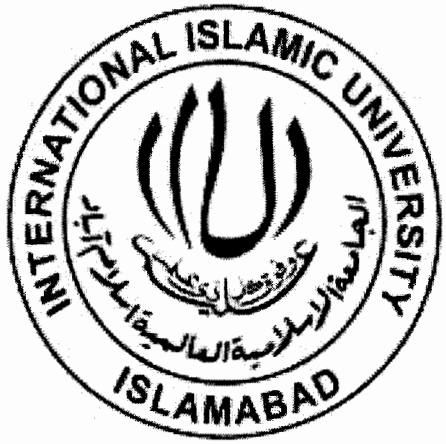
USE OF BT COTTON IN PAKISTAN AND ASSOCIATED ENVIRONMENTAL, SOCIAL AND ECONOMIC ISSUES



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SESSION 2008-2010

USE OF BT COTTON IN PAKISTAN AND ASSOCIATED ENVIRONMENTAL, SOCIAL AND ECONOMIC ISSUES

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A thesis submitted to International Islamic University Islamabad in partial fulfillment of the requirement of degree of Master of Science in subject of Environmental Science

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August, 2010

DEDICATION

This Project is dedicated to my father, who taught me that the best kind of knowledge to have is that which is learned for its own sake. It is also dedicated to my mother, who taught me that even the largest task can be accomplished if it is done one step at a time.

(Acceptance by the Viva Voce Committee)

Title of Thesis: Use of BT cotton in Pakistan and associated, environmental, social and economic issues

Name of Student: Noor-ul-ain (Redg# 161-FBAS/MSCES/FO8)

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Dated 31-08-2010.

ACKNOWLEDGEMENT

Firstly, I would like to say Alhamdulillah, for giving me the strength and health to do this project work until it done Not forgotten to my family for providing everything, such as money, to buy anything that are related to this project work and their advise, which is the most needed for this project. Internet, books, computers and all that as my source to complete this project. They also supported me and encouraged me to complete this task so that I will not delay in doing it.

Then I would like to thank my teachers, especially Dr Rashid Saeed for guiding me throughout this project. I had some difficulties in doing this task, but he taught us patiently until I knew what to do. He tried and tried to teach us until I understand what we supposed to do with the project work.

Finally I would like to thanks my friends who support me emotionally.They were helpful that when we combined and discussed together, I had this task done.

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ABSTRACT

Cotton crop has major contribution in the economy of Pakistan. Rapid increase in population has imposed great pressure on the resources with increased dependence on the modern crop production technologies including Biotechnology. Therefore, many genetically modified varieties of cotton have been introduced. This study utilizes secondary data collected from February to June 2010. It was seen that 50% of cotton cultivated area in Punjab and 80% in Sind was under these unapproved Bt cotton varieties. Indirect pests had become the direct pests of the cotton due to introduction of such Bt cotton. Genetic pollution is also an important issue arising due to the use of GMO's or genetically modified crops resulting in the disturbance or disappearance of indigenous/original gene pool. The results were compared to other studies on Bt cotton in India and suggest certain gains for Pakistan due to shifting to a regulated national market for Bt cotton technologies along with comparatively lower cost for fertilizers, pesticides and labour. Anyhow, lessons learned from India do not portray a good picture regarding use of Bt cotton.

CHAPTER 1

INTRODUCTION

The environmental balance depends upon the stability and balance of its ecosystems. Any disturbance in the ecosystem ultimately disturbs the environment and thus causes negative impact on its inhabitants (Diaz, 2001).

Humans are at top level of food pyramid that is at most important place so their behavior effects the environment. The most, in other words human behavior is one of the factors which shape the environment.

The gradual change in the ecosystem is a natural process but with advancement of technology human activities have accelerated and modified the changes in the ecosystem. Human activities drive the environment in catastrophic changes such as acid rain, climate change etc.

Resources are limiting factors on the earth which is used by the inhabitants of environment to gratify their needs and demands. With the population increase humans are adopting new technology and new methods for satisfying the ever following human needs. For this purpose they are doing new research to produce maximum output from minimum input and producing more advanced and modern technology on the cost of environment. World population is increasing day by day. According to one estimate in 1950 it increases with the ratio of 1.8 and in 2002 its ratio of increasing is 2.2 (Data base

U.S. Census bureau, International Data Base Estimates Updated, Retrieved on Jaunuary 21, 2010).

In Pakistan the population is not evenly distributed throughout the country. There is an average of 146 persons per square kilometer, but the density varies significantly (GOP, 1992).

Background:

Environment is under severe risk, and environmental governance (both nearby and internationally) is complicated. The global environment is an integrated system characterized by links. Population pressure and pollution are the drivers of environmental changes which know no boundaries. Waste is emitted into the same oceans and the atmosphere. Reduction of forest cover reduce carbon sequestration, and hence rate up global climate change. Forests also provide a variety of ecosystem services, such as improving air quality, enriching soil, and providing renewable resources, regulating hydrology, and contributing to biodiversity. To conserve these resources protocols and conventions are signed and ratified globally.

