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Integrated Pest Management Practice and its Adoption Determinants among Apple Farmers in Mustang District of Nepal

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Abstract: Integrated pest management is an eco-friendly solution which can minimize the use of pesticides reducing the cost of production. The study was undertaken to identify the factors affecting the adoption of IPM practices along with reasons, problems and satisfaction level regarding IPM practice among apple farmers. Semi-structured interview schedule was prepared and field survey was conducted in July, 2013 for the collection of data regarding the IPM practice on apple production in Tukuche VDC at Mustang district of Nepal. The socio-demographic profile of the IPM adopters and non-adopters are presented. Probit analysis of a sample of 40 apple farmers suggests that adoption is positively influenced by training and membership in farmers group and negatively influenced by age of the farmers. Model resulted that the adoption level of IPM practice would increase by 45.8 % and 3.3% if farmers are provided trainings and membership in farmers group respectively. With one year increase in age the adoption level would decrease by 1.5 %. Farmer Field School facilitated by the district agriculture office and for management of pest and disease was the major reasons for IPM adoption. Lack of materials used in the IPM was the most severe problem faced by the IPM adopters followed by lack of detailed knowledge. Farmer Field School (FFS) was the major source of information followed by leader farmer in the study area. About 53 percent of farmers were satisfied with the practice. Study revealed that for higher adoption and dissemination of IPM practice it is needed to give more emphasis in extension programs..
Keywords: Adoption, Apple, Farmer field school, Integrated pest management, Mustang, Probit

INTRODUCTION

Mustang, one of the remote Himalayan districts of Nepal lies in between 2100 masl to 4200 masl. Agriculture and tourism are the main occupation where apple is the major fruit crops grown by farmers in the district. Total area under apple in the district is 763 hectare with total production of 4,000 mt. under productive are 285 hectare [1]. Beside apple, other crops like wheat, buckwheat, *naked barley*, potato and seasonal vegetables are also grown in different part of this district which is used as food as well as for additional income. The people who were fully involved in hotels at road corridors are diverted to apple plantation, orchard management and vegetable farming for income generation. In the district use of chemicals inputs in crop production has been increased within a decade, due to which rises the chance of negative effect in soil health, human health and agro bio diversity of these areas. Increasing consciousness about conservation of environment as well as health hazards caused by agrochemicals has brought a change in the farmer's behavior for adoption of eco-friendly agriculture practice for quality production. 'Integrated pest management is one of the approaches for pest m management. IPM is an effective and environmentally sensitive approach to pest management that relies on combination of common sense practice' [2]. IPM is used in combination with the available pest control method to manage pest damage by the most economical means and the least possible hazards to people, property and environment [3]. According to Prokopy [4] IPM is "a decision-based process involving coordinated use of multiple tactics for optimizing the control of all classes of pests (insects, pathogens, weeds, vertebrates) in an ecologically and economically sound manner". Integrated pest management practices emphasize minimal use of pesticides in controlling pests, and their adoption by farmers can reduce the use of pesticides and their adverse impacts.

Taking in mind, Government of Nepal in collaboration with FAO, EU had initiated some Farmers' Field Schools on Integrated Pest Management (IPM) at different VDC's of the district. Later, on 2009 Government of Nepal in Collaboration with Norwegian Government with grand project launched intensive IPM program in the district and started three IPM FFS in apple and vegetables crops. After the completion of IPM FFS, the same project launched Post IPM FFS in the district at the same places. About 100 farmers from

different VDCs had participated in IPM FFS during the period for the respective season long crop. Since then, farmers are involved in IPM practice for the production and management of apple orchard. Some of the farmers who were involved in IPM FFS have been adopting this practice while some of them has not adopted. Likewise some of the farmers who have not participated in IPM FFS have also adopted IPM practice by sharing ideas and knowledge from trained farmers and agriculture technicians.

OBJECTIVES

The general objective of this paper was to analyze the factors affecting the adoption of IPM practice among apple producers in Mustang district of Nepal. The specific objectives of the paper were to;

- assess the factors associated with adoption of IPM practice.
- identify and rank the reasons in the adoption of IPM practice.
- explore major problems associated with IPM adoption.
- find the satisfaction level of apple farmers regarding IPM practice.
- assess the source of information received by the farmers about IPM practice.

