



Overall Performance of *Bacillus thuringiensis* (Bt) Cotton Varieties in Pakistan

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All over in Pakistan the growers have been cultivated cotton that possesses Bt cotton was first cultivated in 2002. These varieties have been cultivated, unapproved and reregulated variety which is formally approved, which is speedily increased by farmers for growing in 2005. A 60 percent of the cotton among Bt cotton varieties was cultivated in 2007, This study reports the performance and economic strategies of *Bacillus thuringiensis* cotton in sindh province Mirpurkhas, Hala and in sanghar in Pakistan. The yield and production of Bt cotton was calculated in two different districts or zones having different environment and different climatic conditions, in both districts also the expenditures and other seed material is also increase, and the due to boll worm sprays the number of sprays that is also expansive labour consume and effect of environment human as well as on all living organisms in both districts. The yield increases in the Mirpur khas and Hala districts but its diminution in sanghar district. Day by day the yield is increases in Mirpurkhas as well, this reports or study is similar others Bt cotton which is cultivated in other countries of the world such as in china and in India.

Key words: Economic performance, Pakistan, Sanghar, Hala, Mirpur Khas. Bt cotton.

1. **INTRODUCTION**

The Gross Domestic Product in Pakistan is grows up to 2282663 Pakistan rupees millions in 2017 form 2307076 Pakistan rupees millions in 2016. The Gross Domestic Product in Pakistan approximately 2125914.23 Pakistani rupees millions from 2016 up to 2017, it reaches high level of 2385742 Pakistani rupees millions in 2017 and very low in 2006 which is 1876335 PKR million (Trade economics in Pakistan). The Pakistan economy is the 25th highest economy the purchasing power parity in the globally, and forty two highest in nominal gross domestic product. The population of Pakistan of over 207 millions (the world's fifth highest), gives a Gross Domestic Product per annual capita of \$1.641 in 2017-2018, and in 2016 it ranks 147th in the world. Moreover the economy of Pakistan is calculated to be 36 % of its overall economy. Now a days the Pakistan is moving on developed country and is one of the next eleven, among 11 countries that have potential that world's highest economies in the 21st century, in 1960 the Pakistan is also have strong economic position, that gives a loan to Japan of 4 million dollars to developed Japan agricultural economy. But unfortunately after decade of social instability and war, as of 2013, a serious difficulties like as electric power and railway transportation had developed. The Pakistan economy is semi-industrialized; the Indus River is the mandatory export commodities which includes leather goods, textile, chemicals, sports goods, medical tools, and carpets/ rugs. The Pakistan economy is the highest 25th

highest economy in the world. "CENSUS-2017 PAKISTAN". Pakistan Bureau of Statistics. August 2017. Archived from the original on 29 August 2017.



The upland Cotton, *Gossypium hirsutum* L., belongs to Malvaceae family is the fiber of great economic importance and natural plant which is cultivated in more than 50 countries in tropical as well as sub tropical areas of the world. The cotton at least 87% of the global growing cotton areas includes in growing countries. And the fiber, cotton seeds offers huge amount of vegetable oil and for animals it provides us protein for animal nutrition's as well as for human being. At least about 97% of the world's cotton yield is from *G.hirsutum*, remaining yield production is made from *G.barbadense*, *G. arboreum*, *G. herbaceum*, since from 1950s, the growing of cotton areas had 30 to 60 million hectare. And over all cotton yield production is grows from 400 % from 6.67 million metric tons in 2013/2013.

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Cotton is white Gold of Pakistan

Pakistan derives the sole position in the cotton worlds 4th biggest producer of cotton after China India and USA. Cotton is considering as a country cash crop and has a vital role in an uplift of country economy. Thought cultivated for vegetable oil purpose, and kernel for its fiber purpose, and it is the 6th largest importer of raw cotton it is also seventh highest producer of cloth, third largest producer of yarn, second largest exporter (ICAS, USA). 1.3 million Farmer out of total 5 million farmers cultivates cotton around 7.86 million acres in 2015–2016 as a growing area of the country it covers about 15%. Upland cotton and cotton related product put in 10 % to Gross Domestic Product and according to economic report of Pakistan it is the 55 % foreign exchange of the country, 2015-16). Punjab and Sindh are the foremost provinces in the production of cotton Punjab are more crucial it shares 79% of total cotton (Nazli, 2010).