The Cartagena Protocol seeks to protect biological diversity from the potential risks posed by living modified organisms resulting from modern biotechnology (Secretariat of the Convention on Biological Diversity, 2000).

The Cartagena Protocol makes clear that products from new technologies must be based on the precautionary principle and allow developing nations to balance public health against economic benefits. It will for example let countries ban imports of a living

modified organism if they feel it harmful there is not enough scientific evidence that the product is safe and requires exporters to label shipments containing genetically altered commodities such as corn or cotton (Secretariat of the Convention on Biological Diversity, 2000).

Genetically modified crops will save billions of rupees in the exchequer for import of pesticides. This will not only reduce the cost of production, environmental pollution but it will result in higher profitability for the farmers.

Cotton is an important part of Pakistan's agriculture system and contributes a lot towards the overall economy of the country. About 26 percent of all farmers grow cotton, and over 15 percent of Pakistan's total cultivated area is devoted to cultivate this crop, with production concentrated in two provinces: Punjab (80%) and Sindh (20%) (GOP, 2003). Cotton and its intermediate and final products (such as, yarn, textiles and apparel) contribute significantly to the gross domestic product is 8%, it provide total employment 17%, and foreign exchange earnings 54% in Pakistan (GOP, 2009a; 2009b). Pakistan is the fourth largest producer and the third largest consumer of cotton in the world. The cotton-textile sectors have important implications for national economic performance and poverty reduction (Cororaton and Orden, 2008).

A wide range of pesticides has been introduced to control various cotton pests. Pakistan has been suffering from huge economic losses due to persistent pest attacks on the cotton crop. As a result farmers use insecticides and pesticides. The use of chemicals increases the environmental pollution (Nazli, 2009).

Population pressure and environmental pollution forced the government of Pakistan to approve the use of genetically modified cotton-Bt cotton. The beginning of genetically modified (GM) cotton offers major guarantee for address the matter of crop loss by controlling some of the pest infestation. Pakistan had not commercially adopted Bt cotton by late 2009. This delay has resulted in the unregulated adoption of Bt- cotton (PARC, 2008).

Around 90% of total cotton area in Australia, South Africa, and the USA planted biotech varieties in 2009-10. China and India planted more than two-third of their cotton area to biotech varieties. In India the cotton production has increase from 14 million bales in 2002 to 32 million bales in 2008 with large increase in yield from 313 kg to 579 kg per hectare. The developed and developing countries had started harnessing the vast potential of biotechnology for plant improvement since 1992. Noticeably higher yields of cotton, soybean, canola and corn have been achieved through, which have a source of additional income at the household and national levels.

The development of genetically modified cotton having its inbuilt capacity to balance the attack of insect pests had resulted in reduction of input costs. Under the present ecosystem, the crop is prone to a number of insect pests. The cost of plant protection to control the pest attack accounts for more than 30 percent of the total input cost. This called an urgent need for development of transgenic cotton varieties through conventional breeding programmed to reduce the plant protection cost (Kakakhel, 2010).

Significance of the study:

Bt cotton is already used in India and china. It is seen that these countries experienced a decline in pest infestation and enjoyed stable and higher yields and higher profits after the adoption of Bt cotton (Kakakhel, 2010). Stable economy has a great attraction for growth of Bt cotton for the farmers. Genetic pollution is also an important phenomenon. It is seen in India that with the use of Bt cotton the pollution of the direct pest of Bt cotton declines. Other insects which are indirect pest of Bt cotton becomes the direct one. This phenomenon is more dangerous one than the environmental pollution .the genes flow from organism to organism and multiply itself (Butler , 1994).

This study overview the importance of Bt cotton versus non Bt varieties. As Bt cotton is expected as environmental friendly and economically beneficial crop for the following reasons:

- It would reduce pesticide use
- It would reduce cost of cultivation and
- It would result in increased yields.

Aims and objectives:

The major focus of this study to overview

- The use of Bt cotton in Pakistan under Cartagena protocol.
- It also aims to observe the phenomena of genenatic pollution.
- The adverse effects of Bt cotton in India are also observed.
- To document the unapproved varieties in Pakistan

For this purpose the study had been conducted from secondary data .Chapter 2 will focus on the literature review, chapter 3 and chapter 4 is about methodology and results respectively. Chapter 5 will discuss about conclusion and recommendations.

CHAPTER 2

REVIEW OF LITERATURE

Pakistan initiated work on the growth of GM cotton in 1997. Although various administrative and research efforts that are required to commercialize a GM crop, Pakistan had not commercially adopted BT cotton by late 2009.This delay has resulted in the unregulated adoption of Bt-type cotton. Estimates show that about 60 percent of the cotton growing area was under these varieties in 2007; 50 percent in Punjab and 80 percent in Sind. Nearly 40 varieties of BT cotton were under cultivation(PARC, 2008).

Cartagena Protocol:

The Cartagena Protocol seeks to protect biological diversity from the potential risks posed by living modified organisms resulting from modern biotechnology. The Cartagena Protocol makes clear that products from new technologies must be based on the precautionary principle and allow developing nations to balance public health against economic benefits. It will for example let countries ban imports of a living modified organism if they feel it harmful, there is not enough scientific evidence that the product is safe and requires exporters to label shipments containing genetically altered commodities such as corn or cotton(Secretariat of the Convention on Biological Diversity, 2000).

