WEED INTERFERENCE IN SOYBEANS: A BIOECONOMIC ANALYSIS OF COCKLEBUR CONTROL USING ALTERNATIVE HERBICIDES AND MANAGEMENT SYSTEMS

by

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INTRODUCTION

Past Trends

The importance of soybeans to Kansas is reflected by substantial increases in acres planted and income generated over time. During 1986, 1.87 million acres of soybeans were planted representing 6.11% of total Kansas cropland. During 1986, the total value of soybeans produced was $268 million representing 12.84% of the total farm value of all the major crops as compared to 0.04% ($54,000) in 1939. In 1986, soybean production ranked fourth among all the other crops, following wheat, grain sorghum, and corn for grain. In 1987 soybeans were the third most valued food crop in Kansas next to only wheat and corn as per the Kansas Farm Facts (1988). In 1987 the farm value of soybeans in dollars amounted to 15.05% ($358 million) of the total value of all crops, using only 10.62% (2.15 million acres) of total land allotted to all crops. This emphasizes the importance of soybeans as one of the most significant crops in the Kansas.

Statistical estimation using data since 1924, showed an average increase of soybean acreage has increased 170 fold, an average of 28,000 acres per year (Figure 1). The estimated equation:

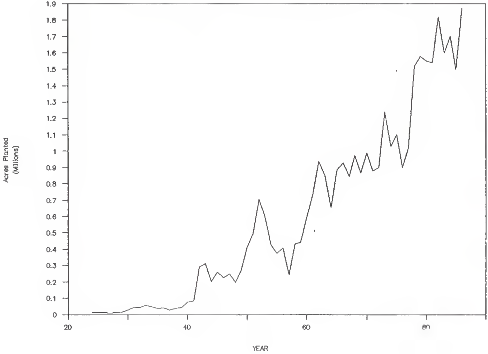
$$\underset{(-5.21)}{Y = -957.12} + \underset{(22.33)}{28.42} * X \qquad R^2 = 0.89$$

Where: Y is the acres planted for all purposes in soybeans

X is the time in years and figures in brackets are t- values.

FIGURE 1

KANSAS SOYBEAN ACRES FOR ALL PURPOSES FROM 1924–1986



Several factors may have stimulated farmers to increase the production of soybeans. Price per bushel, yield per acre, commodity programs, and the possibility to double cropping with soybeans following wheat may have motivated farmers to increase soybean production. Statistical estimation showed that the nominal prices on an average showed an increase of $0.07 per year (Figure 2). The estimated equation shows:

$$E = \underset{(-1.15)}{-1.29} + \underset{(9.80)}{0.07} * X \qquad R^2 = 0.61$$

Where: E is the nominal price per bushel

and X is the time in years

But, this increase will not raise the farmers profitability if input prices increase in the same or greater proportion. For instance, the price of inputs rose as much as the price per bushel of soybeans, but when nominal prices were adjusted to 1986 dollars using the consumer's price index, real prices registered an average decrease of $0.08 per year, as per the statistical estimation (Figure 3). The estimated equation is:

$$C = \underset{(5.83)}{14.12} - \underset{(-4.90)}{0.08} * X \qquad R^2 = 0.28$$

Where: C = is the real price per bushel

X = is the time in years

The real price per bushel was highest at $17.03 in 1925 and was lowest at $4.5 in 1986. During the period 1924-86, soybean yields increased at an average of 0.31 bushel per acre each year as per the statistical

FIGURE 2

KANSAS SOYBEAN PRICE IN NOMINAL DOLLARS FROM 1924-1986

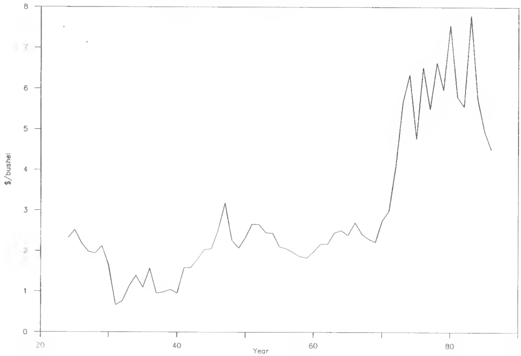
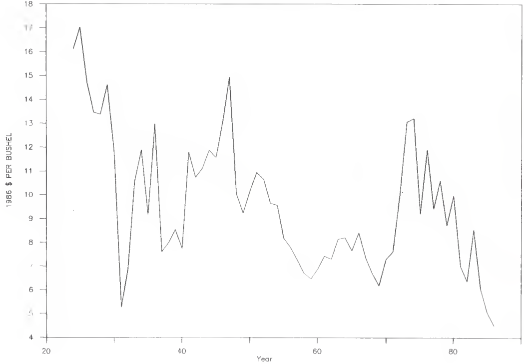


FIGURE 3

KANSAS REAL SOYBEAN PRICE IN 1986 DOLLARS FROM 1924–1986



estimation (Figure 4). The estimated equation is:

$$A = -1.65 + 0.31 * X \qquad R^2 = 0.64$$
$$(-0.38) \quad (10.33)$$

Where: A = is the per acre yield in bushels

X = is the time in years

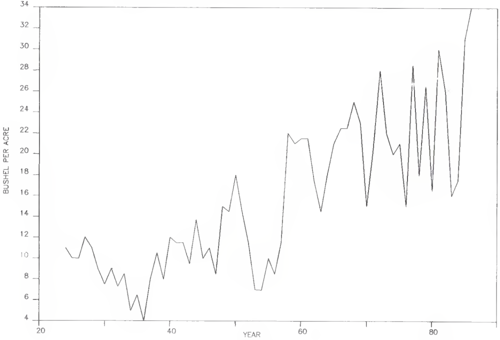
The highest yield for the state of Kansas was 34 bushels per acre in 1986 while the lowest yield was 4 bushels per acre in 1936. Another factor which possibly could have played a significant role here is the relative price of soybeans with respect to corn and wheat.

Review of Literature

Soybeans are not devoid of problems normally encountered by other crops. Weeds are one of the major problems responsible for the yield falling below the maximum potential of the crop. It has been estimated that common cocklebur accounts for approximately 9 million dollars in total losses annually in Arkansas and Mississippi.[1] The major economic loss from common cocklebur is due to crop yield reductions caused by competition (Anderson and McWhorter). Competition studies in soybeans showed soybean yield reductions of 15 to 100% from common cocklebur densities of 1.2 to 40 plants/6 meters of row (Waldrep and McLaughlin and Gossett). More recently, two study reported soybean yield reductions of 12 to 80% by full-season competition from common cocklebur. They also reported that yields of soybeans grown in

[1]Anonymous. 1970-72. Weed losses in soybeans. Inter/Agric. Chicago, IL (Geddes et al).

FIGURE 4
KANSAS SOYBEAN YIELD FROM 1924 –1986



competition with common cocklebur declined with an increase in common cocklebur density and also with an increase in the length of time that common cocklebur was allowed to remain in the field. Seed yields were not reduced when the soybeans were grown free from common cocklebur for the first 4 to 6 weeks or when the common cocklebur plants were removed within 4 weeks after emergence. Their studies also showed that common cocklebur plants located at distances greater than 76 centimeters from soybeans did not influence either leaf area index (LAI) or soybean seed yield (Barrentine, Barrentine and Oliver). Studies have reported a soybean seed yield reduction of 52% from season-long competition with 26,000 common cocklebur plants per hectare and also a 50% yield reduction with 14 common cocklebur plants per 3.1 meters of soybean row (Barrentine, Gossett). Another study reported yield losses ranging from 63% to 75% for six soybean varieties from season-long competition with 7,400 to 16,500 common cocklebur plants per hectare (McWhorter and Hartwig). In addition to decreasing yield, common cocklebur may also affect soybean height, stem diameter, number of pods per plant, seed grade, leaf area, dry weight, crop growth rate, and the amount of foreign matter present in seed samples (McWhorter and Anderson, Barrentine and Oliver,and Eaton, Russ, and Feltner).

One of the reasons for the competitiveness of common cocklebur may be a result of its potential for rapid growth and its water and nutrient requirements. Weed competition often results in a greater percentage of crop loss when moisture is limiting (Burnside and Colville, Burnside and Wicks, and Staniforth). Scientists found that 151, 19, and 154 pounds per acre of N, P, and K, respectively, were contained in 6,990 pounds per acre of common cocklebur dry matter (Shipley and Weise). Other studies indicate that common cocklebur requires up to 331 pounds of water per pound of dry matter produced (Shipley and Weise, Vandiver). The other reason for the competitiveness of common cocklebur may be a result of its root profiles. At maturity, the root profile area for cocklebur when grown under favorable moisture conditions were found to be 17.93 m^2. Further, cocklebur's roots were found to extend 3.3 meter on either side of the plant row and to a depth of over 1.8 meter 10 weeks after transplanting. At maturity it was found that cocklebur had the largest root profile with roots extending 4.3 meters on either side of the plant row and to a depth of 2.9 meters. Scientists also say that in order to expose this root profile, a trench over 8.5 meters long and 3 meters deep is required. They also confirmed that cocklebur grew to a height of 152 centimeters and had a dry matter weight of 590 grams per plant (Davis et al.). Others have also confirmed that the common cocklebur seedlings emerge from as deep as 15 centimeters in the soil throughout the growing season (Gossett and Oliver). These weeds also cause mechanical harvesting problems especially in the soybean fields of Southeast Kansas where there is a wide infestation (Kelley).

