Chapter 7

HERBICIDE USE TRENDS IN COTTON

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INTRODUCTION

Historically, weeds have been a major deterent to profitable production of cotton *(Gossypium hirsutum* L.) in the United States. Prior to the development of selective herbicides, weeds were controlled with row-middle cultivation and hand hoeing. Hand hoeing was generally effective, but the labor needed from year-to-year fluctuated widely and could exceed 100 hours per acre (Porter *et al.*, 1957). At current prices for hand labor, it would not be unusual for weed control costs to be $200 to $300 per acre if hand hoeing was the only method of weed control available today.

Herbicides are used more intensively to control weeds in cotton than in any other major crop in the United States. When first used in the 1950s, herbicides were not necessarily intended to reduce the cost of weed control in cotton, but rather to minimize the large amounts of hand labor needed from year-to-year (Porter *et al.*, 1957). Weeds are particularly troublesome and competitive because cotton is a warm-season perennial that grows slowly in the spring. Young cotton plants compete very poorly with weeds, especially when cool temperatures prevail.

Cotton is often planted in early spring when the soil is relatively cool (55 to 65F). Since the optimum temperature for cottonseed germination is 80 to 90F, germination and seedling growth generally is slow for several weeks. During this period weeds often grow much faster than cotton. In addition, young cotton is plagued by diseases, insects and adverse weather. These factors relate to weed control in cotton, often directly, which contributes to the complexity of cotton production and the role that herbicides play in permitting more economical production of cotton in the United States.

Weeds compete with cotton, as with other field crops, for moisture, sunlight,

nutrients and space; but in addition, weed infestations later in the season interfere with defoliation, reduce harvesting efficiency, and lower the grade of harvested lint. Traditionally, farmers have attempted to maintain a high level of weed control throughout the entire growing season not only to increase yields, but also to avoid reducing harvesting efficiency and lint grades due to stained lint. This chapter will discuss how cotton farmers took a very cautious approach to the use of herbicides in the 1950s but then quickly adopted multiple applications of herbicides in the 1960s.

The prices paid for hand labor in the 1950s and early 1960s increased three- to four-fold partially because of the migration of vast numbers of farm workers from southern to northern states (Mayo, 1965). Several individual southern states experienced a net loss of 200,000 to 300,000 farm workers within a decade. In addition, many workers moved from farms to cities to work in factories and other non-agricultural industries. This dramatic loss of farm labor caused the price of hoe labor to increase dramatically and, in localized situations, to be unavailable for use in cotton.

Labor shortages and the increased cost of hand hoeing caused cotton farmers to make widespread use of several weed control practices that were relatively unique to cotton production. These included flame cultivation, postemergence directed applications of herbicidal oil, and geese. These techniques were both effective and cost-efficient, but required a higher level of management than was often available at the time. A handicap to earlier adoption of herbicides occurred in 1952 when the first widely applied preemergence herbicide, dinoseb[1], killed or severely injured thousands of acres of cotton (Davis, 1964). The level of cotton injury obtained from dinoseb was so severe that most farmers became afraid to use herbicides and adopted a wait-and-see attitude. It was depressing to many weed scientists and extension specialists in the mid-1950s when they could not convince farmers of the potential value of herbicides for weed control in cotton. It would have been almost impossible to have convinced a weed scientist working in the mid-1950s that within the next decade practically the entire cotton acreage in many areas would be treated with herbicides, with much of the acreage receiving multiple applications. The purpose of this chapter is to discuss the extent of use of herbicides since the early 1950s and to summarize the various methods in which herbicides have been used.

[1]Common names for herbicides that have been approved by the Weed Science Society of America (WSSA) are used in this chapter except when other names that have been used in references or surveys are being discussed. For example, if a survey being discussed reported on the use of "Karmex®," we will discuss the use of Karmex® rather than using diuron, Dynex®, or Karmex®/Dynex®. This causes inconsistency in the use of herbicide names, but it increases the accuracy of this report.

USE TRENDS IN THE 1950s

HERBICIDAL OILS

The first herbicide treatment recommended for weed control in cotton was postemergence directed sprays of herbicidal oil in 1950 (Talley, 1950). Special non-fortified oils were recommended at the rate of five gallons per acre directed to the 8- or 10-inch drill area centered over the row. It was suggested that the oils should be directed laterally to the drill area at a height of less than one inch above the soil. It was further suggested that no more than three treatments be applied, with waiting periods of five to seven days between treatments. It was recommended that treatments begin when weeds first appeared in the drill when cotton was three inches tall, and that applications should not be made after cracks appeared in the bark on the cotton stalk.

The herbicidal oil that was first recommended for weed control in cotton (Talley, 1950) was highly effective and provided a significant breakthrough in weed control technology at the time. Unfortunately, the use of herbicidal oil required a very high level of management (Figures 1 and 2). It was specified that the drill area of cotton rows should be one inch higher than the row middle, and that soil in the drill area be pressed flat for at least seven inches on either side of the cotton plants and maintained in this condition for the duration of oil applications. Another disadvantage was that rainfall might delay application for a few days, greatly reducing the effectiveness of the herbicidal oil. Even though complicated to apply, herbicidal oils were highly successful for many producers and continued to be used for many years. Initially, herbicidal oil cost only about 20 to 25 cents per gallon, but the steady increase in cost of petroleum products and the availability of arsenical herbicides in the 1960s lead to the obsolescence of this practice.

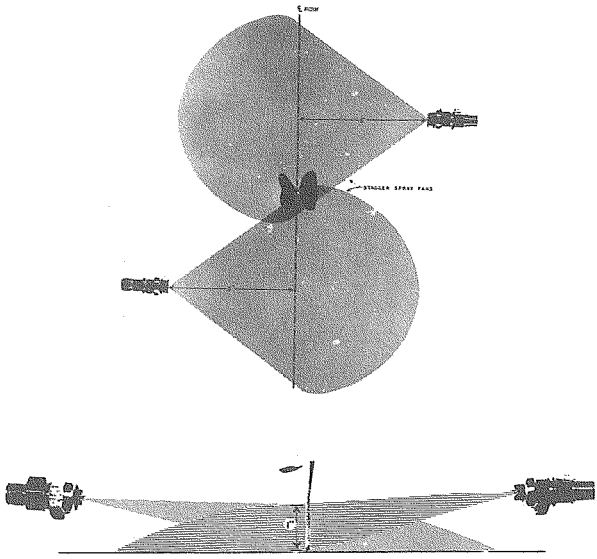

Figure 1. It was necessary to apply herbicidal oils very precisely within a few days after emergence of cotton and weeds for satisfactory results. The top photograph shows an overhead view and the lower photograph shows a side view of the recommended method of application. The high level of management required to achieve this precise method was a primary limiting factor in more widespread use of herbicidal oils.

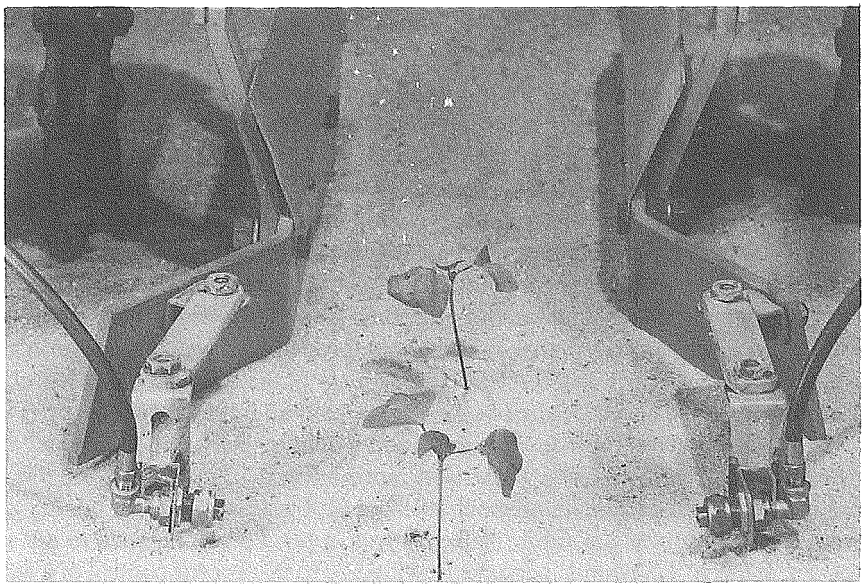

Figure 2. Spray nozzles mounted on the rear end of shielded applicators for applying herbicidal oil postemergence in cotton. The shields prevented movement of soil from the cultivated row middles into the cotton-drill area. It was necessary to keep the drill area flat and smooth to prevent herbicidal oil from being deflected onto cotton seedlings.

PREEMERGENCE HERBICIDES

Various salts of dinoseb were evaluated for preemergence weed control in cotton in the late 1940s (Cowart *et al.*, 1950; Harris *et al.*, 1950). Farmers commonly referred to dinoseb as dinitro, while scientists used the term, DNOSBP. Dinoseb was generally applied at four to eight pounds per acre. An alkanolamine salt of dinoseb was generally selected as the most promising material and it was widely tested in 1951. The most popular product was Premerge®. The earlier warnings of possible severe injury to cotton from dinoseb were ignored (Cowart *et al.*, 1950; Harris *et al.*, 1950) and dinoseb was applied to several thousand acres of cotton in several states in 1952. Treatments killed or severely injured much of the cotton treated in the Mid-South[2] when dinoseb vaporized as the young cotton seedlings emerged (Davis, 1964). It was later shown that a large number of variables affected the toxicity of dinoseb to cotton, including soil type, rainfall, soil pH and air temperatures. All of these variables affected vaporization

[2]States included in the four cotton producing regions are: Mid-South—AR, LA, MS, MO, TN; Southeast—AL, GA, NC, SC; Southwest—NM, OK, TX; West—AZ, CA. Many of the reports and surveys that we cite later used the same four regional names, but placed individual states in other regions other than that shown above. As a result, it will be necessary to refer to the appropriate table, or cited reference, to identify states within regions when reference is made to reports of others.

of dinoseb, and this quickly taught weed scientists the importance of vapor activity of herbicides (Shaw *et al.*, 1953).

Chlorpropham, commonly known as CIPC in the 1950s, had been introduced at about the same time as dinoseb, but generally did not receive as much interest until the injury problem with dinoseb occurred in 1952. Increased research showed that chlorpropham was much more selective to cotton than dinoseb and interest in its usage increased rapidly (Davis, 1964). Like dinoseb, it was usually applied preemergence at four to eight pounds per acre, dependent upon soil type. One of the more popular products was Chloro IPC. The primary disadvantages of chlorpropham was its low activity on certain broadleaf weeds and its relatively brief period of effective control, usually only three to four weeks. Monuron and diuron, known as CMU and DCMU respectively in the 1950s, were researched for preemergence weed control beginning in 1950 and 1951 respectively (Hill, 1980). Within the next few months monuron would be marketed as Telvar® and diuron as Karmex®. Initially, there was more interest in monuron, but diuron became the prime candidate in about 1953 because of lower water solubility and greater adsorption on soil (Hill, 1980). Diuron, applied preemergence to the soil surface at 0.5 to 1.5 pounds per acre provided 70 to 90 percent control of a large number of grasses and broadleaf weeds, and the results obtained were usually more consistent and longer lasting than with chlopropham or dinoseb (Figure 3). Diuron soon became the most commonly used herbicide for weed control in cotton and continued to be so until the mid-1960s.

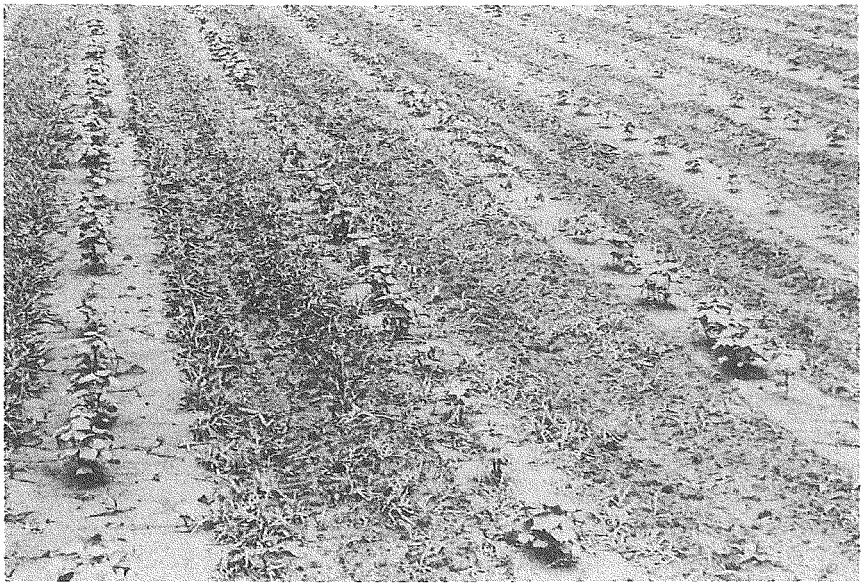

Figure 3. Preemergence weed control in cotton at Stoneville, MS in 1958 about three weeks after the application of Karmex® at 0.5 pounds per acre. Only a 12-inch band was treated with the herbicide after planting. Weeds in the untreated row middles would be removed by cultivation. Karmex® was the first herbicide available that would provide consistent control of the type shown above without excessive crop injury and was the most widely used herbicide in the late 1950s and 1960s.

SPOT TREATMENTS

A spot treatment involves the application of herbicide to a restricted area within a field, such as treatment of spots or patches of weeds. Herbicides that were most commonly used for spot treatment for both perennial and annual weeds in cotton in the 1950s were herbicidal oil, herbicidal oil fortified with one to two percent pentachlorophenol (PCP), sodium chlorate, sodium trichloroacetic acid (TCA) and, in the late 1950s, dalapon (Dowpon®). Initially sodium chlorate and TCA were used more frequently than others but these materials usually killed both cotton and weeds. Sodium chlorate, at one to two pounds per 100 square feet, and TCA at 0.05 to 0.1 pound per 100 square feet would often make the treated area unsuitable for cotton production in the subsequent year. Both were used throughout the Cotton Belt, but never gained a high level of popularity with farmers because of their lack of selectivity.

In the mid- to late-1950s, herbicidal oil used either alone or with PCP was more widely used than either sodium chlorate or TCA. Spot treatments with the oils were applied with a knapsack type sprayer so as to wet the weeds while keeping the oil away from cotton plants. The oils were used more widely for the control

of johnsongrass *[Sorghum halepense* (L.) Pers.] than for all other weeds combined.

Dalapon was introduced as Dowpon® in 1954 (Timmons, 1970) and was highly effective for spot treatment control of johnsongrass and other grasses. Treatments typically consisted of one to two pounds of Dowpon® in five gallons of water and the mixture applied with a knapsack sprayer to wet grass plants to runoff while minimizing contact with cotton. Spot treatment with Dowpon® retarded the growth of cotton, but the margin of selectivity between the weed and the crop was much better than other treatments that were available.

EXTENT OF HERBICIDE USE IN THE 1950s

Dinoseb applied preemergence was tested widely throughout the Cotton Belt in 1951, with widespread sales beginning in 1952. The acreage treated with dinoseb in 1952 has not been published, but it is likely less than 200,000 acres. The use of dinoseb declined after 1952 and it was initially replaced with chlorpropham applied preemergence. The first multi-state survey of cotton acreage treated with herbicides in 1955 showed that about 122,000 acres were treated with chlorpropham, 66,000 with diuron, and 115,000 acres with herbicidal oil, all in the Mid-South, Southeast and Southwest (Table 1[3]). Use of both herbicides was much greater in Mississippi than in other individual states. Preemergence use of dinoseb was not listed in the survey, although it is likely that a relatively small acreage was still being treated in the mid 1950s. Western states used very little herbicide during this period.

The 1955 survey indicated that a herbicidal oil was used to control weeds on about 115,000 acres in nine states (Table 1). The total acreage treated with all herbicides in the 1955 survey was about 302,000 acres, less than two percent of the total cotton acreage in that year.

The data in Table 2 on the extent of use of weed control practices in Texas indicate that the use of herbicidal oil did not exceed 22,000 acres in the 1950s, although the survey shown in Table 1 indicated that herbicidal oil could have been used on 75,000 acres in 1955.

Surveys in Mississippi showed that about 36,000 acres were treated with chlorpropham in 1953, as compared to only about 10,000 acres with dinoseb (Table 3). By 1955, the acreage treated with chlorpropham had increased to 50,000 acres, but it declined to 29,000 acres in 1956. The use of diuron for preemergence control first appeared in the Mississippi surveys in 1955 when 40,000 acres were treated and this increased to about 85,000 acres in 1956. Mullendore (1970) reported that about eight percent (96,000 acres) of the cotton acreage in Mississippi was treated with preemergence herbicides in 1957.

Spot treatments, in which individual weeds or clumps of weeds were treated by hand, began to be commonplace in the 1950s. The extent of usage is not documented, except in a Texas survey (Table 2). This survey showed that 74,000

[3]All tables in this chapter are found in an appendix at end of the chapter.

acres received spot treatments with a herbicidal oil in 1955 and this had increased to 151,000 acres by 1959. This survey also showed that dalapon began to be used as a spot treatment in Texas in 1958 when 40,000 acres were treated, and this had increased to 51,000 acres in 1959 (Table 2).