The cotton yield is very crucial to overall economy of Pakistan's agriculture. About 28 % of the growers cultivate cotton, and more than 25 % of Pakistan's total growing area is followed to cultivation of cotton crop, with maximum yield focused in two provinces of Pakistan: Punjab (60%) and Sindh (40%) (As reported by Government of Pakistan, 2017). The cotton and it's by products like as, Textile, apparel, and yarn, consists significantly to the GDP (18%), the overall employment (26%), and foreign exchange income (64%) in Pakistan it is reported by (Government of Pakistan, 2014a; 2015b). Pakistan is also the world's number 4th highest cotton producer as well as 3rd highest cotton consumer in the globally world. The cotton-textile zones have significant Entailment for local economic strategies and performance and poorness simplification (Cororaton and Orden, 2008). Early in the 1990s upland cotton yield in Pakistan, this also faces lot of challenges such as high range of pest disease conducive to unexpected variation in cotton production and significant economic losses. A broad scale of chemicals and pesticides has been acquainting to moderate different cotton diseases during the previous fifteen years, that is indicates speedily grows up the price of cotton yield. However, as the Pestilence " developed stresses to these chemicals, and potency decline over time. The mandatory aims and economic importance of this cotton crop and its research has been to evaluate new germplasm, and new genotypes that are most resistant to any disease and pests, drought tolerance, heat stress, and had high yield potential with suitable fiber characteristics, in spite different research efforts, Pakistan has facing a lot of economic losses due to many pests that attacks high range of economic losses in cotton crop, the losses which is not estimated in figures (Salam, 2008).

In Pakistan Genetically Modified (Bt) Cotton

Genetically Modified cotton is atleast covered twenty five m/hectare are cultivated globally including exceeding cotton growing countries. Such as China, India, USA, and in Pakistan (James, 2012). *Bacillus thuringiensis* cotton growing is closely raised from 40% to seventy % land is cultivated in Pakistan since from 2004 to 2010 as reported by (Ali *et al.*, 2010). The total area of cotton under Bt cotton growing in Punjab and in Sindh is 85% and 45% respectively (Abdulai and Ali, 2010). In the recent past years the growing of Bt cotton in Pakistan is more popular in all over the country of Pakistan. *Bacillus thuringiensis* Cry 1Ac which covers atleast 80-90% cotton area which is cultivated in Pakistan was reported by (Abdulai and Ali, 2010).

It means it keeps a huge economic contribution overall in our local economy. The introduction of GM cotton proffers positive promise for to address the problem of cotton crop which is losses by many insect pests as well as many pest infestations. In 1997 the Pakistan begins works on evolution of genetically modified cotton. Despite of different research and administrations attempts. That is very necessary for commercialize a genetically modified cotton crop in Pakistan, in 2009 it was not adopted for commercial purpose. So its results delay and irrelevant adoption of Bt cotton. Approximate describes that atleast 80 % of the cotton cultivated areas was cultivated under these cultivars/genotypes are grown in 2007; atleast 50% in Punjab and 60% in Sindh in Sanghar Mirpurkhas and in Hala. Closely atleast about 42 genotypes of *Bacillus thuringiensis* upland cotton were cultivated in above areas (PARK, 2008). A little few others surveys were mentioned to create mandatory differences of the Bt cotton with actually Bt type cotton genotypes with urge non-Bt cotton genotypes in Pakistan which is based on semi structured and informed by many formers (Hayee, 2004; Shaikh *et al.*, 2008; and Arshad *et al.*, 2009). These results show us very poor performance of actually non Bt cotton compared to the original one which is urges conventional varieties. In improver to the other surveys, the Pakistan Agriculture Research Council deport a deep research studies that on atleast 126 different zones in atleast twenty one districts in 2007. This report analysed the presence of *Bacillus thuringiensis* content in arrogate Bt cotton plants. The reports from laboratory which shows us approximately 10 % of the sample in Punjab and 20% in Sindh were not significantly incontrovertible for the "Cry Protein2". Moreover in our information, these studies does not gives us an evaluation of the economic performance of unofficially Bt cotton varieties which is compared to the local varieties in Pakistan which is cultivated in Pakistan, this our study which provide an economic investigation to fill this gap.

The cotton formers analysis based on conducted in sindh, sanghar hala and Mirpur khas in Pakistan. The studies analysis internationally that the importance and impact of bacillus thuringiensis cotton in developing countries (Huang *et al.*, 2002; Pray *et al.*, for China; Qaim and de Janvry, 2003 for Argentina; Ismail *et al.*, 2002; Thirtle *et al.*, 2003; for South Africa; Traxler *et al.*, 2003 for Mexico; and Qaim and Zilberman, 2003; Gandhi and Namboodiri, 2006, and Orphal, 2005, for India). The study report from these above results suggests that these above countries have experience in many pest population and they make it stable and high yields and profits after the aquicent of *Bacillus thuringiensis* cotton. In spite of economic performance which suggests in the study cited above, in many developing countries the use of Bt cotton is controversial. But we are focusing the India because they are most relevant for Pakistan.

