



THE VALUE OF HERBICIDES
IN U.S. CROP PRODUCTION
2005 UPDATE

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1.0 Introduction

In 2003, the report *Value of Herbicides in U.S. Crop Production* was issued by the National Center for Food and Agricultural Policy (NCFAP).[1] The report estimated that if U.S. farmers did not use herbicides, crop production would decline by 21%, equivalent to a loss of 288 billion pounds of food and fiber valued at \$13.3 billion. Under the no herbicide scenario, farmers would substitute hand weeding and cultivation at an increased cost of \$7.7 billion. Overall, the value of herbicides was estimated at \$21 billion. The NCFAP report was based on herbicide use patterns and prices, crop values, and cultivation and labor costs specific for the year 2001 and is referred to below as the “2001 report.”

Significant changes in the costs of herbicides, labor, and cultivation have occurred since 2001. Herbicide use patterns have changed and crop values have fluctuated. CropLife Foundation (CLF) undertook a study to estimate the value of herbicides in 2005 in order to measure the impact of the changes in prices on the value of herbicides. The report for 2005 (referred to below as the “2005 report”) relies on the same methodology and data sources that were used in the 2001 report.

2.0 Crop Production Data

The forty crops selected for the 2001 and 2005 Reports are listed in Table 1 and include field crops, vegetable crops, fruit, nut and berry crops and specialty crops. Table 1 summarizes 2001 and 2005 production and acreage estimates for each crop. Included crops totaled 255 million acres in 2001 and 250 million acres in 2005 with associated volume of production of 1.4 trillion pounds of food and fiber in both years. The combined value of the forty crops was \$66 billion in 2001 and \$80 billion in 2005. Table 2 shows the acreage and production data by state.

3.0 Herbicide Use

Table 3 summarizes national statistics on herbicide use for the forty crops. An estimate of the percent of crop national acreage treated with herbicides is included and is assumed to be the same in both 2001 and 2005. For thirty of the forty crops, the national acreage treated with herbicides exceeds 85%.

Table 3 also contains estimates of the pounds of herbicide active ingredients used in each crop in 2001 and 2005. Herbicide use on the forty crops totaled 410 million pounds in 2001 and 349 million pounds in 2005. Herbicide use in corn declined by 50 million pounds, largely due to the replacement of older high rate herbicides (butylate, cyanazine, EPTC, metolachlor) with new lower rate herbicides (flufenacet, mesotrione, rimsulfuron, s-metolachlor). Herbicide use on cotton went down by 11 million pounds due to the substitution of glyphosate for several older herbicides: MSMA, fluometuron, pendimethalin, and trifluralin.[7]

The herbicide use estimates shown in Table 2 are sums of use estimates of individual active ingredients by state for the forty crops. This data was drawn from national pesticide use databases for 1997 and 2002.[7] This dataset is available at:

http://www.croplifefoundation.org/cpri_npud2002.htm. The 1997 estimates were updated to 2001 for states and crops in which significant active ingredient use changes occurred between 1997 and 2001.[1] The 2005 estimates are unchanged from the database's estimates for 2002 since the 2002 estimates were largely based on the latest data available for each crop, including data representing 2004 pesticide use. A recent USDA survey report for 2005 for corn and soybeans shows exact agreement with the average national per acre herbicide use estimates listed in Table 3 for 2005.[19]

Table 4 displays herbicide use estimates for 2001 and 2005 by state.

4.0 Herbicide Cost

Table 5 contains cost estimates for herbicides and their application to each of the forty crops for 2001 and 2005. Cost estimate consists of three components: cost of the product, cost of application, and premiums for use of herbicide tolerant soybean, corn, canola, rice, and cotton seeds.

Product costs are determined by multiplying estimates of herbicide poundage applied by an average per-pound active ingredient price. The average per-pound price estimates are drawn from a 1996 report.[18] 1996 price estimates were updated to reflect 2001 and 2005 prices.[11]-[17] Nationally, it is estimated that growers of the forty crops spent \$4.7 billion on herbicide products in 2001 and \$4.4 billion in 2005. This reduction in herbicide expenditure was the result of major reductions in the cost of several active ingredients. Chief among these price reductions was glyphosate, the number one selling herbicide, whose price declined by 16% between 2001 and 2005. Table 5's estimated decline in aggregate herbicide sales between 2001 and 2005 is in agreement with the latest estimates from the market research firm Phillips McDougall (See Figure 1).

Application costs are calculated by assigning an average number of herbicide application trips to each crop by state (the same estimates are used for 2001 and 2005) and multiplying the number of trips by an estimate of the per trip cost. The per trip cost of herbicide application was estimated at \$4.00/A in 2001 and at \$5.21/A in 2005.[1][20] The sprayer used for herbicide applications is assumed to be a 60 foot self propelled boom sprayer. The total costs of herbicide application are estimated at \$1.4 billion in 2001 and \$1.9 billion in 2005.

Estimates were made of the number of herbicide tolerant crop acres by state for canola, corn, cotton, rice, and soybeans.[8][9] The number of herbicide tolerant crop acres in 2005 is estimated at 94 million which represents an increase from 66 million in 2001(see Figure 2). The herbicide tolerant rice acres are the result of crop breeding with conventional techniques which produce rice cultivars tolerant to imazethapyr (Clearfield). The number of imazethapyr tolerant rice acres is based on the number of rice acres estimated to be treated with imazethapyr by state.[7] Herbicide tolerant cultivars for the other four crops are the result of genetic engineering (biotech crops). Farmers who purchase the herbicide tolerant seed generally pay a premium price. The premium for the use of the herbicide tolerant rice is estimated at \$20/A.[11] Increased seed costs for the purchase of herbicide tolerant seed in 2005 were estimated at \$13/A for canola, \$6/A for

corn, \$8/A for soybean, and \$14/A for cotton.[9] The estimates for canola and corn are the same that were used in the 2001 report, while the cotton and soybean estimates represent increases from the previous estimates of \$9/A and \$6/A respectively. The total premium for planting herbicide-tolerant seed is estimated at \$773 million in 2005, which represents an increase from \$461 million in 2001.

Table 6 displays the herbicide cost estimates by state.

5.0 Herbicide Value Estimation

Estimates of the value of herbicides are made in terms of the economic value to growers and in terms of reduced labor requirements and soil erosion. The impacts on fuel consumption and crop production are also quantified. These estimates are based on a simulation of the non-use of herbicides by U.S. growers, the substitution of likely alternative practices, and cost and effectiveness comparisons between herbicides and alternative weed control practices (cultivation and hand weeding).

A. Economic Value

Table 7 identifies the likely substitution of hand weeding and cultivation for each crop if herbicides are not used. These values are assumed to be the same for the 2001 and 2005 simulations. Table 7 also specifies the cost of the alternatives. Each hour of hand weeding was estimated to cost \$8.75 in 2001 which increased to \$10.00 per hour in 2005.[10] The hand weeding labor cost includes wage, supervision and other costs associated with employing a crew of hand laborers. Each tillage trip was estimated to cost \$4.50 per acre in 2001 increasing to \$5.84 per acre in 2005.[20] Field cultivation cost is a weighted average based on acres under reduced and intensive tillage and associated operation costs for conventional and high residue six row cultivators. The tillage costs consist of fuel, maintenance and labor charges. By multiplying the per acre cost of the likely alternatives by the number of acres treated with herbicides, estimates are made of the total cost of the alternative weed control practices. These estimates are shown in Table 7. The national cost of the alternatives is estimated at \$14.3 billion for 2001 and \$16.8 billion in 2005.

Estimates of the likely impacts on crop yields of not using herbicides in favor of likely alternatives are shown in Table 8 and are assumed to be the same in 2001 and 2005. These estimates are drawn from a series of studies conducted by USDA, WSSA, and AFBF, and are documented in the 2001 report.[1] For thirty-five crops the yield loss estimates range from 5% to 67% without herbicides. For these crops the projected increase in hand weeding and cultivation is not sufficient to prevent yield loss. For four crops (celery, citrus, hot peppers and raspberries), no yield change is projected as the amount of tillage, hand weeding or other alternative practice is assumed to be sufficient to prevent yield loss. In addition, for grapes, the national loss is 1% which is a weighted average of no loss in California and a 12 to 35% loss in other states.

In total, as shown in Table 8, the non-use of herbicides and the likely substitution of alternatives would result in a loss of \$13.3 billion in 2001 and \$16.3 billion in 2005. Without herbicides the total loss in production would amount to 288 billion pounds in

2001 and 296 billion pounds in 2005, which represents approximately 21% of total production in both years.

Table 9 summarizes the economic impacts of the non-use of herbicides for the forty crops included in the study. The total impact estimated for 2001 is a loss of \$21 billion which includes \$7.7 billion in increased costs for weed control and \$13.3 billion in yield losses due to less effective weed control. The total impact for 2005 is estimated at \$26 billion which includes a reduction of \$16 billion in crop production and an increase of \$10 billion in weed control costs. Table 10 summarizes economic impact estimates by state. Table 11 includes a selected list of crop impacts by state. Table 12 summarizes production volume losses by state.

B. Labor Requirements

One of the major replacements for herbicides identified in this study is increased reliance on hand weeding. Field crops such as wheat, corn, and soybeans are projected to require 2 to 5 additional hours of hand weeding per acre. Most fruit and vegetable crops are projected to require 20 to 60 hours per acre of increased hand weeding. The additional costs of hand weeding are included in the impact estimates by crop in Table 9 and by state in Table 10.

The number of additional workers that would be required to carry out this increased hand weeding is estimated. Table 13 presents estimates of the total number of additional hours of hand labor that would be required by each crop. (These estimates are assumed constant between 2001 and 2005.) For the nation, an additional 1.2 billion hours of hand weeding would be required. These estimates are also shown in terms of the number of workers that would be required by assuming that the weeding would need to be done during a 4 week period for each crop. For the nation, an additional 7.2 million laborers would be required to provide weed control if herbicides were not used. Table 14 presents the labor requirement estimates by state.

The hand weeding requirements specified in this study are not sufficient to prevent yield losses. For major acreage crops, such as corn, approximately 10% of the labor necessary to prevent yield loss is actually specified as a replacement (5 hours vs. 60 hours). An approximate estimate of the amount of labor that would be required to prevent any yield loss in comparison to herbicides is ten times that specified in this study, or an additional 72 million workers at the peak time for hand weeding.

C. Soil Erosion

The USDA has recently reported that cropland soil erosion declined by 700 million tons per year (1.4 trillion pounds) between 1982 and 2003.[25] This reduction has coincided with adoption of practices that conserve soil. No-till crop production, in which the soil is left undisturbed by tillage, is the most effective soil-conserving system.[26] Elimination of tillage means that the grower must rely entirely on herbicides to control weeds.[27][28] In the 2001 report, it was estimated that the adoption of no-till on 52 million cropland acres had resulted in a reduction in soil erosion of 304 billion pounds. USDA data were used to estimate the average soil erosion rates by state for an average

acre receiving tillage and an average acre that received no tillage. These state estimates are shown in Table 15. The weighted average soil erosion rate for a no-till acre in comparison to a tilled acre is 3 tons or 6,000 pounds. No till acres increased to 62 million in 2004 (see Figure 3).[21] Applying the same soil erosion rates used in the 2001 report results in an additional 50 billion pounds of prevented erosion. The state results are presented in Table 15. Without herbicides, U.S. growers could no longer practice no-till agriculture, which means that erosion would have increased by 304 billion pounds in 2001 and 356 billion pounds in 2005.

A recent article by economists at Iowa State University estimated that the external costs of eroded cropland soil ranged from \$2.34 to \$13.98 per ton.[22] The external costs include flood damage, lost reservoir capacity, increased water treatment costs, and cost impacts to waterway navigation and recreational activities. Using the midpoint of the range (\$8.16/ton) implies that by reducing soil erosion from cropland by 356 billion pounds in 2005 (178 million tons), no-till reduces external damages by \$1.5 billion per year.

D. Fuel Use and Production

The amount of diesel fuel used per acre for an herbicide application is estimated at 0.11 gallons, while the amount of fuel used to cultivate an acre is estimated at 0.45 gallons.[20] The total number of herbicide application trips currently made on treated acres is 367 million (1.47 trip/A), which implies the use of 40 million gallons of diesel fuel for herbicide application. The total number of cultivations that would be made as replacement for herbicides is estimated at 838 million (3.35/A), which implies a total diesel use of 377 million gallons for cultivation. The use of herbicides rather than cultivation results in an aggregate reduction of 337 million gallons of diesel. Table 16 displays the fuel use reductions by state.

