Response to
World Wildlife Fund Background Paper
"Transgenic Cotton: Are There Benefits for Conservation?"

By

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Introduction

The recent World Wildlife Fund report, "Transgenic Cotton: Are There Benefits for Conservation?" contains several errors and misrepresentations of adoption and pest control issues. Here, we discuss statements made in that report on adoption, yields and pesticide use in order to clarify the issues.

Adoption

The WWF report notes that transgenic cotton varieties were planted on 57% of the total U.S. cotton acreage in 1999, which is slightly lower than adoption rates reported elsewhere. USDA Agricultural Marketing Service (USDA AMS) reports on cotton varieties planted indicate an adoption rate of 60% in 1999, 32% Bt, 45% herbicide resistant and 16% "stacked" varieties with both insect and herbicide resistance. Aggregate adoption increased for the 2000 crop season, with total adoption at 72%, 39% Bt, 61% herbicide resistant, 28% stacked (USDA AMS). Figure 1 and Table 1 show adoption of transgenic cotton varieties since 1996.

Bt Cotton

The WWF report cites an adoption rate for Bt cotton of 17% in 1998, which is lower than adoption rates reported elsewhere. Other estimates place adoption of Bt cotton at 21-23% in 1998. In addition to USDA AMS report on cotton variety adoption, the Cotton Foundation sponsors an annual survey that provides estimates of adoption of Bt cotton varieties (Williams). The Cotton Foundation survey is coordinated by entomologists in each of the states, collecting information derived from surveys of county agents, extension specialists, private consultants and research entomologists. The adoption estimates from the USDA AMS and Cotton Foundation surveys are similar, showing adoption rates of 12-13% in 1996, increasing to 29-32% in 1999. Tables 2 and 3 show estimates of adoption of Bt cotton from USDA AMS and the Cotton Foundation.

BXN Cotton

The WWF report incorrectly states that BXN cotton varieties, which are tolerant to application of the herbicide bromoxynil, were not planted in the U.S. until 1999, while in fact BXN varieties were first made commercially available in 1995. On May 18, 1995, EPA established time-limited tolerances for residues of bromoxynil on cottonseed. The accompanying registration allowed 200,000 acres of cotton to be treated with bromoxynil. On June 18, 1997, EPA renewed the time-limited tolerances, with an accompanying registration that increased the allowable treated acreage to 400,000 acres. On May 13, 1998, EPA established permanent tolerances for bromoxynil in cotton, with an accompanying registration allowing 1.3 million cotton acres to be treated with bromoxynil (US EPA 1998).

USDA AMS reports indicate planting of BXN varieties since 1995, though adoption was very low until 1998. By 1998, adoption was almost 6%, rising to nearly 8% in 1999 and falling slightly to just over 7% in 2000. With current limitations on the total acreage that may be treated with bromoxynil, adoption can not increase substantially from current levels. The relatively small national adoption numbers hide what has been substantial adoption in some areas. In 1997, 7% of North Carolina and 4% of Tennessee acreage was planted to BXN varieties. By 1998, 40% of Tennessee cotton acreage was in BXN varieties. Adoption has remained over 25% since 1998 in Arkansas. Over 30% of cotton acreage in Missouri was planted to BXN varieties in 1999 and 2000 (USDA AMS). Table 4 shows adoption rates of BXN varieties by state since 1995.

Roundup Ready Cotton

Roundup Ready varieties, which are tolerant to the application of glyphosate (Roundup), became available in 1997. Since 1997, adoption of the technology has been rapid, growing from 4% in 1997 to 54% in 2000. Some areas have adopted the technology more rapidly than others. South Carolina planted 94% of its cotton acreage to Roundup Ready varieties in 1999. Florida and Tennessee have also adopted at rates over 75% of planted acreage. Table 5 shows adoption of Roundup Ready cotton varieties by state.

Yields

The WWF report cites a study by the USDA Economic Research Service (ERS) in the discussion of changes in yields associated with adoption of transgenic varieties. This ERS report summarized preliminary results from an analysis of 1997 survey data.

Bt Cotton

While the WWF report correctly references a result from the ERS report that found that growers had sustained increased yields using Bt cotton in 1997, the report continues by saying “whereas in other years Bt-cotton contributed to lower cotton yields compared to conventional varieties.” It is not clear what data this statement refers to, since the referenced study only presents data from one year, 1997.

