



## **EXECUTIVE SUMMARY**

### **THE VALUE OF INSECTICIDES IN U.S. CROP PRODUCTION MARCH 2009**



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For full report, see [www.croplifefoundation.org](http://www.croplifefoundation.org)

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Almond Board of California  
American Sugarbeet Growers Association  
Artichoke Research Association  
California Asparagus Commission, Research Committee  
California Date Commission  
California Fresh Carrot Board  
California Pear Advisory Board  
California Pistachio Research Board  
Cherry Marketing Institute  
Mint Industry Research Council  
National Alfalfa and Forage Alliance  
National Association of Wheat Growers  
National Onion Association  
National Potato Council  
National Sorghum Producers  
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State University IPM  
Rice Water Weevil Root Pruning  
(L[treated], R [untreated]): UC IPM

## Key Findings

Insecticides are integral to the production of crops in the United States. Their use results in increased yields and farmer income. Without insecticides for control of crop-feeding insects, production of some crops would be impossible in parts or all of the country.

Insecticides are the primary means of defense against insects that feed on the 50 crops surveyed. If left untreated, insects will consume plant foliage, roots, and stems, reducing yield, making crops unmarketable, and in some cases, killing the plant.

Each year, approximately 45 million acres of U.S. crops are treated with insecticides. Over half of the acreage of 42 of the 50 crops is treated with insecticides. Among this group, over 90% of the acres of 23 crops are treated with insecticides.

These insecticides, applied to prevent crop loss to insects, cost farmers a total of \$1.2 billion per year. If left untreated, 31 of the 50 surveyed crops would suffer nationwide production losses of 40% or greater. Seven of the crops would suffer nationwide production losses over 70%.

Insecticides enable U.S. farmers to produce and harvest greater marketable yields than would otherwise be possible. By mitigating the effects of crop feeding insects, U.S. farmers produce 144 billion pounds of additional food, feed, and fiber and reap \$22.9 billion in farm income increases.

Growers in California benefit the most from the use of insecticides (\$7.5 billion/year), followed by Washington and Florida (\$2.8 and \$2.5 billion/year, respectively). Eight additional states gain over \$400 million per year in production value increases.

For every dollar spent on insecticides, U.S. growers gain \$19 in increased production value.

The historical record supports these impact estimates. Before the use of insecticides became widespread, insects consumed about 50% of the nation's crops.

Most fruit and vegetable crops have been sprayed with insecticides for over 100 years. The key insect pests that led to the initial use of insecticides remain as annual threats. In addition, new invasive crop-feeding insects arrive regularly.

The first era of insecticide use lasted from 1890-1950 and consisted of insecticides based on inorganic compounds and botanicals. The second era began in the 1950s with the introduction of synthetic chemical insecticides which were much more effective than the inorganic and botanical compounds. Production of many crops increased dramatically as a result of better insect control.

Consumers have high standards for insect-free food and farmers use insecticides to meet market standards. Organic growers are permitted the use of non-synthetic chemical insecticides derived from plants and soil microbes as well as soaps and oils. The fact that organic growers of fruit and vegetable crops use insecticides is an indicator of their importance.

### Insecticide Use and Impact Summary

Total Acres Treated with Insecticides	45 Million Acres
Current Insecticide Cost to Growers	\$1.2 Billion
Insecticide Use Yield Benefit ( <i>Volume</i> )	144 Billion Pounds
Insecticide Use Yield Benefit ( <i>Value</i> )	\$22.9 Billion
Insecticide Use Net Benefit ( <i>Value</i> )	\$21.7 Billion
Insecticide Return Ratio ( <i>\$ Benefit per \$ Insecticide Cost</i> )	\$19

## Introduction

Insects were feeding on plants long before humans began cultivating crops. The fossil record demonstrates that the oldest known insect from 390 million years ago fed on early land plants. Insect species and their host plants evolved together developing intricate relationships for survival and living in equilibrium for millions of years.

Of the insect species that feed on plants, 80% are host-specific, that is they feed on plants of only one family or a few closely related families. Host-specific insects have an uncanny ability to find and recognize their host plants. With very few exceptions, adult females lay their eggs on the “right” species of plant, which they instinctively “know” will be acceptable food for their offspring.

Humans invented agriculture and formed a partnership with plants only about 10,000 years ago. Wild plants were moved into cultivated fields and orchards and the insects that fed on the wild plants moved in as well.

For thousands of years humans accepted insects as part of the normal environment over which they had little or no control, and it is only in the last 150 years, that humans have made any real attempt to reduce their effectiveness as competitors for crops.

Before the advent of the Europeans, native Americans in eastern areas cultivated maize, pumpkins, squash, and beans. In addition, these peoples ate wild berries, fruits, and nuts. Native Californians did not cultivate crops and subsisted on wild acorns, insects, small game and fish.

Wheat and other grains were introduced by European settlers in the early 1600s. The colonists experimented with seeds of the European garden vegetables which they brought over with them. Cabbages, onions, carrots, spinach, asparagus, and potatoes were mentioned in the 1600s. Apples, pears, plums, cherries, peaches and grapes were grown from

seeds and partly from trees and vines brought over from Europe. In the 1720's the French brought sugarcane plants to Louisiana to determine if a profitable crop could be grown there. All the cultivated crops grown in California were introduced over time.

At the beginning, the ancient cultivated crops, corn and squash, suffered mainly from periodic populations of native insects including armyworms and grasshoppers. Native Americans planted four or more maize seeds in a single mound because so many seedlings were destroyed by worms.

Insect pests of introduced crop plants developed in America in three basic ways: (1) Native insects adapted to feeding on the introduced plants; (2) insect pests were brought into America with the plants; (3) insect pests have continued to arrive in America from around the world decades and centuries after the plants were introduced.

The first introduced insect pest of widespread concern was the Hessian fly which was believed to have been introduced in the bedstraw of Hessian soldiers during the Revolutionary War. Wheat growing in New England declined dramatically as a result of the destructiveness of this fly. The onion maggot first arrived in America in 1841- possibly in soil used as ballast in sailing ships. Many Eastern growers gave up on growing onions. The hop aphid, a native of Europe, first appeared in the U.S. in 1863 and ruined the crop in many eastern states with reported yield losses of 90%.