Herbicides are derived from petrochemicals. Their demands on petroleum energy resources are primarily oil and natural gas raw materials from which they are made and the energy inputs required by the manufacturing process. Investigations of the energy inputs into the manufacturing of pesticides have resulted in a value of 11,000 kcal/pound.[32] A gallon of diesel fuel is equivalent to 37,000 kcal, which implies that manufacturing a pound of herbicide requires the equivalent of 0.30 gallon of diesel fuel.[33] In 2005, 349 million pounds of herbicides were used in U.S. crop production, which required the equivalent of 105 million gallons of diesel fuel.

The U.S. ethanol sector is projected to expand to 7 billion gallons in 2010.[24] Corn is the primary raw material for U.S. ethanol production. Without herbicides, U.S. corn production is estimated to decline by 20% equivalent to 152 billion pounds or 2.71 billion bushels. With a corn-to-ethanol conversion rate of 2.7 gallons per bushel, the corn production loss due to the non-use of herbicides is estimated at the equivalent to 7.32 billion gallons of ethanol.

6.0 Organic Perspective

Organic growers do not use herbicides to control weed populations. Organic cropland acreage in the U.S. increased from 1.3 million acres in 2001 to 1.4 million acres in 2003 (see Figure 4). North Dakota ranks first in the U.S. in the number of organic corn acres. Yields of organic corn in North Dakota are reported to be 25% lower than conventional yields.[30] The problem of controlling weeds without herbicides has been cited numerous times as the single largest obstacle that organic growers encounter. The following quotation from Earthbound Farms (the largest organic producer in North America) underscores the expense of doing without herbicides.[31]:

Controlling weeds without herbicides takes a lot of time and is very costly for us. We do all our weeding by tractor or by hand, which is very labor intensive. Conventional farmers spend only about \$50 an acre on herbicides that knock out every weed in sight. Organic farmers may have to spend up to \$1,000 an acre to keep weeds under control.

Earthbound Farm's experience of doing without herbicides reinforces the findings of this study: the main alternatives to herbicides are hand labor and cultivation, and they are more expensive than herbicides.

7.0 Summary and Conclusions

Herbicides are chemical pesticides that kill weeds. U.S. farmers have sprayed herbicides on close to 90% of the nation's cropland acreage for the past thirty years.

The value of the use of herbicides in 2005 is estimated to have been \$16 billion in increased crop yields and \$10 billion in reduced weed control costs.

The use of herbicides greatly reduces the need for fuel and laborers on U.S. farms. If farmers did not use herbicides, the alternatives for weed control would be increased mechanical cultivation and increased hand labor to pull weeds. The need for fuel would be 337 million gallons higher, since twice as many cultivation trips would be needed to replace herbicide spray trips and cultivators use four times more fuel per trip than herbicide sprayers. A minimum of 1.1 billion hours of hand labor would be required at peak season for hand weeding, necessitating the employment of 7 million more agricultural workers. Even with the increased cultivation and hand weeding, crop yields would be 20% lower. Approximately 70 million workers would be needed to prevent any yield loss without herbicides.

The largest production loss would be in corn, with a reduction of 2.7 billion bushels. Corn is the main feedstock for U.S. ethanol production, a major alternative being developed to reduce dependence on oil. The corn production loss due to herbicides non-use is equivalent to 7.3 billion gallons of ethanol, which is equal to the entire projected capacity of U.S. ethanol production by 2010.

Without herbicides U.S. growers would have to abandon no-till production practices, which are effective and popular techniques for reducing soil erosion. Without tillage growers kill weeds with herbicides. If U.S. growers stop using herbicides and resume tillage on the 62 million acres that were not tilled in 2005, soil erosion would be 356 billion pounds higher than it is today. Soil erosion deposits sediments in streams and rivers resulting in downstream damages. The damage resulting from increased soil erosion due to farming without herbicides is estimated at \$1.4 billion.

This report for 2005 is an update of a previously issued report for 2001. The same methodology was used in both reports, which makes it possible to report on fluctuations in the herbicide market and changes in the benefits of herbicides. Due to significant price decreases, U.S. farm expenditures for herbicides declined by \$300 million between 2001 and 2005. The price decline for herbicides was outweighed by increases in the costs of applying herbicides due to higher labor and fuel costs (+\$500 million) and increases in the premium prices paid for biotech herbicide-tolerant seed (+\$312 million). Thus, the total cost of herbicides and their application increased by \$512 million between 2001 and 2005.

Increased fuel and labor costs, however, also made the costs of alternatives to herbicides higher. The aggregate cost of cultivation and hand weeding as replacements for herbicides increased from \$14.3 billion in 2001 to \$16.8 billion in 2005, resulting in a net increase in weed control costs without herbicides from \$7.7 billion in 2001 to \$10 billion in 2005. The value of the crops also increased significantly between 2001 and 2005, which means the 20% loss in production without herbicides is worth more in 2005 (\$16 billion) than in 2001 (\$13 billion). Overall, the value of herbicides increased from \$21 billion in 2001 to \$26 billion in 2005.

Three trends that occurred in crop production and weed control between 2001 and 2005 are noteworthy, especially those relating to no-till, biotech, and organic crop production. Two of these practices are dependent on herbicides and one is not. The number of no-till acres on which herbicides substitute for tillage increased from 52 million acres to 62 million acres. The number of biotech herbicide tolerant acres where herbicides are used with crops that have been genetically-engineered for tolerance increased from 66 million acres to 94 million acres. Meanwhile, the number of cropland acres grown according to organic standards where herbicides are not used increased by 100,000 acres to 1.4 million. Organic farmers substitute labor and tillage for herbicides, which is very costly. There is not likely to be a vast expansion in domestic organic acreage due to the high cost of labor in the U.S. in comparison to many developing countries.

This study is a simulation of the impacts U.S. farm production and cost of production if farmers did not use herbicides for weed control. There is nothing to suggest that U.S. farmers will not have effective herbicides to use for the foreseeable future. Thus, the study can best be viewed as a cautionary note to those who advocate that growers should stop using chemical pesticides.

Table 1: Acreage and Production by Crop

| Crop | Acreage (000) | | Production | | | |
|----------------|------------------|----------------|-------------------------|------------------|-----------------------|---------------|
| | | | Volume (million lbs) | | Value (\$ million) | |
| | 2001 | 2005 | 2001 | 2005 | 2001 | 2005 |
| Almonds | 525 | 580 | 1,354 | 1,800 | 732 | 2,724 |
| Apples | 430 | 378 | 9,628 | 9,771 | 1,477 | 1,767 |
| Artichokes | 8 | 7 | 100 | 84 | 58 | 38 |
| Asparagus | 77 | 58 | 208 | 182 | 230 | 161 |
| Blueberries | 24 | 22 | 75 | 58 | 23 | 35 |
| Broccoli | 141 | 135 | 2,042 | 1,979 | 504 | 564 |
| Canola | 1,494 | 1,095 | 1,998 | 1,493 | 176 | 140 |
| Carrots | 121 | 92 | 4,005 | 3,166 | 577 | 520 |
| Celery | 29 | 28 | 1,882 | 1,917 | 277 | 274 |
| Citrus | 1,094 | 939 | 34,806 | 22,718 | 2,638 | 2,389 |
| Corn | 75,752 | 81,568 | 736,000 | 777,848 | 19,209 | 21,037 |
| Cotton | 15,787 | 14,121 | 9,600 | 11,343 | 3,384 | 5,554 |
| Cranberries | 34 | 39 | 532 | 622 | 99 | 212 |
| Cucumbers | 59 | 63 | 1,089 | 1,073 | 212 | 233 |
| Dry Beans | 1,430 | 1,598 | 1,954 | 2,621 | 414 | 507 |
| Grapes | 930 | 930 | 13,104 | 13,920 | 2,921 | 2,996 |
| Green Beans | 210 | 186 | 1,397 | 1,388 | 112 | 105 |
| Green Peas | 217 | 188 | 774 | 650 | 102 | 90 |
| Hops | 36 | 30 | 66 | 52 | 126 | 103 |
| Hot Peppers | 33 | 17 | 311 | 301 | 88 | 47 |
| Lettuce | 306 | 333 | 10,053 | 10,271 | 1,907 | 1,982 |
| Mint | 98 | 94 | 8 | 8 | 96 | 104 |
| Onions | 167 | 167 | 6,708 | 7,173 | 703 | 888 |
| Peaches | 151 | 133 | 2,440 | 2,284 | 496 | 468 |
| Peanuts | 1,543 | 1,642 | 4,239 | 4,776 | 1,003 | 838 |
| Potatoes | 1,267 | 1,103 | 44,476 | 41,920 | 2,591 | 2,895 |
| Raspberries | 12 | 16 | 92 | 159 | 46 | 209 |
| Rice | 3,335 | 3,384 | 21,304 | 22,321 | 896 | 1,788 |
| Sorghum | 10,252 | 6,443 | 28,784 | 22,047 | 998 | 715 |
| Soybeans | 74,105 | 71,934 | 174,000 | 184,637 | 12,446 | 16,884 |
| Spinach | 15 | 5 | 284 | 68 | 17 | 9 |
| Strawberries | 47 | 55 | 1,666 | 2,328 | 1,085 | 1,390 |
| Sugarbeets | 1,371 | 1,293 | 52,000 | 55,170 | 1,113 | 1,101 |
| Sugarcane | 1,029 | 899 | 70,000 | 51,640 | 942 | 758 |
| Sunflowers | 2,653 | 1,990 | 3,480 | 3,081 | 317 | 339 |
| Sweet Corn | 733 | 654 | 9,050 | 8,436 | 772 | 810 |
| Sweet Potatoes | 98 | 91 | 1,435 | 1,579 | 210 | 310 |
| Tomatoes | 411 | 423 | 22,192 | 24,265 | 1,665 | 2,269 |
| Wheat | 59,617 | 57,229 | 120,000 | 126,280 | 5,553 | 7,140 |
| Wild Rice | 19 | 23 | 6 | 5 | 10 | 8 |
| Total | 255,660 | 249,984 | 1,393,136 | 1,421,434 | 66,225 | 80,399 |

Source:[2][3][4][5][6]

Notes: Corn for grain only, spinach, green beans, and green peas for processing only. Cucumbers- fresh only; Wild Rice- Minnesota only; Blueberries- Maine only.