Bt Cotton: Bt cotton carries a geneCry1Ac from *Bacillus thuringiensis* that encodes for end toxin Cry protein that makes plant resistance against the insect (pink boll worm). 1st Bt cotton variety commercialized by the Agriculture Biotechnology leading company Monsanto in 1996 the transformation event MON531 incorporated in the cotton known as Bollgard. Currently, about 12.1 million farmers are cultivated GM cotton majority of them in China and India (James, 2008). Three generation of GM Cotton has been commercialized 1st in 1996 company Monsanto and 2nd generation contain a Cry2 AB in addition to Cry1AC and stacked 2nd version is Round-up Ready Flex (RR FLEX) which carry a herbicides resistance gene in addition to Cry1ac and Cry2 AB. Bollgard3 contain a third protein with the addition of Bollgard 2 Vip3A each protein has a different mode of action increase the longevity kill larvae by the different way.

In Pakistan there is various Research station and institute PCCC, CCRI, AARI, NARC, NIBGE, NGAB, NIAB, CEMB, CAMB, and technology is improving but Pakistan is still under the crises of Cotton white Gold turn into Dust in the year 2015-16 cotton catastrophic 28% in Pakistan agriculture economy. Government missed the target of 5.5% with a growth of 4.7% during the financial year 2015-16 which reduced economic growth by 0.5%. There are several reason that makes the cotton slump in the world they are using the latest technology 3rd Generation of Bt cotton seed but in Pakistan we are still reliant on 1st generation of Bt cotton and in Pakistan Bt cotton grow informal way still 2010 from 2002 the formally Bt cotton introduced in 2010 by government of Pakistan A study conducted by assessment of Bt cotton Cry1Ac (1st generation) showed that 52 seed varieties were collected from various seed companies and dealers analysis test show that only 0.86 of the genotype were positive for the MON531 event (Monsanto company event) and 0.14 were negative for any transgene and 0.02 genotype have the reported the optimum level of Bt toxin. There are a lot of facts that affect the cotton production and make cotton slump and a lot of cotton farmers are very poor and small farmers a study showed that 17% of the farmer did not know is it Bt Cotton or not. 33% are not ensured about the presence of the gene. Even by using Bt cotton Sadashivappa and Qaim (2009) portrayed that Bt farmers were able to reduce pesticides application by 40% while simultaneously they were also able to get yield advantages of 30-40%. But the *Bacillus thuringiensis* cotton is not Bt Cotton the reason of the failure of Bt cotton is the technology we are still using the Monsanto gene in our Cotton genome we are failing in the stabilization and getting of actual level of toxin. In 2015-16, cotton was cultivated above 6 million/hectare

Table 1: The expenditures and number of sprays on pesticides on Bt and Non-Bt Cotton varieties.

	Bahawalpur			Mirpurkhas		
	Bt	Non Bt	T-Values	Bt	Non Bt	T-Values
Bollworm	1.54	2.60	-6.26***	1.18	2.67	-7.42***
sprays	(0.91)	0.70		0.39	0.78	
Bollworm pesticide	1.846	3,488	-6.56***	1,259	2,667	-2.74***
Expenditure (Rs/acre)	(1,211)	1,226	0.63	1,099	1,917	
Non-bollworm	4.04	3.88		3.12	3.50	-0.95
Sprays	(1.33)	1.24		1.32	1.09	
Non-bollworm	3.073	2,993	0.22	2,093	2,605	-0.87
Pesticide expenditure (Rs/acre)	(1,989)	1,717		1,975	1,242	
Total	2.98	3.25	-1.24	2.74	3.08	-1.12
sprays	(1.70)	1.19		1.43	1.02	
Total pesticide	2,555	3,238	-2.88***	1,929	2,636	-1.73*
Expenditure (Rs/acre)	(1,804)	1,507		1,862	1,580	

Note: The pesticide which is used for to control bollworm, whereas the pesticide which is used for the diseases, such as Jassids, White fly, aphids, mealy bug etc.

Above is the mean result. Figure the standard deviation.

***, * denote statistical positive significance at the 1%, 5% and 10% respectively.

punjab, but due to demolition of the crop by any pest or diseased attack, the loss happens to country approximately forty five% in terms of crop yield whereas the formers of punjab had to suffer PKR 170 billion loss in cotton yield. There is no subsidy for Bt cotton farmer. Government is supposed to be serious in the Adaptation of 2nd generation and roundup ready flux generation of Bt cotton. Get rid of all seed varieties that failed to stand against the pest and did not show on past the optimum level of Bt Toxin. The government should commence the policies in cotton growing area friendly for the cotton farmer because a farmer is disheartened last year so a lot of farmers are switched to sugarcane and other crops. The breakdown of cottonseed technology is a very somber problem since it is directly associated with the country's economy there are more than 700 seed companies in Pakistan so seed adulteration is key problem in Pakistan. so Government of Pakistan negotiated with MNC Monsanto the acquisition of GM technology from Monsanto The government is very well alert of all these issues which are related to the cultivation of cotton crop and in a recent few years it has approved in total of five billion PKR for US firm Monsanto for evaluation of new seeds. Pakistan cotton production was forecasted to be 7.7 M bales, a 10% boost from the last year. Yield recovery is estimated by the USDA at 699kg/ha 28% up from the last year crop. Area of harvested will be dropped by 14% to 2.4 million ha so the new report shows that this year A 5.30 % boost has been witnessed over the preceding period last year when production stood at 10.147m bales. By using latest Technology and improving the agronomic practices and improving the knowledge of farmer towards the latest Technology by trim down seed Adulteration we can uplift our Cotton crop from the cotton slump and turn it into white Gold.

