Pesticide Applications in BT cotton Farms: Issues Relating to Environment and Non Tariff Barriers

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1. Introduction

There are about 40 million farmers cultivating cotton on approximately 9 million hectares in India. A widely quoted statistics points out that cotton cultivation in India which accounts for about 5 per cent of the total land under cultivation uses nearly 50 per cent of the pesticides produced in India. Production of cotton in India which was at 142.3 lakh bales in 1996-97 dropped to 86.24 lakh bales in 2002-03 and increased steeply to reach 258.06 lakh bales in 2007-08 (advance estimates, as on 9 July 2008)[1]. While the recent introduction of Bt cotton in all the cotton growing regions have contributed significantly to the rise in yield. Gujarat with 2.5 million hectares under cotton accounts for 28 per cent of the total land under cotton in India. With the increase in cotton cultivation, pesticide consumption is expected to rise as cotton is susceptible to both bollworms and sucking pests. While the adoption of Bt cotton is supposed to give protection against the bollworm, it does not offer any protection against the sucking pests[2]. Continuous use of pesticides besides increasing the cost of cultivation does irreversible damage on environment as well as on health of human being and livestock. An additional impact to be added to this list is the potential of affecting the trade prospects due to the pesticide residue in agricultural products. The new dimension of the pesticide impact is on trade that comes in the form of non tariff barriers or sanitary and phytosanitary measures (SPS) that are known as technical barriers to trade. Non Tariff Measures (NTMs) are all measures other than normal tariffs namely trade related procedures, regulations, standards, licensing systems and even trade defense measures such as anti-dumping duties etc which have the effect of restricting trade between nations. With India's cotton exports on the rise recently, this paper attempts to understand (a) and to analyse the use of pesticide on cotton in Gujarat and the possible impact on health and environment (b) trends in cotton exports and the applicability of non-tariff measures.

In doing so the second section following this introduction discusses the introduction of Bt cotton in in Gujarat. The third section discusses the pesticide use pattern among the Bt cotton cultivators in Gujarat. The fourth section examines how the SPS measures could affect or are affecting the trade presently and the fifthe section presents the conclusion.

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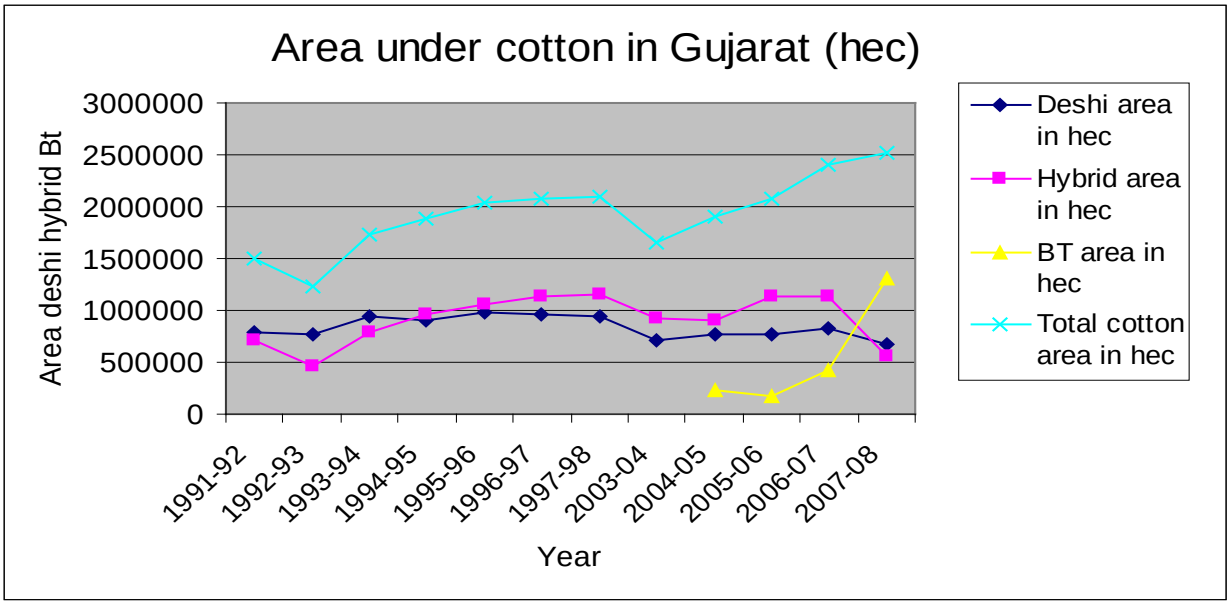
[1] Agriculture statistics division, GOI available at http://dacnet.nic.in/eands/Advance_Estimate/4_advance_2007-08.pdf (accessed on 27th Sep, 2008).

[2] The double bt introduced in 2007 is supposed to provide protection against both bollworm and sucking pests.

2. Cotton scenario in Gujarat:



Compiled from Season and crop report from 1991-92-1997-98 and data from 2003-04 were obtained from the Department of Agriculture, Government of Gujarat