The extent of cotton acreage treated with herbicides began to increase rapidly in the late 1950s. A nation-wide survey by USDA (Saunders, 1962) showed that the acreage treated preemergence was about 1,000,000 acres in 1959. Three of the Mid-South States, Arkansas, Louisiana, and Mississippi, accounted for about 900,000 acres of the national total. The survey did not report that pre-emergence herbicides were used in the Western states. More than 500,000 acres were treated postemergence in 1959, but about 400,000 acres of the total was in only two states, Arkansas and Texas. The specific herbicides used for weed control in 1959 were not reported in the survey.

Seven of the states reporting in the 1959 survey listed the effectiveness of preemergence herbicides as "fair," while four states listed effectiveness as "good" (Saunders, 1962). Five states reported effectiveness of postemergence treatments as "good," and three reported "fair" control. Eleven states reported that the extent of herbicide usage was increasing, while two states, Virginia and Arizona, reported that usage was stationary. When questioned about the need for better herbicides, eleven states reported that there was "some" need and only two states reported an "urgent" need. The level of weed control that was being obtained in 1959 from both pre- and postemergence herbicides must have been much higher than farmers had expected to explain the relative lack of urgency for better weed control practices. If only the herbicides available in 1959 were presently available, their effectiveness would probably be rated "poor," based on present-day expectations.

USE TRENDS IN THE 1960s

The greatly expanded use of herbicides that began in 1958 or 1959 continued at an accelerated rate through the 1960s. The use of preemergence treatments increased from 6.6 percent of the total cotton acreage in the United States in 1959 to 48.6 percent in 1965 (Table 4). The use of postemergence treatments increased from 3.7 percent in 1959 to 43.1 percent in 1965. In 1959, only about 10 percent of the total crop acreage was treated with both pre- and postemergence herbicides but by 1968, 91 percent of the acreage was treated. The average cost of herbicides increased from about $3/A in 1959 to nearly $10/A in 1968 (Table 4). The total value of herbicides used in cotton increased from $4.7 million in 1959 to more than $89 million in 1968.

Many superlatives have been used to describe the importance of the 1960s in the development of weed control technology used in cotton. These have included "dynamic decade," "golden decade," and "the fabulous 60s." These terms were prompted by the introduction and sale of 10 important herbicides within about a

seven-year period (Timmons, 1970). These included Eptam® (EPTC), Dicryl® (dicryl), Lorox® (linuron), DSMA/MSMA, Herban® (norea), Treflan® (trifluralin), Caparol®, Cotoran® (fluometuron), Paraquat (paraquat) and Planavin® (nitralin). A few of these, such as Dicryl®, Herban®, and Planavin®, were available for only a few years but others, including DSMA/MSMA, Treflan®, Caparol® and Cotoran®, are as important in cotton production today as they were in the 1960s.

EXTENT OF USE OF PREEMERGENCE HERBICIDES IN THE 1960s

In Texas, the acreage treated with preemergence herbicides increased from 46,000 acres in 1962 to more than 2,000,000 in 1969 (Table 2). Unfortunately, the specific herbicides used were not listed in the survey.

In Mississippi, the acreage treated preemergence with Karmex® increased from about 85,000 acres in 1956 to nearly 900,000 acres in 1961 (Table 3). Karmex® continued to be the predominant preemergence herbicide used through the mid-60s but by 1969, the acreage treated with this herbicide had declined to about 82,000 acres. The reduced usage of Karmex® was caused primarily by the expanded use of Cotoran®, either alone or in combination, with other herbicides, but also by the greatly expanded usage of Treflan® and other herbicides (Table 3). By 1969, farmers in Mississippi were using more than 14 different herbicides or herbicide combinations for weed control in cotton.

Preemergence use of chlorpropham decreased after 1961 and was not listed in Mississippi surveys after 1963 (Table 3). Eptam® appeared in the Mississippi surveys only in 1969, when 2,000 acres were treated preemergence with injectors (Holstun *et al.*, 1963). Greatest use of Herban® applied preemergence was in 1969 when about 15,000 acres were treated; but usage declined thereafter. Use of Planavin® peaked in 1969, but decreased thereafter. In 1967, many producers in the Mid-South experienced the "cotton stunt" injury problem that was associated primarily with excessively deep incorporation of Treflan® and Planavin® (Mullendore, 1968). There were many contributing factors to the cotton injury problem, other than deep incorporation of herbicides, that included cold-wet weather, shallow planting, and injury from fertilizer and insects. Even so, many producers felt that cotton injury was more severe following use of Planavin® than with Treflan®. As a result, interest in Planavin® declined.

A significant change occurred in the use pattern in which preemergence herbicides were used in the Mississippi Delta in 1967. Previously, farmers had used either a soil surface applied herbicide or an incorporated dinitroaniline herbicide. But, in 1967, 85 to 90 percent of the cotton acreage was treated using two different preemergence herbicides (Mullendore, 1968). Originally the use of two preemergence herbicides was referred to as "double," "overlay," or "dual" treatment. These terms were used to indicate that a dinitroaniline herbicide was applied preplanting and soil incorporated followed by the application of another herbicide to the soil surface. During the next few years, "overlay" became a

more popular term. The extent of use of overlay treatments in Mississippi in the late 1960s is presented in Table 3.

The only other state survey showing the extent of usage of specific herbicides is for Tennessee in 1966, 1967, and 1968 (Table 5). In general, these surveys show a relatively rapid decline in usage of Karmex®, while the use of Cotoran® increased. The dinitroanilines, Treflan® and Planavin®, were not used as extensively in Tennessee as in Mississippi, nor is there evidence of extensive use of the overlay treatments as in Mississippi (Table 5).

In the 1960s, use of preemergence treatments were far more commonplace in Mid-South and southeastern states than in western states (Danielson *et al.*, 1965; Danielson *et al.*, 1968; and Jansen *et al.*, 1972). In 1968, almost half of the cotton (about 550,000 acres in Arizona, California, Nevada, and New Mexico) received preplant-incorporated (PPI) treatment or a combination of PPI plus postemergence treatment, while more than seven million acres received these treatments in the South and Southwest (Danielson *et al.*, 1972). Treflan® was the first widely accepted herbicide in western states because it provided control even when rainfall did not occur after planting.

EXTENT OF USE OF POSTEMERGENCE HERBICIDES IN THE 1960s

Use of herbicides applied postemergence increased dramatically in the 1960s (Table 4). In 1949, only 3.7 percent of the cotton acreage received postemergence treatment but, by 1968, 57 percent of the acreage was treated either postemergence alone or pre- and postemergence.

In Mississippi, the use of herbicidal oil increased from about 106,000 acres in 1961 to about 357,000 acres in 1963 (Table 3). Survey data that show the extent of use of herbicidal oil in Mississippi from 1964 through 1968 are not available but it is likely that this practice peaked in the mid-1960s. Unpublished surveys from Mississippi show that the number of sprayers to apply herbicidal oil increased from 715 to 1,738 from 1961 to 1962. The 1963 survey did not distinguish between sprayers to apply herbicidal oil *vs*. other herbicides but it did show a total of 4,123 postemergence herbicide sprayers in the state. The use of herbicidal oil was probably greatest in the Mid-South and in Texas, although it was used to some extent throughout the Cotton Belt. Surveys in Tennessee indicated that only 4,000 and 7,000 acres were treated in 1966 and 1968, respectively and this decreased to only 1,000 acres in 1970 (Table 5). In Texas, the number of acres treated with herbicidal oil increased from 86,000 to 283,000 from 1961 to 1962, but the number of treated acres declined thereafter. As discussed later, the use of herbicidal oil was largely replaced by the use of DSMA/MSMA applied alone or in combination with other herbicides.

The arsenicals, DSMA/MSMA, were introduced for postemergence weed control in the early- to mid-1960s and quickly became one of the most valuable weed control practices. Originally, the selectivity of the arsenicals for controlling grasses in cotton was not recognized and these materials were first suggested for

weed control in cotton when included in a tank mixture with Dicryl® (Thompson, 1961). Dicryl® was first made available for field evaluation in 1958 and Porter *et al.* (1960) were among the first to propose the use of Dicryl® for postemergence weed control in cotton. Other researchers began evaluating Dicryl® for selective weed control (Frans, 1962), but it was Thompson (1961) who first reported that the combination of Dicryl® + DSMA was highly effective. A product was quickly marketed that contained both Dicryl® and DSMA for use in tank mixtures. However, the product was on the market for only two or three years because it was quickly found that the arsenicals used alone or in combination with other herbicides were equally or more effective.

In 1960, it was found that Karmex® and other substituted ureas were highly effective for postemergence weed control when applied with surfactant (McWhorter and Sheets, 1961). By 1962, 562,000 acres of cotton in Mississippi were treated with Karmex® applied postemergence (Table 3). Postemergence use of the arsenicals (DSMA/MSMA) in Mississippi was first reported in a 1963 survey when about 72,000 acres were treated. By 1969, nearly 1.5 million acres were treated with an arsenical herbicide applied alone or in combination with Caparol®, Cotoran®, dinoseb, Herban®, Karmex® or Lorox® (Table 3). Similar use patterns for the herbicides were developing in adjacent Mid-South states.

In Tennessee, the acreage treated with the DSMA/MSMA alone or in combination increased from 107,000 acres in 1966 to nearly 300,000 acres in 1970 (Table 5). By 1970, most of the treated acreage was either with DSMA/MSMA applied alone or in tank mix with Caparol®, Cotoran®, Herban®, or Karmex®.

DSMA was first reported to be used in Texas in a 1963 survey when 100,000 acres were treated (Table 2). The arsenicals continued to be used on about 600,000 to 800,000 acres in Texas from 1965 to 1970. The Texas survey reports only on the use of DSMA but it is likely that this also included the use of MSMA.

Layby treatments became increasingly popular in the 1960s. Layby treatments are postemergence directed spray applications of herbicides at about the time of the last cultivation. In Mississippi, nearly 350,000 acres were treated with Karmex® applied layby in 1963. By 1970, the acreage treated with Karmex® decreased to 244,000 acres, but about 56,000 acres were treated with Cotoran® and 143,000 acres with Lorox® (Table 3).

Layby treatments were more widely used in the Mid-South states than in any other southern states. In Tennessee, only 14- to 26,000 acres were treated with herbicides applied layby in the late 1960s (Table 5). Karmex® was the most commonly used herbicide for layby treatment in Tennessee in 1968 but by 1970, Cotoran® and Karmex® were used equally.

EXTENT OF USE OF SPOT-TREATMENT HERBICIDES IN THE 1960s

Spot spraying continued to be a frequently used practice to control persistent weeds after the general weed infestation had been treated with other methods (Buchanan and McWhorter, 1970). Spot spraying was expensive because it re-

quired hand labor, but it was usually more economical than hand hoeing (Rea *et al.*, 1955; Rea, 1958). Most spot treatments were used to control perennial weeds. In the early 1960s, herbicidal oil, either used alone or fortified with TCA ester, was more widely used, but spot treatment of grasses with Dowpon® became increasingly popular in the mid- and late 1960s. These treatments continued to be applied by individuals walking through the field with hand sprayers or with two or more men riding through the field on a tractor equipped with seats and a hand-held spray system.

The extent of usage of spot treatments is poorly documented, and only a survey in Texas provides an indication on the number of acres treated. Up to 277,000 acres were spot treated with herbicidal oil in the early 1960s, but this level declined to only about 105,000 acres in 1969 (Table 2). Similarly, there were 137,000 acres spot treated with dalapon at the beginning of the 1960s and only 45,000 acreas were treated in 1969 (Table 2).

There are no surveys to indicate the extent of sodium chlorate or the arsenical herbicides used as spot treatments in the 1960s, but they were widely used. DSMA/MSMA was applied in the same manner as spot treatments with Dowpon® by mixing about one pound of active herbicide in five gallons of water and spraying this solution to thoroughly "wet" weeds. Sodium chlorate was applied either in solid form by hand or in liquid sprays to "wet" weeds. Eichers (1980a) reported that 1.5 million pounds of sodium chlorate were used in cotton in 1966. This represented 23 percent of the total herbicide used on a weight basis in cotton production that year. It is likely that much of this was used as a cotton desiccant/defoliant instead of as a herbicide. Use of sodium chlorate was exceeded only by the use of 2.6 million pounds of trifluralin. Eichers (1980a) also reported that 0.9 million pounds of diuron and 0.4 million pounds of MSMA were used in 1966. These four herbicides, trifluralin, sodium chlorate, diuron and MSMA, represented 83 percent of the total herbicide used in cotton production that year.

The three nationwide surveys conducted by USDA, ARS in 1962 (Danielson *et al.*, 1965), 1965 (Danielson *et al.*, 1968), and 1968 (Danielson *et al.*, 1972) showed that herbicides were used extensively for both pre- and postemergence treatments in Mid-South and southeastern states, but was far less frequently used in the West. In 1968 only about 750,000 acres of cotton received treatment with herbicides in the West and nearly two thirds of this, 450,000 acres, was in California (Jansen *et al.*, 1972). These surveys do not list the specific herbicides used, but they do provide estimates of usage on a state-by-state basis. The surveys also showed that the preemergence treatments used in 1968 had about the same level of effectiveness as those used in 1965, but that postemergence treatments were more effective in 1968 than in 1965. Combinations of preemergence and postemergence treatments were rated "good" in 12 states, "fair" in two states, and no state rated treatments as "poor" (Jansen *et al.*, 1972). Also, no state reported an "urgent" need for better herbicides. The herbicide-use trend was listed as up in 13 states, stationary in five states, and down in no states.

Problems with herbicide soil persistence appeared to be lower in 1968 than in 1965. In 1968, seven states reported problems with persistence, but 11 reported no major problems with persistence. Persistence problems affected about five percent of the treated acreage and were more severe in the West (Jansen *et al.*, 1972) due to a slower rate of herbicide decomposition.

USE TRENDS IN THE 1970s

At the beginning of the 1970s, practically all of the cotton acreage in the Southeast and Mid-South were treated both pre- and postemergence (Table 6). A large percentage of the cotton acreage in the Southwest and the West was also treated, but states in these areas made significantly less usage of both pre- and postemergence treatments than in eastern portions of the Cotton Belt. Less frequent rainfall reduced the effectiveness of preemergence herbicides in the western Cotton Belt, causing significantly reduced usage of soil surface-applied materials, such as Cotoran® and Karmex.® The lower frequency of rainfall, both before and immediately after emergence of cotton in western states, also resulted in lower weed infestations than in eastern states, thus reducing the need for many of the postemergence treatments that were used in the Mid-South and Southeast.

The decade of the 70s was a period of adjustment for many cotton producers who were still attempting to develop best management practices for the large number of highly effective herbicides that were introduced in the 1960s. In addition, they were confronted, and often confused, by a vast array of new herbicides that were introduced in the 1970s. These included five new dinitroaniline compounds, two additional triazines, and three other herbicides that would eventually be widely used. With the vast array of herbicides that had become available in both the 1960s and the 1970s, farmers now had literally hundreds of different possible weed control programs to select from. This often caused both anxiety and confusion because very active competition for sales occurred during the 1970s.

HERBICIDES FOR PREEMERGENCE CONTROL IN THE 1970s

During the early to mid-1970s the five newly introduced dinitroaniline herbicides that competed with Treflan® and Planavin® were Amex® (butralin), Basalin® (fluchloralin), Cobex® (dinitramine), Prowl® (pendimethalin) and Tolban® (profluralin). Within individual experiments or farm trials, there were often subtle differences among the dinitroaniline herbicides in terms of which had greatest cotton tolerance or which persisted the longest in the soil, but as summarized by Talbert (1978), "there is little indication of any consistent differences of the effect of these herbicides" at "reasonable rates." Also, there were no distinct advantages in which any of these products provided a consistently higher level of weed control that could be exploited for sales purposes.

The two new triazines that were introduced in the 70s were Bladex® (cyana-

zine) and Sancap® (dipropetryn). Bladex® would later find a widespread market throughout much of the Cotton Belt for postemergence weed control, but Sancap® was developed for preemergence control in the more arid cotton producing areas of Arizona, New Mexico, Texas, and Oklahoma (LeBaron, 1979). Greatest use of Sancap® was in Texas. LeBaron (1979) provided an excellent review on the history and development of triazine herbicides for use in cotton.

Other new herbicide introductions in the 1970s were Probe® (methazole), Roundup® (glyphosate) and Zorial® (norflurazon). Roundup® and Zorial® would later play a significant role in cotton production.

HERBICIDES FOR POSTEMERGENCE WEED CONTROL IN THE 1970s

Roundup® was introduced in 1971 and quickly became the most effective material available for spot treatment of johnsongrass and other weeds that escaped pre- and postemergence treatments. In the late 1970s, it also achieved significant use when applied in a rope-wick applicator for control of johnsongrass and other weeds that grew taller than cotton. Probe® was introduced for postemergence weed control in the mid 1970s. It gained popularity, especially in the Mid-South, for control of many broadleaf weeds when either applied alone or in combination with MSMA.

In the 1970s the arsenicals, DSMA/MSMA, continued to be the most widely used herbicides for postemergence weed control in cotton. These herbicides were economical as compared to alternatives. They were selective for use in cotton when properly applied, and they effectively controlled several weeds that were either impossible- or difficult-to-control with other herbicides, including the nutsedges, johnsongrass, and cocklebur. The relative importance of the arsenical herbicides is demonstrated in a review by Miller (1977a), who reported that he found 125 papers dealing with the arsenical herbicides in the Proceedings of the Southern Weed Science Society from 1967 to 1976. He concluded from his study that: (a) DSMA caused less cotton injury than MSMA; (b) injury from both herbicides was worse at low temperatures than at high temperatures; (c) directed sprays were much safer to cotton than over-the-top sprays; and (d) treatment should be terminated before the first flower appeared on cotton plants.

