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RESEARCH ARTICLE

Factors Affecting Adoption of BT Cotton: A Case Study of District Toba Tek Singh, Pakistan

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ABSTRACT

Cotton crop is highly susceptible to insect and pest attack. This induces the reduction in the profit of the farmers, by declining the yield and increased production cost due to intensive use of insecticides. To cope this Bt cotton was rapidly adopted in Punjab, Pakistan i.e. 83 percent cotton area is under Bt cotton cultivation. The aim of study was to analyze factors that affect adoption of Bt cotton in district Toba Tek Singh, Pakistan. In this study, the primary data was collected from 150 cotton growers (adopter and non-adopter of Bt cotton) randomly through farmer survey. Logistic regression analysis results indicated that size of land holding, rented in land, and yield had significant positive impact in adoption of Bt cotton. while pesticide use and labor were found significant with negative sign. As the study findings indicated that yield had important implications for adoption of Bt cotton, therefore, there is need to carry out research to develop newer drought resistant and less input intensive Bt varieties.

INTRODUCTION

Cotton in Pakistan is grown on more than 15 percent of arable land mainly in two provinces, Punjab and Sindh. There are more than 1.6 million farmers in Pakistan who mainly depend on cotton production. The role of cotton in economic growth is very important as it contributes 6.7 percent in GDP of Pakistan and it provides almost 17 percent employment and 54 percent earnings from foreign exchange. Cotton is the main source of raw material for textiles, ginners, seed oil crushers and refineries in Pakistan. Pakistan cannot produce enough cotton to meet the growing demand of cotton in industry. The main reason behind this phenomenon is low yield. The reasons for low yield include high prices of inputs, deficiency of irrigation water, high intensity of pest attacks and adulterated inputs (Panhwar, 2014).

Cotton crop is highly susceptible to insect and pest attacks, as it has been remained under attack of numerous insects and pests. This induces a significant reduction in the profit of the farmers, by decline in yield and increased production cost of the crop. The application of pesticides has been increased due to the intensification of pest attacks as farmers have to spend more money to protect their crops from pests' attack. The vulnerability of cotton crop towards insect attacks makes the crop to consume more insecticides as cotton consumes 11 percent of the world's pesticides while 25 percent of world's insecticide is used on cotton crop. There is more consumption of pesticides in developing countries which comprises 50 percent of the world (Pyburn, 2006). According to an estimate, around 75-90 percent of pesticides are used in cotton crop while rest 10-25 percent on other major crops and vegetables (Hashmi and Dilshad, 2011).

The traditional means to overcome boll worm by spraying insecticides were largely ineffective (as the insect produced resistance against certain insecticides) and the use of insecticides became more and more

costly. To solve the issues like pest attack and environment concerns, Bt cotton was introduced. Bt stands for *Bacillus thuringiensis*, a soil bacterium. The genes from this Bt bacterium are transformed to the cotton genome (Qaim et al., 2003). This gene led to the production of a protein which served as a poison for cotton bollworm, a dangerous enemy for the cotton crop (Qaim and de Janvry, 2004).

Punjab is one of the advanced provinces of Pakistan in terms of cotton production, which comprises about 80 percent cotton area of Pakistan. Bt cotton in Punjab was introduced in 2001 (Arshad et al., 2009). Bt cotton cultivation has rapidly increased at the rate of 82.65 percent in Punjab while almost 83.23% in Sindh province. Due to its wide range benefits (economic, social and environmental) in the form of increased productivity, convenience, time and money savings and health, convinced the farmer to adopt Bt cotton varieties (Purcell and Perlak, 2004). Therefore, present study was planned to study the factors affecting adoption of Bt cotton among farmers in district Toba Tek Singh, Punjab, Pakistan.

MATERIALS AND METHODS

Data collection

The study of the adoption of Bt cotton was conducted in cotton area of district Toba Tek Singh, Punjab, Pakistan. The cropping pattern, farming practices and climate is similar throughout the district. In present study the primary data of 150 respondents (adopter and non-adopter of Bt cotton) was collected randomly through farmer surveys from cotton growers in district Toba Tek Singh.

