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Technical-Economic Factors Effecting Adoption of Bio-Control in Rice Fields of Iran

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Abstract: Integrated pest management of key pests should be implemented in complementation with modern farming technologies. A study was conducted to identify technical-economic factors on acceptance of bio-control of pests by farmers in North of Iran during 2009 year. A survey study was conducted using a stratified random sampling to collect data from farmers of selected rural in Tavalesh region. Totally 184 farmers were studied for effective factors. In this study, results showed that there was a significant difference between the two groups of adopters and non-adopters of bio-control regarding variables of number of domestic animals, number of plows, farm workers and kinds of fertilizers in rice field. But there was no significant relationship between other variables and bio-control adoption.

Key words: Adoption, farmers, *Trichogramma* sp., *Chilo suppressalis*, domestic animals, Iran

INTRODUCTION

Rice is second source of food for many people in world, specially Asia such as Iran. Rice has many pests which decrease its yield significantly. Rice stem borers (*Chilo suppressalis*) are serious pests and of regular occurrence infest the crop at all stages of crop growth. The rice plants can compensate the damage caused by the borers during the vegetative phase up to the stage of maximum tillering.

Infestation by stem borers during the reproductive phase, especially during panicle initiation and ear head emergence, causes loss in yield (Kiritani, 1990; Salami and Khaledi, 2001). Pesticides are a necessary input to produce high yields but can result in adverse effects on both health and environment. The negative environmental impacts of chemical application have long been recognized as major public health concerns. Many of the techniques or practices collectively referred to Integrated Pest Management (IPM) have been designed to address some of the health and environmental concerns of pesticide use. In general terms, IPM is defined as a sustainable approach to managing pests by combining biological, cultural, physical and chemical tools in a way that minimizes economic, health and environmental risks (NCIPM, 1994). Now-a-days, pest management systems include the bio-control method due to the increase of implementation problems of chemical control methods (Ahmad and Fahimi, 2001; Niyaki, 2010). Integrated pest management of key pests should be implemented in complementation with modern farming technologies. It was also noted that environmental factors associated with the maintenance of low density of *Chilo suppressalis* and possibly its total extinction in the future, must be considered in developing rice management strategy. This includes maintaining a balance between integrated pest management and conservation of the paddy ecosystem also known as integrated biodiversity management (Kiritani, 1990, 2000). Trichogramma are natural enemies of the *Chilo suppressalis* that parasite the eggs of this moth (Pezeshki-Raad and Masaeli, 2003). During recent years, there have been efforts for bio-control (use of Trichogramma) against *Chilo suppressalis*. But the adoption of integrated pest management has not found its real place among local farmers. Therefore, the study of various effective factors on adoption of this technology will provide extension and development of bio-control significantly. Adoption of any innovation is not a one step process as it takes time for adoption to complete first time. First time adopters may continue or cease to use the new technology.

The duration of adoption of a technology vary among social community, economic units, regions and attributes of the technology itself. Therefore, adequate understanding of the process of biological control technology adoption is necessary for designing effective agricultural research and extension program for applied usage in agriculture. Main effective factors on biological

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agents application was studied to some extent (Dinpanah *et al*., 2009). Karamidehkordi and Hashemi during of their study in Zanjan province of Iran reported that the farmers hardly used non-chemical pest control methods (e.g., mechanical and biological techniques and natural enemies) and their awareness of using these methods was low. Although, the farmers were to some extent aware of the side-effects of the excessive use of chemical fertilizers and pesticides, they still continued utilizing chemical inputs due to the shortage of knowledge of and little access to the alternative or sustainable techniques and facilities. The farmers showed little access to private or public extension or research institutions for this matter.

It is suggested to improve agricultural extension service to facilitate participatory agricultural research, especially using the farmer field school approach and to provide the required chemical and non-chemical inputs in order to make information and inputs more available and accessible. This can make the implementation of IPM projects effective.