EXTENT OF HERBICIDE USE IN THE 1970s

Surveys are available from only two states that show the percentage of acreage treated with different herbicide practices in the early 1970s. In Mississippi, Treflan® continued to be the most widely used soil-incorporated herbicide (Table 3). The use of Planavin® decreased more than two-fold in the early 1970s when the most widely used preemergence practices were overlay treatments of Cotoran® or Karmex® after soil incorporation of Treflan® (Table 3). Cotoran® continued to be more widely used than Karmex.® Caparol®, Herban®, and Telvar® were used on far less acreage than the herbicides previously mentioned.

The use of herbicidal oil continued to decline in Mississippi in the early 1970s,

although Mobilnix,® an emulsifiable herbicidal oil, was used for four or five years in addition to conventional herbicidal oil (Table 3). The most widely used postemergence treatments in Mississippi in 1972 were MSMA alone or MSMA tank-mixed with Cotoran® or Karmex.® Cotoran® continued to be the most widely used herbicide for layby weed control, although Lorox® was commonly used (Table 3).

In Texas, the acreage treated with preemergence herbicides increased from about 2.2 million acres in 1970 to nearly 3.5 million acres in 1973 (Table 2). The extent of use of the arsenical herbicides also continued to increase during that period. Conversely, the use of herbicidal oil decreased dramatically during the period 1970 to 1973 as compared to earlier usage. The use of herbicidal oil or dalapon as a spot treatment was relatively stable in Texas during the early 1970s (Table 2).

Weaver (1983) conducted a series of surveys in Texas from 1973 through 1981 that provided estimates on the acreage treated with specific herbicides. The use of Treflan® represented 80 percent or more of the total acreage treated with the six dinitroaniline herbicides (Table 7). The use of all dinitroaniline herbicides varied from 52 percent of the Texas acreage in 1973 to nearly 87 percent in 1980. Use of the soil surface-applied preemergence herbicides varied from about 14 to 17 percent of the total cotton acreage. Throughout the survey, Caparol® was used on more acres in Texas than all other soil surface-applied herbicides combined (Table 7).

Postemergence herbicides were not used in Texas as extensively from 1973 through 1980 as they were in the Mid-South states (Table 7). Usage of herbicides applied postemergence declined from about 18 percent of the total cotton acreage in 1973 to 11 percent in 1980. The arsenicals were the most commonly used postemergence herbicides, but their use also declined from about 13 percent of the cotton acreage in 1973 to only about 7 percent in 1980 (Table 7).

Eichers (1980b) reported that herbicide use in cotton increased from 6.5 million pounds in 1966 to 18.3 million pounds in 1976 (Table 8). Trifluralin was the most commonly used herbicide overall in both years of the report and represented 38 to 40 percent of all herbicides used. Use of the arsenicals increased from 0.4 million pounds in 1966 to 3.3 million pounds in 1976. Eichers (1980a) did not report the use of fluometuron (Cotoran®) in 1966, but by 1976, 5.3 million pounds were used in cotton, 29 percent of all herbicides used.

In 1976, three herbicides comprised 81 percent of all the herbicides used in cotton. These were trifluralin (38 percent), fluometuron (22 percent), and the arsenicals (21 percent) (Table 9).

The extent of herbicide usage in different regions of the Cotton Belt in 1976 is summarized in Table 10. This summary shows that nearly all of the cotton acreage east of Texas was treated with herbicides in 1976. Only 68 percent of the acreage in Texas and Oklahoma was treated and more than 90 percent was treated in California. Herbicide usage per acre was highest in the Delta states

(3.47 lb/A) and in the Mountain states (3.26 lb/A) and lowest in California (0.84 lb/A).

The time and manner in which herbicides were applied in various states in 1976 are summarized in Table 11. Foliar application of herbicides to weeds before planting was the least used method. The use of soil incorporated treatments for preemergence control was the most extensively used of all methods of application (Table 11). Use of soil surface-applied preemergence treatments was also consistently high in all states, except Arizona, California, New Mexico, Oklahoma and portions of Texas. Greater usage was made of directed sprays than over-the-top sprays in most states, but this survey showed greater use of over-the-top treatments than any other published survey. The use of herbicides applied at layby varied widely from state to state, but in general, layby treatments are used far less frequently than directed sprays (Table 11).

In 1976, the most commonly used foliar-applied herbicides prior to planting were MSMA, paraquat, or mixtures of the two (Table 12), but only seven states reported this type of treatment. As verified in other surveys, Treflan® was the most widely used herbicide in 1976, although this survey suggests that use of Cotoran®/Lanex® was nearly as widespread as Treflan® (Table 12). Karmex® was used for preemergence control in as many states as was Cotoran®/Lanex®, but only about 25 percent as much acreage was treated with Karmex® as with Cotoran®/Lanex®. The use of these substituted urea herbicides, either alone or in combination with MSMA, probably represented 90 percent of all of the post-emergence directed sprays in 1976 (Table 13). The only herbicides applied over-the-top were Cotoran® and the arsenicals. Use of Karmex® and Lorox® accounted for about 80 percent of all herbicides applied at layby (Table 13), but Lorox® was not used in western states.

By 1979, herbicides were applied to more acres of cotton than insecticides and fungicides combined (Table 14). Herbicides were applied about three times more frequently to cotton growing in the southeastern and Mississippi Valley states than in southwestern or western states. Insecticides were applied more frequently on the acres that were treated than herbicides in all four regions of the country (Table 14).

In the mid-1970s, control of johnsongrass and other tall growing weeds in cotton was frequently accomplished with applications of Roundup® in recirculating sprayers (Larsen, 1987). These sprayers reached maximum usage in 1978 when this method began to be replaced by applications of Roundup® with the rope wick applicator. The extent to which these practices were used in cotton is not documented, but they were probably used on 10 to 20 percent of the cotton acreage in most southern and southwestern states over a three- to four-year period. Weaver (1983) estimated that rope-wick applicators were used on 22 and 38 percent of the cotton acreage in Texas in 1980 and 1981, respectively.

Roundup® probably became the most frequently used herbicide for spot treatment in the 1970s, but the extent of this usage is unknown. We estimate that

between 10 to 30 percent of the cotton acreage in each state may have received spot treatments with Roundup.® Dalapon continued to be used for spot treatments also as were the arsenical herbicides, but there are no surveys to indicate the extent to which these were used. In western states, Roundup® quickly replaced Dowpon® for spot treatment of perennial grasses, and was applied with a hooded sprayer at layby for control of field bindweed *(Convolvulus arvensis* L.).

As indicated earlier, considerable attention was devoted in the 1970s to the development of systems or programs to provide seasonal weed control in cotton with combinations of specific weeds. Examples of typical programs for different weed problems in the 1970s were provided by Buchanan and McWhorter (1970). Miller (1977b) provided a summary of weed control practices commonly used in the West in the 1970s.

Several reports were published by USDA in the 1970s that document the manufacture and use of herbicides and other pesticides. These include "The Pesticide Review in 1974" (Fowler and Mahan, 1975) and "The Pesticide Review in 1976" (Fowler and Mahan, 1977); "Farmers Use of Pesticides, 1971" (Andrilenas, 1975); "Farmers Use of Pesticides, 1976" (Eichers *et al.*, 1978); "The Farm Pesticide Industry" (Eichers, 1980a); and "Farmers Expenditures for Custom Pesticide Services, 1971" (Ferguson, 1975).

HERBICIDE USE IN THE 1980s

The 1980s was a period in which cotton producers were confronted with greater economic pressure than they had experienced since the Depression of the 1930s. Adverse weather led to reduced yields and reduced profits in much of the Cotton Belt. In addition, the profitability of cotton production decreased because of increased foreign competition. Many farmers were forced out of cotton production and others were forced to reduce the scope of their operations but, even so, the use of herbicides increased. Ecological shifts of weeds and increased infestations of weeds that were resistant to control with herbicides probably contributed to the increased use of herbicides along with the desire of the farmer to increase both yields and quality.

The 1980s were a contrast from previous decades because as many herbicides were lost as were gained for use in cotton. Use of Basalin®, Cobex®, dinoseb, Probe®, Sancap® and Tolban® was discontinued, although Probe® would be marketed again in 1987. Dual® (metolachlor), Goal® (oxyfluorfen), Poast® (sethoxydim), and Fusilade® (fluazifop) became available in the 1980s, although the extent to which these would be used would not equal the acreage treated with the herbicides that were discontinued.

HERBICIDES FOR PREEMERGENCE CONTROL IN THE 1980s

Loss of three dinitroaniline herbicides, Cobex,® Basalin,® and Tolban,® did not create direct hardships for farmers but only resulted in increased use of Treflan®

and Prowl®. Cobex® had been used in only a few states in the early 1980s as existing supplies were exhausted. Basalin® and Tolban® were used in practically all cotton producing states but their loss did not adversely affect weed control. Probably the greatest impact of their loss was the loss in competition from a marketing standpoint. One of the preemergence herbicides gained in the late 1970s was Destun® (perfluidone), but it was used in the 1980s in only two states for a brief period on a very limited acreage. Dual® has been used more frequently in recent years, but only on limited acreage in about five states. The gain and loss of the preemergence materials had comparatively little impact on cotton production and caused only slight rearrangements within the market place.

HERBICIDES FOR POSTEMERGENCE CONTROL IN THE 1980s

Herbicidal oil was rarely, if ever, used in the 1980s. The use of this practice never appeared in herbicide-use surveys after the mid-1970s.

Use of Probe® applied in directed sprays to control broadleaf weeds began in the late 1970s but use ceased in the early 1980s after existing supplies were sold. Manufacture of Probe® was resumed in 1987 and the product became available again. Probe® was never used on an extensive acreage, but it was used in southeastern states and in most Mid-South states (Tables 15 to 29). Dinoseb was also used for broadleaf weed control when applied in directed sprays but its usage was discontinued in 1987 because its registration was suspended by the Environmental Protection Agency (EPA). Use of dinoseb was highly economical as compared to many other postemergence herbicides, but it was used primarily only in those areas where producers made intensive use of postemergence-directed sprays (Tables 15 to 29). It was used on limited acreage in North Carolina, South Carolina and Tennessee but was more widely used in the four Mid-South states and in Texas.

Goal® became available in the mid-1980s and was used primarily for control of broadleaf weeds. Its use has been limited to relatively small acreages in a few Mid-South and Western states as a preplanting or layby treatment (Tables 15 to 29).

Use of Poast® and Fusilade® began in 1983 but the extent of their use has never achieved the levels that many weed scientists had expected. These herbicides are highly selective for the control of both annual and perennial grasses in cotton but most farmers have apparently been able to continue to achieve satisfactory control with the dinitroanilines applied preplanting and with the arsenicals applied postemergence at a lower price than they could achieve with Poast® or Fusilade®. The exact manner in which producers have applied Poast® and Fusilade® is unknown, but it is likely that most treatments have been with hand sprayers or with tractor spray rigs with the spray boom being turned on and off to spray only heavy infestations of grass. Broadcast over-the-top applications to entire fields with these herbicides have not been common. Treatments with the herbicides have largely replaced the use of Roundup in the rope-wick applicator.

Rope-wick applicators were still being used by some farmers in the mid-1980s but their use has diminished. In the West, Poast® and Fusilade® are used on heavy infestations of johnsongrass and bermudagrass, but results are often erratic when weeds are under drought stress.

ESTIMATES ON THE EXTENT OF HERBICIDE USE IN INDIVIDUAL STATES IN THE 1980s

The only published surveys that document herbicide use in the 1980s are in the "Reports of the Cotton Weed Loss Committee" in the Proceedings of the Cotton Weed Science Research Conference that are included in the annual proceedings of the Beltwide Cotton Production Research Conferences. These surveys are based on estimates made in individual states by extension and research personnel. The eight published reports of this survey have been assembled on a state-by-state basis and these summaries are presented in Tables 15 to 29.

The data in Tables 15 through 29 are so extensive that we will not discuss results on a state-by-state basis. These surveys are valuable for showing general trends in herbicide use, but we feel that some of the estimates are too high based on the totals obtained for some herbicides when data from all states are combined. We cannot predict which state estimates would be too high or too low. Estimates for any one state may be slightly too high or too low, but when the estimates listed in the Appendix Tables are consolidated into a single table representing herbicide usage for the entire country, the combined annual estimates in some cases exceeded the amount of herbicide that would have been available or else exceeded estimates provided by manufacturers and other sources. It seems likely that the total of the annual estimates may be 20 to 30 percent too high for some herbicides applied preemergence to the soil surface or postemergence and possibly 10 to 20 percent too low for herbicides applied preplanting and soil-incorporated. As a result, we have adjusted the values obtained from totaling data from all states (Tables 15 to 29) to provide what we feel are more realistic estimates on the extent of use of individual herbicides (Table 30).

EXTENT OF USE OF INDIVIDUAL HERBICIDES IN THE 1980s

The data summarized in Table 30 provide a list of 33 herbicides and herbicide combinations presented in the annual surveys published in the Cotton Weed Science Research Conference Proceedings. As discussed below, there are about that many additional treatments that are in use that are not listed in the survey. With more than 60 herbicides and herbicide combinations to select from, it is not surprising that any single herbicide or herbicide combination is used on a relatively small percentage of the total cotton acreage. Even so, more than 80 percent of the total acreage treated in the1980s was with Treflan®, Prowl®, Cotoran®/ Lanex® and DSMA/MSMA. Many surveys, such as that by the Cotton Weed

Loss Committee, may report on only one of the arsenicals, MSMA, but it is usually understood that actual usage could be either with DSMA or MSMA. Comparatively large acreages are listed as being treated with Poast®/Fusilade® or Roundup.® It is difficult to gauge the actual scope of use of these materials because their usage to treat one or two spots of weeds per acre might result in this usage being included in the survey as "an acre treated."

Herbicides that showed the most obvious decline in use in the 1980s were those that were discontinued, Basalin®, Cobex®, Destun®, Probe® and Tolban® (Table 30). Herbicides that were used at a relatively low, but constant use-rate, were Dowpon®, Paraquat® and Sancap.® Registration of Sancap® was discontinued in 1988. Those used at a steady intermediate level, from a few hundred thousand to several hundred thousand acres each year, were Bladex®, Caparol®, dinoseb, Karmex®/Dynex® and Lorox®/Linex®. Herbicides that remained at a relatively constant high level from several hundred thousand acres or more, were Cotoran®/Lanex®, DSMA/MSMA, Roundup® and Treflan®.

Use of Dual® and Goal® increased in the mid-1980s but comparatively few acres were treated with them. There were relatively large increases in the acreage treated with Poast®/Fusilade®, Prowl® and Zorial® (Table 30).

Decreased use was made of Cotoran® + Tolban® and MSMA + Probe®, because one of the herbicides in these combinations was discontinued. In 1980, a very limited acreage was treated in two states with Caparol® + Bladex®, but this was discontinued at about the time that Caparol® + Prowl® and Caparol® + Treflan® came into more common usage (Table 30). Cotoran® + Treflan® has continued to be used in seven states on a consistent but low acreage, usually less than 80,000 acres per year. Use of MSMA applied postemergence in tank mixtures with Bladex®, Caparol®, Cotoran®/Lanex® and Karmex®/Dynex® has been commonplace in 10 to 13 states at a relatively constant rate of several hundred thousand acres per year.

Several herbicides and herbicide combinations that were used for preemergence weed control are not reported in Table 30. These include Lasso®, Basalin® + Caparol®, Basalin® + Zorial®, Bladex® + Zorial®, Caparol® + Dual®, Cotoran® + Lasso®, Cotoran® + Prowl®, Cotoran® + Zorial®, Prowl® + Treflan® and Treflan® + Zorial®. There probably are others, but they would not have been used to any appreciable extent. Postemergence treatments that have been used that are not reported in Table 30 include Caparol® + dinoseb, Cotoran® + DSMA, Bladex® + DSMA, dinoseb + Karmex®/Dynex®, dinoseb + Lorox®, Bladex® + dinoseb, MSMA + dinoseb, Bladex® + dinoseb and Bladex® + dinoseb + MSMA. Each of the last three tank mixes listed could have been used on 100 to 200 hundred thousand acres of cotton in any single year in the 1980s. There are probably other tank mixes used for postemergence weed control that are not listed but their use would have been limited.

EXTENT OF HERBICIDE USE IN THE 1980s BASED ON TIME OF APPLICATION

Herbicides are applied as preplanting-foliar applications only infrequently (Table 31). The total of these on a national basis is only a small fraction of total herbicide use. Greater use is made of these treatments in the Mid-South than in all other states combined. Greatest use in the Mid-South is probably in years with high rainfall in March and April when producers are unable to use timely tillage prior to planting. In the West, use is on clay soils where preplanting irrigations are made in November and February or when winter rains are frequent.

The most commonly used preemergence practice on a nationwide basis throughout the 1980s was with soil incorporated herbicides for preemergence control (Table 31). Use of this practice on a national basis increased from 68 percent of the cotton acreage in 1980 to 83 percent in 1986. The second most frequently used practice was the application of herbicides postemergence, which increased from 49 percent of the cotton acreage in 1980 to 84 percent in 1986. Herbicides applied preemergence to the soil surface increased from 28 percent in 1980 to 54 percent in 1986. The use of spot treatments also increased from 36 percent in 1980 to 41 percent in 1986. The use of herbicides applied layby varied from 12 to 20 percent during the period (Table 31).

As in previous decades, greatest use of herbicides on a per-acre basis continued in the Mid-South which averaged 5.7 herbicide treatments per acre each year (Table 31). This large number of applications could be accounted for by: (a) a herbicide applied preplanting; (b) a herbicide applied to the soil surface after planting; (c) herbicides applied post-directed two-to-three times; and (d) a spot treatment and/or a layby application. This sequence is not uncommon in the Mid-South.