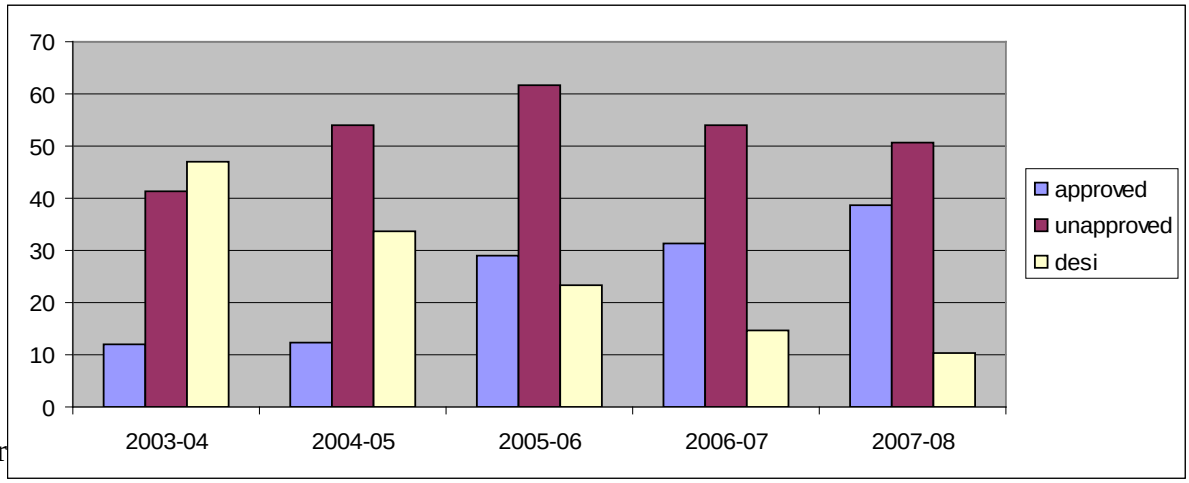
Gujarat has the credit of developing the first cotton hybrid in the '70s. Total area under hybrids increased from 7.13 lakh hectares in 1991-92 to 11.47 hectares in 1997-98. In 2007-08, the area under hybrids estimated to be 5.4 hectares. On the whole, the percentage change in the area under hybrid cotton declined negatively by -22.9 per cent. As compared to this, the desi cotton which was planted in 7.87 lakh hectares in 1991-92 declined over a period of time to 6.6 lakh hectares in 2007-08 or to the extent of 15 per cent over this period. The desi variety or the *G.Arboreum* variety is known for its drought tolerance and resistance to pests. On the other hand, American cottons usually have long and extra long staple and better spinning potential (higher counts) than desi cottons. They were introduced in India by the colonial administrators to meet the demands of English textile manufacturers anxious to secure an alternative and cheaper source than from the United States (Guha, 2007).

As compared to this the *G.Hirsutom*-hybrid varieties which were much sought after by the farmers are long staple varieties and are susceptible to both sucking pests and bollworms. In 2002, Government of India provided approval for the introduction of three Bt cotton varieties viz, Mech 161, Mech 112 and Mech 184 including in the state of Gujarat. By the time the approved varieties were planted in Gujarat in 2002, it came to limelight that the farmers were also planting on a large scale another Bt variety that was not commercially approved by the Government of India. While the widespread adoption could not be prevented as farmers found the yield difference between the approved and unapproved variety to be negligible (Lalitha etal 2007a, 2007b), yet it has nevertheless contributed to bringing in more area under Bt cotton cultivation which has increased from 2.34 lakh hectares in 2003-04 to 13 lakh hectares in 2007-08 bringing about 453.8 per cent rise in the area under Bt and thereby the area under cotton

increased by 67.56 percent from 1991-92 – 2007-08. In 2005, the Government of India approved more Bt varieties for commercial cultivation and thus there were 70 Bt varieties available before farmers in the central region (which includes Gujarat) to choose in 2007.

While the statistics presented above give the total area under Bt cultivation, the data collected from the primary survey present an interesting picture.

Chart 2
Area under varieties of cotton in Gujarat



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Source: Data from the primary survey carried out by GIDR
Note Y axis acres in 00, desi include hybrid varieties as well.

This chart denotes that in 2003-04 when the hybrids and desi varieties were still occupying a larger share of land as compared unapproved Bt and the area under the approved Bt was small. However, after the initial success of the unapproved variety, area under unapproved variety increased tremendously in 2005-06. Nevertheless, slashing of the price of the approved variety to Rs.750 in 2005 from Rs1600 that was prevalent from 2002 and the availability of more choices to the farmers have resulted in the area under approved Bt cotton also to improve which is reflecting in the reduced acreage under desi and hybrid variety.

Bacillus Thuringencis (BT) is a naturally occurring bacterium that acts against the bollworm. Plant biotechnology has enabled that the BT trait is introduced in the plant itself through the seeds, by which the entire plant acts against the pests. The main advantage of BT cotton is believed to be of its trait –the Cry 1 gene that protects the crop from bollworm, tobacco budworm, pink bollworm, which are the major pests that attack cotton in all the cotton cultivating parts of the world. Recognizing the ineffectiveness of the Cry 1 gene on the whole range of sucking pests, scientists have now introduced the double BT which is supposed to provide protection against both bollworms and the sucking pests as well. Therefore if the benefits of the Bt cotton is fully derived, via reduction in the use of pesticide, it would definitely help the farmer to produce a better quality output that would fetch him a better price in the market. Indirectly, the reduction in the pesticide use would prevent the possible land degradation and water contamination. Due to this potential advantage on cost of cultivation by reducing the

pesticide use and further on health and environment, farmers in many countries have started adopting Bt cotton. Area under genetically modified crops increased from a mere 1.7 million hectare in 1996 to 100 million hectares in 2006.

The literature in the context of India presents mixed evidence on use of pesticide against cotton. For instance, Kranthi et al (2005) observe that the commercial Bt cotton hybrids introduced in India, express less than the critical levels of Cry1Ac gene required for full protection against bollworms late in the season and in some plant parts. They report that the "data available support the presumption that Bt cotton hybrids in India may require more supplemental insecticide sprays than being used in Bt cotton varieties elsewhere in the world". But in the context of India, studies that have been carried out so far have tend to analyse the pesticide use on Bt vs. on Bt and not have focused on the varietal differences within Bt or hybrids. Further systematic analysis of the sprays during the different stages of plant life is also lacking. Limitations apart, these studies indicate

Assessing the impact of Bt cotton in China, Pray et al (2001) observe that the Bt cultivators could substantially reduce or eliminate the use of pesticides to control bollworm during the middle and late part of the season. Their study carried out during 1999, notes that majority of the farmers reduced the number of sprays from 12 to 3 or 4 sprays. Hence, assuming that 320,000 hectares were under Bt cotton cultivation, it had resulted in reduction in the pesticide use by 15,000 tons. Their study (2003) observes that reduction has also occurred in organophosphates some of which are banned due to their adverse impact on health and environment.