The effects of common cocklebur on soybean development and seed yields were also investigated at Urbana, Illinois, from 1974 through 1977 by Bloomberg, Kirkpatrick, and Wax. They concluded that under full season competition, one common cocklebur per 3 meters of row reduced soybean yield by 7%. The reduction in soybean yield was less than 10% when common cocklebur was removed six weeks after soybean emergence. Reductions in soybean leaf-area index, plant dry weight, and crop growth rate were good indicators of the time at which common cocklebur began competing with soybeans (Barrentine and Oliver). Similar studies concluded that soybean yield losses from weeds are usually proportional to amount of water, nutrients, and light used by weeds at the expense of soybeans (Burnside and Colville, Burnside and Wicks, and Weber and Staniforth).

Regarding row spacings, some have placed emphasis on developing improved methods of weed control like narrow row spacing (Basnet, et al., Pendleton and Hartwig, and Wilcox). A study found that early weed removal aided soybean stand establishment and that there was an inverse relationship between soybean stand and production of weed top-growth; also that soybean seed weight and numbers per plant both increased as weed growth decreased. It also concluded that weed control the first month after planting is the most critical in obtaining high soybean yields and that soybeans planted in narrow row spacings (51-centimeters or less) provide competition to weeds at an earlier stage of growth than those in wide rows by better distribution of roots and by earlier and more complete shading of the soil surface (Burnside). The time of common cocklebur emergence and the timing of its removal from soybean stands affect soybean seed yield. If common cocklebur was controlled during the first four weeks after soybean emergence, soybean yield was not reduced significantly by later-emerging common cocklebur (Barrentine). Further, common cocklebur emerging with soybeans must be removed within four to eight weeks to prevent seed yield reductions (Oliver). Studies have also summarized that available weed control systems could eliminate the need for cultivation in narrow row soybean production. And that such systems of weed control could increase soybean yields, reduce production costs, require less labor and fuel, and improve ground cover needed to protect the soil from wind and water erosion. They also said that planting soybeans in wide rows (90 to 105 centimeters) is traditional and is a compromise with weeds (Burnside and Moomaw). Regarding pod abortion, a study concluded that common cocklebur plants often start forming a canopy over the soybean crop while soybean plants are flowering and the resulting shade may increase pod abortion (Cartter and Hartwig).

Habit and Habitat

Cocklebur (Xanthium strumarium L.) is a native of South America although it has now spread throughout the world. It is frequently found in areas subject to periodic or shallow flooding. It is widely distributed in the Mediterranean region and Europe, most of Australia, in some costal African countries, the United States and in southern parts of South America but is rarely found in the tropics. Cocklebur is a summer annual, thriving in warm moist soil. It grows best in open unshaded areas and cannot stand dense crowding or intense competition (Holm, et.al.). About 150 seeds are produced per plant. Cocklebur flowers from July to September in the U.S. and fruits are produced from September to November (Gates). The spiny fruits provide the main means of dispersion of the weed. By becoming entangled in the hair of animals, and in clothing or in the fabric of cloth feed sacks, tarpaulins, or other materials, the burs can travel long distances. The fruits also float, moving downstream with floods or high water to germinate and grow. Common cocklebur may be the most difficult weed to control in the United States. This is due in part to its life cycle. Each bur contains two seeds, one of which may germinate months after the other (Barton). Cocklebur can grow on a wide range of soils, from sands to heavy clays, and in a wide range of moisture supply (Gates). On rich soils with high moisture and little competition from other plants, cocklebur grows tall, while in dry and poor soils, its growth is restricted to a few centimeters in height. The ability to grow in a wide range of conditions results in a constant seed supply. And if it is not controlled, cocklebur can be one of the major problem weeds in many soybean fields. Thus, cocklebur control is vital to soybean farmers. It is, therefore, important to evaluate the most economical way to control cocklebur in soybean farms of Southeastern Kansas.

Objectives of the Study

The productivity of different herbicides and row spacings for cocklebur control in soybeans was economically evaluated at the Columbus Experiment Station in Kansas for three years. This is a bi-disciplinary strategy to weed research where the combined expertise of agronomist and economist can be used to identify and evaluate the profitability of weed control using different application methods of herbicides and varied management systems. Such a technique involving interdisciplinary work is quite common today. Other studies that have used a similar strategy for weed research are by King, et al., Lybecker, et al.(1984, 1988), Natasi, et al., Shipley and Weise, and Snipes, et al.. Efficacy as well as economic profitability of alternative herbicides and row combinations is better demonstrated under interdisciplinary work. This result is cost effective and efficient and hence more likely to be adopted by producers.

The present study provides biological and economic information about alternative herbicides, application methods, and management systems for cocklebur control in soybeans. The objectives of the study are: i) to determine the efficacy of alternative herbicides and resulting soybean yields under three production systems, ii) to examine the economic benefit and cost of alternative herbicides and production systems, iii) to determine whether the economic optimum is identical to the biological optimum.

METHODOLOGY AND DATA

The study was conducted during the period 1986-88 at the Southeast Kansas Branch Experiment station near Columbus, Kansas. Soil type was a Parsons silty clay loam with 1.4% organic matter and a ph of 6.8.

Biological Aspects

The experimental design was a split-plot arrangement with three replications. Main plots were management systems consisting of 1) narrow-row spacing (18 centimeter) with no cultivation after planting, 2) wide-row spacing (76 centimeter) with no cultivation after planting, and 3) wide-row spacing with one row cultivation after planting. Herbicide treatments were assigned to subplots, which were 3.04 meter wide x 9.14 meter long.

Herbicide treatments were applied either preplant incorporated, preemerge, or postemerge. Some herbicide application methods were not evaluated during all three years of the study. All treatments were applied with a tractor-mounted compressed air sprayer delivering 180 litre per hectare. Preplant herbicides were incorporated with a field cultivator equipped with a three-bar tine multure the same day as planting. Preemergent herbicides were applied immediately after planting. Postemergent treatments were applied two to three weeks after planting, except for the late postemerge treatment, which was applied four to five weeks after planting. A row cultivation after planting was performed on one of the 76-cm row spacing main plots.

A natural infestation of common cocklebur was the predominant weed competition, although prickly sida gave some late season competition during one year of the study. The experimental area was treated with Trifluralin at 0.84 kilogram of active ingredients per hectare each year to control annual grasses and small-seeded broadleaf weeds. 'Pershing' soybeans were planted near mid-June. Common cocklebur control was determined by a visual rating made four and eight weeks after herbicide application. Grain yield was determined by harvesting the two center rows for 76-cm row spacing and the center eight rows for 18-cm row spacing. Grain yields were based on 13.0% moisture.

Machinery Aspect

The machinery and labor requirements for 1986-1988 were compiled from Fuller and McGuire to calculate the annual total of machinery variable cost for Southeast Kansas. Six different machinery operation combinations were prepared each year used shallow preplant incorporated and/or the control, preemergent and/or postemergent application method for narrow row, wide row, and wide row with one cultivation depending on each operation. The machinery variable costs are the total of repair, fuel, and lubrication. The repair cost per acre are calculated as follows:

$$(\text{List price} * \text{rcl} * ((\text{life}/1000)^{rc2})/\text{life})/\text{acres/hr}$$

The formulas and repair costs are Rotz, C. A., 'A Standard Model for Repair Costs. American Society of Agricultural Engineers paper No. 85-1527. December 1985. Fuel per hour is 0.06 * hp required. The lubrication costs are calculated to ten percent of fuel costs. Fuel per acre is calculated by dividing gallons per hour by acres per hour and multiplied by price per gallon. Repair constants for light and medium truck are assumed to be the same as for tractors. The field operations are almost the same in all the subplots. The only difference is in the use of a sprayer in the case of application of postemerge or preemerge and or a row cultivation in the case of wide row with cultivation plots. The common field operations in order are disking twice with a 24 foot tandem disk one each in April and May, chisel plowing once in April, field cultivating once in May, planting in June, spraying herbicides if it involves a preemerge or postemerge, row cultivating if it is a wide with cultivation subplot in July, and harvesting in October. The shallow preplant incorporated and the control plots do not require a herbicide sprayer as the chemicals are incorporated in the soil with a field cultivator. It has been assumed that a typical farm has two tractors, namely 140 hp and 75 hp. The sizes of machinery and the tractor used for each field operation are from the Doanes Agricultural Report. The machinery hours are multiplied by a factor of 1.3 in order to estimate labor hours (Langemeier, Buller, and Kasper), to account for more labor time required for out of the field activity relating to the additional duties on the tractor like for example hooking, etc. See Tables A1-A18 in Appendix A.