The Southeast received the second most frequent use of herbicides in the 1980s, followed by the Southwest and the West (Table 31). Nationally, the number of herbicide applications annually in cotton varied from a low of 1.95 per acre in 1980 to a high of 2.86 herbicide applications per acre in 1986. There is no evidence available to indicate that the extent of usage of herbicides in cotton will decline in the near future.

Herbicides are used intensively in cotton production, but in 1980 they accounted for only seven percent of the total herbicide sales in the United States (Table 32). Sixty-nine percent of the herbicides sold in 1980 were used on the more widely planted corn and soybeans. The value of herbicides sold for use in cotton in the United States was $142 million as compared to the value of herbicides used in cotton in the rest of the world of $179 million (Table 32).

SUPPLY AND COST OF HERBICIDES

There have been few shortages of herbicides registered for weed control in cotton. Economic Research Service, USDA, began publication of evaluation reports on pesticide supply and demand in 1975, and some of these reports include Andrilenas (1975) and Eichers (1976), Eichers and Andrilenas (1978), Eichers and Andrilenas (1979) and Eichers (1980b). Other useful information concerning the availability of herbicides is included in Fowler and Mahan (1975, 1977), Eichers (1980a and 1980b), Eichers (1981) and Eichers and Serletis (1982).

There are few published reports on the prices of specific herbicides over a period of several years, but Eichers (1980b) reported that the price increase for pesticides from 1970 to 1979 was only 53 percent. By comparison, the price of fertilizer increased 123 percent, tractors 147 percent, fuel and energy 165 percent and seed 155 percent. In 1982, Eichers and Serletis (1982) reported that pesticide prices had increased 78 percent from 1971 to 1981. During this same period, the cost of fertilizer increased 186 percent, machinery 207 percent, fuel and oil 302 percent and seed 204 percent.

The average price of nine selected herbicides commonly used in cotton in the Delta of Mississippi increased in price by 66 percent from 1969 to 1987 (Table 33). During this period, the price of some herbicides doubled (Cotoran® and Lorox®) or tripled (dalapon and MSMA), but others (Karmex® and Treflan®) did not increase in price (Table 33). The prices paid for herbicides usually do not vary dramatically throughout the Cotton Belt, so these prices might be representative of increases in other regions.

CUSTOM APPLICATION OF HERBICIDES

Traditionally, cotton producers make less use of custom applicators than producers of many other crops. In 1959, 94 percent of the acres treated with herbicides was by farmers and only 6 percent was by custom applicators (Saunders *et al.*, 1962). Some states in the Mid-South and Southwest did not report any use of custom applicators. In the West, 53 percent of the acres treated was by custom operators in 1959. In both 1962 and 1965, farmers in both the Mid-South and Southwest were still applying their own herbicides to 92 percent of the treated acreage (Danielson *et al.*, 1962 and Danielson *et al.*, 1965). In the West, 28 and 31 percent of the treated acreage was by custom applicators in 1962 and 1965, respectively. Greatest use of custom applicators to apply herbicides in 1962 was in New Mexico (50 percent) and in 1965 in California (40 percent).

In 1968, only Texas reported that more than 25 percent of the acreage treated with herbicides was with custom applicators (Jansen *et al.*, 1972). The limited use of custom applicators to apply herbicides has probably been due to: (a) preemergence herbicides are usually applied only on a band basis; and (b) most postemergence herbicides are applied on a band basis as directed sprays. Both

of these practices preclude use of aircraft or large ground devices commonly used by custom applicators.

FUTURE HERBICIDE USE

It is unlikely that there will be any substantial increase in the use of herbicides in cotton production in the United States in the next few years. Most of the herbicides marketed have now been available for many years and any changes in the total use will likely be dependent upon the number of acres of cotton planted each year. Some herbicides will be lost, especially in the western states, due to regulatory restrictions. Others will be lost due to the costs for registration, so this will especially be true where market shares are low and/or proprietary rights no longer exist.

New herbicides will probably continue to be provided at the rate of one every second or third year over the next several years. There are several new herbicides that are undergoing preliminary testing and some of these will likely be registered within the next three to ten years. Some of the new herbicides being developed include the sulfonyl chemistries that are effective at only a few grams per acre. This will be highly beneficial in reducing the total weight of herbicides applied annually in addition to providing improved control of broadleaf weeds.

One or two biological weed control agents, probably fungi, will likely be introduced for weed control in cotton within the next few years. The impact of these will be relatively minor on a national basis because the spectrum of weed control with pathogens is very narrow, often limited to one or two specific weeds.

Ecological shifts of weeds will probably continue, especially as greater usage is made of conservation tillage. A series of major ecological shifts could greatly increase herbicide usage within specific geographical areas.

Some weeds that are now adequately controlled could develop resistance to herbicides within the next 10 to 20 years. During the past 10 years, resistance or tolerance has been reported to such herbicides as atrazine, trifluralin, 2,4-D, bentazon, diuron, dicamba, paraquat, and others (LeBaron and Gressel, 1982). As of 1981, triazine-resistant weeds had been confirmed in 23 states of the United States, in four provinces of Canada and in a total of seven countries. The possibility of tolerance or resistance to herbicides increases in the Cotton Belt as individual herbicides (or chemistries) are used on a repetitive basis over a period of years.

The primary herbicide needs in cotton have been shown in recent surveys (Patterson and Monks, 1986; Weaver, 1986; Sanders, 1986). The major desire of most producers is for herbicides to provide more effective control of broadleaf weeds without injury to cotton or rotational crops. Most farmers prefer a herbicide that can be applied broadcast over-the-top. Morninglories (*Ipomoea* sp.) are the major problem weeds throughout much of the Cotton Belt and a survey in Louisiana in 1985 showed that farmers are now paying as much as $56 per acre

to control this weed (Sanders, 1986). Other problem weeds include cocklebur (*Xanthium strumarium* L.), sicklepod (*Cassia obtusifolia* L.), nutsedges (*Cyperus esculentus* L. and *Cyperus rotundus* L.), tropic croton (*Croton glandulosus* var. *Septentrionalis* Muell.-Arg.), bermudagrass [*Cynodon dactylon* (L.) Pers.], spurred anoda [*Anoda cristata* (L.) Schlecht.], wild poinsettia (*Euphorbia heterophylla*), velvetleaf (*Abutilon theophrasti* Medik.), nightshades (*Solanum* sp.), horsenettle (*Solanum* sp.) and unicorn-plant [*Proboscidea louisianica* (Mill.) Thellung].

As more use is made of alternative agriculture and conservation tillage, more cost-effective control measures will be needed for many winter weeds and for horseweed [*Conyza canadensis* (L.) Cronq.]. Many of the newer herbicides are so specific for control of only a few weeds that it seems likely that several different new herbicide chemistries will be needed for use in cotton to control the complex of weeds mentioned above.

The continued safe use of herbicides is essential to the cotton industry. The pesticide industry will continue to discover, develop and market more effective, safe and selective herbicides. These are needed to: (a) conserve energy in cotton production; (b) permit wider use of conservation tillage; (c) keep the price of fiber and food from increasing; (d) provide freedom from the drudgery of controlling weeds by hand; and (e) to permit producers in the United States to remain competitive with foreign producers.

Most producers feel that the "ultimate" herbicides are those that are sufficiently selective to cotton to permit over-the-top postemergence applications. Cotton is the only major crop produced in the United States that does not have one or more herbicides registered for over-the-top application for the control of broadleaf weeds. Both industry and producers are anxious for the development of herbicides to fill this void. The availability of such herbicides will provide considerable impetus to the increased use of conservation tillage. Herbicides of this type are now in development programs, but sales will not likely occur until the mid to late 1990s.

Herbicides developed during the next decade will be more selective to cotton and more toxic to weeds, on a per-unit basis, than present herbicides. Herbicides will continue to be an essential element in the management of weeds in cotton and their efficient use in integrated production management systems will be mandatory for economical production. The frequency of herbicide applications will not be reduced to any appreciable extent by the year 2000, but the total amount of herbicides used will likely decrease by one-to-two percent per year. Even so, essentially all of the cotton acreage in the United States will continue to receive annual herbicide treatments.

LITERATURE CITED

Andrilenas, P. A. 1975. Farmers' use of pesticides in 1971. Econ. Res. Serv., U.S. Dep. Agric., Agric. Econ. Rpt. 268, Washington, DC. 25 pp.

Andrilenas, P. A. and T. R. Eichers. 1976. Evaluation of pesticide supplies and demand for 1976. Econ. Res. Serv., U.S. Dep. Agric., Econ. Rpt. 332, Washington, DC. 15 pp.

Buchanan, G. A. and C. G. McWhorter. 1970. Weed control in cotton, Pages 163-168 *in* Proc. First. Int. Weed Cont. Conf., pub. by Weed Sci. Soc. Amer., Davis, CA 668 pp.

Cowart, L. E., L. E. Creasey, and E. R. Stamper. 1950. Studies on the control of annual weeds in cotton. Proc. South. Weed Conf. 3:70-77.

Danielson, L. L., W. B. Ennis, Jr., D. L. Klingman, W. C. Shaw, and F. L. Timmons. 1965. A survey of extent and cost of weed control and specific weed problems. Agric. Res. Serv., Fed. Ext. Serv., U. S. Dep. Agric., 34-23-1, Washington, DC. 78 pp.

Danielson, L. L., W. B. Ennis, Jr., J. T. Holstun, Jr. L. L. Jansen, D. L. Klingman, and F. L. Timmons. 1968. Extent and cost of weed control with herbicides and an evaluation of important weeds in 1965. Agric. Res. Serv., U. S. Dep. Agric., ARS 34-102. 85 pp.

Danielson, L. L., W. B. Ennis, Jr., P. A. Frank, W. A. Gentner, E. W. Hauser, D. L. Klingman, and R. J. Smith, Jr. 1972. Guidelines for weed control. Agric. Res. Serv. U. S. Dep. Agric. Handbook No. 447, Washington, DC. 30 pp.

Davis, D. E. 1964. Physiology and history of herbicides in cotton. Proc. South. Weed Sci. Soc. 17:10-24.

DeBord, D. V. 1977. Cotton insect and weed loss analysis. The Cotton Foundation, Memphis, TN. 122 pp.

Edwards, F. E., W. B. Ennis, V. C. Harris, J. T. Holstun, and O. B. Wooten. 1952. Chemical weed control recommendations for cotton. Miss. Agric. Exp. Stn. Circular 171. 13 pp.

Eichers, T. R., P. A. Andrilenas, and T. W. Anderson. 1978. Farmers' use of pesticides in 1976. Econ. Stat. and Coop. Serv., U. S. Dep. Agric., Agric. Econ. Rpt. 418, Washington, DC. 58 pp.

Eichers, T. R., and P. A. Andrilenas. 1978. Evaluation of pesticide supplies and demand for 1978. Econ. Stat. and Coop. Serv., U. S. Dep. Agric., Agric. Econ. Rpt. 399, Washington, DC. 20 pp.

Eichers, T. R., and P. A. Andrilenas. 1979. Evaluation of pesticide supplies and demand for 1979. Econ. Stat. and Coop. Serv., U. S. Dep. Agric., Agric. Econ. Rpt. 422, Washington, DC. 17 pp.

Eichers, T. R. 1980a. The farm pesticide industry. Econ. Stat. and Coop. Serv., U. S. Dep. Agric., Agric. Econ. Rpt. 461, Washington, DC. 24 pp.

Eichers, T. R. 1980b. Evaluation of pesticide supplies and demand for 1980. Econ. Stat. and Coop. Serv., U. S. Dep. Agric., Agric. Econ. Rpt. 454, Washington, DC. 17 pp.

Eichers, T. R. 1981. Farm pesticide economic evaluation, 1981. Econ. and Stat. Serv., U. S. Dep. Agric., Agric. Econ. Rpt. 464, Washington, DC. 21 pp.

Eichers, T. R., and W. S. Serletis. 1982. Farm pesticide supply-demand trends, 1982. Econ. Res. Serv., U. S. Dep. Agric., Agric. Econ. Rpt. 485, Washington, DC. 23 pp.

Ferguson, W. L. 1975. Farmers' expenditures for custom pesticide services. Econ. Res. Serv., U. S. Dep. Agric., Agric. Econ. Rpt. 314, Washington, DC. 31 pp.

Fowler, D. L., and J. N. Mahan. 1975. The pesticide review, 1974. Agric. Stab. and Conser. Serv., U. S. Dep. Agric., Washington, DC. 57 pp.

Fowler, D. L., and J. N. Mahan. 1977. The pesticide review, 1976. Agric. Stab. Conser. Serv., U. S. Dep. Agric., Washington, DC. 42 pp.

Frans, R. E. 1962. Some aspects of post-emergence application of *N*-(3,4- dichlorophenyl)methacrylamide, diuron and DSMA to cotton. Proc. South. Weed Conf. 15:78-84.

Harris, V. C., F. E. Edwards, and O. A. Leonard. 1950. Preliminary studies on the effect of ammonium dinitro-secondary-butyl penate on hill-dropped and drilled cotton. Proc. South. Weed Conf. 3:68-69.

Hill, G. D. 1980. History and development of the phenylurea herbicides. Proc. Beltwide Cotton Prod. Res. Conf. 34:167-174.

Holstun, J. T., Jr., O. B. Wooten, Jr., C. G. McWhorter, and C. G. Crowe. 1960. Weed control practices, labor requirements, and cost in cotton production. Weeds 8:232-243.

Holstun, J. T., Jr., O. B. Wooten, R. E. Parker, and E. E. Schweizer. 1963. Triband weed control—a new concept for weed control in cotton. U. S. Dep. Agric., Agric. Res. Serv., Series 34-56, Washington, DC. 34 pp.

Jansen, L. L., L. L. Danielson, W. B. Ennis, Jr., P. A. Frank, J. T. Holstun, Jr., and D. L. Klingman. 1972. Extent and cost of weed control with herbicides and an evaluation of important weeds, 1968. Econ. Res. Serv., Ext. Serv., and Agric. Res. Serv., U. S. Dep. Agric., ARS 34-102. 227 pp.

Kempen, H. M. 1987. Growers Weed Management Guide. Thompson Publications, Fresno, California. 233 pp.

Larsen, T. E. 1987. Unique methods of herbicide application. Pages 171-176 *in* G. B. Beestman and D. I. B. Vander Hooven, eds. 7th Vol. ASTM STP 968, Pesticide Formulations and Application Systems, Amer. Soc. Test. Mat., Philadelphia, Pennsylvania.

LeBaron, H. M. 1979. History and development of triazine herbicides. Proc. Beltwide Cotton Prod. Res. Conf. 33:158-161.

LeBaron, H. M., and J. Gressel. 1982. Herbicide Resistance in Plants. John Wiley and Sons. New York. 401 pp.

Mayo, S. C. 1965. The changing South: from mules to machines. Proc. South. Weed Conf. 18:12-27.

McWhorter, C. G. and T. J. Sheets. 1961. The effectiveness of five phenylureas as foliar sprays and the influence of surfactants on their activity. Proc. South. Weed Conf. 14:54-59.

Miller, J. H., C. L. Foy, H. M. Kempen, L. M. Carter, and M. Hoover. 1962. Weed control in cotton. California Agric. Exp. Stn. Bull. 791. 30 pp.

Miller, J. H. 1977a. Use of methylarsonate herbicides in cotton. Proc. Beltwide Cotton Prod. Res. Conf. 31:165-167.

Miller, J. H. 1977b. Cotton weed control in the irrigated southwest. Proc. Beltwide Cotton Prod. Res. Conf. 31:176-178.

Miller, J. H., H. M. Kempen, D. W. Cudney, B. B. Fischer, and P. E. Keeley. 1981. Weed control in cotton. California Coop. Ext. Leaflet 2991. 18 pp.

Mullendore, G. P. 1968. Cotton injury and weed control as affected by dual preemergence herbicide usage in the Delta of Mississippi. Proc. South. Weed Conf. 21:358-365.

Mullendore, G. P. 1970. Trends in herbicide usage in the Mississippi Delta. Proc. South. Weed Sci. Soc. 23:353-357.

Patterson, M. and D. Monks. 1986. Cotton weed control research needs in the Southeast. Proc. Beltwide Cotton Prod. Res. Conf. 40:246-247.

Porter, W. K., Jr., C. H. Thomas, L. F. Curtis, and D. R. Melville. 1957. A critical evaluation of the use of preemergence herbicides for weed control in cotton. Weeds. 5:237-242.

Porter, W. K., Jr., C. H. Thomas, L. W. Sloane, and D. R. Melville. 1960. A proposed method of postemergence weed control in cotton. Proc. South. Weed Conf. 13:30.

Rea, H. E., M. J. Norris, and F. C. Elliot. 1955. Spot-oiling johnsongrass. Texas Agric. Ext. Serv. Circ. B-808. 15 pp.

Rea, H. E. 1958. Spot oiling johnsongrass. Texas Agric. Ext. Serv. Bull. 902. 12 pp.

Sanders, D. E. 1986. Cotton weed science research needs in the Mid-South. Proc. Beltwide Cotton Prod. Res. Conf. 40:247.

Saunders, J. M., L. L. Danielson, W. B. Ennis, Jr., D. L. Klingman, W. C. Shaw, F. L. Timmons, and P. E. Strickler. 1962. A survey of extent and cost of weed control and specific weed problems. ARS 34-23, Agric. Res. Serv., Fed. Ext. Serv., U. S. Dep. Agric., Washington, D. C. 65 pp.