Table 2: Acreage and Production by State

| State | Acreage (000) | | Production | | | |
|----------------|------------------|--------|-------------------------|---------|-----------------------|--------|
| | | | Volume (million lbs) | | Value (million \$) | |
| | 2001 | 2005 | 2001 | 2005 | 2001 | 2005 |
| Alabama | 1,190 | 1,265 | 2,549 | 3,244 | 420 | 423 |
| Arizona | 544 | 511 | 4,498 | 4,162 | 725 | 823 |
| Arkansas | 6,943 | 6,253 | 21,939 | 20,993 | 1,330 | 2,020 |
| California | 4,712 | 5,143 | 69,903 | 74,986 | 10,335 | 13,969 |
| Colorado | 3,592 | 4,080 | 18,040 | 18,303 | 903 | 890 |
| Connecticut | 7 | 7 | 48 | 46 | 14 | 15 |
| Delaware | 432 | 411 | 2,158 | 2,252 | 106 | 99 |
| Florida | 1,619 | 1,509 | 61,933 | 46,734 | 2,899 | 2,970 |
| Georgia | 2,698 | 2,826 | 6,445 | 7,228 | 1,083 | 1,310 |
| Idaho | 1,975 | 2,136 | 28,514 | 29,023 | 1,292 | 1,327 |
| Illinois | 22,395 | 22,348 | 124,750 | 149,272 | 5,709 | 5,949 |
| Indiana | 11,693 | 11,703 | 68,249 | 80,294 | 3,064 | 3,197 |
| Iowa | 22,420 | 22,922 | 122,102 | 183,341 | 5,566 | 6,907 |
| Kansas | 18,188 | 19,613 | 60,985 | 73,132 | 2,526 | 3,159 |
| Kentucky | 2,611 | 2,926 | 13,161 | 15,479 | 576 | 688 |
| Louisiana | 3,254 | 3,033 | 38,819 | 30,465 | 924 | 1,112 |
| Maine | 93 | 85 | 1,745 | 1,674 | 155 | 175 |
| Maryland | 1,126 | 1,125 | 5,274 | 5,563 | 270 | 259 |
| Massachusetts | 27 | 27 | 304 | 282 | 67 | 84 |
| Michigan | 5,222 | 5,415 | 27,332 | 37,350 | 1,239 | 1,586 |
| Minnesota | 16,264 | 17,004 | 85,443 | 128,737 | 3,400 | 4,679 |
| Mississippi | 3,749 | 3,577 | 9,148 | 10,143 | 785 | 1,115 |
| Missouri | 9,152 | 9,488 | 35,872 | 38,297 | 1,802 | 2,052 |
| Montana | 4,297 | 5,470 | 8,506 | 14,354 | 392 | 780 |
| Nebraska | 14,960 | 15,633 | 85,719 | 111,450 | 3,582 | 4,060 |
| Nevada | 10 | 20 | 250 | 281 | 16 | 14 |
| New Hampshire | 5 | 4 | 40 | 31 | 11 | 11 |
| New Jersey | 236 | 240 | 1,283 | 1,211 | 156 | 164 |
| New Mexico | 580 | 831 | 2,762 | 2,453 | 218 | 233 |
| New York | 925 | 1,322 | 7,303 | 7,375 | 589 | 597 |
| North Carolina | 3,681 | 3,808 | 10,749 | 12,003 | 948 | 1,041 |
| North Dakota | 15,135 | 16,597 | 41,563 | 50,809 | 2,027 | 2,722 |
| Ohio | 8,716 | 8,859 | 40,325 | 49,150 | 2,015 | 2,323 |
| Oklahoma | 5,096 | 6,876 | 10,306 | 11,153 | 533 | 664 |
| Oregon | 1,118 | 1,191 | 6,885 | 8,530 | 529 | 661 |
| Pennsylvania | 1,646 | 2,017 | 8,092 | 10,898 | 466 | 571 |
| Rhode Island | 1 | 1 | 15 | 12 | 1 | 2 |
| South Carolina | 1,244 | 1,260 | 3,097 | 3,955 | 267 | 321 |
| South Dakota | 10,803 | 12,396 | 35,265 | 50,384 | 1,530 | 2,116 |
| Tennessee | 2,699 | 2,697 | 8,512 | 9,231 | 541 | 721 |
| Texas | 14,289 | 16,378 | 33,753 | 38,507 | 2,200 | 3,609 |
| Utah | 169 | 227 | 643 | 715 | 38 | 49 |
| Vermont | 4 | 4 | 46 | 40 | 11 | 11 |
| Virginia | 1,211 | 1,347 | 4,894 | 5,299 | 359 | 399 |
| Washington | 3,111 | 3,074 | 27,059 | 29,292 | 2,479 | 2,735 |
| West Virginia | 42 | 58 | 329 | 330 | 18 | 19 |
| Wisconsin | 4,712 | 5,949 | 28,453 | 40,531 | 1,330 | 1,686 |
| Wyoming | 250 | 319 | 2,299 | 2,440 | 70 | 81 |

Table 3: Herbicide Use by Crop

| Crop | Acres Treated | | | | Lbs./Year (000) | |
|----------------|-------------------|--------------------|----------------|--------------------|-------------------|----------------|
| | 2001 ¹ | | 2005 | | 2001 ¹ | 2005 |
| | % | (000) ³ | % ² | (000) ³ | | |
| Almonds | 86 | 452 | 86 | 499 | 1,229 | 1,342 |
| Apples | 63 | 271 | 63 | 238 | 1,530 | 760 |
| Artichokes | 58 | 5 | 58 | 4 | 12 | 8 |
| Asparagus | 91 | 70 | 91 | 53 | 213 | 187 |
| Blueberries | 95 | 23 | 95 | 21 | 14 | 23 |
| Broccoli | 51 | 70 | 51 | 69 | 211 | 147 |
| Canola | 99 | 1,479 | 99 | 1,084 | 718 | 662 |
| Carrots | 98 | 119 | 98 | 90 | 169 | 142 |
| Celery | 85 | 25 | 85 | 24 | 50 | 40 |
| Citrus | 95 | 1,039 | 95 | 892 | 7,879 | 5,626 |
| Corn | 98 | 74,237 | 98 | 79,937 | 206,052 | 158,547 |
| Cotton | 95 | 14,998 | 95 | 13,415 | 33,113 | 21,815 |
| Cranberries | 95 | 32 | 95 | 37 | 120 | 110 |
| Cucumbers | 60 | 35 | 60 | 38 | 252 | 227 |
| Dry Beans | 99 | 1,416 | 99 | 1,582 | 3,799 | 3,039 |
| Grapes | 75 | 698 | 75 | 698 | 1,831 | 1,779 |
| Green Beans | 96 | 202 | 96 | 179 | 743 | 627 |
| Green Peas | 94 | 204 | 94 | 177 | 245 | 161 |
| Hops | 95 | 34 | 95 | 29 | 71 | 28 |
| Hot Peppers | 95 | 31 | 95 | 16 | 111 | 29 |
| Lettuce | 62 | 190 | 62 | 206 | 290 | 394 |
| Mint | 95 | 93 | 95 | 89 | 375 | 268 |
| Onions | 88 | 147 | 88 | 147 | 568 | 662 |
| Peaches | 66 | 100 | 66 | 88 | 234 | 340 |
| Peanuts | 97 | 1,497 | 97 | 1,593 | 3,038 | 1,912 |
| Potatoes | 93 | 1,178 | 93 | 1,026 | 3,109 | 2,209 |
| Raspberries | 91 | 11 | 91 | 15 | 34 | 29 |
| Rice | 98 | 3,268 | 98 | 3,316 | 15,736 | 15,281 |
| Sorghum | 91 | 9,329 | 91 | 5,863 | 16,579 | 12,358 |
| Soybeans | 96 | 71,141 | 96 | 69,057 | 76,604 | 91,108 |
| Spinach | 90 | 14 | 90 | 5 | 37 | 11 |
| Strawberries | 39 | 18 | 39 | 21 | 75 | 53 |
| Sugarbeets | 98 | 1,344 | 98 | 1,267 | 2,398 | 1,258 |
| Sugarcane | 95 | 977 | 95 | 854 | 5,904 | 7,039 |
| Sunflowers | 95 | 2,520 | 95 | 1,891 | 1,841 | 1,634 |
| Sweet Corn | 90 | 660 | 90 | 589 | 1,890 | 1,446 |
| Sweet Potatoes | 70 | 69 | 70 | 64 | 71 | 69 |
| Tomatoes | 96 | 394 | 96 | 406 | 684 | 520 |
| Wheat | 55 | 32,789 | 55 | 31,476 | 21,789 | 16,933 |
| Wild Rice | 10 | 2 | 10 | 2 | 1 | <1 |
| Total | (86) | 221,181 | (86) | 214,986 | 409,619 | 348,823 |

¹ From [1]² Assumed same as 2001.³ Calculated using acreage data from Table 1.

| Table 4: Herbicide Use by State | | |
|--|------------------------|-------------|
| State | Lbs./Year (000) | |
| | 2001 | 2005 |
| Alabama | 2,867 | 2,690 |
| Arizona | 1,088 | 771 |
| Arkansas | 13,813 | 13,389 |
| California | 12,607 | 10,052 |
| Colorado | 2,691 | 2,145 |
| Connecticut | 124 | 41 |
| Delaware | 965 | 922 |
| Florida | 9,282 | 8,380 |
| Georgia | 6,056 | 4,210 |
| Idaho | 3,246 | 2,349 |
| Illinois | 44,263 | 39,653 |
| Indiana | 23,768 | 21,252 |
| Iowa | 51,095 | 37,314 |
| Kansas | 18,411 | 18,588 |
| Kentucky | 5,263 | 4,462 |
| Louisiana | 12,169 | 12,571 |
| Maine | 190 | 184 |
| Maryland | 2,366 | 2,318 |
| Massachusetts | 170 | 120 |
| Michigan | 10,353 | 9,086 |
| Minnesota | 22,596 | 21,928 |
| Mississippi | 9,344 | 6,625 |
| Missouri | 16,270 | 14,885 |
| Montana | 2,984 | 4,004 |
| Nebraska | 28,922 | 19,554 |
| Nevada | 10 | 8 |
| New Hampshire | 50 | 21 |
| New Jersey | 674 | 627 |
| New Mexico | 856 | 437 |
| New York | 4,688 | 3,156 |
| North Carolina | 6,311 | 6,035 |
| North Dakota | 13,775 | 12,912 |
| Ohio | 14,974 | 16,039 |
| Oklahoma | 2,601 | 1,517 |
| Oregon | 1,504 | 1,224 |
| Pennsylvania | 5,435 | 4,080 |
| Rhode Island | 10 | 9 |
| South Carolina | 2,889 | 2,100 |
| South Dakota | 14,646 | 11,951 |
| Tennessee | 4,384 | 4,260 |
| Texas | 18,510 | 12,832 |
| Utah | 184 | 133 |
| Vermont | 340 | 106 |
| Virginia | 2,803 | 3,055 |
| Washington | 4,393 | 3,222 |
| West Virginia | 269 | 164 |
| Wisconsin | 9,162 | 7,339 |
| Wyoming | 268 | 122 |

| Table 5: Herbicide Cost by Crop (\$ 000) | | | | | | |
|---|-------------------------|------------------|------------------------------------|------------------|------------------|------------------------------------|
| Crop | 2001¹ | | | 2005 | | |
| | Total | Product | Application & Seed Fees | Total | Product | Application & Seed Fees |
| Almonds | 20,533 | 16,921 | 3,612 | 20,439 | 15,242 | 5,197 |
| Apples | 17,715 | 16,610 | 1,105 | 9,615 | 8,324 | 1,291 |
| Artichokes | 419 | 401 | 18 | 335 | 313 | 22 |
| Asparagus | 2,833 | 2,282 | 551 | 3,035 | 2,486 | 549 |
| Blueberries | 652 | 472 | 180 | 814 | 593 | 221 |
| Broccoli | 2,398 | 2,109 | 289 | 3,128 | 2,767 | 361 |
| Canola | 30,603 | 13,278 | 17,325 | 26,253 | 9,929 | 16,324 |
| Carrots | 3,739 | 2,871 | 868 | 4,357 | 3,411 | 946 |
| Celery | 696 | 511 | 185 | 715 | 472 | 243 |
| Citrus | 80,607 | 72,365 | 8,242 | 61,738 | 52,433 | 9,305 |
| Corn | 2,265,353 | 1,823,501 | 441,852 | 2,634,093 | 1,875,382 | 758,711 |
| Cotton | 559,963 | 344,195 | 215,768 | 506,967 | 240,051 | 266,916 |
| Cranberries | 3,109 | 2,850 | 259 | 3,261 | 2,874 | 387 |
| Cucumbers | 3,505 | 2,701 | 804 | 3,451 | 3,002 | 449 |
| Dry Beans | 40,030 | 34,775 | 5,255 | 43,552 | 35,311 | 8,241 |
| Grapes | 27,932 | 24,691 | 3,241 | 26,678 | 22,392 | 4,286 |
| Green Beans | 6,548 | 5,108 | 1,440 | 8,143 | 6,291 | 1,852 |
| Green Peas | 4,051 | 3,366 | 685 | 3,745 | 2,823 | 922 |
| Hops | 1,201 | 1,065 | 136 | 896 | 750 | 146 |
| Hot Peppers | 1,547 | 1,475 | 72 | 535 | 451 | 84 |
| Lettuce | 8,477 | 7,955 | 522 | 13,220 | 12,316 | 904 |
| Mint | 10,392 | 9,648 | 744 | 7,849 | 6,921 | 928 |
| Onions | 8,268 | 7,149 | 1,119 | 13,596 | 12,031 | 1,565 |
| Peaches | 2,978 | 2,563 | 415 | 4,428 | 3,931 | 497 |
| Peanuts | 63,896 | 48,250 | 15,646 | 55,215 | 31,871 | 23,344 |
| Potatoes | 45,450 | 38,505 | 6,945 | 47,866 | 40,472 | 7,394 |
| Raspberries | 674 | 618 | 56 | 522 | 448 | 74 |
| Rice | 217,996 | 179,170 | 38,826 | 248,359 | 193,251 | 55,108 |
| Sorghum | 134,918 | 103,731 | 31,187 | 125,709 | 95,162 | 30,547 |
| Soybeans | 2,110,780 | 1,224,075 | 886,705 | 2,418,313 | 1,196,199 | 1,222,114 |
| Spinach | 471 | 414 | 57 | 322 | 278 | 44 |
| Strawberries | 1,420 | 1,210 | 210 | 1,246 | 959 | 287 |
| Sugarbeets | 138,163 | 118,434 | 19,729 | 128,231 | 103,573 | 24,658 |
| Sugarcane | 51,323 | 43,678 | 7,645 | 56,122 | 47,223 | 8,899 |
| Sunflowers | 26,347 | 18,408 | 7,939 | 27,019 | 17,192 | 9,827 |
| Sweet Corn | 16,134 | 13,700 | 2,434 | 16,767 | 13,694 | 3,073 |
| Sweet Potatoes | 1,664 | 1,390 | 274 | 2,319 | 1,987 | 332 |
| Tomatoes | 11,593 | 8,517 | 3,076 | 12,777 | 8,540 | 4,237 |
| Wheat | 649,779 | 503,606 | 146,173 | 544,346 | 329,278 | 215,068 |
| Wild Rice | 9 | 1 | 8 | 14 | 1 | 13 |
| Total | 6,574,166 | 4,702,569 | 1,871,597 | 7,085,992 | 4,400,624 | 2,685,368 |