Herbicide Tolerant Cotton

Again, while the WWF report correctly refers to ERS results showing small increases in yields in 1997 for growers who planted herbicide tolerant cotton varieties, the report goes on to state, “[i]n some regions herbicide tolerant cotton contributed to yield losses up to 10% for herbicide tolerant cotton according to the estimations by the authors.” It is not clear what this statement is based on, since nothing in the cited ERS report indicates such a result.

Pesticide Use

Herbicides

The WWF report states that “no substantial reduction in herbicide use for cotton farming occurred” between 1997 and 1998, presumably based on average application rates from NASS data. However, in our analysis of NASS data, we find declining herbicide use in cotton over the past several years. NASS data show that average application rates decreased from 1.7 lbs/acre in 1997 to 1.61 lbs/acre between in 1998. There has been a general decline in average cotton herbicide application rates since 1994. (See Table 6.) The total amount of herbicide applied to cotton acreage has also declined since 1995. (See Figure 2.) Further, the number of applications made to cotton acreage has declined by 1.8 million applications in 1998 and 1.3 million applications in 1999. (See Figure 3 and Table 6.)

In 1996, a new, conventional, herbicide became available. Pyrithiobac (Staple) was used on 10% of U.S. cotton acreage in 1996, increasing to 23% in 1997, then dropping back to 16% in 1998 and 14% in 1999. Staple is used at a very low average rate, 0.05 lbs/acre, compared to other herbicides that are used at 0.09 lbs/acre to 1.18 lbs/acre (USDA NASS 2000). Much of the decline in total pounds of herbicides used in cotton since 1995 is likely due to the adoption of Staple and is probably not attributable to the introduction of herbicide tolerant varieties. However, the decline in the number of applications is more likely due to the introduction of herbicide tolerant varieties and the associated use of broad spectrum herbicides, such as Roundup, which reduce the number of herbicides needed for effective weed control.

Reductions in cotton herbicide use since the introduction of herbicide tolerant varieties are shown in Table 7. For comparison with earlier estimates of changes in cotton herbicide use (Carpenter and Gianessi), 1994 herbicide use is compared to use levels in 1998 and 1999. Reductions have been adjusted to account for the decline in acreage in recent years.

The WWF report notes that shifts have occurred between herbicides, as glyphosate use has increased. Indeed, glyphosate use increased from use on 13% of planted acres in 1994 to use on 36% of planted acres in 1999 (USDA NASS). Table 8 shows the extent of use cotton herbicides by active ingredient in 1994, the year before BXN cotton varieties were introduced, to 1999. Use of many of the most commonly used herbicides, such as trifluralin, fluometuron, and MSMA, has declined since 1994. Figure 4 shows trends in herbicide use in Mississippi from 1990 to 1999 for glyphosate, bromoxynil, pyrithiobac, and the three most commonly used conventional herbicides. As shown, the use of conventional herbicides has declined since 1996, while the use of glyphosate and bromoxynil has increased.

Insecticides

The WWF report examines trends in the use of all cotton insecticides, concluding that insecticide use has "remained more or less at the same level." The report criticizes an analysis of trends in the use of insecticides that are recommended for the control of Bt target pests (Gianessi and Carpenter) on two grounds: that insecticides control more than one insect, making it difficult to identify the target pest of a particular insecticide; and that non-Bt target pests may increase, requiring increased use of other insecticides. Unless there is some other factor contributing to decreased insecticide use for these other pests, a decrease in the use of these insecticides would likely be attributable to the adoption of Bt varieties. Further, many growers have faced increased populations of secondary pests that had been incidentally controlled by sprays directed at Bt target pests. If these same insecticides are used to control these secondary pests, the use of these insecticides towards these secondary pests is considered in the analysis. Finally, while it is theoretically possible that other non-Bt target pests, besides those that had been controlled with treatments for Bt-target pests, may increase in areas where Bt cotton is adopted, to our knowledge, this has not been reported.

An analysis of trends in the use of insecticides used for the control of Bt target pests show a substantial decrease. The use of cotton insecticides for Bt target pests declined by over 2 million pounds between 1995, the year before Bt varieties were introduced, and 1998, and by 2.7 million pounds by 1999. The number of insecticide applications has also declined, by 8.7 million applications in 1998 and by 15 million applications in 1999. Table 9 shows reductions in insecticides recommended for control of Bt target pests through 1998 and 1999.

