CHAPTER – 5

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SUMMARY

After having made an effort to analyse the benefits drawn from Bt cotton farming and observed the results and discussion was made accordingly. The study is summarized precisely in this chapter. Besides, to test the expected hypotheses certain findings extracted from the field survey with the aid of questionnaire and through conducting interviews and interactions with the respondents, were summarized in this chapter. Further certain rational suggestions for further research also made. In a nut shall the contents of total chapters from 1-5 of this thesis were summarized.

Agriculture is one of the most significant sectors of India. The only means of living for almost two-third of the employed class in India. It has occupied almost 43% of India’s geographical area. India is one of the major cotton producing country, ranking 3rd after USA and China. Cotton accounts for 30% of agricultural Gross Domestic Protection (GDP) in India and has the largest cotton area of 20 million acres. It provides livelihood to more than 60 million people in India. With a vast population base and its growing demand for food needs, the related burden on agriculture has increased severely extract more agricultural productivity.
As agriculture evolved into a more productive activity, it became more energy-intensive too. Since agriculture is closely associated with the environment, it has a major impact on land use, soil, water biodiversity and the landscape. The intensive agriculture has disrupted ecological balance. In the process extracting higher productivity on par with the growing demand, the varieties of crops chosen, though highly-yielding, were found to be prone to epidemic diseases. To protect the crop from the epidemic diseases caused by pests and insects, it is complied to use large quantities of pesticides and insecticides.

As a result of decades of high pesticide application, the environment has been degraded, causing serious damage to the structure and function of ecosystems. In addition, the economic loss incurred as a result of environmental pesticide pollution is enormous. Many of the pesticides used are highly toxic resulting in tens of thousands of users being injured or dying every year.

India is one of the major cotton producing countries, ranking third after U.S.A. and China. Cotton accounts for 30% of agricultural gross domestic product (CAI, 2008) in India and has the largest cotton area of 20 million acres. (Sadasivappa & Quim, 2009). It provides a livelihood to more than 60 million people in India by way of support in agriculture, processing and use of cotton in textiles get, the productivity of cotton is substantially low. The major reason for this low productivity is damage caused by insect pests—such as *Helicoverpa Armigeria*, commonly referred to as ‘American Bollworm’. Nearly ` 12 billion worth
of pesticides are being used in India to control just the bollworm complex of cotton (Barwale et al., 2004). Indian farmers often lose up to half of their entire cotton crop or sometimes the whole crop to the cotton bollworm. (Joseph Huesing and Leigh English, 2004).

Traditionally, the major obstacles to the expansion of cotton yields have been the inadequacy of water and attack by insects. To overcome the damage caused by the insect pest, chemical fertilizers, pesticides, insecticides etc. were sprayed. The indiscriminate and excessive use of chemicals to control pest incidence, though increased yield levels with in a short span, it has been the major contributor to environmental degradation as measured in terms of adverse effects on human health, soil and water quality, local biodiversity and ecological balance.

Pesticides being used in agricultural tracts are released into the environment and come into human contact directly and indirectly. Human beings are exposed to pesticides found in environmental media (soil, water, air and food) by different routes of exposure such as inhalation, ingestion and dermal contact. Exposure to pesticides results in acute and chronic health problems. These range from temporary acute effects like irritation of eyes, excessive salivation to chronic diseases like cancer, reproductive and developmental disorders etc. (Wukong-Ming, 2007). The number of pesticide sprays per crop season may vary from 5 to 20 or more. It is estimated that insecticides worth about ` 30 billion (US $ 660 million) are used annually in Indian agriculture of which about ` 16 billion are
spent for the control of cotton pests and of this `. 12 billion against bollworm alone. In terms of volume, about 54 percent of the total insecticides used in Indian agriculture are sprayed on cotton crop. This indicates the economic importance of bollworms in general and *H. armigra* in particular. Despite such huge efforts, bollworm control has not been generally satisfactory mainly because a pest like *H-armigra* has developed resistance to most of the currently recommended insecticides repeatedly as they have no option except ‘spray’ or ‘pray’ (Shanmugham et.al., 2007). This bewildering critical situation has led the farmers to a series of social and economic risks especially the small farmers in developing countries. Many small farmers in the South India fall ill or die due to lack of adequate equipment and knowledge about how to handle pesticides properly. Medical costs and inability to work are a severe economic burgen on affected farmers. The excessive use of chemicals fertilizers and pesticides in monoculture causes soil degradation reducing its nutrient and water retention capacity. As a consequence, farmers face declining yields and have to increase production inputs. The resistance of some pests and the appearance of secondary pests only add to the problem. To pay for the increasing costs of farm input, small scale farmers are obliged to borrow from banks or cotton buyers or money lenders and mere and more farmers will be driven into indebtedness. This had frustrated the farmers, scientists and policy makers alike. Bt cotton came as a boon at a time when they were in deep dungeon of crisis and desperately looking for an alternative and dependable control measure.
Realizing the economic importance of cotton bollworms and the benefits that Bt-cotton can offer to the growers, MAHYCO (Maharashtra Hybrid seed Company), a leading Indian seed company, took the initiative in introducing this technology into India in collaboration with Monsanto Company of USA. (Shanmugham et al., 2007).