The preemerge and postemerge are applied with a sprayer at their respective times and hence incur additional costs. A sprayer costs an additional $0.44 for 1986, $0.39 for 1987, and $0.43 for 1988 excluding the labor charges. Labor charges are $0.55 for the sprayer operation. Narrow row plots are planted with a drill whereas the wide and the wide with cultivation plots use a corn planter. In 1986 the planter was $1.43 more expensive than the grain drill, in 1987, it was $0.91 more and in 1988, it was $0.99 more. There is an additional cultivation involved in the wide with cultivation plots before harvest. The row cultivation cost for 1986 was $1.32, $1.11 for 1987, and $1.23 for 1988 excluding the labor charges. The additional labor charges for cultivation are $1.34. The machinery operations for the experimental plots of soybeans are based on Kelley's research at the Experiment Station at Parsons. The rest of the operations remain the same as other plots (Table 1).

Table 1. Machinery Operations per acre used in Alternative Herbicides and Production Systems for Cocklebur Control in Soybeans, for three year period[a].

Machinery Operations	Shallow Preplant Incorporated and No Herbicide method for Narrow Row	Shallow Preplant Incorporated and No Herbicide method for Wide Row	Shallow Preplant Incorporated and No Herbicide method for Wide with Cultivation	Preemergent and Postemergent method for Narrow Row	Preemergent and Postemergent method for Wide Row	Preemergent and Postemergent method for Wide with Cultivation
	Number of Times Over the Field					
Tandem Disk	2.00	2.00	2.00	2.00	2.00	2.00
Chisel Plow	1.00	1.00	1.00	1.00	1.00	1.00
Field Cultivate with Herbicide Application	1.00	1.00	1.00	1.00	1.00	1.00
Corn Planter		1.00	1.00		1.00	1.00
Grain Drill	1.00			1.00		
Sprayer				1.00	1.00	1.00
Row Cultivator			1.00			1.00
Soybeans Combine	1.00	1.00	1.00	1.00	1.00	1.00
	Acres per truck load					
Medium Truck[a]	21.90	21.90	21.90	21.90	21.90	21.90
Light Truck	3.50	3.50	3.50	3.50	3.50	3.50
	Dollars per Acre					
Total Variable Costs[b] 1986	13.44	14.87	16.19	13.88	15.31	16.63
1987	14.91	14.00	16.02	14.39	15.30	16.41
1988	15.31	16.30	17.53	15.74	16.73	17.96

[a] These are the total of farm operations conducted in Southeast Kansas during 1986-1988 for this experiment. The table indicates the number of time acres the specific machinery runs over the field during the experiment.

[b] Acres/truck load for a 400 bu truck are based on yields of 18 bu/a for soybeans. Lower yields would increase the acres/hr and decrease costs/a and vis-a-versa. Because adjustments in costs would be small, acres/hr and costs/a are not adjusted for yield differences.

[b] Variable costs include fuel, lubrication, and repairs. These do not include fertilization costs as no fertilizer was applied during the crop season in all the three years. Thus after subtracting the fertilizer costs from tables A1 to A18 in Appendix A these costs should be similar.

Benefit/Cost Model

This model is used to calculate the specific costs involved with each herbicide and management system. Thus the common operations are assumed to be evened out and are not considered. Producer's benefits and costs are calculated by the following formula:

$$\text{Benefit} = (A - B) * P \qquad (1)$$

$$\text{Cost} = H + S + C + L + I \qquad (2)$$

where :

- A = the yield on using herbicide
- B = the yield on the control plot
- P = the price per bushel of soybean
- H = the herbicide cost
- S = the variable cost of sprayer
- C = the variable cost of row cultivator
- L = the labor cost of spraying and row cultivating
- I = the interest on all the relevant cost

Such procedure enables the inclusion of all benefits and costs attributed to herbicide use either directly or indirectly. Benefit/cost ratios are thus calculated for each management system by dividing equation (1) by (2) for each year. Separate columns are designated for each of the costs in every table. The benefit minus cost for each herbicide in each year is obtained by subtracting the total costs of weed control for a specific activity calculated using equation (2) from the respective benefits calculated using equation (1). Cultivation is done only in wide with cultivation plots and hence are not an element of every table. Refer to Tables B1 to B8 (Appendix B) for individual calculation of benefits and costs. The results are summarized in Table 4.

The Variables

The yields for the experimental plots were collected from 1986 to 1988 from southeast Kansas Branch Experiment Station, Parsons, Kansas (Kelley).

The price for soybeans is the price of grain at harvest time from U.S.D.A. publication of Agricultural Prices.

The price of liquid nitrogen, a surfactant, to be applied with all postemergence herbicides, is taken from the 'Ag. Prices'. The herbicide costs are from 'Chemical Weed Control for Field Crops, Pastures, Rangeland, and Noncropland'.

The machinery costs are based on the figures from the University of Minnesota Extension Service adjusted for southeastern Kansas farms.

The labor wage and the interest rate are taken for each specific year from the 'K.S.U. Farm Management Guide'. Labor hours are calculated by taking 1.3 times machinery hours as suggested by Langemeier, et al..

RESULTS AND DISCUSSION

On economically evaluating the productivity of different herbicides and row spacings for cocklebur control in soybeans at the Columbus Experiment Station in Kansas for three years, cocklebur was seen to be moderately controlled in all the plots (Kelley). See Table 2. Nevertheless, the narrow rows and the wide rows cultivated once yielded a 92 or higher percentage of control on average over the three years. Treatment wise, postemergence resulted in a 98% repression of cocklebur generally; except in the 1988 plots, a preemergence yielded the same result (Kelley). Yields were better in the herbicidal plots than in the control were no herbicide was applied for cocklebur (Table 2). In 1986 the highest yield of 36.9 bushels was observed in Basagran treated narrow row plots. In 1987 also Basagran peaked in narrow rows yielding 34.2 bushels per acre. But in 1987, two very close high yields were observed in wide with cultivation plots with Canopy applied preemerge and Basagran applied postemerge . In 1988 Classic applied in narrow rows yielded the highest yield of 32.3 bushels (Kelley). These results are summarized in Table 2.

Comparing individual herbicide yield results for 1988, Classic and Basagran applied postemergent resulted in the first and second position yield levels with soybeans planted in narrow rows and wide rows respectively (Table 2). When wide rows with a cultivation was used, Scepter applied postemergent had the highest gross income with a yield of 28.9 bushels per acre and Classic and Basagran applied postemergent had the second and the third highest gross income yield levels for 1988 (Table 2). Thus postemergent herbicides resulted in the two highest yield levels for all the three production systems in 1988. Canopy and Preview applied preemergent with narrow row spacings also resulted in high income levels in 1988.

On observing the combined effect of herbicide treatments in specific management systems, the use of narrow rows resulted in the highest production levels for 1986 and 1988 for all the herbicide application methods except in Classic and the control plots. In these, the wide with cultivation yielded higher results.

In 1986, Narrow row spaced plots had the highest yields in all the herbicide applications with two exceptions. The exceptions were found in Classic treated and the control plots where, the highest yields were found in the wide with cultivation plots. In 1987, the wide with cultivation plots yielded higher returns except in the Basagran plots where narrow rows had a 0.10 bushel lead. In 1988, narrow row spacings gave prominently higher yields in all the herbicide application plots except the control. In the control plot wide with one cultivation was the most productive management system. For all herbicides, cultivation was more profitable than no cultivation in 30-inch row soybean production (Table 2).

Among the management systems in each year, wide with cultivation showed a higher percentage of cocklebur control with an average of 94.33%. When all the herbicides and application methods were compared, Scepter applied postemerge gave the highest control during the three years. Considering the prominent results of individual years, Classic gave 98% control in 1986, Scepter gave 97.33% control, and Classic and

Scepter controlled 97.66% each in 1988. The resulting yields and cocklebur control percentage wise are the contents of Table 2.

On analyzing the itemized cost description among the management systems, Canopy applied preemerge cost the most with $17.28 for narrow and wide and $20.10 for wide row with cultivation. On looking at the itemized cost description, one finds that Canopy is the most expensive of all the involved herbicides. Comparing all three management systems the production costs are greater for using a preemergent or postemergent because of the additional cost involved for the sprayer which has a machinery variable cost and labor cost. The shallow preplant incorporated and the no herbicide treatments do not have this addition cost as the chemical if applied is incorporated at the time of field cultivation. All the three highest cost figures were observed in 1986. The reason for this could be the factors of inflation and the its own price. Annual analysis led to the conclusion that Canopy applied preemerge was indeed the most expensive herbicide in the study with wide with cultivation management system (Table 3).

Total benefits indicate the same general pattern as the biological data. Basagran in narrow rows showed the highest income for 1986 and 1987 and Classic in narrow rows was highest for 1988. Benefit minus cost analysis also resulted in the same management and herbicide prominence with varied figures. But benefit cost ratio analysis leads to the conclusion that total benefits were highest in narrow rows for all the three years. This result is in congruence with certain earlier studies regarding better narrow row spaced benefit in comparison with wider rows of soybean cultivation (Basnet, et al., Pendleton and

Hartwig, and Wilcox). Annual comparison showed Basagran as best for 1986 and 1987 and Classic as best for 1988.