Due to similarities in yield and other cultural practices which is usually used in crops, the Indian formers created argument and apprehensions about the *Bacillus thuringiensis* cotton evolution in Pakistan. The Bt cotton performance which is depends on the environmental conditions, if the climatic condition is desirable it gives high yield and profit, if the climatic condition is not suitable the high amount of loss which is paying by formers due to heavy costs of seed fertilizer, and pests. It also depends on the germplasm of the variety and cropping practices. So a well performing genotype of Bt cotton variety in one area may not give high yield results if the climatic condition is not suitable. Therefore the farmers are suggested to use only approved variety of Bt cotton, which is already rested for the local and national agro climatic and environmental conditions, are highly preferred for use. And a country is also follow bio safety guidelines to use

approved variety of Bt cotton, the main problem in Pakistan the Bt cotton variety is approved by many private as well as semi private local sectors plant breeders through conventional crossing Bt material with local variety or germ plasm so that they can easily transferred the Bt germplasm in local varieties. And then these varieties are locally distributed to all formers without any official recommends which raised many problem in quality of seed, awareness between formers, it also effects on human and animals too, and bio diversity. Among the Bt cotton varieties 6 of these varieties are approved for field trail to check the performance of that cotton in small plots in 2009, and it expected results is good and give high yield than we distributed to others formers through government sector, the lack of research work on Bt cotton and its economic performance of these *Bacillus thuringiensis* varieties related to conventional local varieties. And the Pakistan reports about the formers "suicide" death of sheep flocks and lower profits rises of commercial evolution of *Bacillus thuringiensis* cotton varieties in Pakistan. The NGO and civilization society organization demonstrates against the adoption of commercial varieties of Bt cotton by giving Pakistani examples. Given these circumstances, the paper possess a high amount of assesment is needed.

To see the performance of Bt unapproved variety some of which is already been approved for a field trail in 2010. According to section wise this our paper is divided into four parts. Part two depicts the data analysis and collection, and the analysis of performance of *Bacillus thuringiensis* cotton varieties which is cultivated in Pakistan as presented in section 3. And in the last section which is focused on policies implements of the results and conclusion of the paper. According to survey of Pakistan rural house hold (PRHH), among four districts of Pakistan in the PRHH, the Bt cotton was surveys in two districts of Pakistan where the large number of farmers which grow cotton was so sufficient in the sample. This study reports which covers on eight villages and about 105 cotton growers in every districts. It is consisted on 208 formers which are growing cotton in sixteen villages of 2 districts of Pakistan in each village atleast 10 cotton formers were checked out. And the area where cotton grows is divided into 6 climatic zones and on the basis of temperature and rainfall. Because of each zone have different climatic environments, and the pests and disease of the zones are also changed due to environment changes (Soomro and Khaliq, 1996). These above districts and zones have different climatic conditions, such as maximum rain fall high humidity, low rainfall, maximum temperature, due to the various pest attacks on crops because of low temperature and high humidity which increases pest manifestation such as bollworm, and other sucking

insect pests. As in sanghar has very hot and dry climatic condition, in hala its changed dry and hot climatic condition.

As well as in Mirpurkhas has humid and hot climatic condition. And also the rainfall is very low in above districts. The one third of sanghar district is covered by desert. And the quality of soil is also differences in each district. Mostly the sanghar soil is sandy and clay in Hala and in Mirpurkhas. In above districts the main source of irrigation is canal system. The above selected areas are mostly for cotton growing areas in province of sindh Pakistan. In addition an attempt was made to collect data from cotton growing areas in terms of different climatic conditions. The attempts was made to collect the information on individual persons such as (age, married, education), farm (size of form, type of form), and households (house holds size, number of dependents). And also data were collected on the cost which is input on cotton out of cotton, pesticides expenditures.

