Chapter 24

THE ECONOMIC IMPACT OF COTTON INSECTS AND MITES

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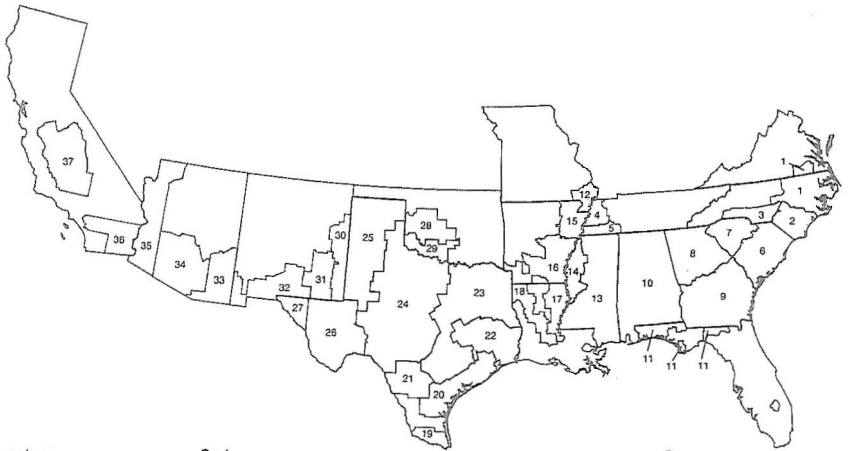
INTRODUCTION

Cotton farming is a major field crop enterprise and an important source of foreign exchange in the United States. In 1985-86, cotton ranked fifth among field crops in value of production with about 38,000 growers scattered from Virginia to California earning $4 billion from the sale of lint and cottonseeds (Starbird *et al.*, 1987). United States cotton production is particularly susceptible to losses caused by the presence of insect and mite pests. Indeed, a major factor influencing the viability of cotton production in many areas is the ability of growers to control insect and mite populations and, therefore, minimize production losses, risk and uncertainty.

Many insect and mite species attack cotton foliage and bolls limiting potential yields. The aggregate damage attributed to cotton insects and mites is often reported as annual yield reductions of 7 to 14 percent and control expenditures in excess of $200 million per year despite best control efforts (Anonymous, 1980, 1981, 1983; Head, 1982, 1984, 1985; and King *et al.*, 1986, 1987). Using recent years as examples, estimates of the extent of economic impacts caused by these pests are examined in this chapter. A brief survey was conducted of available data on grower control practices, crop damage and aggregate effects and public expenditures. Reported results provide approximations of current economic impacts on domestic agricultural production, producers and consumers.

KEY INSECT AND MITE PESTS

Cotton production areas are clearly defined in the United States, each with a different ecosystem and complex of serious insect and mite problems (Figure 1). In general, these areas can be classified as: the humid areas of the Southeast (Alabama, Florida,



Regions and subregions	Code
Appalachia:	
Virginia and North Carolina--North	1
North Carolina--South	2
Piedmont	3
Tennessee--North Brown Loam	4
South Brown Loam	5
Southeast:	
South Carolina--Coastal Plains	6
Piedmont	7
Georgia--Piedmont	8
East and Southwest	9
Alabama--Limestone Valley and South	10
Florida	11
Corn Belt:	
Missouri--Bootheel	12
Delta States:	
Mississippi--Non-Delta	13
Delta	14
Arkansas--Northeast	15
Southeast	16
Louisiana--Northeast	17
Red River Valley	18
Southern Plains:	
Texas--Lower Rio Grande	19
Upper and Lower Coast	20
Winter Garden	21
Central River Bottom	22
Blacklands	23
Rolling Plains and Upper Concho	24
High Plains	25
Trans Pecos	26
El Paso and Hudspeth Counties	27
Oklahoma--North	28
South	29
Mountain States:	
New Mexico--Southern Plains	30
Pecos Valley	31
Upper Rio Grande	32
Arizona--Southeast	33
Central	34
Yuma and Mohave Counties	35
West:	
California--Lower Desert Valleys	36
San Joaquin Valley	37

Figure 1. Subregions of cotton production in the United States Cotton Belt.

Georgia, North Carolina, and South Carolina); Delta or Mid-South (Arkansas, Louisiana, Mississippi, Missouri and Tennessee), and coastal areas of Texas where the bollworm, *Helicoverpa zea* (Boddie), tobacco budworm, *Heliothis virescens* (F.), boll weevil, *Anthonomus grandis grandis* (Boheman), plant bugs, and thrips are the key pests; the semi-arid areas of the Southwest (New Mexico, Oklahoma and inland Texas) where the key pests are the bollworm, tobacco budworm, cotton fleahopper, *Pseudatomoscelis seriatus* (Reuter), and the boll weevil; and the irrigated deserts of the Far West (Arizona and California) where the pink bollworm, *Pectinophora gossypiella* (Saunders), spider mites, and the western lygus bug, *Lygus hesperus* Knight, are the key pests.

In the sections that follow, aggregate estimates of pest control incidence, chemical use, grower control expenditures and yield loss are reported for key insect and mite species in each cotton producing state and area in the United States. Estimates generally rely on selected cotton pesticide use surveys (USDA, 1964-87) and on cotton experts who have provided state and area specific estimates of pest incidence, control measures (Suguiyama and Osteen, 1988), and yield losses (Anonymous, 1980, 1981, 1983; Head, 1982, 1984, 1985; and King *et al.*, 1986, 1987). Target pests include individual species and two major complexes: (a) bollworm/tobacco budworm/boll weevils; and (b) pink bollworm/other pests. The individual pests category includes the bollworm, boll weevil, plant bugs, stink bugs, and other minor pest species.

PEST INCIDENCE

Early planting, the use of rapid fruiting and early maturing varieties, optimum fertilization and irrigation, plant spacing, trap crops[1], early harvest and crop residue disposal have long been recognized and adopted as excellent measures for reducing potential insect and mite damage on cotton production (National Academy of Sciences, 1975; Namken *et al.*, 1983; Grimes, 1985). These cultural practices have been extensively investigated and complement pest management strategies for detection, augmentation of biological control techniques, and timing of chemical control practices. Bradley and Agnello (1986) recently provided examples of four major cotton insect pests (bollworm, tobacco budworm, boll weevil and pink bollworm) whose management may be achieved through the application of cultural techniques as basic elements of cotton production programs.

Despite good agronomic practices, cotton insects and mites reach population and potential damage levels that justify the use of chemical control measures in every production area in the United States. An estimated range of 50 to 70 percent of the total cotton acreage harvested is treated annually one or more times with insecticides or miticides (Figure 2). Almost all of the cotton acreage is treated in southeastern, Delta, and western states. Only the southwestern states (New Mexico, Oklahoma and Texas) traditionally have considerably less than 100 percent of acreage treated.

[1]While trap crops have been recognized, they have not been adopted to any significant extent.

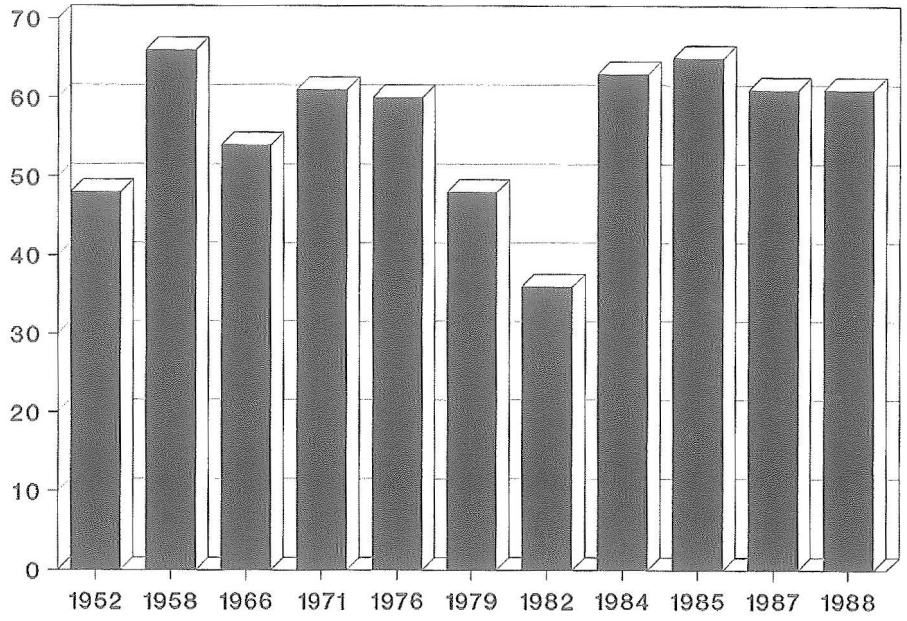


Figure 2. Percentage of cotton acreage treated with insecticides/miticides, 1952–1988. (Source: Economic Research Service, United States Department of Agriculture.)