Comparing the herbicides for all the three years, Classic applied on narrows showed prominence with $175.45 benefit. Narrow rows in 1988 seemed to have the best net benefits over all the other years (Table 4). Net benefits were highest for Basagran for 1986 and 1987 and for Classic for 1988.

Benefit cost estimation proved Basagran to be the most cost effective herbicide in this experiment. For each management system in each year, Basagran had the highest ratio. 1988 yielded the highest net benefits in each management system.

In finale, the highest total benefit of $175.45 was from Classic when treated in narrow row plots of 1988. The second highest was obtained from Canopy applied preemerge in narrow row plots of 1988 with $170.93. For individual years, Basagran had highest results in 1986 and 1987 in narrow rows with $103.74 and 101.81 respectively. But in 1988, Classic resulted in highest benefit in narrow row spacings with $175.45. The second highest for 1986 was Scepter applied preplant incorporated in wide rows which amounted to $100.56, for 1987 was Basagran also in wider rows with $82.15, and for 1988 was Canopy applied preemerge in narrow rows with a benefit of $170.93. Net benefits analysis showed maximum results in Basagran treated narrow row plots of 1986 and 1987 with $95.38 and $93.6J respecitively, but yielded second highest for 1988 with $156.72. And, In 1988 Classic treated narrow row plots yielded highest net benefit with $163.46. Basagran treated in wide rowed plots yielded second highest results for 1986 ($81.73) and 1987 ($73.99).

CONCLUSION

Of the three management systems, narrow row spacings (18 centimeter), wide row spacings (76 centimeter), and wide row spacing with one cultivation, narrow row spacings yielded the highest profitability level in majority of the plot treatments. Across years and treatments, narrow row plots gave $92.93 per acre net benefits on an average whereas the wide rows and the wide rows with one cultivation gave $73.13 and $54.52 net benefits per acre respectively. The result is in conformity with the observation that the higher density of soybean plants in narrow row spacings makes the potential yield more sensitive to competition from weeds, implying that the larger the number of soybean plants per acre, the greater is the response to effective weed control. The net benefits are also higher in narrow row production systems as row cultivation is not required.

The type of herbicide with the highest net benefits was found by averaging out across management systems and years. Basagran (bentazon) applied postemerge was found to yield highest net benefits with an average of $93.36 per acre. The second best was Canopy (metribuzin + chlorimuron ethyl) with $82.62 per acre when applied as a preplant incorporated.

Deviations from the above results are noticed in 1988 where Classic (chlorimuron ethyl) resulted in the highest net benefits of $163.46. It is possible that climatic factors such as low rainfall could have modified the impacts of herbicides in 1988. There is need for continuing research of this kind to measure the results under varying growing conditions from year to year. The results from this study seem convincing, but as new herbicides and management systems are developed, continuing research will be needed to assure soybean producers of up to date test results and recommendations.

Table 2. Effects of Herbicides and Row Spacings on Soybean Yield and Cocklebur Control[a]

Herbicide	When Applied	Row Spacing	Soybean Yield 1986	1987	1988	Cocklebur Control 1986	1987	1988
Canopy	PPI	Narrow	35.2	---	30.7	97	--	91
		Wide	24.4	---	21.2	85	--	84
		Wide + Cultiv	28.9	---	22.8	98	--	95
		(Average)	(29.5)	---	(24.9)			
Scepter	PPI	Narrow	33.0	---	26.8	98	--	95
		Wide	27.1	---	19.9	90	--	91
		Wide + Cultiv	29.5	---	20.3	98	--	97
		(Average)	(29.9)	---	(22.3)			
Canopy	PRE	Narrow	35.8	25.3	31.7	98	75	92
		Wide	27.7	27.3	19.5	87	80	83
		Wide + Cultiv	29.6	34.0	23.5	98	87	94
		(Average)	(31.0)	(28.9)	(24.9)			
Preview	PRE	Narrow	---	28.8	31.0	--	75	93
		Wide	---	24.8	21.4	--	70	78
		Wide + Cultiv	---	33.4	21.6	--	87	93
		(Average)	---	(29.0)	(24.7)			
Scepter	PRE	Narrow	---	28.6	24.2	--	92	90
		Wide	---	29.4	19.8	--	91	83
		Wide + Cultiv	---	29.7	22.2	--	91	96
		(Average)	---	(29.2)	(22.1)			
Basagran	POST	Narrow	36.9	34.2	30.9	98	98	97
		Wide	25.4	29.5	22.2	96	93	97
		Wide + Cultiv	32.7	34.1	26.4	97	88	98
		(Average)	(31.7)	(32.6)	(26.5)			
Classic	POST	Narrow	28.5	26.1	32.3	98	88	98
		Wide	19.3	26.3	21.3	98	85	97
		Wide + Cultiv	29.4	32.7	27.9	98	94	98
		(Average)	(25.7)	(28.4)	(27.2)			
Scepter	POST	Narrow	31.3	28.5	30.4	98	98	98
		Wide	23.9	27.8	21.2	97	98	97
		Wide + Cultiv	30.0	33.3	28.9	98	96	98
		(Average)	(28.4)	(29.9)	(26.8)			
Rescue	POST	Narrow	28.8	20.9	24.9	77	95	78
		Wide	12.3	21.4	13.3	65	98	67
		Wide + Cultiv	18.7	28.4	16.2	83	98	83
		(Average)	(19.9)	(23.6)	(18.1)			
Control	--	Narrow	14.1	14.0	9.0	25	20	20
		Wide	5.6	13.2	5.8	0	0	0
		Wide + Cultiv	18.8	19.1	10.8	47	45	43
		(Average)	(12.8)	(15.4)	(8.5)			

[a] The source of this data description is based on the experimental results from 1986 to 1988 at Columbus, Kansas. Rpt. of Progress, Agr. Exp. Sta., Kansas State University, 1989 (Kelley, 1989). Not all treatments could be experimented in all the years. Hence the blank lines indicated the lack of data in the respective years.

Table 3. Herbicide related items' description[a]

Herbicide Name[b]	Rate[c]	When Applied[d]	Application Remarks[e]	Itemized costs[f] 1986	1987	1988
Canopy	0.50 lb.	PPI	All Manage. Systems	15.31	---	15.25
Scepter	0.67 pt.	PPI	All Manage. Systems	13.71	---	13.26
Canopy	0.50 lb.	PRE	All Manage. Systems	15.31	15.00	15.25
Preview	0.50 lb.	PRE	All Manage. Systems	---	13.25	13.25
Scepter	0.67 lb.	PRE	All Manage. Systems	---	13.44	13.26
Basagran	1.00 pt.	POST	All Manage. Systems	6.89	6.76	6.74
Classic	0.50 oz.	POST	All Manage. Systems	10.36	10.15	10.33
Scepter	0.67 pt.	POST	All Manage. Systems	13.87	13.59	13.44
Rescue	2.00 qt.	POST	All Manage. Systems	6.53	6.40	6.18
Sprayer	0.07 hr.	Jun/Jul	All Pre & Post Plots	0.44	0.39	0.43
Labor	0.09 hr.	Jun/Jul	Sprayer	0.55	0.55	0.55
	0.22 hr.	July	Cultivator	1.34	1.34	1.34
Cultivator	0.17 hr.	July	Wide with Cultivation Plots only	1.32	1.11	1.23

[a] The description is based on the experimental results from 1986 to 1988 at Columbus, Kansas.
[b] These are itemized according to its usage in the alternative herbicide and management plots. Interest rates included are 6% of the costs specific to herbicide and management techniques.
[c] Rate specifies the amount of specific items used per acre. The abbreviations 'lb.' stands for pound, 'pt.' for pint, 'oz.' for ounce, 'qt.' for quart, and 'hr.' for hour.
[d] 'PPI' stands for preplant incorporated, 'PRE' for preemerge, 'POST' for postemerge, 'Jun' for June, and 'Jul' for July.
[e] One quart of liquid nitrogen was applied to all postemerge treatments plots. Treflan was applied in all plots at 0.84 kg/ha.
[f] Herbicide costs are from Nilson et al., "Chemical Weed Control for Field Crops, Pastures, Rangeland, and Noncropland, 1986, 1987, & 1988," Rpt. of Progress 530, Agr. Exp. Sta., Kansas State University, Jan. 1986, 1987,& 1988. Machinery operating costs (fuel, repairs, and lubrication) are based on from Fuller, Earl I, and Mark F. McGuira, Minnesota Farm Machinery Economic Cost Estimates for 1986, 1987, & 1988, Minnesota Extension Service, University of Minnesota, AG-FO-2308, revised 1988 with adjustments for southeastern Kansas. Time for machinery operations was multiplied by 1.3 to provide the hours of labor. Wage rate ($6.00) is from Figuriski and Schlender, "Soybean Production in Eastern Kansas" KSU Farm Management Guide, MF-570, Dept. of Agr. Econ., Kansas State University, Revised Aug, 1986 1987, & 1988.