¹ From [1]

Table 6: Herbicide Use and Cost By State

| State | Lbs (000/yr) | | Application & Seed Fees (\$ 000/yr) | | Product Cost (\$ 000/yr) | | Total Cost (\$ 000/yr) | |
|----------------|-----------------|--------|---|---------|-----------------------------|---------|---------------------------|---------|
| | 2001 | 2005 | 2001 | 2005 | 2001 | 2005 | 2001 | 2005 |
| Alabama | 2,866 | 2,690 | 15,824 | 21,201 | 29,310 | 24,705 | 45,134 | 45,906 |
| Arizona | 1,087 | 771 | 6,552 | 5,985 | 13,899 | 9,734 | 20,421 | 15,719 |
| Arkansas | 13,812 | 13,389 | 74,160 | 101,089 | 150,187 | 171,012 | 224,347 | 272,101 |
| California | 12,606 | 10,052 | 34,167 | 44,137 | 166,999 | 113,006 | 201,166 | 157,143 |
| Colorado | 2,690 | 2,145 | 14,839 | 23,034 | 32,911 | 25,472 | 47,750 | 48,506 |
| Connecticut | 124 | 41 | 23 | 29 | 987 | 340 | 1,010 | 369 |
| Delaware | 964 | 922 | 3,594 | 4,348 | 12,925 | 13,500 | 16,519 | 17,848 |
| Florida | 9,281 | 8,380 | 13,756 | 16,664 | 82,774 | 74,105 | 96,530 | 90,769 |
| Georgia | 6,056 | 4,210 | 35,767 | 42,165 | 69,115 | 45,143 | 104,882 | 87,308 |
| Idaho | 3,246 | 2,349 | 12,292 | 17,186 | 73,184 | 46,318 | 85,476 | 63,504 |
| Illinois | 44,262 | 39,653 | 192,229 | 259,439 | 460,051 | 457,655 | 652,280 | 717,094 |
| Indiana | 23,768 | 21,252 | 103,780 | 142,658 | 235,261 | 236,479 | 339,041 | 379,137 |
| Iowa | 51,094 | 37,314 | 208,424 | 298,410 | 600,270 | 529,956 | 808,694 | 828,366 |
| Kansas | 18,411 | 18,588 | 80,868 | 117,765 | 151,625 | 180,320 | 232,493 | 298,085 |
| Kentucky | 5,263 | 4,462 | 21,819 | 32,319 | 69,084 | 58,245 | 90,903 | 90,564 |
| Louisiana | 12,169 | 12,571 | 36,249 | 44,358 | 121,741 | 133,111 | 157,990 | 177,469 |
| Maine | 189 | 184 | 466 | 559 | 3,478 | 3,840 | 3,944 | 4,399 |
| Maryland | 2,365 | 2,318 | 9,201 | 13,098 | 29,048 | 28,439 | 38,249 | 41,537 |
| Massachusetts | 169 | 120 | 144 | 204 | 2,386 | 1,815 | 2,530 | 2,019 |
| Michigan | 10,352 | 9,086 | 41,891 | 58,946 | 96,107 | 113,411 | 137,998 | 172,357 |
| Minnesota | 22,596 | 21,928 | 151,380 | 219,052 | 373,858 | 337,428 | 525,238 | 556,480 |
| Mississippi | 9,343 | 6,625 | 49,931 | 63,845 | 111,669 | 95,498 | 161,600 | 159,343 |
| Missouri | 16,269 | 14,885 | 81,614 | 124,581 | 190,929 | 191,425 | 272,543 | 316,006 |
| Montana | 2,983 | 4,004 | 16,397 | 27,111 | 38,148 | 74,137 | 54,545 | 101,248 |
| Nebraska | 28,922 | 19,554 | 110,914 | 171,507 | 272,656 | 230,910 | 383,570 | 402,417 |
| Nevada | 9 | 8 | 43 | 81 | 136 | 187 | 179 | 268 |
| New Hampshire | 49 | 21 | 13 | 16 | 384 | 138 | 397 | 154 |
| New Jersey | 674 | 627 | 1,961 | 2,597 | 11,984 | 9,581 | 13,945 | 12,178 |
| New Mexico | 855 | 437 | 2,398 | 4,759 | 7,387 | 5,015 | 9,785 | 9,774 |
| New York | 4,688 | 3,156 | 6,168 | 10,419 | 35,808 | 33,570 | 41,976 | 43,989 |
| North Carolina | 6,311 | 6,035 | 38,004 | 52,242 | 65,893 | 69,527 | 103,897 | 121,769 |
| North Dakota | 13,774 | 12,912 | 99,949 | 153,521 | 263,958 | 228,718 | 363,907 | 382,239 |
| Ohio | 14,973 | 16,039 | 74,478 | 102,497 | 152,534 | 176,671 | 227,012 | 279,168 |
| Oklahoma | 2,601 | 1,517 | 18,494 | 29,745 | 31,514 | 21,531 | 50,008 | 51,276 |
| Oregon | 1,503 | 1,224 | 6,327 | 8,911 | 23,370 | 17,805 | 29,697 | 26,716 |
| Pennsylvania | 5,434 | 4,080 | 12,564 | 19,874 | 43,120 | 42,483 | 55,684 | 62,357 |
| Rhode Island | 10 | 9 | 3 | 4 | 69 | 80 | 72 | 84 |
| South Carolina | 2,888 | 2,100 | 12,525 | 18,282 | 32,547 | 22,825 | 45,072 | 41,107 |
| South Dakota | 14,645 | 11,951 | 91,632 | 138,815 | 200,347 | 182,039 | 291,979 | 320,854 |
| Tennessee | 4,383 | 4,260 | 29,775 | 41,502 | 54,606 | 55,224 | 84,381 | 96,726 |
| Texas | 18,509 | 12,832 | 97,984 | 149,241 | 171,979 | 120,163 | 269,963 | 269,404 |
| Utah | 183 | 133 | 599 | 1,151 | 1,507 | 1,262 | 2,106 | 2,413 |
| Vermont | 339 | 106 | 11 | 14 | 2,337 | 510 | 2,348 | 524 |
| Virginia | 2,803 | 3,055 | 10,471 | 16,287 | 31,307 | 37,224 | 41,778 | 53,511 |
| Washington | 4,393 | 3,222 | 13,824 | 18,295 | 65,690 | 45,568 | 79,514 | 63,863 |
| West Virginia | 268 | 164 | 261 | 481 | 2,041 | 2,044 | 2,302 | 2,525 |
| Wisconsin | 9,161 | 7,339 | 37,190 | 64,985 | 109,403 | 129,045 | 146,593 | 194,030 |
| Wyoming | 268 | 122 | 1,229 | 1,957 | 6,043 | 3,431 | 7,272 | 5,388 |

Table 7: No Herbicide Use, Alternative Costs by Crop

| Crop | Hand Weeding (Hrs/A) ¹ | Tillage (#/A) ¹ | Other (\$/A) | Cost | | | |
|----------------|-----------------------------------|----------------------------|------------------|---------------------|--------|----------------------------|-------------------|
| | | | | (\$/A) ² | | (\$ 000/year) ³ | |
| | | | | 2001 | 2005 | 2001 | 2005 |
| Almonds | 7 | 0 | 36 ⁴ | 97.25 | 106.00 | 43,957 | 52,873 |
| Apples | 20 | 2 | | 184.00 | 211.68 | 49,864 | 52,469 |
| Artichokes | 23 | 0 | | 201.25 | 230.00 | 1,006 | 974 |
| Asparagus | 5 | 5 | | 66.25 | 79.20 | 4,638 | 4,174 |
| Blueberries | 5 | 0 | | 43.75 | 50.00 | 1,006 | 1,059 |
| Broccoli | 20 | 2 | | 184.00 | 211.68 | 12,880 | 14,657 |
| Canola | 0 | 2 | | 9.00 | 11.68 | 13,311 | 12,662 |
| Carrots | 14 | 2 | | 131.50 | 151.68 | 15,648 | 13,768 |
| Celery | 60 | 4 | | 543.00 | 623.36 | 13,575 | 14,561 |
| Citrus | 0 | 0 | 400 ⁵ | 400.00 | 400.00 | 415,600 | 357,216 |
| Corn | 5 | 4 | | 61.75 | 73.36 | 4,584,134 | 5,848,585 |
| Cotton | 13 | 7 | | 145.25 | 170.88 | 2,178,459 | 2,290,722 |
| Cranberries | 20 | 0 | | 175.00 | 200.00 | 5,600 | 7,429 |
| Cucumbers | 30 | 3 | | 276.00 | 317.52 | 9,660 | 13,695 |
| Dry Beans | 16 | 2 | | 149.00 | 171.68 | 210,984 | 271,567 |
| Grapes | 8 | 2 | | 79.00 | 91.68 | 55,142 | 71,196 |
| Green Beans | 12 | 2 | | 114.00 | 131.68 | 23,028 | 23,407 |
| Green Peas | 12 | 2 | | 114.00 | 131.68 | 23,256 | 23,291 |
| Hops | 35 | 6 | | 333.25 | 385.04 | 11,330 | 10,807 |
| Hot Peppers | 60 | 0 | | 525.00 | 600.00 | 16,275 | 9,690 |
| Lettuce | 38 | 2 | | 341.50 | 391.68 | 64,885 | 67,931 |
| Mint | 18 | 0 | | 157.50 | 180.00 | 14,647 | 16,023 |
| Onions | 64 | 2 | | 569.00 | 651.68 | 83,643 | 89,857 |
| Peaches | 6 | 0 | | 52.50 | 60.00 | 5,250 | 5,642 |
| Peanuts | 10 | 2 | | 96.50 | 111.68 | 144,460 | 178,853 |
| Potatoes | 10 | 5 | | 110.00 | 129.20 | 129,580 | 131,824 |
| Raspberries | 43 | 9 | | 416.75 | 482.56 | 4,584 | 6,887 |
| Rice | 0 | 4 | | 18.00 | 23.36 | 58,824 | 76,729 |
| Sorghum | 0 | 3 | | 13.50 | 17.52 | 125,941 | 102,722 |
| Soybeans | 5 | 4 | | 61.75 | 73.36 | 4,392,956 | 5,082,068 |
| Spinach | 20 | 3 | | 188.50 | 217.52 | 2,639 | 920 |
| Strawberries | 30 | 4 | | 280.50 | 323.36 | 5,049 | 7,566 |
| Sugarbeets | 15 | 2 | | 140.25 | 161.68 | 188,496 | 206,859 |
| Sugarcane | 25 | 3 | | 232.25 | 267.52 | 226,908 | 228,475 |
| Sunflowers | 0 | 7 | | 31.50 | 40.88 | 79,380 | 77,104 |
| Sweet Corn | 5 | 3 | | 57.25 | 67.52 | 37,785 | 39,828 |
| Sweet Potatoes | 24 | 2 | | 219.00 | 251.68 | 15,111 | 16,014 |
| Tomatoes | 37 | 8 | | 359.75 | 416.72 | 141,741 | 169,433 |
| Wheat | 2 | 2 | | 26.50 | 31.68 | 868,908 | 1,176,233 |
| Wild Rice | 0 | 0 | | 0 | 0 | 0 | 0 |
| Total | | | | | | 14,280,140 | 16,775,772 |

¹ Assumed to be the same for 2001 and 2005 [1]

² For 2001, hand weeding costs estimated at \$8.75/hour; cultivation costs estimated at \$4.50/trip. For 2005, hand weeding costs estimated at \$10/hour; cultivation costs estimated at \$5.84/trip.

