Pak. J. Agri. Sci., Vol. 58(1), 291-300;2021
ISSN (Print) 0552-9034, ISSN (Online) 2076-0906
DOI: 10.21162/PAKJAS/21.227
http://www.pakjas.com.pk

IMPACT ASSESSMENT OF BETTER MANAGEMENT PRACTICES OF COTTON: A SOCIOLOGICAL STUDY OF SOUTHERN PUNJAB, PAKISTAN

Shabbir Ahmad[1,3], Wu Huifang[1,*], Saira Akhtar[2], Shakeel Imran[3], Haroon Yousaf[2], Chunyu Wang[1], and Muhammad Sohail Akhtar[2]

[1]College of Humanities and Development Studies, China Agricultural University, No. 17, Qinghua Donglu, Haidian District, 100083, Beijing P. R. China; [2]Department of Rural Sociology, University of Agriculture, Faisalabad, Punjab, Pakistan; [3]University of Agriculture, Faisalabad, Sub Campus Burewala, Punjab, Pakistan
***Corresponding author's e-mail: wuhf@cau.edu.cn**

The current research study was designed to evaluate the impact assessment of Better Management Practices of cotton by comparing the performance of both the adopters and non-adopters of BMPs. The present quantitative (cross-sectional) study was conducted in the Southern region of the Punjab province of Pakistan. A sample of 160 farmers constituting equal number of adopters and non-adopters of BMPs of cotton was drawn from district Khanewal which was purposively selected from the Southern Punjab. Data were collected by the utilization of a well-structured interview schedule. The results of the logit model revealed that education and farming experience had a significant influence on the adoption of BMPs. Furthermore, it was found that the adoption of BMPs was mainly affected by the area under cotton cultivation, land ownership status, age, and family size of the cotton grower, but the probability of these variables was not found statistically significant. The frequency analysis of the collected data revealed that the average number of irrigations applied by both the adopters and non-adopters was 16.0 and 21.0, respectively. Mean numbers of fertilizer (Urea, DAP, Potassium Nitrate, etc.) bags and pesticide applications applied by the adaptors and non-adopters were 3.5 and 4.2 bags, 3.8 and 7.7 applications, respectively. Child labor was exploited by 11.3% of adopters and 78.8% of non-adopters. Health and safety measures were highly considered by 75.0% of the adopters and 42.5% of the non-adopters. It was concluded that BMPs on cotton had significant impact not only on the productivity but also on the environmental safety and sustainability of the cotton crop.
Keywords: Better Management Practices, Adopters, Non-adopters, Logit Model, Southern Punjab, Pakistan.

INTRODUCTION

Cotton (G*ossypium hirsutum* L.) is the pre-eminent fiber of the world, which contributes a yearly economic impact of $600 billion worldwide (Ashraf *et al.*, 2018). Cotton is cultivated in more than 100 countries around the globe. China, USA, India, Pakistan, Brazil, and Uzbekistan produce 24%, 19%, 16%, 10%, 5%, and 4% cotton (global cotton production), respectively (Kooistra *et al*., 2006). Nearly, 25 million tons of cotton is produced each year around the globe which is used to make about 50% of the clothes. It provides living to 250 million people around the world. It uses 2.5% of the total arable land of the world, and account about 7% labor of the developing countries (WWF-P, 2013). Pakistan ranks the 4th largest among the cotton producing, the 3rd largest consumer of cotton, and the 7th largest among the clothes producing countries around the globe (Allah *et al*., 2009; GOP, 2009; GOP, 2011; Shuli *et al*., 2018). Its share in the GDP is 1.4% (GOP, 2014; Usman, 2016; GOP, 2016; MOF, 2018), and contributes 5.5% in the agricultural value addition. The cultivation of cotton has jumped from 2,489 thousand hectares to 2,699 thousand hectares in the last year showing an increase of 8.4% (MOF, 2018). In Pakistan, about 30 million ranchers have cotton in their crop rotation schemes, and 20 million entirely rely on the cotton cultivation for their sustenance (Kooistra *et al.*, 2006).

Cotton, which is grown by traditional ways, consumes a lot of resources, damage the environment, and create many social problems, which is a somber peril to the sustainability of the cotton crop. Keeping in view theses social and environmental harms WWF-P (World Wildlife Fund-Pakistan) and other stakeholders started Better Cotton Initiatives (BCI) with the aim to make cotton production better for the people and environment through "Better Management Practices" of cotton by comparing the efficiency of the adopters and the non-adopters of BMPs. The term BMPs for cotton was devised by WWF-P, which was working in the Khanewal district, Southern Punjab, Pakistan to improve the quality of cotton. It includes the judicious utilization of the field inputs such as number of irrigations, doses of herbicides or pesticides, and fertilizer applications. The BMPs of cotton also include the adaptation of health and safety measures, reduction of child labor, and provision of on-farm facilities to the labor force. Conventional farming practices such as the application of high doses of irrigations, fertilizers, and pesticides etc. are still utilized by majority of the cotton cultivators in Pakistan (Van Der Werf, 1996; Tilman *et al*., 2002; Maroni *et al.*, 2006; Carvalho, 2006; Watto and Mugera, 2015; Zulfiqar and Thapa, 2016; Ahmad *et al.*, 2018). The conventional cotton growers have, consequently, low resource efficiency and high cost of production as compared to the adopters of BMPs (Watto and Mugera, 2015; Zulfiqar *et al.*, 2017). Furthermore, the climate change has badly affected the cotton production in Pakistan (Nazli *et al.*, 2012). Several researchers have found that the production of cotton is negatively affected by climate change (Ahmad *et al*., 2016; Ahmad and Nawaz, 2016) along with inefficient cotton production management practices (Zulfiqar *et al*., 2017). The excessive utilization of groundwater, the augmented susceptibility of cotton to insect and pest attacks, deterioration of natural resources, (Atreya, 2008; Lopes Soares and Firpo de Souza Porto, 2009; Fantke *et al*., 2012), and human health have raised apprehensions due to conventional based agriculture about the long-term sustainability of the system (NFDC, 2013; Watto and Mugera, 2013; Iqbal et al., 2016; Zulfiqar and Thapa, 2016; Ahmad and Nawaz, 2016; Akhtar *et al*., 2018). The societal apprehensions associated with cotton cultivation are ubiquitous around the world. These impacts are incorporated in biodiversity, child labor, working conditions, and human health (Rehman *et al.*, 2016). The wildlife as well as domestic animals are affected by the utilization of the pesticides (Banuri, 1998; Nazli *et al.*, 2012). The issue of unsuitable farming management practices is attributed to many aspects including inadequate organizational structure at the local farmer level (Adhikari *et al.*, 1999; Dobermann *et al.*, 2003), the absence of training and education among the farmers (Hussain *et al.*, 1994; Ahmad, *et al.*, 2005), and insufficient extension services at the national, provincial and regional levels, respectively (Hussain *et al*., 1994; Bakhsh, 2012). Lack of capacity, financial resources, and knowledge about appropriate management practices are some of the other constraints (FAO, 2006). In cotton production, inefficient cultural practices, have directed to the degradation of the freshwater resources, nutrient runoff, and biodiversity. Cotton produced in a conventional manner poses a great threat to many social and environmental complexities. Sustainable agriculture practices (SAP) and better management practices (BMPs) are the only solutions to preserve our scarce natural resources. These BMPs are aiming at minimizing the degradation of the environment (WWF-P, 2006). Fluctuating from outdated to sustainable agricultural approaches is a viable way to control over the non-point pollution sources at farm level. Moreover, these improved farming techniques (BMPs) would definitely contribute to the eradication of extreme poverty from the rural communities (Ali and Abdulai, 2010).