Edge et al (2002) observe "production of the Bt protein by bollgard cotton reduces and in some cases eliminates the need to spray for major caterpillar and other lepidopteron pests such as cotton leaf perforator, cabbage lopper, cotton leaf worm, and European corn borer and salt marsh caterpillar. These additional benefits include reduced risk to growers health, improved environment for beneficial insects and farmland wildlife and a more stable economic outlook for the cotton industry'' (p.123).

Their reviews observe that the total number of spray reductions per hectare for all arthropod pests ranged from 1.0 to 7.7 sprays and an average reduction of 3.5 sprays per hectare was achieved by Bt cultivators, which had resulted in an estimated loss of $200 to $300 million a year for the pesticide manufacturers. Hence, assuming an average reduction of 2.2 sprays hectare on the 972,000 hectare cotton produced in 1998 in the US, they conclude that 962 280 KG insecticide active ingredient did not enter the environment and local watersheds thus reducing the potential exposure to non-target animals.

Qaim's study (2001) using the field trial data of Mahyco-Monsanto clearly brings out the cost advantages of Bt cotton particularly in pesticide reduction over hybrids and conventional cotton variety. Indira et al's(2004) study (survey of farmers who had participated in the trials) shows that though the pest load was generally higher in 2001, it was lower in the Bt crop compared to non Bt and the check variety.

Similarly, Qaim and Janvry (2005) report that in Argentina on an average, Bt farmers used 50 per cent less insecticides on their Bt plots than on plots grown with conventional cotton. Almost

all the reductions occurred in a highly toxic chemical, which emphasizes the positive effect of Bt on the environment. Naik et al's (2005) study carried out in Maharashtra, Karnataka, Tamil Nadu and Andhra Pradesh for the 2002 season indicates that Bt cotton required 2.6 times less pesticide sprays than conventional cotton, which has a positive impact on yield due to less crop losses. However, these savings in pesticide reduction did not compensate the higher seed costs that the farmers spent on Bt seeds.

In South Africa, on an average, Bt variety reduced the number of insecticide sprays to three. Though the Bt adaptors still sprayed against pests such as ashids, jassids and thrips, yet the reduction of three sprays for bollworm will reduce the costs, amount of labour and the distance walked carrying the knapsack (Bennett et al, 2006). Narayanamurthy and Kalamkar (2006) analysed the performance of Bt cotton in two districts of Maharashtra. Their analysis of inputs on Mech 184 and Mech 162 compared to other non-bt varieties shows that Mech 184 consumed less pesticide as compared to Mech 162 and both the Bt varieties together consumed more pesticides than the non-bt varieties.

Mahendra Dev etal's study (2006) carried out in four districts of Andhra Pradesh point out that since farmers use insecticides as a precautionary measure or on noticing any pests on the plants without any regard to the threshold limits of the pests. Hence, the cost of insecticide is likely to be more than the benefit it provides. Nevertheless their study proves that the cost of insecticide in Bt cotton reduced by 18.2 per cent over non-Bt cotton and the number of sprays on an average have reduced from 12 in nonBt cotton to 9 in Bt cotton.

Gandhi et als study carried out in Maharashtra, Gujarat, Andhra Pradesh and Tamil Nadu observes that adoption of Bt cotton has resulted in significant reduction in cost of pesticide as much as 36 per cent in Maharashtra and Andhra Pradesh and in Tamil Nadu 50 per cent reduction was observed the number of sprays reduced in Bt. They observed that Bt cotton provides resistance to bollworm as well as other sucking pests.

Lalitha and Ramaswami (2007) analyzing the pesticide use among the cotton cultivators in Gujarat during the kharif 2003-04, observe that approved variety required as many as 6.3 number of sprays per hectare, while hybrids and unapproved required an average of 5.9 and 4.6 sprays respectively. Desi cotton required the least of just 0.25 sprays. Of the total of 1926 sprays on the cotton crop, 675 or 35 per cent has been sprayed against bollworm, 48 per cent for sucking pests and the rest 17 per cent for the other pests. Thus during 2003-04, it emerges that farmers had to spray an average of 1.8 times on sucking pests as compared to 1.3 times on boll worm, which is perhaps the positive impact of Bt technology.

The different studies that have been carried out in India point to the fact that since, majority of farmers spray pesticides as a precaution, expenditure on pesticides continued to be incurred by the farmers, yet in comparison with the non-bt the costs have been lower in Bt. But in countries other than India where pesticide cost is always higher, farmers have found it advantageous to cultivate Bt cotton. With this background, in the following pages, we discuss the pesticide use scenario among the cotton cultivators in Gujarat.

3. Pesticide Use Scenario in Gujarat

The required information has been collected through a primary survey carried out by GIDR during Kharif 2007-08. This study was conducted in five districts of Gujarat, namely Rajkot, Bhavnagar, Baroda, Surendranagar and Ahmedabad from where a sample of 200 farmers were randomly drawn. The required information was collected by canvassing a detailed questionnaire with each of the chosen farmer.

Table 1
Area under cotton by varieties (in acres)

Variety	Total	%
approved	813.56	37.9
unapproved	1154.96	53.96
desi	172.9	8.07
Total	2141.42	100

Source: Primary survey

In the chosen five districts, Bt adoption is nearly complete with 91 per cent of the area under Bt cotton. However, the area under the approved variety is less than the area under the unapproved variety (Table 1).