On the aggregate, grower control efforts are mainly directed at bollworm/ tobacco budworm (an estimated 53 percent of harvested acreage), thrips (42 percent), boll weevil (40 percent), plant bugs (37 percent) and spider mites (17 percent) (Table 1[2,3]). These species predominate in most states and areas. Of particular regional importance are the pink bollworm, seedcorn maggot, *Delia platura* (Meigen), wireworms and whiteflies in western states; and grasshoppers in the Southwest. Estimates of harvested acreage treated for each species in specific cotton production areas are shown in Table 2.

The intensity of pest incidence during the growing season is indicated by the number of chemical applications required to control each population species. Bollworm/tobacco budworm and the boll weevil receive the most applications per harvested acre, on average, of all insect and mite target pests (Table 3[4]). Treated as single targets or as a complex, these pests account for over half of all chemical applications in United States cotton (2.4 out of 4.6 applications per harvested acre). Thrips and plant bugs also account for a large number of applications because of the heavy incidence of acreage treated for these pests in many states.

[2]Comparable estimates of cotton acreage treated for ten important insect and mite pests has been reported from a pesticide use survey for the 1979 crop year (Suguiyama and Carlson, 1985).

[3]All tables referenced in this chapter are found in a Chapter Appendix at the end of this chapter.

[4]The average number of applications per harvested acre in each state is a weighted estimate calculated as the product of the share of total acreage treated times the average number of applications per treated acre.

Great variability is found in the number of applications among producing states and areas (Tables 3, 4). Oklahoma and Texas cotton average the lowest number of applications per harvested acre, 1.3 and 1.9, respectively. In contrast, the southeastern states average the highest number of applications per harvested acre, ranging from 5.9 in North Carolina to 18.4 in Florida. The number of applications on North Carolina cotton have declined considerably in recent years in comparison to other southeastern states due to the absence of the boll weevil as a result of the eradication effort (Carlson *et al.*, 1987).

CHEMICAL USE

During this century, cotton insect and mite control practices in the United States have evolved from sole reliance on cultural methods to heavy reliance on chemicals to adoption of integrated crop and pest management systems (Ridgway and Lloyd, 1983; Bradley and Agnello, 1986). The use of chemical controls remains as an effective tool to reduce damaging population levels. These compounds generally are toxic to beneficial arthropods and are potentially hazardous to other nontarget organisms if proper application or disposal procedures are ignored. These are important factors contributing to the overall impact that these pests have on agricultural production, thus they need to be examined.

Suguiyama and Osteen (1988) estimated that the average United States cotton harvested acre receives 1.64 pounds of active ingredients for insect and mite control (Table 5). The total amount of active ingredients varies considerably among states, ranging from a high of 7.43 pounds per harvested acre in Florida cotton to a low of 0.34 pounds in Oklahoma. Among the compounds, methyl parathion (average estimate of 0.34 pounds per harvested acre), azinphosmethyl (Guthion®) (0.21 lb.), pyrethroids (0.13 lb.), chlordimeform (Galecron®, Fundal®) (0.12 lb.), propargite (Comite®) (0.11 lb.), and aldicarb (Temik®) (0.11 lb.) accounted for about 63 percent of all active ingredients applied to cotton fields in the United States. Figure 3 shows the average amounts of active ingredients for insecticides and miticides applied to United States cotton for selected years. Since 1977, the shift to the pyrethroids to control bollworm/tobacco budworm has resulted in a significantly smaller amount of insecticides being applied to cotton (Cooke and Parvin, 1983). This is largely due to smaller dosages being required for the pyrethroids. However, longer application intervals due to increased effectiveness and/or longer residual activity may also contribute.

The amount and class of chemicals applied to cotton fields have also changed considerably in recent years. Figure 4 contrasts the quantity of chemical materials by classes between the period prior to 1979 when pyrethroids were not registered for use and the following years when pyrethroids were registered and extensively used. The substantial decline in total amounts of chemical used is noted as the past extensive use of organochlorines (for example: DDT, endrin, and toxaphene) has been proportionately replaced with the use of organophosphates, carbamates and pyrethroids. Several factors have contributed to these changes. They include the development of newer and

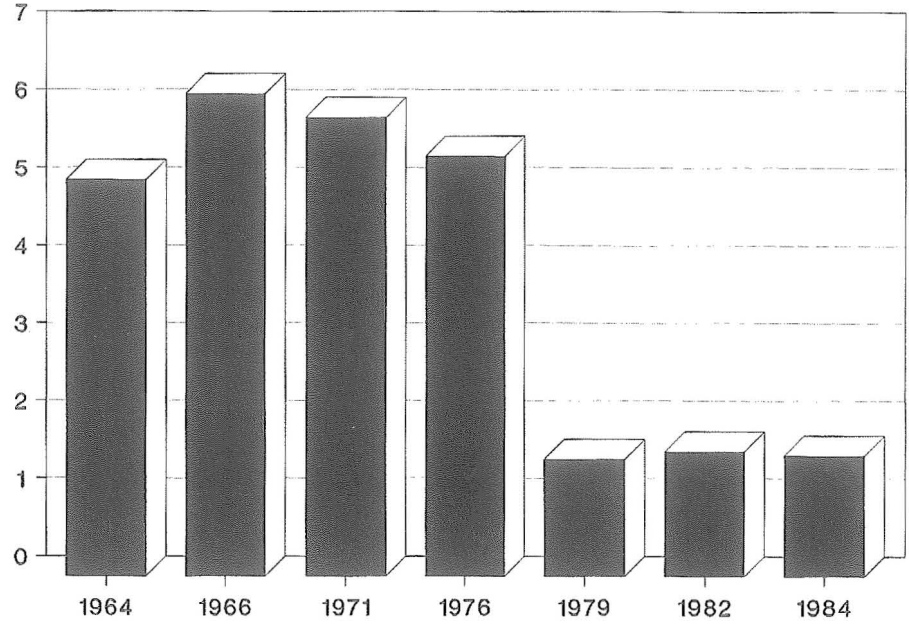


Figure 3. Pounds per planted acre of insecticide/miticide used on cotton 1964-1984. (Source: Economic Research Service, United States Department of Agriculture.)

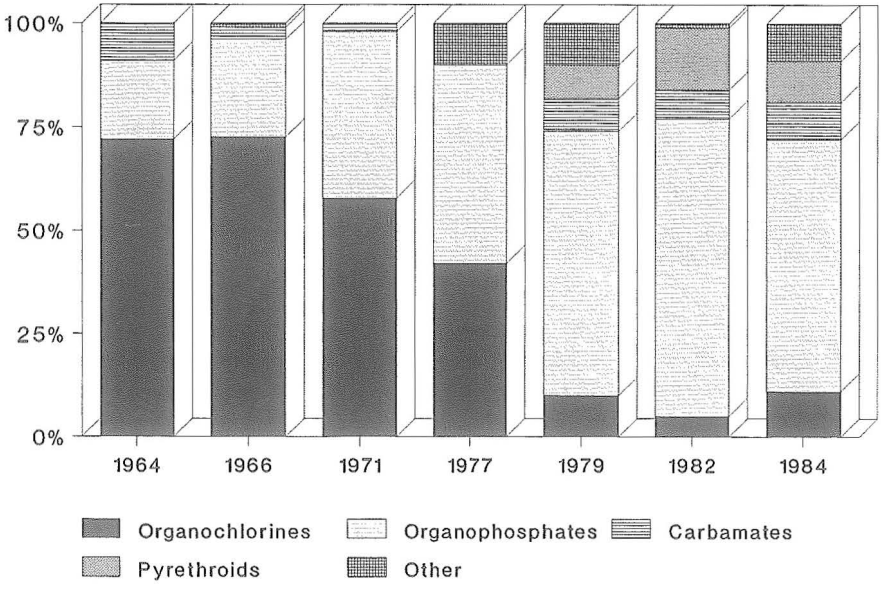


Figure 4. Distribution by chemical class of cotton insecticides/miticides used, 1964-1984. (Source: Economic Research Service, United States Department of Agriculture.)

safer compounds, stricter pesticide regulations, pest resistance, and the extensive efforts of research and extension specialists in promoting integrated crop and pest management practices.

