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Determination of Influencing Factors for Integrated Pest Management Adoption: A Logistic Regression Analysis

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Abstract

Adoption of an environment friendly agricultural technique, namely Integrated Pest Management (IPM) depends on various socio-economic and demographic factors. This study attempts to determine the factors that influence farmers' decision to receive IPM. For analysis purpose several socio-economic and demographic information were collect from 617 farmers of five division (Dhaka, Chittagong, Rangpur, Khulna, Barisal), Bangladesh by prepared a structured query. To ensure randomness, simple random sampling technique was used for data collection. Farmers' ten background characteristics were analyzed in both bivariate and multivariate setup. In bivariate setup, association between selected factors and adoption status of IPM were investigated by performing a chi-square test. To get the adjusted effect, a binary logistic regression model was estimated in multivariate setup. The results of the model provide evidence that farmers' age, education level, farming experience, training on IPM and membership status of IPM club are the highly significant ($P<0.05$) factors for IPM adoption. Farm ownership status and Barisal division also found significant ($P<0.10$) factors for IPM adoption in Bangladesh.

Keywords: Adoption; IPM; Chi-square test; Logistic regression model

Introduction

Management of pesticide to control pest has become a major cause for concern in most of the developing countries. It is acute in Bangladesh, a densely (964/sq.km) populated country having increasing growth rate of 1.34% [1]. Every year we have lost a substantial amount of production because of the attack of various pests. A previous study conducted by MOA [2] estimate that on an average 16% of rice, 30-40% of vegetables, 15% of jute, 25% of pules, 11% of wheat were annually lost due to the serious attack of different types of pastes. For controlling pests, most of the farmers still fully depend on the application of chemical pesticide in their cultivated land. The fully dependence on chemical pesticide is not a good sign for environment, since excessive use of chemical has so much negative effects on soil, health and environment [3]. Therefore we need to think an alternative approach that can control not only pest but also helpful for environment. In this context, organic agriculture is a powerful tool having no negative impact on ecology [4-6]. But only one approach may not enough to meet the increasing demand of growing population in Bangladesh. So we have to think an integrated approach that should be helpful for better production and ensure the safety of environment. In this dilemma, there is a simple solution, which is Integrated Pest Management (IPM) [7].

In literature, IPM has more than 65 definitions [8]. However, the actual meaning of IPM is still a mystery for us [9]. By considering the ecological behavior of IPM, several scholars define IPM according to their own way. For example, IPM is said to be an environmentally friendly agricultural technique in Dasgupta et al. [10], economically sound technique in Prokopy and Kogan [8], and sustainable agriculture in De Souza Filho et al. [11], and clean farming technologies in Veisi [12]. In spite of having different opinions from various scholars about the definition of IPM, the original massage remains almost same: 'Controlling pest in a sustainable manner'.

Now-a-days development of a sustainable agriculture is the most challenging task in Bangladesh. Moreover, sustainable agriculture remains incomplete without adopting IPM practice. Generally, adoption of any new method depends on several social, economic, demographic and physiological factors. These factors may influence the mentality of human being in any moment. Hence, adoption of IPM is not exception from this setup. In our study, we try to determine the possible influencing factors for the adoption of IPM in the context of Bangladesh by fitting a binary logistic regression model.

Materials and Methods

Data sources

Since the determination of influencing factors for IPM adoption was the main focus of this study, all Bangladeshi farmers were the major sources of data collection. In the practical point of view, it is totally impossible to gather information from all Bangladeshi farmers (target population). However, we can interview a part (study population) of our target population by determining appropriate sample size.

Determination of sample size

In this research our determined sample size is 617 (for detailed calculation of sample size determination (Appendix). Therefore we have to choose 617 farmers randomly, and collect desired information from them.