As per the biosafety regulations, companies selling Bt cotton seeds are required to sell a small packet of non-bt seeds of 120grams along with the regular Bt cotton seeds (which are packed to gather). These are called refuge seeds. The purpose of growing refuge is to delay the bollworm resistance to Bt. For effective protection, farmers are supposed to grow these non-bt seeds as a border to the Bt cotton plot which is indicated in the form of a diagram in the short literature page that accompanies the seed packet. While the approved Bt companies are required to sell this non-bt seeds as well, the unapproved seed sellers do not sell any refuge seeds. It has been demonstrated that wherever refuge is grown around the Bt plot, resistance to Bt is delayed and the technology would last long for more years. However, we found that in our survey that 27.8 per cent age of the approved plots has planted refuge as well and 72.2 per cent of the plots do not. On the other hand 3.8 per cent of the unapproved cultivators have on their own had cultivated refuge plants.

Table 2

Percentage of Plots with Refuge

		Approved	Unapproved
Planted	Yes	27.8	3.8
	No	72.2	96.2
Total plot		223	288

1 Pests attack:

During the 2007-08 Kharif season, farmers reported the infestation of sucking pests on cotton than the bollworm. In fact, farmers reported names of 12 different sucking pests and six kinds of bollworm to be affecting the cotton crop in the current season. By and large, sucking pests and bollworm were reported by the farmers, only 22 per cent of the farmers reported seeing any new pests in cotton. Interestingly, among the new pests that the farmers had seen in the current season that they had not seen five years before, mealy bug figures prominently (77% of the farmers) by the approved, unapproved and desi cultivators. Mealy bug that falls in the category of sucking pests, is reported to be devastating among other types of sucking pests.

II Pesticide spraying pattern

There was totally 2833 pesticide application on the total cotton crop (2141.4 acres) in the chosen districts of Gujarat. This amounts to 1.33 sprays per acre. Of the total 2851 responses that we had got for this issue, 2833 responses indicated pesticide spraying application ranging from 0ne to 20 times. Less than one per cent of the responses (18 responses) indicated of not spraying any type of pesticides. Of the total sprays, approved Bt and unapproved Bt account for 44 and 54 per cent of the sprays (1243 and 1540) respectively. But the difference is not statistically significant. The desi cotton variety accounts for just 1. 8 per cent of the sprays.

Table 3

Mean Difference between the Approved and Unapproved Variety in Number of Sprays

Variety	**No.of sprays**	**Mean**	**SD**	**t**	**Sig.**
Approved	1243	3.1	1.12		
Unapproved	1540	3	1.1	1.42	0.2

Among the districts, Rajkot and Bhavnagar account for 27 and 25 per cent of the share in total number of sprays while Surendranagar rank the least with 15 per cent of the application. Among the districts we observed that while in Rajkot number of applications on approved Bt was higher (70per cent) than that of unapproved Bt (30 per cent), in Bhavnagar it was the reverse (22 and 78 per cent respectively). In other districts, the difference wasn't huge like this.

Pesticide spray pattern among the different land holdings show that the number of sprays among the marginal land holders is the highest. Does this imply that the marginal land holders take extra care of their crop by spraying more pesticide? The mean difference between the number of sprays between marginal and small holdings is negative and significant. But the mean difference between the small and medium land holders is negative and insignificant.

Table 4

Type of Landholdings	Mean	N	t	sig
Marginal	4.89404	1057		
Small	5.364204	961	-3.19	0.001
Medium	5.773537	786	-0.953	0.341
Large	4.021277	47		
Total	5.280603	2851		

When we examined the question of against which pest have the farmers sprayed pesticides, it emerges that the sprays against sucking pests were more than the bollworms or those meant for diseases etc which is true for both approved and unapproved and desi varieties. Further, the numbers of sprays drastically rise after the first month of plant life in both approved and unapproved variety. It is true for the desi variety as well. Secondly, the incidence of bollworm attack appears to emerge only after the first month in both the variety. Interestingly whereas the application for bollworm in approved almost stops after 150 days (except for the 3 sprays after 180 days), in unapproved variety it goes on till 180 days. For the desi variety, though it is a long duration one, yet, the need for the pesticide spray does not arise after 150 days of the plant life. Similar pattern of spraying was observed in 2003-04 as well, where the number of applications peaked after the first month.

Table 5

Types of Pests against which Pesticides were Sprayed during the Plant Life According to the Variety

Approved Variety								
	1-30days	**31-60**	**61-90**	**91-120**	**121-150**	**151-180**	**181 above**	**Total**
Sucking pests	63	485	588	403	144	35	4	1722
Bollworm	1	37	110	84	16	0	3	251
Diseases	0	0	1	0	0	0	0	1
Others	0	3	5	1	1	0	0	10
Nutrient	16	65	52	24	5	9	3	174
Total no. spray	55	347	426	288	93	27	7	1243
Spray Per hectare								3.77
Unapproved variety								
	1-30days	**31-60**	**61-90**	**91-120**	**121-150**	**151-180**	**181 above**	**Total**
Sucking pests	77	509	643	381	135	53	30	1828
Bollworm	1	48	127	92	32	11	0	311
Diseases	0	0	1	0	0	0	0	1
Others	0	14	17	34	6	0	0	71
Nutrient	43	160	90	39	10	4	0	346
Total no. spray	85	452	518	322	107	31	15	1530
Spray Per hectare								3.3

Desi Variety								
	1-30days	**31-60**	**61-90**	**91-120**	**121-150**	**151-180**	**181 above**	**Total**
Sucking pests	6	18	17	13	4			58
Bollworm	2	1	1	2	0			6
Nutrient	5	7	3	1	0			16
Total no. sprays	9	16	13	9	3			50
Spray Per hectare								0.88
Spray per hectare of total								3.28

It appears that in the current season, the number of sprays per hectare on approved and unapproved have reduced compared to the number of pesticide applications made in 2003-04 season as shown in Table 6. While for the approved variety number of sprays per hectare has reduced from 6.3 to 3.77, in the case of unapproved variety it has reduced from 4.59 in 2003-04 to 3.3 in 2007-08. On cotton as a whole, the number of sprays per hectare has reduced from 3.81 in 2003-04 to 3.28 in 2007-08.

