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A survey conducted on cotton and Bt cotton farming practices, with pesticide application: a case study

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ABSTRACT
Agricultural produce has to increase to fulfill the necessity of the farmer and population demand due to this reason pesticide and fertilizers cane be used to increase the crop yield and agricultural produce. The excessive use of chemicals to control pest incidence, though increased yield levels within 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. Anyone who uses pesticides or is present when pesticides are sprayed is at risk for dangerous exposure. Present research focused and suggested. They are airborne thus they are found long distances from the site application. Exposure of wildlife over an extended period of time to pesticide levels not immediately lethal may result in chronic poisoning.
Keywords: Pesticides, exposure, risk, wildlife, effects**.**

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I. INTRODUCTION

Traditionally, the major obstacles for expansion of cotton yields have been the inadequacy of water and attack by insects. To overcome the damage caused by the insect pests, chemical fertilizers, pesticides, insecticides etc. were usually applied to the cotton crops. The excessive use of chemicals to control pest incidence, though increased yield levels within 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 (Anon, 2010; Gregg elliote 2015). Pesticides being used in agricultural tracts are released into the environment and come into human contact directly and indirectly (Mohamad, 2017). 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. (Kong-Ming 2007). The number of sprays per crop season might 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 percentage 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 was not successful because a pest like *H.armigra* had developed resistance to most of the currently recommended insecticides (Shanmugham et.al., 2007). This bewildering critical situation had led the farmers to a series of social and economic risks especially the small-scale farmers in developing countries like India. Many small-scale farmers in the south India ill or die due to exposure of pesticides and lack of adequate equipment and knowledge about how to handle pesticides safely. Medical costs and inability to work were a severe economic burgen on affected farmers. The indiscriminate and excessive use of chemical fertilizers and pesticides caused soil degradation reducing its nutrient and water retention capacity. As a consequence farmers experienced in declining yields and had to increase production inputs. The resistance of some pests and the appearance of secondary pests would add to the multiplication of the problem (, Insect-Plant Interactions in a Crop Protection Perspective (2017)).

To pay for the increasing costs of farm inputs, small-scale farmers were obliged to credit from banks or cotton buyers or money lenders and mere and more farmers would be driven into indebtedness (Appiah et al., 2016). 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 (Phipps and Park, (2002)). Keeping in a view of the economic importance of cotton bollworms and the benefits that Bt-cotton can offer to the growers.

II. MATERIALS AND METHODS

Operationalization of variables

There were different types of variables used in the present study under five major sections *viz* general information, pesticide usage pattern, information on health status of Bt-cotton growers, economic status of Bt-cotton growers and social status of Bt-cotton growers. The description of the each important variable (Table 3.3) was depicted and the method of operationalisation was illustrated as follows.

Sl.No	Objective	Name of the Variables	Tools used for data collection
1	To analyze environmental benefits and to assess the pesticide usage pattern in Bt cotton farming	Pesticide usage pattern over years in Bt-cottonand non Bt-cotton farming in Guntur district	Primary data was collected through the interview schedule developed with the study aided with specially designed questionaries' Secondary data was generated from published data
2	To analyze human health beefits of Bt cotton farming	Health problems include 1, general weakness 2, coughing 3,nausea 4, Diarrhea 5, Asthma 6, eye irritation 7, Stomach ache 8, blurred vision 9, wounds 10, severe cold 11, respiratory problems 12, sleeplessness 13, fever and 14, skin irritation	Primary data was collected through the interview schedule developed with the study aided with specially designed questionaries' Secondary data was generated from published data

III. RESULTS

Pesticide usage pattern in Guntur district

It was evidenced from the statistics (Table 4.1.4a) provided by department of Agriculture on pesticide usages in Guntur district over years, the drastic reduction occurred in 2002-03, the year Bt was introduced. During 2001-02, the quantity of the plant protection chemicals utilized in cotton growing was 2681 technical grade. It was reduced to 960 t during 2002-03. Further gradually but to a greater extent it came down to 649 tons, 666 tons, 162 tons, 64 tons, 72 tons, 52 tons during 2003-04, 2004-05, 2005-06, 2006-07, 2007-08, 2008-09 respectively. It is a clear indication that the usage of different groups of plant protection chemical has been steadily comedown with increasing adoption of Bt Cotton.