It is demonstrated that farmer literacy, farm size and ownership, family size affect on adoption of biological control application in Mazandaran province of Iran (Salami and Khaledi, 2001). It is reported that individual education, participation in extension programs and visits, corporation with extension center and experts and relationship with best farmers were main factors on adoption of biological control agent by soybean farmers in Ardebil province, Northwest of Iran. The results of a research by Hosseini and Niknami (2001) showed that was a significant statistical relationship between educational level, type of land ownership, easy access to Trichogramma, low cost of biological control, complexity of spraying, contact with extension agent and adopting Trichogramma. But in results of those was not any significant relationship between the adoption of innovations by farmers and variables of watching TV programs, size of land-holding, cost of chemical inputs and recommendation of family members. Also, the results of their study indicated that advancing the knowledge of diffusion process in Iran would be useful in developing extension programs and their effectiveness, especially in new strategies as sustainable agriculture. Also, the results of other research by Pezeshki-Raad and Masaeli (2003) showed that rate of adoption of integrated campaign to control rice stem borer among the farmers was moderate. Among the economic characteristics, there was a significant relationship between adoption of integrated campaign and area of land, amount of area under cultivation, degree of family cooperation in the agricultural activities, access to agricultural inputs, access to financial resources and yield of rice per hectare. This study regards as single case study effective economic factors on adoption of bio-control by farmers in Guilan province, North of Iran.

MATERIALS AND METHODS

This study was carried out by survey during July and August, 2009. Studied area including Talesh, Rezvanshahr and Masal set in Tavalesh region of Guilan province, near Caspian sea in North of Iran (Fig. 1). The main tool for collecting data was questionnaire. Target population were farmers of Tavalesh region in North of Iran. Responder farmers who selected from rural area were categorized into adopters and non adopters of biological control agent for control *Chilo suppressalis*. Totally 184 farmers were selected by random sample using the table for determining the sample from given population

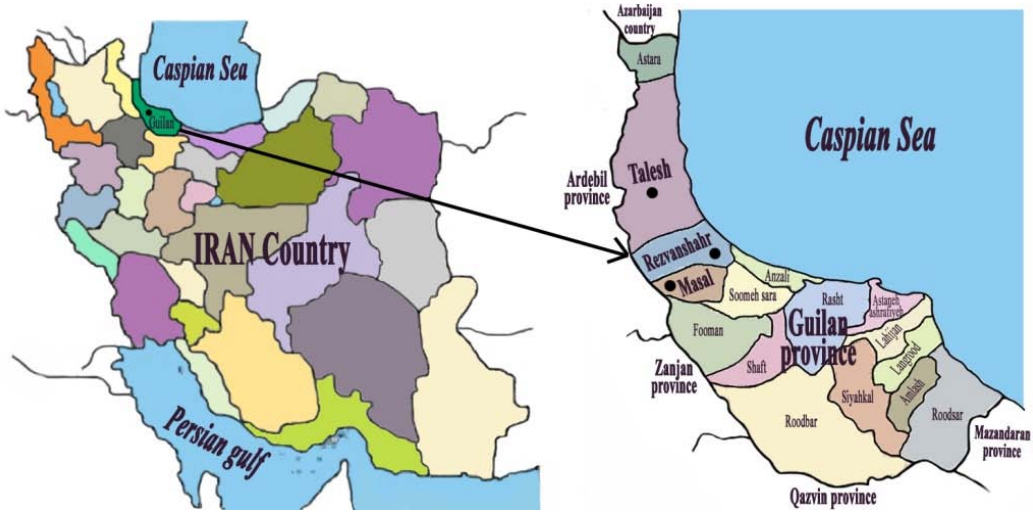

Fig. 1: Site of study

developed by Bartlett *et al.* (2001) that including 33 adopters and 151 non-adopters for answering the questionnaire. The questionnaire was pre-tested by interviewing three farmers (not included in the study). After some modifications, it was tested a gain with 10 other respondents. In this study, dependent variable was adoption of biological control agent for control *Chilo suppressalis* among farmers of Tavalesh region in North of Iran. The dependent variable was dichotomized with a value 1 if a farmer was an adopter of biological control and 0 if non-adopter. Frequency, percent, mean and standard deviation were used for the descriptive analysis of data. Chi square (χ^2), Mann-Whitney and t-test were used for inferential analysis of data by SPSS (16) software.

RESULTS AND DISCUSSION

Descriptive analysis of data: The study of frequency distribution showed that 49.5% of responders had <1 ha field for rice culture and about 44% had more between 1-3 ha (mean = 1.56 ha). More of responders (94.6%) had livestock ownership. Family members had equal role as workers in studied fields. Accessibility to input was poor for about 23% of responders and remains have adequate Accessibility to agricultural input such as fertilizer, pesticides and machinery equipments was intermediate. Accessibility to financial resources/credits/investment was poor for approximately 65% of responders.