The WWF continues by asserting that farmers faced high yield losses in 1996, a year with relatively high cotton bollworm pressure, due to ineffective control by Bt cotton varieties and that as a consequence, insecticide use increased in 1997. Both points are mistaken and the basis for these claims is unclear. Yield losses due to tobacco budworm, cotton bollworm and pink bollworm were lower in 1996 than the 11-year average from 1985 to 1995 in 10 out of 16 states. In the 6 states where yield losses were higher than the 11-year average, adoption rates were between 1 and 21%. Table 10 shows yield losses due to Bt target pests from 1985 to 1999 for major cotton producing states.

Insecticide use for Bt target pests was also not increased in 1997. The number of insecticide applications for tobacco budworm, cotton bollworm and pink bollworm were lower in 1997 than the average for the 10-year period prior to the introduction of Bt varieties in all states except Missouri, New Mexico and Oklahoma, which had low adoption rates in 1996 and 1997. Table 11 shows the number of insecticide applications directed towards tobacco budworm, cotton bollworm and pink bollworm from 1986 to 1999 for major cotton producing states.

The example used in the WWF report to demonstrate increasing insecticide use in 1997 is Alabama. The WWF report states that insecticide use increased from 0.6 lbs/acre in 1997 to 0.8 lbs/acre in 1998. No reference is given for these insecticide use rates, which do not seem to be based on USDA NASS data. Our examination of USDA NASS insecticide use data for Alabama show declining application rates from 1.03 lbs/acre in 1997 to .94 lbs/acre in 1998 and .87 lbs/acre in 1999. (See Table 12.)

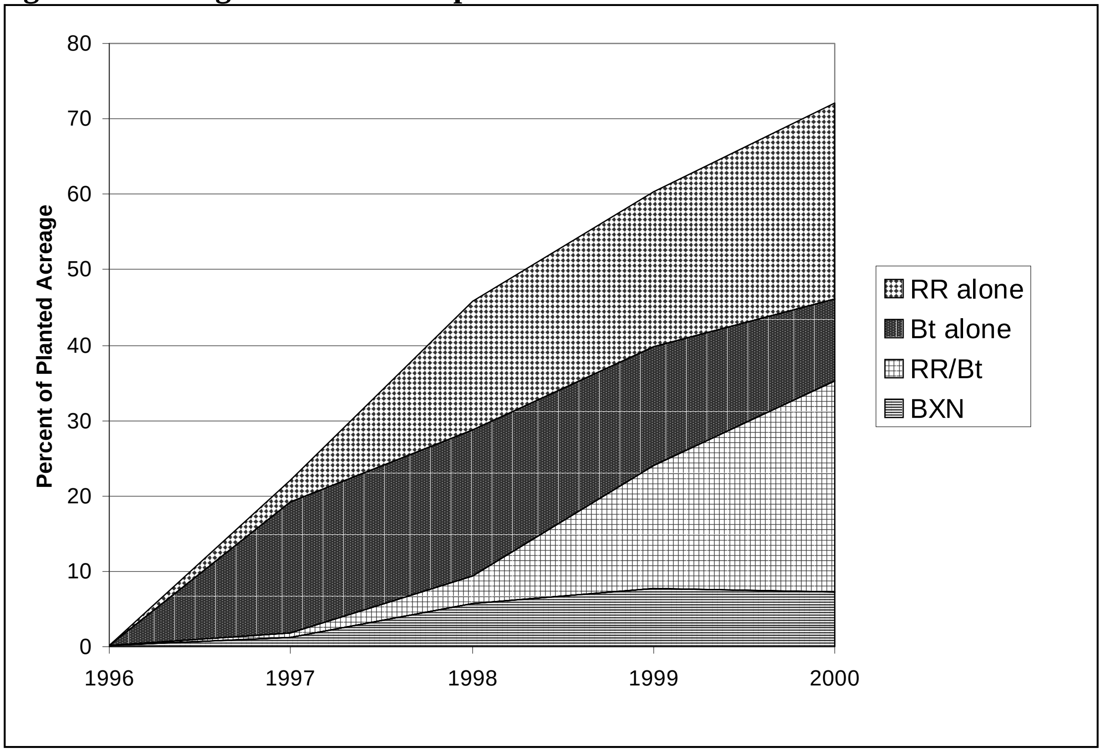
In 1999, three states surveyed insecticide use in Bt cotton and conventional varieties, Arizona, Louisiana and Tennessee. In each state, the number of insecticide treatments for Bt target pests was lower in Bt varieties than for conventional varieties. Also, the number of insecticide treatments for other insects is higher in Bt varieties than for conventional varieties. This difference is believed to be due to treatments directed towards pests that otherwise would have been controlled by treatments directed towards Bt target pests. The total number of applications is lower for Bt acreage than for conventional acreage in Arizona and Louisiana, but slightly higher in Tennessee. This difference is likely due insecticide use patterns in boll weevil eradication programs. Areas where boll weevil eradication is being pursued are believed to have higher adoption rates for Bt cotton than other areas. This is apparent from the higher number of applications for boll weevil in Bt acreage than in conventional acreage. Growers in boll weevil eradication areas choose to plant Bt varieties because the insecticide normally used in eradication programs destroys populations of beneficial insects that would normally control Bt target pests. Table 13 shows cotton insecticide use for Bt and conventional varieties in 1999 for Arizona, Louisiana and Tennessee.