Rice, a grass plant, was introduced into America in the 1690s. Two native insect species that had been feeding on grass plants adapted to rice and became known as the “rice water weevil” and “rice stink bug.” By feeding on the rice plant, these insects can reduce yields by up to 45%. Filberts (hazelnuts) were introduced into Oregon where a native insect that had been feeding on acorns adapted to the new nut crop and became known as the “filbertworm.” The filbertworm damages about 20% of the nuts in untreated orchards every year. The artichoke, a

thistle plant, was introduced into California where an insect feeding on thistles adapted and became known as the “artichoke plume moth.” Before the use of insecticides, 50-70% of California’s artichokes contained worms at harvest.

Many attempts have been made to introduce into America natural predators and parasites of crop insect pests from their place of origin. Despite some spectacular success stories, most attempts to establish effective biological controls of crop pests in America have not been successful.

Borers caused an estimated annual loss of 8-30% in Louisiana sugarcane fields in the early 1900s. Twenty-one species of exotic parasites were released. These parasites had been known to be parasitizing borers in the Caribbean Islands. However, these parasites failed in Louisiana perhaps because winter temperatures in the state are too cold for their survival.

In the early 1900s, California researchers looked for predators of the codling moth which was causing losses of up to 50% in walnuts. Although a number of parasites and predators were found, it was concluded by the 1920s that seldom, if ever, are these enemies of the codling moth important enough to effect satisfactory control. The pea aphid threatened the Northwestern canning industry in the early 1930s with about 50% crop losses. Lady beetles were imported from California and released into pea fields. However, most of the lady beetles flew away and provided no control of the aphid.

In the 1930s the State of Georgia conducted a mass release program of a parasite that provided about 50% control of the oriental fruit moth. The program was abandoned with the introduction of synthetic chemical insecticides that provided 98% control.

Ten year research in a New York apple orchard demonstrated that within two years after insecticides were no longer used, insect injuries had increased to the point where the crop was commercially worthless. Damage increased

until the eighth year when not a single worm-free apple could be found.

Some insects vector bacterial diseases to plants when they feed. Pathogens are spread from plant to plant. Control of the bacterial disease depends on control of the insect vector. In pistachio and peanuts, there is a high correlation of feeding by the navel orangeworm and the lesser cornstalk borer and the presence of aflatoxins. The use of insecticides protects consumers from harmful aflatoxins in foodstuffs.

The Asian citrus psyllid transmits the citrus greening pathogen. Trees infected by the disease live 5 to 8 years during which time they produce unmarketable fruit with a bitter taste. The psyllid was first identified in Florida in 1998 and in California in 2008. The psyllid populations are managed with insecticide sprays.

Insecticides are used to manage approximately 90% of current crop insect problems in the United States. Insecticides have certain characteristics that account for their widespread use:

- Few pests cannot be controlled by one or more of the many chemical insecticides available.
- Insect control by chemicals is positive and rapid. High and damaging populations of most pests generally can be reduced within hours and thus provide immediate protection.
- A single insecticide or a combination of two or more insecticides often can be used to control several pest species on a given crop at the same time.
- An individual property owner can take unilateral action as needed to protect his or her interests when pest problems arise.
- Suitable materials, formulations, and equipment supplied by chemical and equipment industries are readily available for immediate use.

- For new pest species, one or more of the chemical insecticides already available can be evaluated quickly and used for control. This allows time for research on alternative means of control if they are needed.

About 750 insect species are serious pests of crops every year in the U.S. In addition, one major new pest becomes established in the U.S. every three years on the average.

## Methodology

To document the value of insecticides in U.S. crop production, this study examines their role in the growing of fifty specific crops which are listed in Table 1. These crops were selected as being the major users of insecticides based on insecticide use data compiled in the CropLife Foundation's national pesticide use database (available at [www.croplifefoundation.org](http://www.croplifefoundation.org)). Table 1 displays 2008 national production and acreage estimates for each crop along with estimates of national insecticide cost. The fifty crops total 268 million acres with an annual production of 1.4 trillion pounds of food, feed and fiber with a combined value of \$144 billion. Nationally, it is estimated that 45 million acres of the fifty crops are treated with insecticides. For 23 of the fifty crops, the national percent acreage treated with insecticides exceeds 90%. Growers of the fifty crops are estimated to spend \$1.2 billion annually on the purchase of insecticides. The national estimates are sums of 470 state estimates by crop shown in the study's data appendix available at [www.croplifefoundation.org](http://www.croplifefoundation.org). Table 2 displays the production and insecticide use estimates summed by state.

To document the value of insecticides to U.S. crop production, two methods are used: literature review and quantitative calculation.

## Literature Review

For each of the 50 crops, a literature review was conducted to collect information on insects that are targets of insecticide use, the history of their

control in the U.S., the results of control experiments, and the practices employed by organic growers to control insects. This literature review is summarized for each crop in a series of Case Study documents available at: [www.croplifefoundation.org](http://www.croplifefoundation.org). These Case Study documents total 440 pages of text and cite 1400 references.

## Historical Review

The historical record makes clear the importance of insecticides in preventing serious crop losses in U.S. agriculture. The first insect problem addressed with widespread insecticide spraying was the Colorado potato beetle which had reduced potato production by 25-35%, leading to a quadrupling in the price of potatoes. Spraying insecticides to prevent these losses to the Colorado potato beetle began in the 1870s and has continued ever since. The San Jose scale killed thousands of fruit trees in the U.S. before the development of dormant season insecticide sprays in the 1890s. By 1908 USDA estimated that all the commercial apple trees in the U.S. were being sprayed with insecticides to prevent damage from insects like the codling moth which, left unsprayed, would have resulted in a high percentage of wormy apples.

