Soil Environ. 30(1): 74-77, 2011
www.se.org.pk
Online ISSN: 2075-1141
Print ISSN: 2074-9546

The adoption of integrated pest management (IPM) technologies by cotton growers in the Punjab

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Abstract

Pesticides applications generate negative externalities for health, environment and also add up to economic cost to cotton producers. Consequently, there is an urgent need of alternative methods of pest management for environment friendly cotton production systems. Integrated pest management (IPM) is a right method which can reduce or minimize the use of pesticides as well as can lessen the cost. The cross-sectional data was collected from district Jhang. A random sample of 99 farmers was selected to collect the data. The main factors which influence the adoption of IPM in cotton are age, education, farm size, farm labour, family size, progressive farmers and opinion leader farmers. The logistic regression was used to estimate the model. Three variables are significant at 5 percent level of significance and two variables are significant at 10 percent level of significance. The family size and opinion leader farmer (variables) are non-significant. The Hosmer Lemeshow test value was 0.316 (Chi-square) which was non-significant indicating that overall model was correctly specified. The estimated odds ratio for education, farm size, family labour, progressive farmer, and opinion leader farmer were 1.49, 1.07, 11.08, 12.26 and 4.27, respectively. All these factors had positive influence on the adoption of IPM technology by the magnitude of their respective odds ratio. However, the estimated odds ratio for family size was 0.48 and for age was 0.88 (both the estimated coefficient have negative signs), which suggests a negative influence on the adoption of IPM.

Keywords: IPM, cotton, logit regression, adoption, pesticides, Punjab

Introduction

Agriculture is the largest sector in the economy of Pakistan and cotton is an important cash crop. Cotton is also a significant source of foreign exchange earnings. Cotton accounts for 7.3 percent of the value added in agriculture and about 1.6 percent of GoP (Government of Pakistan, 2009). The advancement in agricultural production processes increases crop productivity and well-being in the rural areas. It also ensures self-sufficiency in food, grains and fiber production. In Pakistan, approximately 45 percent population is engaged in agriculture sector. In southern Punjab, cotton is a major fiber crop known as White Gold. In cotton production, pesticides are intensively used to control the pests. The public health officials are increasingly concerned about the adverse effects of the applications of pesticides by the farmers in cotton production. Pesticide applications not only generate negative externalities for health and environment, but also increase significantly the economic cost of cotton producers (Wilson and Tisdell, 2001). The southern Punjab is a major cotton production region of Pakistan. The average yield of cotton is about 560 kilogram per acre. In this region, the demand of pesticides is continuously increasing. There is a dire need of alternative methods of pest management for sustainable and profitable cotton production (Swinton and Day, 2000). Integrated pest management (IPM) is an appropriate method which can reduce or minimize the use of pesticides as well as can reduce the cost of production.

The scientists are in search of finding the factors affecting the adoption rate of IPM. The specific objectives of this research work include, 1) the identification the factors which influence the adoption of IPM of individual cotton growers, 2) quantification of these factors influencing the adoption of IPM practices, and 3) recommendation of suggestions to increase the adoption of IPM practices among the cotton growers in the study area.

Materials and Methods

The cross-sectional data was collected from the district Jhang from the respondents on both the qualitative and quantitative variables. A random sample of 99 farmers was interviewed from the district Jhang in 2010. The logit model was used for data analysis. Logistic regression methods are becoming increasingly prevalent for data analysis, when outcome variable is discrete, taking on two

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or more possible values (Hosmer and Lemeshow, 2000). The outcome variable in logistic regression is binary or dichotomous. The practical use of logit and probit models is continuously increasing in multiple disciplines (Hoetker, 2001). In adoption decision, where the random variable is discrete or dichotomous the limited dependent variable models become most appropriate and powerful tools such as the ordinary logit model (Hosmer and Lemeshow, 2000):

$$\ln\left[\frac{P(Y=1)/X}{1-P(Y=1/X)}\right] = \alpha \sum_{i=1}^{n} \beta_i X_i + e$$