³ Cost per acre times number of acres treated with herbicides.

⁴ Mowing, cover crops.

⁵ Mowing, increased fertilizer and irrigation.

| Table 8: No Herbicide Use, Production Impacts By Crop | | | | | |
|--|--|--------------------|------------------|-------------------|-----------------|
| | | Production | | | |
| Crop | % Yield Loss w/o Herbicides² | <i>Million Lbs</i> | | <i>\$ Million</i> | |
| | | 2001 | 2005 | 2001 | 2005 |
| Almonds | 5 | 58.2 | 77.4 | 31.5 | 117.1 |
| Apples | 15 | 909.8 | 923.4 | 139.6 | 167.0 |
| Artichokes | 16 | 9.3 | 7.8 | 5.4 | 3.5 |
| Asparagus | 55 | 104.1 | 91.1 | 115.1 | 80.6 |
| Blueberries | 67 | 47.7 | 36.9 | 14.6 | 22.3 |
| Broccoli | 14 | 145.8 | 141.3 | 36.0 | 40.3 |
| Canola | 45 | 890.1 | 665.1 | 78.4 | 62.4 |
| Carrots | 48 | 1,884.0 | 1,489.3 | 271.4 | 244.6 |
| Celery | 0 | 0 | 0 | 0 | 0 |
| Citrus | 0 | 0 | 0 | 0 | 0 |
| Corn | 20 | 144,256.0 | 152,458.2 | 3,765.0 | 4,123.3 |
| Cotton | 27 | 2,462.4 | 2,909.5 | 868.0 | 1,424.6 |
| Cranberries | 50 | 252.7 | 295.5 | 47.0 | 100.7 |
| Cucumbers | 66 | 431.2 | 424.9 | 84.0 | 92.3 |
| Dry Beans | 25 | 483.6 | 648.7 | 102.5 | 125.5 |
| Grapes | 1 | 98.3 | 104.4 | 21.9 | 22.5 |
| Green Beans | 20 | 268.2 | 266.5 | 21.5 | 20.2 |
| Green Peas | 20 | 145.5 | 122.2 | 19.2 | 16.9 |
| Hops | 25 | 15.7 | 12.4 | 29.9 | 24.5 |
| Hot Peppers | 0 | 0 | 0 | 0 | 0 |
| Lettuce | 13 | 810.3 | 827.8 | 153.7 | 159.7 |
| Mint | 58 | 4.4 | 4.4 | 53.0 | 57.3 |
| Onions | 43 | 2,538.3 | 2,714.3 | 266.0 | 336.0 |
| Peaches | 11 | 177.1 | 165.8 | 36.0 | 34.0 |
| Peanuts | 52 | 2,138.2 | 2,409.0 | 505.9 | 422.7 |
| Potatoes | 32 | 13,236.1 | 12,475.4 | 771.1 | 861.6 |
| Raspberries | 0 | 0 | 0 | 0 | 0 |
| Rice | 53 | 11,065.3 | 11,593.5 | 465.4 | 928.7 |
| Sorghum | 26 | 6,810.3 | 5,216.3 | 236.1 | 169.2 |
| Soybeans | 26 | 43,430.4 | 46,085.4 | 3,106.5 | 4,214.2 |
| Spinach | 50 | 127.8 | 30.6 | 7.6 | 4.1 |
| Strawberries | 30 | 194.9 | 272.4 | 126.9 | 162.6 |
| Sugarbeets | 29 | 14,778.4 | 15,679.3 | 316.3 | 312.9 |
| Sugarcane | 25 | 16,625.0 | 12,264.5 | 223.7 | 180.0 |
| Sunflowers | 16 | 529.0 | 468.3 | 48.2 | 51.5 |
| Sweet Corn | 25 | 2,036.2 | 1,898.1 | 173.7 | 182.3 |
| Sweet Potatoes | 20 | 200.9 | 221.1 | 29.4 | 43.4 |
| Tomatoes | 23 | 4,900.0 | 5,357.7 | 367.6 | 501.0 |
| Wheat | 25 | 16,500.0 | 17,363.5 | 763.0 | 981.8 |
| Wild Rice | 50 | 0.3 | 0.3 | 0.5 | 0.4 |
| Total | | 288,565.5 | 295,722.2 | 13,301.6 | 16,291.0 |

² Assumed identical 2001 and 2005.

| Table 9: Summary of No Herbicide Use Impacts by Crop (\$ 000) | | | | | | |
|--|--|------------------|--|-------------------|-------------------------------------|-------------------|
| Crop | Weed Control Cost (+)¹ | | Production Impact (-)² | | Total Impact (-)³ | |
| | <i>2001</i> | <i>2005</i> | <i>2001</i> | <i>2005</i> | <i>2001</i> | <i>2005</i> |
| Almonds | 23,424 | 32,434 | 31,500 | 117,100 | 54,924 | 149,534 |
| Apples | 32,149 | 42,854 | 139,600 | 167,000 | 171,749 | 209,854 |
| Artichokes | 587 | 639 | 5,400 | 3,500 | 5,987 | 4,139 |
| Asparagus | 1,805 | 1,139 | 115,100 | 80,600 | 116,905 | 81,739 |
| Blueberries | 354 | 245 | 14,600 | 22,300 | 14,954 | 22,545 |
| Broccoli | 10,482 | 11,529 | 36,000 | 40,300 | 46,482 | 51,829 |
| Canola | -17,292 | -13,591 | 78,400 | 62,400 | 61,108 | 48,809 |
| Carrots | 11,909 | 9,411 | 271,400 | 244,600 | 283,309 | 254,011 |
| Celery | 12,879 | 13,846 | 0 | 0 | 12,879 | 13,846 |
| Citrus | 334,993 | 295,478 | 0 | 0 | 334,993 | 295,478 |
| Corn | 2,318,781 | 3,214,492 | 3,765,000 | 4,123,300 | 6,083,781 | 7,337,792 |
| Cotton | 1,618,496 | 1,783,755 | 868,000 | 1,424,600 | 2,486,496 | 3,208,355 |
| Cranberries | 2,491 | 4,168 | 47,000 | 100,700 | 49,491 | 104,868 |
| Cucumbers | 6,155 | 10,244 | 84,000 | 92,300 | 90,155 | 102,544 |
| Dry Beans | 170,954 | 228,015 | 102,500 | 125,500 | 273,454 | 353,515 |
| Grapes | 27,210 | 44,518 | 21,900 | 22,500 | 49,110 | 67,018 |
| Green Beans | 16,480 | 15,264 | 21,500 | 20,200 | 37,980 | 35,464 |
| Green Peas | 19,205 | 19,546 | 19,200 | 16,900 | 38,405 | 36,446 |
| Hops | 10,129 | 9,911 | 29,900 | 24,500 | 40,029 | 34,411 |
| Hot Peppers | 14,728 | 9,155 | 0 | 0 | 14,728 | 9,155 |
| Lettuce | 56,408 | 54,711 | 153,700 | 159,700 | 210,108 | 214,411 |
| Mint | 4,255 | 8,174 | 53,000 | 57,300 | 57,255 | 65,474 |
| Onions | 75,375 | 76,261 | 266,000 | 336,000 | 341,375 | 412,261 |
| Peaches | 2,272 | 1,214 | 36,000 | 34,000 | 38,272 | 35,214 |
| Peanuts | 80,564 | 123,638 | 505,900 | 422,700 | 586,464 | 546,338 |
| Potatoes | 84,130 | 83,958 | 771,100 | 861,600 | 855,230 | 945,558 |
| Raspberries | 3,910 | 6,365 | 0 | 0 | 3,910 | 6,365 |
| Rice | -159,172 | -171,630 | 465,400 | 928,700 | 306,228 | 757,070 |
| Sorghum | -8,977 | -22,987 | 236,100 | 169,200 | 227,123 | 146,213 |
| Soybeans | 2,282,176 | 2,663,755 | 3,106,500 | 4,214,200 | 5,388,676 | 6,877,955 |
| Spinach | 2,168 | 598 | 7,600 | 4,100 | 9,768 | 4,698 |
| Strawberries | 3,629 | 6,320 | 126,900 | 162,600 | 130,529 | 168,920 |
| Sugarbeets | 50,333 | 78,628 | 316,300 | 312,900 | 366,633 | 391,528 |
| Sugarcane | 175,585 | 172,353 | 223,700 | 180,000 | 399,285 | 352,353 |
| Sunflowers | 53,033 | 50,085 | 48,200 | 51,500 | 101,233 | 101,585 |
| Sweet Corn | 21,651 | 23,061 | 173,700 | 182,300 | 195,351 | 205,361 |
| Sweet Potatoes | 13,447 | 13,695 | 29,400 | 43,400 | 42,847 | 57,095 |
| Tomatoes | 130,148 | 156,656 | 367,600 | 501,000 | 497,748 | 657,656 |
| Wheat | 219,129 | 631,887 | 763,000 | 981,800 | 982,129 | 1,613,687 |
| Wild Rice | -9 | -14 | 500 | 400 | 491 | 386 |
| Total | 7,705,974 | 9,689,780 | 13,301,600 | 16,291,000 | 21,007,574 | 25,980,780 |

¹ Current herbicide cost (Table 5) minus alternative cost (Table 7).

² From Table 8.

³ In calculating total impact, an increase in net cost is considered a loss.

Table 10: Summary of No Herbicide Use Impacts by State (\$ 000)