Conclusions

The WWF report concludes that pesticide use in cotton has remained unchanged since the introduction of trangenic varieties. However, the use of both insecticides and herbicides in cotton production have declined since Bt and herbicide tolerant varieties were introduced. The use of insecticides declined by 2.7 million pounds by 1999, while the number of insecticide applications has declined by over 15 million applications. Herbicide use has also declined, although the decline in the total amount of herbicides applied may not all be attributable to the introduction of herbicide tolerant varieties. The number of herbicide applications has declined by over 1 million applications.

While much of the analysis in the WWF report is based on weak or incorrect evidence, the authors are correct to point out that the few years of data available since the introduction of transgenic cotton varieties are insufficient to draw firm conclusions. The use of pesticides, insecticides in particular, can be highly variable from year to year. Trends attributable to the introduction of transgenic varieties will become more clear over time.

Figure 1. Transgenic Cotton Adoption



Note: RR-Roundup Ready, BXN-bromoxynil resistant
Source: USDA AMS

Table 1. Transgenic Cotton Adoption

	BXN	Bt	RR	RR/Bt	Total
1995	0.1				**0.1**
1996	0.1	12			**12**
1997	1.2	18	4	1	**22**
1998	5.8	23	21	4	**46**
1999	7.8	32	37	16	**60**
2000	7.2	39	54	28	**72**

Source: USDA AMS

Table 2. USDA AMS Bt Cotton Adoption

	1996	1997	1998	1999	2000
	percent of planted acres				
Alabama	65	80	61	75	65
Arizona	11	64	57	56	57
Arkansas	15	14	14	22	60
California	0	2	5	8	6
Florida	42	79	80	66	75
Georgia	23	34	47	51	48
Louisiana	21	32	71	67	81
Mississippi	37	45	60	66	75
Missouri	0	0	0	1	5
New Mexico	9	13	38	28	36
North Carolina	3	2	4	37	41
Oklahoma	2	7	2	47	55
South Carolina	16	27	17	84	71
Tennessee	0	6	7	59	76
Texas	1	4	7	9	10
Virginia	0	3	1	16	41
US	**12**	**18**	**23**	**32**	**39**

Source: USDA AMS

Table 3. Cotton Foundation Bt Cotton Adoption

	1996	1997	1998	1999
	percent of planted acres			
Alabama	77	68	63	66
Arizona	21	61	71	63
Arkansas	14	13	12	16
California	0	0	1	3
Florida	43	60	50	56
Georgia	30	38	44	58
Louisiana	15	38	60	61
Mississippi	35	43	58	67
Missouri	0	1	1	2
New Mexico	1	6	35	23
North Carolina	6	3	12	20
Oklahoma	6	8	8	21
South Carolina	14	31	39	81
Tennessee	1	3	19	68
Texas	2	5	5	8
Virginia	0	0	3	7
US	**13**	**17**	**21**	**29**

Source: Williams

Table 4. BXN Cotton Adoption

	1995	1996	1997	1998	1999	2000
	percent of planted acres					
Alabama			0.0			
Arizona		0.1	0.3	1.0	1.9	1.7
Arkansas	0.3	0.5	2.0	27.8	41.3	21.9
California					3.0	8.7
Florida					0.7	0.3
Georgia		0.2	0.7	2.5	2.3	0.8
Louisiana	0.2	0.3	0.6	8.0	8.7	3.4
Mississippi	0.3	0.2	3.1	6.2	15.0	11.0
Missouri	0.2	0.1	0.7	11.1	29.9	39.5
New Mexico						
North Carolina	0.1	0.1	7.1	4.3	13.4	13.1
Oklahoma				1.6	0.7	2.9
South Carolina	0.2	0.2	1.1	0.2	1.2	0.4
Tennessee		0.0	3.7	39.6	10.3	7.3
Texas		0.1	0.2	0.4	1.1	1.8
Virginia				3.4	11.2	16.4
US	**0.1**	**0.1**	**1.2**	**5.8**	**7.8**	**7.2**