The present study was designed to evaluate the impact assessment of the BMPs of cotton by comparing the performance of both the adopters and non-adopters of BMPs.

MATERIALS AND METHODS

Data Information and Salient Features of the Study Area: The district Khanewal is situated in the Southern part of the Punjab Province, Pakistan where the finest irrigation system of the world is situated (Basharat, 2012). It has a total area of 4,349 km^2 and 2.922 million (2017, census) inhabitants are residing in this district. It is located at 30°18'0 N 71°55'0 E with an altitude of 128 meters. This district is comprised of four tehsils viz. Khanewal, Kabirwala, Jahanian, and Mian Channu. It is surrounded by the districts Multan, Vehari, and Sahiwal. The major crops which are cultivated in the district include cotton, wheat, and sugarcane. Due to the extensive cultivation of cotton, this district along with districts Vehari, Multan, and Bahawalnagar, is called the “Cotton Belt”. The main focus of this study was to assess the impact of the BMPs of the silver fiber “cotton” of the country. For the purpose of this study, the farmers were classified into the categories of adopters and non-adopters of BMPs.

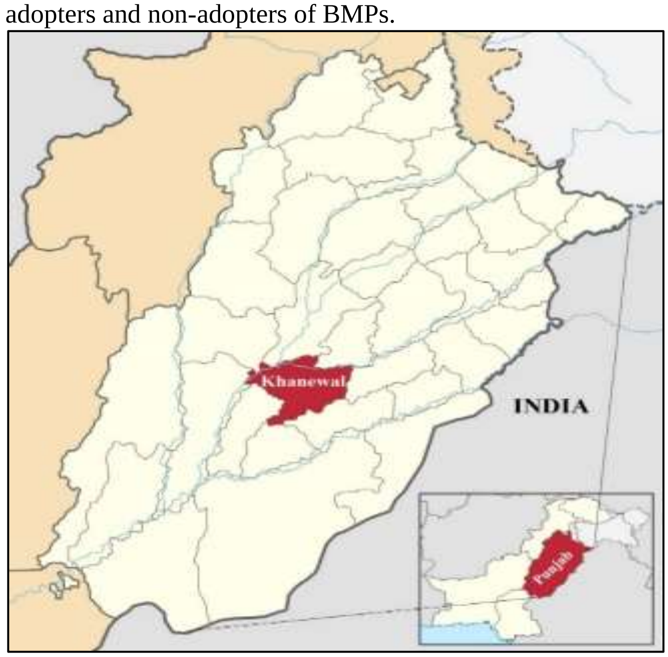

Figure 1. Geographical location of the study area

Population and Sampling

***Research Design*:** Research design is a plan of study, which provides an overall strategic framework of data collection to answer the formulated research questions (Leedy, 1997; McMillian and Schumacher, 2001; Durrheim, 2004). The present investigation was a cross-sectional quantitative research study that was conducted in the Khanewal district of the Punjab province, Pakistan.

***Population of the Study*:** The Population of this study contained all the cotton growers of the Khanewal district. WWF-P was working on BMPs, in the two Tehsils namely Khanewal and Kabir Wala of District Khanewal. There are

100 Learning Groups of Adopters (LGs) in each tehsil and 30 to 40 adopter farmers are there in each learning group.

***Sampling Technique*:** For the purpose of data collection, multistage sampling technique was utilized. The multistage sampling technique has also been used by Yousaf *et al*. (2018), Ahmad *et al*. (2019), and Ahmad *et al*. (2020). The respondents were selected by the utilization of both probability and non-probability sampling. District Khanewal was purposively selected from the Southern Punjab, Pakistan, because WWF-P was working there. Tehsil Kabirwala was selected, at the 1st stage, through probability sampling technique (Simple random sampling). Sixteen learning groups out of 100 were selected at the 2nd stage from Kabirwala (the selected tehsil) randomly. Moreover, at the 3rd stage, 5 adopter farmers were selected randomly from each selected learning group (in total 80 adopter farmers were selected). The probability sampling was used for the selection of the respondents from the learning groups because a complete list of the adopter farmers was available with the WWF-P. The non-adopters were selected through convenient sampling (non-probability sampling) because the lists of non-adopter farmers were not available that is why convenient sampling technique was utilized. A sample of 80 non-adopter farmers was drawn. A sample of 160 farmers constituting equal number of adopters and non-adopters of BMPs of cotton was drawn for the purpose of the data collection. Most of the agricultural activities were carried out by men in the study area that is why only male respondents for the administration of the interview schedule were selected.

***Data Collection Tool*:** A well-structured interview schedule containing close ended questions about the demo-graphic characteristics of the respondents, land and seed preparation, irrigation attitude, chemical fertilizer and pesticide (chemical and non-chemical) utilization, child labor and women participation, impacts of adoption of BMPs on yield, reasons for the adoption of BMPs, and the key factors which affect the adoption of BMPs of cotton were included to access the BMPs of cotton, was administered in the form of face to face interview. For the purpose of data analysis, version 20 of the SPSS (Statistical Package for Social Sciences) was used. The reliability of the questionnaire items was assessed by Cronbach alpha.