Table 4. An analysis of benefits and costs in dollars per acre[a].

Herbicide Management systems	Canopy PPI	Scepter PPI	Canopy Pre	Preview Pre	Scepter Pre	Basagran Post	Classic Post	Scepter Post	Rescue Post
Total costs									
Narrow									
1986	16.23	14.53	17.28	--	--	8.36	12.03	15.75	7.97
1987	--	--	16.90	15.24	15.04	8.16	11.76	15.40	7.78
1988	16.17	17.20	17.20	15.08	15.09	8.18	11.99	15.29	7.59
Wide									
1986	16.23	14.53	17.28	--	--	8.36	12.03	15.75	7.97
1987	--	--	16.90	15.24	15.04	8.16	11.76	15.40	7.78
1988	16.17	17.20	17.20	15.08	15.09	8.18	11.99	15.29	7.59
Wide with cultivation									
1986	17.81	17.35	20.10	--	--	11.18	14.85	18.57	10.79
1987	--	--	19.49	17.84	17.64	10.76	14.35	18.00	10.38
1988	18.89	16.78	19.93	17.81	17.82	10.91	14.71	18.01	10.31
Total benefits									
Narrow									
1986	96.01	86.00	98.74	--	--	103.74	65.52	78.26	66.89
1987	--	--	56.95	74.59	73.58	101.81	60.98	73.08	34.78
1988	163.40	134.03	170.93	165.66	114.46	164.91	175.45	161.14	119.73
Wide									
1986	85.54	100.56	97.83	--	--	90.09	62.34	83.27	30.49
1987	--	--	71.06	58.46	81.65	82.15	66.02	73.58	41.33
1988	115.96	106.17	103.16	117.47	105.42	123.49	116.72	115.96	56.48
Wide with cultivation									
1986	45.96	48.69	49.14	--	--	63.25	48.23	50.96	-0.46
1987	--	--	75.10	73.58	53.42	75.60	68.54	71.57	46.87
1988	90.36	71.54	95.63	81.32	85.84	117.47	128.76	136.29	40.66
Benefits minus costs									
Narrow									
1986	79.78	71.46	81.46	--	--	95.38	53.49	62.51	58.91
1987	--	--	40.06	59.55	58.34	93.65	49.23	57.68	27.00
1988	147.24	119.98	153.73	150.58	99.36	156.72	163.46	145.86	112.14
Wide									
1986	69.31	86.02	80.55	--	--	81.73	50.30	67.51	22.51
1987	--	--	54.17	43.42	66.41	73.99	54.27	58.18	33.55
1988	99.80	92.12	85.96	102.38	90.33	115.31	104.73	100.68	48.89
Wide with cultivation									
1986	28.15	31.33	29.04	--	--	52.06	33.38	32.39	-11.25
1987	--	--	55.60	55.95	35.58	64.84	54.19	53.57	36.49
1988	71.47	54.76	75.70	63.52	68.02	106.56	114.05	118.28	30.35
Benefit cost ratio									
Narrow									
1986	5.92	5.92	5.71	--	--	12.40	5.45	4.97	8.39
1987	--	--	3.37	4.96	4.83	12.47	5.19	4.74	4.47
1988	10.11	9.54	9.94	10.98	7.58	20.15	14.63	10.54	15.78
Wide									
1986	5.27	6.92	5.66	--	--	10.77	5.18	5.29	3.82
1987	--	--	4.21	3.89	5.36	10.07	5.62	4.78	5.31
1988	7.17	7.55	6.00	7.79	6.98	15.09	9.74	7.59	7.44
Wide with cultivation									
1986	2.58	2.81	2.45	--	--	5.66	3.25	2.74	-0.04
1987	--	--	3.85	4.17	2.99	7.03	4.48	3.98	4.52
1988	4.78	4.26	4.80	4.57	4.82	10.77	8.75	7.57	3.94

[a] These numbers are the summary and results from tables B1 to B9 in Appendix B.

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Table A1. Postemergent and Preemergent herbicide Machinery Operations with Cultivation, 1986

				Machinery Hours/Acre						Labor Hours/	
						Tractor 1[d]		Tractor 2[d]			
Machinery Operation	Month	Size	Times Over	Truck This Budget	Combine This Budget	One Time Over[a]	This Budget	One Time Over[a]	This Budget	Acre This Budget[b]	Variable Cost /acre[c]
Disk	April	24ft	1.00			0.09	0.09			0.11	1.45
Fertilizer Buggy	April		1.00			0.07	0.07			0.09	3.26
Chisel Plow	April	17ft	1.00			0.13	0.13			0.18	2.13
Disk	May	24ft	1.00			0.09	0.09			0.11	1.45
Field Culti -vate & herbicide	May	18ft	1.00			0.11	0.11			0.15	1.40
Plant	June	6-30	1.00					0.20	0.20	0.26	3.16
Sprayer	June	30 ft	1.00					0.07	0.07	0.09	0.44
Row Cultivation	July	6-30	1.00					0.17	0.17	0.22	1.32
Combine	Oct	Large	1.00		0.20					0.26	2.51
Medium Truck	Oct	400bu	1.00	0.66						0.86	0.94
Light Truck		pickup	1.00	0.66						0.86	1.83
Annual Total										3.18	19.89

[a]Machinery hours per acre are based on acres per hour reported in Doanes Agricultural Report 3-27-86.

[b]Machinery hours are multiplied by 1.3 to estimate labor hours. The 1.3 factor is taken from Langemeier, L.N., O.H. Buller, and J.C. Kasper, Labor Requirements for Eastern Kansas Crops, Kansas Agr. Exp. Sta. Bul. 587, June 1975.

[c]Variable costs are based on Fuller, Earl I. and Calvin W. Dornbush, Minnesota Farm Machinery Economic Cost Estimates Minnesota Extension Service.

[d]Tractor 1 and tractor 2 have 140 and 75 horse power respectively.

Table A2. Postemergent and Preemergent Herbicide Machinery Operations, 1986.

Machinery Operation	Month	Size	Times Over	Machinery Hours/Acre: Truck This Budget	Combine This Budget	Tractor 1[d]: One Time Over[a]	Tractor 1[d]: This Budget	Tractor 2[d]: One Time Over[a]	Tractor 2[d]: This Budget	Labor Hours/ Acre This Budget[b]	Variable Cost $/acre[c]
Disk	April	24ft	1.00			0.09	0.09			0.11	1.45
Fertilizer Buggy	April		1.00			0.07	0.07			0.09	3.26
Chisel Plow	April	17ft	1.00			0.13	0.13			0.18	2.13
Disk	May	24ft	1.00			0.09	0.09			0.11	1.45
Field Cultivate & herbicide	May	18ft	1.00			0.11	0.11			0.15	1.40
Plant	June	6-30	1.00					0.20	0.20	0.26	3.16
Sprayer	June	30 f	1.00					0.07	0.07	0.09	0.44
Combine	Oct	Large	1.00		0.20					0.26	2.51
Medium Truck	Oct	400bu	1.00	0.66						0.86	0.94
Light Truck	Oct	pickup	1.00	0.66						0.86	1.83
Annual Total										2.96	18.57

[a]Machinery hours per acre are based on acres per hour reported in Doanes Agricultural Report 3-25-86.

[b]Machinery hours are multiplied by 1.3 to estimate labor hours. The 1.3 factor is taken from Langemeier, L.N., O.H. Buller, and J.C. Kasper, Labor Requirements for Eastern Kansas Crops, Kansas Agr. Exp. Sta. Bul. 587, June 1975.

[c]Variable costs are based on Fuller, Earl I. and Calvin W. Dornbush, Minnesota Farm Machinery Economic Cost Estimates Minnesota Extension Service.

[d]Tractor 1 and tractor 2 have 140 and 75 horse power respectively.

Table A3. Postemergent and Preemergent Herbicide Machinery Operetions for Narrow Row, 1986.

Machinery Operation	Month	Size	Times Over	Truck This Budget	Combine This Budget	Tractor 1[d] One Time Over[a]	Tractor 1[d] This Budget	Tractor 2[d] One Time Over[a]	Tractor 2[d] This Budget	Labor Hours/ Acre This Budget[b]	Verieble Cost $/Acre[c]
				Machinery Hours/Acre							
Disk	April	24ft	1.00			0.09	0.09			0.11	1.45
Fertilizer Buggy	April		1.00			0.07	0.07		0.00	0.09	3.26
Chisel Plow	April	17ft	1.00			0.13	0.13			0.18	2.13
Disk	May	24ft	1.00			0.09	0.09			0.11	1.45
Field Cult -ivate & herbicide	Mey	18ft	1.00			0.11	0.11			0.15	1.40
Plant-Drill	June	24ft	1.00					0.10	0.10	0.14	1.73
Spreyer	June	30 ft	1.00					0.07	0.07	0.09	0.44
Combine	Oct	Large	1.00		0.20					0.26	2.51
Medium Truck	Oct	400bu	1.00	0.66						0.86	0.94
Light Truck	Oct	pickup	1.00	0.66						0.86	1.83
Annual Total										2.83	17.14

[a]Machinery hours per acre are based on ecres per hour reported in Ooanes Agricultural Report 3-25-86.