2. **RESULTS**

Our studies reports that the mandatory the formers are small having small piece of land. Closely total of 80.1 % of the study reports that the formers operate less than 12.5 acre of the land. And most of them are having less than 5 acre land in all three zones. The majority of the formers are concentrated in sanghar 72.9% and most of the share croppers which are in Mirpurkhas which is 73.1% and in hala (69.3%). The distribution of land in Pakistan, especially in the sindh district, as our study report the mostly the formers are small; some are tie into share cropping systems (World Bank, 2002). The reports also shows that the majority of the share croppers in our survey report is indicates the land lord will provides 49% of the inputs accepts labour and the sharecroppers is responsible for 51 % of the inputs and their timely uses. And the output is divided into fifty-fifty shares. And about 40% of the formers they are cultivated cotton through for generations. The aquicent of *Bacillus thuringiensis* cotton was speedily from 2006 to 2008 in all over the above three districts. The adoption of Bt cotton in sanghar was higher at 37% in 2006. And in Mirpurkhas is 32%. In addition most of the formers which grow Bt cotton in Mirpurkhas in 2008 which is about 87%, and in Hala 74%. With discussion of some of formers about Bt cotton and performance of *Bacillus thuringiensis* cotton, due to a large number of formers they described the problems about the quality of Bt cotton and high expenditures, low production, also high use of fertilizers and water, and the yield is high of *Bacillus thuringiensis* cotton as compare to non-Bt cotton varieties. Due to increases of bollworm in Bt cotton it loss the yield of cotton, and the interesting is that most of the formers

and growers they don't know the actual name of variety or the seed company too because of no awareness. And most the formers they don't know the importance of seed quality in refuge areas. To know the differences of performance of *Bacillus thuringiensis* cotton and non Bt cotton varieties, this section which compares the difference between *Bacillus thuringiensis* and non Bt cotton, and cost of yield, the total margin of both varieties, to determines the significance differences in the mean values of the these variables, comparison tests are performed.

Impact on pesticide

The expenditures of seed and pesticides

The Bt cotton have high resistant against pest disease, so growers they assumed Bt cotton, and the formers they are not using Bt cotton its about 92.9% they reported that there is bollworm infestation more attack on Bt cotton, between them some of the describes high intensity of this infestation, reported by 58.9%. A closely 35.9 % the formers they adopt Bt cotton they are also reported high attack of bollworms. The infestation intensity is moderate to low, Bt cotton adopters are also reported that high amount of attack on Bt cotton such as cotton leave curl virus (CLCV), and secondly the mealy bug a majority of the formers they reported. The sample of Bt cotton which is tests from Pakistan laboratory that also reports that the presence of Cry 1 Ab/Ac in majority of the samples. The intensity which is not consistent which is varies from low to high, which is indicating the mixing of seed possibilities (PARC, 2008). In 2009 the surveys of Bt cotton, they found lot of spurious seed, as recognized by many liberal formers, *bacillus thuringiensis* is not effective for bollworm attack. As mentioned in Table-1 a number of expenditures on per acre on *Bacillus thuringiensis* cotton and non Bt cotton varieties, and the number of sprays which is used on *Bacillus thuringiensis* and non Bt cotton in hala, reports in standard deviation and means sanghar and mirpur khas. The Bt cotton pests are divides into 2 groups, such as bollworms, which includes pink, spotted, army worm, and American worm, non-bollworms, and all others crops which is infested by many sucking insect pests like as, jassids, mealy bug, aphid, and white fly. In above table which shows that significant difference in the number of sprays on pesticides in above districts. Different districts have different times and number of sprays on Bt cotton, such as in sanghar, the farmers they spray 2.6 times on non Bt cotton, where as 1.5 times on Bt cotton. While as in Mirpurkhas this figures will be changes as 2.15 and 2.97 for Bt and non Bt cotton genotypes. As in this results its reports that the number of expenditures of pesticides is significant low on Bt cotton genotypes as compare to non Bt cotton varieties in both districts. There is no positive significant difference of number of sprays was found in these districts, on non Bt cotton