Table 6

Comparison of Number of Pesticide Sprays in 2003-04 and 2007-08

Approved									
	1-30 days	31-60	61-90	91-120	121-150	151-180	181 above	Total	
Bollworm	**8**	**42**	**52**	**28**	**14**			**144**	**-2.3**
Sucking	18	62	64	27	15			186	-3
Others	6	14	22	15	8			65	-1
All Sprays	32	118	138	70	37			**395**	**---**
All sprays per hectare	-0.5	-1.9	-2.2	-1.1	-0.6			**---**	**-6.3**
Unapproved									
Bollworm	**15**	**97**	**106**	**52**	**26**			**296**	**-1.4**
Sucking	47	179	174	66	45			511	-2.4
Others	17	54	60	24	16			171	-0.8
All sprays	79	330	340(1.6)	142(0.7)	87 (0.4)			**978**	
All sprays per hectare	-0.4	-1.5	-1.6	-0.7	-0.4				**-4.59**
			2007-08						
Approved									
Sucking pests	63	485	588	403	144	35	4	1722	
Bollworm	1	37	110	84	16	0	3	251	
Diseases	0	0	1	0	0	0	0	1	
Others	0	3	5	1	1	0	0	10	
Nutrient	16	65	52	24	5	9	3	174	
total no. spray	55	347	426	288	93	27	7	1243	3.77

Unapproved variety									
	1-30 days	31-60	61-90	91-120	121-150	151-180	181 above	Total	
sucking pests	77	509	643	381	135	53	30	1828	
bollworm	1	48	127	92	32	11	0	311	
diseases	0	0	1	0	0	0	0	1	
Others	0	14	17	34	6	0	0	71	
Nutrient	43	160	90	39	10	4	0	346	
total no. spray	85	452	518	322	107	31	15	1530	3.3
sprays per hectare in total land in 2003-04			3.81						
sprays per hectare in total land in 2007-08	l land in 2007-08		3.28						

3. 1 Pesticide awareness among the farmers:

In analyzing the use of pesticides, it is also essential to understand, the knowledge of the farmer in using these products that ranges from the name of the pesticides, the ingredient, against which pest the product is aimed at and why pesticide application is required at a particular point of time, impact of pesticide use on health etc. In the following pages information on some of these aspects is analysed.

In all the farmers reported 244 names of pesticides which mostly consisted of the trade or brand names. It is a common practice among the farmers to use combinations of chemicals when they apply pesticide, which according to the entomologists should not be done. Chemicals should not be used in combinations as it will work against control of pests. This is because, if a pest is resistant to one chemical, it would become resistant to the entire combinations that has been used and if farmers are not aware of this they would spray more pesticides. In our survey we found that there just 20 per cent of the total sprays which had used just one ingredient. 52 per cent have used two chemicals (Table 7). Perhaps because of this reason the number of sprays in general is rising and on sucking pests it is more.

Table 7
Combination of Chemicals Used by Gujarat Farmers

Combination	Responses	%
No pesticide	25	0.9
One chemical	569	20.0
Two chemicals	1483	52.0
Three chemicals	622	21.8
Four chemicals	118	4.1
Five chemicals	31	1.1
Seven chemicals	3	0.1
Total	2851	100.0

We could match about 50 per cent of the names available with the active ingredients with the WHO classification of pesticides. Accordingly we have classified the pesticides, provided in Table 8.

Classification of pesticides that are reported to be used in Gujarat

Classification	**Number of Pesticides**	**%**
Class 1a(WHO)	6	2.45
Class 1b(WHO)	19	7.78
Class 2(WHO)	66	27.04
Class 3(WHO)	19	7.78
O(WHO)	5	2.04
U(WHO)	15	6.14
Not available	113	46.31
Not classifiable	1	0.4
Total pesticides reported	244	100

Note: Class 1a, 1b, 2, 3, O and U refer to extremely hazardous, highly hazardous, moderately hazardous, slightly hazardous, obsolete as pesticide and unlikely to cause any hazard in normal use.

Presently 37 per cent of the pesticides used by the farmers are coming under the first three categories with majority belonging to the moderately hazardous group. Further a small percentage of 2 per cent of the pesticides fall in the obsolete category, which when used in combination with any other chemical might nullify the chemical effects, thus necessitating more sprays.

We have arrived at a short list of pesticides that were found to be common for all the three varieties and which appeared to be popular among the farmers in terms of their frequent application (Table 9). It shows that except for Acepahte which is considered to be slightly hazardous for humans and environment by WHO, the rest either fall in highly hazardous or moderately hazardous category. Particularly Monocrotophos which is the favorite of the farmers comes under the highly hazardous category and is also banned under the UN PIC (prior informed consent). According to the PIC convention export of a chemical can take place only with the prior informed consent of the importing country. The PIC procedure is a means of formally obtaining and disseminating decisions of importing countries as to know whether they wish to receive further shipment of a particular chemical and for ensuring compliance to these decisions by the exporting countries. The aim is to promote a shared responsibility between exporting and importing countries in protecting the humans and environment about the harmful effect of the chemicals (WHO 2004, P.no.39.).