Pakistan as an Agricultural Country:

Pakistan is situated in the North-eastern part of the sub-continent between 23° and 37° north latitude and 62° and 75° east longitude. The length and breath, it covers is approximately 1400 kilometers and 500 kilometers, respectively. Pakistan is mainly an agricultural country and thus agriculture is the 'backbone' of the economy and the mainstay of our national economic life. It contributes about 25% to the GDP, employs about 50 % of the total labor-force, provides livelihood directly to 70 % of the rural population, and earns about 60 % of the total value of exports. Overall, it meets the food needs of the population (Syed, 2001).

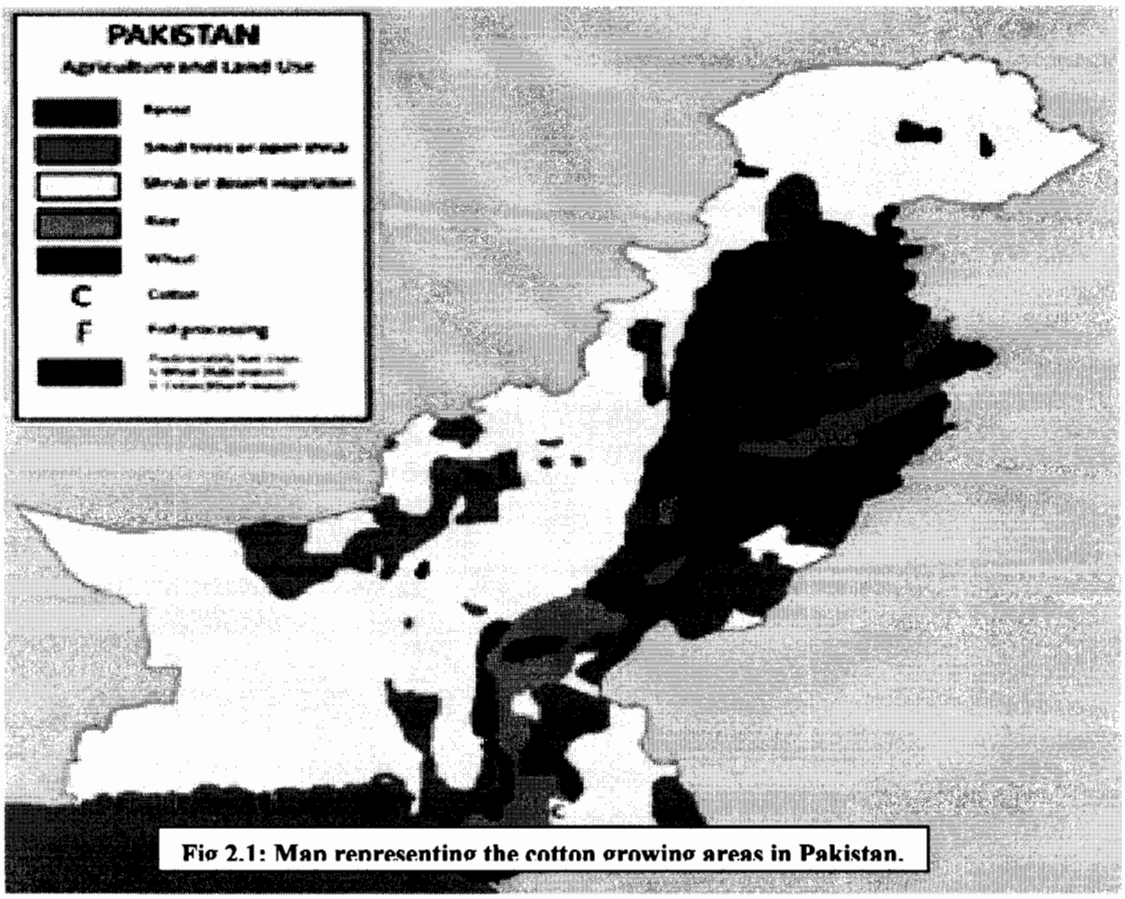

Fig 2.1: Map representing the cotton growing areas in Pakistan.

Source: maps.thefullwiki.org/Agriculture_in_Pakistan

Importance of Cotton for Pakistan:

Cotton - the white gold has a fascination for farmers since ages. It is making history as it is the economical backbone of the seventh Asian countries. Cotton cultivation is expanding exponentionaly in this age (Qayum and Kiran, *2003).* Hundreds of cotton hybrids come in to the market even very small farmers entered into this market with the hope of earning desperate cash.

Pakistan is an agricultural country. It produces many cash crops such as wheat, maize, cotton and rice. Cotton-wheat is a extended well-known crop production system of north-western plains of India and Pakistan, and it occupies an important place in the agricultural economy of mutually these countries(Mayee, 2008). While cotton is a cash crop, wheat provides the necessary food security. Accordingly, this crop rotation has brought rich dividends to the farmers.