METHODOLOGY

Study area, sample size and sampling procedure

Tukuche VDC of Mustang district in Nepal was purposively selected for the study as it is the renowned VDC of Mustang for quality apple production and also intensive IPM program was successfully implemented by Government of Nepal. Altogether 40 apple farmers were randomly selected for the study comprising 25 adopters and 15 non-adopters of IPM practice in apple production.

Data collection

Semi-structured interview schedule was prepared and field survey was conducted in July, 2013 for the collection of data regarding the IPM practice on apple production in the study area. The questionnaire was pre-tested with 5 percent of total respondent before main survey. Also one Focus Group Discussion (FGD) was carried out. A field team of four well-trained data collectors was deployed in the field for survey and field observations.

Data analysis

The main focus of the current paper was to see the factors affecting the adoption of IPM practice and also to evaluate the impact of IPM among apple farmers. So the data analysis proceeded in the same way with the application of binary Probit model to see the factors affecting the adoption of IPM practice. Also, using scaling technique reasons and problems in the adoption of IPM was calculated. Quantitative data were analyzed by using the both descriptive and analytical statistics. The final analysis was done by using computer software Statistical Package for Social Sciences (SPSS), Microsoft Excel and STATA 12.

Modeling Specification for the factors affecting adoption of IPM practice

The dependent variables in the adoption model are 0, 1 dummy variable, which indicate one if a household adopted IPM practice and zero if otherwise. Since, both logit and probit models are quite similar, but the logistic distribution has slightly fatter tails. Therefore, the conditional probability approaches zero or one at a slower rate in the logit than in the probit model [5]. This study uses the probit adoption model to analyze households' adoption decision because it is an appropriate econometric model for the binary dependent variable and the error term is assumed to be normally distributed.

The model assumes that household's adoption of IPM practice is determined by household specific attributes X (e.g., household head's education, age of respondent, farm size, family type, training, access to credit and membership in an agricultural association). The probit model of IPM practice adoption is derived from an underlying latent variable model, which is expressed as:

$$Yi^* = \beta 0 + \beta ijXij + ei$$

Where Yi* is a dependent variable explaining 1 for adopters and 0 for non-adopters; β0 is the intercept, βij is a vector of parameters to be estimated; Xij is independent variables which explain IPM adoption; and ei is the standard normally distributed error term that is independent of Xj and is symmetrically distributed about zero.

From the latent variable model and the assumptions given, the household adoption of IPM model is derived as

$$P(Yi^* = 1|x) = F(\beta 0 + \beta ijXij)$$

Where F is the function that ensures the likelihood of adopting IPM practice are strictly between zero and one. Therefore, a farm household adopts IPM if $Yi^* > 0$, and otherwise if $Yi^* \leq 0$.

Marginal Effect after Probit Regression

In most applications, once parameter estimates from the probit or the logit regressions are obtained, a natural next step is to consider the marginal effects. According to Gujrati [5] regression analysis usually aims at estimating the marginal effect of an independent variable on the dependent variable, controlling for the influence of other independent variables. In the linear regression model, the estimated parameters can be interpreted as marginal effects.

In most applications of binary regression models (e.g., probit model), the primary goal is to

explain the effects of the Xj on the probability regression Pi (y = 1|X).

Table 1: Description of the variables used in the Probit model

Variable	Type	Description	Expected sign
Dependent Variable Yi	Dummy	1 if farmer has adopted IPM, otherwise 0	
Explanatory Variables			
Age of respondent	Continuous	Age of the household head (years)	-
Education of household head	Continuous	Formal education of the household head (years of schooling)	+
Farm size	Continuous	Amount of land under cultivation (ropani)	+/-
Family type	Dummy	1 if joint, otherwise 0	+/-
Training	Dummy	1 if received training, otherwise 0	+
Membership in group	Dummy	1 if received membership,otherwise 0	+
Credit availability	Dummy	1 if access, otherwise 0	+/-