In the early 1900s insecticide spray recommendations were made for the grape berry moth which had reduced grape production in parts of New York by 25-50%. Similarly in Wisconsin in the early 1900s, it was common for as many as 35-40% of cabbage heads to be made unfit for market because of worm damage. Insecticide sprays reduced the damage to 1-2%. Research in the early 1900s demonstrated that insecticide sprays reduced cherry maggot infestations from as much as one-third of the crop to less than 1%.

The cotton leafworm was the first insect of major importance to deprive the cotton grower of a substantial portion of the crop. Records dating from the eighteenth century show that in some years it destroyed 25 to 90% of the cotton. The bollworm became notorious early in the nineteenth century. It and the cotton leafworm

often destroyed the crop completely in some localities. The boll weevil crossed the Rio Grande in 1892. It advanced 40 to 160 miles a year and by 1922 it had infested more than 85% of U.S. cotton acreage. Hundreds of spraying experiments for cotton insects were made in the early 1900s. In 1916, it was shown that dust applications of calcium arsenate would control the bollworm, boll weevil, and leafworm. Thus, it became possible for cotton to be profitably produced despite the insects.

Despite the widespread use of inorganic and botanical insecticides throughout the early 1900s which greatly reduced crops lost to insects, there were many insects that were poorly controlled until synthetic chemical insecticides were introduced in the late 1940s.

Although Southern Florida had an ideal climate for growing sweet corn in the winter, it was impossible to grow the crop until synthetic insecticides were developed in the 1940s. As a result of insecticide use, Florida established itself as the number one state in the U.S. in the growing of fresh sweet corn (Figure 1). Economical control of onion thrips was not successful until the introduction of synthetic chemical insecticides which increased yield by 40-80% and produced a net financial gain of \$5 for every \$1 spent on insecticides.

In the early 1900s the pepper weevil caused a 33% loss in the commercial pepper crop for several consecutive years. Many growers gave up the growing of peppers. Until synthetic chemicals were introduced, there was no satisfactory control. In the early 1940s insects caused a loss of between 50 and 75% of the California date crop depending on variety. Insecticide spraying reduced the number of hidden insects in the date cavity to less than 1%. With inorganic and botanical compounds, the best farmers could hope for was about 15% wormy apples. With synthetic chemicals, the rate of wormy apples was 1-2% or less.

Although the inorganic insecticides had controlled Colorado potato beetle populations for many years, they had no effect on

leafhoppers. The use of synthetic chemicals to control the Colorado potato beetle and the potato leafhopper increased potato yields by 60% for a return of \$29 per \$1.00 spent on insecticides (Figure 2).

The first record of sugarbeet root maggot infestation in the Red River Valley was reported in 1947. Synthetic chemical insecticides provided good maggot control with yield increase of from 2 to 4 tons per acre and a return of \$10, for every \$1 spent on insecticides. Nectarine production in California became viable only when new insecticides were introduced to eliminate surface blemishes caused by thrips feeding (Figure 3)

A treatment in the 1930s for carrot rust fly was to apply 250 pounds of naphthalene flakes (moth balls) per carrot acre which deterred the fly from laying eggs. However, carrots could not be used for at least one month because they retained the flavor and odor of moth balls. In the 1960s organophosphate insecticides became the standard treatment reducing infestations from 99% to 2%.

Field corn acres were not treated with inorganic or botanical insecticides in the early 1900s due to their expense. With the introduction of inexpensive broad-spectrum soil-applied synthetic chemicals, field corn acreage treated with insecticides grew dramatically in the 1950s.

In recent decades new insect pests have caused considerable crop destruction before being brought under effective control with insecticides. In 1990, the glassy-winged sharpshooter (GWSS) appeared in California. The GWSS is an extremely efficient vector of a bacterium that causes Pierce's Disease which results in grapevine death within two years. Grape growers have been advised to spray insecticides if any GWSS are found in a vineyard.

Pecan losses in Georgia to aphids reached 19 million pounds in 1984. Following the introduction and widespread use of systemic

insecticides for aphid control, losses to aphids were reduced by 60-90% (Figure 4).

The avocado thrips was first noticed in California in 1996. Heavily infested orchards experienced 50-80% damage before effective insecticides were made available (Figure 5). Similarly the olive fruit fly was first detected in California in 1998. This pest colonized the state more quickly than any other pest in the past 25 years and was brought under control with insecticide use (Figure 6).

The sweet potato whitefly has been considered a pest in Florida since 1987 when losses in tomatoes were estimated at \$15 million. The whitefly has not been a problem since the introduction of new chemical insecticides. California celery growers lost \$20 million in the last half of 1984 as a result of a newly-introduced leafminer species. Losses continued until new insecticide registrations were approved.

In 2000 soybean aphid was first detected and subsequently spread throughout the Midwest. Spraying for aphids have prevented soybean yield losses of 30-50% in heavily infested fields (Figure 7).

### **Food Marketing Standards**

The necessity of meeting food industry standards for marketability has resulted in insecticide spraying to prevent damage from insects and to prevent insect contamination of food.

The spraying of insecticides became a priority for several crops in the early 1900s because of the actions of the FDA in seizing canned shipments because of the presence of maggots. In Maine before spraying of blueberries began in the 1920s, 80% of the berries contained maggots. By 1931, as a result of insecticide spraying, close to 100% of the berries were maggot-free (Figure 8). Several shipments of fresh blueberries from New Jersey were confiscated in 1935 because of the presence of

maggots. Since 1936, insecticides have been obligatory in blueberries.

In the 1930s the FDA was made aware of consumer complaints regarding the presence of aphids in canned spinach and adopted a standard of no more than 500 aphids per pound of spinach. Until effective insecticides were developed, fields that were heavily infested with aphids were not harvested.

Interest in improvements of methods for control of the tomato fruitworm was accelerated in 1935 by the finding of worm fragments in canned products, which were subsequently seized and destroyed as contaminated foods by the FDA. In the 1930s, tomato processors in California set a standard of no more than 10% insect infestation in incoming truckloads; currently the industry standard is 2%.