Statistical Analysis: Chi square, gamma statistics, and "Binary Logistic Regression"[1] was utilized. Chi square was employed to estimate the association, and gamma statistics was employed to estimate the direction of relationship of the independent and dependent variables involved in the study. The following form of the logistic model was used (Eneyew and Bekele, 2012).

$$P_i = E\left(Y = \frac{1}{X_i}\right) = \frac{1}{1+e^{-(\beta_0+\beta_i X_i)}}$$

The probability that a given farmer is adopter, for ease of exposition, is expressed as

$$P_i = \frac{1}{1+e^{-(Z_i)}}$$

The probability for a non-adopter is 1-P_i thus

$$\frac{P_i}{1-P_i} = \frac{1+e^{Z_i}}{1+e^{-Z_i}}$$

Is the ratio of the probability that a farmer was adopter to the probability that he was non-adopter?

$$L_i = ln\left[\frac{P_i}{1-P_i}\right] = Z_i$$
$$= \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 + \cdots + \beta_n X_n$$

Where P_i is the probability of adoption which changes from 0 to 1

***Dependent Variable*:** L_i = 1 for adopters and 0 for otherwise

***Independent Variables*:** X_1 = Age of the farmer (Years); X_2 = Educational level of the farmer (No. of schooling years); X_3 = Land owned (Acres); X_4 = Agri. Equipment's proprietorship status (1 for owned and 0 otherwise)

RESULTS AND DISCUSSION

***Demographic characteristics of the respondents*:** The demographic characteristics of the respondents are worth understanding because they give us a comprehensive set of information about their age, education, income, family composition, and other economic and social traits which shape their personality and outlook towards life. As far as the demographic characteristics of the respondents involved in the study are concerned, it was explored that the mean age, years of schooling, and farming experience of both the adopters and non-adopters of BMPs of cotton was 37.4 and 43.8%, 9.5 and 5.6, and 11.8 and 19.4 years with standard deviation of 9.7 and 9.1, 2.9 and 4.8, and 6.8 and 10.8 years, respectively. It was found that on the adoption of the modern farming practices, the age factor has a negative impact. As the farmers become more mature with the passage of time, they show greater resilience to adopt innovative agricultural practices, and furthermore try to stick to the obsolete farming practices (Frisvold *et al*., 2009). The education factor, the results have exposed, had a positive impact on the adoption of BMPs (Toma and Mathijs, 2007). The farming experience, as revealed by the results, informed us that it had a negative impact on the adoption of BMPs. The age and farming experience of the farmers were found to be inversely proportional to the adoption of new farming practices. It has been explored that the older farmers are mostly like to stick to the old practices out of stubbornness and furthermore they show resilience to adopt most cost-efficient technologies of production. The farmers with more farming experience, the results had revealed that, are less educated (Frisvold *et al.*,

[1]Because the dependent variable was dichotomous in nature i.e. adopters and non-adopters

Table 1. Demographic characteristics of the respondents.

Sr. #	Variables	Adopters		Non-Adopters		Total	
		Mean	**S. D***	**Mean**	**S. D**	**Mean**	**S. D**
1	Age	37.4	9.7	43.8	9.1	40.6	9.4
2	Education (years of schooling)	9.5	2.9	5.6	4.8	5.6	3.9
3	Farming experience	11.8	6.8	19.4	10.8	15.6	8.8
4	Number of family members	6.0	3.0	8.0	4.0	8.4	4.1
5	Land holding size	9.0	6.8	7.0	4.1	8.1	5.5
6	**Area under cultivation	8.1	5.8	5.0	3.5	6.5	4.6
7	***Per acre cotton yield	35.3	8.5	33.0	7.6	34.2	8.1

*****Standard Deviation, **Area in Acres, **** Yield in Maunds (1 Maund =40 kg)

2009). Furthermore, it was explored that the mean number of family members, land holding size, and area under cultivation, for both the adopters and non-adopters, was 6.0 and 8.0, 9.0 and 7.0 acres, and 8.1 and 5.0 acres with standards deviation of 3.0 and 4.0 members, 6.8 and 4.1 acres, and 5.8 and 3.5 acres, respectively. The results revealed that the adopter of BMPs had smaller family size as compared to the non-adopters. The adopter farmers had more average agricultural land as compared to the non-adopters. The obvious reason behind this factor is that the small land holders usually avoid risky ventures, and they usually like to restrict themselves to the primitive production techniques (Ghazalian *et al.*, 2009). Mean per acre cotton yield for adopters and non-adopters was 35.3 Maunds and 33.0 Maunds with standard deviation of 8.5 and 7.6 Maunds, respectively. The statistical estimates have exposed that the non-adopters had significantly less per acre cotton yield as compared to the adopters of BMPs.

Assessment of the impact of BMPs on the cotton cultivation

Agricultural machinery ownership status*:* The ownership status of the agricultural machinery is an important determinant of the adoption or non-adoption of BMPs. As revealed by the results, 75.0% of the adopters and 48.8% of the non-adopters were the owners of their own agricultural tools, whereas 25.0% adopters and 52.3% non-adopters were not. Therefore, the farmers who possess their personal agricultural tools are apparently to adopt the modern and cost-effective production techniques.

Land preparation and seed utilization**:** It was found that for both the adopters and non-adopters, the mean number of plough applications was 4.0 with standard deviation of 0.6 and the average seed rate was 9.38 kg and 9.90 kg with standard deviation of 1.05 kg and 1.30 kg, respectively. Results have uncovered that the seed rate of the adopters was slightly less than that of the non-adopters.

Seed variety, seed source, and consultation behavior regarding seed: Both the adopters and non-adopters, as it was observed that, were using IUB-2013, IUB-2015, IUB-2018, MNH-886, SS-32, and J-5 seed varieties. Among all the seed varieties mentioned above, majority of the adopters (58.8%) and non-adopters (36.3%) were using SS-32 variety, and the seed source for most of them was from the "Dealers". Furthermore, it was found out that 88.5% of the adopters and 53.5% of the non-adopters like to consult about the seed varieties with the extension officers.