Where;

P(.) = Probability that an IPM technology (Y) is adopted

α = Constant term

X = A set of core explanatory variables

β = A vector of unknown parameters

e = Disturbance term

The dependent variable of this model represents whether a farmer is an adopter or non-adopter of IPM cotton production technologies. The characteristics and related variables assumed to be affecting the adoption of IPM cotton production technologies are given here:

(i) Education is expected to be positively related to the adoption of IPM cotton production technologies.
(ii) Farm size is expected to be positively related to the adoption of IPM cotton production technologies.
(iii) Age may be negatively related to the adoption of IPM cotton production technologies. Younger farmers may be more dynamic adopters of the IPM cotton production technologies.
(iv) Family size is expected to be positively related to the adoption of IPM cotton production technologies.
(v) Farm labour is expected to be positively related to the adoption of IPM cotton production technologies.
(vi) Progressive farmers are likely to be adopters of new production technologies like IPM.
(vii) Opinion leader farmer status. If the opinion leader farmer is superior to followers in socio-economic distance or status but not excessively so; he may be more effective in transmitting the knowledge. Excessive socio-economic distance may reduce the effectiveness of diffusion.

The model used to analyze the factors affecting the adoption of IPM cotton production technologies are given below:

Y_i = β_0 + β_1Education + β_2 Age + β_3Farm Size + β_4Family Labor + β_5Family Size + β_6Prog. Farmer + β_7Opinion LF + ε_i

Odds are just a ratio of the probability that an event will occur versus the probability that the event will not occur, or probability / (1-probability). For example, if you go fishing and you catch 3 big and 1 small, then the odds of catching a small fish = [(1/4)/(3/4)] = 1/3 = 0.33. It is important to note that this differs from risk (or probability): the risk of catching a small fish is equal to (number of small fish caught) / (total number of fish caught) = 1/4 = 0.25. Therefore, odds ratios are simply ratio of odds. For example, if you compare fishing with no bait versus fishing with bait and cast 100 times using each method, the result is shown in Table 2.

Hence, odds ratio can be used to give an idea of how strongly a given variable may be associated with the outcome of interest compared to other variables (Examples of .com, 2011).

Results and Discussion

The adoption of IPM cotton production technology decisions are mainly influenced by age, education, farm size, farm labor and family size and attitudes (Gershon and Sara, 2006). The estimated coefficients of the logistic regression model that is the adoption of IPM cotton production technologies model are presented in Table 3. In this model the seven most relevant explanatory variables were included which are given in the Table 1. Among these seven variables, three variables (education, age and family labor) were significant at 5 percent level of significance, two variables (farm size and progressive farmer) were significant at 10 percent level of significance, two variables were non-significant (family size and opinion leader farmer) and their signs were also as expected except one (family size). In Table 3, odds ratios are also presented which show the effects of individual independent variables of the possibility or chances of adoption of IPM cotton production technologies, other things being equal. The odds ratio is computed by exponentiating the parameter estimates for each explanatory variable. The ratio of the correct prediction was 93 per cent. The likelihood ratio test is significant at one percent level indicating that the model has good explanatory power. The Hosmer Lemeshow test value was 0.316 (Chi-square) which is non-significant indicating that overall model was correctly specified.

The estimated odds ratio for education was1.49 which means if the education of a farmer increases by one year, the adoption of IPM cotton production technologies will increase by 1.49 times. The excellent way to accelerate the adoption of IPM technology was by means of education and training of farmers about IPM (Hussain and Korejo, 2007). The estimated odds ratio for the age was 0.88 (the estimated coefficient has negative sign) which means if the age of the farmer increases by one year there were 0.88 times less chances that former will adopt the IPM cotton production technologies. The young and rich farmers with large land farms have greater tendency to adopt Environmental Management Systems in Canada. (Udith and Weersink, 2004).

cotton production technologies. The estimated odds ratio for family size was 0.48 (the estimated coefficient has negative sign) which means that as the size of the families was increasing there were 0.48 times fewer chances that the farmers will adopt the IPM cotton production technologies.