Indexing

Scaling techniques provides the direction and extremity attitude of the respondent towards any proposition [6]. The reasons of adoption and the problems faced by the apple farmers using IPM practice were ranked by using scaling technique comparing intensity of importance and severity using five point scale values 1, 0.8, 0.6, 0.4 and 0.2. And the calculation was done using formula;

$$I = \sum Sifi / N$$

Where,

I = index $0 \angle I \angle 1$

Si = scale value at ith severity

fi= frequency of the ith severity

N = total number of respondents = $\sum fi$

RESULT AND DISCUSSIONS

Socio-demographic profile of IPM adopters and non-adopters in the study area

Among the adopters, 68.0 percent of the respondents were male with average family size 4.9 while 86.6 percent were male among non-adopters with average family size of 4.2. About 64 percent of the population were economically active (i.e. 16 to 59 age group) with average number 3.1 per household among adopters whereas, 61.9 percent among non-adopters with average number 2.6. Among adopters average age of the respondent was 43.2 years while it was 45 among non-adopters. Only 20 percent and 26.7 percent of the household were living jointly among adopters and non-adopters respectively. Among adopters about 80 percent of sampled population was literate with 6 years of average education of household head whereas, literate percent was only 74.6 with average years of education of household head 4.8 among non-adopters. Average cultivated area of adopters was higher (i.e.18.9 ropani) of which 14.8 ropani was under irrigation while that of non-adopters was 8 ropani of which 6.9 ropani area was under irrigation. Agriculture was the main occupation for 92 percent of farmers among adopters and for 86.6 percent among non-adopters. Involvement in IPM trainings was higher (92 percent) among adopters compared to non-adopters (20 percent). About 27 percent of adopters were accessed with credit and 88 percent were involved in farmers group whereas only 13.3 percent of non-adopters were accessed with credit and only 46.7 percent were involved in farmers group (Table 2).

Table 2: Socio-demographic profile of IPM adopters and non-adopters in the study area

Characteristics	Adopter	Non-adopter
Gender of respondent (%)		
Male	68.0	86.6
Female	32.0	13.4
Average family size (Number)	4.9	4.2
Age group of the sampled farmers (%)		
≤15 years	25.6	26.9
16-59 years	63.6	61.9
≥60 years	10.7	11.2
Average number of economically active members in a household	3.1	2.6
Average age of respondent (years)	43.2	45.0
Family type (%)		
Joint	20.0	26.7
Nuclear	80.0	73.3

Education status of sampled household (%)		
Illiterate	19.5	25.4
Literate	80.4	74.6
Average education of Household head (education Years)	6.0	4.8
Landholdings (Ropani)		
Average cultivable area	21.6	9.3
Average cultivated area	18.9	8.0
Mean area under irrigation	14.8	6.9
Occupation of sampled household (%)		
Agriculture only	36.0	53.3
Agriculture and business both	28.0	26.7
Agriculture and service both	8.0	13.3
Agriculture and labor both	28.0	6.7
Farmers with agriculture as a main occupation	92.0	86.6
Training received and credit availability (%)		
Respondent involved in IPM training	92.0	20.0
Access of credit	26.6	13.3
Involved in farmers group	88.0	46.7

Note: 19.66 Ropani= 1 Hectare *Source: Field survey, 2013*

Reasons for the Adoption of IPM practice

In the adoption of any agricultural practice there lie different reasons. Apple growers of the study area ranked farmers field school conducted by the district agriculture development office, Mustang as a first reason in the adoption of IPM practice followed by management of pest and disease with index value 0.84 and 0.68 respectively. For safe environment and soil was ranked as third important reason with index value 0.64. Similarly, quality product and high cost of chemical inputs were the fourth and fifth reasons with index value 0.48 and 0.35 respectively (Table 3).

Table 3: Reasons for the adoption of IPM practice in the study area

Reasons	Index Value	Rank
Farmer Field School Facilitated by District Agriculture Office	0.84	I
Management of Pest and diseases	0.68	II
Safe environment and soil	0.64	III
Quality Product	0.48	IV
High cost of Chemical Inputs	0.35	V

Source: Field survey, 2013

Problems in the Adoption of IPM practice

Respondent under study pointed lack of tools used in IPM was the most severe problem in the adoption of IPM practice scoring 0.72. Lack of detailed knowledge about IPM and lack of market were the second and third most severe problem with index value 0.63 and 0.60 respectively. No control of disease and pest from IPM practices was fourth severe problem with value 0.54 whereas, respondent put weak extension service of government organization as least severe problem in the adoption of IPM practice (Table 4).