Yearly income from agricultural activities was about 34 million Rials. Number of farm owned patches livestock number, yearly cost for rice production and their yield showed in Table 1. Also, results of frequency distribution for other variables showed in Table 1 and 2.

Amount of farm ownership: In this study, the results showed that there was no significant relation between adoption of bio-control and amount of farm ownership variable (Table 2) and no significant difference between the two groups of adopters and non-adopters of bio-control regarding the amount of farm ownership variables (Table 3). These results are in agreement with those obtained by Adeogun *et al.* (2008) and Joshi and Pandy (2005).

Table 1: Frequency, percent, mean and standard deviation of economic factors of farmers

		Adopters		Non-adopters		Total	
Factors	Groups	Frequency	Percentage	Frequency	Percentage	Frequency	Percentage
Amount of farm ownership (per hectare)	<1	18	9.78	73	39.67	91	49.5
	1-3	12	6.52	69	37.5	81	44.0
	3-5	2	1.09	7	3.80	9	4.9
	5<	1	0.54	2	1.09	3	1.6
	Total	33	17.93	151	82.07	184	100
	Mean (SD)	1.76 (1.45)	-	1.52 (1.18)	-	1.56 (1.23)	-
Utilization system	Ownership	30	16.3	144	78.26	174	94.6
	Sharing	3	1.63	6	3.26	9	4.9
	1 and 2	0	0.00	1	0.54	1	0.5
	Total	33	17.93	151	82.07	184	100
Farm workers	Family members	13	7.07	36	19.57	49	26.6
	Hired workers	10	5.43	33	17.93	43	23.4
	1 and 2	10	5.43	82	44.57	92	50
	Total	33	17.93	151	82.07	184	100
Accessibility to agriculture input (fertilizers, pesticides, machinery equipments, etc.)	Very little	1	0.54	6	3.26	7	3.8
	Little	10	5.43	25	13.59	35	19
	Intermediate	10	5.43	66	35.87	76	41.3
	Much	8	4.35	48	26.09	56	30.4
	Very much	4	2.17	6	3.26	10	5.4
	Total	33	17.93	151	82.07	184	100
Accessibility to financial resources/credits/investment	Very little	15	8.15	50	27.17	65	35.3
	Little	9	4.89	45	24.46	54	29.3
	Intermediate	6	3.26	42	22.83	48	26.1
	Much	1	0.54	12	6.52	13	7.1
	Very much	2	1.09	2	1.09	4	2.2
	Total	33	17.93	151	82.07	184	100
Yearly income from agricultural activities (Rls)	5000000>	1	0.54	14	7.61	15	8.2
	5000001-20000000	13	7.07	74	40.22	87	47.3
	20000001-35000000	6	3.26	21	11.41	27	14.7
	35000001-50000000	3	1.63	23	12.5	26	14.1
	50000001<	10	5.43	19	10.33	29	15.8
	Total	33	17.93	151	82.07	184	100
	Mean (SD)	44636000 (50074200)	- -	31705000 (37365100)	- -	34024000 (40094700)	- -
Average yield of rice per year (ton ha^{-1})	1.5>	13	10.16	32	25	45	35.2
	1.5-2.5	12	9.38	43	33.59	55	43