[b]Machinery hours are multiplied by 1.3 to estimate lebor hours. The 1.3 factor is taken from Langemeier, L.N., O.H. Buller, end J.C. Kasper, Labor Requirements for Eastern Kansas Crops, Kansas Agr. Exp. Sta. Bul. 587, June 1975.

[c]Variable costs ere based on Fuller, Earl I. end Celvin W. Oornbush, Minnesote Farm Machinery Economic Cost Estimates Minnesota Extension Service.

[d]Trector 1 end tractor 2 have 140 end 75 horse power respectively.

Table A4. No Herbicide and Shallow Preplant Machinery Operations with Cultivation, 1986

Machinery Operation	Month	Size	Times Over	Machinery Hours/Acre: Truck This Budget	Combine This Budget	Tractor 1[d] One Time Over[a]	Tractor 1[d] This Budget	Tractor 2[d] One Time Over[a]	Tractor 2[d] This Budget	Labor Hours/Acre This Budget[b]	Variable Cost $/acre[c]
Disk	April	24ft	1.00			0.09	0.09			0.11	1.45
Fertilizer Buggy	April		1.00			0.07	0.07			0.09	3.26
Chisel Plow	April	17ft	1.00			0.13	0.13			0.18	2.13
Disk	May	24ft	1.00			0.09	0.09			0.11	1.45
Field Culti-vate& herbicide	May	18ft	1.00			0.11	0.11			0.15	1.40
Plant	June	6-30	1.00					0.20	0.20	0.26	3.16
Row Culti-vation	July	6-30	1.00					0.17	0.17	0.22	1.32
Combine	Oct	Large	1.00		0.20					0.26	2.51
Medium Truck	Oct	400bu	1.00	0.66						0.86	0.94
Light Truck		pickup	1.00	0.66						0.86	1.83
Annual Total										3.09	19.45

[a]Machinery hours per acre are based on acres per hour reported in Doanes Agricultural Report 3-27-88.

[b]Machinery hours are multiplied by 1.3 to estimate labor hours. The 1.3 factor is taken from Langemeier, L.N., O.H. Buller, and J.C. Kasper, Labor Requirements for Eastern Kansas Crops, Kansas Agr. Exp. Sta. Bul. 587, June 1975.

[c]Variable costs are based on Fuller, Earl I. and Calvin W. Dornbush, Minnesota Farm Machinery Economic Cost Estimates Minnesota Extension Service.

[d]Tractor 1 and tractor 2 have 140 and 75 horse power respectively.

Table A5. No Herbicide and Shallow Preplant Incorporated Machinery Operations, 1986.

						Machinery Hours/Acre					
						Tractor 1[d]		Tractor 2[d]			
Machinery Operation	Month	Size	Times Over	Truck This Budget	Combine This Budget	One Time Over[a]	This Budget	One Time Over[a]	This Budget	Labor Hours/ Acre This Budget[b]	Variable Cost $/acre[c]
Disk	April	24ft	1.00			0.09	0.09			0.11	1.45
Fertilizer Buggy	April		1.00			0.07	0.07			0.09	3.26
Chisel Plow	April	17ft	1.00			0.13	0.13			0.18	2.13
Disk	May	24ft	1.00			0.09	0.09			0.11	1.45
Field Cultivate & herbicide	May	18ft	1.00			0.11	0.11			0.15	1.40
Plant	June	6-30	1.00					0.20	0.20	0.26	3.16
Combine	Oct	Large	1.00		0.20					0.26	2.51
Medium Truck	Oct	400bu	1.00	0.66						0.86	0.94
Light Truck	Oct	pickup	1.00	0.66						0.86	1.83
Annual Total										2.87	18.13

[a]Machinery hours per acre are based on acres per hour reported in Doanes Agricultural Report 3-25-86.

[b]Machinery hours are multiplied by 1.3 to estimate labor hours. The 1.3 factor is taken from Langemeier, L.N., O.H. Buller, and J.C. Kasper, Labor Requirements for Eastern Kansas Crops, Kansas Agr. Exp. Sta. Bul. 587, June 1975.

[c]Variable costs are based on Fuller, Earl I. and Calvin W. Oornbush, Minnesota Farm Machinery Economic Cost Estimates Minnesota Extension Service.

[d]Tractor 1 and tractor 2 have 140 and 75 horse power respectively.

Table A6. No Herbicide end Shellow Preplent Incorporeted Machinery Dperetions for Narrow Row, 1986.

Machinery Dperetion	Month	Size	Times Over	Machinery Hours/Acre: Truck This Budget	Combine Thie Budget	Tractor 1[d]: One Time Over[a]	Tractor 1[d]: This Budget	Trector 2[d]: One Time Over[a]	Trector 2[d]: This Budget	Lebor Hours/ Acre This Budget[b]	Veriable Cost $/Acre[c]
Disk	April	24ft	1.00			0.09	0.09			0.11	1.45
Fertilizer Buggy	April		1.00			0.07	0.07		0.00	0.09	3.26
Chisel Plow	April	17ft	1.00			0.13	0.13			0.18	2.13
Disk	Mey	24ft	1.00			0.09	0.09			0.11	1.45
Field Cult-ivete & herbicide	May	18ft	1.00			0.11	0.11			0.15	1.40
Plent-Drill	June	24ft	1.DD					0.10	0.10	0.14	1.73
Combine	Oct	Large	1.00		0.20					0.26	2.51
Medium Truck	Dct	40Dbu	1.00	0.66						0.86	0.94
Light Truck	Dct	pickup	1.00	0.66						0.86	1.83
Annual Totel										2.74	16.70

[a]Machinery hours per ecre ere based on ecres per hour reported in Doenes Agricultural Report 3-25-86.

[b]Machinery hours are multiplied by 1.3 to estimate lebor hours. The 1.3 fector is taken from Lengemeier, L.N., D.H. Buller, and J.C. Kesper, Labor Requirements for Eastern Kensas Crops, Kenses Agr. Exp. Sta. Bul. 587, June 1975.

[d]Veriable costs ere based on Fuller, Earl I. and Celvin W. Dornbush, Minnesote Ferm Machinery Economic Cost Estimates Minnesote Extension Service.

[d]Tractor 1 and tractor 2 heve 140 and 75 horse power respectively.

Teble A7. Postemergent end Preemergent Herbicide Machinery Operations with Cultivation, 1987

Machinery Operation	Month	Size	Times Over	Truck Thie Budget	Combine This Budget	Tractor 1 One Time Over[a]	Tractor 1 This Budget	Tractor 2 One Time Over[a]	Tractor 2 This Budget	Lebor Hours/ Acre This Budget[b]	Variable Cost $/acre[c]
				Machinery Hours/Acre							
Disk	April	24ft	1.00			0.09	0.09			0.11	1.12
Fertilizer Buggy	April		1.00			0.07	0.07			0.09	3.11
Chisel Plow	April	17ft	1.00			0.13	0.13			0.18	1.64
Disk	May	24ft	1.00			0.09	0.09			0.11	1.12
Field Cult-ivate & herbicide	Mey	18ft	1.00			0.11	0.11			0.15	1.17
Plant	June	6-30	1.00					0.20	0.20	0.26	2.50
Sprayer	June	30 ft	1.00					0.07	0.07	0.09	0.39
Row Cult-ivation	July	6-30	1.00					0.17	0.17	0.22	1.11
Combine	Oct	Large	1.00		0.20					0.26	5.43
Medium Truck	Oct	400bu	1.00	0.66						0.86	0.66
Light Truck		pickup	1.00	0.66						0.86	1.27
Annual Total										3.18	19.52

[a]Machinery hours per ecre are based on acres per hour reported in Doanes Agricultural Report 3-27-87.

[b]Machinery hours ere multiplied by 1.3 to estimate labor hours. The 1.3 factor is taken from Langemeier, L.N., O.H. Buller, end J.C. Kesper, Labor Requirements for Eestern Kensas Crops, Kensas Agr. Exp. Sta. Bul. 587, June 1975.

[c]Variable costs are based on Fuller, Earl I. and Celvin W. Dornbush, Minnesota Farm Machinery Economic Cost Estimates Minnesota Extension Service.

[d]Tractor 1 and tractor 2 have 140 and 75 horse power respectively.

Tabla A8. Postemergant and Praemergant Herbicida Machinery Operations for narrow row, 1987.