Bt cotton is produced by inserting a synthetic version of a gene from the naturally occurring soil bacterium *Bacillus thuringiensis*, into cotton. The primary reason is to induce the plant to produce its own Bt toxin to destroy the bollworm, a major cotton pest. The gene causes the production of Bt toxin in all parts of the cotton plant throughout its entire life span. When the bollworm ingests any part of the plant, the Bt cotton toxin pierces its small intestine and kills the insect. Bt-cotton contains a foreign gene obtained from *Bacillus thuringiensis* which is an aerobic bacterium characterized by its ability to produce crystalline inclusions during sporulation.

With the advent of Bio technology, this bacterial gene had been introduced genetically into the cotton seeds, and it protects the plants from Bollworms, a major pest of cotton. The worms feeding on the leaves of a Bt-cotton plant become lethargic and sleepy and are gradually eliminated. The cotton hybrid containing Bt gene produces its own toxin for bollworm attack, thus significantly reducing chemicals insecticide use and providing a major benefit to cotton growers and the environment. Since the introduction of transgenic crops in 1996,
there had been a substantial increase in the area of cotton cultivation (Chaturvedi and Sachiv, 2002).

In India, the Ministry of Environment and Forest had notified the rules for the moisture, use, import, export and storage of hazardous microorganisms. Cover the areas of research, large scale application GMOs, and products made their from throughout India. Based on the recommendation of RCGM (Review committee for Genetic Modification), the Genetic Engineering Approval Committee (GEAC) of India in its 32nd meeting held in New Delhi on 26th March, 2002 approved Mahyco’s Bt-cotton for commercial cultivation, pronouncing it to be safe and beneficial. This was a landmark decision as Bt-cotton happened to be the first-ever agricultural biotech product to receive official approval and with it India made its long awaited entry into commercial agriculture biotechnology. In India, Bt cotton widely used and the acreage stood at 6.20 million ha for 2007, a growth of 63 percent over the previous year. Use of GM (Genetically Modified) seeds might diminish the use of insecticides.

5.1 Environmental benefits of Bt-cotton farming

Bt cotton can substantially reduce the number of pesticide sprayings, which can provide significant environmental benefits. A number of studies have demonstrated that insecticide sprays are reduced by using Bt cotton (Carpenter et.al. 2002; Edge et.al., 2001; James, 2002).
The use of Bt cotton in place of conventional systems can positively impact non target organisms (NTOs) and beneficial organisms by preserving populations (Head et.al, 2001; Smith, 1997; Xia et.al., 1999). It is also compatible with integrated pest management initiatives (Benedict & Altman, 2001). In addition, Bt-cotton farming adoption can provide secondary positive environmental impacts such as a) saving on raw materials needed to manufacture chemical insecticides b) conserving fuel oil required to manufacture, distribute, and apply such insecticides and c) eliminating the need to use and dispose of insecticide containers (Leonard and smith, 2001).

A report found that in field trials in India, average yields for Bt cotton hybrids were 80% greater than non-Bt hybrids (Qaim and Zilberman, 2003), although other results from India are less dramatic (James, 2002). Production advantages can result from the level of insect control achieved and the time savings and reduced labour needs that may result (Benedict & Altman, 2001; Edge et.al., 2001). Bt cotton is a valuable option for growers, as it provides superior pest control with several features that provide advantages over other insect control agents (Perlak et.al., 2001).