Irrigation behavior of the farmers**:** The mean number of irrigations for both the adopters and non-adopter in the first month and irrigations during the whole season was 2.4 and 3.5 and 16 to 21 with standard deviation of 0.6 and 0.5 and 3.4 and 3.3 irrigations, respectively. It is obvious that in the first month, the non-adopters were applying a greater number of irrigations as compared to the adopters. Data revealed that the non-adopters were applying more irrigations in the first month than that of the adopters. Hence, the adopters know the judicious use of water due to the acquaintance of BMPs as compared to the non-adopters (Matuschke *et al.*, 2007). It was further found out that, for both the adopters and non-adopters, the mean interval in days was 11 and 9.2 days, respectively. As far as the source of irrigation is concerned both the adopters (79.8%) and non-adopters (81.0%) were using both canal and tube well water for irrigation.

Fertilizer and pesticide utilization behavior of the adopters and non-adopters**:** It was explored that 78.8% of the adopters and 65.0% of the non-adopters were using organic fertilizer. Along with the utilization of organic fertilizers, both the adopter and non-adopters were fertilizing their cotton fields with chemical fertilizers (Urea, DAP, Potash, Nitrogen, and Calcium Ammonium Nitrate). For both the adopters and Non-adopters, the average quantity of Urea, DAP, Potash, Nitrogen, and Calcium Ammonium Nitrate used per acre was 1.2 and 1.7 bags (60 kg and 85 kg), 0.8 and 1 bag (40 kg and 50 kg), 0.39 and 0.63 bag (19.5 kg and 31.5 kg), 0.33 and 0.59 bag (16.5 kg and 29.5 kg), and 0.74 and 0.26 bag (37 kg and 13 kg), respectively. Data show that the adopters were utilizing less quantity of chemical fertilizers as compared to the non-adopters. The results are in line with that of Makhdum *et al.* (2011). As far as the application of pesticides and herbicides is concerned, it was reported by 88.8% of the adopters and 31.3% of the non-adopters that they conduct pest scouting before spraying the pesticides. The behavior of conducting pest scouting is more frequent in the adopters as compared to the non-adopters. Data reveal that 67.5% of the adopters and 0.0% non-adopters were utilizing non-chemical pest control methods (Neem oil and Tobacco water). The

Table 2. Assessment of better management practices of adopters and non-adopters.

Sr. #	Variables	Adopters		Non-adopters		Total	
		Mean	S. D	Mean	S. D	Mean	S. D
1	Plough applications / *Acre	4.0	0.6	4.0	0.6	0.4	0.6
2	Seed (kg)	9.4	1.1	9.9	1.3	9.7	1.2
3	Irrigation in the first month	2.4	0.6	3.5	0.5	2.9	0.6
4	Total no. of irrigations	16.0	3.4	21.0	3.3	18.5	3.4
5	Interval of Irrigations	11.0	2.0	9.2	1.6	10.1	1.8
6	Pesticide applications / Acre	3.8	0.9	7.7	1.9	5.8	1.5
7	Age of the Spraying man	34.5	6.1	24.8	6.9	29.7	6.5

*1 Acre = 0.40 hectares

BMPs has rendered useful information to the adopters about the environmentally friendly effects of non-chemical pest control methods and vice versa. For the adopter and non-adopters, the mean number of pesticide applications was 3.76 and 7.7 with standard deviation 0.96 and 1.9, respectively. It was found that the non-adopters were applying more pesticide applications as compared to the adopters due to lack of awareness. During the investigation, it was also observed that the prime consultants regarding pesticide applications for the adopters (97.3%) were WWF-P representatives while the non-adopters (70.2%) used to consult "Dealers". Moreover, for the adopters and non-adopters, the mean age of spray man was 34.5 and 24.8 years with standard deviation 6.1 and 6.9 years, respectively. Consequently, the adopters of BMPs were taking the services of experienced spray men as compared to the non-adopters. Safety measures for the agriculture labor are of utmost importance, the results of the present study reveal that masks were being used by both the adopters and non-adopters, the 63.5% of the adopters and 16.3% of the non-adopters were using safety gloves, the 98.5% of the adopters and 70.0% of the non-adopters were using googles, and 67.3% of the adopters and 55.0% of the non-adopters were using spraying shoes as a precautionary measure during the application of the pesticides. Disposing off the pesticide's bottles indicate the concern of the farmers towards environmental protection, in this regard, it was observed that 93.5% of the adopters and 43.5% of the non-adopters buried the empty pesticide bottles, while 8.5% of the adopters and 58.5% of the non-adopters burned them. The results indicate that a clear majority (93.5%) of the adopter of BMPs were taking care of the environment protection by burying the empty pesticide bottles. Similar results were generated by Khan *et al*. (2010) who investigated during a research study conducted in Faisalabad and Bahawalpur that the cotton growers who adopted BMPs experienced 39.0%, 38.0%, and 40.0% reduction in chemical fertilizers, irrigation water, and pesticide, respectively with a cost-benefit ratio of 1:3.2 for BMPs as compared with 1:2.5 of non-adopters. Adil *et al.* (2014) has investigated that BMPs linking to the resourceful utilization of fertilizers and doses of irrigations were discovered to have significant contribution in the sugarcane cultivation. The irrigation water, quality of seeds, and fertilizers were also found to have positive association with the crop yield.

***Trends of child labor and women participation in the cotton cultivation between adopters and non -adopters of BMPs*:** The engagement of children in any type of work which denies them of their childhood, education, and recreation, can be termed as child labor. It was explored that 11.3% adopters and 78.8% non-adopters responded in affirmation that they were utilizing child labor in the cultivation of cotton. The mean age of the children for both adopters and non-adopters was 13.8 with standard deviation 0.7. In the agriculture sector, "rural women" also unleash their potential in different agri.-related activities such as land preparation, sowing, weeding, and picking (Akhtar *et al*., 2018; Tabasam *et al*., 2018). It was explored during the investigation that both the adopters and non-adopters were not utilizing the services of women labor force related to land preparation activities because of the technical intervention which needs skilled labor force. It was found that 100.0% adopters and 90.0% non-adopters affirmed to a great extent that women were participating in sowing of cotton. The 98.8% adopters and 66.3% non-adopters were utilizing women labor force in weeding, while 100.0% adopters and non-adopters were utilizing the services of women in cotton picking. For both the adopters and non-adopters, the mean picking rate was 318 to 324 Pkr. /day, respectively. The adopters pay to the cotton pickers at a slightly higher rate than that of the non-adopters. If we evaluate the on-farm facilities provided to the labor force (women and children), it was found that 93.5% of the adopters and 78.8% of the non-adopters informed that they provide drinking water and paraphernalia related to safety precautions to the cotton pickers.