Cotton is the oldest fiber crop. The archeological studies show the existence of cotton cloth in Pakistan such as Mohenjo-Daro and Harappa. Pakistan is the 4th largest producer of the cotton of the world and third largest consumer. Cotton and textile contributes 10% to GDP, 21% to employment and 60% to export earnings. Cotton farmers of Pakistan are facing many problems regarding cotton. For example: high fluctuation of yield due to pest infection and high cost production(GOP, 2003).

Bt Cotton :

Genetically modified cotton is obtained by inserting the gene of soil born bacterium Bacillus thruingiensis (Bt) in to cotton seed. This gene produces Cry protein which is harmful to the larvae of butterflies, beetle and flies. As a result these larvae's do not

develop on the cotton crop. As a result the sprays of insecticides and pesticides are not required. This will reduce the cost as well as the chemical use is also reduced. The environmental pollution and the labor cost also is also reduced(Nazli, 2009).

The use of Bt cotton increases the annual yield as a result it increase the profitability than conventional varieties. Although the Bt cotton seed is expensive. With the reduction of number of sprays environmental pollution is reduced and health problems are reduced.

BT Cotton in Pakistan:

In Pakistan cotton is grown in two provinces that are Punjab and sindh. About 80% of the area is under the cultivation of cotton in Punjab and in sindh 20%.The farmers who have the private land, grow Bt cotton varieties. Pakistan agriculture research council conducted a detailed scientific survey in 2008. From the survey report it is seen that 50% of cotton cultivated area in Punjab and 80% in Sind was under these unapproved Bt cotton varieties. About 39% of unapproved is under varieties of Bt cotton.10% of the samples in Punjab and 19% in sindh were not positive for the cry protein. The farmers do not know the variables and quality of seed mixing as a result non uniform plant population was observed(Badruddin and Pervez, 1996).

Why Unapproved Bt Cotton?

Farmers wanted to escape from the problems as they liker sprays and pest attack. The agriculture biotech research was initiated in 1981. Two public institutions and private breeders were involved. There is almost no research infrastructure present or there is a weak institutional research infrastructure. There is lack of coordination between the

institutions and there is weak institutional support. Convention of biodiversity(CBD) was signed by Pakistan in 1992. Cartagena Protocol on biodiversity was signed in 2001 but was not ratified until 2009.Biosafety guidelines and the rules were approved in April 2005. An independent body, the Intellectual Property Organization – Pakistan (IPOP) was formed in 2005. Amendments in the Plant Breeders' Right Act and Seed Act are still awaiting approval from the parliament (Nazli, 2009).

Public Issues :

The major problems raised by the public are intellectual property rights. Farmers are facing many problems such as technical issues, Market issues and social issues. First of all are the technical issues that Bt varieties are ineffective for sucking pests (Nazli, 2009). There is no awareness about the use of biotechnology they just take it for harnessing.

Market issues are also very important; there is uncertainty about the quality of seed. Shopkeepers sold their products unhonestly and sold the non Bt varieties by saying the Bt ones (Mayee, 2008).

Incompetent seed pricing is also an important issues. Confidence of farmers on approved varieties is much than on the unapproved ones. Bt variety also has Impact on textile sector (quality of fiber).

Social issues have more importance for the society. Feudal system is more popular in Sindh and Punjab provinces of Pakistan. Uneven distributions of benefits among the people raise insecurity among the farmers. (raised by NGOs).Issues of food security (long duration) are also an important social issue.

Current Situation:

Keeping in observation that government has introduced the three tier system is introduced for the approval of a GM variety. This system includes three institutions that are: Institutional biosafety committee (IBC), Technical advisory committee (TAC), National biosafety committee (NBC). The unapproved varieties used in the field were not submitted to NBC for approval in 2008. Many fears prevail in the society. The GOP recently approved the field trials for six Bt cotton varieties and allowed the import of hybrid seed from India and China for field trials. The commercial Bt seed is expected to be available for the 2010-11 planting season(Nazli, 2009).

BT Cotton Survey 2009

The Pakistan Agricultural Research Council (PARC) conducted a detailed scientific survey on 126 locations in 21 districts in 2007. This survey examined the presence of Bt content in claimed Bt plants. The laboratory results indicate that about 10 percent of the samples in Punjab and 19 percent in Sind were not positive for the Cry protein. The Bt gene produces various proteins. Among them, the crystalline proteins, prefixed with Cry proteins are harmful for the larvae of moths and butterflies, beetles and flies and thus act as a natural pesticide. The analysis is based on survey of cotton farmers, conducted during January to February 2009 in two districts of Pakistan.

CHAPTER 3

METHODOLOGY

Advanced technology has changed the human life to great extent. New technologies have been developed to gain the maximum output with minimum input. Now researchers are searching for methods to increase quality and quantity of crops for fulfilling the demands of the rapidly growing population. Genetically modified species of some crops are introduced for this purpose for example Bt cotton, cultivation of which in Pakistan has been taken as a case study.