Source: USDA AMS

Table 5. Roundup Ready Cotton Adoption

	1997	1998	1999	2000
	percent of planted acres			
Alabama	1	13	40	60
Arizona	2	11	12	25
Arkansas	5	3	8	42
California		0	2	21
Florida	0	7	54	83
Georgia	2	35	55	66
Louisiana	1	3	12	54
Mississippi	11	10	27	53
Missouri		2	4	22
New Mexico	1	2	2	4
North Carolina	10	32	58	65
Oklahoma	2	22	57	68
South Carolina	4	45	94	76
Tennessee	11	18	57	81
Texas	2	27	41	55
Virginia	3	19	39	49
US	4	21	37	54

Source: USDA AMS

Table 6. Cotton Herbicide Application Rates 1994 to 1999

	lbs/acre	applications/acre
1994	2.02	2.96
1995	1.89	2.91
1996	1.57	2.53
1997	1.7	2.84
1998	1.61	2.76
1999	1.63	2.82

Source: USDA NASS

Table 7. Reductions in Cotton Herbicide Use Since Introduction of Herbicide Tolerant Varieties

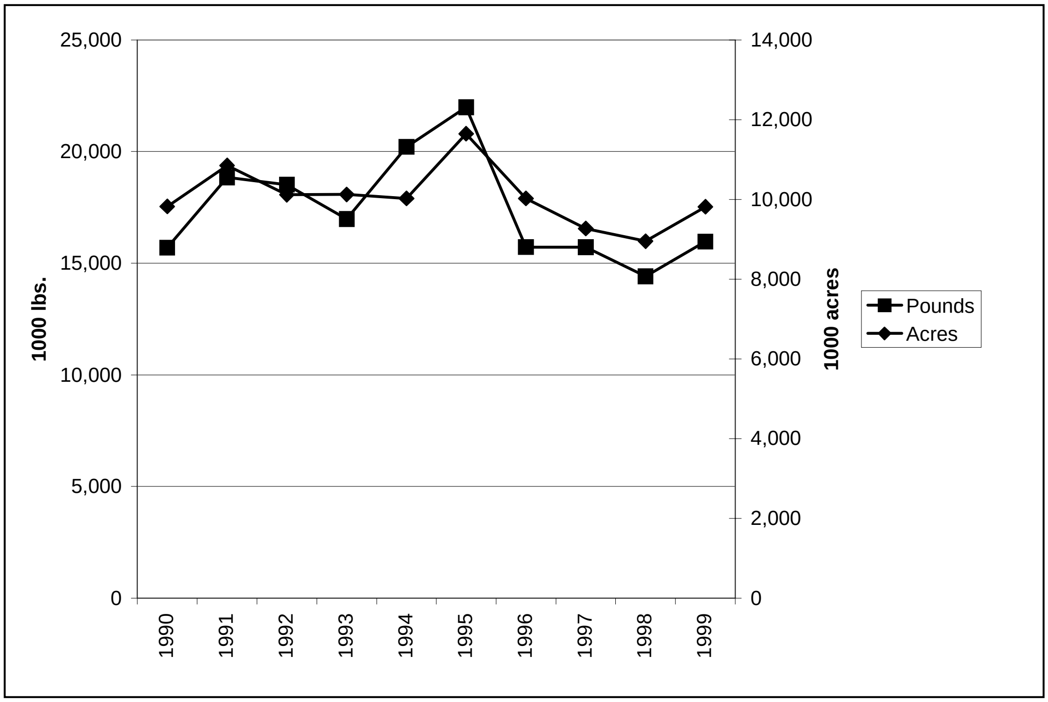
	1994 to 1998	1994 to 1999
	(1,000)	
Pounds	3,643	3,825
Applications	1,775	1,316

Table 8. Use of Individual Cotton Herbicide Active Ingredients 1994 and 1999

	1994	1999
	percent of acres treated	
2,4-D		1
Bromoxynil		7
Clethodim		2
Clomazone	12	3
Cyanazine	18	15
Diuron	11	24
DSMA	5	2
Fluaziflop-P-butyl	4	1
Fluometuron	30	27
Glyphosate	8	36
Lactofen	3	
Metolachlor	4	5
MSMA	22	18
Norflurazon	13	5
Pendimethalin	18	24
Prometryn	26	14
Pyrithiobac-sodium		14
Trifluralin	61	52