Table 4: Problems in the adoption of IPM practice in the study area

Problems	Index Value	Rank
Lack of tools used in IPM	0.72	I
Lack of detailed knowledge	0.63	II
Lack of market	0.60	III
No control of disease and pest	0.54	IV
Weak extension service	0.50	V

Source: Field survey, 2013

Source of information received by the farmers about IPM Practice

Information source helps farmers in the adoption and continuation of any agriculture practices. In the extension of any agricultural practice source of information plays most significant role. In this study, 47.5 percent of respondent opinioned IPM farmers field schools as the major source of information about IPM practice. Similar to this result, Adeogun [7] reported that FFS has had positive effects on cocoa farmers' job performance in Nigeria. Likewise, Leader farmer was the source of information for 35.0 percent of household

followed by agricultural technicians i.e. for 17.5 percent. Newspaper and radio and television source were not used as information source by the respondent in the study area (Table 5). It may be due to the remoteness and inaccessibility of these sources in the district.

Table 5: Source of information received by the farmers about IPM practice

Information Source	Frequency/Percentage
IPM Farmer Field Schools	19(47.5)
Leader Farmer	14(35.0)
Radio/Television	0(0.00)
Agricultural Technicians	7(17.5)
Newspapers	0(0.00)

Source: Field survey, 2013

Satisfaction level of respondent towards IPM Practice

Among the adopters of IPM, different levels of satisfaction were asked to response. Majority of the respondent i.e. 52.5 percent lied in the satisfied group. Only 25.0 percent of the respondent lied in the highly satisfied group whereas, 20.0 percent were neutral. Only, 2.5 percent of the respondent were found dissatisfied with the IPM practice in the study area (Figure 1).

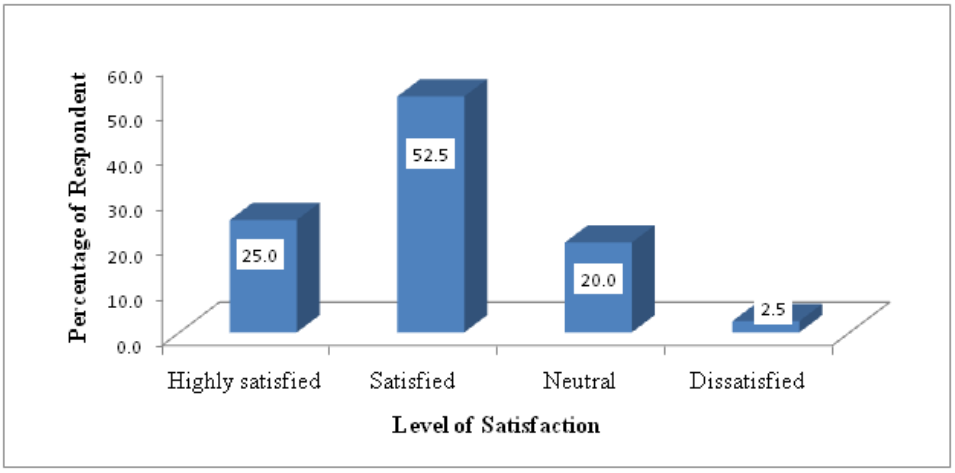

Figure 1: Satisfaction level of respondent towards IPM practice (2013)

Factors affecting the adoption of IPM practice

Adoption is an outcome of a decision to accept a given innovation. It is a mental process an individual passes from first hearing about an innovation to final utilization [8]. Probit regression analysis focused on the 40 sampled farmers. The parameters estimated for the model were eventuated at 1% and 5% level of significance. The wald test (LR chi^2) for the model indicated that the model had good explanatory power at 1% level. The Pseudo R^2 value was 0.570. For the interpretation of the model, marginal effect after Probit were driven from the regression coefficients calculated from partial derivatives as a marginal probability. Among different parameters used, only three were found statistically significant at 5% level of significance. Among the variables age of the respondent, training and membership in group were the most determinant factors affecting the adoption of IPM practice in the study area while education of household head, farm size, family type and credit availability were found insignificant (Table 6).