Shaw, W. C., P. J. Linder, and P. C. Marth. 1953. The importance of the relative vapor activity of chemicals in the development and use of herbicides. Proc. South. Weed Conf. 6:45-46.

Suguiyama, L. F. and G. A. Carlson. 1985. Field crops pests: farmers report the severity and intensity. Econ. Res. Serv., U. S. Dep. Agric., Agric. Info. Bull. 487, Washington, D. C. 52 pp.

Talbert, R. E. 1978. Soil availability of dinitroaniline herbicides and subsequent response of cotton roots. Proc. Beltwide Cotton Prod. Res. Conf. 32:139.

Talley, P. J. 1950. Tentative recommendations for weed control in cotton. Miss. State College, Agric. Exp. Stn. Bull. 471. 15 pp.

Thompson, J. T. 1961. Weed control activity of dicryl enhances in mixture. Proc. South. Weed Conf. 14:48-49.

Timmons, F. L. 1970. A history of weed control in the United States and Canada. Weed Sci. 18:294-303.

Weaver, D. 1983. Survey of herbicide usage in Texas. Proc. Beltwide Cotton Prod. Res. Conf. 37:253-254.

Weaver, D. N. 1986. Cotton research needs in Texas and Oklahoma. Proc. Beltwide Cotton Prod. Res. Conf. 40:247.

Chapter 7

APPENDIX

Table 1. Estimates of herbicides used in cotton in 1955[1].

State	Preemergence		
	Chlorpropham	Diuron	Herbicidal oil
		(acres x 1000)	
Alabama	5.0	2.5	little
Arkansas	15.0	3.0	9.0
Georgia	5.5	—[2]	—
Louisiana	19.1	11.8	10.0
Mississippi	50.0	40.0	20.0
North Carolina	2.0	1.5	—
South Carolina	4.0	4.0	little
Tennessee	12.0	2.0	0.5
Texas	5.0	0.5	75.0
Missouri, Oklahoma	4.0	0.3	0.5
TOTAL	121.6	65.6	115.0
Grand Total = 302.2			

[1]From a summary by Dr. W. B. Ennis, Jr., ARS/USDA, Mississippi State, MS in a memo dated Sept. 29, 1955.

[2]Dash indicates that no data were provided.

Table 2. Extent and use of weed control practices in Texas from 1952 to 1973[1].

Year	Herbicide application				
	Pre-emergence[2]	Post-emergence	Directed herbicidal oil	Spot treated with oil	Spot treated with dalapon
	(number of acres x 1000)				
1952	8	—[3]	2	—	—
1953	—	—	7	—	—
1954	—	—	13	—	—
1955	—	—	15	74	—
1956	—	—	20	89	—
1957	—	—	13	88	—
1958	—	—	17	135	40
1959	—	—	22	151	51
1960	—	—	71	194	70
1961	—	—	86	219	137
1962	46	—	283	255	122
1963	174	100	181	277	131
1964	407	273	223	273	92
1965	495	506	208	211	70
1966	1,109	617	119	158	58
1967	1,397	768	107	140	52
1968	1,864	686	81	90	43
1969	2,155	788	53	105	45
1970	2,185	687	45	123	48
1971	2,638	682	44	76	60
1972	3,218	874	31	101	57
1973	3,476	813	30	114	71

[1]Data compiled by Cotton Specialist Fred C. Elliott, Texas Agricultural Extension Service, Texas A&M University from County Agent's annual reports.

[2]Includes herbicides applied to soil surface and soil incorporated after 1962.

[3]Dash indicates information not provided.

Table 3. Extent of use of herbicides in Mississippi.[1]

Herbicide	Year									
	1953	1955	1956	1961	1962	1963	1969	1970	1971	1972
	(Acres X 1000)									
State cotton acreage	2554	1745	1641	1665	1636	1485	1225	1235	1355	1664
Preemergence										
Chlorpropham	36.4	50.0	29.1	14.0	11.9	11.7	—	—	—	—
Dinoseb	9.6	—	—	—	—	—	—	—	—	—
Caparol®	—	—	—	—	—	—	2.2	3.3	1.3	1.6
Cotoran®	—	—	—	—	—	—	189.2	263.9	196.9	176.4
Karmex®	—	40.0	84.9	873.9	998.4	982.0	82.2	111.1	78.8	96.2
Eptam®	—	—	—	—	—	—	2.0	0	0	—
Herban®	—	—	—	—	—	1.3	14.8	8.3	6.6	4.8
Planavin®	—	—	—	—	—	—	143.9	94.5	52.5	64.1
Telvar®	—	—	—	—	—	59.6	27.1	31.3	39.4	16.0
Treflan®	—	—	—	—	—	1.2	508.9	452.2	170.6	192.4
Caparol® + DNA	—	—	—	—	—	—	1.5	1.1	13.1	8.0
Cotoran® + DNA	—	—	—	—	—	—	409.3	284.6	459.4	721.6
Herban® + DNA	—	—	—	—	—	—	17.6	4.4	6.6	16.0
Karmex® + DNA	—	—	—	—	—	—	125.2	67.9	144.4	224.5
Telvar® + DNA	—	—	—	—	—	—	23.2	11.5	39.4	80.2
Others	—	—	—	—	—	0.5	1.2	1.5	1.3	—
Subtotal	46.0	90.0	114.0	887.9	1010.3	1056.3	1548.3	1335.6	1210.3	1600.8
Postemergence										
Herbicidal oil	7.0	20.0	—	105.6	222.1	356.7	68.0	75.5	78.8	64.1
Mobilnix®	—	—	—	—	—	—	—	36.0	39.4	32.1
Dicryl® + DSMA	—	—	—	—	—	39.9	—	—	—	—
Dinoseb	—	—	—	—	—	—	102.6	49.8	78.8	48.1
Karmex®	—	—	—	264.9	562.1	248.7	—	—	—	—
MSMA	—	—	—	—	—	71.6	60.0	392.2	735.1	641.4
MSMA + Caparol®	—	—	—	—	—	—	129.8	55.2	170.6	160.4
MSMA + Cotoran®	—	—	—	—	—	—	314.9	454.6	472.5	1106.5
MSMA + Dinoseb	—	—	—	—	—	—	—	99.0	210.1	481.1
MSMA + Herban®	—	—	—	—	—	—	197.7	99.1	262.5	96.2
MSMA + Karmex®	—	—	—	—	—	52.4	356.9	333.6	498.8	833.9
MSMA + Lorox®	—	—	—	—	—	—	207.9	80.8	131.3	160.4
Others	—	—	—	—	—	—	8.0	—	6.6	80.2
Subtotal	7.0	20.0	0	370.5	784.2	769.3	1445.8	1675.8	2684.5	3704.4
Layby										
Cotoran®	—	—	—	—	—	—	60.3	55.8	65.6	48.1
Karmex®	—	—	—	—	—	348.8	195.2	244.2	249.4	368.8
Lorox®	—	—	—	—	—	—	153.4	143.0	157.5	176.4
Others	—	—	—	—	—	—	2.9	9.2	1.3	1.6
Subtotal	0	0	0	0	0	348.8	411.8	452.2	473.8	594.9
TOTAL	53.0	110.0	114.0	1258.4	1794.5	2174.4	3405.9	3463.6	4368.6	5901.1

[1]Estimates from 1956 through 1972 were by County Agents and summarized by Cooperative Extension Specialists, Mississippi State University, Mississippi State, MS. The 1953 survey was conducted by J. T. Holstun, Jr., ARS/USDA, Stoneville, MS and the 1955 survey was by W. B. Ennis, previously cited in Table 1.

[2]DNA = dinitroaniline herbicides (either Treflan or Planavin).

Table 4. Extent of usage and cost of weed control practices in cotton in the USA from 1959 to 1968. (Adapted from Danielson *et al.*, 1965; Danielson *et al.*, 1968; and Jansen *et al.*, 1972.)

Method of weed control or cost	Year			
	1959	1962	1965	1968
		(% of acreage)		
Preemergence	6.6	21.6	48.6	34.0
Postemergence	3.7	13.3	43.1	11.6
Preemergence + Postemergence	—	—	—	45.4
		($ x 1,000)		
Total herbicide cost	4,709	16,805	59,678	89,342
		($)		
Average cost/A	3.03	3.09	4.78	9.66

Table 5. Extent of cotton treated with herbicides in Tennessee in 1966, 1968 and 1970[1].

Method applied and herbicide	Year 1966	1968	1970
		(Acres x 1000)	
State cotton acreage	410	392	425
Preemergence:			
Caparol®	4	—	8
Chloro IPC®	4	—	—
Cotoran®	46	116	145
Dachthal®	3	—	—
Karmex®	158	70	63
Herban®	—	14	—
Planavin®	0	35	48
Treflan®	105	92	130
Subtotal	320	327	394
Postemergence:			
Herbicidal oil	4	7	1
DSMA/MSMA	74	94	155
DSMA/MSMA + Caparol®	2	3	46
DSMA/MSMA + Cotoran®	7	18	32
DSMA/MSMA + Herban®	—	7	2
DSMA/MSMA + Karmex®	24	28	63
Subtotal	111	157	299
Layby:			
Cotoran®	—	6	6
Lorox®	—	5	2
Karmex®	—	15	6
Subtotal	0	26	14

[1]Estimates provided by Extension Leaders and summarized by Dave Weaver, Extension Agronomist, University of Tennessee, Knoxville, TN.

Table 6. Estimates of cotton acreage treated with herbicides in 1971. (Adapted from the Farm Journal, Southern Edition, pages 8, 9 and 12, January 1972.)

Region and state	Acres of cotton harvested	Acres treated	
		Preemergence	Postemergence
		(A x 1000)	
Southeast:			
Alabama	550	475	223
Georgia	385	408	264
North Carolina	167	175	110
South Carolina	335	335	300
Tennessee	425	412	318
Subtotal	1,862	1,805	1,215
Mid-South:			
Arkansas	1,135	1,000	1,100
Louisiana	505	477	455
Mississippi	1,350	1,350	1,300
Missouri	300	315	290
Subtotal	3,290	3,242	3,145
Southwest:			
Oklahoma	396	100	60
Texas	4,885	2,500	1,000
Subtotal	5,281	2,600	1,060
West:			
Arizona	278	140	150
California	702	490	140
New Mexico	145	60	80
Subtotal	1,125	690	370
TOTAL	11,558	8,337	5,790

Table 7. Extent of use of herbicides in cotton in Texas from 1973 through 1981. (Adapted from Weaver, 1983.)

Herbicide and method applied	Year				
	1973	1975	1977	1980	1981
Total cotton acreage (X 1000)	5231	3900	6450	7873	7477
			(% of acres treated)		
Preplanting incorporated					
Basalin®	—[1]	—	0.1	1.0	0.8
Cobex®	0.1	1.5	1.5	—	—
Planavin®	6.2	—	—	—	—
Prowl®	—	—	7.7	15.8	13.6
Tolban®	—	1.8	2.8	5.4	3.9
Treflan®	45.5	54.7	54.7	64.7	58.4
Subtotal	51.8	58.0	66.8	86.9	76.7
Preemergence					
Bladex®	—	—	—	0.0	0.2
Caparol®	12.1	11.1	9.3	8.0	7.9
Cotoran®/Lanex®	0.8	0.6	1.0	0.9	0.5
Dacthal®	0.2	0.2	0.3	0.1	0.1
Karmex®	1.5	0.8	1.2	0.9	0.7
Lasso®	1.5	0.7	0.6	0.5	0.5
Sancap®	1.2	3.0	2.8	3.8	4.6
Surflan®	—	—	0.3	0.2	0.2
Subtotal	17.3	16.4	15.5	14.4	14.7
Postemergence					
Caparol®	2.9	2.4	1.4	2.9	2.1
Cotoran®/Lanex®	0.4	0.2	0.3	0.9	1.5
Karmex®	0.9	0.5	0.4	0.6	0.7
MSMA/DSMA	10.8	9.5	9.1	5.5	5.1
MSMA/DSMA Plus	2.9	1.3	2.1	1.3	1.4
Probe® + MSMA	—	—	0.2	—	—
Subtotal	17.9	13.9	13.5	11.2	10.8

[1]A dash indicates that data were not provided.

Table 8. Major herbicides used in cotton in 1966 and 1976. (Adapted from Eichers, 1980a.)

Herbicide	1966		1976	
	Amount	Percent of total	Amount	Percent of total
	(lb X 1 mil.)	(%)	(lb X 1 mil.)	(%)
Trifluralin	2.6	40	7.0	38
Sodium chlorate	1.5	23	—[1]	—
Diuron	0.9	14	—	—
MSMA/DSMA	0.4	6	3.3	18
Fluometuron	—	—	5.3	29
Others	1.1	17	2.7	15
TOTAL	6.5	100	18.3	100

[1]A dash indicates that data were not provided.

Table 9. Herbicides used in cotton in 1976. (Adapted from Eichers *et al.*, 1978.)

Herbicide	Land area treated	Percent of total herbicides used
	(Acres X 1000)	(%)
Arsenicals		
Sodium cacodylate + cacodylic acid	1,384	5.8
DSMA	1,183	5.0
MSMA	2,460	10.3
Phenyl ureas		
Diuron	1,074	4.5
Fluometuron	5,161	21.7
Linuron	913	3.8
Amides		
Alachlor	10	< 0.1
Triazines		
Prometryn	908	3.8
Other	87	0.4
Dinitroanilines		
Dinitramine	708	3.0
Pendimethalin	15	< 0.1
Profluralin	2	< 0.1
Trifluralin	9,086	38.2
Others		
Dinoseb	240	1.0
Paraquat	519	2.2
Other	24	0.1
TOTAL	23,774	

Table 10. Herbicide usage in cotton in 1976. (Adapted from Eichers *et al.*, 1978.)

Region	Land area in cotton	Level of land area treated with herbicides	Total herbicide usage	Average amount of herbicide used per treated area
	(A X 1000)	(%)	(lb X 1000)	(lb/A)
Appalachian (TN, NC, VA)	509	100	750	1.48
Southeast (SC, GA, AL, FL)	936	98	1,083	1.13
Delta States (LA, MS, AR)	3,338	100	11,561	3.47
Southern Plains (TX, OK)	5,293	68	2,761	0.77
Mountain (NM, AZ)	473	92	1,302	3.26
Pacific (CA)	1,160	92	891	0.84
TOTAL	11,709	—	18,348	—
Average	—	84	—	1.83

Table 11. Percentage of the cotton acreage in 1976 in various states treated with different herbicide practices. (Adapted from DeBord, 1977.)

State	Region	Preplanting		Pre-emergence	Postemergence		
		Foliar to weeds	Soil incorporated		Directed sprays	Over the top	Layby
				(%)			
Alabama	1	—	90	95	90	30	20
	2	—	90	80	50	35	10
	3	—	90	85	60	35	10
	4	—	90	90	75	55	50
	5	—	90	90	70	40	10
	6	—	90	85	70	40	10
Arkansas		5	70	95	100	30	20
California	1	10	85	0	5	0	10
	2	0	85	10	20	0	70
Georgia		—	99	35	40	50	10
Louisiana		2	75	99	100	20	30
Mississippi		5	88	85	175	35	40
Missouri		10	50	80	25	50	15
New Mexico		—	75	5	20	—	40
North Carolina	1	—	100	90	—	60	10
	2	—	100	90	—	70	10
	3	—	100	80	—	40	10
Oklahoma	1	0	70	10	20	10	0
	2	0	75	10	5	10	—
	3	0	85	—	—	—	—
South Carolina		0	100	50	80	45	35
Tennessee		2	80	95	20	40	1
Texas	1	10	60	15	20	20	< 1
	2	20	40	45	52	3	< 1

Table 12. Percent of acres in various states receiving preplanting and preemergence treatments and the percentage distribution of herbicides used on the treated acres in 1976. For example, five percent of the cotton acreage in Arkansas received foliar-applied preplanting treatments and 80 percent of these acres were with MSMA and 20 percent with paraquat. (Adapted from DeBord, 1977.)

Time of application and herbicide use	Region and state												
	Southeast					Mid-South			Southwest			West	
	AL	GA	NC	SC	TN	AR	LA	MS	MO	TX	OK	CA	NM
Preplanting foliar trts.													
Percent acres receiving	0	0	0	0	2	5	2	5	10	15	0	5	0
	(% of herbicides used on treated acreage)												
Arsenic acid	—	—	—	—	—	—	—	10	—	—	—	—	—
Dinoseb	—	—	—	—	—	—	—	30	10	—	—	3	—
MSMA	—	—	—	—	—	80	—	50	40	100	—	—	—
Paraquat	—	—	—	—	100	20	—	20	50	—	—	45	—
Paraquat or MSMA	—	—	—	—	—	—	100	—	—	—	—	—	—
2,4-D	—	—	—	—	—	—	—	—	—	—	—	3	—
Preplanting soil inc.													
Percent acres receiving	90	99	100	100	80	70	75	88	50	50	77	85	75
	(% of herbicides used on treated acreage)												
Amex®	—	—	—	—	3	—	—	—	—	—	—	—	—
Basalin®	—	—	—	—	6	—	—	—	1	—	—	—	—
Caparol®	—	—	—	—	—	—	—	—	—	—	—	33	5
Cobex®	15	14	20	10	—	15	10	15	5	4	3	3	—
Dacthal®	—	—	—	—	—	—	—	—	—	—	—	25	—
Planavin®	—	—	—	—	—	—	—	10	—	—	—	—	—
Prowl®	10	—	—	5	—	25	5	—	—	2	3	3	—
Tolban®	5	2		5	10	20	5		4	2	5	4	—
Treflan®	70	55	80	75	80	50	80	75	90	91	83	65	70
Preemergence													
Percent acres receiving	90	35	87	40-60	95	95	99	85	80	30	7	5	5
	(% of herbicides used on treated acreage)												
Bladex®	1	—	—	—	5	9	—	45	—	—	—	—	—
Caparol®	4	—	—	—	—	—	2	—	—	73	27	—	—
Cotoran®/Lanex®	80	80	70	85	70	70	80	72	95	5	2	—	—
Dacthal®	—	—	—	—	—	—	—	—	—	—	—	50	—
Karmex®	15	20	17	15	25	20	18	22	5	5	5	—	—
Lasso®	—	—	—	—	—	—	—	—	30	5	—	—	—
Sancap®	—	—	—	—	—	—	—	—	—	20	—	—	—
Zorial®	—	—	—	—	—	1	—	1	—	10	—	—	—

Table 13. Percent of acres in various state receiving directed postemergence, postemergence over-the-top, and layby treatments and the percentage distribution of herbicides used on the treated acres in 1976. For example, 40 percent of the cotton acreage in Georgia received treatments with postemergence-directed sprays and 60 per cent of these acres were with Cotoran® + MSMA, 20 percent with Karmex® + MSMA, and 20 percent with Probe® + MSMA. (Adapted from DeBord, 1977.)