varieties. So it is clear that the number of pesticides expenditures are low as compare to Bt and non Bt cotton cultivars, a total of expenditures on Bt varieties is 1,929 Rs/acre in Mirpurkhas, and in sanghar which is 2,555 Rs/acre. And as mentioned to non Bt cotton varieties which is 2,636 Rs/acre in Mirpurkhas and in Hala which is 3,238 Rs/acre were used in non Bt cotton varieties. So the number of sprays is statically in significant in above districts of Pakistan. the use of pesticide is also reflects on the expenditure on pesticides how much quantity uses and how much quantity is effect on directly and appropriate, the usage of seed per acre and conventional expenditures of seed requirement 8 to 10 kg of cotton seed per acre. The Bt cotton varieties the requirement of seed is also lower as compare to non Bt cotton varieties. However this study data also describes that there is no significant differences between quantity of seed in both varieties, Bt and non Bt cotton varieties. A majority of formers they receive seeds without any proper instruction this is one of them a major fact. In Table 2 which shows the formers of Mirpurkhas, are generally used lower amount of seed which is 6.1 kg/acre for non Bt cotton variety, and 5.9 kg/acre for Bt cotton variety. While as in Sanghar the requirement of seed is 7.7 kg/acre for non Bt cotton variety and for Bt cotton variety which is 7.2 kg/acre are used. So standard deviation which indicates that small changes in the use of above districts. The study reports that the Bt cotton variety seed is more costly than non-Bt cotton varieties so most of the small formers they used non Bt cotton varieties. Majority of small formers they don't have enough money to purchase seed and fertilizers, the study report that the price of Bt cotton varieties which is 185.8 kg, which is significantly high than the non Bt cotton which is 109.6 kg. In mirpur khas the price is also difference for non Bt cotton variety the rate is 110 kg, and for Bt cotton variety which is 195.3 kg. So both varieties of seed are more expensive as compare to hala and in sanghar as mentioned in the (Table 2).

The expenditures of both Bt and non Bt cotton varieties is significantly higher than the conventional local varieties. As mentioned in the study reported in 2009 may not comparable for these above districts. In Table 3 which provide the costs and expenditure on cotton picking and fertilizer, and other material, like as sowing, land preparation, water, seed, fertilizer, and the labour charges for picking for cotton. In this table it shows that the price for labour charges is also high for picking Bt cotton varieties, the formers they spent lot of money to charge the labour for picking, such as in hala the formers spent 358 Rs/acre for Bt cotton variety, the starting date of cotton flowering from a half month after the planting, sowing. And regularly blooming occurs for many days. It also takes two and half month from

blooming to first flower opening of the bolls. The picking time starts with the opening of bolls, the sowing date of cotton in Pakistan which is starts from 10th April to end of June. And generally picking time starts from august to may be end of December. Cotton is picked manually in Pakistan; mostly by women, the formers they hired cotton pickers to pick their cotton in time and they will pay the money to cotton pickers, there are different ways of cotton picking some formers they pay the cash money to picker and some formers they manually paid 1/16th share of the harvest, i-e., 2.8 kg per 40 kg of the harvest. In mirpur khas the majority of formers they grows cotton in April and the picking time starts from early august, a Bt surveys in 2009, in sanghar the time period of cotton planting is starts from may and picking time starts from 12 September, Whereas in hala cotton planted in 15 may and the picking time is starts from end of October. The number of picking is also varies from districts to districts, due to their climatic condition changes. The cotton picking in Mirpurkhas is usually 3 to 5 times whereas in sanghar 2 to 3 times. Our study also reports that the information about the cost of cotton they received after the sale of each picking. To estimate the expenditure of picking, the average amount of all picking is used to estimate the value of 1/16th share of total harvest. The study survey demonstrates that the numbers of bolls are *Bacillus thuringiensis* cotton is more as compare to non-Bt cotton varieties. Due to higher bolls in BT cotton is also expensive for picking as compare to non BT and conventional varieties. The picking expenditures are also not significant in above districts, there is no significant differences of expenditures are found in both districts which includes the sowing, irrigation, land preparation, labour costs for different operations which is manually used in the cotton crops. There is no significant difference was found in the Bt cotton and non Bt cotton genotypes/cultivars. The formers they indicated that the revenue is estimated using the quantity of sold cotton and price at the time of sold out. The material includes higher number of sharecroppers who share the harvest and input expenditures on 50-50 basis. The expenditures and the revenue adjusted for the sharecroppers, as in described in (Table 3).

In mirpur khas the revenue and total margins are highly significantly for Bt cotton varieties. Whileas in Hala and in Sanghar there is no significant difference was found. The higher yield given by *Bacillus thuringiensis* cotton gives high revenue in all above districts. As a result the Bt cotton variety appeared more suitable, and the performance of Bt cotton is more desirable as compare to non Bt cotton variety as in table 1. The results which indicates the performance of actually unapproved varieties of *Bacillus thuringiensis* cotton that occurs the first generation of the Bt gene. In

Table 2: Quality, expenditure and price of Bt and non-Bt cotton Seed.

Bahawalpur				Mirpurkhas		
	Bt	Non Bt	T-Values	Bt	Non Bt	T-Values
Quality		7.7	-1,023	5.9	6.1	-0.281
(Kg/acre)	7.6	1.5		2.3	1.9	
Price	1.3	107.7	5.771***	195.3	110.0	6.017***
(Rs/Kg)	180.9	47.0		48.4	43.9	
Expenditure	75.3	838	5.097***	1,149	652	2.954***
(Rs/acre)	1,318	406		593	330	

Note: in the above figure the standard deviation. ***, **, shows positive significance at the 1%, 10%.