Impacts of the adoption of BMPs on the utilization of farm inputs

***Water Conservation*:** It was informed by 53.8% of the adopters that BMPs help to a great extent in water conservation. While 36.3% of the adopters reported that BMPs help to some extent in water conservation. Only 10.0% of the adopters reported that BMPs has nothing to do with water conservation at all during cotton cultivation. The chi-square value 57.301 showed a highly significant association (*p*-value=.000) between the adoption of BMPs and total the

Table 3. Impacts of the adoption of BMPs on the cotton cultivation.

Statement	Response							
	To a great extent		To some extent		Not at all		Total	
	F	P	F	P	F	P	F	P
Water conservation is facilitated by BMPs	43	53.8	29	36.3	8	10.0	80	100.0
Reduction in pesticide utilization is facilitated by BMPs	50	62.5	28	35.0	2	2.5	80	100.0
Reduction in fertilizer utilization is facilitated by BMPs	23	28.8	38	47.5	19	23.8	80	100.0
Reduction in child labor is facilitated by BMPs	0	0.0	39	48.8	41	51.3	80	100.0
Women participation in cotton production is encouraged by BMPs	14	17.5	42	52.5	24	30.0	80	100.0

number of irrigations applied. The gamma value (Gamma=-.775) shows that there was a negative relationship between the variables (i.e. with adoption of BMPs, the number of irrigations decreases).

***Pesticide Use*:** It was turned out that majority of the respondents 61.3%, who were the adopters of BMPs, reported that they have reduced the application of chemical pesticides and herbicide usage to a great extent. The chi-square value 110.806 showed a highly significant association (*p*-value=.000) between the adoption of BMPs and the total number of pesticide applications. The gamma value (Gamma=-.983) showed that there was a negative relationship between the variables (i.e. with adoption of BMPs, the number of pesticide application decreases).

***Fertilizer Use*:** It was responded by 28.8% of the adopters that BMPs helps to a great extent to reduce fertilizer usage. The 47.5% of the adopters reported that BMPs helps to some extent to reduce fertilizer usage. Moreover, 23.8% of the adopters reported that BMPs has nothing to do in the reduction of the fertilizer usage at all during cotton cultivation. The chi-square value 110.806 revealed a highly significant association (*p*-value=.000) between the adoption of BMPs and the fertilizer usage. The gamma value (Gamma=-.968) shows that there was a negative relationship between the variables (i.e. with the adoption of BMPs, the fertilizer utilization decreases). The finding of this current research are in line with that of Adil *et al*. (2014) who investigated that BMPs linking to the resourceful utilization of fertilizers and doses of irrigations were discovered to have significant contribution in the sugarcane cultivation. The irrigation water, quality of seeds, and fertilizers were also found to have positive association with the crop yield. The comparative analysis of the adopters and non-adopters indicated that the adopters of BMPs were found performing better in terms of profitability, yield, and total variable cost.

***Child Labor*:** It was informed by 48.8% of the adopters that BMPs helps to some extent to reduce child labor. While majority of the respondents (adopters) i.e. 51.3% reported that BMPs has nothing to do with the reduction of child labor in the agricultural sector particularly in the cotton cultivation. The chi-square value 73.636 unfolded a significant association (*p*-value=.002) between the adoption of BMPs and child labor. The gamma value (Gamma=-.934) showed that there was a negative relationship between the variables (i.e. with the adoption of BMPs, the child labor decreases).

***Women Participation*:** It was responded by 17.5% of the adopters that BMPs encourage women participation to a great extent. The 52.5% of the adopters reported that BMPs encourage to some extent women participation. While 30.0% of the adopters reported that BMPs has nothing to do with the women participation in the cotton cultivation.

Health and Safety Measures: Regarding the health and safety, it was reported by 80%, 50%, 78%, and 53% of the adopters of BMPs that they were using masks, gloves, goggles, and spraying shoes, respectively, while 80%, 13%, 56%, and 44% of the non-adopters were utilizing masks, gloves, goggles, and spraying shoes, respectively. The association between the variables BMPs and health and safety measures showed that there was a significant relationship as unfolded by the *p*-value .001 but the Gamma statics (Gamma=.638) revealed that the direction of relationship was positive (i.e. with adoption of BMPs, adoption of health and safety measures increases).

***Impact of BMPs on the cotton yield and income of the farmers*:** It was explored that 22.5% of the adopters conveyed that after the adoption of BMPs, their yield was significantly increased, 12.5% of the adopters informed that after the implementation of BMPs, their yield was decreased. While 65.0% of the adopters stated that after the adoption of BMPs they did not observe any significant change in their yield at all. Moreover, 52.5% of the adopters reported that after the adoption of BMPs their income had increased significantly. While 47.5% of the adopters reported that after the adoption of BMPs, they do not observe any significant change in their income. Majority of the adopters 65.0% responded that there was no change in the yield despite the adoption of BMPs while they (52.5%) claimed increased in their income. When the researcher probed the adopters about this conflicting statement, they responded that the quality of cotton obtained by the adoption of BMPs was considerably higher than that of the non-adopters. The results of this present research are in line with the study conducted by (Prokopy *et al*., 2008) who were of the opinion that by focusing on the generally consistent determinants of agricultural BMPs, the adoption rate of the farmers can significantly be improved.

***Factors affecting the adoption of BMPs of cotton (Logit model)*:** Age, education, land owned, and agricultural

Table 4. Logit Model (Parameter Estimates).