The necessity of producing fruit free of insect blemishes in order to receive high prices from consumers led to widespread use of insecticides. In 1915, estimates were made of the profit realized from producing a better grade of oranges by spraying for citrus thrips in California. The total cost of three sprays was \$14/A which led to an increase in value of \$30/A. In 1924 it was estimated that the depreciation in value of an apple crop as a result of San Jose scale spotting averaged 50%.

Soil-borne insects feed directly on sweet potatoes developing underground causing holes, scars, and surface tunnels. Insecticide use typically increases the yield of marketable sweet potatoes by 50% or more.

Pickle processors will refuse to accept a truckload of cucumbers if they notice even one with a pickleworm hole.

The feeding of hop aphids on hops plants results in prolific amounts of sugary excrement. Sooty mold grows on the excrement and can destroy a crop's value, as mold renders hops cones unacceptable for brewing.

Snap beans for the canned and frozen markets are not visually inspected; thus insecticides are used to guarantee 100% insect-free beans. A set of trade standards have been developed for sunflower kernels for snack foods which stipulate that there should be no more than 2% insect damage. Sunflower growers who do not spray insecticides invariably have insect damage above 10%.

Over the years, improvements in fruit quality have been an important competitive market force for pear growers in maximizing profits and have resulted in preferential prices being paid for fruit nearly blemish free. More than two scale insects per pear will drop fruit grade from the U.S. No. 1 to the Fancy level. Cannery reject cling peach deliveries with worm damage in excess of 4% by weight because of the difficulty and expense of sorting damaged fruit. Wholesale shippers of fresh peaches universally ascribe to a zero tolerance for insect infestation. No grower can afford to risk rejection of a single tractor trailer of peaches with a value of \$14,000 due to insect contamination.

A study of the use of synthetic chemical insecticides in preventing lygus bug damage to strawberries showed a net return of \$1170 per acre for an application costing \$34 per acre.

There is no interest in the food industry in lowering food quality standards in order to reduce insecticide use since the blemish-free produce commands the highest price.

### **Organic Insect Control**

The market pressure to produce high quality food has led organic growers of fruit and vegetables to spray insecticides that are approved for organic operations. The organically-approved insecticides do not contain synthetic chemicals.

University of California *Pest Management Guidelines* identifies sprays of *Bacillus Thuringiensis* and the Entrust formulation of spinosad as approved and acceptable for organic growers to use in controlling such pests as

tomato fruitworm, cabbageworms, codling moth, beet armyworm, oblique banded leafroller, and western flower thrips. Entrust is also effective in controlling blueberry maggot and cherry fruit fly. Sprays of insecticidal soaps, oils and neem oil are acceptable for reducing populations of whiteflies, lygus bug, leafminers and aphids in organic systems.

Organic almond growers typically make a dormant oil application to control San Jose scale. In late March *Bacillus Thuringiensis* is sprayed to control peach twig borer. Mites are managed with two in-season oil sprays. In July, Entrust is sprayed to control navel orangeworm.

Organic raspberries are typically picked by hand to avoid insect contamination. Because of the extremely high cost of manual harvest, conventional raspberry growers spray insecticides to remove insects before mechanical harvest. Some organic rice millers use color sorting equipment to identify and remove insect-damaged rice kernels. This process is expensive and slows down the milling process.

### **Quantitative Calculation**

Insecticide value is estimated in terms of the economic value to growers of the increased production attributable to the application of insecticides. These estimates of insecticide value are based on assessments of the losses that would be suffered if insecticides were not used as compiled by extension entomologists and released in reports by USDA and the American Farm Bureau Federation. These reports are listed in the "Key References" list. The yield changes predicted in these studies are consistent with losses to uncontrolled insect species as documented in the historical record. The yield loss estimates for each state and crop combination are included in the data appendix available at: [www.croplifefoundation.org](http://www.croplifefoundation.org).

Table 3 displays the portion of national production attributable to insecticide use for the fifty crops. For 26 of the fifty crops, the portion of total national production attributable to

insecticide use is 50% or greater. For 3 crops, the proportion of national yield attributable to insecticides exceeds 90% including a complete loss (100%) in hops production without insecticide use. The national aggregate production attributable to insecticides is 144 billion pounds of food, feed and fiber. The total value of production attributable to insecticide use is estimated at \$22.9 billion. These benefits are realized after an expenditure of \$1.2 billion on insecticides (Table 1). The net value gained by U.S. farmers from insecticide use is approximately \$21.7 billion. Nationally, U.S. agriculture realizes a return of \$19 on every \$1.00 invested in insecticides for crop protection. These national estimates are sums of estimates by state and crop which are presented in the Data Appendix available at: [www.croplifefoundation.org](http://www.croplifefoundation.org). Table 4 displays the impact estimates summed by state. Two examples of crop impacts for each state are included in Table 4. Figure 9 displays insecticide usage by state in terms of acres treated while Figure 10 displays crop production increase in value due to insecticide use by state.

### Comparison to Other Studies

This study's findings with regard to the value and benefits of insecticide use in U.S. crop production are consistent with previously issued studies:

- Michigan State University researchers estimated that without insecticides, there would be no commercially marketable quality apples or cherries produced in the eastern U.S.
- Washington State University researchers concluded that without an effective insecticide for the asparagus aphid, there would be a total collapse of the California and Washington asparagus crop.
- A series of commodity studies conducted by USDA estimated that without insecticide use, the following reductions in U.S. production would occur: cranberries 15-50%; strawberries

53%; carrots 12%; cotton 28%; tomatoes 51% (processing), 64% (fresh).

### Summary & Conclusions

Plant-feeding insects are a constant enemy of crop production in the U.S. Every growing season, countless larvae hatch from eggs laid the previous growing season. The eggs are laid in proximity to crop plants that are the preferred diet for the insect species. The larvae feed on the crops, become adults, and produce multiple generations each year dramatically increasing their numbers and resultant crop-feeding damage.

Prior to the 20<sup>th</sup> century, much of the nation's crops were consumed by insects. In the early 1900s farmers began using inorganic and botanical compounds which greatly reduced crop losses to insects. The introduction of synthetic chemical insecticides in the 1950s revolutionized chemical control of insect pests of crops. Newly discovered insecticidal molecules were rapidly adopted by U.S. farmers for their expanded range of insect control and their increased effectiveness.