CONTROL EXPENDITURES

Past survey results on expenditures for cotton insecticides and miticides for the 1971-77 period have been carefully reviewed by Cooke and Parvin (1983). Their analysis showed that while insect and mite populations are highly variable, the national per acre cost of insect and mite control has remained remarkably constant. Table 6 shows average estimates of per acre expenditures for insect and mite control for selected years between 1964 and 1980.

Suguiyama and Osteen (1988) estimated average grower control expenditures in United States cotton production to be about $37 per harvested acre, including scouting costs (Table 7[5]). Based on this estimate, the total annual grower expenditures for insect and mite control was approximately $381 million. Bollworm/tobacco budworm and the boll weevil account for over 42 percent of the total insect control expenditures, about $16 out of $37. Cotton grown in the Southeast requires the highest per acre expenditures to control these pests — Florida ($119 per harvested acre), Georgia ($72) and Alabama ($56). The lowest per acre expenditures for these pests are in California ($3), Missouri ($5) and Texas ($5). Also significant are expenditures for pink bollworms in the infested areas of the West. For example, Arizona cotton farmers spend an average of $96 per harvested acre to control primarily pink bollworms.

Per acre grower expenditures for all cotton insects and mites vary considerably among states and areas. The Southeast and Delta states usually report the highest per-acre expenditures for all insect and mite control. Florida farmers spend the most, $145 per harvested acre, while Oklahoma farmers spend the least, about $11 per harvested acre. Estimates of insect control expenditures per harvested acre by species in each cotton production area are reported in Table 8.

COTTON YIELD LOSSES

Yield losses caused by insects and mites have been reported in several studies with significant differences across time (for examples see reports by the U. S. Department of Agriculture, 1965; DeBord, 1977; Schwartz and Klassen, 1981; and Schwartz, 1983). However, estimating yield losses are notoriously difficult to fix on aggregate levels. Survey and experimental methods are used for obtaining replicated loss estimates for adjacent treated and untreated plots. The vexing problem is that such information cannot be easily extrapolated over large areas or average farm conditions because many cultural, physical and environmental factors are important determinants of yield in complex and dynamic crop ecosystems (Carlson and Castle, 1972).

[5]The per acre cost estimate is expressed in 1986 dollars and represents approximately 17 percent of total variable costs per acre of cotton grown in the United States.

In this study, estimates of insect and mite losses in cotton production were obtained from the Proceedings of the Annual Beltwide Cotton-Insect Research and Control Conferences (Anonymous, 1980, 1981, 1983; Head, 1982, 1984, 1985; and King *et al.*, 1986, 1987). The insect and mite cotton loss estimates presented in these annual reports are generated by entomologists and other cotton experts in each of the cotton producing states. These estimates are widely accepted and used by entomologists, extension personnel, pesticide vendors, and cotton producers.

Average production-weighted loss estimates have been summarized for major insect and mite pests. Beltwide loss estimates are shown in Table 9; loss estimates by individual states are shown in Table 10. In the aggregate, 7.7 percent of the annual cotton crop is estimated to be lost to damage despite control measures. Bollworm/tobacco budworm (2.5 percent loss), the boll weevil (1.5 percent), plant bugs (1.6 percent) and spider mites (0.8 percent) are responsible for 65 percent of the total crop loss attributed to insects and mites. The only other species causing significant yield loss is the pink bollworm in the infested areas of the West.

VALUE OF DIRECT DAMAGE

The composite values of damage (yield loss plus control costs) caused by individual species rarely have been reported for cotton pests, with the exception of the boll weevil. Aggregate estimates of economic damage reported in Table 11 are expressed as the sum value of yield losses (from estimates in Table 10) and control expenditures (from Table 7). The calculation of value of yield loss assumes the average market price of cotton to be $0.5844 per pound of lint (1981-84 average). These values represent maximum damage values directly affecting producers alone, since cotton market and other production effects or adjustments in the absence of insect and mite damage are ignored.

The total annual damage caused by all insects and mites on cotton production is estimated to be about $645 million. By species, over half of the damage can be attributed to bollworm/tobacco budworm ($216 million) and the boll weevil ($146 million). Plant bugs also cause significant damage, $76 million. Plant bugs are viewed as serious in California (western lygus bug) and Texas (cotton fleahopper) as well as the Mid-South (tarnished plant bug). The damage caused by the pink bollworm, $71 million, is particularly significant because all damage is concentrated on only six percent of the total United States cotton harvested acreage (Table 1).

AGGREGATE EFFECTS

The continued presence of cotton pests and their associated control measures influence: (a) adjustments in farm cropping patterns (acreage shifts, cultural practices, resistant varieties); (b) the demand for farm inputs (insect control inputs and their efforts on other input use); (c) supply and demand relationships in both the domestic and world market (product price and U.S. comparative advantage); and (d) future production and

income stability. As a result, the $645 million crop damage estimate for cotton does not fully reflect the annual impact of insects and mites on total agricultural production.

Several studies have attempted to approximate, either directly or indirectly, the regional and aggregate effects of cotton pests on crop production and marketing (Casey and Lacewell, 1973; Taylor, 1980; Suguiyama and Osteen, 1988). There also are other reports dealing with the effects of pesticide use decisions or areawide pest management programs on crop production. But, because of the complex and interconnected nature of the United States agricultural industry, it is difficult to estimate the effects of producing in the absence of insects and mites, either on total cotton production or on the production of alternative crops.

In one particular study, Suguiyama and Osteen (1988) constructed a scenario in which cotton and other pertinent field crops suffer no damage from insects and mites. As a result, the yield losses and control expenditures were eliminated as output-reducing factors, therefore, yield increased and production costs decreased. Where the absence of insects was restricted to predominant species in cotton and to bollworm and fall armyworm damage in corn, soybean and sorghum, the net annual aggregate impact approached $1.3 billion, or twice the $645 million damage estimate reported earlier for cotton alone[6].

Analytical results generally indicate that the presence of insect and mite pests cause significant changes in cotton planted acreage among production regions. Cotton acreage decreases while soybean, sorghum and corn acreage increases. The Southeast and Delta states, where insect pests cause the greatest direct damage, significantly decrease their cotton plantings. This result is not surprising, since most acreage declines due to pest problems have historically occurred in these regions. Producer income above variable costs are also affected as producers from the southeastern and Delta states, and Arizona suffer the most losses (yield damage and high control costs).

Cotton consumers also lose from lower crop output and thus, higher cotton prices. In turn, lower output and higher prices for fiber alter domestic and foreign cotton markets. Traditionally, the United States has been a residual supplier of cotton in foreign markets; that is, the difference between foreign production and consumption has been met from United States production (National Academy of Sciences, 1975). Furthermore, additional effects may be expected from farm programs since cotton programs have generally included price support or acreage control provisions.

In summary, the annual net domestic aggregate impact of cotton insects and mites on agricultural production involves many significant economic and distributional effects among cotton producers, domestic and foreign, and between cotton producers and consumers.