Variables	B	S.E.	Wald	Df	Sig.	Exp(B)
Age	-0.576	0.121	22.730	1	0.000	0.562***
Education	0.311	0.091	11.653	1	0.001	1.364**
Land Owned	0.101	0.049	4.299	1	0.038	1.107**
Machinery	1.543	0.639	5.819	1	0.016	4.676**
Constant	-1.620	1.108	2.136	1	0.144	0.198

***Significant at $p<0.01$; **Significant at $p<0.05$; N=160; -2 log likelihood ratio=105.55; Cox and Snell $R^2=0.516$; Nagelkerke $R^2=0.689$

machinery of the farmer were the major factors which were included in the binary logistic regression model. The adoption of BMPs was significantly affected by the age of the farmers but in opposite direction. It was shown by the results that an additional year of age may result in the decreased likelihood of the adoption of BMPs by a factor of 0.562. The major reason of this phenomenon is that the age of the farmers is inversely proportional to the adoption of new production techniques. The stubbornness on the part of the older farmers renders them circumscribed to their outdated farming practices and they are mostly not prone to adopt cost-effective and modern technologies of production (Frisvold *et al.*, 2009). Personal ownership of the agricultural machinery and education of the farmers also significantly affect the adoption of BMPs of cotton (in the same direction). An extra year of schooling, the results illustrate that, may result in increased likelihood of adoption of BMPs by a factor of 1.364. Because there is a positive association between the education factor and the adoption of new production techniques (Toma and Mathijs, 2007). As compared to the illiterate farmers, the educated ones are more likely to adopt not only new agricultural technology but the modern means of cultivation also. The ownership of agricultural machinery, the results illustrates that, may result in increased likelihood of adoption of BMPs by a factor of 4.67. Farm size or land owned by the farmer is positively associated with the adoption of the BMPs. An extra acre of land, the results show that, may result in an increased likelihood of the adoption of BMPs by a factor of 1.107. The results provided by Awan *et al*. (2015) and Ullah *et al*. (2017) had also explored in their respective research studies revealed that land holding size and education level of the cotton growers have a positive influence on the adoption of BMPs of the "Silver Fiber". However, age and farming experience of the cotton growers were explored to have an adverse influence on the adoption rate of BMPs. Doses of irrigations, FYM (Farm Yard Manure) applications, HSV (Hybrid Seed Verities) cotton varieties, water, scouting, number of fertilizer applications were found to have positive contribution in the adoption of BMPs. The co-efficient of variables such as age and pesticide application could have negative impact. Moreover, it was confirmed by the "Goodness of Fit" test that the econometric model elucidated the key part of transformation in the dependent variable due to the influence of explanatory variables. The results yielded by Awan *et al*. (2015) and Ullah *et al*. (2017) are more or less in line with the current study. Imran *et al*. (2018) has pointed out after the econometric analysis of the collected data that the implementation of CSA (Climate Smart Agriculture) practices and technologies such as groundwater quality, suitable method and time of picking, cautious use of water and fertilizer, and access to extension services were found to have a substantial influence on the gross value of cotton production. Riar *et al.* (2013) have explored in their research study that the significant impediments for the espousal of most HR-BMPs include extra costs, deficiency of labor and paraphernalia, profitability, hostile weather conditions, complacency, time restrictions, and herbicide related concern.

***Conclusion and Recommendations*:** The current study concludes that the better management practices are locally upgraded farming methods which usually help the farming communities to improve their profitability level. In cotton cultivation, the use of BMPs helps to accomplish quantifiable reduction of the major environmental impacts while expanding the financial advantages for the cotton producers around the world. Reducing pesticide use, integrated crop management, improving water use efficiency, efficient utilization of the fertilizers, participation of women, and addressing the issues of child labor are some of the financial and ecological advantages of the BMPs. The results obtained from the application of the binary logistic regression model illustrated that the farming experience of the cotton grower is significantly and negatively associated. Whereas the ownership of the agricultural machinery and education of the farmer is significantly and positively associated with the adoption of the better management practices. It has further been explored that the age, farm size, family size, and area under cotton cultivation of the farmer also affect the adoption of the better management practices, however, the probability of the above-mentioned variables was found statistically insignificant. Chi square and Gamma statistics have revealed that the implementation of the BMPs was significantly associated (p-value=000) with number of irrigations, quantity of fertilizer applied, pesticide applications child labor, and the adoption of health and safety measures. To sum up the conclusion of the study, it was found that the adopters of the BMPs performed slightly better than the non-adopters in every aspect from sowing of cotton till the picking. To raise the level of awareness of the farming community regarding the adoption of the better management practices not only in the cotton cultivation but also in the cultivation of maize, sugarcane, paddy etc. successful exhibitions should be launched by the extension department in collaboration with WWF-P. Moreover, Liu *et al*. (2018) further directed that the future researchers on BMPs should accentuate on integration of social norms, study scale, measuring and modeling of adoption as a continuous process, and ambiguity into the decision-making process.

The government of Pakistan must guarantee the availability of quality farm inputs to the farming communities by the establishment of stringent rules and regulations. Non-recommended agro-chemicals should be sternly proscribed. It is highly recommended that to control pest attacks, non-chemical methods should be preferred over the chemical ones. For the products produced by adopting BMPs, it is enthusiastically recommended that, a phenomenal premium on expenses should be indorsed to the cotton growers to encourage them for sustaining BMPs and motivating the non-adopters to follow suit. Seed varieties of BT (*Bacillus thuringiensis*) should be made available at considerably low prices for the farming communities. For the capacity building, well-planned and sophisticated training programs should be launched. Moreover, awareness campaigns should be initiated to educate the farming community regarding the efficient use of scarce resources.

***Conflict of interest*:** It is hereby declared by the authors that there is no potential conflict of interest with respect to research, financial relationship, authorship, and/or publication of this article.

***Funding**:* It is hereby declared by all the authors that "no funding" was received from any organization for the accomplishment of this research study.

REFERENCES

Adhikari, C., K.F. Bronson, G.M. Panuallah, A.P. Regmi, P.K. Saha, A.Dobermann, D.C. Olk, P.R. Hobbs and E. Pasuquin. 1999. On-farm soil N supply and N nutrition in the rice-wheat system of Nepal and Bangladesh. Field. Crops. Res. 64:273-286.

Adil, S.A., K. Bakhsh, Q. Shehnila and A.K. Muhammad. 2014. Better Management Practices and Sugarcane Productivity : An Econometric Analysis. Pak. J. Soc. Sci. 34: 577-587.

Ahmad, M., G. Mustafa and M. Iqbal. 2016. Impact of farm households'adaptations to climate change on food security: Evidence from different agro-ecologies of Pakistan. Pak. Dev. Rev. 55:561-588.