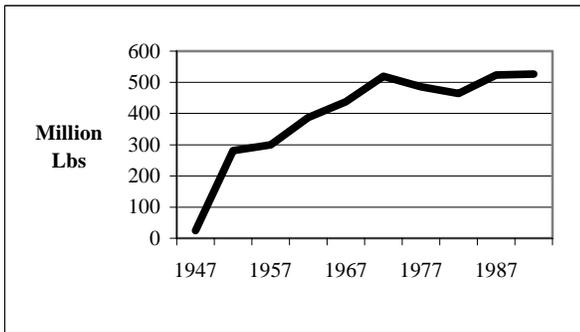
Insecticides are the chief means of controlling 90% of the major insect pests attacking crops in the U.S. Farmers spray insecticides on 45 million acres at a cost of \$1.2 billion. If left untreated, yields of most crops would decline by 40-50%. Growers gain \$22.9 billion in increased production value from the control of crop-feeding insects with insecticides.

The benefit of insecticide use in U.S. crop production is a significant increase in domestic production of food, feed, and fiber.

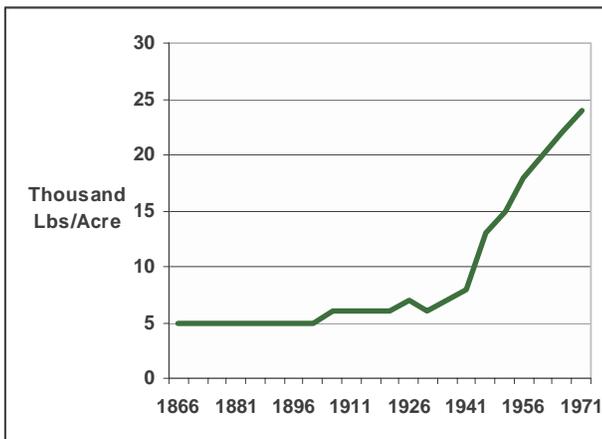
Organic production too, is dependent upon the use of insecticides that do not contain synthetic chemicals.

This study is a comprehensive documentation of the role that insecticides play in U.S. crop production. U.S. crop production and crop quality today would be considerably lower without the use of insecticides.

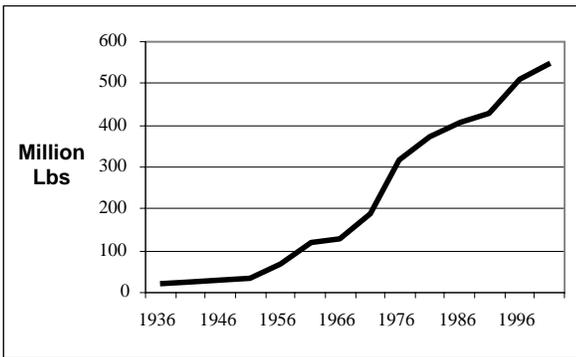
**Figure 1: Florida Sweet Corn Production**



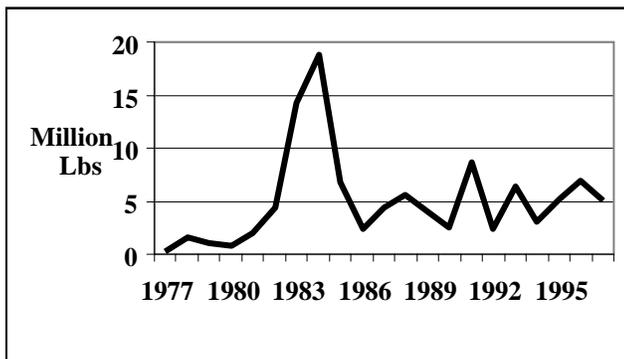
**Figure 2: U.S. Potato Yield**



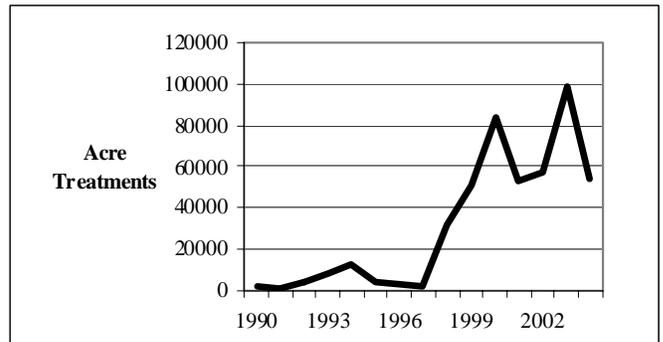
**Figure 3: California Nectarine Production**



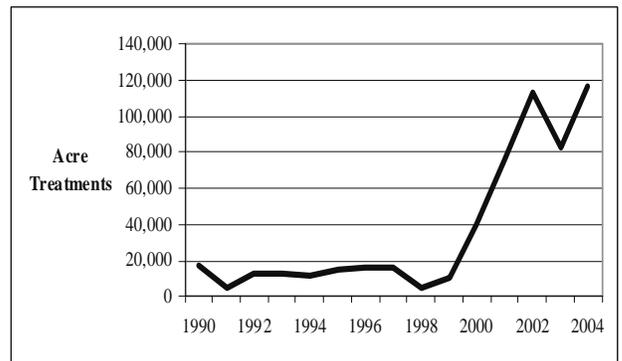
**Figure 4: Pecan Production Losses Due to Aphids (Georgia)**



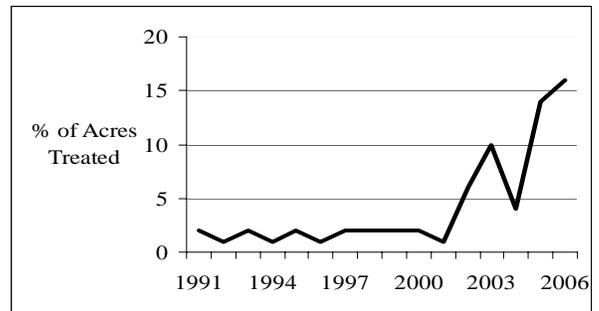
**Figure 5: Avocados – California Insecticide Use**