Table 1: Description of the variables used in the adoption of IPM techniques by the Cotton Growers

Variable	Description
Dependent Variable (Y)	1 if the farmer adopts IPM techniques for cotton production; 0 otherwise.
Explanatory variables	
Education	Education of the farmer in years.
Age	Age of the farmer in years.
Farm Size	Farm size in acres.
Family Labour	Number of unpaid family members available to work on the agriculture farm.
Family Size	Total number of family members
Progressive farmer	1 if the farmer is a progressive producer; 0 otherwise.
Opinion leader farmer	1 if the opinion leader farmer is slightly superior to followers in socio-economic class or status but not very superior; 0 otherwise.

Table 2: Result of an example fishing with no bait versus fishing with bait

	Number of times caught	Number of times not caught	Total number of casts
With bait	50	50	100
without bait	2	98	100

The odds of catching a fish with bait is 50/50 or 1.0.
The odds of catching a fish with no bait is 2/98 or 0.02.
Therefore, the odds ratio for catching a fish with bait vs. no bait is 1.0/0.02 = 50.
The probability of catching a fish with bait is 50/100 or 0.50.
The probability of catching a fish with no bait is 2/100 or 0.02.
Therefore, the relative risk for catching a fish with the bait vs. no bait is 0.50/0.02 = 25.

Table 3: The Coefficients of the estimated IPM Adoption Logistic Regression Model

Variable	Estimated Coefficients	Standard Error	Significance	Odds Ratio
Constant	1.219	4.229	0.773	3.384
Education	0.398	0.191	0.038*	1.488
Age	-0.129	0.060	0.030*	0.879
Farm Size	0.067	0.039	0.084**	1.069
Family Labour	2.405	1.028	0.019*	11.080
Family Size	-0.744	0.617	0.228	0.475
Progressive farmer	2.506	1.405	0.074**	12.261
Opinion leader farmer	1.451	2.216	0.513	4.267

The Nagelkerk R^2 = 0.76 -2 Log likelihood = 41.02
Hosmer Lemeshow Test = 0.316 Chi-square with 8 df (p=9.32)

The ratio of the correct prediction is 93 per cent.
*significant at 5%
**significant at 10%

Similarly, the estimated odds ratio for the farm size was 1.07 which indicates that there were 1.07 times more chances that the farmer will adopt the IPM cotton production technologies. The estimated odds ratio for the unpaid family labor was 11.08; it means those farm families which have their family labor or workers there are 11.08 times more chances that the farmers will adopt the IPM

The estimated odds ratio for progressive farmer was 12.26 which suggest the progressive farmers were willing to adopt the IPM cotton production technologies by 12.26 times more. The estimated odds ratio for the opinion leader was 4.27 which signify that if the cotton producer was also an opinion leader in the community there were 4.27 times more chances that those producers will adopt the IPM cotton production technologies. Gershon and Sara, (2006) found that if the opinion leaders were slightly superior to followers but not very superior in socio-economic status then they were also effective in disseminating the information and awareness about IPM technology among other farmers. The adoption of improved conservation practices increase the crop yield (Hadda and Arora, 2006).

The conclusions drawn from the results of this study can be used to suggest recommendations for the adoption of IPM technology at farm level. Some recommendations have been suggested below to boost the adoption of IPM technology.

i. The results of this study pointed out that education plays an effective role in the adoption of IPM technology. Hence, it is recommended that government may take actions to upgrade the education as well as training programs for cotton producers.
ii. This study also exposed that elder farmers do not adopt the innovative technologies like IPM. Hence, it is suggested that government may mediate to create awareness about IPM technology among elder farmers. Incentives should be given to young farmers in cotton production.
iii. The adoption of IPM technology may be accelerated if farmers also complement a disease resistant variety of cotton, for example, Bt. cotton.

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