Table 10

Use of Pesticides in Varieties

	Classification		Approved	Unapproved	Desi	Total
Name of pesticide	Pesticide group	WHO Class				
Monocrotophus	OP,	1b	502	510	21	1033
Acephate	Op	Class3	330	689	29	1048
Confidor	Neonicotinoids	Class2	245	240	11	496
Acetamapride	Neonicotinoid	NA	183	128	2	313
Imidacrop	Neonicotinoid	Class2	156	165	3	324
Computor	Neonicotinoid	Class2	62	217	0	279
Ektara			75	82	1	158
Endosulphun	OC	Class2	124	134	5	263
Starthion	OP	Class3	101	18	0	119
Prophanophus	OP	Class2	37	40	0	77

Compiled from the number of insecticides used per spray
Note: OP, OC refer to organophosphate, organochlorin.
Note: 1b highly hazardous, class 2 moderately hazardous and class 3 slightly hazardous.

Table 10a

Quantity of Pesticides used per acre

	Liter per acre	Powder per acre
Approved	1.35	0.78
Unapproved	0.98	0.59
Desi	0.40	0.14

In quantity terms, in all, the approved variety cultivators have used more quantity of pesticides in their farms than others. Desi farmers have used the least due to the nature of the cotton itself.

Assessing the need to spray pesticides

98.4 of the responses indicated that farmers visited the field to observe whether there was any need to spray pesticides. This visit indicated the intensity of pests for the farmers as evident from the table. Both approved and unapproved variety cultivators indicated that the pest intensity was high which necessitated spraying of pesticides, as indicated by the curling of the leaves in majority of the cases prompted them to spray pesticides.

Table 11

Intensity of Pests Before Spraying Pesticide by Variety

	Approved	**%**	**Unapproved**	**%**	**Desi**	**%**
High	776	63.1	925	61.3	18	38.3
Medium	276	22.5	348	23.0	27	57.4
Low	151	12.3	225	14.9	2	4.3
Don't know	19	1.5	12	0.8	0	0.0
No pests	7	0.6	0	0.0	0	0.0
Total	1229	100.0	1510	100.0	47	100.0
Mean	1.54		1.56			
Tstat*	-0.631					
Sig	-0.53					

Mean difference between the intensity of pests between approved and unapproved variety indicate that the intensity of pests between the two varieties is not significant.

Table 12
Farmers Responses on Effectiveness of the pesticide application.

		Seed Variety			
		Approved	Unapproved	Desi	Total
Pesticide spraying was effective	1	1017	1370	35	2422
Not effective	2	213	156	12	381
Don't know	3	11	2	0	13
	Total	1241	1528	47	2816
Mean		1.19	1.1		
T		5.968*			
Significant at 1% level.					

Majority of the responses indicated that the pesticide application had been effective in all the varieties, and the intensity of the pests did decrease after the application as indicated by the intensity of the pests after the pesticide application is reported to be less by at least 62.5 and 54.5 per cent of the approved and unapproved Bt cultivators (Table 13).

Table 13

Intensity of the pests after pesticide application

	%	%	%
	Approved	**Unapproved**	**Desi**
High	17.8	23.0	0.0
Medium	16.0	18.5	14.3
Less	62.5	54.5	80.0
Don't know	2.9	2.0	0.0
The pests are not seen	0.8	1.9	5.7
Total	100.0	100.0	100.0

The responses from the farmers on who prompted them to spray pesticide demolished our opinion that farmers go by the suggestion of the pesticide dealers (Table 14). While this could be true for deciding on the product to be applied, the decision to spray pesticide appears to be taken by the farmers in 67 per cent of the cases. Though discussion with farmers and the visit to the dealers shop also seem to influence the decision, yet the role of gramsevak in informing the farmers about the need to spray appears to be very minimal as evident from Table 14.

Table 14

Decision to spray application made by (%)

	Approved	**Unapproved**	**Desi**	**Total**
Self	67.6	66.5	57.1	66.8
Discussion with farmer	1.1	6.1	7.7	4.0
After visiting the field	20.6	15.4	19.8	17.7
After visiting the field/dealer	9.5	11.1	14.3	10.5
gramsevak	0.8	0.7	1.1	0.8
owner	0.5	0.1	0.0	0.3
	100.0	100.0	100.0	100.0

Knowledge about the pesticide products among the farmers:
Table 15

Hazard indicator	**Approved**	**Unapproved**	**Desi**
Red	37.9	41.9	62.5
Green	23.4	20.2	18.75
Yellow	29.4	25.8	6.25
.Blue	5.1	12.1	6.25
.Don't know	4.2	0.0	6.25
Total	100.0	100.0	100

Red, yellow, blue and green are the colours that are used to indicate the hazard of pesticides on the cover. They indicate the extreme hazard, highly hazard, moderately hazard and slightly

hazard nature respectively. In all 50 per cent of the farmers had observed the color indicator on the pesticide pack which indicates the level of hazardous of the product inside. While most of the farmers responded correctly about the red and green indication, 23 per cent of the farmers thought that yellow are not harmful.

In spite of seeing the hazard indicator on the pack, only 52 percent of the farmers in all (57, 52 and 52 per cent of the responses from the approved, unapproved and desi cultivators) said that they take some precautions while spraying pesticides. These precautions range from wearing gloves to not eating while spraying pesticides. Nevertheless, it should be mentioned that only 50 per cent of the responses from the three variety cultivators indicated that wearing face masks (covering the mouth and nose with a piece of cloth) appear to be the most used precaution as compared to wearing gloves or wearing goggles while spraying pesticide. However a very small number of farmers (7 out of 200) reported getting unwell after spraying pesticide. Skin irritation is the most observed impact (44%) on farmers who spray pesticides. However, none of the symptoms were serious according to the farmers to get medical attention immediately and hence there is no medical expenditure reported or man days lost due to sickness. Similarly none of the farmers reported any adverse impact on the environment due to pesticide use. It is also a limitation of the study since we stopped with asking the farmers about the `observed' environmental impact like hardening of the land, reduction in the beneficial insects etc and have not undertaken any scientific testing of the water or land to prove the adverse impact of the pesticides.