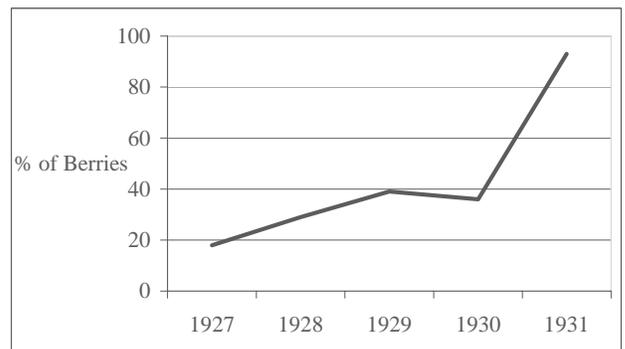
**Figure 6: Olives – California Insecticide Use**



**Figure 7: Soybeans – U.S. Insecticide Use**



**Figure 8: Maggot-Clean Blueberries (Maine)**



**Table 1: Crop Production and Insecticide Use: 2008**

Crop	Production			Insecticide Use		
	Acres (000)	Volume (Million lbs)	Value (Million \$)	% Acres Treated	Acres Treated (000)	Cost (million \$/yr)
Alfalfa	20980	139240	10806	9	1977	29.6
Almonds	660	1550	2228	85	561	66.2
Apples	346	9955	2565	93	321	48.1
Artichokes	9	119	57	99	9	3.1
Asparagus	34	95	90	82	28	0.9
Avocados	66	320	315	80	53	9.5
Blueberries	77	385	523	90	69	1.6
Broccoli	126	1977	708	95	120	17.0
Cabbage	51	1758	276	96	49	6.6
Carrots	76	2679	555	32	24	0.9
Celery	33	2125	346	97	32	7.5
Cherries	113	666	637	92	104	11.4
Corn	78470	675835	47215	13	10571	155.8
Cotton	9435	6240	3540	62	5880	113.4
Cranberries	39	725	444	82	32	1.5
Cucumbers	124	1791	357	76	94	6.3
Dates	5	35	26	95	5	2.3
Eggplant	1	20	5	90	1	0.1
Grapes	928	14814	3308	61	566	48.9
Green Beans	259	1879	423	87	226	8.8
Green Peas	196	750	135	41	80	1.2
Hazelnuts	28	64	52	90	25	0.9
Hops	41	80	320	100	41	8.2
Lettuce	286	9060	1979	99	283	49.5
Mint	80	11	119	90	72	2.9
Nectarines	31	575	105	80	25	5.5
Olives	30	134	51	100	30	2.2
Onions	159	7177	824	84	134	9.5
Oranges	657	20330	2160	95	628	97.2
Peaches	108	2130	475	99	107	16.9
Peanuts	1512	5066	1037	80	1208	21.1
Pears	55	1599	377	95	52	16.8
Pecans	519	182	258	66	343	17.9
Pistachios	118	278	539	80	94	3.9
Potatoes	987	38739	3542	81	798	94.6
Raspberries	16	121	284	94	15	0.7
Rice	2995	20373	3390	39	1162	10.4
Sorghum	6745	24036	1522	19	1311	6.5
Soybeans	75088	176714	27263	14	10723	92.9
Spinach	41	623	154	80	33	1.5
Strawberries	56	2530	1884	98	55	27.5
Sugarbeets	920	43328	1131	65	600	15.0
Sugarcane	405	23490	354	75	304	7.3
Sunflowers	245	312	92	100	245	5.4
Sweet Corn	563	7992	1052	78	441	23.3
Sweet Peppers	57	1668	673	93	53	15.9
Sweet Potatoes	88	1388	258	90	79	8.1
Tomatoes	410	27757	2384	91	371	37.2
Walnuts	218	750	751	60	131	14.9
Wheat	63122	149796	16556	7	4568	22.8
Total	267608	1429261	144145	(17)	44733	1177.2

**Table 2: Crop Production and Insecticide Use by State: 2008**

State	Production			Insecticide Use	
	Acres (000)	Volume (mil lbs)	Value (mil \$)	Acres Treated (000)	Cost (Millions \$/year)
Alabama	1350	3950	633	520	11.7
Arizona	668	7913	1136	269	19.2
Arkansas	6850	24575	3546	1717	30.4
California	5724	89594	18064	3160	320.7
Colorado	4350	21621	1847	602	8.7
Connecticut	15	99	29	10	0.4
Delaware	444	1914	190	107	1.6
Florida	966	20655	3485	870	126.2
Georgia	3081	9208	1968	1886	47.6
Idaho	3077	36032	2880	367	17.4
Illinois	22682	152535	12764	2226	21.9
Indiana	11823	68917	6049	1158	11.6
Iowa	23740	158103	13554	2367	21.7
Kansas	19985	73720	6733	1871	16.1
Kentucky	3331	14513	1328	325	4.1
Louisiana	3163	33754	1639	1377	28.9
Maine	92	1633	219	82	8.6
Maryland	1218	5069	511	287	4.4
Massachusetts	34	403	186	28	2.0
Michigan	5786	32130	3068	1513	27.8
Minnesota	18258	120410	9171	3774	47.3
Mississippi	3848	14232	1833	1134	22.4
Missouri	10047	40657	4167	1210	15.8
Montana	7418	18223	1561	354	3.1
Nebraska	16445	107267	8592	2124	37.9
Nevada	291	2658	255	28	0.3
New Hampshire	9	76	26	6	0.3
New Jersey	264	1507	334	94	3.3
New Mexico	908	4036	487	135	2.4
New York	1552	12212	1507	520	18.6
North Carolina	3995	12173	1648	973	28.3
North Dakota	17435	58262	5026	2150	23.7
Ohio	9206	40943	4090	837	10.6
Oklahoma	6816	15275	1534	1087	8.4
Oregon	1647	11675	1599	414	20.8
Pennsylvania	2141	12812	1253	437	11.1
Rhode Island	4	29	7	3	0.3
South Carolina	1305	3451	543	373	9.8
South Dakota	14726	62936	5145	1389	14.7
Tennessee	3059	9643	1187	665	9.4
Texas	16690	35479	4509	3982	49.5
Utah	725	5245	451	69	0.7
Vermont	34	151	34	18	0.6
Virginia	1439	5548	656	324	8.7
Washington	3416	32161	5117	817	71.3
West Virginia	87	504	47	17	0.9
Wisconsin	6689	40310	3271	1003	25.3
Wyoming	775	5048	266	54	0.7
Total	267608	1429261	144145	44733	1177.2