Table 3: unapproved Bt cotton varieties comparison of Pakistan with India and china Bt cotton varieties.

Sr. No	Difference % between Bt and non-Bt varieties			Total margin (US\$/ha)			
	#of Sprays	Pesticide Cost	Seed Cost	Total Cost	Yield	Bt	Non Bt
China (2001)	--	-56.9	392.2	-29.7	9.10	288	-235
India (2006) Gujrat	--	--	129.9	15.8	34.8	822	306
Maharashtra	-1.7	-22.5	194.3	22.9	51.5	499	322
Andhra Pradesh	-3.6	-32.2	182.3	4.9	41.8	444	132
Tamil Nadu	-2.8	-66.7	199.8	11.6	25.9	299	140
Pakistan (2009) Bahawalpur	-1.8	-19.2	74.6	-3.1	6.8	463	394
Mirpurkhas	-2.7	-31.9	86.5	3.7	40.2	400	240

Origin: Bt cotton studies for Pakistan, Gandhi and Namboodiri 2006 for India, and Huang *et al.*, 2002 for china.

Mirpurkhas the number of sprays declined an average on 1.5, and in sanghar 1.2 on average 1.1. Due to large number of sprays on non-Bt cotton variety, total number of sprays was declined by 0.4. In mirpur khas total pesticides expenditures declined by 26.8%, and in hala 21.1 %, in India this results similar to compare of Bennet *et al.*, 2006, who estimated the same decline in India, Maharashtra. The results shows that in mirpur khas the Bt cotton variety gives high yield as compare to non Bt cotton variety which is 39.3% and in hala 5.9%. it also indicated that yield increase in sanghar is not statically significant in Table-2. There is no significant difference was found by shaikh *et al.*, 2008, in *Bacillus thuringiensis* cotton varieties and in non Bt cotton varieties in sindh. In spite of high amount of expenditures on fertilizer, seed, and cotton picking, the total expenditure of *Bacillus thuringiensis* varieties are 5.3% lower than non Bt cotton varieties in Sanghar. For both varieties a high yield and higher gross margins that is Rs 2,335/acre lower in Hala and higher in Mirpur khas which is 5,777/acre. The result of Pakistan is useful to compare with other countries. The differences of the performance of illegally Bt cotton varieties in Pakistan with un approved variety in India and in china as mentioned in Table 3. This also indicates that the significant differences of pesticide expenditure and yield total margins in Pakistan are compare to both these countries china and India. In Pakistan and in India the yield of *Bacillus thuringiensis* and non Bt cotton varieties are not same, and the performance of *Bacillus thuringiensis* cotton, however the price and expenditures of pesticides are also not same of Bt and non Bt cotton varieties with India and in china.

3.

CONCLUSIONS

Transgenic *Bacillus thuringiensis* is very crucial and important crop for economical outcomes, so hence there should be more through-puts on Government and Private scale for the adoption and commercialization of Bt based crops with safe implications. It will also provide better chance to equilibrate between resources and demands of the country.

REFERENCES:

- Ali, A., and A. Abdulai, (2010). The Adoption of Genetically Modified Cotton and Poverty Reduction in Pakistan. *Journal of Agricultural* 61(1), 175–192.
- Arshad, M., S. A. Gogi, M. Dildar, Yaseen, M. Asghar, M., Tayyib, M., Karar, Haider, H. Faisal and U. U. Naeem. (2009). “Farmers” perceptions of insect pests and pest management practices in Bt cotton in the Punjab, Pakistan”. *International Journal of Pest Management*, 55:1, 1–10.
- Chaudhary, M. R. (2010) *Cotton Production and Processing, Industrial Applications of Natural Fibres*; John Wiley and Sons, Ltd. Hoboken, NJ, USA, 219–234.
- Cororaton, C. B. and O. David, (2008). “Pakistan's cotton and textile economy: Intersectoral linkages and effects on rural and urban poverty,” *Research reports* 158, International Food Policy Research Institute (IFPRI), Washington, D.C.
- Gandhi, V and N. Namboodiri (2006). The Adoption and Economics of Bt Cotton in India: Preliminary Results from a Study, Working Paper No. 20006-09-04