| State | Weed Control Cost | | Production Impact | | Total Impact | |
|----------------|-------------------|---------|-------------------|-----------|--------------|-----------|
| | (+) | | (-) | | (-) | |
| | 2001 | 2005 | 2001 | 2005 | 2001 | 2005 |
| Alabama | 79,553 | 99,348 | 164,275 | 151,209 | 243,828 | 250,557 |
| Arizona | 47,639 | 54,982 | 84,058 | 100,952 | 131,697 | 155,934 |
| Arkansas | 144,688 | 166,223 | 671,917 | 1,091,295 | 816,605 | 1,257,518 |
| California | 359,213 | 483,528 | 899,173 | 1,213,979 | 1,258,386 | 1,697,507 |
| Colorado | 90,967 | 128,501 | 109,045 | 109,641 | 200,012 | 238,142 |
| Connecticut | 363 | 205 | 1,259 | 1,425 | 1,622 | 1,630 |
| Delaware | 4,850 | 6,020 | 36,195 | 33,957 | 41,045 | 39,977 |
| Florida | 356,060 | 328,008 | 485,132 | 669,613 | 841,192 | 997,621 |
| Georgia | 195,746 | 252,835 | 532,769 | 630,474 | 728,515 | 883,309 |
| Idaho | 42,712 | 93,088 | 402,178 | 402,190 | 444,890 | 495,278 |
| Illinois | 651,008 | 834,502 | 1,191,742 | 1,240,428 | 1,842,750 | 2,074,930 |
| Indiana | 356,875 | 449,553 | 446,818 | 463,769 | 803,693 | 913,322 |
| Iowa | 534,156 | 805,639 | 1,434,355 | 1,789,985 | 1,968,511 | 2,595,624 |
| Kansas | 257,506 | 343,713 | 221,626 | 265,489 | 479,132 | 609,202 |
| Kentucky | 45,285 | 90,925 | 102,390 | 128,042 | 147,675 | 218,967 |
| Louisiana | 146,439 | 142,344 | 353,432 | 429,916 | 499,871 | 572,260 |
| Maine | 4,887 | 4,392 | 35,206 | 43,811 | 40,093 | 48,203 |
| Maryland | 21,750 | 30,299 | 62,392 | 59,946 | 84,142 | 90,245 |
| Massachusetts | 1,473 | 2,067 | 18,654 | 26,783 | 20,127 | 28,850 |
| Michigan | 205,563 | 236,544 | 436,220 | 507,740 | 641,783 | 744,284 |
| Minnesota | 449,402 | 656,615 | 488,454 | 653,136 | 937,856 | 1,309,751 |
| Mississippi | 174,123 | 197,998 | 335,522 | 505,884 | 509,645 | 703,882 |
| Missouri | 244,315 | 338,998 | 632,296 | 746,449 | 876,611 | 1,085,447 |
| Montana | 57,399 | 67,407 | 95,622 | 200,359 | 153,021 | 267,766 |
| Nebraska | 448,457 | 627,872 | 444,856 | 507,833 | 893,313 | 1,135,705 |
| Nevada | 647 | 682 | 4,229 | 3,657 | 4,876 | 4,339 |
| New Hampshire | 357 | 242 | 759 | 895 | 1,116 | 1,137 |
| New Jersey | 1,288 | 5,670 | 67,381 | 69,576 | 68,669 | 75,246 |
| New Mexico | 28,461 | 39,559 | 27,779 | 31,397 | 56,240 | 70,956 |
| New York | 27,506 | 63,927 | 106,223 | 104,200 | 133,729 | 168,127 |
| North Carolina | 184,956 | 201,988 | 348,218 | 388,429 | 533,174 | 590,417 |
| North Dakota | 158,412 | 367,576 | 462,539 | 587,487 | 620,951 | 955,063 |
| Ohio | 251,037 | 301,599 | 586,622 | 666,128 | 837,659 | 967,727 |
| Oklahoma | 85,525 | 131,806 | 48,738 | 55,758 | 134,263 | 187,564 |
| Oregon | 33,294 | 48,051 | 165,956 | 223,447 | 199,250 | 271,498 |
| Pennsylvania | 41,600 | 79,455 | 61,567 | 74,970 | 103,167 | 154,425 |
| Rhode Island | 56 | 16 | 202 | 213 | 258 | 229 |
| South Carolina | 44,174 | 65,883 | 67,615 | 88,442 | 111,789 | 154,325 |
| South Dakota | 255,303 | 394,490 | 269,223 | 394,178 | 524,526 | 788,668 |
| Tennessee | 112,272 | 144,070 | 122,121 | 173,057 | 234,393 | 317,127 |
| Texas | 762,476 | 966,343 | 632,446 | 1,018,621 | 1,394,922 | 1,984,964 |
| Utah | 3,120 | 6,515 | 6,250 | 6,659 | 9,370 | 13,174 |
| Vermont | 367 | -91 | 1,206 | 1,274 | 1,573 | 1,183 |
| Virginia | 35,747 | 44,596 | 70,950 | 86,800 | 106,697 | 131,396 |
| Washington | 84,970 | 131,955 | 654,552 | 702,532 | 739,522 | 834,487 |
| West Virginia | 490 | 1,508 | 1,387 | 1,608 | 1,877 | 3,116 |
| Wisconsin | 145,349 | 237,591 | 210,392 | 280,836 | 355,741 | 518,427 |
| Wyoming | 7,432 | 14,722 | 8,560 | 10,176 | 15,992 | 24,898 |

| Table 11: No Herbicide Use, Crop Impacts by State (% Yield Change) | |
|---|--|
| State | Selected Impacts |
| Alabama | Cotton -25, peaches -10, peanuts -75, soybeans -45, tomatoes -30 |
| Arizona | Corn -23, cotton -30, lettuce -13, sorghum -14, wheat -15, |
| Arkansas | Apples -15, corn -48, cotton -40, rice -53, soybeans -80, tomatoes -20 |
| California | Broccoli -13, carrots -45, cotton -17, lettuce -13, onions -35, tomatoes -20 |
| Colorado | Corn -20, dry beans -23, onions -23, potatoes -7, sugarbeets -10, wheat -6 |
| Connecticut | Peaches -12, sweet corn -12 |
| Delaware | Corn -45, potatoes -20, soybeans -35, sweet corn -30, wheat -50 |
| Florida | Cotton -50, peanuts -33, potatoes -30, strawberries -55, sweet corn -17 |
| Georgia | Cotton -65, onions -20, peaches -25, peanuts -60, soybeans -35 |
| Idaho | Corn -35, dry beans -25, hops -25, onions -15, potatoes -35, sugarbeets -40 |
| Illinois | Corn -22, green beans -10, potatoes -5, sorghum -15, soybeans -22 |
| Indiana | Corn -15, cucumbers -59, mint -58, soybeans -15, tomatoes -23 |
| Iowa | Corn -25, soybeans -29, wheat -5 |
| Kansas | Corn -10, dry beans -12, sorghum -15, soybeans -15, wheat -10 |
| Kentucky | Corn -15, sorghum -10, soybeans -28, wheat -8 |
| Louisiana | Cotton -10, rice -53, sugarcane -44, sweet potatoes -30 |
| Maine | Apples -45, blueberries -67, potatoes -15, sweet corn -15 |
| Maryland | Apples -9, corn -31, peaches -14, soybeans -25, tomatoes -15, wheat -9 |
| Massachusetts | Cranberries -50, potatoes -10, sweet corn -15, tomatoes -30 |
| Michigan | Apples -35, asparagus -50, green beans -60, potatoes -50, soybeans -35 |
| Minnesota | Corn -15, dry beans -10, green peas -15, soybeans -10, wheat -30 |
| Mississippi | Corn -39, cotton -40, rice -53, soybeans -61, sweet potatoes -20 |
| Missouri | Corn -30, cotton -40, grapes -25, soybeans -45, wheat -15 |
| Montana | Corn -13, potatoes -15, sugarbeets -11, wheat -30 |
| Nebraska | Corn -12, dry beans -25, potatoes -13, sorghum -13, soybeans -15 |
| Nevada | Potatoes -30, wheat -25 |
| New Hampshire | Apples -5, sweet corn -15 |
| New Jersey | Cucumbers -50, lettuce -50, peaches -50, soybeans -55, spinach -50 |
| New Mexico | Corn -20, cotton -32, onions -15, peanuts -23, wheat -10 |
| New York | Apples -17, grapes -12, green beans -18, potatoes -30, sweet corn -20 |
| North Carolina | Cotton -70, cucumbers -25, peanuts -66, soybeans -21, sweet potatoes -20 |
| North Dakota | Canola -45, corn -10, potatoes -9, sugarbeets -24, wheat -30 |
| Ohio | Corn -34, potatoes -52, soybeans -32, strawberries -35, tomatoes -25 |
| Oklahoma | Corn -15, cotton -25, peanuts -40, sorghum -10, soybeans -20, wheat -5 |
| Oregon | Grapes -15, green beans -30, mint -58, strawberries -25, sweet corn -15 |
| Pennsylvania | Apples -20, corn -10, grapes -25, potatoes -22, sweet corn -20 |
| Rhode Island | Apples -10, potatoes -20 |
| South Carolina | Cotton -30, peaches -40, peanuts -52, soybeans -23, tomatoes -15 |
| South Dakota | Corn -15, potatoes -21, sorghum -19, soybeans -18, sunflowers -16 |
| Tennessee | Apples -27, cotton -25, soybeans -30, tomatoes -27, wheat -15 |
| Texas | Carrots -25, corn -46, cotton -30, onions -25, peanuts -33, sorghum -45 |
| Utah | Corn -35, dry beans -29, onions -22, potatoes -27, wheat -22 |
| Vermont | Apples -17, sweet corn -15 |
| Virginia | Corn -22, cotton -17, peanuts -22, soybeans -18, tomatoes -40 |
| Washington | Apples -8, asparagus -55, green peas -20, potatoes -55, wheat -23 |
| West Virginia | Apples -12, corn -5, peaches -25, wheat -17 |
| Wisconsin | Corn -10, green peas -12, potatoes -33, soybeans -15, sweet corn -15 |
| Wyoming | Corn -20, dry beans -23, sugarbeets -10, wheat -6 |

Note: Selected impacts only; assumed identical for 2001 and 2005. [1]

**Table 12: No Herbicide Use, Crop
Production Volume Impact by State**

| State | Production Loss (<i>Million lbs</i>) | |
|----------------|--|--------|
| | 2001 | 2005 |
| Alabama | 826 | 966 |
| Arizona | 482 | 442 |
| Arkansas | 10,833 | 11,776 |
| California | 9,003 | 9,487 |
| Colorado | 2,241 | 2,446 |
| Connecticut | 4 | 4 |
| Delaware | 801 | 867 |
| Florida | 4,297 | 3,849 |
| Georgia | 2,476 | 2,877 |
| Idaho | 9,424 | 9,515 |
| Illinois | 26,121 | 31,525 |
| Indiana | 9,941 | 11,738 |
| Iowa | 31,012 | 46,260 |
| Kansas | 5,447 | 6,341 |
| Kentucky | 2,106 | 2,496 |
| Louisiana | 16,361 | 13,096 |
| Maine | 294 | 274 |
| Maryland | 1,317 | 1,447 |
| Massachusetts | 81 | 80 |
| Michigan | 9,800 | 12,130 |
| Minnesota | 13,552 | 20,084 |
| Mississippi | 3,956 | 4,775 |
| Missouri | 11,832 | 12,626 |
| Montana | 1,890 | 3,475 |
| Nebraska | 10,368 | 13,417 |
| Nevada | 67 | 72 |
| New Hampshire | 2 | 2 |
| New Jersey | 442 | 410 |
| New Mexico | 320 | 303 |
| New York | 1,181 | 1,152 |
| North Carolina | 2,652 | 2,813 |
| North Dakota | 9,527 | 10,624 |
| Ohio | 11,950 | 14,913 |
| Oklahoma | 607 | 695 |
| Oregon | 2,273 | 2,808 |
| Pennsylvania | 878 | 1,144 |
| Rhode Island | 2 | 2 |
| South Carolina | 708 | 991 |
| South Dakota | 5,992 | 8,619 |
| Tennessee | 1,756 | 2,005 |
| Texas | 10,158 | 12,168 |
| Utah | 112 | 123 |
| Vermont | 5 | 5 |
| Virginia | 886 | 994 |
| Washington | 9,427 | 10,164 |
| West Virginia | 21 | 21 |
| Wisconsin | 3,796 | 4,967 |
| Wyoming | 235 | 260 |

Table 13: No Herbicide Use, Labor for Hand Weeding by Crop, 2001

| Crop | Acres (000)¹ | Hours/A² | Total Hours (000) | Total Laborers³ |
|----------------|------------------------------------|----------------------------|------------------------------|---------------------------------------|
| Almonds | 452 | 7 | 3,164 | 19,775 |
| Apples | 271 | 20 | 5,420 | 33,875 |
| Artichokes | 5 | 23 | 115 | 719 |
| Asparagus | 70 | 5 | 350 | 2,188 |
| Blueberries | 23 | 5 | 115 | 719 |
| Broccoli | 70 | 20 | 1,400 | 8,750 |
| Canola | 1,479 | 0 | 0 | 0 |
| Carrots | 119 | 14 | 1,666 | 10,412 |
| Celery | 25 | 60 | 1,500 | 9,375 |
| Citrus | 1,039 | 0 | 0 | 0 |
| Corn | 74,237 | 5 | 371,185 | 2,319,906 |
| Cotton | 14,998 | 13 | 194,974 | 1,218,588 |
| Cranberries | 32 | 20 | 640 | 4,000 |
| Cucumbers | 35 | 30 | 1,050 | 6,562 |
| Dry Beans | 1,416 | 16 | 22,656 | 141,600 |
| Grapes | 698 | 8 | 5,584 | 34,900 |
| Green Beans | 202 | 12 | 2,424 | 15,150 |
| Green Peas | 204 | 12 | 2,448 | 15,300 |
| Hops | 34 | 35 | 1,190 | 7,438 |
| Hot Peppers | 31 | 60 | 1,860 | 11,625 |
| Lettuce | 190 | 38 | 7,220 | 45,126 |
| Mint | 93 | 18 | 1,674 | 10,462 |
| Onions | 147 | 64 | 9,408 | 58,800 |
| Peaches | 100 | 6 | 600 | 3,750 |
| Peanuts | 1,497 | 10 | 14,970 | 93,563 |
| Potatoes | 1,178 | 10 | 11,780 | 73,625 |
| Raspberries | 11 | 43 | 473 | 2,956 |
| Rice | 3,268 | 0 | 0 | 0 |
| Sorghum | 9,329 | 0 | 0 | 0 |
| Soybeans | 71,141 | 5 | 355,705 | 2,223,156 |
| Spinach | 14 | 20 | 280 | 1,750 |
| Strawberries | 18 | 30 | 540 | 3,375 |
| Sugarbeets | 1,344 | 15 | 20,160 | 126,000 |
| Sugarcane | 977 | 25 | 24,425 | 152,656 |
| Sunflowers | 2,520 | 0 | 0 | 0 |
| Sweet Corn | 660 | 5 | 3,300 | 20,625 |
| Sweet Potatoes | 69 | 24 | 1,656 | 10,350 |
| Tomatoes | 394 | 37 | 14,578 | 91,112 |
| Wheat | 32,789 | 2 | 65,578 | 409,862 |
| Wild Rice | 2 | 0 | 0 | 0 |
| Total | 221,181 | (5) | 1,150,088 | 7,188,050 |

¹ Acres currently treated with herbicides.