Sources of Data:

This study is conducted to examine the future adverse impacts of Bt cotton cultivation in Pakistan. To study the use of BT cotton in Pakistan under Cartagena protocol various research papers and articles were studied. A visit to ministry of Pakistan was also arranged for gathering information about genetically modified cotton. The first report of BT cotton is under process of development.

Data Collection:

This study is based on the secondary data, collected from February to June 2010. The selected sample is drawn from the presented sampling frame of the panel survey, the Pakistan Rural Household Survey (PRHS). This survey was conducted jointly by the World Bank and Pakistan Institute of Development Economics (PIDE).

Out of four cotton districts in the PRHS, BT Cotton Survey 2009 was conducted in two districts where the number of cotton growers was sufficient in the sample. This survey enclosed 8 villages and 104 cotton growers in each district. It gave a total sample of 208 cotton growers in 16 villages of two districts. In each village 13 cotton growers were surveyed.

The collected data and literature review led to conclusion and recommendations regarding the pros and cons of Bt cotton cultivation and adaptations of other genetically modified organisms/crops Economic ,environmental and ethical aspects were taken in to consideration while working on this dissernation.

Chapter 4

RESULT AND DISCUSSION

Cotton production in Pakistan has been facing many challenges of large scale pest infestation. A large number of pesticides have been introduced to control these cotton pests which increased the cost of cotton production. Moreover the pests also developed resistance to these chemicals.

In Pakistan majority of the farmers are small farmers. The land distribution in Pakistan, particularly in Sind, is highly unfair. As a result, a large number of landless households and small owners are joined into share cropping arrangements (World Bank, 2002)

Genetically Modified cotton comes into sight as a solution to farmers' problems as it addresses the issue of crop loss by controlling some of the pest infestation Pakistan started work on GM cotton in1997 (Cororaton & Orden, 2008).

The accurate estimates of area under cotton wheat production system are not available but it is definitely the next main cropping system after rice-wheat in north-western India and cotton growing areas of Pakistan (Mayee et al, 2008).However the total estimated area under cotton cultivation is given in table 4.1.

Estimated area under cotton

State/ Province	Area (mha)cotton	
	1995-96	2007-08
India		
Punjab	0.44	0.65
Haryana	0.49	0.48
Rajastan	0.37	0.37
Total	1.3	1.5
Pakistan		
Punjab	2.4	2.6
Sindh	0.6	0.6
Total	3	3.2

Table 4.1: Total estimated area under cotton cultivation

Source: Agricultural Statistics at a Glance, Ministry of Agriculture (2007) and Country Report (2007) 66th Plenary Meeting of ICAC, Izmir, Turkey, October, 22-26, 2007 (Anonymous, 2007).

According to the table 4.1 in India the total area under cultivation of cotton is 1.30 mha in 1995-96 and in 2007-2008 is increased up to 1.50 mha. Whereas in Pakistan it is 3.00 mha in 1995-96 and is increased up to 3.2 mha. The total area under cultivation is 4.00

mha in the different regions of India and Pakistan. Cotton covers about 82 to 93% of the total area under cultivation in India and Pakistan.

Basic facts-Selected Samples		
	C.W Punjab	**C.W Sindh**
Poverty (%)	**55.51**	**56.81**
% of rural population	**17.47**	**11.2**
% of rural poor	**20.13**	**13.21**
	Bhawalpur	**Mirpurkhas**
Development rank(%)	**64**	**65**
Weather	**Hot and dry**	**Hot and humid**

Table 4.2 Basic facts about selected sample for survey

Source: (Nazli, 2009).

Table 4.2 represents the basic facts about two different selected areas from Punjab and Sindh provinces. According to this data, in Punjab poverty 55%, total rural population is 17.47%, among which 20.13 % is living below the poverty line. In case on of the region

of Punjab, the development rate in Bhawalpur is 64 % in the cotton cultivated area while the weather conditions are hot and dry. Whereas in Sindh the poverty rate is 56.81%, the total rural population is 11.20% out of which 13.21% is living below poverty line. The development of rank Mirpur khas 65% in cotton cultivated areas and the climatic conditions are hot and humid.

Impact on pesticides, seed and other expenditures:

Although the cultivation of Bt cotton remained prohibited for several years yet. Its acceptance among farmers is very encouraging because of its resistance against pests. As high as 92.9 percent of the farmers who do not use Bt cotton reported the infection of bollworms. Among them, 58.9 percent point to the high concentration of this infestation (Nazli, 2009). A common complaint of farmers is about the attack of cotton leave curl virus (CLCV) and mealy bug irrespective of the variety they used. The laboratory tests of BT cotton samples grown in Pakistan indicates the presence of Cry 1Ab/Ac in most of the samples. However, the intensity varies to a wide range between low to high, indicating the possibility of seed mixing (PARC, 2008).

Pesticide expenditure:

Cotton crop is suffering from severe economic damage from several insect pests, diseases and weeds, particularly bollworms, especially *Helicoverpa armigera*, has been responsible for heavy losses in yield (Mayee et al.,2008). Pests are divided in two groups: bollworms, includes spotted, pink, American and armyworm are the direct pests of the

cotton crop and non-bollworms, includes all other pests, such as, white fly, mealy bug, aphids, jassids and others are include in the pest catagory.