Thus the foregoing analysis of the pesticide use among the cotton cultivators in Gujarat indicate, the adoption of Bt is almost complete in the chosen districts. While the number of sprays against bollworm is less as compared to the sucking pests, yet, farmers use a combination of pesticides and a few of them ranging from most hazardous to moderately hazardous. Perhaps because the pesticides are used in combinations, the effect is not vigorous thus making the farmers to go for repeated applications.

4. Export of Cotton from India and NTBs.

India is one of the eight largest importers of cotton and the dominant exporters are United States, Uzbekistan, Francophone Africa and Australia which account for more than two thirds of global exports. Export of cotton from India is regulated by the Ministry of Textiles based on the availability for domestic use. Presently it is deregulated. The import of cotton is under open general license with 10 per cent of import duty. The quantity of raw cotton imported came down from 22 lakh bales in 2001-02 to 6 lakh bales in 2004-05. At the same time exports increased from 0.6 lakh bales in 2001-02 to 20 lakh bales in 2004-05' (GOI, 2006, Table 16). While the increase in production contributed by the Bt adoption in different states is one of the reasons, favorable monsoon and weather conditions have also helped the farmer to reap a better harvest than that they have realized a few years back. It is in this context, that we look at the pesticide use pattern in Bt with concern. As shown in the analysis, though the number of sprays against bollworm is less than the sucking pests, the pesticide Monocrotophus which is banned in many countries and under the UN PIC is being used the most by the farmers. The permissible Maximum Residue Limit (MRL) of monocrotophus in cottonseed and cotton seed oil (raw) is 0.1 and 0.05 respectively (Mukhopadhyay, 2003). We are not sure with the most number of farmers

using monocrotophus, what would be the residue limit of this and the other pesticides that we have listed under the different hazard category on cotton and other products of cotton.

Table 16

Export and Import of Cotton

Year	Export	Import
1996-97	16.82	0.30
1997-98	3.50	4.13
1998-99	1.01	7.87
1999-00	0.65	22.01
00-01	0.60	22.0
01-02	1.0	16.0
02-03	0.84	17.67
03-04	13.25	7.21
04-05 (anticipated)	20.00	6.0

Quantity in lakh bales
Source: Government of India (2006)

Presently India has been exporting cotton to various countries including the US. Table 17 provides the information the destination of India's cotton exports.

As trade is expanding the fear is the imposition of non-tariff barriers on the cotton exports from India based on the types of pesticides used or pesticides residue in the cotton. Non tariff barriers could be in the form of product standards, process standards, registration and certification and testing. Vietnam and Philippines require the exporters to give report on the chemistry of the product and toxicity of the product in the case of pesticides and fine chemicals. Toxicity tests are conducted over a period of time and may take up to two years. Presently toxicity studies are asked only by Vietnam and Philippines and exporters from India find it time consuming and unviable to trade with these countries. Simlarly process standards concerning yarn are required by Singapore (Saqib and Taneja, 2005). India has been exporting cotton to Vietnam (Table 17) which has increased from 0.14 per cent in 1993-94 to 3.52 in 2006-07. Singapore on the other hand has declined from 1.17 to 0.18 during the same period.

An analysis by Rajesh Mehta (2005) shows the Index Frequency Ratio of woven apparel, knit apparel and the textile floor coverings in the US alone amounts 19, 7 and 1 per cent respectively where the Index of frequency ratio is defined as the number of products or product lines that are subject to NTBs in the given class to the total of number of commodities in that class. As Table 17 indicates, India's cotton export to the US has been fluctuating. The textile products from India that use Azo dyes and pentachlorophenol have also been banned in a few countries. These indicate that cotton and cotton textile products could be subject to NTBs more in the days to come if India's cotton production continues to increase. Hence, India should take suitable measures to ensure that cotton exports from India do not suffer due to lack of standards.

5. Conclusion

This paper focused on the pesticide use scenario among Bt cotton cultivators in Gujarat, exports from India and the prevalence of non-tariff measures in cotton. The analysis indicates that farmers use a variety of pesticide that range from extremely hazard to moderately hazard in their effect. Acephate and Monocrotophus are the most used pesticide by the farmers. While Acephate falls in the slightly hazardous category of WHO, monocrotophus falls in the highly hazardous category. They use different combinations of chemicals also during spraying. During the kharif 2007-08, the incidence of bollworm was less, while the infestation of sucking pests was more necessitating more sprays on sucking pests. We are not sure whether it is due to the (a) ineffectiveness of chemicals that the farmers have to resort to more number of applications or (b) the chemical combinations that they use make the sprays in effective. Perhaps due to this, the farmers have not observed any adverse health impact or environmental impact.

India has been witnessing a rise in export of cotton in the recent years. With more number of countries adopting NTBs to prevent imports, cotton with more use of pesticides could be subject to NTBs in the days to come. Hence, if India needs to sustain its exports to other countries, measures need to be introduced to curb pesticide use by inducing more awareness regarding pesticide use and integrated pest management programmes in cotton cultivation. The health and environmental hazards of pesticides are known and only more awareness could lead to reduction in the use and safe use of pesticides that will lead to quality cotton being exported from India.

References

Baffes John, Cotton,(2004) Market Setting, trade policies and Issues, World Bank , World Bank Policy Research Working Paper 3218, Feb.

CMIE, 1997, Foreign Trade, November

CMIE (2007), Foreign Trade and Balance of Payments, August.