SUMMARY

Bollworms and tobacco budworms were the most damaging insect pests of cotton, causing direct annual losses of $216 million. The boll weevil ($146 million), plant

[6]The same data estimates were utilized to approximate the direct impact to production and to approximate the net aggregate impact.

bugs ($76 million), pink bollworm ($71 million), spider mites ($64 million), and thrips ($44 million) are also important. Plant bugs and thrips infest a large portion of United States cotton acreage, while the pink bollworm causes heavy damage in the West.

The aggregate economic effects of cotton insects and mites include losses in producer revenues, higher production costs, consumer losses, and net losses to society from wasted resources. Commonly used methods to estimate pest impacts or damages rely on the value of control expenditures plus yield losses. The estimated annual value of direct damage to cotton producers is $645 million, of which about $381 million are chemical control expenditures. More comprehensive analyses suggest that the overall impact from cotton insects and mites has been greater than the above damage estimate.

These reported estimates constitute benchmarks for the assessment of economic impacts caused by cotton insects and mites on United States agriculture. Despite limitations with the data employed in this study, these estimates support current farmer concerns and the need for continued research and educational activities on pest control technologies.

DISCLAIMER

The views presented are those of the authors and do not represent those of any agency or organization. This chapter was written in 1988 and some changes in cotton production and pest control have occurred since then. At the time this chapter was submitted, the senior author was a USDA/APHIS employee.

Chapter 24

APPENDIX

Table 1. Percent of cotton harvested acreage treated one or more times against target pest.

Target pest	Acreage treated																
	AL	AZ	AR	CA	FL	GA	LA	MS	MO	NM	NC	OK	SC	TN	TX	VA	U.S. cotton
	Percent																
BW & TBW[1]	—	73.6	75.0	8.3	100.0	50.0	90.0	52.8	30.0	64.4	98.0	25.0	96.7	50.0	22.8	98.0	34.5
Boll weevil/BW & TBW	100.0	—	55.0	—	100.0	98.8	100.0	37.0	—	—	—	—	—	0.5	6.5	—	19.1
Boll weevil[2]	30.0	32.2	43.9	0.6	100.0	77.1	72.4	49.1	—	—	20.2	7.7	39.0	0.5	11.7	—	20.8
Pink bollworm	—	99.5	—	5.8	—	—	—	—	—	11.3	—	—	—	—	0.6	—	5.8
Pink bollworm/other pests[3]	—	94.7	—	—	—	—	—	—	—	—	—	—	—	—	—	—	4.5
Spider mites	15.0	46.2	—	75.9	2.0	19.4	31.7	21.3	5.0	—	—	—	9.6	2.0	0.9	—	17.0
Thrips	95.0	18.8	98.0	9.4	100.0	87.7	97.6	95.0	100.0	21.3	92.3	2.5	98.3	100.0	24.0	85.0	42.3
Plant bugs[4]	15.0	68.1	34.5	44.4	2.0	29.1	51.2	93.3	50.0	24.5	—	18.7	5.8	75.0	21.8	—	37.1
Fall and beet armyworms	—	—	—	12.3	65.0	19.1	8.8	23.5	1.0	15.5	2.7	1.0	9.6	—	4.3	2.0	7.0
Seedcorn maggot/wireworms	—	—	—	84.8	—	—	—	—	—	—	—	—	—	—	—	—	10.8
Aphids	10.0	—	—	4.7	5.0	29.4	24.4	21.3	5.0	10.7	—	1.7	5.0	2.0	12.4	—	11.0
Whiteflies	—	1.0	—	10.2	2.0	—	—	4.0	—	—	—	—	1.8	—	—	—	1.7
Cotton leafperforator	—	27.1	—	1.2	—	—	—	—	—	—	—	—	—	—	—	—	1.4
Cabbage looper	—	—	—	4.7	2.0	0.9	—	—	1.0	—	—	—	—	—	—	—	0.6
Cutworms	—	2.7	—	4.7	—	—	—	—	—	—	—	—	—	—	0.2	—	0.8
Stink bugs	—	—	—	2.3	—	—	—	—	—	—	—	—	—	—	—	—	0.3
Grasshoppers	—	—	—	—	—	—	—	—	—	15.7	—	3.3	—	—	0.3	—	0.4
All insects and mites[5]	100.0	99.5	100.0	100.0	100.0	99.7	100.0	100.0	100.0	80.7	98.0	63.0	98.3	100.0	56.8	98.0	77.5

— = Unreported or insignificant estimate.

Source: Suguiyama and Osteen, 1988.

[1]Includes the bollworm (BW) and tobacco budworm (TBW).

[2] The acreage treated for the boll weevil in Arizona, California, North Carolina, and South Carolina were estimated prior to completion of cooperative efforts to eradicate the boll weevil from these States.

[3]Other pests include bollworm, tobacco budworm, boll weevil, *Lygus* spp., and stink bugs.

[4]Include *Lygus* spp. and cotton fleahoppers.

[5]Columns may not total 100 due to multiple treatments.

Table 2. Percent of cotton harvested acreage treated one or more times against target pests.

	NC subregions[6]			TN subregions[6]		SC subregions[6]		GA subregions[6]		MS subregions[6]		AR subregions[6]		LA subregions[6]		TX subregions[6]	
Target pest	1	2	3	4	5	6	7	8	9	13	14	15	16	17	18	19	20
									Percent								
BW & TBW[1]	98.0	100.0	85.0	50.0	50.0	99.0	70.0	50.0	50.0	30.0	65.0	50.0	95.0	90.0	90.0	59.0	18.0
Boll weevil/BW & TBW	—	—	—	—	2.0	—	—	80.0	100.0	50.0	30.0	5.0	95.0	100.0	100.0	100.0	49.0
Boll weevil	5.0[2]	45.0[2]	40.0[2]	—	2.0	40.0[2]	27.0[2]	30.0	80.0	85.0	30.0	5.0	75.0	70.0	90.0	98.0	54.0
Spider mites	—	—	—	2.0	2.0	10.0	5.0	10.0	20.0	5.0	30.0	—	—	25.0	80.0	—	—
Thrips	90.0	100.0	70.0	100.0	100.0	99.0	90.0	50.0	90.0	95.0	95.0	98.0	98.0	100.0	80.0	—	20.0
Plant bugs[3]	—	—	—	75.0	75.0	5.0	15.0	15.0	30.0	90.0	95.0	40.0	30.0	50.0	60.0	85.0	90.0
Fall and beet armyworms	2.0	4.0	2.0	—	—	10.0	5.0	5.0	20.0	30.0	20.0	—	—	10.0	—	—	—
Aphids	—	—	—	2.0	2.0	5.0	5.0	20.0	30.0	5.0	30.0	—	—	25.0	20.0	—	10.0
Whiteflies	—	—	—	—	—	2.0	—	—	—	2.0	5.0	—	—	—	—	—	—
Cabbage looper	—	—	—	—	—	—	—	—	1.0	—	—	—	—	—	—	—	—
Cutworms	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	4.0
All insects and mites[5]	98.0	100.0	85.0	100.0	100.0	99.0	90.0	95.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	97.0