Data collection

For collecting desired information from study population, a structured questionnaire was prepared. The questionnaire was made as simple as possible and only relevant questions were included. Best

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efforts were made to obtain unbiased answers from the respondents. To collect several socio-economic and demographic information we randomly interviewed 450 conventional farmers (those who use chemical pesticides) and 167 IPM farmers (those who recently adopted IPM) from five divisions (Dhaka, Chittagong, Rangpur, Khulna, Barisal) of Bangladesh. Therefore we have a total of 617 (desired sample size) Bangladeshi farmers for further analysis. To ensure the randomness we consider simple random sampling as a sampling technique for data collection.

Variable selection

The adoption status of IPM (1, if adopt IPM, 0, otherwise) is considered as the main variable of interest. The farmer is considered to be IPM farmer if he recently adopt IPM, otherwise the farmers is treated to be a conventional farmer. Besides the main variable, we also consider respondents' age (categorized into five groups), education level (no/primary education, secondary, higher), division, farming experience (at least 10 years of farming experience, more than 10 years), farm size (categorized into three groups based on existing size of the cultivated land), ownership of the farm (yes, no), training on IPM (yes, no), membership on IPM club (yes, no), attending in farmer field school (FFS) (yes, no) as possible influencing factors of IPM adoption. These variables were found significant in previous studies [7,10,13-19].

Statistical analysis

To assess the influencing factors of IPM adoption, we conduct our analysis into both bivariate and multivariate setup. In bivariate setup, we perform chi-square test to assess the unadjusted effect of the selected explanatory variables on IPM status. Since bivariate analysis fail to explain the adjusted effect of explanatory variables, we consider a statistical model appropriate for binary response namely binary logistic regression model in multivariate setup. For details on binary logistic regression model [20]. The software that we used for data analysis purpose is SPSS (version 20 for windows).

Results

Univariate analysis

The average age of the surveyed farmers is found to be 35 years with a standard deviation of 10 years. It is investigated that among 617 individuals, 48.9% have no or primary education. On the other hand 37.1% and 13.9% of participants have secondary and higher education, respectively. Most of the farmers (71%) have greater than 10 years of farming experience. The distribution of sampled farmers among the divisions Dhaka, Chittagong, Rangpur, Khulna and Barisal are 20.1%, 19.8%, 20.9%, 18.6% and 20.6%, respectively. More than 50% farmers have 1 to 1.5 acres of cultivated land. It is found than 66.1% farmers have a cultivated land of their own and 78.1% receive training on IPM farming. Moreover, 26.9% and 19.8% farmers are the member of IPM club and FFS, respectively. However, less than one-third of the sampled farmers (27.1%) adopt IPM farming.

Bivariate analysis

The results obtained from bivariate analysis are displayed in Table 1. It is very much surprising to observe that, adoption rate of IPM increases as age of the farmer increases. This implies, older farmers are more interested to adopt IPM compared to younger farmers. Among the education level, the higher education group has higher proportion of IPM farmers (44.2%); whereas other two groups has almost similar (around 24%). Considering the divisions, farmers from Barisal are more likely to adopt IPM (37%); whereas it is least in Khulna (21.7%). Among the IPM farmers, 29.5% have more than 10 years of farming experience, 39.6% have more than 1.5 acres of cultivated land, 28.7% are the owner of his farm, 30.3% receive training on IPM, 28.3% join the IPM club and 29.5% are the member of FFS. Note that age, education level, farm size and training on IPM are reported to be highly significant (P<0.01) factors for IPM adoption. Beside these factors, division and farming experience of the farmers also found significant at 5% level (P<0.05). However, ownership status of farm and membership status of IPM club or FFS show insignificant effect on IPM adoption (P>0.10).