At the farm level, improvement in the insect control system being used can positively impact the quality of life for farmers and their families by increasing incomes, reducing insecticide spraying, and offering savings in time (Ismael et.al., 2002 a; Pray et.al., 2002). The nutritional demands of families may
also be better met, as these families now have increased income that could potentially be used for more food purchases and food consumption (James, 2002; Pray, et.al., 2001). Time savings may be particularly important for women in South Africa, where women serve as heads of many of the households. The time saved by using Bt-cotton may allow these women to care for children, elderly, or the sick or to engage in income-generating activities (Ismael et.al. 2002a). Children were also a beneficiary of this technology, as those children in South Africa who no longer have to spray insecticides could now potentially devote more time to educational or other worth while pursuit.

5.2 Statement of the Problem

The present study has been conducted to find out

1) Whether the farming of Bt cotton is eco friendly?
2) Whether the farming of Bt cotton has reduced the usage of pesticides?
3) Whether the adoption of Bt cotton has afforded health benefits to the farmers?
4) Whether Bt cotton farming has increased the economic status of the farmers and brought out the social changes of farmers?

5.3 Objectives of the present study

The objectives of the study are as follows

1) To assess and evaluate the environmental benefits of Bt-cotton farming.
2) To study and estimate the pesticide usage in Bt-cotton farming.
3) To analyse the impact of pesticide usage on human health and assess the same in Bt-cotton farming.

4) To assess the socio-economic benefits of Bt-cotton grower.

As the aim of the research is to gain insight into the adoption of Bt-cotton and the environmental health and socio-economic benefits extracted by growing Bt-cotton. The study targeted the Bt-cotton farmers of Guntur district of Andhra Pradesh State. Further, to delve deep into the research and extract accurate information from the respondents, multi-stage purposive random sampling method was employed.

At the first stage, Guntur district in Andhra Pradesh was purposively selected as the cultivation of cotton has been highly intensive. In the second stage, three mandals out of 56 in the district and in the third stage, seven villages from every selected mandal were purposively selected taking the high intensity in cotton cultivation into consideration. Having selected 21 villages from the district, Bt-cotton farmers from every village were selected randomly as sample respondents. Thus, altogether 210 respondents farmers were selected. However, finally the number of respondents was scrutinized and fixed as 200, as the responses of the remaining few farmers were vague, ambiguous and incomplete due to their ignorance.

To extract complete information from the sample respondents, personal interview schedule was planned and conducted aided with questionnaire specially
develop for this purpose regarding their adoption of Bt-cotton, intensity of Bt-cotton and the benefits that the respondents derived from adoption of Bt-cotton. The data pertaining to their responses were tabulated and obtained results were presented elaborately and discussed accordingly. The secondary data from published literature was also used and analysed.

The results obtained in the present study were summarized as follows:

- The results derived from the present study evidently showed that no. sprays targeting bollworms especially on Heliothis and Pectinophera indicated that Bt-cotton expression was satisfactory.

- Sprays targeting sucking pests were not confined to early stage (upto 60 DAS), but spread throughout the crop growth period. Evidently no farmer is practicing stem application technique usage of neem based and other botanical insecticides were not found.

- It was observed that sprays targeting Spodoptera has been taken in 60 days-90 days which may be protective sprays rather than damage control which is not warranted.

- Sprays on disease control were also observed to be negligible. The average number of sprays on Bt-cotton was only 4.36 as the seed was genetically modified against 9.83 sprays in non Bt-cotton, reducing the use of broad spectrum insecticides in Bt-cotton produces afforded with the benefits, viz., increased effectiveness of beneficial anthropoids as pest control agents, improved control of non-target pests, reduced risk for farmland wild life
species, reduced run-off of broad spectrum insecticides, reduced fuel usage, lower levels of air pollution and related waste production and improved safety of farm workers and neighbours.

- Hence, the use of Bt-cotton established that Bt cotton technology has achieved the goal of providing an effective tool for *Lepidopteron* control that is safer to human beings and more environmentally benign than broad spectrum insecticide.

- The benefits in terms of socio-economic were also proved and established positive results.