Table 2. Continued

Target pest	TX subregions[6]							OK subregions[6]		NM subregions[6]			AZ subregions[6]			CA subregions[6]	
	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37
	Percent																
BW & TBW[1]	100.0	98.0	15.0	10.0	23.0	88.0	75.0	15.0	30.0	30.0	90.0	70.0	45.0	70.0	100.0	95.0	3.0
Boll weevil	100.0	35.0	40.0	10.0	—	—	—	1.0	10.0	—	—	—	—	—	90.0	10.0	—
Pink bollworm	—	—	—	—	—	15.0	75.0	—	—	—	10.0	20.0	95.0	100.0	100.0	100.0	—
Pink bollworm/other pests[4]	—	—	—	—	—	—	—	—	—	—	—	—	45.0	100.0	100.0	—	—
Spider mites	100.0	15.0	5.0	—	—	—	—	—	—	—	—	—	20.0	40.0	80.0	90.0	75.0
Thrips	75.0	15.0	70.0	2.0	33.0	2.0	5.0	1.0	3.0	20.0	10.0	30.0	7.0	20.0	20.0	—	10.0
Plant bugs[3]	100.0	85.0	65.0	5.0	15.0	20.0	15.0	15.0	20.0	15.0	40.0	20.0	60.0	60.0	100.0	100.0	41.0
Fall and beet armyworms	5.0	—	—	—	7.0	5.0	20.0	—	1.0	—	10.0	30.0	—	—	—	50.0	10.0
Seedcorn maggot/wireworms	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	90.0
Aphids	5.0	—	20.0	2.0	18.0	20.0	5.0	1.0	2.0	—	15.0	15.0	—	—	—	—	5.0
Whiteflies	—	—	—	—	—	—	—	—	—	—	—	—	—	—	5.0	95.0	5.0
Cotton leafperforator	—	—	—	—	—	—	—	—	—	—	—	—	—	30.0	30.0	20.0	—
Cabbage looper	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	5.0
Cutworms	—	—	—	—	—	—	—	—	—	—	—	—	—	3.0	3.0	—	5.0
Stink bugs	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	40.0	—
Grasshoppers	—	—	—	1.0	—	3.0	—	4.0	3.0	15.0	20.0	20.0	—	—	—	—	—
All insects and mites[5]	100.0	98.0	92.0	15.0	65.0	92.0	85.0	45.0	80.0	60.0	92.0	87.0	95.0	100.0	100.0	100.0	100.0

— = Unreported or insignificant estimate.
Source: Suguiyama and Osteen, 1988.
[1]Includes the bollworm (BW) and tobacco budworm (TBW).
[2]The acreage treated for the boll weevil was estimated prior to completion of cooperative efforts to eradicate the boll weevil from these States.
[3]Include *Lygus* spp. and cotton fleahoppers.
[4]Other pests include bollworm, tobacco budworm, boll weevil, Lygus spp., and stink bugs.
[5]Columns may not total 100 due to multiple treatments.
[6]Map locations of subregions are shown in Figure 1 of chapter 24.

Table 3. Applications per harvested acre, by target pests.

Target pest	Applications per harvested acre																
	AL	AZ	AR	CA	FL	GA	LA	MS	MO	NM	NC	OK	SC	TN	TX	VA	U.S. cotton
	Number																
BW & TBW[1]	—	0.62	1.50	0.22	7.00	1.43	2.59	1.90	0.85	1.42	3.84	0.72	5.75	1.00	0.45	2.74	0.86
Boll weevil/BW & TBW	7.94	—	1.10	—	7.00	6.29	4.88	1.13	—	—	—	—	—	.02	.18	—	.85
Boll weevil[2]	.42	.32	.88	.01	3.00	3.50	1.67	1.57	—	—	.81	.31	2.19	.02	.54	—	.67
Pink bollworm	—	5.02	—	.29	—	—	—	—	—	.13	—	—	—	—	.02	—	.28
Pink bollworm/other pests[3]	—	3.12	—	—	—	—	—	—	—	—	—	—	—	—	—	—	.15
Spider mites	.20	.47	—	.99	.04	.32	.48	.39	.10	—	—	—	.15	.02	.02	—	.24
Thrips	1.19	.19	1.42	.19	1.30	1.77	1.19	1.79	1.50	.21	1.20	.04	1.56	2.45	.25	1.15	.62
Plant bugs[4]	.15	.63	.34	.53	.02	.43	.55	1.84	1.00	.35	—	.19	.09	.75	.28	—	.51
Fall and beet armyworms	—	—	—	.22	1.30	.23	.09	.47	.02	.21	.02	.01	.19	—	.04	.02	.11
Seedcorn maggot/wireworms	—	—	—	.85	—	—	—	—	—	—	—	—	—	—	—	—	.11
Aphids	.10	—	—	.08	.05	.58	.24	.43	.05	.13	—	.02	.05	.02	.14	—	.15
Whiteflies	—	.02	—	.28	.02	—	—	.04	—	—	—	—	.04	—	—	—	.04
Cotton leafperforator	—	.27	—	.02	—	—	—	—	—	—	—	—	—	—	—	—	.02
Cabbage looper	—	—	—	.09	.02	.01	—	—	.01	—	—	—	—	—	—	—	.01
Cutworms	—	.03	—	.05	—	—	—	—	—	—	—	—	—	—	.01	—	.01
Stink bugs	—	—	—	.02	—	—	—	—	—	—	—	—	—	—	—	—	.00
Grasshoppers	—	—	—	—	—	—	—	—	—	.35	—	.03	—	—	.01	—	.01
All insects and mites[5]	9.70	10.69	5.24	3.84	18.36	13.05	11.69	9.56	3.53	2.80	5.87	1.32	10.02	4.29	1.94	3.91	4.58

— = Unreported or insignificant estimate.

Source: Suguiyama and Osteen, 1988.

[1]Includes the bollworm (BW) and tobacco budworm (TBW).

[2]Boll weevil applications in Arizona, California, North Carolina, and South Carolina were estimated prior to completion of cooperative efforts to eradicate the boll weevil from these States.

[3]Other pests include bollworm, tobacco budworm, boll weevil, *Lygus* spp., and stink bugs.

[4]Include *Lygus* spp. and cotton fleahoppers.

[5]Columns may not total due to tank-mixed applications for several target pests.

Table 4. Applications per harvested acre, by target pests.

	NC subregions[6]			TN subregions[6]		SC subregions[6]		GA subregions[6]		MS subregions[6]		AR subregions[6]		LA subregions[6]		TX subregions[6]	
Target pest	1	2	3	4	5	6	7	8	9	13	14	15	16	17	18	19	20
									Number								
BW & TBW[1]	2.74	6.20	1.62	1.00	1.00	6.08	1.91	0.99	1.46	0.60	2.60	1.00	1.90	2.70	1.80	0.76	0.18
Boll weevil/BW & TBW	—	—	—	—	.10	—	—	3.58	6.46	1.00	1.20	.10	1.90	5.00	4.00	3.00	1.15
Boll weevil	.20[2]	1.80[2]	1.60[2]	—	.10	2.29[2]	1.12[2]	.66	3.68	3.40	.60	.10	1.50	1.40	3.60	7.84	1.97
Spider mites	—	—	—	.02	.02	.16	.09	.18	.33	.10	.54	—	—	.38	1.20	—	—
Thrips	1.15	1.32	.94	2.45	2.45	1.58	1.40	.68	1.84	1.70	1.84	1.47	1.37	1.15	1.50	—	.20
Plant bugs[3]	—	—	—	.75	.75	.08	.30	.15	.45	1.28	2.14	.40	.30	.50	.90	.85	1.80
Fall and beet armyworms	.02	.02	.02	—	—	.20	.05	.08	.24	.60	.40	—	—	.10	—	—	—
Aphids	—	—	—	.02	.02	.05	.05	.20	.60	.10	.60	—	—	.25	.20	—	.10
Whiteflies	—	—	—	—	—	.04	—	—	—	.02	.05	—	—	—	—	—	—
Cabbage looper	—	—	—	—	—	—	—	—	.01	—	—	—	—	—	—	—	—
Cutworms	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	.04
All insects and mites[5]	4.76	10.91	4.48	4.61	4.81	10.99	5.26	5.91	13.49	9.11	10.59	4.30	9.07	12.16	13.71	12.61	5.72