Machinery Operation	Month	Siza	Times Ovar	Machinery Hours/Acre: Truck Thia Budget	Combine Thia Budgat	Tractor 1[d]: One Time Ovar[a]	Tractor 1[d]: This Budgat	Tractor 2[d]: One Time Ovar[a]	Tractor 2[d]: This Budgat	Labor Hours/ Acra Thia Budgat[b]	Variabla Cost $/acra[c]
Disk	April	24ft	1.00			0.09	0.09			0.11	1.12
Fartilizar Buggy	April		1.00			0.07	0.07			0.09	3.11
Chisel Plow	April	17ft	1.00			0.13	0.13			0.18	1.64
Oisk	May	24ft	1.00			0.09	0.09			0.11	1.12
Fiald Cult-ivate & herbicide	May	18ft	1.00			0.11	0.11			0.15	1.17
Plant drill	June	6-30	1.00					0.20	0.20	0.26	1.59
Sprayer	June	30 ft	1.00					0.07	0.07	0.09	0.39
Combina	Oct	Larga	1.00		0.20					0.26	5.43
Medium Truck	Oct	400bu	1.00	0.66						0.86	0.66
Light Truck	Oct	pickup	1.00	0.66						0.86	1.27
Annual Total										2.96	17.50

[a]Machinery hours per acra are based on acras per hour reported in Ooanes Agricultural Report 3-25-87.

[b]Machinery hours are multiplied by 1.3 to estimate labor hours. Tha 1.3 factor is taken from Langemeier, L.N., O.H. Buller, and J.C. Kasper, Labor Requirements for Eastern Kansas Crops, Kansas Agr. Exp. Sta. Bul. 587, June 1975.

[c]Variable costs are based on Fullar, Earl I. and Calvin W. Dornbush, Minnesota Farm Machinery Economic Cost Estimatas Minnesota Extension Sarvice.

[d]Tractor 1 and tractor 2 have 140 and 75 horsa powar respectivaly.

Table A9. Postemergent and Preemergent Herbicide Mechinery Operations, 1987.

Machinery Opeation	Month	Size	Times Over	Truck This Budget	Combine Thia Budget	Trector 1[d] One Time Over[a]	Trector 1[d] Thie Budget	Trector 2[d] One Time Over[a]	Trector 2[d] Thia Budget	Labor Hours/ Acre Thia Budget[b]	Variable Cost $/Acre[c]
				Machinery Houra/Acre							
Disk	April	24ft	1.00			0.09	0.09			0.11	1.12
Fertilizer Buggy	April		1.00			0.07	0.07		0.00		3.11
Chisel Plow	April	17ft	1.00			0.13	0.13			0.18	1.64
Disk	May	24ft	1.00			0.09	0.09			0.11	1.12
Field Cult- ivate & herbicide	May	18ft	1.00			0.11	0.11			0.15	1.17
Plent	June	24ft	1.00					0.10	0.10	0.14	2.50
Sprayer	June	30 ft	1.00					0.07	0.07	0.09	0.39
Combine	Oct	Large	1.00		0.20					0.26	5.43
Medium Truck	Oct	400bu	1.00	0.66						0.86	0.66
Light Truck	Oct	pickup	1.00	0.66						0.86	1.27
Annual Total										2.75	18.41

[a]Machinery hours per acre are based on acres per hour reported in Doenes Agricultural Report 3-25-87.

[b]Machinery hours are multiplied by 1.3 to estimate labor hours. The 1.3 fector is taken from Langemeier, L.N., O.H. Buller, and J.C. Kasper, Labor Requirements for Eastern Kansas Crops, Kansas Agr. Exp. Sta. Bul. 587, June 1975.

[c]Veriable costs are based on Fuller, Earl I. and Calvin W. Dornbush, Minnesota Farm Machinery Economic Cost Estimates Minnesote Extension Service.

[d]Tractor 1 end trector 2 have 140 and 75 horse power respectively.

Table A10. No Herbicide and Shallow Preplant Machinery Operations with Cultivation, 1987

Machinery Operation	Month	Size	Times Over	Machinery Hours/Acre: Truck This Budget	Combine This Budget	Tractor 1[d]: One Time Over[a]	Tractor 1[d]: This Budget	Tractor 2[d]: One Time Over[a]	Tractor 2[d]: This Budget	Labor Hours/Acre This Budget[b]	Variable Cost $/acre[c]
Disk	April	24ft	1.00			0.09	0.09			0.11	1.12
Fertilizer Buggy	April		1.00			0.07	0.07			0.09	3.11
Chisel Plow	April	17ft	1.00			0.13	0.13			0.18	1.64
Disk	May	24ft	1.00			0.09	0.09			0.11	1.12
Field Cultivate & herbicide	May	18ft	1.00			0.11	0.11			0.15	1.17
Plant	June	6-30	1.00					0.20	0.20	0.26	2.50
Row Cultivation	July	6-30	1.00					0.17	0.17	0.22	1.11
Combine	Oct	Large	1.00		0.20					0.26	5.43
Medium Truck	Oct	400bu	1.00	0.66						0.86	0.66
Light Truck		pickup	1.00	0.66						0.86	1.27
Annual Total										3.09	19.13

[a]Machinery hours per acre are based on acres per hour reported in Doanes Agricultural Report 3-27-87.

[b]Machinery hours are multiplied by 1.3 to estimate labor hours. The 1.3 factor is taken from Langemeier, L.N., O.H. Buller, and J.C. Kasper,
Labor Requirements for Eastern Kansas Crops, Kansas Agr. Exp. Sta. Bul. 587, June 1975.

[c]Variable costs are based on Fuller, Earl I. and Calvin W. Oornbush, Minnesota Farm Machinery Economic Cost Estimates Minnesota Extension Service.

[d]Tractor 1 and tractor 2 have 140 and 75 horse powers respectively.

Table A11. No Herbicide and Shallow Preplant Incorporated Machinery Operations for Narrow Row, 1987.

Machinery Operation	Month	Size	Times Over	Machinery Hours/Acre: Truck This Budget	Combine This Budget	Tractor 1[d]: One Time Over[a]	Tractor 1[d]: This Budget	Tractor 2[d]: One Time Over[a]	Tractor 2[d]: This Budget	Labor Hours/Acre This Budget[b]	Variable Cost $/acre[c]
Disk	April	24ft	1.00			0.09	0.09			0.11	1.12
Fertilizer Buggy	April		1.00			0.07	0.07			0.09	3.11
Chisel Plow	April	17ft	1.00			0.13	0.13			0.18	1.64
Disk	May	24ft	1.00			0.09	0.09			0.11	1.12
Field Cultivate & herbicide	May	18ft	1.00			0.11	0.11			0.15	1.17
Plant	June	6-30	1.00					0.20	0.20	0.26	1.59
Combine	Oct	Large	1.00		0.20					0.26	5.43
Medium Truck	Oct	400bu	1.00	0.66						0.86	0.66
Light Truck	Oct	pickup	1.00	0.66						0.86	1.27
Annual Total										2.87	17.11

[a]Machinery hours per acre are based on acres per hour reported in Doanes Agricultural Report 3-25-86.

[b]Machinery hours are multiplied by 1.3 to estimate labor hours. The 1.3 factor is taken from Langemeier, L.N., O.H. Buller, and J.C. Kasper, Labor Requirements for Eastern Kansas Crops, Kansas Agr. Exp. Sta. Bul. 587, June 1975.

[c]Variable costs are based on Fuller, Earl I. and Calvin W. Dornbush, Minnesota Farm Machinery Economic Cost Estimates Minnesota Extension Service.

[d]Tractor 1 and tractor 2 have 140 and 75 horse power respectively.

Table A12. No Herbicide and Shallow Preplant Incorporated Mechinery Operations, 1987.

				Machinery Hours/Acre							
						Tractor 1[d]		Tractor 2[d]		Lebor Hours/	
Machinery Operetion	Month	Size	Times Over	Truck This Budget	Combine This Budget	One Time Over[a]	This Budget	One Time Over[a]	This Budget	Acre Thie Budget[b]	Variable Cost $/Acre[c]
Oisk	April	24ft	1.00			0.09	0.09			0.11	1.12
Fertilizer Buggy	April		1.00			0.07	0.07		0.00		3.11
Chisel Plow	April	17ft	1.00			0.13	0.13			0.18	1.64
Oisk	May	24ft	1.00			0.09	0.09			0.11	1.12
Field Cult-ivete & herbicide	May	18ft	1.00			0.11	0.11			0.15	1.17
Plant-Orill	June	24ft	1.00					0.10	0.10	0.14	2.50
Combine	Oct	Large	1.00		0.20					0.26	5.43
Medium Truck	Oct	400bu	1.00	0.66						0.86	0.66
Light Truck	Oct	pickup	1.00	0.66						0.86	1.27
Annual Total										2.66	18.02

[a]Machinery hours per acre are based on ecres per hour reported in Ooenes Agricultural Report 3-25-87.

[b]Mechinery hours are multiplied by 1.3 to estimate labor hours. The 1.3 factor is taken from Langemeier, L.N., O.H. Buller, end J.C. Kesper, Labor Requirements for Eastern Kansas Crops, Kansaa Agr. Exp. Sta. Bul. 587, June 1975.