- (Indian Institute of Management, Ahmedabad). Government of Pakistan (GOP). 2003. Census of Agriculture 2000. Lahore: Agriculture Census Organization.
- Government of Pakistan. (2009a.) Pakistan Economic Survey 2008-2009. Federal Bureau of Statistics, Government of Pakistan.
- Government of Pakistan. (2009b). Census of Manufacturing Industries 2005-2006. Federal Bureau of Statistics, Government of Pakistan.
- Gruère, G. P., P. Mehta-Bhatt, and D. Sengupta. (2008). Bt Cotton and Farmer Suicides in India. IFPRI Discussion Paper 00808. Environment and Production Technology Division, International Food Policy Research Institute, Washington, D.C.
- Hayee, A. (2004). Cultivation of Bt Cotton-Pakistan's Experience. Action Aid, Pakistan.
- Herring, R. (2009). Persistent Narratives: Why is the "Failure of Bt Cotton in India" Story Still with Us? *AgBioForum*, 12(1): 14-22.
- Huang, J., R. Hu, C. Fan, C. Pray, and S. Rozelle. (2002). Bt cotton benefits, costs, and impacts in China. *Ag Bio Forum*, 5, 153-166.
- International Cotton Advisory Committee (ICAC). (2014) Cotton: World Statistics; ICAC: Washington, DC, USA.
- Ismael, Y., R. Bennett, and S. Morse. (2002). Farm-level economic impact of biotechnology: Smallholder Bt cotton farmers in South Africa. *Outlook on Agriculture*, 31, 107-111.
- Kouakou, T.H., Waffo, Teguo, P. Kouadio, Y. J. Valls, J. Richard, J. M. Phenolic (2007) compounds and somatic embryogenesis in cotton (*Gossypium hirsutum* L.). *Plant Cell Tissue Organ Cult.* 90, 25–29.
- Orphal, J. (2005). Comparative analysis of the economics of Bt and non-Bt cotton production. Pesticide Policy Project Publication Series Special Issue No. 8. Hannover, University of Hannover. 53 Pp.
- PARC. (2008). Status of Cotton Harboring Bt Gene in Pakistan. Institute of Agr-Biotechnology and Genetic Resources, National Agricultural Research Centre, Pakistan Agricultural Research Council, Islamabad.
- Pray, C. E., D. Ma, J. Huang, and F. Qiao (2001): "Impact of Bt Cotton in China," *World Development*, 29(5), 813-825.
- Qaim, M. (2003). Bt cotton in India: Field trial results and economic projections. *World Development*, 31, 2115-2127.
- Qaim, M., and A.de Janvry. (2003). "Genetically Modified Crops, Corporate Pricing Strategies, and Farmers' Adoption: The Case of Bt Cotton in Argentina." *American Journal of Agricultural* 85(4): 814-828.
- Qaim, M. and D. Zilberman. (2003). "Yield Effects of Genetically Modified Crops in Developing Countries," *Science*, Vol. 299, 900–902.
- Qayum, A., and K. Sakkhari. (2005). Bt cotton in Andhra Pradesh -3 year assessment. The first sustained independent scientific study of Bt cotton in India. Andhra Pradesh, India: Deccan Development Society.
- Rao, I. A (2006). First Bt Cotton Grown in Pakistan. Pak Kissan, 17 March 2006.
<http://www.pakissan.com/english/advisory/biotechnology/first.bt.cotton.grown.in.pakistan.shtml>.
- Rani, P. U., and S. Pratyusha, (2013) Defensive role of *Gossypium hirsutum* L. anti-oxidative enzymes and phenolic acids in response to *Spodoptera litura* F. feeding. *J. Asia-Pac. Entomol*, 16, 131–136.
- Salam, A.. (2008). Production, Prices and Emerging Challenges in the Pakistan Cotton Sector. ed.) Cotton-Textile-Apparel Sectors of Pakistan: Situation (In Cororaton, Caesar B. et al. and Challenges Faced. IFPRI Discussion Paper 00800. Washington, D.C.
- Sheikh, A. D., M. A. Mahmood, A. Hussain, A. Bashir and R. Saeed. (2008). BT Cotton Situation in Punjab. Technology Transfer Institute. Faisalabad.
- Soomro B and P. Khaliq, (1996). Cotton Production in Pakistan: A Success Story. Report No. 2. Asia Pacific Association of Agricultural Research Institutions, FAO Regional Office for Asia and the Pacific, Bangkok.
- Thirtle, C., L. Beyers, Y. Ismael, and J. Piesse. (2003). Can GM-technologies help the poor? The impact of Bt cotton in Makhathini Flats, KwaZulu-Natal. *World Development* 31 (4): 717–732.
- Traxler, G., and J. F- Zepeda. (1999). The distribution of benefits from the introduction of transgenic cotton varieties. *AgBioForum*, 2(2), 94-98.
- Traxler, G., S. Godoy-Avila, J. Falck-Zepeda, and J. J. Espinoza-Arellano. (2003). Transgenic cotton in Mexico: Economic and environmental impacts of the first generation biotechnologies. In *The economic and environmental impacts of agbiotech: A global perspective*, ed. N. Kalaitzandonakes, 183–202. New York: Kluwer Academic/Plenum.
- World Bank (2002). "Pakistan Poverty Assessment: Poverty in Pakistan: Vulnerabilities, Social Gaps, and Rural Dynamics". The World Bank. Washington D.C.