Empirical analysis

This factors which affect the adoption of Bt cotton were analyzed by using logistic regression model because logit and probit models had been used extensively in studying adoption behavior of farmers (Adeogun et al., 2008). The logistic model is used when dependent variable is dichotomous. The binary values are assigned to dependent variable as 0 or 1. As in this study the farmers are categorized as adopters and non-adopters of Bt cotton, the value of 1 is given to adopters and 0 to non-adopters (Padaria et al., 2009). The Binary logistic model is written as (Gujrati and Sangheeta, 2003).

$$L_i = \ln\left(\frac{P_i}{1-P_i}\right) = \beta_o + \sum_{i=1}^{m} \beta_i X_i + \mu_i$$

Where,

L_i is logit variable or log of the odd ratio. Odd ratio is the ratio of probability of yes to no and **ln** is the natural log and P_i is the probability of dependent variable. Similarly, β_o is the intercept and β_i are unknown parameters of the model. The X_i is the vectors of factors affecting adoption of Bt cotton e.g. farm size, farming experience, rented in land, education, labor, pesticide and yield etc. and μ_i is the error term.

RESULTS AND DISCUSSION

Socio-economic characteristics of sample households

The socio-economic characteristic of both Bt and non-Bt cotton adopters are presented in Table 1. Analysis shows that average age of Bt cotton adopters and non-adopters is about 38 and 40 years respectively. The average education of Bt cotton adopters and non-adopters is about 9 and 6 years respectively. The farming experience of Bt cotton adopters and non-adopters is about 17 and 20 years respectively. Average land holding size of Bt cotton growers is larger than non-Bt cotton growers i.e., 12.40 and 7.85 acres respectively. Furthermore, the rented in land for Bt cotton grower is 3.22 acres on the average as compared to non-Bt cotton growers who have 1.66 acres rented in land on the average. Similarly, land under Bt cotton is larger than non-Bt cotton i.e., there is 4.67 acres land under Bt cotton on the average and 1.67 acres land under non-Bt cultivation.

Agronomic characteristics of sample household

Table 2 indicates the agronomic factors contributing in cotton cultivation for both Bt and non-Bt cotton growers. The average number of sprays of pesticide used among Bt cotton growers were 4.15 which is lesser than non-Bt cotton growers. Average seed rate was 6.36 kg/acre and 6.98 kg/acre for Bt and non-Bt cotton growers respectively. There was 1.18 trolley/acre on average FYM applied by Bt cotton growers and 1.43 trolley/acre by the non-Bt cotton growers. Similarly, there was 2.83 bags/acre of urea, 0.85 bags/acre of DAP and 0.39 bags/acre of other fertilizers on the average were applied by the Bt cotton adopters. The average numbers of irrigations of canal water was 5.70 by Bt cotton adopters and 4.80 by non-Bt cotton growers. Similarly, the average numbers of irrigations of tube well water was 3.78 by the Bt cotton adopter and 2.75 by the non-Bt cotton growers was observed. Furthermore, 4.09 ploughings, 1.11 planking and 0.90 rotavator were used by Bt cotton adopters and 3.87 ploughings, 0.87 planking and 0.88 rotavator were used by non-Bt cotton growers.

Logistic model results

Econometric analysis through logistic analysis was conducted to analyze the role of variables including farming experience, education, size of land holding, rented in land, insecticide use, labor, and yield on adoption of Bt cotton and results are presented in Table 3. Farming experience was found statistically insignificant in adoption of Bt cotton. The negative coefficient shows that the experienced farmers would not likely to adopt new technology or variety of seeds.