Table 4. Continued

Target pest	TX subregions[6]							OK subregions[6]		NM subregions[6]			AZ subregions[6]			CA subregions[6]	
	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37
	Number																
BW & TBW[1]	9.00	5.29	0.31	0.12	0.39	2.29	1.50	0.20	0.90	0.68	2.27	1.33	0.61	0.60	1.00	2.85	0.06
Boll weevil	3.00	.99	.70	.20	—	—	—	.04	.40	—	—	—	—	—	.90	.20	—
Pink bollworm	—	—	—	—	—	.30	2.25	—	—	—	.15	.20	2.85	5.70	3.70	5.00	—
Pink bollworm/other pests[4]	—	—	—	—	—	—	—	—	—	—	—	—	.61	2.34	7.40	—	—
Spider mites	2.00	.37	.05	—	—	—	—	—	—	—	—	—	.20	.40	.82	1.53	1.12
Thrips	.75	.13	1.05	.02	.33	.02	.05	.01	.05	.20	.10	.30	.07	.20	.20	—	.10
Plant bugs[3]	2.00	1.25	.81	.05	.17	.30	.15	.15	.20	.20	.70	.20	.60	.60	.74	1.70	.40
Fall and beet armyworms	.05	—	—	—	.07	.05	.20	—	.01	—	.19	.38	—	—	—	.50	.20
Seedcorn maggot/wireworms	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	.90
Aphids	.05	—	.20	.02	.22	.26	.05	.01	.02	—	.23	.15	—	—	—	—	.08
Whiteflies	—	—	—	—	—	—	—	—	—	—	—	—	—	—	.10	2.47	.15
Cotton leafperforator	—	—	—	—	—	—	—	—	—	—	—	—	—	.30	.30	.34	—
Cabbage looper	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	.10
Cutworms	—	—	—	—	—	—	—	—	—	—	—	—	—	.03	.03	—	.05
Stink bugs	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	.40	—
Grasshoppers	—	—	—	.01	—	.06	—	.04	.03	.07	.40	.50	—	—	—	—	—
All insects and mites[5]	16.85	8.03	3.12	.42	1.17	3.50	4.34	.44	1.61	1.15	4.03	3.06	4.33	10.27	15.18	14.99	3.16

— = Unreported or insignificant estimate.

Source: Suguiyama and Osteen, 1988.

[1]Includes the bollworm (BW) and tobacco budworm (TBW).

[2]Boll weevil applications were estimated prior to completion of cooperative efforts to eradicate the boll weevil from these States.

[3]Include *Lygus* spp. and cotton fleahoppers.

[4]Other pests include bollworm, tobacco budworm, *Lygus* spp., and stink bugs.

[5]Columns may not total due to tank-mixed applications for several target pests.

[6]Map locations of subregions are shown in Figure 1 of chapter 24.

Table 5. Pounds of active ingredients of insect and mite pest control chemicals per harvested acre.[1]

Active ingredient	Brand Name	Active ingredients per harvested acre																
		AL	AZ	AR	CA	FL	GA	LA	MS	MO	NM	NC	OK	SC	TN	TX	VA	U.S. cotton
		Pounds																
Acephate	Orthene®	0.028	0.286	—	0.191	0.025	0.183	—	0.122	0.005	—	0.025	—	0.032	0.049	0.018	0.023	0.063
Aldicarb	Temik®	.257	.268	0.245	.187	.026	.132	0.146	.094	.188	0.001	.323	—	.259	.150	.057	.320	.112
Azinphosmethyl	Guthion®	.263	2.432	.356	.029	.850	.598	.078	.143	—	—	—	0.002	.007	.003	.082	—	.208
Carbaryl	Sevin®	—	.027	—	.054	—	—	—	—	—	.061	—	.003	—	—	.002	—	.010
Carbofuran	Furadan®	—	—	—	—	—	—	—	—	—	—	—	—	—	—	.004	—	.002
Chlordimeform	Galecron®, Fundal®	.406	.732	.164	.048	.613	.356	.181	.221	.088	.016	.050	.080	.330	.025	.028	.036	.119
Chlorpyrifos	Lorsban®	.064	—	.017	.263	.030	.069	.033	.246	.001	.005	—	.001	.001	.029	.010	—	.068
Demeton	Systox®	—	—	—	.015	—	—	—	—	—	—	—	—	—	—	—	—	.002
Dicofol	Kelthane®	—	.233	—	.556	—	.010	.097	.029	.010	—	—	—	.058	—	.002	—	.092
Dicrotophos	Bidrin®	.067	.003	.126	.021	.128	.068	.164	.096	.266	.064	.008	.013	.049	.089	.025	.008	.049
Dimethoate	Cygon®, Defend®	—	—	.104	.017	.002	.104	.094	.096	.244	.027	.008	.004	.032	.082	.015	.008	.036
Disulfoton	DiSyston®	.124	—	—	—	.375	.132	—	—	—	—	.027	—	.059	—	.003	.027	.008
Endosulfan	Thiodan®	—	—	—	.023	—	—	—	—	—	—	—	—	—	—	—	—	.003
EPN		—	—	—	—	—	—	—	—	—	—	—	.077	.126	—	.052	—	.029
Lindane		—	—	—	.005	—	—	—	—	—	—	—	—	—	—	—	—	.001
Malathion		.009	.074	—	.017	—	.087	.073	—	—	.210	1.010	.022	1.319	—	.056	—	.060
Methamidophos	Monitor®	—	—	—	.120	—	—	—	.037	—	—	—	—	—	—	—	—	.019
Methidathion	Supracide®	—	.182	—	.015	—	—	—	—	—	—	—	—	—	—	—	—	.010
Methomyl	Lannate®, Nudrin®	—	.077	—	.009	—	—	—	.023	.002	.184	.009	—	.054	—	.017	.009	.017
Methyl parathion		2.124	.838	.275	—	3.000	2.176	.593	.641	—	.080	—	.039	.458	.018	.193	—	.343
Monocrotophos	Azodrin®	.068	.766	—	.037	.034	.188	.173	.050	—	—	—	.017	.218	—	.010	—	.068

Table 5. Continued

Oxamyl	Vydate®	—	—	—	.023	—	—	—	—	—	—	—	—	—	—	.001	—	.003
Phorate	Thimet®	—	—	—	.024	.075	.033	—	—	—	—	.014	—	.027	—	.005	.014	.006
Phosmet	Imidan®	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	.000
Phosphamidon	Swat®	—	—	—	—	—	—	—	—	—	—	.008	—	—	—	—	.008	.000
Profenofos	Curacron®	.032	.017	—	.111	—	.017	—	.112	—	—	—	.004	.014	—	—	—	.027
Propargite	Comite®	—	.097	—	.819	—	—	—	.031	—	—	—	—	—	—	.002	—	.113
Pyrethroids[2]		.393	.043	—	—	.030	.559	—	—	.084	—	—	—	.087	—	—	—	.024
Cypermethrin	Cymbush®, Ammo®	—	.283	.096	.026	.546	—	.184	.208	—	.009	.127	.017	.124	—	.021	.091	.064
Fenvalerate	Asana®	—	.059	.030	.022	.490	—	.381	—	—	.097	.116	.014	.173	.101	.013	.082	.042
Flucythrinate	Pay-Off®	—	—	—	—	—	—	—	—	—	—	—	—	—	—	.001	—	.000
Permethrin	Ambush®, Pounce®	—	—	—	.001	.001	.001	—	—	—	—	.038	.027	.035	—	—	.027	.002
Tralomethrin	Scout®	—	.013	—	—	—	—	—	—	—	—	—	—	—	—	—	—	.001
Sulprofos	Bolstar®	—	—	—	.008	.390	.024	.039	—	—	—	—	—	.146	—	—	—	.006
Thiodicarb	Larvin®	.043	—	—	—	.819	.079	.043	.251	.015	—	—	.021	—	—	.004	—	.033
Trichlorfon	Dylox®	—	—	—	.015	—	—	—	—	—	—	—	—	—	—	—	—	.002
Total		3.878	6.430	1.413	2.656	7.434	4.816	2.279	2.400	.903	.754	1.763	.341	3.608	.546	.621	.653	1.642

— = Unreported or insignificant estimate.

Source: Suguiyama and Osteen, 1988.

[1]Excludes use of microbials, sex attractants, and sulfur. Also excludes active ingredients with less than 0.001 pounds per harvested acre.

[2]In some chemical entries, only an aggregated use for all pyrethroids was provided.

Table 6. Per-acre and aggregate expenditures for insect and mite control in U.S. cotton[1].

Year	Per acre	Total
	Actual dollars	
1964	5.69	83,643,000
1966	6.42	66,126,000
1969	6.79	80,122,000
1971	4.66	57,318,000
1972	7.35	102,165,000
1974	12.35	167,960,000
1976	15.83	183,628,000
1977	24.68	335,648,000
1978	21.49	285,817,000
1979	21.90	304,410,000
1980	25.31	366,995,000

[1]Sources: Starbird, 1974; Krenz et al., 1976; and Economic Research Service, 1984-87.