Regression analysis

To get the adjusted effect of selected factors for IPM adoption, we consider a binary logistic regression model, since our main variable IPM adoption status has two category (farmer adopt IPM or not). The necessary results are given in Table 2. From this table we observe that farmers' age has a positive effect on IPM adoption. That is, as age of the farmer increases the chance of adopting IPM also increases in a

Factors	IPM adoption status		*P* value
	Yes n (%)	No n (%)	
Age group			
<30	29 (17.3)	139 (82.7)	0.000***
30-34	33 (18.9)	142 (81.1)	
35-39	36 (30.5)	82 (69.5)	
40-44	37 (42.5)	50 (57.5)	
45 or more	32 (46.4)	37 (53.6)	
Education level			
No/primary	74 (24.5)	228 (75.5)	0.001***
Secondary	55 (24.0)	174 (76.0)	
Higher	38 (44.2)	48 (55.8)	
Division			
Dhaka	37 (29.8)	87 (70.2)	0.033**
Chittagong	28 (23.0)	94 (77.0)	
Rangpur	30 (23.3)	99 (76.7)	
Khulna	25 (21.7)	90 (78.3)	
Barisal	47 (37.0)	80 (63.0)	
Farming experience			
At least 10 years	38 (21.2)	141 (78.8)	0.022**
More than 10 years	129 (29.5)	309 (70.5)	
Farm size			
<1 acre	34 (22.8)	115 (77.2)	0.004**
1-1.5 acre	89 (24.9)	268 (75.1)	
>1.5 acre	44 (39.6)	67 (60.4)	
Farm ownership status			
Yes	107 (26.2)	301 (73.8)	0.566
No	60 (28.7)	149 (71.3)	
Training on IPM			
Yes	146 (30.3)	336 (69.7)	0.001***
No	21 (15.6)	114 (84.4)	
Member of IPM club			
Yes	47 (28.3)	119 (71.7)	0.372
No	120 (26.6)	331 (73.4)	
Member of FFS			
Yes	36 (29.5)	86 (70.5)	0.284
No	131 (26.5)	364 (73.5)	
***P value <0.01, **P value <0.05, *P value <0.10			

Table 1: Assessing association between IPM adoption status and selected factors with P values obtained from chi-square test.

significant manner (P<0.01). To be specific, the odds of adopting IPM is more than double for the farmers belong to the age group (35-39) [OR=2.338] and (40-44) [OR=2.415], compared to the farmers having age less than 30. This odds is much higher [OR=3.267] for the farmers with age 45 or more. It is interesting to see that, the higher educated farmers [OR=3.407] are more likely to adopt IPM than no or primary educated farmers. Moreover, the farmers with more than 10 years of farming experience [OR=2.425] and receive training on IPM [OR=3.836] have more than double chance for IPM adoption. Farmers belonging to IPM club are 43% [OR=1.426] more likely to adopt IPM. The farm ownership status and Barisal division have significant positive effect at 10% level of significant (P<0.10). However, farm size and membership status of FFS have no significant effect on IPM adoption (P>0.10).

Discussion and Conclusion

The main target of this study is to identify the influencing factors for the adoption of IPM in Bangladesh. To fulfill our target we first performed a bivariate analysis in our collected dataset. From the bivariate analysis we observed that farmer's age, education level, division, farming experience, farm size and training status on IPM are the highly significant factors for IPM adoption in Bangladesh. On the other hand, we estimate the adjusted effect of the suspected factors by fitting a binary logistic regression model.

Based on the fitted logistic model, we get strong evidence that the older farmers are more likely to adopt IPM compared to their counterpart. Higher educated farmers have higher odds of adopting IPM. This may due to the awareness of educated farmers about the bad effects of chemical pesticides on human health and environment. The farmers having more farming experience and receive training on IPM have more chance to practice IPM farming to control pests. Farmers from Barisal division and having a cultivated land of their own, also have higher odds of IPM adoption. One of the reasons for getting significant of the ownership status of a farm is that the farmers having own land are mentally ready to practice new techniques on their cultivated land. We also get evidence that the farmers of an IPM club have more chance to receive IPM farming. However, membership status of FFS has found no significant effect on IPM adoption in Bangladesh.