Time of application and herbicide use	Region and state												
	Southeast					Mid-South				Southwest		West	
	AL	GA	NC	SC	TN	AR	LA	MS	MO	TX	OK	CA	NM
Directed postemerg. trts.													
Percent acres receiving	70	40		70-90	20	100	100	175	25	36	8	5	20
	(% of herbicides used on treated acreage)												
Caporal®	—	—	—	—	—	—	—	—	—	5	—	50	15
Caparol® + DSMA	—	—	—	—	—	—	—	—	—	—	10	—	—
Caporal® + MSMA	10	—	—	5	10	—	25	—	—	—	—	—	—
Cotoran®	—	—	—	—	—	80	—	75	—	—	—	—	—
Cotoran® + MSMA	60	60	—	25	40	—	60	—	30	—	—	—	—
Dinoseb	—	—	—	—	—	50	—	60	—	—	—	—	—
DSMA/MSMA	—	—	—	70	25	100	—	100	70	70	53	50	3
Karmex®	—	—	—	—	15	80	—	30	—	5	3	—	—
Karmex® + MSMA	20	20	—	—	—	—	25	—	—	—	—	—	—
Probe®	—	—	—	—	—	—	—	—	—	—	—	—	2
Probe® + MSMA	10	20	—	—	—	—	5	—	—	—	—	—	—
MSMA/DSMA + Karmex®/Cotoran®	—	—	—	—	—	—	—	—	—	20	—	—	—
Post—Over the Top													
Percent acres receiving	40	50	57	40-50	40	30	20	35	50	2.5	7		
	(% of herbicides used on treated acreage)												
Ansar®	—	—	57	—	—	—	—	—	—	—	33	—	—
Cotoran®	5	—	—	—	—	—	—	10	—	—	—	—	—
Cotoran® + MSMA	—	—	—	10	—	—	50	—	—	5	—	—	—
DSMA/MSMA	95	65	—	90	95	100	50	100	100	95	33	—	—
Layby													
Percent acres receiving	10	10	10	30-40	1	20	30	40	15		0		40
	(% of herbicides used on treated acreage)												
Caparol®	—	—	—	—	—	—	—	—	—	40	—	100	28
Cotoran®	10	—	1	25	35	—	10	—	—	—	—	—	—
Dinoseb	—	—	—	—	—	—	—	25	—	—	—	—	10
Karmex®	30	50	—	50	40	60	90	50	—	40	—	—	—
Lorox®	60	50	9	25	25	40	—	50	100	20	—	—	—
MSMA	—	—	—	—	—	—	—	20	—	—	—	—	—
Probe®	—	—	—	—	—	—	—	—	—	—	—	—	2
Treflan®	—	—	—	—	—	—	—	—	—	—	—	35	—

Table 14. Percent of cotton acreage treated with herbicides and other pesticides and average number of applications per acre in 1979. (Adapted from Sugiyama and Carlson, 1985.)

	Region			
Pest treated	Southeast (AL, GA, SC)	Mississippi Valley (AR, LA, MS, MO, TN)	Southwest (OK, TX)	West (AZ, CA, NM)
		(% of acres treated)		
Diseases	2	7	0	3
Insects	82	80	28	76
Weeds	94	99	86	81
Other pests	6	1	1	2
		(No. of applications/A)		
Diseases	1.0	1.3	0	1.0
Insects	9.6	5.5	4.6	2.3
Weeds	3.7	4.5	1.4	1.4
Other pests	1.0	1.3	1.0	1.3
Farmers surveyed	246	734	670	377

Table 15. Percentage of cotton acreage in Alabama treated with herbicides from 1979 through 1986. (Adapted from the Reports of the Cotton Weed Loss Committee, Cotton Weed Science Research Conference, Beltwide Cotton Production Research Conferences.)

Herbicide	Year							
	1979	1980	1981	1982	1983	1984	1985	1986
Acres of cotton (X 1000)	320	325	377	287	195	305	293	313
				(% of acres treated)				
Preplanting, Foliar								
Paraquat	—[1]	—	—	—	—	1	1	1
Subtotal	—	—	—	—	—	1	1	1
Preplanting, Soil Incorp.								
Basalin®	6	6	9	9	7	7	7	—
Prowl®	10	10	8	8	10	10	10	38
Tolban®	4	4	3	1	1	—	—	—
Treflan®	79	75	80	80	80	76	76	71
Subtotal	99	95	100	98	98	93	93	109
Preemergence								
Bladex®	4	4	9	6	2	2	3	2
Caparol® + Bladex®	3	3	3	3	—	—	—	—
Cotoran®/Lanex®	71	42	39	39	41	41	41	84
Karmex®/Dynex®	4	4	5	5	5	5	5	7
Zorial®	12	13	16	16	19	19	25	54
Subtotal	94	66	72	69	67	67	74	147
Postemergence								
Bladex®	—	—	—	—	—	—	—	37
Bladex® + MSMA	5	5	5	5	8	9	9	25
Caparol® + MSMA	5	5	5	5	5	5	5	6
Cotoran®/Lanex®	—	—	—	—	—	—	—	20
Cotoran® + MSMA	13	13	13	13	13	13	13	40
Dinoseb	—	—	—	—	—	—	1	2
Karmex®/Dynex® + MSMA	2	2	2	2	2	2	2	3
MSMA/DSMA	86	86	86	75	80	80	80	64
Poast®/Fusilade®	—	—	—	8	5	5	8	15
Subtotal	111	111	111	108	113	114	118	212
Spot Treatment								
MSMA	14	14	14	14	14	14	14	12
Poast®/Fusilade®	—	—	—	3	5	5	5	10
Roundup®	—	6	6	6	4	4	4	4
Subtotal	14	20	20	23	23	23	23	26
Layby								
Bladex®	1	2	1	1	1	1	1	1
Karmex®/Dynex®	2	3	3	3	3	3	3	3
Lorox®	5	5	5	5	4	4	4	4
Subtotal	8	10	9	9	8	8	8	8
TOTAL	326	302	312	307	309	306	317	503

[1]A dash indicates that no data were provided.

Table 16. Percentage of cotton acreage in Arizona treated with herbicides from 1979 through 1986. (Adapted from the Reports of the Cotton Weed Loss Committee, Cotton Weed Science Research Conference, Beltwide Cotton Production Research Conferences.)

Herbicide	Year							
	1979	1980	1981	1982	1983	1984	1985	1986
Acres of cotton (X 1000)	623	592	634	507	350	490	390	370
	(% of acres treated)							
Preplanting, Soil Incorp.								
Basalin®	0	—[1]	1	1	3	0	0	0
Caparol®	18	23	—	—	—	—	—	—
Prowl®	20	19	30	30	30	40	40	35
Prowl® + Caparol®	9	11	12	12	12	15	15	15
Tolban®	2	2	2	2	0	—	—	—
Treflan®	33	30	30	30	30	40	40	35
Treflan® + Caparol®	0	—	20	20	20	20	20	20
Subtotal	82	85	95	95	95	115	115	105
Preemergence								
Bladex®	—	—	—	—	—	—	—	—
Caparol® + Bladex®	—	—	—	—	—	—	—	—
Cotoran®/Lanex®	—	—	—	—	—	—	—	—
Karmex®/Dynex®	—	—	—	—	—	—	—	—
Zorial®	—	—	—	—	—	—	—	—
Subtotal	0	0	0	0	0	0	0	0
Postemergence								
Bladex®	—	—	—	—	—	—	—	10
Bladex® + MSMA	—	—	—	—	—	1	1	2
Caparol® + MSMA	1	1	3	4	15	20	20	10
Cotoran®/Lanex®	—	—	—	3	3	3	—	—
Cotoran® + MSMA	—	—	—	—	—	—	—	—
Dinoseb	—	—	1	1	1	2	2	2
Goal®	—	—	—	—	—	—	—	5
Karmex®/Dynex®	—	—	—	—	—	—	—	2
Karmex®/Dynex® + MSMA	< 1	< 1	2	3	5	5	5	2
MSMA/DSMA	9	9	—	—	3	3	3	3
Poast®/Fusilade®	—	—	—	—	8	1	1	1
Subtotal	10	10	6	11	35	35	32	37
Spot Treatment								
Dalapon	1	1	—	—	—	—	—	—
MSMA	15	13	10	10	5	5	—	5
Poast®/Fusilade®	—	—	—	—	—	15	—	25
Roundup®	39	24	40	35	30	30	—	20
Subtotal	55	38	50	45	35	50	—	50
Layby								
Bladex®	—	—	10	10	10	10	10	15
Caparol®	59	54	30	30	30	50	50	50
Karmex®/Dynex®	8	8	10	10	10	8	8	8
Subtotal	67	62	50	50	50	68	68	73
TOTAL	214	195	201	201	215	268	215	265

[1]A dash indicates that no data were provided.

Table 17. Percentage of cotton acreage in Arkansas treated with herbicides from 1979 through 1986. (Adapted from the Reports of the Cotton Weed Loss Committee, Cotton Weed Science Research Conference, Beltwide Cotton Production Research Conferences.)

	Year							
Herbicide	1979	1980	1981	1982	1983	1984	1985	1986
Acres of cotton (X 1000)	610	700	610	410	330	430	440	480
			(% of acres treated)					
Preplanting, Foliar								
Dalapon	1	1	1	1	1	1	1	1
MSMA	1	1	1	1	1	1	1	1
Paraquat	1	1	1	1	1	1	1	1
Roundup®	1	1	1	1	1	1	1	1
Subtotal	4	4	4	4	4	4	4	4
Preplanting, Soil Incorp.								
Basalin®	5	5	5	5	5	5	5	—[1]
Prowl®	20	20	20	20	20	25	40	40
Tolban®	5	5	5	5	5	—	—	—
Tolban® + Cotoran®	2	2	2	2	2	—	—	—
Treflan®	50	50	50	50	50	50	45	45
Treflan® + Cotoran®	2	2	2	2	2	4	4	4
Zorial®	—	—	—	—	—	—	6	6
Subtotal	84	84	84	84	84	84	100	95
Preemergence								
Bladex®	5	5	5	5	5	5	5	5
Cotoran®/Lanex®	80	80	80	70	70	70	60	60
Karmex®/Dynex®	10	10	10	10	10	10	10	10
Zorial®	5	10	10	20	20	20	40	40
Subtotal	100	105	105	105	105	105	115	115
Postemergence								
Bladex®	5	5	5	5	5	5	5	5
Bladex® + MSMA	20	20	20	20	35	35	35	35
Caparol®	1	1	1	1	1	1	1	1
Caparol® + MSMA	1	1	1	1	1	1	40	40
Cotoran®/Lanex®	5	5	5	5	5	5	5	5
Cotoran® + MSMA	80	80	80	100	100	100	100	100
Dinoseb	20	20	20	20	20	20	20	20
Karmex®/Dynex®	1	1	1	1	1	1	1	1
Karmex®/Dynex® + MSMA	60	60	60	60	60	60	60	60
MSMA/DSMA	100	100	100	100	100	100	100	100
Poast®/Fusilade®	—	—	—	—	30	30	5	5
Subtotal	293	293	293	313	358	358	372	372
Spot Treatment								
Dalapon	5	5	5	5	5	5	5	5
MSMA	5	5	1	1	1	1	1	1
Poast®/Fusilade®	—	—	—	—	—	—	30	30
Roundup®	25	25	25	25	25	25	25	25
Subtotal	35	35	31	31	31	31	61	61
Layby								
Bladex®	—	—	—	—	—	—	10	10
Karmex®/Dynex®	30	30	30	30	30	30	30	30
Lorox®	60	60	60	60	60	60	40	40
Subtotal	90	90	90	90	90	90	80	80
TOTAL	606	611	607	627	672	672	732	727

[1]A dash indicates that no data were provided.

Table 18. Percentage of cotton acreage in California treated with herbicides from 1979 through 1986. (Adapted from the Reports of the Cotton Weed Loss Committee, Cotton Weed Science Research Conference, Beltwide Cotton Production Research Conferences.)

	Year							
Herbicide	1979	1980	1981	1982	1983	1984	1985	1986
Acres of cotton (X 1000)	1650	1550	1540	1380	980	1400	1340	1010
				(% of acres treated)				
Preplanting, Foliar								
Caparol®	—[1]	<1	<1	—	—	—	—	—
Dalapon	—	—	—	—	—	—	—	1
Dinoseb	1	—	—	—	—	—	—	—
MSMA	—	—	1	5	—	—	—	—
Paraquat	1	1	0	0	2	2	2	1
Roundup®	—	—	—	—	1	1	1	1
Others	—	—	—	1	3	3	3	3
Subtotal	2	1	1	6	7	6	6	6
Preplanting, Soil Incorp.								
Basalin®	—	—	3	3	1	1	1	—
Caparol®	48	45	48	—	—	—	—	—
Cobex®	—	1	—	—	—	—	—	—
Dacthal®	13	3	—	—	—	—	—	—
Prowl®	10	10	15	15	18	18	18	28
Prowl® + Caparol®	—	—	—	4	5	5	5	1
Tolban®	1	1	3	—	—	—	—	—
Tolban® + Cotoran®	—	—	1	—	—	—	—	—
Treflan®	55	55	60	20	18	18	18	18
Treflan® + Caparol®				8	5	5	5	1
Treflan® + Cotoran®	1	<1	1	—	—	—	—	—
Subtotal	128	115	131	50	47	47	47	48
Preemergence								
Dacthal®	13	13	13	—	—	—	—	—
Subtotal	13	13	13	—	—	—	—	—
Postemergence								
Bladex®	—	—	—	—	5	—	—	—
Bladex® + MSMA	—	—	—	—	1	1	1	1
Caparol®	—	—	—	11	1	1	1	—
Caparol® + MSMA	—	—	—	—	—	1	1	1
Cotoran® + MSMA	—	—	—	—	—	—	—	1
Goal®	—	—	—	—	—	—	—	1
MSMA/DSMA	3	3	3	5	2	3	3	3
Poast®/Fusilade®	—	—	—	—	1	1	1	—
Subtotal	3	3	3	16	10	7	7	7
Spot Treatment								
MSMA	1	1	1	2	—	—	—	—
Poast®/Fusilade®	—	—	—	—	1	1	1	1
Roundup®	2	2	2	2	—	1	1	1
Subtotal	3	3	3	4	1	2	2	2
TOTAL	149	135	151	76	65	62	62	63

[1]A dash indicates that no data were provided.

Table 19. Percentage of cotton acreage in Florida treated with herbicides from 1979 through 1986. (Adapted from the Reports of the Cotton Weed Loss Committee, Cotton Weed Science Research Conference, Beltwide Cotton Production Research Conferences.)

Herbicide	Year							
	1979	1980	1981	1982	1983	1984	1985	1986
Acres of cotton (X 1000)	3.4	6.0	18.0	16.0	9.5	11.0	14.0	12.0
	(% of acres treated)							
Preplanting, Soil Incorp.								
Prowl®	8	30	40	40	40	50	50	50
Treflan®	75	50	50	50	50	40	40	40
Subtotal	83	80	90	90	90	90	90	90
Preemergence								
Bladex®	5	20	10	—[1]	10	5	3	3
Cotoran®/Lanex®	10	20	10	—	10	15	20	25
Zorial®	5	—	2	—	2	5	7	7
Subtotal	20	40	22	0	22	25	30	35
Postemergence								
Bladex® + MSMA	—	—	2	2	2	10	15	15
Caparol® + MSMA	—	—	—	—	—	—	3	2
Cotoran® + MSMA	5	—	2	2	2	5	5	5
Karmex®/Dynex®	—	—	1	—	—	—	—	—
Karmex®/Dynex® + MSMA	—	—	—	—	—	2	5	5
MSMA/DSMA	70	9	75	75	75	75	75	75
Poast®/Fusilade®	—	—	—	—	—	2	2	2
Subtotal	75	9	80	79	79	94	105	104
TOTAL	178	129	192	169	191	209	225	229

[1]A dash indicates that no data were provided.

Table 20. Percentage of cotton acreage in Georgia treated with herbicides from 1979 through 1986. (Adapted from the Reports of the Cotton Weed Loss Committee, Cotton Weed Science Research Conference, Beltwide Cotton Production Research Conferences.)