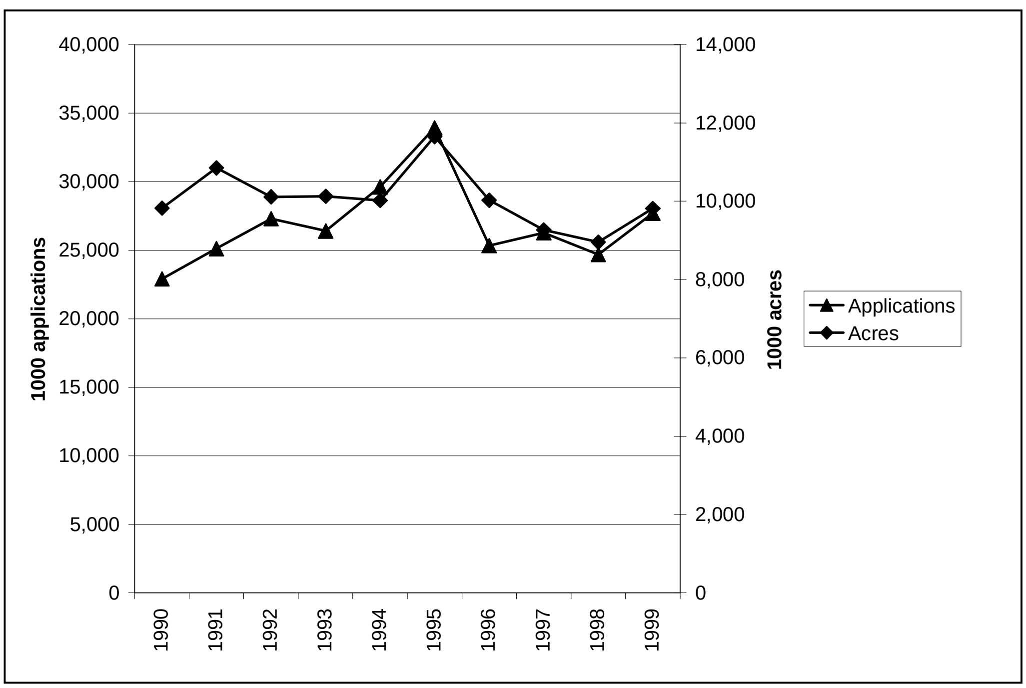
Source: USDA NASS

Figure 2. Herbicide Use in Cotton 1990-99 (AR, AZ, CA, LA, MS, TX)