Table No: 4.1.1 pesticide usage pattern of Bt-cotton farmers

Sl.No	Duration	Pesticides taken
1	Upto 60 DAS*	Imidachloprid Acetamiprid Dimethoate Acephate
2	60-90 DAS	Novaluce Acetamiprid Triazophos Lufenuron
		Acephate Intreprid Streptomycilin Monochrotophos
3	90-120 DAS	Imidachlophos Acephate Triazophos Novaluron Acetamiprid
4	120 DAS	Acephate Streptomycilin

DAS= Days after sowing Bt-cottonseed

Table No: 4.1.2. Pesticide usage pattern in Bt cotton farmers in Guntur district

Name of the Chemicals	1998-1999	1999-2000	2000-2001	2001-2002	2002-2003	2003-2004	2004-2005	2005-2006	2006-2007	2007-2008	2008-2009	%change between 1998-99 to 2008-09
Synthetic pyrethriods	64	60	59	120	54	27	28	13	4	4	3	4.69
Other Insecticides	1020	1012	1002	2096	674	451	439	108	42	47	38	3.73
weedicides	128	121	134	84	43	23	26	11	5	10	4	3.13
fungicides	423	421	441	361	177	142	167	20	9	1	7	1.65
Rodenticides	18	17	16	20	12	6	6	10	4	3	3	16.67
Neem based pesticides	-	-	-	-	-	-	-	-	-	2	1	-
Plant growth regulator	-	-	-	-	-	-	-	-	-		2	-
total	1653	1631	1652	2681	960	649	666	162	64	72	58	3.51

Sl.No	Duration	Total no of sprayers	Percentage of insecticide against sucking pests	Percentage of pesticides against sucking pests
1	Up to 60 DAS	395	100	100
2	60-90 DAS	212	60(35% for Spodoptera targeted)	95(5% bactericide)
3	90-120 DAS	182	100	83.7(16.7% fungicides)
4	After 120 DAS	84	100	66.7 (16.6 bactericide and 16.7% fungicides)
	Average	4.36		

Table No: 4.1.3 pesticide usage pattern in non Bt cotton farmers in Guntur district

Sl.No	Duration	Total noof sprayers	Percentage of insecticides against Bollworm	Percentage of pesticide against Bollworm
			s	s
1	Up to 60 DAS	428	48	66
2	60-90 DAS	593	89	95(5% bactericide)
3	90-120 DAS	548	92	78.3 (21.7% fungicides)
4	After 120 DAS	397	100	66.7(16.6 bactericide and 16.7% fungicides)
	Average	9.83		

Table 4.1.4a plant protection chemicals-composition from 1998-99 to 2008-09

Source Agriculture action plan (2009-10)

Table 4.1.4.b Analysis of variance (ANOVA) of plant protection chemicals

Source of Variation	SS	df	MS	F	P-value	F crit
Rows	3219254238	6	536542373	10.0738631	6.98E-08	2.239481489
Columns	1186145.143	11	107831.377	2.02459038	0.030585	1.936957261
Error	3515215.19	66	53260.8362			
total	7920614571	83				