Table 6: Factors affecting the adoption level of IPM practices in the study area (2013)

Variables	**Coefficients**	**P>|z|**	**S.E.**	**dy/dx[b]**	**S.E.[b]**
Age of respondent(Years)	-0.062**	0.098	0.037	-0.015	0.010
Education of household head(Years)	0.118	0.262	0.105	0.028	0.243
Farm size (Ropani)	-0.012	0.589	0.022	-0.003	0.005
Family type (Dummy)	-0.039	0.966	0.913	-0.009	0.213
Training (Dummy)	1.580**	0.063	0.848	0.458	0.229
Membership in group (Dummy)	1.463**	0.078	0.199	-0.033	0.438
Credit availability (Dummy)	0.761	0.342	0.831	0.391	0.188
Constant	0.958	0.596	0.800	0.168	0.163

Summary statistics

Number of observation(N)	40
Log likelihood	-11.121
LR $chi^2(8)$ $Prob>chi^2$	29.55^{***} 0.000
Pseudo R2 Cases predicted correctly (%)	0.570 84.4
Goodness of fit test	Pearson chi^2 (31) = 23.82. Prob> chi^2 = 0.817

*** Significant at P = 0.01; ** significant at P = 0.05; * significant at P ≥ 0.1

Source: Field survey, 2013

The statistical significance of the individual explanatory variables in the model is discussed as follows;

Age of respondent

The young farmers are more interested in trying out new agricultural technologies because of their risk taking character. The variable age of the respondent entered the model is in agreement with the expected negative sign. Age of the respondent was negatively significant (P>0.05) to the adoption of IPM practice. The result of this study showed that the age factor negatively affect the adoption of IPM practice. The model resulted that one year increased in the age of respondent would decrease the level of IPM adoption by 1.5%. Finding is in line with the result to what Roger [9] stated that young farmers are more willing to adopt a new innovation than an elder one because they are more open but contrary to this findings age was found to positively influence adoption of IPM on peanuts in Georgia [10]. In contrast to this result, Odendo et al [11] also reported that age had a positive relationship with the adoption of traditional practice such as manure.

Training

Training (dummy) was positively significant (P>0.05) to the adoption of IPM practice. Whether the farmer received formal as well as informal trainings from governmental and non-governmental organization, the level of adoption of IPM practice would increase by 45.8 percent. This might be due to improving skills, increasing awareness and realization of positive benefits from the IPM adoption. Ofuoku et al [3] also mentioned that the poor level of adoption of the practice was poor because of the poor frequency of extension contact would have enhanced the adoption of the innovation. The excellent way to accelerate the adoption of IPM practice was by means of education and training of farmers about IPM [12].

Membership in farmer groups

Membership in groups exposes farmers to a wide range of ideas and sometimes gives farmers the opportunity to have better access to reliable information through trainings and extension services which may positively change their attitude towards an innovation [13]. Coefficient of membership in farmer group was positively significant (P<0.05) from the study and if farmers were participated in a farmer group would increases the probability of adoption of IPM practice level by 3.3 per cent. This might be due to the facts that, farmers gain high skills and knowledge while involving in groups and are in the direct influence of such practices. Similar result was reported by Chi [14].

SUMMARY, CONCLUSION AND RECOMMENDATIONS

The ultimate goal of this research was to explain the factors affecting the adoption if IPM practices in the high Himalayan region of Nepal. A Probit regression model was estimated for this purpose. The ratio of the correct prediction is 84.4 % and the likelihood ratio test is significant at 1 % level indicating the model has good explanatory power. Among all the selected explanatory variables, included in the model three variables that are age, training and membership in farmer group were significant at five percent level of significance. The result revealed that the adoption level of IPM practice increases with the increase of trainings and group approach of extension while adoption level decreases with the increase in age of the farmers. For best adoption trainings should be provided to younger farmers. IPM farmer field school is playing significant role in the process of adoption. Farmers in the study area are more concerned with environment and soil health. Further, adoption level can also be raised by making available of those tools and materials used in IPM practice. The findings of this study can also be used as reference for adoption of other agricultural technologies in the district.

Some recommendations have been suggested as a guideline for evolving appropriate policies to enhance the adoption rate of IPM practice.

I. Group approach is found quite effective in IPM adoption such that it is recommended to involve all the farmers in different groups by concerned agencies of Government as well as non-government organizations.
II. It is recommended that more farmers' training program should be implemented by the agriculture extension department of Nepal to enhance the technical skills among farmers about IPM practice for best adoption.
III. IPM farmer field school is a relevant source of information. Continuation of farmer's field

school to other VDCs of Mustang will help in quick adoption of IPM.

IV. IPM tools should be made available at correct time and adequate volume to apple farmers for better adoption of IPM in the study area.

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