Herbicide	Year							
	1979	1980	1981	1982	1983	1984	1985	1986
Acres of cotton (X 1000)	155	170	180	163	120	180	260	210
				(% of acres treated)				
Preplanting, Foliar								
MSMA	1	1	1	1	1	1	1	1
Paraquat	< 1	< 1	< 1	< 1	< 1	< 1	< 1	< 1
Roundup®	< 1	< 1	< 1	< 1	< 1	< 1	< 1	< 1
Subtotal	1	1	1	1	1	1	1	1
Preplanting, Soil Incorp.								
Basalin®	8	8	8	8	8	2	2	2
Prowl®	7	7	7	7	22	37	37	37
Tolban®	9	9	9	9	9	—[1]	—	—
Tolban® + Cotoran®	< 1	< 1	< 1	< 1	< 1	< 1	< 1	< 1
Treflan®	75	75	75	75	60	60	60	60
Treflan® + Cotoran®	< 1	< 1	< 1	< 1	< 1	< 1	< 1	< 1
Subtotal	99	99	99	99	99	99	99	99
Preemergence								
Bladex®	1	1	1	1	1	1	1	1
Cotoran®/Lanex®	74	73	73	60	50	50	50	50
Destun®	1	—	—	—	—	—	—	—
Karmex®/Dynex®	18	18	18	22	20	20	20	20
Zorial®	6	8	8	12	20	20	20	20
Subtotal	100	100	100	95	91	91	91	91
Postemergence								
Bladex®	1	3	3	3	3	3	3	3
Bladex® + MSMA	8	20	50	50	50	50	50	50
Caparol® + MSMA	1	1	1	1	1	1	1	1
Cotoran®/Lanex®	1	1	1	1	1	1	1	1
Cotoran® + MSMA	15	15	15	15	15	15	15	15
Dinoseb	2	2	2	2	2	2	2	2
Karmex®/Dynex® + MSMA	5	5	5	5	5	5	5	5
MSMA/DSMA	35	35	35	35	35	35	35	35
Probe® + MSMA	5	2	1	—	—	—	—	—
Subtotal	73	84	113	112	112	112	112	112
Spot Treatment								
Dalapon	1	1	1	1	1	1	1	1
MSMA	2	2	2	2	2	2	2	2
Roundup®	7	7	7	7	7	5	5	5
Subtotal	10	10	10	10	10	8	8	8
Layby								
Bladex®	1	3	3	10	15	15	15	15
Karmex®/Dynex®	2	2	3	3	3	3	3	3
Lorox®	5	5	5	5	10	10	10	10
Subtotal	8	10	11	18	28	28	28	28
TOTAL	291	304	334	335	341	339	339	339

[1]A dash indicates that no data were provided.

Table 21. Percentage of cotton acreage in Louisiana treated with herbicides from 1979 through 1986. (Adapted from the Reports of the Cotton Weed Loss Committee, Cotton Weed Science Research Conference, Beltwide Cotton Production Research Conferences.)

Herbicide	Year							
	1979	1980	1981	1982	1983	1984	1985	1986
Acres of cotton (X 1000)	470	570	700	605	410	645	630	570
			(% of acres treated)					
Preplanting, Foliar								
Dalapon	3	3	3	3	3	3	3	1
MSMA	7	6	6	6	6	6	6	6
Paraquat	1	1	1	1	5	5	5	5
Roundup®	10	10	10	10	15	15	15	20
Subtotal	21	20	20	20	29	29	29	32
Preplanting, Soil Incorp.								
Basalin®	8	8	8	13	21	21	21	15
Cobex®	2	2	—[1]	—	—	—	—	—
Prowl®	9	9	9	14	20	20	20	30
Tolban®	6	5	5	5	—	—	—	—
Treflan®	53	53	53	43	35	35	35	40
Treflan® + Cotoran®	3	3	3	3	3	3	3	3
Zorial®	—	—	—	5	10	10	10	10
Subtotal	81	80	78	83	89	89	89	98
Preemergence								
Bladex®	6	8	6	6	6	6	6	6
Caparol®	1	—	1	—	—	—	—	—
Cotoran®/Lanex®	74	55	73	73	66	66	66	66
Dual®	—	—	—	—	2	2	2	2
Karmex®/Dynex®	14	5	15	15	15	15	15	15
Zorial®	3	3	3	10	15	20	20	30
Subtotal	98	71	98	104	104	109	109	119
Postemergence								
Bladex®	6	5	5	5	5	5	5	5
Bladex® + MSMA	12	10	10	10	10	10	10	10
Caparol®	5	4	4	4	4	4	4	4
Caparol® + MSMA	2	2	2	2	2	10	10	10
Cotoran®/Lanex®	50	41	41	41	20	20	20	20
Cotoran® + MSMA	21	18	18	18	25	25	25	25
Dinoseb	18	18	18	18	20	20	20	20
Goal®	—	—	—	—	—	5	5	15
Karmex®/Dynex®	22	17	17	17	5	5	5	5
Karmex®/Dynex® + MSMA	21	17	17	17	17	10	10	10
MSMA/DSMA	76	63	63	63	63	63	63	63
Poast®/Fusilade®	—	—	—	15	20	30	30	30
Probe®	3	2	—	—	—	—	—	—
Probe® + MSMA	5	3	—	—	—	—	—	—
Subtotal	241	200	195	210	191	207	207	217

Table 21. Continued.

Herbicide	Year							
	1979	1980	1981	1982	1983	1984	1985	1986
Acres of cotton (X 1000)	470	570	700	605	410	645	630	570
	(% of acres treated)							
Spot Treatment								
Dalapon	1	1	1	1	1	1	1	1
MSMA	3	2	2	2	2	2	2	2
Poast®/Fusilade®	—	—	—	—	20	20	20	20
Roundup®	2	6	6	6	6	6	6	6
Subtotal	6	9	9	9	29	29	29	29
Layby								
Bladex®	—	10	—	—	—	—	—	10
Karmex®/Dynex®	28	10	20	20	20	20	20	20
Lorox®	40	20	30	30	30	30	30	20
Subtotal	68	40	50	50	50	50	50	50
TOTAL	515	420	450	476	492	513	513	545

[1]A dash indicates that no data were provided.

Table 22. Percentage of cotton acreage in Mississippi treated with herbicides from 1979 through 1986. (Adapted from the Reports of the Cotton Weed Loss Committee, Cotton Weed Science Research Conference, Beltwide Cotton Production Research Conferences.)

Herbicide	Year							
	1979	1980	1981	1982	1983	1984	1985	1986
Acres of cotton (X 1000)	1050	1150	1230	1000	750	1040	1040	975
	(% of acres treated)							
Preplanting, Foliar								
Dalapon	1	0	1	<1	1	1	0	0
MSMA	1	1	1	1	1	1	1	1
Paraquat	1	<1	<1	<1	1	1	1	1
Roundup®	1	<1	1	<1	1	1	1	1
Subtotal	4	1	3	1	4	4	3	2
Preplanting, Soil Incorp.								
Basalin®	8	5	12	20	5	5	0	0
Cobex®	1	1	0	0	0	0	0	0
Prowl®	38	28	29	35	35	36	35	40
Tolban®	5	5	1	1	1	0	0	0
Treflan®	38	48	57	25	35	35	35	35
Treflan® + Cotoran®	1	1	0	0	0	0	0	0
Zorial®	—[1]	—	—	—	15	15	20	25
Subtotal	91	88	99	81	91	91	90	100
Preemergence								
Bladex®	13	8	2	2	2	2	3	10
Cotoran®/Lanex®	63	55	62	40	46	46	60	70
Dual®	—	—	—	—	—	—	—	5
Karmex®/Dynex®	10	5	2	2	6	6	4	4
Zorial®	10	30	29	50	66	66	50	60
Subtotal	96	98	95	94	120	120	117	149
Postemergence								
Bladex®	3	1	—	—	—	—	—	5
Bladex® + MSMA	20	20	16	16	20	20	20	30
Caparol®	1	—	—	2	12	12	8	6
Caparol® + MSMA	5	10	16	16	16	16	15	8
Cotoran®/Lanex®	10	5	5	5	5	5	7	5
Cotoran® + MSMA	50	80	75	65	65	65	40	35
Dinoseb	20	40	61	50	61	61	20	18
Karmex®/Dynex®	8	2	—	—	—	—	15	10
Karmex®/Dynex® + MSMA	14	15	14	14	14	14	40	20
MSMA/DSMA	60	40	19	19	19	19	19	20
Poast®/Fusilade®	—	—	—	—	5	5	5	2
Probe®	1	—	—	—	—	—	—	—
Probe® + MSMA	3	—	—	—	—	—	—	—
Subtotal	195	213	206	187	217	217	189	159

Table 22. Continued.

Herbicide	Year							
	1979	1980	1981	1982	1983	1984	1985	1986
Acres of cotton (X 1000)	1050	1150	1230	1000	750	1040	1040	975
	(% of acres treated)							
Spot Treatment								
Dalapon	1	1	1	2	2	2	1	1
MSMA	5	1	1	1	1	1	1	5
Poast®/Fusilade®	—	—	—	10	30	30	30	50
Roundup®	35	60	67	30	15	15	10	15
Subtotal	41	62	69	43	48	48	42	71
Layby								
Bladex®	10	—	9	12	15	15	15	30
Cotoran®	—	—	—	—	5	5	5	2
Karmex®/Dynex®	10	10	8	8	8	8	8	9
Lorox®	20	20	19	15	10	10	8	20
Subtotal	40	30	36	35	38	38	36	61
TOTAL	467	492	508	441	518	518	477	542

[1]A dash indicates that no data were provided.

Table 23. Percentage of cotton acreage in Missouri treated with herbicides from 1979 through 1986. (Adapted from the Reports of the Cotton Weed Loss Committee, Cotton Weed Science Research Conference, Beltwide Cotton Production Research Conferences.)

Herbicide	Year							
	1979	1980	1981	1982	1983	1984	1985	1986
Acres of cotton (X 1000)	157	245	242	154	93	160	152	167
	(% of acres treated)							
Preplanting, Foliar								
Dalapon	—[1]	—	1	—	—	—	—	—
MSMA	1	1	1	1	1	1	1	1
Paraquat	2	2	—	2	2	2	2	2
Roundup®	—	—	1	—	1	1	1	1
Subtotal	3	3	3	3	4	4	4	4
Preplanting, Soil Incorp								
Basalin®	5	5	12	5	5	1	—	—
Prowl®	15	15	29	15	15	25	25	25
Tolban®	5	5	1	5	—	—	—	—
Tolban® + Cotoran®	1	1	—	1	1	—	—	—
Treflan®	50	50	57	50	50	50	50	50
Treflan® + Cotoran®	1	1	—	1	1	—	1	5
Subtotal	77	77	99	77	72	76	76	80
Preemergence								
Bladex®	—	—	2	—	5	5	5	5
Cotoran®/Lanex®	60	60	62	60	60	60	60	60
Karmex®/Dynex®	25	25	2	25	25	10	10	10
Lasso® + Cotoran®	10	8	10	10	10	—	—	—
Zorial®	1	1	29	1	20	20	20	20
Others	—	—	—	—	—	4	—	—
Subtotal	96	94	105	96	120	99	95	95
Postemergence								
Bladex®	—	—	—	—	2	2	2	2
Bladex® + MSMA	—	—	—	—	5	10	20	20
Caparol®	—	—	—	—	—	—	8	—
Caparol® + MSMA	5	5	—	—	—	—	15	20
Cotoran®/Lanex®	—	—	—	—	3	3	3	3
Cotoran® + MSMA	25	25	25	25	25	40	40	40
Dinoseb	—	—	—	—	2	5	20	20
Goal®	—	—	—	—	—	—	—	3
Karmex®/Dynex®	—	—	—	—	—	—	15	—
Karmex®/Dynex® + MSMA	10	10	10	10	10	10	40	10
MSMA/DSMA	50	50	50	50	50	50	50	50
Poast®/Fusilade®	—	—	—	—	2	5	5	10
Probe® + MSMA	—	—	5	5	—	—	—	—
Subtotal	90	90	90	90	99	125	218	178

Table 23. Continued

Herbicide	Year							
	1979	1980	1981	1982	1983	1984	1985	1986
Acres of cotton (X 1000)	157	245	242	154	93	160	152	167
	(% of acres treated)							
Spot Treatment								
MSMA	—	—	—	—	5	5	—	—
Poast®/Fusilade®	—	—	—	—	5	5	10	10
Roundup®	5	5	5	5	—	—	10	10
Subtotal	5	5	5	5	10	10	20	20
Layby								
Bladex®	—	—	—	—	—	5	5	5
Karmex®/Dynex®	—	—	—	—	—	5	5	5
Lorox®	10	10	10	10	10	10	10	10
Subtotal	10	10	10	10	10	20	20	20
TOTAL	281	279	312	281	315	334	433	397

[1]A dash indicates that no data were provided.

Table 24. Percentage of cotton acreage in New Mexico treated with herbicides from 1979 through 1986. (Adapted from the Reports of the Cotton Weed Loss Committee, Cotton Weed Science Research Conference, Beltwide Cotton Production Research Conferences.)

Herbicide	Year							
	1979	1980	1981	1982	1983	1984	1985	1986
Acres of cotton (X 1000)	170	158	143	88	57	72	55	42
	(% of acres treated)							
Preplanting, Soil Incorp.								
Basalin®	1	1	1	1	1	—[1]	—	—
Caparol®	1	1	15	—	—	27	27	27
Prowl®	1	3	3	3	3	4	4	4
Tolban®	20	30	30	30	30	—	—	—
Tolban® + Cotoran®	30	20	20	20	20	—	—	—
Treflan®	5	10	10	10	10	44	44	44
Others	—	—	—	15	15	3	3	3
Subtotal	58	65	79	79	79	78	78	78
Preemergence								
Dual®	—	—	—	—	—	8	8	8
Subtotal	—	—	—	—	—	8	8	8
Postemergence								
Caparol®	5	5	5	5	5	5	5	5
Caparol® + MSMA	1	1	1	1	1	1	1	1
Karmex®/Dynex®	1	5	5	5	5	5	5	5
MSMA/DSMA	5	10	10	10	10	10	10	10
Poast®/Fusilade®	—	—	—	—	—	—	1	1
Probe®	1	—	—	—	—	—	—	—
Subtotal	13	21	21	21	21	21	22	22
Spot Treatment								
Dalapon	1	1	1	1	1	1	1	1
MSMA	3	3	3	3	3	3	3	3
Roundup®	5	25	25	25	25	25	25	25
Subtotal	9	29	29	29	29	29	29	29
Layby								
Caparol®	50	50	50	50	50	50	50	50
Karmex®/Dynex®	5	5	5	5	5	5	5	5
Subtotal	55	55	55	55	55	55	55	55
TOTAL	135	170	184	184	184	191	192	192

[1]A dash indicates that no data were provided.

Table 25. Percentage of cotton acreage in North Carolina treated with herbicides from 1979 through 1986. (Adapted from the Reports of the Cotton Weed Loss Committee, Cotton Weed Science Research Conference, Beltwide Cotton Production Research Conferences.)

Herbicide	Year							
	1979	1980	1981	1982	1983	1984	1985	1986
Acres of cotton (X 1000)	46	66	83	71	59	94	92	79
			(% of acres treated)					
Preplanting, Soil Incorp.								
Basalin®	2	2	2	2	5	5	5	—[1]
Prowl®	8	8	8	8	32	32	40	42
Tolban®	15	15	15	15	—	—	—	—
Tolban® + Cotoran®	1	1	1	—	—	—	—	—
Treflan®	63	63	63	63	63	63	55	55
Treflan® + Cotoran®	5	5	5	5	—	—	—	—
Zorial®	—	—	—	—	—	—	20	2
Subtotal	94	94	94	93	100	100	120	99
Preemergence								
Bladex®	2	2	2	2	1	1	1	—
Cotoran®/Lanex®	83	82	82	83	99	99	98	99
Karmex®/Dynex®	6	6	6	6	—	—	—	—
Zorial®	< 1	< 1	< 1	< 1	—	—	1	1
Subtotal	91	90	90	91	99	99	100	100
Postemergence								
Bladex®	3	3	3	3	3	3	—	—
Bladex® + MSMA	—	—	—	—	—	—	10	10
Caparol®	—	—	—	—	7	7	—	—
Cotoran®/Lanex®	12	12	12	12	3	3	—	—
Cotoran® + MSMA	10	10	10	10	—	< 1	20	20
Dinoseb	1	1	1	1	3	3	5	5
MSMA/DSMA	48	48	48	48	50	50	75	75
Poast®/Fusilade®	—	—	—	—	10	10	15	15
Probe®	1	1	—	—	—	—	—	—
Probe® + MSMA	4	4	—	—	—	—	—	—
Subtotal	79	79	74	74	76	76	125	125
Spot Treatment								
Poast®/Fusilade®	—	—	—	—	—	—	5	5
Roundup®	1	1	1	1	—	—	—	—
Subtotal	1	1	1	1	—	—	5	5
Layby								
Lorox®	12	12	12	12	—	—	2	2
Subtotal	12	12	12	12	—	—	2	2
TOTAL	277	276	271	271	275	275	352	331

[1]A dash indicates that no data were provided.

Table 26. Percentage of cotton acreage in Oklahoma treated with herbicides from 1979 through 1986. (Adapted from the Reports of the Cotton Weed Loss Committee, Cotton Weed Science Research Conference, Beltwide Cotton Production Research Conferences.)