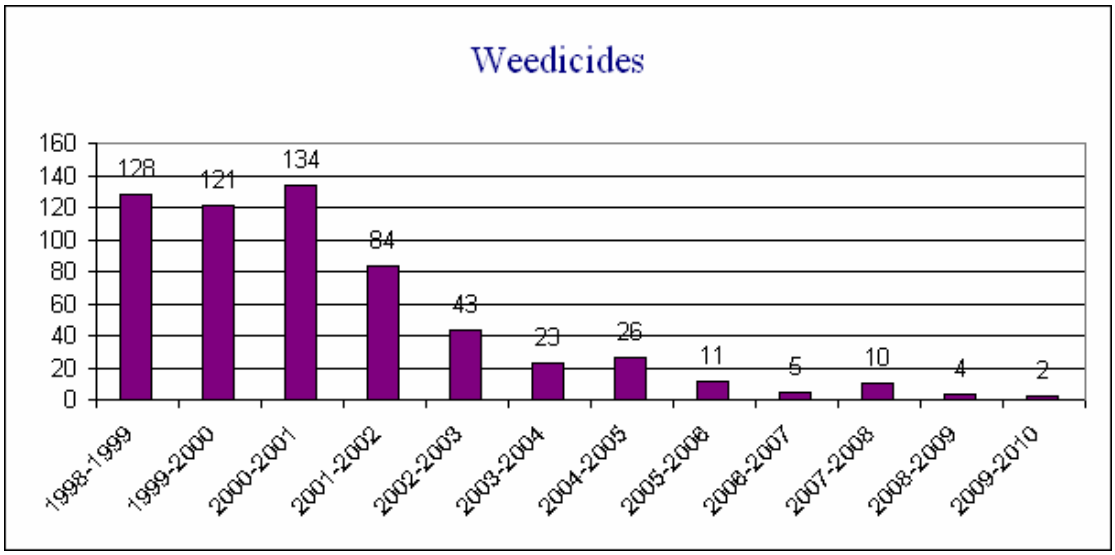
The synthetic pyrethroids use was 120 tons during 2001-02 and the present usage is 3 t in 2008-09. The usage of other insecticides had also comedown heavily from 2096 t in 2001-02 to 38 t in 2008-09.The results of ANOVA (Table 4.1.4b), revealed that there were significant differences among the rows which indicate differences among the plant protection chemicals i.e., synthetic pyrethroids, other insecticides, weedicides, etc. Further significant differences do find among the columns *i.e.* during the years from 1998-99 to 2009-10, the usage of plant protection chemicals was found to be different.