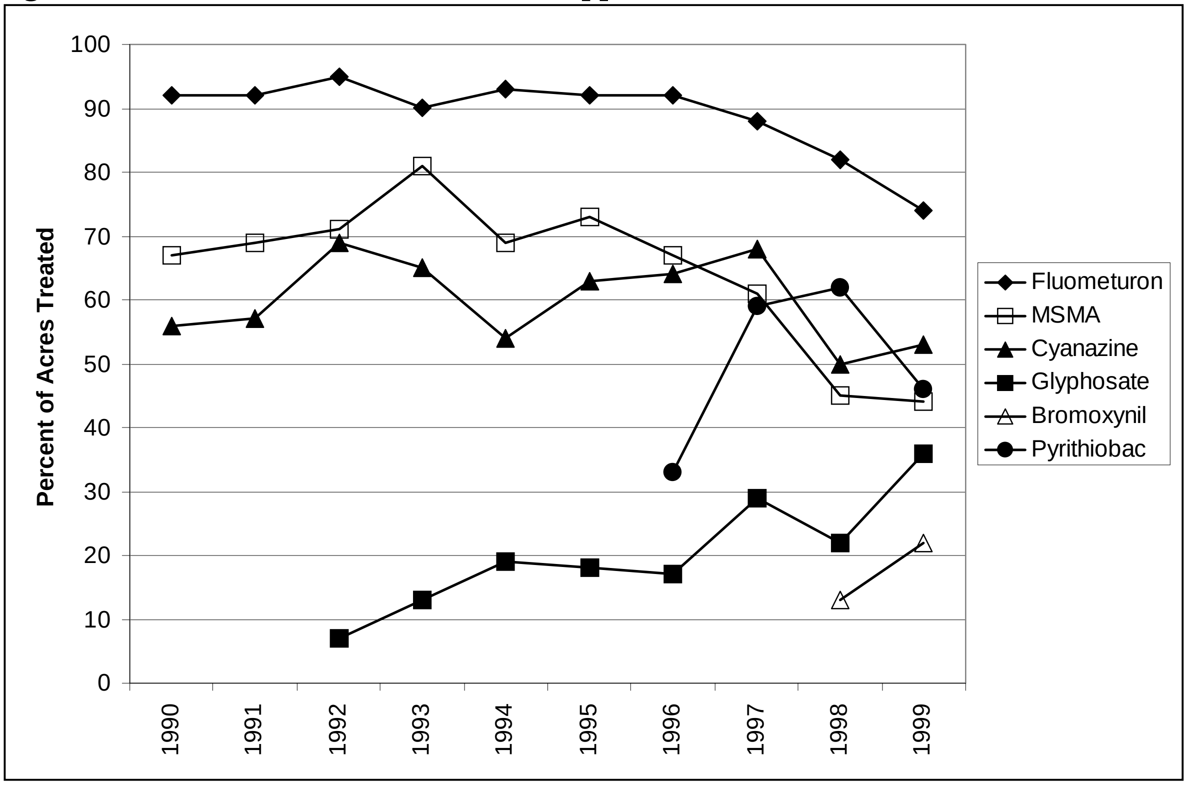
Source: USDA NASS

Figure 3. Cotton Herbicide Applications 1990-99 (AR, AZ, CA, LA, MS, TX)



Source: USDA NASS

Figure 4. Herbicide Use Trends in Mississippi 1990 to 1999



Source: USDA NASS

Table 9. Reductions in Cotton Bollworm/Tobacco Budworm/Pink Bollworm Insecticide Use After Introduction of Bt Varieties (AR, AZ, CA, LA, MS, TX)

	Reduction from 1995 to 1998		Reduction from 1995 to 1999	
	Pounds (1,000)	Applications (1,000)	Pounds (1,000)	Applications (1,000)
Amitraz	66	347	73	408
Cyfluthrin	23	824	72	2,115
Cypermethrin	62	1,696	109	2,550
Deltamethrin	-15	-566	-1	-88
Esfenvalerate	34	885	40	1,039
Lambdacyhalothrin	35	1,154	85	2,870
Methomyl	328	1,238	404	1,457
Profenofos	955	1,804	1,114	2,091
Spinosad	-31	-481	-19	-288
Thiodicarb	568	1,888	842	2,574
Tralomethrin	22	988	26	1,165
Zeta-cypermethrin	-40	-1,037	-31	-751
Total	2,008	8,738	2,715	15,142

Table 10. Yield Losses Due to Tobacco Budworm, Cotton Bollworm and Pink Bollworm

	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
Alabama	2.6	4.5	4.5	2.6	3.4	1.4	1.7	2.5	6.8	6.1	29.1	3.1	3.2	4.7	2.0
Arizona	3.6	2.9	2.3	1.4	1.5	4.6	1.1	0.7	0.1	3.9	1.2	2.8	2.7	0.0	1.0
Arkansas	1.8	1.8	1.1	1.4	1.0	1.3	1.5	2.6	1.5	1.8	3.6	3.1	2.7	4.7	1.3
California	0.8	0.0	0.0	1.0	0.0	0.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Florida	4.3	5.5	7.2	4.4	5.5	9.1	4.0	3.0	3.0	3.7	3.9	3.3	4.3	2.1	0.7
Georgia	3.6	4.1	2.1	2.7	4.7	5.0	1.0	1.8	1.9	1.9	2.8	1.9	2.5	2.8	0.8
Louisiana	4.0	5.3	2.7	2.3	5.8	4.0	3.5	7.5	3.6	2.9	3.2	2.3	1.9	1.5	0.8
Mississippi	1.3	4.9	4.6	4.9	4.6	4.5	0.6	3.9	3.9	4.1	8.0	1.9	2.4	4.2	2.5
Missouri	1.0	0.6	1.9	7.5	0.0	1.1	1.6	1.7	0.9	0.5	1.4	1.3	1.3	6.1	0.7
New Mexico	4.5	3.9	0.8	2.4	2.5	5.0	3.4	1.6	3.0	1.6	3.3	10.6	8.6	6.1	3.7
North Carolina	8.5	2.5	0.9	5.2	8.6	3.6	12.6	4.3	2.3	6.4	3.7	5.2	5.3	4.4	4.1
Oklahoma	5.0	1.8	1.9	1.3	0.5	1.2	1.6	3.3	3.1	1.7	2.5	3.3	3.0	4.0	5.0
South Carolina	4.3	3.2	2.1	4.6	2.6	2.4	1.9	2.8	3.4	3.4	4.7	5.0	4.7	3.5	1.9
Tennessee	3.0	2.0	2.1	1.6	0.8	0.3	1.0	1.0	6.7	0.5	10.8	0.8	1.0	5.9	1.6
Texas	3.8	2.3	1.9	0.9	1.5	1.1	1.8	1.4	0.5	0.8	1.0	3.0	1.7	1.3	0.4
Virginia	15.0	10.0	2.4	3.4	4.7	12.5	4.0	0.2	0.0	0.5	1.0	2.0	0.3	0.0	0.3