Farmers put their full resources to fight against the boll-worms through pesticide spray but the bollworm has become more and more resistant over the passage of time. Thus there was no source of resistance present for the bollworm attack. Therefore, efforts were directed to tie together genetic engineering (GE) technology for bollworm resistance and transgenics using the known cry genes from soil bacterium, Bacillus thuringiensis (Bt).

The comparison of costs, yield, revenue and gross margin between BT and conventional varieties of cotton in Pakistan is shown in the table 4.3

Comparison of costs, yield, revenue and gross margin between BT and non-BT varieties in Pakistan

	Bahawalpur	Mirpur Khas	Average
Number of boll worm sprays	-1.1	-1.5	-1.3
Number of non-bollworm sprays	0.2	-0.4	-0.1
Number of total sprays	-0.9	-1.9	-1.4
Expenditure on bollworm pesticide (%)	-47.1	-52.8	-49.3
Expenditure on non-bollworm pesticide (%)	2.7	-19.7	-12.8
Expenditure on pesticides (%)	-21.1	-26.8	-27.1
Expenditure on seed (%)	64.9	76.3	29.0
Total expenditure (%)	-4.2	4.5	-7.1
Yield (%)	5.9	39.3	15.6
Revenue (%)	6.1	43.5	0.04
Gross margin (Rs/acre)	2,224	5,777	3,617

Table 4.3 : Number of pesticide sprays, expenditures in Bhawalpur and Mirpurkhas on BT and Non-BT varieties

Source:(Nazli, 2009)

As already discussed, two sides from Punjab and Sindh from cotton cultivated area. In Bahawalpur and Mirpur khas the numbers of non bollworm sprays were found more in number as compare to the number of bollworm sprays. It clearly indicates the rapid increase in the population of indirect pests that are aphids, jassids etc. But total number of sprays was found more in case of Bhawalpur than Mirpur khas. The numbers of sprays show the difference between Bt and non Bt cotton and the expenditures are the percentage differences. The expenditure on pesticides is more in Bahawalpur than Mirpur khas but the Farmers of Mirpur khas spend more on seeds than farmers of Bahawalpur. This results in increase in yield in Mirpur khas i-e 39.3%

Seed usage and expenditure:

The price and expenditure of Bt and non Bt seed in Pakistan's districts are exhibited in the table 4.4. The varieties of cotton require 8 to 10 kg of cotton seed per acre. Bt seed requirement less as compared to conventional varieties.

Quantity, price and expenditure of Bt and non-Bt seed

	Bahawalpur		Mirpur Khas	
	Bt	**Non-Bt**	**Bt**	**Non-Bt**
Quantity (kg/acre)	7.6	7.7	5.9	6.1
	(1.3)	(1.5)	(2.3)	(1.9)
Price (Rs/kg)	180.9	107.7	195.3	110.0
	(75.3)	(47.0)	(48.4)	(43.9)
Expenditure (Rs/acre)	1,318	838	1,149	652
	(536)	(406)	(593)	(330)

Table 4.4 : Expenditures on seeds

Source: (Nazli,2009)

Most of the farmers in Pakistan are receiving seed without proper instructions. Bt seed is more expensive than the non-Bt seed. In Bahawalpur, the average price of Bt seed was Rs 180.9/kg, that is significantly higher than the price of non-Bt seed Rs (107.7/kg). This price difference is higher in Mirpur Khas (Rs 195.3s/kg for Bt and Rs 110/kg for non-Bt). Both types of seeds are expensive in Mirpur Khas as compared to Bahawalpur . The difference in price is reflected in the expenditure on seed. Because of the lower use of seed in Mirpur Khas, the seed expenditure in this district is less than the expenditure in Bahawalpur. The expenditure on Bt seed in both districts is significantly higher than that on the conventional varieties (Nazli, 2009).

Other expenditures:

Other expenditures on fertilizer, cotton picking and other items, such as, land preparation, sowing, irrigation and labor charges of Bt and Non-Bt cotton in both districts are shown in the table4.5

Expenditures on fertilizer, irrigation, picking and other items of Bt and non-Bt cotton

	Bahawalpur		Mirpur Khas	
	Bt	**Non-Bt**	**Bt**	**Non-Bt**
Fertilizer expenditure (Rs/acre)	3,020	2,663	2,819	2,532
	(749)	(717)	(977)	(716)
Picking expenditure (Rs/acre)	1,811	1,711	1,965	1,411
	(629)	(566)	(461)	(367)
All other expenditures (Rs/acre)	3,166	2,929	2,182	2,224
	(1,280)	(857)	(836)	(1,133)

Table:4.5expenditure on fertilizers ,irrigation, picking and others items

Source :(Nazli, 2009)

The expenditure on fertilizer and cotton picking is higher for Bt varieties. This difference is noteworthy for fertilizer in Bahawalpur and for cotton picking in Mirpur Khas. Farmers in Bahawalpur spent 358 Rs/acre more on fertilizer for Bt varieties (Nazli, 2009).The values in brackets are standard deviations and the number of sprays and gross margin are simple differences.