Table 7. Expenditures per harvested acre for insect and mite control and scouting, by target pests.

Target pest	Expenditures per harvested acre																
	AL	AZ	AR	CA	FL	GA	LA	MS	MO	NM	NC	OK	SC	TN	TX	VA	U.S. cotton
	Dollars																
BW & TBW[1]	—	12.90	9.20	2.62	52.14	10.36	16.70	13.27	4.96	10.27	23.36	6.23	40.26	5.65	3.47	16.56	6.53
Boll weevil/BW & TBW	54.48	—	8.79	—	54.78	49.84	32.04	8.47	—	—	—	—	—	.13	1.31	—	6.01
Boll weevil[2]	1.41	3.47	3.61	.08	11.70	12.25	5.02	6.68	—	—	4.96	1.30	11.11	.08	2.75	—	3.00
Pink bollworm	—	48.42	—	6.29	—	—	—	—	—	.67	—	—	—	—	.10	—	3.13
Pink bollworm/other pests[3]	—	47.86	—	—	—	—	—	—	—	—	—	—	—	—	—	—	2.25
Spider mites	1.11	4.53	—	20.78	.35	2.11	3.09	3.70	.42	—	—	—	1.20	.06	.15	—	3.54
Thrips	7.65	1.35	7.13	2.53	7.52	8.36	4.78	5.17	7.08	.88	8.04	.32	8.35	6.60	1.86	7.86	3.12
Plant bugs[4]	.43	7.00	1.10	8.65	.06	.27	1.37	7.24	3.23	1.46	—	.81	.28	1.64	1.04	—	2.89
Fall and beet armyworms	—	—	—	3.03	14.33	1.95	1.18	5.30	.29	1.70	.17	.10	1.53	—	.50	.17	1.28
Seedcorn maggot/wireworms	—	—	—	6.74	—	—	—	—	—	—	—	—	—	—	—	—	0.86
Aphids	.24	—	—	.61	.16	.51	.91	1.78	.18	.50	—	.09	.15	.06	.52	—	0.58
Whiteflies	—	.34	—	3.02	.18	—	—	.23	—	—	—	—	.20	—	—	—	0.42
Cotton leafperforator	—	3.84	—	.49	—	—	—	—	—	—	—	—	—	—	—	—	0.24
Cabbage looper	—	—	—	1.31	.16	.05	—	—	.14	—	—	—	—	—	—	—	0.17
Cutworms	—	.16	—	.56	—	—	—	—	—	—	—	—	—	—	.01	—	0.08
Stink bugs	—	—	—	.30	—	—	—	—	—	—	—	—	—	—	—	—	0.04
Grasshoppers	—	—	—	—	—	—	—	—	—	1.88	—	.14	—	—	.02	—	0.03
All insects and mites	65.32	129.86	29.84	57.02	141.38	85.70	65.10	51.84	16.30	17.37	36.53	8.98	63.08	14.22	11.73	24.59	34.17
Pest scouting	2.75	2.91	3.65	4.92	3.67	3.37	4.93	4.01	2.33	2.69	5.30	1.59	4.22	.72	1.83	5.30	2.81
Total expenditures	68.07	132.77	33.49	61.94	145.05	89.07	70.03	55.85	18.63	20.06	41.83	10.57	67.30	14.94	13.56	29.89	36.98

— = Unreported or insignificant estimate.

Source: Suguiyama and Osteen, 1988.

[1]Includes the bollworm (BW) and tobacco budworm (TBW).

[2]Expenditures for the boll weevil in Arizona, California, North Carolina, and South Carolina were estimated prior to completion of cooperative efforts to eradicate the boll weevil from these States.

[3]Other pests include bollworm, tobacco budworm, boll weevil, *Lygus* spp., and stink bugs.

[4]Include *Lygus* spp. and cotton fleahoppers.

Table 8. Expenditures per harvested acre for insect and mite control and scouting, by target pests.

	NC subregions[5]			TN subregions[5]		SC subregions[5]		GA subregions[5]		MS subregions[5]		AR subregions[5]		LA subregions[5]		TX subregions[5]	
Target pest	1	2	3	4	5	6	7	8	9	13	14	15	16	17	18	19	20
									Dollars								
BW & TBW[1]	16.56	38.03	9.00	5.65	5.65	42.65	12.83	6.80	10.58	3.69	18.39	5.88	11.87	17.46	11.27	5.99	1.22
Boll weevil/BW & TBW	—	—	—	—	.51	—	—	27.73	51.20	6.96	9.27	.80	15.20	32.98	25.31	21.60	8.10
Boll weevil	1.23[2]	11.03[2]	9.81[2]	—	.34	11.51[2]	6.48[2]	2.32	12.86	14.20	2.66	.41	6.17	4.28	10.33	41.16	8.10
Spider mites	—	—	—	.06	.06	1.24	.71	1.05	2.18	.81	5.24	—	—	2.53	7.12	—	—
Thrips	7.86	8.63	6.41	6.60	6.60	8.43	7.37	4.06	8.62	4.49	5.53	6.96	7.26	4.73	5.14	—	.67
Plant bugs[5]	—	—	—	1.64	1.64	.23	.85	.09	.28	4.44	8.74	1.28	.96	1.29	1.98	3.35	6.34
Fall and beet armyworms	.17	.16	.17	—	—	1.63	.41	.59	2.03	6.21	4.81	—	—	1.34	—	—	—
Aphids	—	—	—	.06	.06	.15	.14	.20	.53	.31	2.57	—	—	.93	.73	—	.34
Whiteflies	—	—	—	—	—	.22	—	—	—	.21	.24	—	—	—	—	—	—
Cabbage looper	—	—	—	—	—	—	—	—	.05	—	—	—	—	—	—	—	—
Cutworms	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	.34
All insects and mites	25.82	57.85	25.39	14.01	14.86	66.06	28.79	42.84	88.33	41.32	57.45	15.33	41.46	65.54	61.88	72.10	25.11
Pest scouting	5.30	5.30	5.30	.72	.72	4.22	4.22	2.18	3.44	2.97	4.57	3.65	3.65	4.93	4.93	2.05	2.85
Total expenditures	31.12	63.15	30.69	14.73	15.58	70.28	33.01	45.02	91.77	44.29	62.02	18.98	45.11	70.47	66.81	74.15	27.96

Table 8. Continued

Target pest	TX subregions[5]							OK subregions[5]		NM subregions[5]			AZ subregions[5]			CA subregions[5]	
	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37
	Dollars																
BW & TBW[1]	79.23	45.14	2.66	0.98	2.80	19.88	13.04	1.59	7.78	5.48	13.13	11.54	—	14.60	13.12	32.32	0.79
Boll weevil	15.54	5.27	3.09	1.10	—	—	—	.17	1.68	—	—	—	—	1.30	12.66	1.42	—
Pink bollworm	—	—	—	—	—	1.86	13.81	—	—	—	.95	.93	33.33	41.55	79.45	108.42	—
Pink bollworm/other pests[4]	—	—	—	—	—	—	—	—	—	—	—	—	8.97	30.32	127.29	—	—
Spider mites	17.55	3.08	.63	—	—	—	—	—	—	—	—	—	3.73	2.10	13.35	24.74	23.78
Thrips	5.91	.68	3.55	.14	2.76	.11	.49	.02	.42	.77	.41	1.29	1.85	.97	2.43	—	1.00
Plant bugs[3]	11.47	4.69	3.00	.18	.59	1.07	.52	.65	.86	.77	3.16	.74	6.34	5.57	12.29	32.52	5.63
Fall and beet armyworms	.63	—	—	—	.82	.63	1.85	—	.13	—	1.39	3.08	—	—	—	7.21	2.77
Seedcorn maggot/wireworms	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	7.16
Aphids	.18	—	.77	.07	.78	.37	.18	.05	.11	—	.88	.57	—	—	—	—	.65
Whiteflies	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1.67	31.62	1.26
Cotton leafperforator	—	—	—	—	—	—	—	—	—	—	—	—	—	3.91	5.40	8.51	—
Cabbage looper	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1.39
Cutworms	—	—	—	—	—	—	—	—	—	—	—	—	—	.14	.31	—	.59
Stink bugs	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	5.20	—
Grasshoppers	—	—	—	.06	—	.30	—	.15	.13	.40	2.16	2.69	—	—	—	—	—
All insects and mites	130.51	58.86	13.70	2.53	7.75	24.22	29.89	2.63	11.11	7.42	22.08	20.84	54.22	100.46	267.97	251.96	45.02
Pest scouting	6.80	6.20	3.25	1.26	1.76	2.94	1.84	1.31	1.69	2.69	2.78	2.62	3.18	2.95	2.64	25.00	3.68
Total expenditures	137.31	65.06	16.95	3.79	9.51	27.16	31.73	3.94	12.80	10.11	24.86	23.46	57.40	103.41	270.61	276.96	48.70

— = Unreported or insignificant estimate.