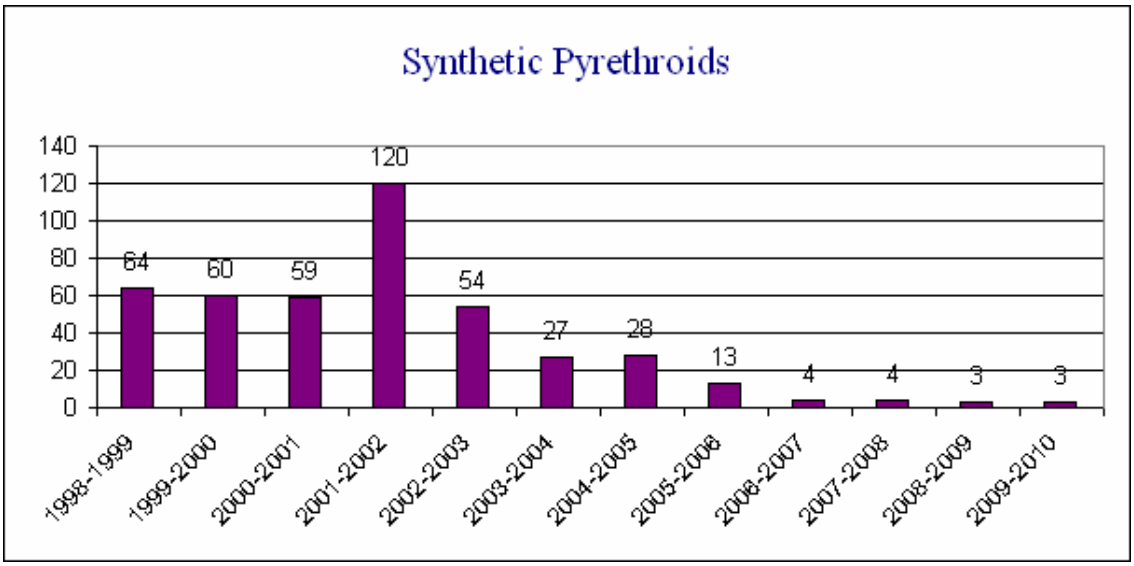
Consumption of weedicides

It was observed from the (Fig.2) that weedicides usage in cotton farming was fluctuated during 1998-2001 between 128 tons and -134 tons. Later, it recduced to 84 tons during 2001-02 and registered a study decline which had been recorded till 2009-10 with slight fluctations during the years from 2005 to 2008. The decline in weedicide consumption could be attributed to Bt-technology adoption.

Consumption of synthetic pyrethroids

It was proved (Fig.3) that the usage of synthetic pyrethroids was reduced from 2002-03 onwards. During the years from 1948 to 2001, there had been fluctuations but from 2002 onwards the reduction has been diminished from 120 tons to mere 3 tons during 2009-10. It was clearly observed that the usage of synthetic pyrethroids had gone to an extreme peak stages during 2000-01 which touched 120 tons during the two preceded crop years and then drastically declined from 134 tons to 60 tons in the very next year (2001-2002), because of Bt-cotton introduction.





Other insecticides

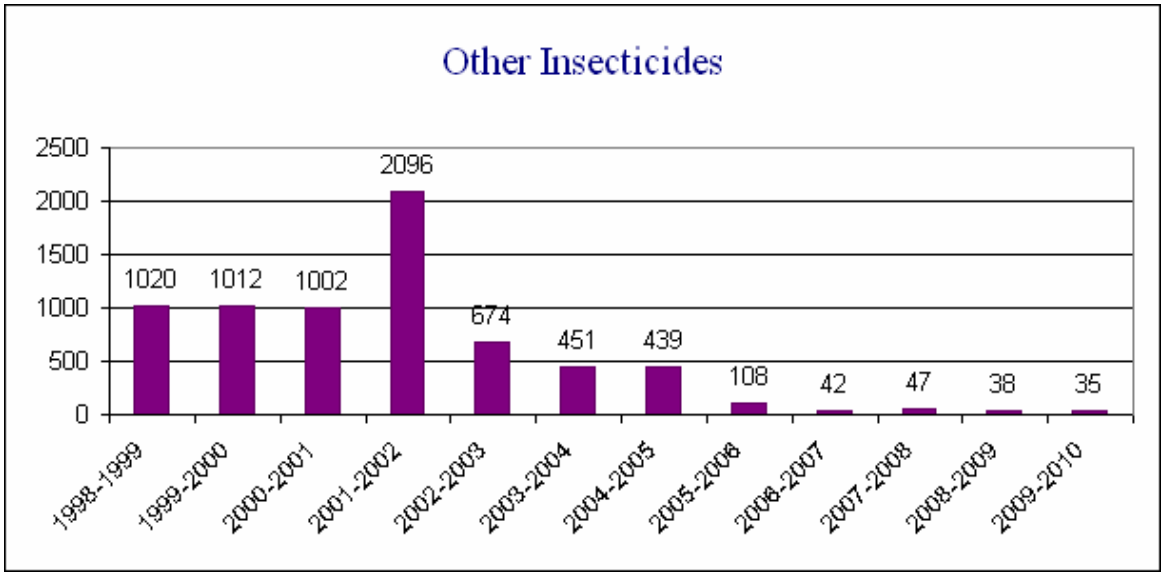
The peak usage of insecticides was observed (Fig.4) during 2001-02 with 2096 tons which has been doubled by earlier three years average (1998-2001). The usage of insecticides declined suddenly to 674 tons during the very next year (2002-03) and further tremendously reduced to 35 tons by 2009-10.