Performance of Bt cotton:

This study shows a relatively better performance of the varieties of Bt cotton that contain the first generation of the Bt gene. The number of bollworm sprays declined by 1.2 to 1.1 in Bahawalpur and 1.5 in Mirpur Khas. The total pesticide expenditure declined by 21.1 percent in Bahawalpur, and 26.8 percent in Mirpur Khas(Table 4.3). This decline is mainly driven by a substantial decline in the expenditure on bollworm sprays. This indicates the effectiveness of existing Bt varieties in controlling the bollworms. This result is same as that of Bennet et al. (2006a) who found a similar decline in Maharashtra, India. The results show that Mirpur Khas experienced much higher increase in yield per acre from Bt varieties as compared to non-Bt varieties (39.3%) than Bahawalpur (5.9%). Sheikh et al. (2008) found no significant difference in the yield of Bt and non-Bt varieties in Punjab. Despite higher expenditure on seed, fertilizer and cotton picking, the total expenditure on Bt varieties was 5.3 percent lower than non-Bt varieties in Bahawalpur. Where as in Mirpur khas, Bt varieties invites higher expenditure.

Another important phenomenon regarding Bt varieties is the genetic pollution. Due to less expenditures, farmers will prefer genetically modified organisms crops, as a result the naturally occurring crops and varieties may become extinct. It will lead to imbalance in the ecosystem. For example direct pests of the cotton crop may become extinct from the planet earth and the indirect ones may become the direct pests. It may lead to great disaster and uncontrollable circumstances. So genetic pollution more dangerous as campare to other types of pollution as other types are not replicable.

Comparison of Pakistan with India and china for approved Bt cotton and non Bt varieties

	Percentage difference in Bt and non-Bt varieties					Gross margin (US$/ha)	
	# of sprays	Pesticide cost	Seed cost	Total cost	Yield	Bt	Non Bt
China (2001)	--	-58.1	333.3	-27.5	10.9	277	-225
India (2006)							
Gujrat	--	--	136.8	13.7	35.4	715	407
Maharashtra	-1.9	-21.3	192.4	36.5	46.3	504	319
Andhra Pradesh	-3.8	-25.8	173.1	5.6	44.6	420	121
Tamil Nadu	-2.0	-54.5	237.0	13.7	28.5	340	129
Pakistan (2009)							
Bahawalpur	-0.9	-21.1	64.9	-4.2	5.9	452	384
Mirpur Khas	-1.9	-26.8	76.3	4.5	39.3	408	230

Table 4.6: Comparison Of Pakistan with other countries

Source: Huang *et al.* (2002) for China, Gandhi and Namboodiri (2006) for India, and Bt Cotton Survey 2009 for Pakistan

Table 4.6 compares the pesticide expenditure, seed cost, yield and gross margin for Bt and non Bt cotton varieties of Pakistan with both these countries i-e India and china.

Pakistan and India also experience same regional differences in the performance of Bt cotton. On the other hand, the difference in seed price of Bt and non-Bt varieties is much lower in Pakistan as compared to India and China.

Varieties of Cotton grown in Pakistan:

Some of the important cotton varieties that became popular in cotton rotation in India and Pakistan have been listed in Table 4.7

Pakistan Cotton Varities	
Punjab	Sindh
CIM-496	NIAB-78
CIM-506	CRIS-134
MNH-786	FH-901
CIM-534	FH-1000
CIM473	HARIDOST
BH-160	SHABAZ-85
NIAB-111	CRIS -121
CIM-499	SHONI
FH-901	CHANDNI
NIBGE-11	CIM-473

Table 4.7: **Varieties of Cotton grown in Pakistan**

Source: Federal Seed Certification & Registration Department, Islamabad, Pakistan, Country Report: Pakistan; 66th Plenary Meeting of ICAC, Izmir, Turkey, October 22-26, 2007 (Anonymous, 2007); AICCIP Reports (1985-2000) and Visit http://www.pakissan.com

Cotton repeatedly attains too much vegetative growth due to high soil fertility, which coincides with rainy season and high relative humidity. Thick crop covering prevents adequate penetration of light and utilization of energy, resulting in shedding of flower buds, flowers, immature bolls, and rotting and poor opening of bolls.

Genetic Pollution:

The commercial release of Bt cotton hybrids added a new chapter to the agriculture of world. It was expected that Bt cotton would help to reduce the pesticide use, increase the yield and make the cultivation of cotton more economical and environment friendly. And on the other hand, there were serious concern about it that would lead to increased pest resistance, antibiotic resistance, increased genetic pollution, destruction of biodiversity, and lasting dependence on transnational agrochemical and seed companies. Thus, this evoked a mixed response from the farming communities and the civil society in India.

Warangal District in Andhra Pradesh, more than 200 cotton farmers were caught in the brutal cycle of pests, pesticides and debts, found no way out and committed suicide. As a result, the district naturally became an area of interest for Governmental and Non-Government Organizations (*Qayum and Kiran , 2003)*

According to a recent research, animals that graze on GM crops were suffering from bloody diarrhea and died. (Derbeyshire, 2010).