Source: Suguiyama and Osteen, 1988.

[1]Includes the bollworm (BW) and tobacco budworm (TBW).

[2]Expenditures for the boll weevil in North Carolina and South Carolina were estimated prior to completion of cooperative efforts to eradicate the boll weevil from these States.

[3]Include *Lygus* spp. and cotton fleahoppers.

[4]Other pests include bollworm, tobacco budworm, boll weevil, *Lygus* spp., and stink bugs.

[5]Map locations of subregions are shown in Figure 1 page .

Table 9. Cotton yield losses caused by target insects and mites in spite of control measures.

Target pest	Cotton yield losses										1979-86		
	1951-60	1974-76	1979	1980	1981	1982	1983	1984	1985	1986	Mean	Standard deviation	Coefficient of variation
	Percent												
Boll weevil	8.00	2.49	1.40	0.96	1.29	2.36	2.50	0.40	0.98	1.93	1.48	0.68	46.32
BW & TBW[1]	4.00	3.61	3.00	3.07	2.08	2.59	1.70	3.20	2.40	2.20	2.53	.50	19.67
Cotton fleahopper	—	.01	1.40	.54	.46	.44	.40	.30	.37	.86	.60	.34	57.46
Lygus spp.	3.40	.74	1.40	1.28	.78	.76	.70	1.30	.74	.80	.97	.28	28.81
Cotton leafperforator	—	.01	—	.13	.09	.01	—	.10	.01	.01	.04	.05	114.25
Pink bollworm	—	.08	—	.33	.31	.63	.40	.40	.25	.21	.32	.17	53.43
Spider mites	—	.12	.70	1.37	.97	.85	.60	.60	.51	.37	.75	.29	39.42
Thrips	—	.11	.30	.40	.21	.24	1.20	.20	.67	.27	.44	.32	73.88
Other pests[2]	—	.18	.60	.72	.55	.44	.10	.40	1.10	1.06	.62	.31	50.60
All insects and mites	19.00	6.60	8.80	8.73	6.74	8.32	7.60	6.90	7.01	7.76	7.73	.77	9.91

— = Unreported or insignificant estimate.

Sources: Agricultural Research Service, 1965; De Bord, 1977; Anonymous, 1980, 1981, 1983; Head, 1982, 1984, 1985; and King *et al.*, 1986, 1987.

[1]Includes the bollworm (BW) and the tobacco budworm (TBW).

[2]Other pests include fall armyworm, beet armyworm, stink bugs, European corn borer, yellowstriped armyworm, seedcorn maggot, wireworms, cabbage looper, grasshoppers, cotton aphid, cutworms, whiteflies, and Western flower thrips.

Table 10. Cotton yield losses caused by target insects and mites, 1981-84.

Target pest	AL	AZ	AR	CA	FL	GA	LA	MS	MO	NM	NC	OK	SC	TN	TX	VA	U.S. cotton
								Percent									
Boll weevil	5.13	0.67	1.94	—	6.62	3.74	3.65	2.39	—	—	1.83	1.51	4.30	0.82	1.78	—	1.50
BW & TBW[1]	3.81	1.32	2.18	0.38	6.08	3.32	3.80	1.87	2.27	6.06	9.68	8.05	4.90	3.14	3.82	4.96	2.52
Pink bollworm	—	3.27	—	.39	—	—	—	—	—	2.17	—	—	—	—	.10	—	.44
Spider mites	.51	.19	.14	2.56	.11	.13	.39	.09	.21	.57	.14	.30	.27	.89	.28	.82	.78
Thrips	.59	—	.45	.38	.70	.09	.31	.21	.56	2.26	.24	.34	.78	.35	.41	.54	.34
Lygus spp.	.90	1.29	.77	1.16	.15	1.57	.63	1.84	1.24	7.42	.21	.86	.48	3.02	1.50	—	1.32
Cotton leafperforator	—	.29	—	.01	—	—	—	—	—	.12	—	—	—	—	—	—	.03
Other pests2/	.70	.57	—	—	.88	.50	.71	.23	.79	.03	4.98	.38	1.11	.07	.68	—	.44
All insects and mites	11.64	7.60	5.48	4.88	14.54	9.35	9.49	6.63	5.07	18.63	17.08	11.44	11.84	8.29	8.57	6.32	7.37

— = Unreported or insignificant estimate.

Source: Anonymous, 1983; and Head, 1982, 1984, 1985.

[1]Includes the bollworm (BW) and tobacco budworm (TBW).

[2]Other pests include fall armyworm, beet armyworms, stink bugs, European corn borer, yellowstriped armyworm, seedcorn maggot, wireworms, cabbage looper, grasshoppers, cotton aphid, cutworms, whiteflies, and Western flower thrips.

Table 11. Value of damage caused by target insects and mites.

Target pest	Value of damage																
	AL	AZ	AR	CA	FL	GA	LA	MS	MO	NM	NC	OK	SC	TN	TX	VA	U.S. cotton
	Million dollars																
BW & TBW[1]	20.1	10.6	10.8	6.5	2.0	11.2	37.1	28.9	1.7	2.3	4.2	8.4	5.7	4.1	62.3	—	216.1
Boll weevil[2]	21.9	3.9	8.1	.1	1.4	11.7	29.9	24.6	—	—	.8	1.6	2.7	.7	38.1	—	145.7
Pink bollworm	—	57.5	—	11.4	—	—	—	—	—	.6	—	—	—	—	1.5	—	71.0
Spider mites	.9	2.8	.2	47.9	—	.4	2.7	4.0	.2	.2	—	.2	.2	.7	3.6	—	63.9
Thrips	2.9	.7	3.7	6.4	.2	1.4	3.5	5.9	1.3	.7	.7	.4	1.1	2.1	13.4	—	44.1
Plant bugs[3]	1.1	7.7	1.6	20.7	—	.9	2.2	14.6	1.0	2.0	.1	1.0	.2	2.9	20.3	—	76.3
Cotton leafperforator	—	2.8	—	.7	—	—	—	—	—	—	—	—	—	—	—	—	3.6
Other pests[4]	1.2	2.1	2.5	20.4	.3	1.3	4.1	9.5	.6	.3	1.6	.3	.8	.4	12.6	—	57.9
All insects and mites[5]	32.8	89.5	24.8	120.5	3.1	19.6	63.6	83.1	5.2	6.3	7.8	12.5	11.1	11.0	154.4	—	645.4

— = Unreported or damage values less than $0.5 million.

Source: Suguiyama and Osteen, 1988.

[1]Includes the bollworm (BW) and the tobacco budworm (TBW).

[2]The value of damage caused by the boll weevil in Arizona, California, North Carolina, and South Carolina were estimated prior to completion of cooperative efforts to eradicate the boll weevil from these States.

[3]Include *Lygus* spp. and cotton fleahoppers.

[4]Include fall and beet armyworms, wireworms, seedcorn maggot, cotton aphid, whiteflies, cabbage looper, cutworms, stink bugs and grasshoppers.

[5]Columns may not total because expenditures for the boll weevil/bollworm/tobacco budworm were allocated to each target. The total estimated expenditures for scouting have also been included.