpretable. The Varimax rotation option, which tries to minimize the number of variables that load highly on a factor, was used.

Eigenvalues, variance percentage and the cumulative variance percentage of extracted determinants are presented in table 5.

Table 5: Eigen Values, Variance Percentage And The Cumulative Variance Percentage Of Extracted Determinants

Factors	Eigenvalue	% of variance	Cumulative % of variance
1	2.864	17.902	17.902
2	2.468	15.427	33.330
3	2.438	15.236	48.566
4	2.053	12.831	61.397
5	1.265	7.906	69.303

Table 6: Items Loaded In The Factors Using Varimax Rotated Factor Analysis

Factor	Variables	Factor loadings
Infrastructure	Lack of plant protection clinics	0.883
	Inappropriate quality of some biological materials used in previous years	0.838
	Lack of easy access to inputs for IPM practices	0.833
	Lack of equipments and facilities for using IPM technologies	0.800
Management	Complexity and difficulty of using IPM technologies	0.929
	Unsuccessful results of IPM practices in previous years	0.885
	Need to better management for IPM practices	0.877
Economics-social	immediate effects of chemical pesticides	0.906
	Lack of sufficient risk for using IPM technologies	0.906
	Low participation of farmers	0.859
Institutional - Support	Lack of government support of IPM products	0.811
	The low price of rice products produced with IPM practices	0.735
	Lack of government support for paying loan and facilities for using IPM technologies	0.672
	Lack of timely delivery of information about pest management	0.564
Training - Skills	Lack of experience and technical skills for using IPM technologies	0.807
	Lack of access to extension services	0.618

Accordingly, five factors were extracted (table 6). Factors were examined and given a descriptive title that represented the characteristics of the constructs. The first factor was infrastructure barriers which explained 17.902 percent of variance. Other factors were management barriers, economics-social barriers, institutional-support barriers and training-skills barriers which explained 15.427, 15.236, 12.831 and 7.906 percent of the total variance respectively. These factors explained 69.303 percent of the total variance. The five factors that were extracted are as follows:

Factor 1: The first factor accounted for 17.902 percent of the total variance and 4 variables loading significantly (Loadings range from 0.800 to 0.883). These variables were lack of plant protection clinics, inappropriate quality of some biological materials used in previous years, lack of easy access to inputs for IPM practices and lack of equipments and facilities for using IPM technologies. So, this factor was termed “infrastructure barriers”.

Factor 2: The second factor accounted for 15.427 percent of the total variance and 3 variables loading significantly (Loadings range from 0.877 to 0.929). These variables were complexity and difficulty of using IPM technologies, unsuccessful results of IPM practices in previous years and need to better management for IPM practices. So, this factor was termed “management barriers”.

Factor 3: The third factor accounted for 15.236 percent of the total variance and 3 variables loading significantly (Loadings range from 0.859 to 0.906). These variables were immediate effects of chemical pesticides, lack of sufficient risk for using IPM technologies and low participation of farmers. So, this factor was termed “economics-social barriers”.

Factor 4: The fourth factor accounted for 12.831 percent of the total variance and 4 variables loading significantly (Loadings range from 0.564 to 0.811). These variables were lack of government support of IPM products, the low price of rice products produced with IPM practices, lack of government support for paying loan and facilities for using IPM technologies and lack of timely delivery of information about pest management. So, this factor was termed “institutional-support barriers”.

Factor 5: The last factor accounted for 7.906 percent of the total variance and 2 variables loading significantly (Loadings range from 0.618 to 0.807). These variables were lack of experience and technical skills for using IPM technologies and lack of access to extension services. So, this factor was termed "training-skills barriers" (table 6).

CONCLUSION AND RECOMMENDATIONS

According to results, 53.85% of farmers had negative and relatively negative attitudes toward effectiveness of IPM technologies. In contrast, 46.15% of farmers had positive and relatively positive attitudes toward effectiveness of IPM technologies. Since negative attitude of farmers toward effectiveness of IPM technologies is one of the major barriers in their orientation for IPM technologies usage, it is recommended that agriculture extension agents educate farmers about benefits of IPM technologies. Maraddi *et al.* [16] and Ofuoku *et al.* [17] in their studies expressed the effective role of extension services to adoption of IPM technologies by farmers.

The findings revealed that the major barriers to adoption of IPM technologies by paddy farmers were lack of knowledge and information for using IPM technologies (accordant to the result of Nowak [6]. Ferguson *et al.* [18]; Muthuraman and Sain [10]. Rodriguez Baide [11]. Truong Thi [12]. lack of equipments and facilities for using IPM technologies (accordant to the result of Muthuraman and Sain [10]. Louise Flint *et al.* [9]. Rodriguez Baide [11] and low participation of farmers (accordant to the result of Muthuraman and Sain [10]. Rodriguez Baide [11]. Therefore, it seems that farmer field school (FFS) approach is one of the best approaches which facilitates awareness enhancement and participation of farmers.

Factor analysis showed that infrastructure barriers (17.90%), management barriers (15.42%), economics-social barriers (15.23%), institutional-support barriers (12.83%) and training-skills barriers (7.90%) explained 69.303 percent of the total variance. Since infrastructure barriers had the most percent of variance in barriers to adoption of IPM technologies by paddy framers, it is important to pay attention to its variables such as increasing plant protection clinics and increasing centers for presenting inputs for IPM practices to farmers.

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