Source: Williams

Table 11. Insecticide Treatments for Tobacco Budworm, Cotton Bollworm and Pink Bollworm

	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
Alabama	5.2	4.9	2.0	3.7	2.5	2.9	2.9	4.8	4.4	6.7	0.1	0.5	1.4	0.4
Arizona	2.2	6.3	2.9	3.9	7.4	3.2	1.1	0.1	2.9	2.9	2.0	1.1	0.1	0.4
Arkansas	2.9	1.3	2.9	2.6	2.4	3.3	3.7	3.6	3.0	4.6	2.3	1.6	3.1	0.5
California	0.1	0.0	0.6	0.2	0.1	0.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Florida	9.0	7.1	5.6	8.4	7.2	5.0	5.0	5.3	5.3	5.7	1.1	1.0	2.0	0.5
Georgia	7.3	6.2	4.4	4.3	5.0	4.9	3.4	2.7	4.3	3.4	1.7	2.5	1.5	0.6
Louisiana	5.5	4.3	3.7	5.8	5.0	3.5	5.8	4.7	4.8	4.7	3.9	3.2	3.5	1.2
Mississippi	4.6	4.7	3.7	4.8	3.4	1.5	5.1	4.3	4.1	5.7	2.2	2.5	2.5	1.3
Missouri	0.3	0.6	1.5	0.0	0.1	0.3	0.3	0.9	0.8	1.3	0.1	0.7	1.6	0.9
New Mexico	1.1	0.1	0.4	0.6	1.1	0.8	0.3	0.3	0.7	0.8	1.1	0.7	2.0	1.1
North Carolina	3.5	2.7	2.6	2.9	2.8	3.1	3.0	2.5	3.6	2.6	3.1	2.0	3.0	1.9
Oklahoma	1.8	1.1	1.3	0.8	0.9	1.3	1.1	2.3	0.7	1.8	1.7	1.9	1.5	0.7
South Carolina	3.1	2.8	3.7	3.5	3.8	3.8	3.7	4.9	4.4	4.7	4.2	3.3	3.4	1.1
Tennessee	0.4	0.5	0.3	0.4	0.3	0.6	0.1	2.0	0.3	2.9	0.2	0.3	2.7	0.6
Texas	0.8	1.2	0.8	0.7	0.7	1.1	0.7	0.4	0.7	0.5	0.7	0.6	0.6	0.1
Virginia	2.0	1.0	1.4	0.8	1.5	2.5	0.2	1.0	1.7	1.5	1.0	1.2	2.2	1.8

Source: Williams

Table 12. Cotton Insecticide Use Rates in Alabama

Year	Planted Acreage (1,000)	Percent of Acreage Treated	Pounds Applied (1,000)	Rate (lbs/acre)
1997	535	85	469	1.03
1998	495	91	422	.94
1999	565	87	436	.87

Source: USDA NASS

Table 13. Cotton Insecticide Applications in Bt and Conventional Varieties 1999

	Arizona		Louisiana		Tennessee	
Target Pest	**Bt**	**Conv.**	**Bt**	**Conv.**	**Bt**	**Conv**
Cotton Bollworm, Tobacco Budworm and Pink Bollworm	0.0	1.1	0.8	1.8	0.3	1.2
Boll Weevil	0.0	0.0	3.1	2.7	4.5	3.9
Other Insects	1.6	1.4	3.4	3.3	2.1	1.5
Total	1.6	2.5	7.3	7.8	6.8	6.6

Source: Williams 2000

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