Any effort taken by government to unfurl IPM farming will be useless if the majority of the farmers reject it. We observed that less than one-third (27.1%) of our sampled farmer adopt this farming. It is very much practical that before unfurling any new techniques at farm level, one have to realize the background characteristics of the farmers. In literature, several studies were conducted to identify farmers' background characteristics that can influence the adoption status of IPM [21]. However, different scholars used different techniques to fulfill their objectives and get different results. Considering this fact, our research attempt to explore the factors for IPM adoption by fitting a binary logistic regression model.

Our findings coincide with several previous studies. For example, farmers' age, education level, farming experience, training on IPM is found to be highly significant factors for increasing the adoption rate of IPM farming. These factors also found significant in previous studies [13-19]. According to our findings, we strongly suggest the policy maker to take initiatives for increasing farmers' education level and facilitate more training programme on IPM. Several motivational seminars on IPM may be organized by establishing IPM club in village level.

Factors	Estimate	Odds ratio (95% CI)	*P* value
Age group			
<30 (ref)	-	-	-
30-34	-0.186	0.830 (0.461, 1.494)	0.534
35-39	0.849	2.338 (1.288, 4.244)	0.005***
40-44	0.882	2.415 (1.299, 4.488)	0.005***
45 or more	1.184	3.267 (1.705, 6.261)	0.000***
Education level			
No/primary (ref)	-	-	-
Secondary	0.034	1.034 (0.545, 1.962)	0.917
Higher	1.226	3.407 (1.085, 5.698)	0.036**
Division			
Dhaka (ref)	-	-	--
Chittagong	-0.302	0.739 (0.381, 1.433)	0.371
Rangpur	-0.452	0.636 (0.245, 1.653)	0.353
Khulna	-0.764	0.466 (0.693, 2.513)	0.399
Barisal	0.277	1.139 (0.210, 1.033)	0.060*
Farming experience			
At least 10 years (ref)	-	-	-
More than 10 years	0.886	2.425 (1.467, 4.008)	0.001***
Farm size			
<1 acre (ref)	-	-	-
1-1.5 acre	-0.04	0.961 (0.392, 4.990)	0.91
>1.5 acre	-0.336	0.715 (0.464, 3.893)	0.605
Farm ownership status			
No (ref)	-	-	-
Yes	0.721	2.057 (0.988, 4.284)	0.054*
Training on IPM			
No (ref)	-	-	-
Yes	1.345	3.836 (1.985, 5.413)	0.000***
Member of IPM club			
No (ref)	-	-	-
Yes	0.355	1.426 (1.389, 3.326)	0.000***
Member of FFS			
No (ref)	-	-	-
Yes	-0.441	0.643 (0.350, 1.181)	0.154
***P value <0.01, **P value <0.05, *P value <0.10			

Table 2: Logistic regression model based adjusted effects of selected factor for IPM adoption.

This research has several limitations. There is lot of socio-economic and demographic factors for farmers' adoption decision of IPM. Because of time and money we consider only nine factors for our analysis. Moreover, for policy development, it is important to consider all significant factors that can influence IPM adoption. A recent study conducted by Kabir et al. [22], report that FFS has significant effect on IPM farming. However, we do not get any evidence of significance of FFS. This may due to the data pattern that was used for analysis. So, more research should conduct by considering more factors that can influence this environmentally friendly farming technique.

Appendix

We used following formula for estimating the sample size.

$$n = \frac{Z^2_{\alpha/2} pq}{d^2}$$

Where,

$Z_{\alpha/2}$: Standard normal deviate usually set at 1.96, which corresponds to the 95% confidence level.

p: Assumed proportion in the target population estimated to have a particular characteristic.

q=1-p

d: Allowable maximum error in estimating population proportion.

Here we consider: p=0.5; q=0.5; d=0.0394.

Therefore,

$$n = \frac{(1.96)^2 \times 0.5 \times 0.5}{(0.0394)^2} = 617.617 \cong 617$$

Here we have taken 617 samples for data analysis.

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