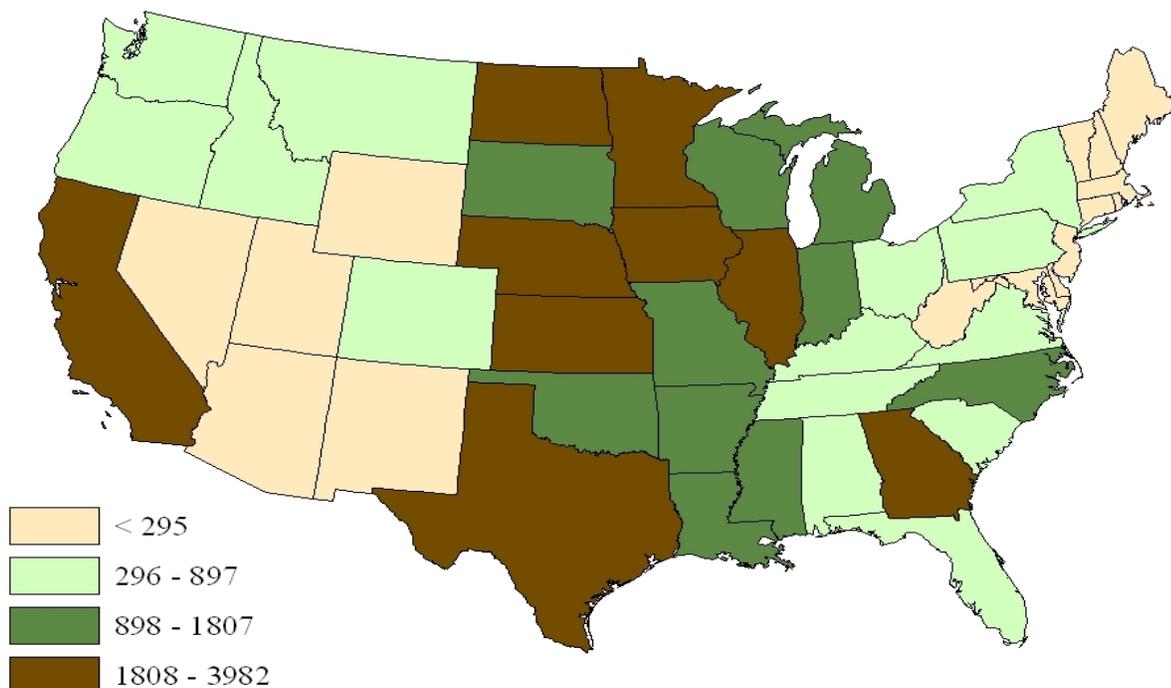
**Table 3: Value of Insecticide Use by Crop: 2008**

Crop	Decrease W/O Insecticides			Net Return Ratio (\$ / \$ Spent on Insecticides)
	%	Production Volume (million lbs)	Production Value (million \$/yr)	
Alfalfa	5	6608	604	20
Almonds	43	659	947	14
Apples	93	9299	2400	50
Artichokes	60	71	34	11
Asparagus	67	64	62	68
Avocados	48	154	152	16
Blueberries	69	266	356	222
Broccoli	75	1502	538	32
Cabbage	64	1119	170	26
Carrots	10	259	31	33
Celery	48	1029	167	22
Cherries	84	562	515	45
Corn	3	20095	1406	9
Cotton	30	1809	1053	9
Cranberries	50	366	219	146
Cucumbers	34	610	138	22
Dates	85	30	22	10
Eggplant	25	5	1	25
Grapes	35	5134	1132	23
Green Beans	58	1085	211	24
Green Peas	22	166	27	22
Hazelnuts	45	29	23	26
Hops	100	80	320	39
Lettuce	50	4485	980	20
Mint	54	6	64	22
Nectarines	64	369	67	12
Olives	90	121	46	21
Onions	22	1611	185	19
Oranges	77	15579	1646	17
Peaches	51	1095	294	17
Peanuts	55	2766	560	26
Pears	85	1367	322	19
Pecans	56	101	144	8
Pistachios	64	178	345	88
Potatoes	29	11157	1083	11
Raspberries	55	67	164	234
Rice	13	2567	430	41
Sorghum	8	1865	118	18
Soybeans	5	9550	1474	16
Spinach	16	101	25	17
Strawberries	56	1430	1017	37
Sugarbeets	23	9975	260	17
Sugarcane	22	5285	80	11
Sunflowers	50	187	55	10
Sweet Corn	28	2260	431	18
Sweet Peppers	53	890	380	24
Sweet Potatoes	45	625	116	14
Tomatoes	53	14860	1331	36
Walnuts	36	270	271	18
Wheat	3	4202	462	20
Total	(10)	143970	22878	(19)