² From Table 7.

³ Calculated by dividing the total number of hours by 160, which is the equivalent to the number of hours needed in a four-week period.

Table 14: No Herbicide Use, Labor for Hand Weeding by State, 2001

| State | # Hours (000) | # Laborers |
|----------------|---------------|------------|
| Alabama | 11,290 | 70,566 |
| Arizona | 5,723 | 35,771 |
| Arkansas | 28,751 | 179,695 |
| California | 43,990 | 274,940 |
| Colorado | 11,107 | 69,422 |
| Connecticut | 50 | 317 |
| Delaware | 1,714 | 10,713 |
| Florida | 16,201 | 101,261 |
| Georgia | 27,633 | 172,711 |
| Idaho | 11,398 | 71,240 |
| Illinois | 105,573 | 659,836 |
| Indiana | 56,553 | 353,462 |
| Iowa | 108,719 | 679,500 |
| Kansas | 33,861 | 211,636 |
| Kentucky | 11,057 | 69,111 |
| Louisiana | 27,770 | 173,565 |
| Maine | 780 | 4,875 |
| Maryland | 4,891 | 30,574 |
| Massachusetts | 356 | 2,230 |
| Michigan | 30,114 | 188,216 |
| Minnesota | 80,984 | 506,150 |
| Mississippi | 28,795 | 179,971 |
| Missouri | 41,908 | 261,928 |
| Montana | 8,702 | 54,393 |
| Nebraska | 67,309 | 420,682 |
| Nevada | 68 | 428 |
| New Hampshire | 42 | 263 |
| New Jersey | 1,343 | 8,396 |
| New Mexico | 3,529 | 22,059 |
| New York | 6,246 | 39,041 |
| North Carolina | 25,280 | 158,004 |
| North Dakota | 43,344 | 270,900 |
| Ohio | 38,873 | 242,957 |
| Oklahoma | 10,243 | 64,024 |
| Oregon | 5,457 | 34,110 |
| Pennsylvania | 8,083 | 50,519 |
| Rhode Island | 8 | 53 |
| South Carolina | 7,696 | 48,104 |
| South Dakota | 42,204 | 263,777 |
| Tennessee | 16,730 | 104,567 |
| Texas | 87,632 | 547,706 |
| Utah | 433 | 2,710 |
| Vermont | 42 | 264 |
| Virginia | 6,660 | 41,630 |
| Washington | 13,919 | 86,997 |
| West Virginia | 222 | 1,388 |
| Wisconsin | 24,305 | 151,910 |
| Wyoming | 1,401 | 8,760 |

Table 15: Cropland Erosion by State

| State | No-Till Acres ¹ | | Cultivated | Non-Cultivated | Difference | No-Till Erosion Prevention (million lbs) | |
|----------------|----------------------------|-------------------|------------|----------------|------------|---|----------------|
| | 2001 | 2005 | | | | 2001 | 2005 |
| Alabama | 434,916 | 676,408 | 6.7 | 0.5 | 6.2 | 5,392 | 8,387 |
| Arizona | 4,100 | 1,700 | .7 | 0.2 | .5 | 4 | 2 |
| Arkansas | 755,413 | 804,252 | 3.5 | 0.6 | 2.9 | 4,381 | 4,665 |
| California | 12,692 | 17,957 | .7 | 0.5 | .2 | 5 | 7 |
| Colorado | 513,435 | 770,620 | 1.7 | 0.2 | 1.5 | 1,540 | 2,312 |
| Connecticut | 3,825 | 3,031 | 5.6 | 0.7 | 4.9 | 37 | 30 |
| Delaware | 233,775 | 175,844 | 2.0 | 0.4 | 1.6 | 748 | 563 |
| Florida | 53,856 | 64,504 | 1.8 | 0.5 | 1.3 | 140 | 168 |
| Georgia | 505,112 | 1,100,542 | 5.9 | 0.3 | 5.6 | 5,657 | 12,326 |
| Idaho | 233,781 | 180,824 | 3.4 | 0.4 | 3.0 | 1,402 | 1,085 |
| Illinois | 6,961,627 | 6,667,311 | 4.1 | 0.6 | 3.5 | 48,731 | 46,671 |
| Indiana | 4,908,432 | 4,555,530 | 3.0 | 0.9 | 2.1 | 20,615 | 19,133 |
| Iowa | 5,056,840 | 5,169,075 | 4.9 | 0.8 | 4.1 | 41,466 | 42,386 |
| Kansas | 3,154,908 | 4,224,926 | 2.2 | 0.4 | 1.8 | 11,357 | 15,210 |
| Kentucky | 1,784,529 | 1,954,391 | 4.4 | 1.2 | 3.2 | 11,420 | 12,508 |
| Louisiana | 240,186 | 478,833 | 3.3 | 0.6 | 2.7 | 1,297 | 2,586 |
| Maine | 672 | 347 | 3.9 | 0.3 | 3.6 | 4 | 2 |
| Maryland | 686,162 | 789,489 | 4.4 | 1.2 | 3.2 | 4,391 | 5,053 |
| Massachusetts | 4,080 | 0 | 4.5 | 0.1 | 4.4 | 35 | 0 |
| Michigan | 1,387,500 | 1,351,684 | 2.0 | 0.5 | 1.5 | 4,162 | 4,055 |
| Minnesota | 457,790 | 667,700 | 2.1 | 0.3 | 1.8 | 1,648 | 2,404 |
| Mississippi | 791,984 | 1,108,764 | 5.3 | 1.2 | 4.1 | 6,494 | 9,092 |
| Missouri | 3,170,081 | 3,114,316 | 5.6 | 0.7 | 4.9 | 31,066 | 30,520 |
| Montana | 1,115,249 | 2,011,552 | 1.9 | 0.3 | 1.6 | 3,568 | 6,437 |
| Nebraska | 3,468,978 | 4,320,627 | 2.9 | 0.5 | 2.4 | 16,651 | 20,739 |
| Nevada | 0 | 3,520 | .2 | 0.0 | .2 | 0 | 1 |
| New Hampshire | 600 | 0 | 3.5 | 0.4 | 3.1 | 3 | 0 |
| New Jersey | 84,277 | 88,220 | 5.6 | 0.6 | 5.0 | 842 | 882 |
| New Mexico | 110,931 | 63,914 | .9 | 0.1 | .8 | 177 | 102 |
| New York | 114,627 | 160,474 | 3.9 | 0.7 | 3.2 | 733 | 1,027 |
| North Carolina | 1,456,624 | 1,798,753 | 5.0 | 1.0 | 4.0 | 11,652 | 14,390 |
| North Dakota | 1,906,711 | 3,289,774 | 1.4 | 0.3 | 1.1 | 4,194 | 7,238 |
| Ohio | 4,204,204 | 4,407,606 | 2.6 | 1.4 | 1.2 | 10,090 | 10,578 |
| Oklahoma | 497,806 | 819,147 | 2.8 | 0.5 | 2.3 | 2,289 | 3,768 |
| Oregon | 165,115 | 218,133 | 3.1 | 0.4 | 2.7 | 891 | 1,178 |
| Pennsylvania | 515,273 | 654,069 | 5.1 | 1.2 | 3.9 | 4,019 | 5,102 |
| Rhode Island | 108 | 130 | 3.5 | 1.8 | 1.7 | 0 | 0 |
| South Carolina | 354,605 | 714,585 | 3.2 | 0.7 | 2.5 | 1,773 | 3,573 |
| South Dakota | 2,996,322 | 5,045,881 | 2.0 | 0.2 | 1.8 | 10,786 | 18,165 |
| Tennessee | 1,410,364 | 1,716,510 | 7.7 | 0.6 | 7.1 | 20,027 | 24,374 |
| Texas | 447,452 | 769,583 | 2.6 | 0.8 | 1.8 | 1,610 | 2,770 |
| Utah | 11,298 | 11,330 | 1.6 | 0.2 | 1.4 | 31 | 32 |
| Vermont | 3,550 | 5,894 | 3.1 | 0.7 | 2.4 | 17 | 28 |
| Virginia | 665,482 | 873,577 | 5.9 | 1.5 | 4.4 | 5,856 | 7,687 |
| Washington | 342,494 | 386,198 | 4.7 | 0.6 | 4.1 | 2,808 | 3,167 |
| West Virginia | 47,655 | 48,040 | 4.3 | 0.8 | 3.5 | 33 | 336 |
| Wisconsin | 876,734 | 1,175,263 | 3.7 | 1.2 | 2.5 | 4,383 | 5,876 |
| Wyoming | 28,869 | 14,543 | 1.1 | 0.1 | 1.0 | 58 | 29 |
| Total | 52,181,024 | 62,475,371 | | | | 304,483 | 356,646 |

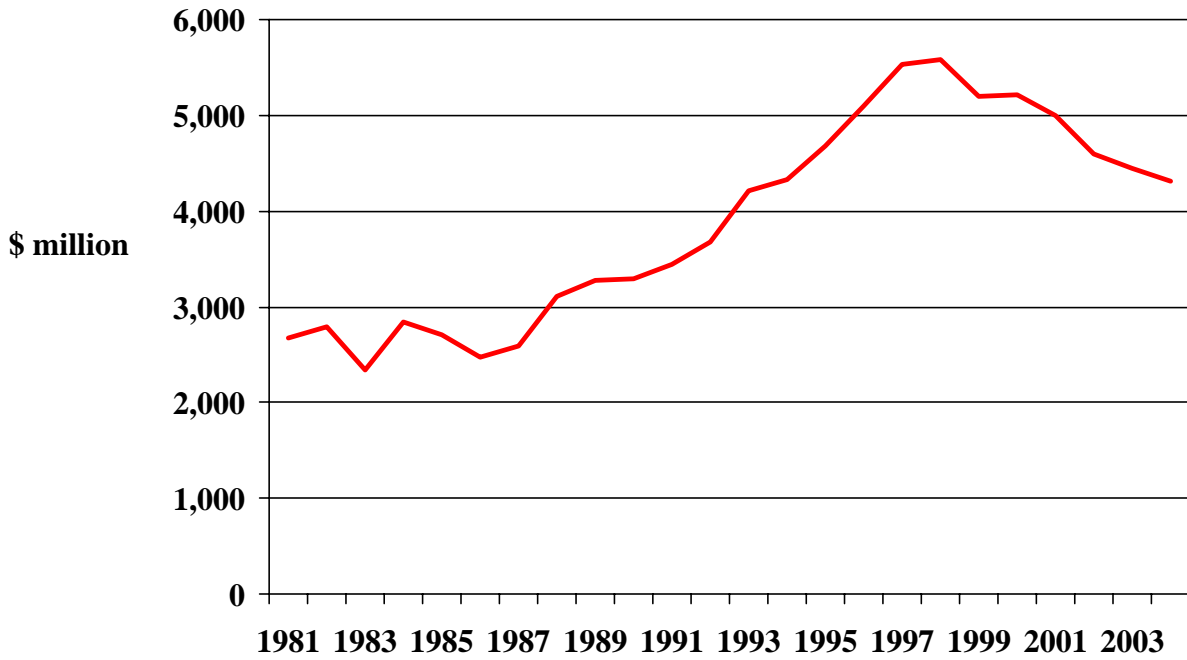
Note: Sheet and Rill Erosion

¹ Source:[21], data for 2000 and 2004.