Edge Julie, Benedict John, Carroll John, and Reding Keith, (2001), `Bollgard Cotton: An Assessment of Global Economic, Environmental and Social Benefits', The Journal of Cotton Science, 5(2). P.121-136.

Gandhi Vasant and Namboodiri (2006), The Adoption and Economics of Bt Cotton in India-Preliminary Results from a study, WP2006-09-04, Indian Institute of Management, Ahmedabad.
Government of India (2006) Report of the fact finding team on Vidharbha to study the causes of regional disparities and rural distress in Maharashtra with particular reference to Vidharbha, Report submitted to the Planning Commission, GOI, May.

Guha, Sumit, (2007), "Genetic change and colonial cotton improvement in 19th and 20th century India**"** Forthcoming in Ranjan Chakrabarti ed. *Situating Environmental History* Delhi: Manohar Publications 2007

Hayee Abdul Cultivation of Bt Cotton- Pakistans experience, available at www.actionaid.org/pakistan.

Indira A, Bhagwan M R, Virgin, I, (2005)`Agricultural Biotechnology and Biosafety in India:Expectations, Outcomes and Lessons', Stockholm Environment Research Institute, Stockholm, April.

Kranthi K R, Naidu S et al (2005), ` Temporal and Intra-plant Variability of Cry1Ac Expression in Bt cotton and its Influence on the Survival of the Cotton Bollworm, Helicoverpa, Armigena (Hubner) (Noctuidae;Lepidoptera), Current Science, Vol.89, No.2, July.

Lalitha N and Ramaswami Bharat, (2007) `Pesticide Use Pattern Among Cotton Cultivators in Gujarat' in Frontiers of Agricultural Development in Gujarat (ed) Dholakia Ravindra, Centre for Management in Agriculture, Indian Institute of Management, Ahmedabad, June 2007.

Mahendra Dev and Chandrasekhara Rao, (2007) Socio Economic Impact of Bt Cotton, CESS Monograph No.3, Centre for Economic and Social Studies Hyderabad, November.

Mehta Rajesh (2005), `Non Tariff Barriers Affecting India's Exports' RIS Discussion Paper no.97, Research and Information System for Developing Countries, New Delhi.

Mukhopadhyay, (2003) , ` Pesticide Usage Scenario in India and Viable Alternatives', Voluntary Health Association of India, New Delhi.

Narayanamurthy A and Kalamkar S `Is Bt cotton cultivation economically viable for Indian farmers? An Empirical Analysis', Economic and Political Weekly, Vol, 41, No.26, June 30, 2006

Pray Carl, Ma Danmeng, Huang Jikun and Qiao Fangbin (2001), ` Impact of Bt Cotton in China', World Development, Vol.29, No.5, pp 813-825.

Saqib Mohammad and Taneja (2005), ` Non-Tariff Barriers and India's Exports: The Case of Asean and Srilanka', Working Paper no.165, ICRIER,New Delhi.

Shetty P K (2004), `Socio-Ecological Implications of Pesticide Use in India', Economic and Political Weekly, Vol39, No.39, PP 5261-67.

Qaim Matin and Janvry Alain De (2005), `Bt Cotton and Pesticide Use in Argentina: Economic and Enviornmental Effects', Environment and Development Economics 10, 179-200

Qaim Matin, Naik Gopal, Subramanian Arjunan and Zilberman David (2005), `Bt Cotton Controversy: Some Paradoxes Explained', Economic and Political Weekly, April, 9.

WHO 2005, `The WHO recommended classification of pesticides by hazard and guidelines to classification, 2004, Geneva.

Table 17

Export of Raw cotton and waste from India

	1993-4	1996-97	1999-00	2000-01	2001-02	2002-03	2003-04	2004-05	2005-06	2006-07
WORLD	100	100	100	100	100	100	100	100	100	100
China				6.66	0.36	1.45	17.28	21.43	63.27	48.67
Pakistan							21.39	10.87	6.91	14.75
Turkey				0.46	0.22	0.41	0.35	0.17	0.79	6.83
Indonesia				0.35		2.12	7.08	5.01	4.17	5.03
Thailand	17.89	9.22	1.2	0.95	0.61	0.49	3.82	6.12	3.14	4.87
Hong Kong	24.45	21.34	0.75	8.02			0.4	2.46	2.73	3.72
Vietnam	0.14	0.16	0.34	0.32	0.24		1.27	1.4	3.29	3.52
Bangladesh	5.21	1.26	0.51	4.4	4.72	1.64	24.1	6.25	7.41	3.4
Taiwan	3.08	8.14	0.58	1.21		0.89	6.25	20.2	3.65	2.65
Chile									0.01	2.57
Korea republic	0.73	1.75	0.65	2.15	6.28	4.54	6.46	0.89	0.63	0.73
Malaysia				7.64	11.28	12.26	0.26	1.57	0.26	0.48
Mauritius				9.73			2.36	9.56	1.68	0.41
Japan	14.33	9.44	36.07	9.6	33.23	53.02	2.31	3.25	0.64	0.35
Italy	0.79	4.65	19.41	12.01	7.73	0.02	0.72	1.84	0.03	0.21
Singapore	1.17	0.62	0.42	2.95	0.05		0.27		0.04	0.18
Belgium	0.75	1.2	5.74	2.9	3	10.76	0.09	1.3	0.11	0.18
USA	0.33	1.05	1.23	0.32	6.91	0.5	0.02	1.32	0.02	0.17
Germany	0.44	0.65	3.44	2.54	1.1	0.48	0.16	0.29	0.12	0.16
UK	0.39	2.2	18.66							
France	0.41	0.61	5.21							
Nepal	0.38	0.16	1.56							
Netherlands		0.4	0.47							
Australia	0.03	0.2	0.36							
Nigeria			0.35							
Canada	0.01	0.01	0.33							

Source: CMIE, November 1997 and August 2007.