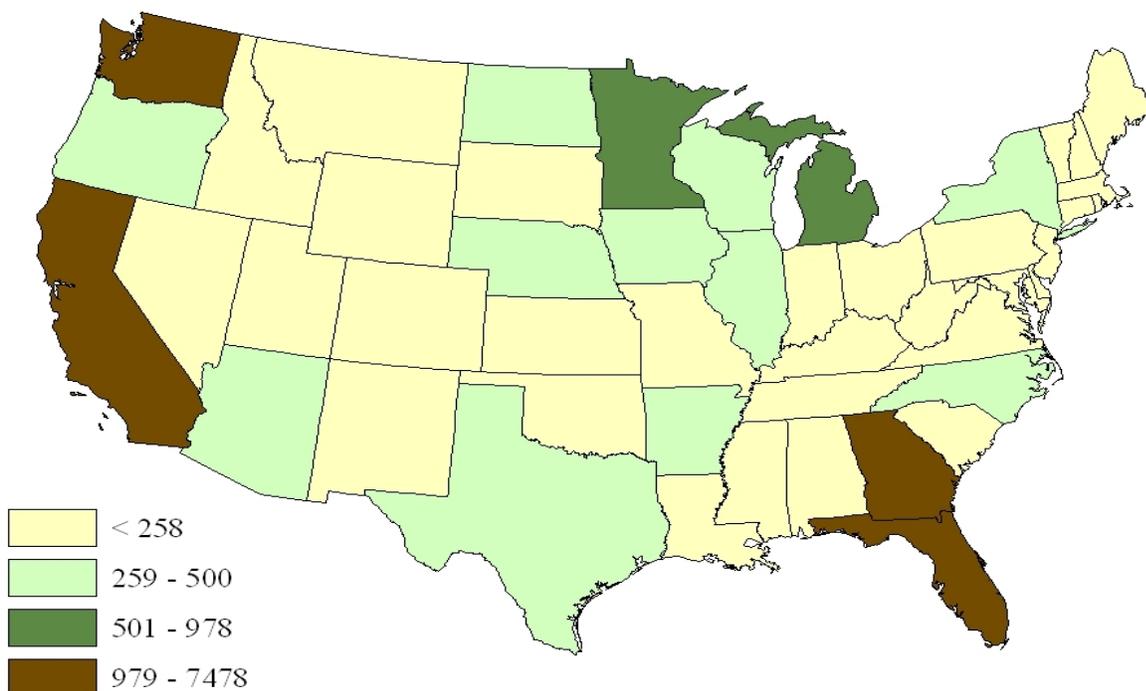
**Table 4:  
Value of Insecticide Use by State: 2008**

<b>State</b>	<b>Net Return Ratio</b>	<b>Volume Decrease w/o Insecticides (mil lbs)</b>	<b>Value Decrease w/o Insecticides (mil \$)</b>	<b>Yield Loss w/o Insecticides (On Treated Acres)</b>
Alabama	16	745	183	Peanuts 70%; Cotton 70%
Arizona	17	1720	324	Lettuce 50%; Alfalfa 50%
Arkansas	15	2107	461	Rice 30%; Wheat 40%
California	23	35220	7478	Tomatoes 60%; Strawberries 60%
Colorado	13	1159	115	Corn 25%; Wheat 40%
Connecticut	32	30	13	Apples 100%; Sweet Corn 25%
Delaware	11	148	18	Soybeans 40%; Sweet Corn 50%
Florida	20	15715	2463	Tomatoes 70%; Sweet Corn 100%
Georgia	22	3389	1051	Cotton 90%; Peanuts 70%
Idaho	14	2489	237	Potatoes 25%; Mint 60%
Illinois	20	4993	447	Corn 28%; Soybeans 40%
Indiana	19	2397	225	Alfalfa 44%; Wheat 40%
Iowa	20	5006	440	Corn 28%; Soybeans 40%
Kansas	14	2702	227	Wheat 40%; Soybeans 40%
Kentucky	10	428	39	Alfalfa 44%; Corn 15%
Louisiana	8	6155	225	Rice 30%; Sugarcane 30%
Maine	14	763	123	Blueberries 80%; Potatoes 50%
Maryland	13	412	56	Green Beans 50%; Sweet Corn 50%
Massachusetts	71	277	142	Tomatoes 15%; Cranberries 90%
Michigan	22	3415	614	Cherries 100%; Potatoes 50%
Minnesota	14	10626	673	Sugarbeets 40%; Sweet Corn 15%
Mississippi	11	1162	246	Cotton 50%; Rice 30%
Missouri	13	1601	200	Rice 30%; Corn 28%
Montana	11	379	35	Wheat 40%; Alfalfa 44%
Nebraska	9	4707	356	Sorghum 40%; Wheat 40%
Nevada	37	115	11	Alfalfa 44%; Wheat 40%
New Hampshire	47	37	14	Apples 100%; Sweet Corn 15%
New Jersey	50	402	166	Blueberries 80%; Peaches 100%
New Mexico	22	196	53	Onions 10%; Pecans 80%
New York	26	2660	483	Apples 100%; Grapes 50%
North Carolina	12	1763	348	Cotton 40%; Sweet Potatoes 50%
North Dakota	15	5629	357	Sugarbeets 40%; Potatoes 50%
Ohio	20	1451	210	Tomatoes 20%; Soybeans 40%
Oklahoma	10	799	89	Sorghum 40%; Wheat 40%
Oregon	22	2350	470	Hops 100%; Pears 90%
Pennsylvania	17	1209	193	Corn 18%; Apples 100%
Rhode Island	10	11	3	Potatoes 50%; Sweet Corn 25%
South Carolina	15	508	148	Peaches 100%; Cotton 25%
South Dakota	12	1847	173	Wheat 40%; Corn 25%
Tennessee	10	485	91	Soybeans 40%; Tomatoes 35%
Texas	7	2242	370	Cotton 20%; Rice 30%
Utah	27	222	19	Corn 10%; Onions 12%
Vermont	33	52	20	Alfalfa 20%; Apples 100%
Virginia	14	638	120	Tomatoes 50%; Peanuts 70%
Washington	39	10660	2778	Apples 100%; Potatoes 25%
West Virginia	13	107	12	Alfalfa 44%; Apples 100%
Wisconsin	14	2742	354	Cranberries 40%; Cabbage 40%
Wyoming	7	100	5	Corn 10%; Sugarbeets 10%
<b>Total</b>	<b>(19)</b>	<b>143970</b>	<b>22878</b>	

**Figure 9:**  
**Insecticide Use in Crop Production by State: 2008**  
 (1000 Acres Treated)



**Figure 10:**  
**Crop Production Decrease Without Insecticide Use by State: 2008**  
 (\$ Millions)



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