Table 16: Fuel Use for Weed Control by State

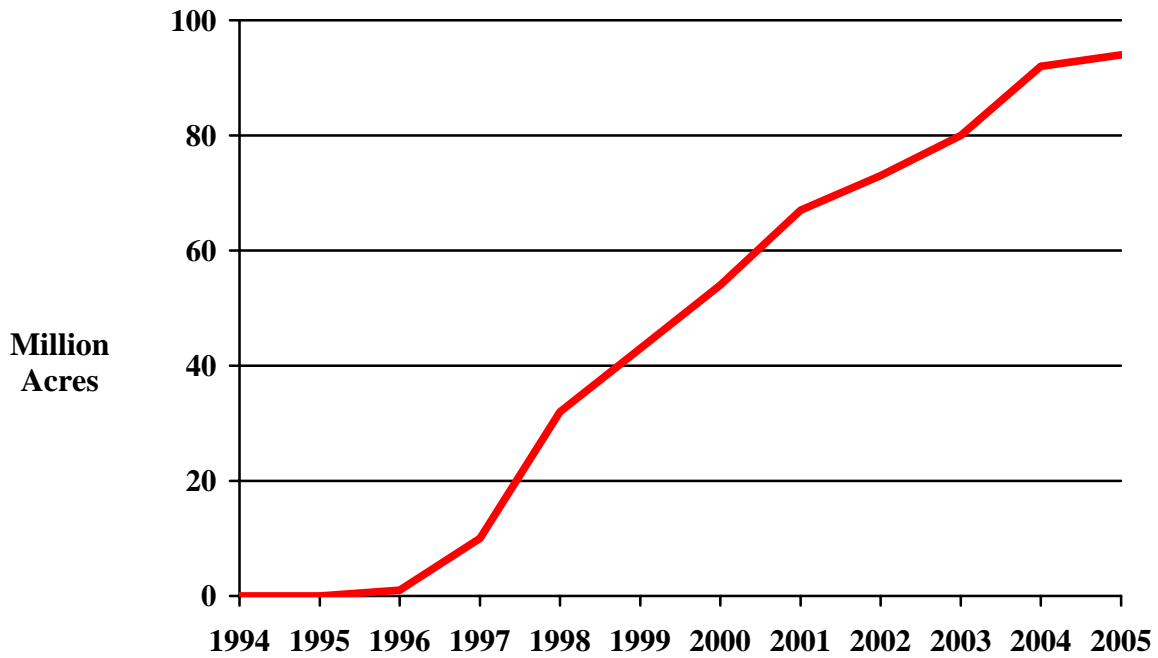
| State | Herbicide Use | | Tillage | | Increased Fuel Use Without Herbicides (gallons) |
|----------------|--------------------|--------------------|--------------------|--------------------|---|
| | # of Applications | Fuel Use (gallons) | # of Cultivations | Fuel Use (gallons) | |
| Alabama | 2,425,341 | 266,788 | 5,723,650 | 2,575,643 | 2,308,855 |
| Arizona | 679,746 | 74,772 | 2,065,181 | 929,331 | 854,559 |
| Arkansas | 13,038,546 | 1,434,240 | 26,040,969 | 11,718,436 | 10,284,196 |
| California | 7,418,565 | 816,042 | 14,002,271 | 6,301,022 | 5,484,980 |
| Colorado | 3,787,785 | 416,656 | 10,053,744 | 4,524,185 | 4,107,528 |
| Connecticut | 5,610 | 617 | 14,652 | 6,593 | 5,976 |
| Delaware | 569,097 | 62,601 | 1,276,965 | 574,634 | 512,034 |
| Florida | 2,957,260 | 325,299 | 2,958,893 | 1,331,502 | 1,006,203 |
| Georgia | 5,618,448 | 618,029 | 11,996,376 | 5,398,369 | 4,780,340 |
| Idaho | 3,209,325 | 353,026 | 6,743,708 | 3,034,669 | 2,681,643 |
| Illinois | 36,447,709 | 4,009,248 | 84,516,515 | 38,032,432 | 34,023,184 |
| Indiana | 18,982,633 | 2,088,090 | 44,794,134 | 20,157,360 | 18,069,271 |
| Iowa | 39,478,308 | 4,342,614 | 89,081,016 | 40,086,457 | 35,743,843 |
| Kansas | 16,914,681 | 1,860,615 | 44,529,362 | 20,038,213 | 18,177,598 |
| Kentucky | 4,429,632 | 487,259 | 9,855,834 | 4,435,125 | 3,947,866 |
| Louisiana | 5,865,028 | 645,153 | 12,410,950 | 5,584,928 | 4,939,774 |
| Maine | 107,262 | 11,799 | 286,350 | 128,858 | 117,059 |
| Maryland | 1,726,194 | 189,881 | 3,832,379 | 1,724,571 | 1,534,689 |
| Massachusetts | 39,127 | 4,304 | 36,537 | 16,442 | 12,138 |
| Michigan | 8,332,333 | 916,557 | 18,461,734 | 8,307,780 | 7,391,224 |
| Minnesota | 30,373,488 | 3,341,084 | 61,704,494 | 27,767,022 | 24,425,939 |
| Mississippi | 6,981,840 | 768,002 | 17,345,330 | 7,805,399 | 7,037,396 |
| Missouri | 15,255,103 | 1,678,061 | 35,391,256 | 15,926,065 | 14,248,004 |
| Montana | 5,184,872 | 570,336 | 10,132,550 | 4,559,648 | 3,989,312 |
| Nebraska | 22,435,835 | 2,467,942 | 56,109,739 | 25,249,383 | 22,781,441 |
| Nevada | 15,631 | 1,719 | 48,675 | 21,904 | 20,184 |
| New Hampshire | 3,033 | 334 | 7,776 | 3,499 | 3,166 |
| New Jersey | 362,462 | 39,871 | 774,462 | 348,508 | 308,637 |
| New Mexico | 792,306 | 87,154 | 2,150,404 | 967,682 | 880,528 |
| New York | 1,771,749 | 194,892 | 4,563,567 | 2,053,605 | 1,858,713 |
| North Carolina | 6,201,562 | 682,172 | 14,797,730 | 6,658,979 | 5,976,807 |
| North Dakota | 23,082,986 | 2,539,128 | 37,654,100 | 16,944,345 | 14,405,217 |
| Ohio | 13,995,096 | 1,539,461 | 31,307,109 | 14,088,199 | 12,548,738 |
| Oklahoma | 4,482,394 | 493,063 | 12,067,550 | 5,430,398 | 4,937,334 |
| Oregon | 1,690,139 | 185,915 | 3,558,596 | 1,601,368 | 1,415,453 |
| Pennsylvania | 3,026,815 | 332,950 | 7,373,018 | 3,317,858 | 2,984,908 |
| Rhode Island | 840 | 92 | 2,703 | 1,216 | 1,124 |
| South Carolina | 2,088,766 | 229,764 | 4,870,403 | 2,191,681 | 1,961,917 |
| South Dakota | 18,238,752 | 2,006,263 | 42,618,450 | 19,178,303 | 17,172,040 |
| Tennessee | 4,561,695 | 501,786 | 11,526,842 | 5,187,079 | 4,685,292 |
| Texas | 18,970,118 | 2,086,713 | 58,140,440 | 26,163,198 | 24,076,485 |
| Utah | 189,298 | 20,823 | 502,038 | 225,917 | 205,094 |
| Vermont | 2,781 | 306 | 6,642 | 2,989 | 2,683 |
| Virginia | 2,100,939 | 231,103 | 4,816,818 | 2,167,568 | 1,936,465 |
| Washington | 3,454,425 | 379,987 | 9,343,243 | 4,204,459 | 3,824,472 |
| West Virginia | 74,175 | 8,159 | 186,550 | 83,948 | 75,788 |
| Wisconsin | 9,346,251 | 1,028,088 | 22,271,019 | 10,021,959 | 8,993,871 |
| Wyoming | 347,987 | 38,279 | 722,758 | 325,241 | 286,963 |
| Total | 367,063,967 | 40,377,036 | 838,675,481 | 377,403,967 | 337,026,930 |

Figure 1: U.S. Market for Crop Production Herbicides



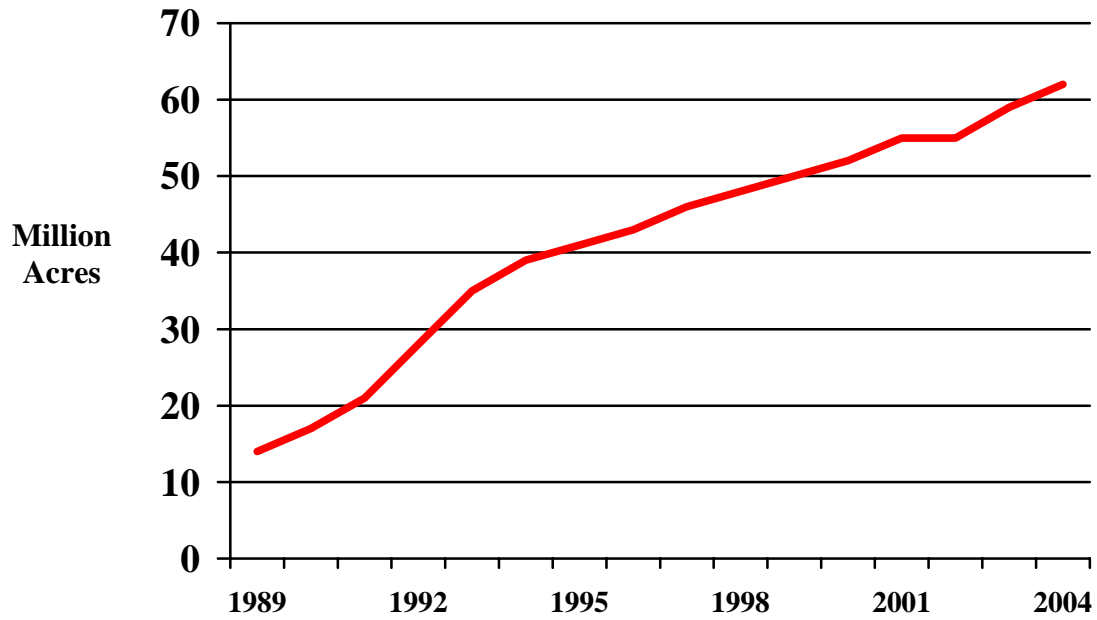
Source: Phillips McDougall

Figure 2: U.S. Biotech Herbicide Tolerant Crop Acreage



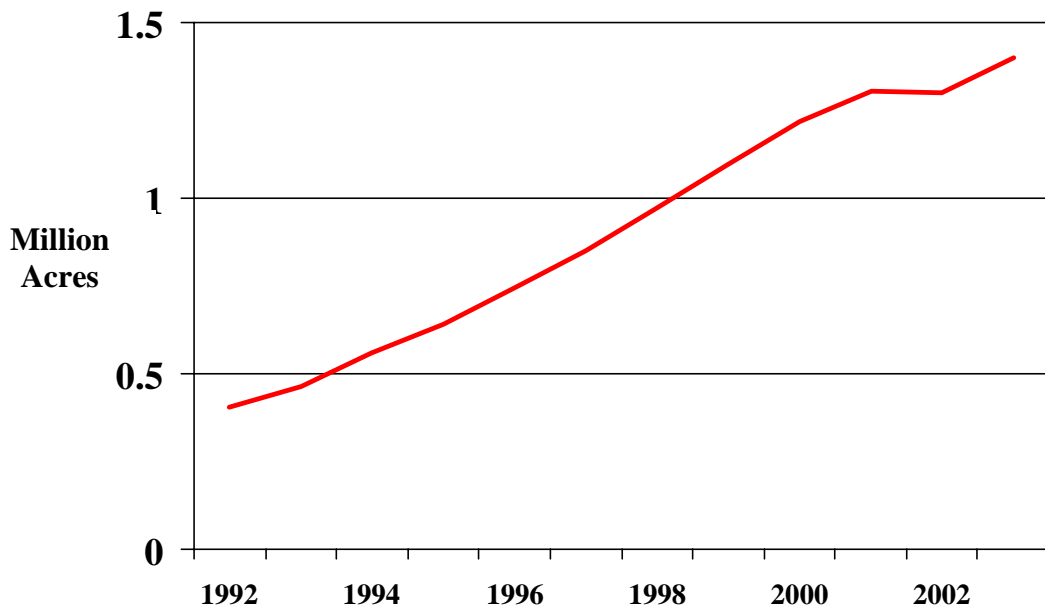
Source: USDA [8]

Figure 3: U.S. No-Till Acreage



Source: CTIC [21]

Figure 4: U.S. Organic Cropland Acreage



Source: ERS [29]

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