Table 1: Continue

		Adopters		Non-adopters		Total	
Factors	Groups	Frequency	Percentage	Frequency	Percentage	Frequency	Percentage
	2.5-3.5	3	2.34	18	14.06	21	16.4
	3.5<	3	2.34	4	3.13	7	5.5
	Total	31	24.22	97	75.78	128	100
	Mean (SD)	2.04 (1.008)	- -	2.09 (0.82)	- - (0.86)	- -	2.08
Yearly expenditure in rice culture (Rls)	5000000>	11	5.98	42	22.83	53	28.8
	5000001-15000000	14	7.61	72	39.13	86	46.7
	15000001-25000000	3	1.63	23	12.50	26	14.1
	25000001<	5	2.71	14	7.61	19	10.3
	Total	33	17.93	151	82.07	184	100
	Mean (SD)	12955000 (10851500)	- -	12028000 (9371350)	- 12194000 - (9628280)	- -	
Number of owned farm patches	1	17	9.24	94	51.09	111	60.3
	2	9	4.89	38	20.65	47	25.5
	3	5	2.71	13	7.07	18	9.8
	4<	2	1.09	6	3.26	8	4.3
	Total	33	17.93	151	82.07	184	100
	Mean (SD)	1.81 (1.13)		1.58 (1.02)	- 1.63 (1.4)	-	
Number of domestic animals	5>	23	12.5	129	70.11	152	82.6
	6-15	8	4.35	18	9.78	26	14.1
	16-25	0	0.00	3	1.63	3	1.6
	26-35	0	0.00	1	0.54	1	0.5
	36<	2	1.09	0	0.00	2	1.1
	Total	33	17.93	151	82.07	184	100
	Mean (SD)	5.90 (10.59)	-	3.15 (4.41)	-	3.64 (6.06)	-
Number of plows	2	13	7.07	26	14.13	39	21.2
	3	19	10.32	123	66.85	142	77.2
	4	1	0.54	2	1.09	3	1.6
	Total	33	17.93	151	82.07	184	100
	Mean (SD)	2.63 (0.54)	2.84 (0.4)	2.80 (0.43)			
Kinds of fertilizers in rice field	Chemical fertilizers	22	11.96	142	77.17	164	89.1
	Organic fertilizers	1	0.54	1	0.54	2	1.1
	Chemical and organic	10	5.43	8	4.35	18	9.8
	Total	33	17.93	151	82.07	184	100
Method of control weeds	Chemical control	0	0	1	0.54	1	0.5
	Mechanical and cultural	1	0.54	3	1.63	4	2.2
	1 and 2	32	17.39	147	79.89	179	97.3
	Total	33	17.93	151	82.07	184	100
Accessibility to water supply for irrigation	Very little	4	2.17	12	6.52	16	8.7
	Little	7	3.8	33	17.93	40	21.7
	Intermediate	7	3.8	38	20.65	45	24.5
	Much	13	7.07	64	34.78	77	41.8
	Very much	2	1.09	4	2.17	6	3.3
	Total	33	17.93	151	82.07	184	100

Table 2: Effect of factors on adoption of biological control using Chi-square test

Factors	Chi-square	Sig.
Amount of farm ownership	1.342^{NS}	0.719
Utilization system	1.725^{NS}	0.422
Farm workers	6.407*	0.041
Accessibility to agriculture input	7.747^{NS}	0.101
Accessibility to financial resources	5.911^{NS}	0.206
Yearly income from agricultural activities	8.279^{NS}	0.082
Average yield of rice per year	3.161^{NS}	0.367
Yearly expenditure in rice culture	2.076^{NS}	0.557
Number of owned farm patches	2.021^{NS}	0.568
Number of domestic animals	13.747**	0.008
Number of plows	8.768*	0.012
Kinds of fertilizers in rice field	20.983**	0.000
Method of control weeds	0.355^{NS}	0.838
Accessibility to water supply for irrigation	1.745^{NS}	0.782

NS: Non Significant; *Significant at p<0.05; **Significant at p<0.01

Table 3: Comparison of some factors of adopters and non-adopters of biological control using t-test

Factors	t-test	Sig.
Amount of farm ownership	1.018^{NS}	0.310
Yearly income from agricultural activities	1.687^{NS}	0.093
Average yield of rice per year	0.249^{NS}	0.804
Yearly expenditure in rice farming	0.500^{NS}	0.618
Number of owned farm patches	1.137^{NS}	0.257
Number of domestic animals	2.398*	0.018
Number of plows	2.471*	0.014

NS: Non Significant; *significant at p<0.05; Survey results (2009)

Utilization system: In this study, the results showed that there was no significant relation between adoption of bio-control and utilization system variable (Table 2). These results were not similar to Tabaraee and Hassannejad (2009) and Rostami *et al*. (2008).