Herbicide	Year							
	1979	1980	1981	1982	1983	1984	1985	1986
Acres of cotton (X 1000)	600	715	650	480	309	414	355	350
	(% of acres treated)							
Preplanting, Foliar								
MSMA	1	1	1	1	2	2	2	2
Roundup®	1	1	1	1	1	1	1	1
Subtotal	2	2	2	2	3	3	3	3
Preplanting, Soil Incorp.								
Basalin®	—[1]	—	—	—	3	3	3	—
Prowl®	3	3	3	3	15	17	17	20
Tolban®	10	10	10	10	—	—	—	—
Treflan®	72	72	72	72	75	73	73	70
Subtotal	85	85	85	85	93	93	93	90
Preemergence								
Caparol®	5	5	5	5	12	12	12	12
Cotoran®/Lanex®	1	1	1	1	2	2	2	2
Sancap®	7	8	10	10	8	8	8	8
Subtotal	13	14	16	16	22	22	22	22
Postemergence								
Caparol® + MSMA	3	3	3	3	5	5	5	5
MSMA/DSMA	16	16	16	16	20	18	18	18
Poast®/Fusilade®	—	—	—	—	—	—	—	3
Subtotal	19	19	19	19	25	23	23	26
Spot Treatment								
Poast®/Fusilade®	—	—	—	—	3	3	3	2
Roundup®	15	15	15	15	25	27	27	20
Subtotal	15	15	15	15	28	30	30	22
TOTAL	134	135	137	137	171	171	171	163

[1]A dash indicates that no data were provided.

Table 27. Percentage of cotton acreage in South Carolina treated with herbicides from 1979 through 1986. (Adapted from the Reports of the Cotton Weed Loss Committee, Cotton Weed Science Research Conference, Beltwide Cotton Production Research Conferences.)

Herbicide	Year							
	1979	1980	1981	1982	1983	1984	1985	1986
Acres of cotton (X 1000)	110	122	119	97	69	105	124	115
	(% of acres treated)							
Preplanting, Soil Incorp.								
Basalin®	5	8	8	8	8	8	2	—[1]
Prowl®	2	15	18	18	19	32	34	40
Tolban®	18	7	4	4	—	—	—	—
Treflan®	75	70	70	70	73	60	64	58
Other	—	—	—	—	—	—	—	2
Subtotal	100	100	100	100	100	100	100	100
Preemergence								
Bladex®	3	15	15	8	5	—	—	
Cotoran®/Lanex®	70	58	58	65	68	70	70	70
Karmex®/Dynex®	5	5	5	5	5	3	3	3
Zorial®	4	4	4	2	4	6	8	8
Subtotal	82	82	82	80	82	79	81	81
Postemergence								
Bladex®	—	—	—	15	15	15	15	15
Bladex® + MSMA	1	18	20	20	20	25	25	25
Caparol®	—	—	—	—	—	2	2	2
Caparol® + MSMA	1	1	—	—	—	—	—	—
Cotoran® + MSMA	90	90	75	75	75	65	65	65
Dinoseb	0	2	5	5	5	5	5	5
Karmex®/Dynex® + MSMA	3	3	—	—	—	—	—	—
MSMA/DSMA	50	50	60	60	60	70	70	70
Poast®/Fusilade®	0	0	0	0	1	1	1	1
Probe® + MSMA	2	—	—	—	—	—	—	—
Subtotal	147	164	160	175	176	183	183	183
Spot Treatment								
MSMA	3	3	3	3	3	3	3	3
Poast®/Fusilade®	0	0	0	0	2	2	2	2
Roundup®	1	1	1	1	1	1	1	1
Subtotal	4	4	4	4	6	6	6	6
Layby								
Bladex®	2	—	—	15	—	20	20	25
Caparol®	—	10	10	—	—	—	—	50
Karmex®/Dynex®	10	10	10	6	10	5	5	5
Lorox®	28	23	23	15	23	20	20	15
Other	—	—	—	—	10	—	—	—
Subtotal	40	43	43	36	43	45	45	95
TOTAL	373	393	389	395	407	413	415	465

[1]A dash indicates that no data were provided.

Table 28. Percentage of cotton acreage in Tennessee treated with herbicides from 1979 through 1986. (Adapted from the Reports of the Cotton Weed Loss Committee, Cotton Weed Science Research Conference, Beltwide Cotton Production Research Conferences.)

Herbicide	Year							
	1979	1980	1981	1982	1983	1984	1985	1986
Acres of cotton (X 1000)	250	290	325	260	150	320	330	320
			(% of acres treated)					
Preplanting, Soil Incorp.								
Basalin®	5	15	15	23	15	—[1]	—	—
Prowl®	10	15	15	23	15	30	30	30
Tolban®	5	5	5	3	3	—	—	—
Treflan®	78	63	63	48	63	50	50	50
Treflan® + Cotoran®	3	3	3	3	—	—	—	—
Zorial®	—	—	—	8	5	—	—	—
Other	—	—	—	—	—	—	—	5
Subtotal	101	101	101	108	101	80	80	85
Preemergence								
Bladex®	3	3	3	3	3	1	1	1
Cotoran®/Lanex®	88	88	88	80	88	78	78	83
Dual®	—	—	—	—	—	1	1	1
Karmex®/Dynex®	8	8	8	8	5	5	5	5
Prowl®	—	—	—	—	—	5	5	5
Zorial®	3	3	3	10	5	18	18	16
Subtotal	102	102	102	101	101	108	108	111
Postemergence								
Bladex®	—	—	—	—	1	1	1	1
Bladex® + MSMA	1	1	1	1	1	1	1	1
Caparol®	1	1	1	1	1	—	—	1
Caparol® + MSMA	3	3	3	3	3	3	3	3
Cotoran®/Lanex®	1	1	1	1	1	1	1	1
Cotoran® + MSMA	7	7	7	7	7	7	7	7
Dinoseb	1	1	1	1	1	1	1	1
Karmex®/Dynex® + MSMA	1	1	1	1	1	1	1	1
MSMA/DSMA	13	13	13	13	13	17	17	17
Poast®/Fusilade®	—	—	—	—	50	50	50	55
Probe®	1	—	—	—	—	—	—	—
Subtotal	29	28	28	28	79	82	82	88
Spot Treatment								
Dalapon	1	1	1	1	1	1	1	1
MSMA	1	1	1	1	1	1	1	1
Poast®/Fusilade®	—	—	—	—	4	4	4	8
Roundup®	4	10	10	10	10	10	10	1
Subtotal	6	12	12	12	16	16	16	11
TOTAL	238	243	243	249	297	286	286	295

[1]A dash indicates that no data were provided.

Table 29. Percentage of cotton acreage in Texas treated with herbicides from 1979 through 1986. (Adapted from the Reports of the Cotton Weed Loss Committee, Cotton Weed Science Research Conference, Beltwide Cotton Production Research Conferences.)

Herbicide	Year							
	1979	1980	1981	1982	1983	1984	1985	1986
Acres of cotton (X 1000)	7731	7873	7477	5819	3500	4600	4700	3700
				(% of acres treated)				
Preplanting, Soil Incorp.								
Basalin®	<1	<1	<1	4	4	3	3	—[1]
Prowl®	4	9	13	13	20	23	23	23
Tolban®	1	2	2	0	<1	0	0	—
Tolban® + Cotoran®	<1	—	—	—	—	—	—	—
Treflan®	27	39	50	48	50	55	55	55
Subtotal	32	50	65	65	74	81	81	78
Preemergence								
Caparol®	5	3	5	7	7	7	7	7
Cotoran®/Lanex®	<1	<1	—	—	3	3	—	—
Dacthal®	—	—	3	—	—	—	—	—
Dual®	—	—	—	—	1	1	3	2
Karmex®/Dynex®	<1	<1	—	—	—	—	—	—
Prowl®	—	—	—	—	—	—	—	3
Sancap®	—	3	—	4	4	4	4	5
Surflan®	<1	<1	<1	<1	<1	<1	<1	<1
Zorial®	—	—	<1	<1	<1	<1	<1	<1
Subtotal	5	6	8	11	15	15	14	17
Postemergence								
Caparol®	<1	<1	<1	<1	<1	<1	<1	<1
Cotoran®/Lanex®	<1	<1	<1	<1	<1	<1	<1	<1
Dinoseb	—	—	<1	<1	<1	10	—	—
Karmex®/Dynex®	<	<1	<1	<1	<1	<1	—	—
MSMA/DSMA	5	2	2	2	2	2	2	2
Poast®/Fusilade®	—	—	—	—	8	—	12	15
Probe® + MSMA	<1	—	—	—	—	—	—	—
Subtotal	5	2	2	2	10	12	14	17
Spot Treatment								
Poast®/Fusilade®	—	—	—	—	—	8	15	15
Roundup®	25	46	46	35	33	35	35	35
Subtotal	25	46	46	35	33	43	50	50
Layby								
Caparol®	<1	<1	<1	<1	<1	<1	<1	<1
Karmex®/Dynex®	<1	<1	<1	<1	<1	<1	<1	<1
Lorox®	<1	—	—	—	—	—	—	—
Subtotal	0	0	0	0	0	0	0	0
TOTAL	67	104	121	113	132	151	159	162

[1]A dash indicates that no data were provided.

Table 30. Estimates of the percentage of acres of cotton treated with various herbicides in the United States. Estimates were made by the authors using base information obtained from Reports of the Cotton Weed Loss Committee, Cotton Weed Science Research Conference, Proceedings of the Beltwide Cotton Production Research Conferences, and adjusting these estimates based on contacts with herbicide manufacturers, wholesalers, extension personnel and others.

Herbicide	States reporting usage[1]	Year						
		1980	1981	1982	1983	1984	1985	1986
Acres in cotton (X 1000)	(No.)	14532	14328	11340	7382	10266	10215	8713
		(% of acres treated)						
Basalin®	14	1.7	3.0	6.8	4.3	4.9	2.3	0.2
Bladex®	12	2.5	3.0	2.4	5.8	4.4	4.4	3.9
Cobex®	3	0.3	0	0	0	0	0	0
Caparol®	12	10.7	10.4	8.6	6.4	6.6	9.7	7.9
Cotoran®/Lanex®	13	16.1	17.4	15.5	16.3	19.5	18.6	20.1
Dacthal®	2	2.0	3.0	0	0	0	0	0
Dalapon	9	0.3	0.4	0.3	0.3	0.5	0.3	0.3
Destun®	2	0	0	0	0.1	0.1	0.1	0.1
Dinoseb	12	1.7	2.4	1.8	1.1	2.3	3.4	1.8
Dual®	5	0	0	0.3	0.3	0.1	0.5	0.2
Goal®	4	0	0	0	0	0.1	0.6	0.4
Karmex®/Dynex®	13	2.9	2.9	2.6	1.9	2.5	1.9	2.0
Lorox®	9	0.7	0.7	0.4	0.7	1.0	1.0	1.1
MSMA/DSMA	15	9.6	9.1	8.8	9.5	10.7	9.8	11.5
Paraquat	7	0.1	0.1	0.1	0.1	0.1	0.1	0.1
Poast®/Fusilade®	14	0	0	0.4	4.1	3.9	4.4	6.3
Probe®	5	0.1	0	0	0	0	0	0
Prowl®	15	10.3	11.9	32.6	14.9	17.5	18.6	19.5
Roundup®	14	11.7	12.6	8.8	10.8	8.8	6.9	5.7
Sancap®	2	0.4	0.1	0.6	0.9	1.7	0.6	0.5
Tolban®	14	2.8	2.4	1.7	0.3	0	0	0
Treflan®	15	48.2	60.0	51.1	61.0	59.4	56.8	63.1
Zorial®	12	2.1	2.8	5.9	6.1	6.3	4.4	7.5
Caparol® + Bladex®	2	0.1	0.1	0	0	0	0	0
Caparol® + Prowl®	2	0.3	0.3	0.5	0.5	0.5	1.0	1.0
Caparol® + Treflan®	2	0	0.9	2.6	1.9	1.6	2.0	2.1
Cotoran® + Tolban®	7	0.4	0.5	0.3	0.1	0	0	0
Cotoran® + Treflan®	7	0.3	0.3	0.3	1.1	1.2	1.5	0.6
MSMA + Bladex®	12	2.2	2.1	2.2	1.4	1.5	2.4	2.3
MSMA + Caparol®	13	0.7	1.0	1.1	1.4	1.8	1.1	0.9
MSMA + Cotoran®	12	4.1	4.2	4.4	2.7	3.4	3.4	3.1
MSMA + Karmex®/ Dynex®	10	0.7	0.6	0.7	0.4	0.4	0.7	0.6
MSMA + Probe®	7	0.2	0	0	0	0	0	0
All Others		20.6	20.9	17.6	13.5	14.6	17.6	13.8

[1]Number of states reporting use in the Reports of the Cotton Weed Loss Committee mentioned above.

Table 31. A comparison of timing of herbicide applications for weed control in cotton in the United States on a regional basis. A value of 200 percent indicates that each acre in the region was treated two times.

Year	Region[1]	Acres in cotton	Time of application: Pre-plant foliar	Pre-plant soil incorp.	Pre-emergence	Post-emergence	Spot treatment	Lay-by	Accumulative regional percentages
			(% of acres[2])						
1980	Southeast	979	< 1	98	86	85	12	11	293
	Mid-South	2665	6	84	94	220	38	46	489
	Southwest	8588	< 1	53	7	3	43	0	107
	West	2300	< 1	94	9	6	14	20	143
	Weighted totals	14532	1	68	28	49	36	12	195
1981	Southeast	1102	< 1	99	87	89	13	10	298
	Mid-South	2782	8	90	99	220	40	49	506
	Southwest	8127	< 1	67	9	3	44	0	122
	West	2317	< 1	118	9	5	17	17	167
	Weighted totals	14328	2	82	32	52	36	13	218
1982	Southeast	897	< 1	97	82	84	13	10	287
	Mid-South	2169	7	82	99	210	24	48	470
	Southwest	6299	< 1	67	11	3	33	0	115
	West	1975	4	63	< 1	15	16	15	113
	Weighted totals	11340	2	71	32	51	27	13	196
1983	Southeast	603	< 1	108	92	125	15	17	357
	Mid-South	1583	10	88	113	232	37	50	532
	Southwest	3809	< 1	66	16	11	33	0	126
	West	1387	4	60	0	17	11	15	108
	Weighted totals	7382	3	73	40	69	28	15	228
1984	Southeast	1015	< 1	91	88	107	14	12	313
	Mid-South	2275	11	88	113	234	37	50	533
	Southwest	5014	< 1	82	16	13	42	0	153
	West	1962	4	65	< 1	15	15	19	118
	Weighted totals	10266	3	81	41	72	33	16	246
1985	Southeast	2262	11	91	113	232	41	45	531
	Mid-South	1113	< 1	94	90	114	14	14	326
	Southwest	5055	< 1	82	15	15	49	0	160
	West	1785	4	63	< 1	13	2	17	99
	Weighted totals	10215	3	82	42	73	35	14	250
1986	Southeast	1049	< 1	98	113	143	14	19	387
	Mid-South	2192	10	97	130	222	54	57	570
	Southwest	4050	< 1	79	118	18	48	0	162
	West	1422	4	64	< 1	15	21	21	125
	Weighted totals	81713	4	83	54	84	41	20	286

[1]Southeast includes the states of: AL, FL, GA, NC, SC, and TN; Mid-South states are: AR, MS, and MO; Southwest states are: OK and TX; West includes the states of: AZ, CA, and NM.

[2]Values on acres treated were determined by multiplying the cotton acreage in each state by the percentage of acreage treated with various practices in Reports of the Cotton Weed Loss Committee, Cotton Weed Science Research Conference, Proceedings of the Beltwide Cotton Production Research Conferences.

Table 32. Value of herbicides used in cotton in 1980 as compared to other major crops. (Adapted from Eikers and Serletis, 1982.)

	United States		Rest of the World	
	Costs	Percent of total	Costs	Percent of total
	($ X 1,000,000)	(%)	($ X 1,000,000)	(%)
Corn	754	35	323	12
Soybeans	749	34	164	6
Cotton	142	7	179	7
Wheat	97	5	525	19
Rice	53	2	376	14
Others	376	17	1153	42
Total	2171	100	2720	100

Table 33. Average price of selected herbicides in the Delta of Mississippi. Prices are expressed on the basis of one pound of active herbicide[1].

Herbicide (and formulation)	Year				
	1969	1973	1976	1980	1987
			($/lb)		
Bladex® (80 wp)	—[2]	3.56	5.06	3.56	4.13
Caparol® (80 wp)	4.00	3.38	4.50	6.19	5.38
Cotoran® (80 wp)	5.00	4.67	6.68	6.87	10.50
Dalapon (75 wp)	1.00	1.22	1.66	1.90	3.10
Dinoseb (3 ppg)	1.20	1.36	1.98	2.86	2.13
Karmex® (80 wp)	3.75	3.06	3.88	3.69	3.69
Lorox® (50 wp)	5.70	6.40	7.10	9.00	11.10
MSMA (6.67 ppg)	.45	.49	1.21	1.49	1.61
Paraquat (2 ppg)	15.00	15.00	19.39	20.75	20.60
Probe® (75 wp)	—	5.53	8.47	—	—
Roundup® (3 ppg)	—	—	—	20.97	19.50
Surflan® (75 wp)	—	—	—	10.40	12.70
Treflan® (4 ppg)	5.88	5.40	6.93	6.35	5.49
Zorial® (80 wp)	—	—	—	8.69	11.76
Avg. price of the 9 herbicides that are listed each year	4.66	4.55	5.93	6.57	7.07

[1]Prices are average prices of dealers in the Greenville/Greenwood, MS area.
[2]Prices not available.