Ahmad, S.A., M. Rehman, Z. Ejaz, M. Fatima, M. Kan and M. Ahmed. 2018. Agricultural Land-Use Change of Major Field Crops in Pakistan (1961-2014). Sci. Technol. Dev. 37:113-121.

Ahmad, M. and M. Nawaz. 2016. Analysing the Impact of Climate Change on Rice Productivity in Pakistan.Available online with updates at https://mpra.ub.uni-muenchen.de/id/eprint/7286

Ahmad, S., W. Huifang, S. Akhtar, S. Maqsood andS. Imran. 2020. An analytical study of child labour in the agriculture sector of the rural areas of central Punjab, Pakistan. Sri. Lank. J. Soc. Sci. 43:21-37.

Ahmad, S., W. Huifang, S. Akhtar, S. Imran and H. Yousaf. 2019. Women in Male Chauvinistic Society: A Sociological Study of District Faisalabad. Pakistan. Int. J. Gen. Women. Stud. 7:46-52.

Ahmad, B., S. Hassan and K. Bakhsh. 2005. Factors Affecting Yield and Profitability of Carrot in Two Districts of Punjab. Int. J. Agr. Biol. Eng. 7:794-798.

Akhtar, S., S. Ahmad, W. Huifang, A. Shahbaz, A. Ghafoor, S. Imran and A. Zafar. 2018. Women in Agriculture–Lack of Access to Resources (An Analytical Studyof District Faisalabad, Punjab, Pakistan). Int. J. Econs. Mgmt. Stud. 5:6-24.

Ali, A. and A. Abdulai. 2010. The adoption of genetically modified cotton and poverty reduction in Pakistan. Int. J. Econs. Mgmt. 61:175-192.

Ashraf, J., D. Zuo, Q. Wang, W. Malik, Y. Zhang, M.A. Abid and G. Song. 2018. Recent insights into cotton functional genomics: progress and future perspectives. Plant. Biotechnol. J. 16:699-713.

Atreya, K. 2008. Health costs from short-term exposure to pesticides in Nepal. Soc. Sci. Med. 67:511-519.

Awan, S.A., M. Ashfaq, S.A.A. Naqvi, S. Hassan, M.A. Kamran, A. Imran and A.H. Makhdum. 2015. Profitability analysis of sustainable cotton production: A case study of cotton-Wheat farming system in Bahawalpur District of Punjab. Bulg. J. Agric. Sci. 21:251-256.

Bakhsh, K. 2012. Environmental and technical efficiency analysis in bitter gourd production. Pak. J. Agric. Sci. 49:583-588.

Bakhsh, A., A.Q. Rao, A.A. Shahid, T. Husnain and S. Riazuddin. 2009. Insect resistance and risk assessment studies in advance lines of Bt cotton harboring Cry1Ac and Cry2A genes. Am. Eurasian. J. Agric. Environ. Sci. 6:1-11.

Banuri, T. 1998. Pakistan: Environmental Impact of Cotton Production and Trade. International Institute for Sustainable Development. Available online with updates at http://www.iisd.org/TKN/pdf/pk_banuri.pdf

Basharat, M. 2012. Integration of Canal and Groundwater to Improve Cost and Quality Equity of Irrigation Water in a Canal Command. Ph.D. diss., Univ. Engrg. Tech., Lahore, Pakistan.

Carvalho, F.P. 2006. Agriculture, pesticides, food security and food safety. Environ. Sci. Policy. 9:685-692.

Dobermann, A., C. Witt, S. Abdulrachman, H.C. Gines, R. Nagarajan, T.T. Son, P.S. Tan, G.H. Wang, N.V. Chien, V.T.K. Thoa, C.V. Phung, P. Stalin, P. Muthukrishnan, V. Ravi, M. Babu, G.C. Simbahan and M.A.A. Adviento. 2003. Soil fertility and indigenous nutrient supply in irrigated rice domains of Asia. Agron. J. 95:913-923.

Durrheim, K. 2004. *Research in practice: Applied methods for the social sciences,* 2nd Ed. University of Cape Town press., Cape Town.

Eneyew, A. and W. Bekele. 2012. Determinants of livelihood strategies in Wolaita, Southern Ethiopia. Agric. Res. Rev. 1:53-161.

Fantke, P., R. Friedrick and O. Jolliet. 2012. Health impact and damage cost assessment of pesticides in Europe. Environ. Int. 49:9-17.

FAO. 2006. Fertilizer use by crop in Pakistan.Available on line with updates at http://www.fao.org/docrep/007/y5460e/y5460e00.htm

Frisvold, G.B., T.M. Hurley and P.D. Mitchell. 2009. Adoption of best management practices to control weed resistance by corn, cotton, and soybean growers. Ag. Bio. Forum. 12:370-381.

Ghazalian, P.L., B. Larue and G.E. West. 2009. Best Management Practices to Enhance Water Quality: Who is Adopting Them? J. Agric. App. Econ. 41:663-682.

GOP. 2009. Census of Manufacturing Industries 2005-2006. Federal Bureau of Statistics, Government of Pakistan. Islamabad, Pakistan.

GOP. 2011. Pakistan Economic Survey (2010-11). Federal Bureau of Statistics, Government of Pakistan. Islamabad, Pakistan.

GOP. 2014. Economic Survey of Pakistan. (2013-14). Government of Pakistan, Finance Division, Economic Advisor's Wing, Islamabad, Pakistan.

Hussain, S.S., D. Bylerlee and P.W. Heisey. 1994. Impacts of the training and visit extension system on farmers' knowledge and adoption of technology: Evidence from Pakistan. Agric. Econ. 10:39-47.

Imran, M., A. Ali, M. Ashfaq, S. Hassan, R. Culas and C. Ma. 2018. Impact of Climate Smart Agriculture (CSA) practices on cotton production and livelihood of farmers in Punjab, Pakistan. Sustde. 10:1-20.

Iqbal, M.A., Q. Ping, M. Abid, M.M.S. Kazmi and M. Rizwan. 2016. Assessing risk perceptions and attitude among cotton farmers: A case of Punjab province, Pakistan. Int. J. Disaster. Risk. Reduct. 16:68-74.

Khan, H.M., A.H. Makhdum, Z. Jamil, A.Imran, R.A. Bhutto and L.K. Babar. 2010. Promoting Better Management Practices:An Initiative of WWF–Pakistan to reduce the ecological footprint of thirsty crops. World Environment Day. pp. 71-84.