Table 4: Comparison of some factors of adopters and non-adopters of biological control using Mann-Whitney test

Factors	Z	Sig.
Accessibility to agriculture input	0.395^{NS}	0.693
Accessibility to financial resources	1.227^{NS}	0.220
Accessibility to irrigation water supply	0.103^{NS}	0.918

NS: Non Significant; *Significant at $p<0.05$; **Significant at $p<0.01$; Survey results (2009)

Farm workers: In this study, the results showed that there was a significant relation between adoption of bio-control and farm workers variable (Table 2). These results are in agreement with those obtained by Kohansal *et al.* (2009).

Accessibility to agriculture input: In this study, the results showed that there was no significant relation between adoption of bio-control and accessibility to agriculture input variable (Table 2) and no significant difference between the two groups of adopters and non-adopters of bio-control regarding the accessibility to agriculture input variables (Table 4). These results are not consistent with Rezvanfar and Mandape (2000) and Darvish *et al.* (2009).

Accessibility to financial resources: In this study, the results showed that there was no significant relation between adoption of bio-control and accessibility to financial resources variable (Table 2) and no significant difference between the two groups of adopters and non-adopters of bio-control regarding the accessibility to financial resources variables (Table 4). These results are not consistent with Darvish *et al.* (2009) and Iravani *et al.* (2006).

Yearly income from agricultural activities: In this study, the results showed that there was no significant relation between adoption of bio-control and yearly income from agricultural activities variable (Table 2) and no significant difference between the two groups of adopters and non-adopters of bio-control regarding the yearly income from agricultural activities variables (Table 3). These results did not correspond to Darvish *et al.* (2009).

Average yield of rice: In this study, the results showed that there was no significant relation between adoption of bio-control and average yield of rice variable (Table 2) and no significant difference between the two groups of adopters and non-adopters of bio-control regarding the average yield of rice variables (Table 3). These results did not correspond with Astaneh and Irvani (2007).

Yearly expenditure in rice culture: In this study, the results showed that there was no significant relation between adoption of bio-control and yearly expenditure in rice culture variable (Table 2) and no significant difference between the two groups of adopters and non-adopters of bio-control regarding the yearly expenditure in rice culture variables (Table 3).

Number of owned farm patches: In this study, the results showed that there was no significant relation between adoption of bio-control and number of owned farm patches variable (Table 2) and no significant difference between the two groups of adopters and non-adopters of bio-control regarding the number of owned farm patches variables (Table 3). These results were not similar to Kohansal *et al.* (2009).

Number of domestic animals: In this study, the results showed that there was a significant relation between adoption of bio-control and number of domestic animals variable (Table 2) and a significant difference between the two groups of adopters and non-adopters of bio-control regarding the number of domestic animals variables (Table 3). These results were similar to Astaneh and Irvani (2007).

Number of plows: In this study, the results showed that there was a significant relation between adoption of bio-control and number of plows variable (Table 2). A significant difference between the two groups of adopters and non-adopters of bio-control regarding the number of plows variables (Table 3). These results are consistent with Noorhosseini and Allahyari (2010).

Kinds of fertilizers in rice field: In this study, the results showed that there was a significant relation between adoption of bio-control and kinds of fertilizers in rice field variable (Table 2). These results were similar to Noorhosseini and Allahyari (2010).

Accessibility to water supply for irrigation: In this study, the results showed that there was no significant relation between adoption of bio-control and accessibility to water supply for irrigation variable (Table 2) and no significant difference between the two groups of adopters and non-adopters of bio-control regarding the accessibility to water supply for irrigation variables (Table 4).

Method of control weeds: In this study, the results showed that there was no significant relation between adoption of bio-control and method of control weeds variable. These results are not consistent with Niyaki and Raalfabi (2010) and Noorhosseini and Allahyari (2010).

CONCLUSION

Economic analyses of bio-control programs are a valuable input into the decision-making process for bio-control programs (Jetter, 2005). The basic criterion is

that a bio-control program should be considered when the benefits are greater than the costs. However, assessing all benefits and costs to a bio-control program presents a challenge due to the different ways that uncertainty enters the analysis.

RECOMMENDATIONS

According to results of this investigation, main important factors of adoption including number of domestic animals, number of plows, farm workers and kinds of fertilizers in rice field, recommend that the first need to promote training for farmers with high potential in various adoption of bio-control that can increase the tendency to new technology. Second, propagator must be attending to the economic factors and conditions of farm associated to social factors of farmers. It should ultimately improve the usefulness of bio-control in rice fields.

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