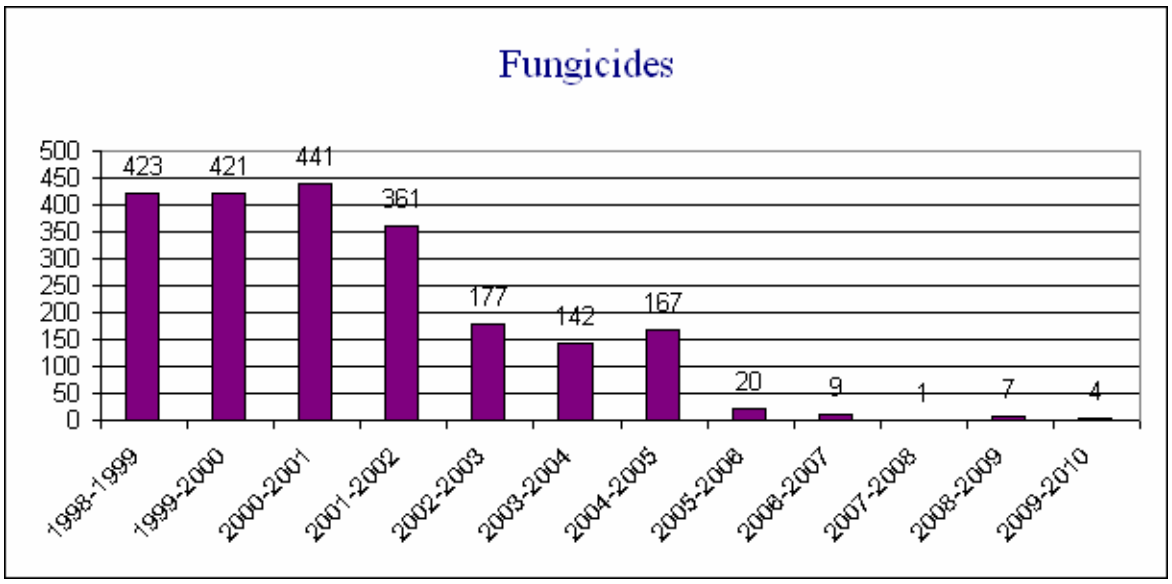
Consumption of fungicides

The usage of fungicides (Fig.5) was also fluctuated between 421 tons and 441 tons during the years 1998 to 2001. It further reduced to 361 by 2001-02 and tremendously got reduced to a negligible quantity of 4 tons by 2009-10.

Consumption of neem based pesticides

Positive indication of the usage of neem based pesticides was observed (Fig.5), which showed that the usage of neem based pesticides touched 2 tons during 2007-08 when compared to the previous years which recorded zero usage. Position and during the next two consecutive years this usage has got stabilized. The usage of neem based pesticides could be attributed to education of synthetic pesticide and increased awareness towards advanced scientific technology.