Kooistra, K.J., A.J. Termorshuizen and R. Pyburn. 2006. The sustainability of cotton: Consequences for man and environment (Report No. 223). Science Shop Wageningen University and Research Centre. Available on line at https://edepot.wur.nl/17214

Leedy, P.D. 1997. *Practical Research: Planning and design.* 6th Ed. Prentice-Hall., New Jersey.

Liu, T., R. Bruins and M. Heberling. 2018. Factors influencing farmers' adoption of best management practices: A review and synthesis. Sustde. 10:1-26.

Lopes Soares, W. and M. Firpo de Souza Porto. 2009. Estimating the social cost of pesticide use: An assessment from acute poisoning in Brazil. Ecol. Econ. 68:2721-2728.

Maroni, M., A.C. Fanetti and F. Metruccio. 2006. Risk assessment and management of occupational exposure to pesticides in agriculture. Medicina. Del. Lavoro. 97:430-437.

Matuschke, I., R.R. Mishra and M. Qaim. 2007. Adoption and Impact of Hybrid Wheat in India. World. Dev. 35:1422-1435.

McMillian, J. and S. Schumacher. 2001. *Research in education: A conceptual introduction.* 5th Ed. Longman., New York.

MOF. 2018. Agriculture. Pakistan Economic Survey 2017-2018. Economic Adviser's Wing, Finance Division, Government of Pakistan. Islamabad, Pakistan.

Nazli, H., D. Orden, R. Sarker and K. Meilke. 2012. Bt Cotton Adoption and Wellbeing of Farmers in Pakistan. In Proceedings of the International Association of Agricultural Economists (IAAE) Triennial Conference, Foz do Iguaçu, Brazil. August 18-24, 2012. pp. 1-26.

NFDC. 2013. Consumption of fertilizer in Pakistan. National Fertilizer Development Center, Islamabad, Pakistan. Available online at http://www.nfdc.gov.pk

Paudel, K.P., N. Devkota and Y. Tan. 2016. Best management practices adoption to mitigate non-point source pollution a conditional frailty model. China. Agr. Econ. Rev. 8:534-552.

Prokopy, L.S., K. Floress, D. Klotthor-Weinkauf and A. Baumgart-Getz. 2008. Determinants of agricultural best management practice adoption: Evidence from the literature. J. Soil. Water. Conserv. 63:300-311.

Rehman, A., L. Jingdong, A.A. Chandio, I. Hussain, S.A. Waganand Q.U.A. Memon. 2016. Economic perspectives of cotton crop in Pakistan : A time series analysis (1970-2015) (Part 1). J. Saudi. Soc. 15:1-7.

Riar, D.S., J.K. Norsworthy, L.E. Steckel, D.O. Stephenson, T.W. Eubank, J. Bond and R.C. Scott. 2013. Adoption of Best Management Practices for Herbicide-Resistant Weeds in Midsouthern United States Cotton, Rice, and Soybean. Weed. Technol. 27:788-797.

Shuli, F., A.H. Jarwar, X. Wang, L. Wang and Q. Ma. 2018. Overview of the Cotton in Pakistan and its Future Prospects. Pakistan. J. Agri. Res. 31:396-407.

Sial, K.B., A.D. Kalhoro, M.Z. Ahsan, M.S. Mojidano, A.W. Soomro, R.Q. Hashmi and A. Keerio. 2014. Performance of Different Upland Cotton Varieties under the Climatic Condition of Central Zone of Sindh. J. Agric. Environ. Sci.15:45-47.

Tabasam, N., A. Arshad, S. Ahmad and S. Akhtar. 2018. Factors Affecting the Scenario of Women Participation in the Agricultural Labor Force in Punjab, Saudi. J. Econ. Fin. 2:251-256.

Tilman, D., K.G. Cassman, P.A. Matson, R. Naylor and S. Polasky. 2002. Agricultural sustainability and intensive production practices. Nature. 418:671-677.

Toma, L. and E. Mathijs. 2007. Environmental risk perception , environmental concern and propensity to participate in organic farming programmes. J. Environ. Mgmt. 83:145-157.

Ullah, A., M. Ashfaq, S. Asif, A. Naqvi, S.A. Adil and S. Hassan. 2017. Impact of Better Management Practices (BMPS) on Sustainability of Cotton Production in Punjab, Pakistan. J. Appl. Environ. Biol. Sci. 7:144-149.

Usman, U. 2016. Contribution of Agriculture Sector in the GDP Growth Rate of Pakistan. J. Glob. Econ. 4:1-3.

Van Der Werf, H.M.G. 1996. Assessing the impact of pesticides on the environment. Agric. Ecosyst. Environ. 60:81-96.

Watto, M.A. and A.W. Mugera. 2013. Measuring Groundwater Irrigation Efficiency in Pakistan: A DEA Approach Using the Sub-vector and Slack-based Models. Conference (57th), February 5-8, 2013. Sydney, Australia.

Watto, M.A. and A.W. Mugera. 2015. Econometric estimation of groundwater irrigation efficiency of cotton cultivation farms in Pakistan. J. Hydrol. Reg. Stud. 4:193-211.

WWF-P. 2006. Better management practices (BMPs) for cotton and sugarcane. Head Office, Firozpur Road, Lahore. Pakistan.

WWF-P. 2013. Cleaner, Greener Cotton: Impacts and Better Management Practices, Worldwide Fund-International. Available on https://www.worldwildlife.org/publications/cleaner-greener-cotton-impacts-and-better-management-practices

Yousaf, H., M.U. Zafar, M.O., Zafar, S. Ahmad and Q.A. Raza. 2018. Regional Distribution of Food Security and its Determinants Across Regions of the Punjab, Pak. J. Agri. Sci. 55: 711-717.

Zulfiqar, F., A. Datta and G.B. Thapa. 2017. Determinants and resource use efficiency of “better cotton”: An innovative cleaner production alternative. J. Clean. Prod. 166:1372-1380.

Zulfiqar, F. and G.B. Thapa. 2016. Is “Better cotton” better than conventional cotton in terms of input use efficiency and financial performance? Land. Use. Polic. 52:136-143.

[Received 18 Feb 2020; Accepted 14 Oct 2020; Published (online) 11 Jan 2021]