Almost all farmers mixed Bt and non-Bt seed cotton before marketing. As cotton is also used for oil production in India, thus they are road surface way for GM crops to enter in to the food chain. The seed of cotton is also used for making food for milk producing animals. It is an extremely critical biosafety concern and it indicates the complete failure of regulatory mechanisms of genetically modified crops. (*Qayum and Kiran , 2003*)

Although (in India) most farmers claimed that the sucking pests attacked their crop more in case of Bt cotton than in non Bt cotton. It shows that even though there was some decrease in the frequency of Bollworm in Bt cotton. The decrease in the direct pests on the cotton crops leads to the increase in indirect pests for example sucking pests. The

immediate increase in the frequency of sucking pests on Bt crop leveled farmers' expenses on the use of pesticides (*Qayum and Kiran 2003*)

Chapter 5

CONCLUSION AND RECOMMENDATIONS

This study examines the use of BT cotton in Pakistan under Cartagena protocol. It is based on the data collected (secondary data) in February to June 2010 in two cotton growing districts of Pakistan; Bahawalpur and Mirpur Khas. The agro-climatic conditions of these districts are different; Mirpur Khas is hot and humid and Bahawalpur is hot and dry. This study finds high adoption of available Bt varieties in both districts. Most of the farmers, are both sharecroppers and owner operators, are using this technology.

Conclusion:

Opposite to the findings of earlier studies (Hayee, 2004; Sheikh et al., 2008; Arshad et al., 2009), results of this study show a relatively better performance of the existing unapproved varieties of Bt cotton that contain the first generation of Bt gene compared to conventional varieties. A decline in the number of sprays, hence, in the expenditure of pesticides has been observed. Both districts Bhawalpur and Mirpur khas experienced a decline in pesticide expenditure and an increase in expenditure on seed, fertilizer, and picking. An increase in yield was observed in both districts that resulted in a higher gross

margin for BT varieties. The extent of the impact of BT cotton on cost of production and yield were different across districts. For example, the number of non-bollworm sprays increased in Bahawalpur, whereas they declined in Mirpur Khas. Total expenditures declined in Bahawalpur by 5.3 percent and increased in Mirpur Khas by 37.5 percent. Bahawalpur experienced a yield increase by 5.9 percent and Mirpur Khas by 39.3 percent. This resulted in differences in total revenue and gross margins.

Farmer's knowledge about the use of Bt seed is extremely limited. They do not know about the quality of seed or the importance of refuge areas. The increased incidence of secondary pests has emerged as an important problem. Genetic pollution is another an other important issue which comes forward. It is also proving as a threat to the conventional varieties. These findings are consistent with the results from other developing countries. To control the crop losses and spread of indirect pests, there is an urgent need to commercialize the approved varieties.

It is also seen that GM crops are entering in the food chain and causing many serious liver and kidney diseases. Almost all the expenses are leveled for the farmers when sucking pests such as aphids appear as a great threat to the crops.

Due to high diversity of cotton growing areas, more location-specific information and larger sample size is required to capture the impact of Bt technology in the cotton growing areas of Pakistan.

From the study, it is concluded that critical examination of from GMO's must be performed(following policy) the point of view of environment, diversity and health.

Recommendations:

Following recommendations are furnisished owing to the results of the study:

- National survey should be conducted in the cotton growing areas. More location-specific information and larger sample size is required to capture the impact of Bt technology in the cotton growing areas of Pakistan.
- Farmers should be properly educated and trained for the use of Bt cotton and other genetically modified organisms.
- The impacts of Bt cotton and genetically modified crops for decision making in this regard should be observed in India, China and other countries.
- The economic gains coming from Bt cotton and other genetically modified crops should be compared with ecological and environmental losses and decision should be made considering the ethical and legal point of view.
- Extensive research must be carried out in order to workout the actual worth of each genetically modified crops/organisms
- Scenarios must be developed to work out the impacts of genetically modified organisms/crops on their surrounding (both biotic and abiotic components).
- The advance scenarios must be developed regarding interaction of genetically modified organisms. The impact of Food web chain must be understood well.
- The advanced scenarios must be developed regarding shift of pests from one crop to another and for possible losses before introducing a genetically modified organism/crop.

- The international seed producing companies must be brought under litigation in the case of apathy observed on their behalf and must be held responsible if farmer any un accepted and unrevealed losses due to the use of genetically modified organisms and crops.
- The Cartagena protocol and its obligations must be enforced with true letter and sprit.
- Though a cell has been established in Pakistan but its performance is very poor. Well trained, sufficient human resources in the relevant field must be hired for the cell in order to enhance its performance.
- Research must be conducted for each newly developed genetically modified organism/ crops to probe its impacts on human other animal's health.
- An immediate and extensive adaptation of genetically modified organism/crops is unwise. A balanced approach must be adapted in this regard.
- The existing gene pool of indigenous crops and animal specie must be conserved through control and genetically modified organisms/crops.

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