They were strict with traditional ways of growing conventional cotton varieties (Mal et al., 2010). The education level of respondent was also found insignificant in adoption of Bt cotton. The coefficient of farm size was found significant in adoption of Bt cotton. It indicates that a unit increase in farm size would bring 1.15 times more chances in adoption of Bt cotton. An increase in land holdings made the farmer more risk averse as compared to smaller land holders

Table 1: Socio-economic Characteristics of Sample Households

Indicators	Bt cotton adopter	Non-Bt cotton adopters
	Average	Average
Age (yrs.)	38.63	40.20
Education (yrs.)	8.82	6.33
Farming exp. (yrs.)	17.42	19.91
Family size (No.)	7.98	6.94
Land holdings (Acres)	12.40	7.85
Rented land (Acres)	3.22	1.66
Land under cotton (Acres)	4.67	1.67

Table 2: Agronomic characteristics of sample household

Indicators	Bt cotton adopter	Non-Bt cotton adopters
	Average	Average
Pesticide (No.)	4.15	7.02
Seed rate (Kgs)	6.36	6.98
Fertilizers		
FYM (Trollies)	1.18	1.43
Urea (Bags/Acre)	2.83	2.77
DAP	0.85	0.80
Other	0.39	0.63
Irrigation		
Canal (No.)	5.70	4.80
Tube well (No.)	3.78	2.75
Land preparation		
Ploughing (No.)	4.09	3.87
Planking (No.)	1.11	0.87
Rotavator (No.)	0.90	0.88

Table 3: Results of logistic regression model

Indicators	B	S.E.	Sig.	Exp(B)
Farming Exp.	-0.051	0.035	0.147	0.951
Edu	0.006	0.083	0.942	1.006
Farm Size	0.139	0.064	0.029	1.149
Rent in land	0.241	0.116	0.039	0.786
Pesticide	-1.138	0.281	0.000	0.320
Labor	-0.928	0.442	0.036	0.395
Yield	0.130	0.056	0.020	1.138
Constant	.045	2.398	.985	1.046
Hosmer-Lemeshow goodness-of-fit	0.994			

because larger farmers have enough resources to manage their crops. That's why farmers with larger farm size adopt new technology more quickly than farmer with smaller land holdings (Arshad et al., 2007). The rented in land was also found significant in adoption of Bt cotton. Analysis showed that a unit increase in rented in land would increase the probability of adoption of Bt cotton by 0.78 times. The farmer with rented in land would try to adopt the high yielding technology so that he could procure enough profit to pay land rent and likes to maximize his profit in short time period (Zelda and Sekar, 2015). The pesticide use was negatively significant in the study. Empirical analysis indicated that a unit decrease in pesticide use increased 0.32 times probability of adoption of Bt cotton. The Bt cotton required lesser amount of pesticides because it was made resistant towards pest attacks e.g. Bollworms (Loganathan et al., 2009). The coefficient of labor use was significant with negative sign. It indicates that an additional unit increase in labor would decrease the probability of 0.40 times adoption of Bt cotton. Bt cotton required less labor because easy management of cotton crop due to less attack of insects (Morse, 2007). Yield was found significant in adoption of Bt cotton. A unit increase in yield increased by 1.14 times the probability of adoption of Bt cotton. The increase in yield was due to less attack of insects. The results of this study were found consistent with (Kiresur and Ichangi, 2011). Furthermore, the overall goodness of fit of estimated model can be tested through Cox and Snell R square and Negelkerke R square. The estimated Cox and Snell R square and Negelkerke R square have values 0.52 and 0.74 respectively implying that this much percentage variation in the model is explained by variables present in the model and rest is explained by other variables.

Conclusions and recommendations

This study was conducted to analyze factors that affect adoption of Bt cotton in district Toba Tek Singh, Punjab, Pakistan. Data was collected from 150 cotton growers (adopter and non-adopter of Bt cotton) randomly through farmer survey. Logistic regression analysis results indicate that size of land holding, rented in land, and yield has significant positive impact on adoption of Bt cotton. While pesticide use, and labor were found significant with negative sign. As the study findings indicate that yield had important implications for adoption of Bt cotton, therefore, there is need to carry out research to develop newer drought resistant and less input intensive Bt verities.

Authors' contribution

All others contributed equally in this study.

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