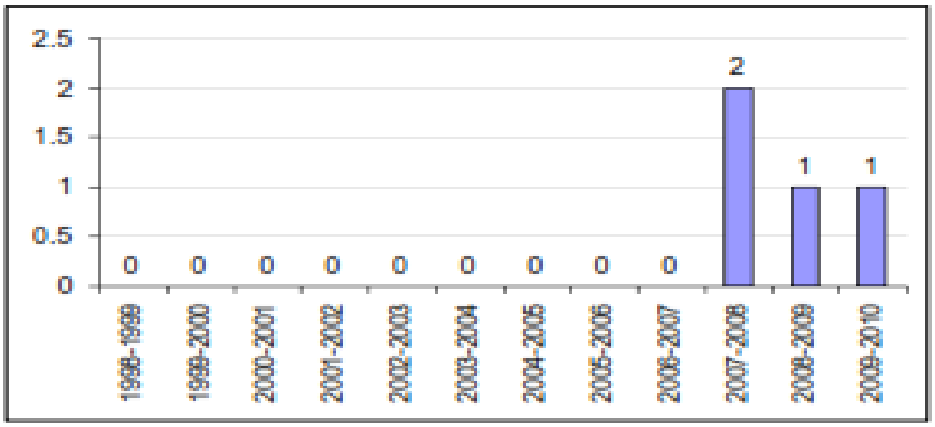


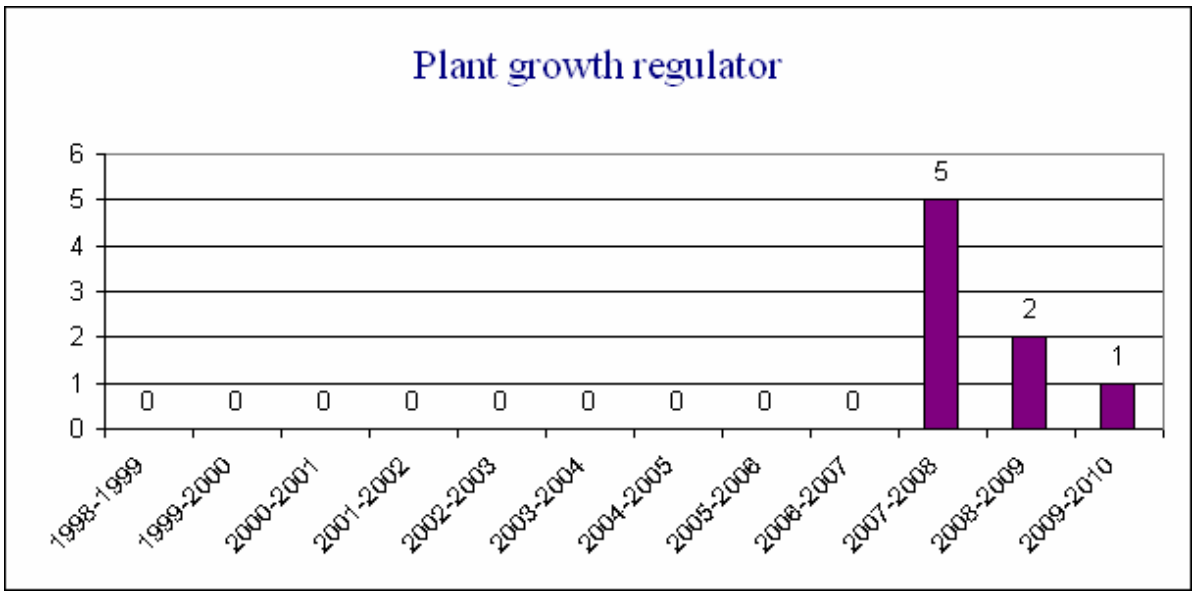
Plant growth regulators

The results showed that usage of plant growth regulators had reached to 5tons by 2007-08

from a position of zero usage during the 9 preceding years between 1998-99 to 2006-2007. But this usage had recorded diminishing scale in 2008-09 with 2 tons and further declined to 1 ton by 2009-10 during 2007-08 from previous years nil position. It gives an induction that knowledge on usage of non-toxic chemicals increased amongst cotton farmers. To summarise the environmental benefits of Bt-cotton, it is obviously known that various types and kinds of chemical contented synthetic pesticides will be sprayed over cotton plants to extract higher yields and protect the plants from the pests or insects which destroy the cotton crop completely. An extreme environmental exposure to these poisonous pesticides has led to dreadful damage creating environmental imbalances and deteriorated the eco system. At that moment of environmental crisis, genetically modified cotton seed has been introduced which have been affording to conserve the ecosystem. Number of sprays for Bt cotton on an average is 4.36 (Table 4.1.2) while it was 9.83 (Table 4.1.3) for non Bt-cotton. It was clearly observed that the usage of toxic pesticides and insecticides has substantially got reduced to a greater extent after the adoption Bt-cotton seed, besides reducing environmental exposure to chemical insecticides, as observed from both the primary and the secondary data pertaining to the usage of synthetic pesticides by the farmers in growing cotton crop in Guntur district. It is evident that the usage of these pesticides has been very less in Bt cotton. Since the