### 5.4 Testing of hypothesis

The expected hypothesis “the adoption of Bt-cotton farming will result in positive environmental effects, prevents the environmental pollution and stabilizes the eco system”, has been evidently proved to be true.

The findings from the present study perceived on change in health issues with the adoption of Bt-cotton also gave a positive outlook. A total of 14 common health disorders such as general weakness, coughing nausea, diarrhea, asthma, eye irritation, stomachache, blurred vision, wounds, severe cold, respiratory problems, sleeplessness fever and skin irritation were taken into consideration. It was evidently observed that after the introduction of Bt cotton frequency of illness and number of workdays lost were considerably reduced. There were no complaint on serious illness was recorded, amongst the Bt-cotton cultivators.
Thus, the hypothesis, “the introduction of Bt-cotton will protect and conserve the human health more particularly the farmers from sickness and hazardous diseases as the pesticide applications are reduced” is proved to be a fact.

The findings from the survey perceived on socio-economic benefits of the farmers after the introduction of Bt cotton also gave a positive results. It was observed that the Bt-cotton farmers have gained 9.55 q/ha of more yield when compared to those of non Bt cotton farmers and the net returns of Bt-cotton farmers was \( \text{Rs. } 14,369.28/ \) ha. The cost of production is reduced to \( \text{Rs. } 1464/\text{qtl} \) in Bt-cotton farming against \( \text{Rs. } 1529.37/\text{qtl} \) in non Bt-cotton. The cost of plant protection accounted for 32.18 per cent to total costs in non Bt-cotton technology while it was accounted for just 12.48 per cent after the adoption of Bt technology, which clearly showed significant reduction in pesticide sprayings. The Bt-cotton farmers marked 44.17 per cent of more yield, realized 64.70 per cent of more gross returns and 302 per cent of more net returns because of Bt cotton varieties. The incremental benefit cost ratio was 0.87 for Bt-cotton, since the Bt-cotton farmers gained higher net returns and they have achieved economic sustenance which had led to the improvement in their social status too.

Thus the hypothesis, “Bt-cotton farming affords to increase the yield consequently leading to the improvements in socio-economic standards of the farmers” was also proved evidently true. Another hypothesis, “the use of
pesticides will be reduced with the adoption of Bt cotton since the seed is of genetically modified technology” had also been proved correct as reduction in the pesticides usage the reduction in the cost of cultivation, which confirmed the economic benefit.

5.5 Conclusion

Bt cotton is an increasingly gaining acceptance and became an important tool for farmers around the world. Large and small acreage farmers benefit from increased productivity, convenience, and time savings. The vast majority of farmers using Bt cotton globally are small holder farmers who may reap economic, environmental, and social benefits from adoption of this important tool for agriculture. Adoption of this technology has led to positive implications for the farmers, their surrounding communities, and the future of agriculture.

The benefits of Bt cotton farming in India are in line with those enjoyed by farmers worldwide who have cultivated Bt cotton. The area under Bt cotton cultivation is increased, the increased production and reduced costs in an environmental favourable manner. This will positively affect the livelihood of millions of small farmers by improving their net incomes.

Bt cotton is undoubtedly the most extensively studied cotton variety today. Rigorous scientific studies conducted in India and abroad demonstrated that Bt cotton and its products are safe for the environment, humans, animals, and agriculture. In fact, the use of Bt cotton is a positive step towards environmental
protection because it makes possible the reduction of the insecticide load in the environment and reduces handling of such chemicals by farmers. This reduced use of insecticides will enhance the effectiveness of biological controls and implementation of integrated Pest Management (IPM) programs of government.

5.6 Suggestions for further research

Despite positive returns in favour of Bt cotton, farmers mean net revenues were still low, and could be improved by rational agricultural practices such as fertilization and weed control. Farmers could enhance their income through the combination of insect resistance afford by Bt technology and integrated crop management practices, but this is not yet the case in Guntur district. Subsequently research at the state and country level might usefully extend this analysis to incorporate more sophisticated consideration of dynamic economic impacts and broader (outside the Andhra Pradesh) examination of the less tangible (non pecuniary) economic impacts. The present study was conducted in the selected district and these results can be used by policy makers, Government organization and other responsible organizations for their decision making in the Guntur district. It would be preferable to extend the study area to all the Bt-cotton farming lead districts and location wise and region wise benefits can be analysed.