Fig. 6 Consumption of Neem based pesticides





IV. DISCUSSION

Major environmental benefits could be attributed to decrease of 50 percent in the number of insecticide sprays per season, which in turn reduced insecticide residues that could potentially runoff into watersheds and aquifers. A decrease of 14 sprays in China (from 28 to 14 sprays), 7 in South Africa, and 2 in USA. Global insecticide savings attributed to Bt cotton in 2001 were 10,500 MT of insecticide active ingredient equivalent to 13% of the 81,200 MT (a.i) of all cotton insecticides used globally in 2001 (Anders et al., 2014). According to department of agriculture Andhra Pradesh State, India during 2001-02 the quantity of plant protection chemicals utilized in cotton growing area was 2681 tons technical grade. It was reduced to 52 tons during the 2008-09 respectively (Tulsi Bhardwaj. and Sharma, (2013). The important aspects of the environmental debate surrounding the introduction of G.M. crops and that in their potential reduction in pesticides use in the European Union 50% reduction of pesticide spraying resulting from the introduction of Bt-cotton varieties. (Phipps and Park, 2008). Hence, it is important to know the reduction in pesticide use can be linked to improve the surrounding environment.

Quaim and Alinde (2005) reported that they had empirically analyzed the effects of Bt cotton on pesticide use and productivity in Argentina. The farm survey revealed that the Bt technology lead to a considerable decline in pesticide application rates (Sadashivappa, (2015). On an average Bt technology adopting farmer use 50% less insecticide on their Bt plots than on plots grown with conventional cotton. All most all of these reductions occur include in highly toxic chemicals, with concomitant positive effects for the environment (Shetty, (2014; Mark Lynas, (2017). Moreover, Bt cotton adopters benefit from significantly higher yields compared to conventional cotton due to insufficient pest control methods. It was also observed from the present study that with introduction of Bt-cotton, number of sprays reduced to 4.36 from 9.83 which could be attributed to the environmental benefits associated with introduction of Bt-cotton technology (Kranthi et al., 2012). Bt-cotton farming has reduced pesticide sprayings by 172 million Kg and reduced the environmental toot print associated with pesticide use by 14 percent (Saravanan, (2016). The Bt technology has also significantly reduced the release of greenhouse gas emissions from agriculture which is equivalent to removing 5 million cars from roads (Brookes and Barfoot, 2004). GM crops have contributed to a significant reduction in global environmental impact of production agriculture. Since1996, the use of pesticide was reduced by 224 million kg of active ingredient (6.9% reduction) and the overall environmental impact associated pesticide use on these crops was reduced to 15.3 percent (Brookes and Barfoot, (2015). In absolute terms the largest environmental gain has been associated with the adoption of Bt cotton. Phipps and Park, (2002) stated that despite the limitations in the analysis, the overall complexities of the debate that the authors believed the GM technology has the potential to markedly reduce overall pesticide use. Further, if less chemical is used and the number of spray applications are reduced, there would be a considerable saving in support of energy required for crop production (Brookes and Barfoot, (2016). According to Kline, a New Jersey based consulting firm, analyzed the future trends in pesticide use in the USA during the year 2009. Their analyses of the market indicated that by 2009, Bt and insect protected crops would contribute to annually 20 million and 6 million kg of herbicide and insecticide active ingredient respectively.

V. CONCLUSION:

In a recent survey, conducted in the USA showed that about 75% of people surveyed, said that they approved the use of biotechnology to produce insect protected crops which in turn reduced the use of pesticides. This is supported by studies carried out in Canada by the University of Guelph. According to their studies the public was offered the choice of either buying conventional or GM sweet corn and potatoes. A list of sprays used on the produce was clearly visible for the public to see. Under these circumstances 60% of the public preferred to buy GM rather than conventional produce. The authors of these studies expressed their interest to observe the attitude of Europe Union consumers towards G.M. and Non G.M. varieties. From all these, 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.

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