[c]Variable costs ere based on Fuller, Earl I. and Calvin W. Oornbush, Minnesote Ferm Mechinery Economic Cost Estimates Minnesota Extension Service.

[d]Tractor 1 and tractor 2 have 140 end 75 horse power respectively.

Table A13. Postemergent and Preemergent Herbicide Machinery Operations with Cultivation, 1988

				Machinery Hours/Acre							
						Tractor 1[d]		Tractor 2[d]			
Machinery Operetion	Month	Size	Times Over	Truck This Budget	Combine This Budget	One Time Over[a]	Thie Budget	One Time Over[a]	This Budget	Labor Hours/ Acre This Budget[b]	Variable Cost $/ecre[c]
Oisk	April	24ft	1.00			0.09	0.09			0.11	1.25
Fertilizer Buggy	April		1.00			0.07	0.07			0.09	3.19
Chisel Plow	April	17ft	1.00			0.13	0.13			0.18	1.84
Oisk	May	24ft	1.00			0.09	0.09			0.11	1.25
Field Cult-ivete & herbicide	May	18ft	1.00			0.11	0.11			0.15	1.31
Plant	June	6-30	1.00					0.20	0.20	0.26	2.73
Sprayer	June	30 ft	1.00					0.07	0.07	0.09	0.43
Row Cult-ivetion	July	6-30	1.00					0.17	0.17	0.22	1.23
Combine	Oct	Large	1.00		0.20					0.26	5.92
Medium Truck	Oct	400bu	1.00	0.66						0.86	0.56
Light Truck		pickup	1.00	0.66						0.86	1.44
Annual Total										3.18	21.15

[a]Machinery hours per acre ere based on acres per hour reported in Ooenes Agricultural Report 3-27-88.

[b]Machinery hours are multiplied by 1.3 to estimate labor hours. The 1.3 fector is taken from Langemeier, L.N., O.H. Buller, end J.C. Kasper, Labor Requirements for Eestern Kansas Crops, Kansas Agr. Exp. Sta. Bul. 587, June 1975.

[c]Veriable costs ere based on Fuller, Earl I. end Celvin W. Oornbush, Minnesota Farm Machinery Economic Cost Estimates Minnesote Extension Service.

[d]Tractor 1 and tractor 2 heve 140 end 75 horse power respectively.

Table A14. Postemergent and Preemergent Herbicide Machinery Operations, 1988.

				Machinery Hours/Acre							
						Tractor 1[d]		Tractor 2[d]		Labor Hours/	
Machinery Operation	Month	Size	Times Over	Truck This Budget	Combine This Budget	One Time Over[a]	This Budget	One Time Over[a]	This Budget	Acre This Budget[b]	Variable Cost $/acre[c]
Disk	April	24ft	1.00			0.09	0.09			0.11	1.25
Fertilizer Buggy	April		1.00			0.07	0.07			0.09	3.19
Chisel Plow	April	17ft	1.00			0.13	0.13			0.18	1.84
Disk	May	24ft	1.00			0.09	0.09			0.11	1.25
Field Cultivate & herbicide	May	18ft	1.00			0.11	0.11			0.15	1.31
Plant	June	6-30	1.00					0.20	0.20	0.26	2.73
Sprayer	June	30 ft	1.00					0.07	0.07	0.09	0.43
Combine	Oct	Large	1.00		0.20					0.26	5.92
Medium Truck	Oct	400bu	1.00	0.66						0.86	0.56
Light Truck	Oct	pickup	1.00	0.66						0.86	1.44
Annual Total										2.96	19.92

[a]Machinery hours per acre are based on acres per hour reported in Doanes Agricultural Report 3-25-88.

[b]Machinery hours are multiplied by 1.3 to estimate labor hours. The 1.3 factor is taken from Langemeier, L.N., O.H. Buller, and J.C. Kasper, Labor Requirements for Eastern Kansas Crops, Kansas Agr. Exp. Sta. Bul. 587, June 1975.

[c]Variable costs are based on Fuller, Earl I. and Calvin W. Dornbush, Minnesota Farm Machinery Economic Cost Estimates Minnesota Extension Service.

[d]Tractor 1 and tractor 2 have 140 and 75 horse power respectively.

Table A15. Postemergent and Preemergent Herbicide Machinery Operations for Narrow Row, 1988.

Machinery Operation	Month	Size	Times Over	Machinery Hours/Acre: Truck This Budget	Combine This Budget	Tractor 1[d]: One Time Over[a]	This Budget	Tractor 2[d]: One Time Over[a]	This Budget	Labor Hours/ Acre This Budget[b]	Variable Cost $/Acre[c]
Disk	April	24ft	1.00			0.09	0.09			0.11	1.25
Fertilizer Buggy	April		1.00			0.07	0.07		0.00	0.09	3.19
Chisel Plow	April	17ft	1.00			0.13	0.13			0.18	1.84
Disk	May	24ft	1.00			0.09	0.09			0.11	1.25
Field Cultivate & herbicide	May	18ft	1.00			0.11	0.11			0.15	1.31
Plant-Drill	June	24ft	1.00					0.10	0.10	0.14	1.74
Sprayer	June	30 ft	1.00					0.07	0.07	0.09	0.43
Combine	Oct	Large	1.00		0.20					0.26	5.92
Medium Truck	Oct	400bu	1.00	0.66						0.86	0.56
Light Truck	Oct	pickup	1.00	0.66						0.86	1.44
Annual Total										2.83	18.93

[a]Machinery hours per acre are based on acres per hour reported in Doanes Agricultural Report 3-25-88.

[b]Machinery hours are multiplied by 1.3 to estimate labor hours. The 1.3 factor is taken from Langemeier, L.N., O.H. Buller, and J.C. Kasper, Labor Requirements for Eastern Kansas Crops, Kansas Agr. Exp. Sta. Bul. 587, June 1975.

[c]Variable costs are based on Fuller, Earl I. and Calvin W. Dornbush, Minnesota Farm Machinery Economic Cost Estimates Minnesota Extension Service.

[d]Tractor 1 and tractor 2 have 140 and 75 horse power respectively.

Table A16. No Herbicide and Shallow Preplant Machinery Operations with Cultivation, 1988

				Machinery Hours/Acre							
						Tractor 1[d]		Tractor 2[d]		Labor Hours/	
Machinery Operation	Month	Size	Times Over	Truck This Budget	Combine This Budget	One Time Over[a]	This Budget	One Time Over[a]	This Budget	Acre This Budget[b]	Variable Cost $/acre[c]
Disk	April	24ft	1.00			0.09	0.09			0.11	1.25
Fertilizer Buggy	April		1.00			0.07	0.07			0.09	3.19
Chisel Plow	April	17ft	1.00			0.13	0.13			0.18	1.84
Disk	May	24ft	1.00			0.09	0.09			0.11	1.25
Field Cultivate & herbicide	May	18ft	1.00			0.11	0.11			0.15	1.31
Planter	June	6-30	1.00					0.20	0.20	0.26	2.73
Row Cultivation	July	6-30	1.00					0.17	0.17	0.22	1.23
Combine	Oct	Large	1.00		0.20					0.26	5.92
Medium Truck	Oct	400bu	1.00	0.66						0.86	0.56
Light Truck		pickup	1.00	0.66						0.86	1.44
Annual Total										3.09	20.72

[a]Machinery hours per acre are based on acres per hour reported in Doanes Agricultural Report 3-27-88.

[b]Machinery hours are multiplied by 1.3 to estimate labor hours. The 1.3 factor is taken from Langemeier, L.N., O.H. Buller, and J.C. Kasper, Labor Requirements for Eastern Kansas Crops, Kansas Agr. Exp. Sta. Bul. 587, June 1975.

[c]Variable costs are based on Fuller, Earl I. and Calvin W. Dornbush, Minnesota Farm Machinery Economic Cost Estimates Minnesota Extension Service.

[d]Tractor 1 and tractor 2 have 140 and 75 horse power respectively.

Table A17. No Herbicide and Shallow Preplant Incorporated Machinery Operations, 1988.

Machinery Operation	Month	Size	Times Over	Machinery Hours/Acre: Truck This Budget	Combine This Budget	Tractor 1[d]: One Time Over[a]	Tractor 1[d]: This Budget	Tractor 2[d]: One Time Over[a]	Tractor 2[d]: This Budget	Labor Hours/Acre This Budget[b]	Variable Cost $/acre[c]
Disk	April	24ft	1.00			0.09	0.09			0.11	1.25
Fertilizer Buggy	April		1.00			0.07	0.07			0.09	3.19
Chisel Plow	April	17ft	1.00			0.13	0.13			0.18	1.84
Disk	May	24ft	1.00			0.09	0.09			0.11	1.25
Field Cult-ivate & herbicide	April	18ft	1.00			0.11	0.11			0.15	1.31
Plant	June	6-30	1.00					0.20	0.20	0.26	2.73
Combine	Oct	Large	1.00		0.20					0.26	5.92
Medium Truck	Oct	400bu	1.00	0.66						0.86	0.56
Light Truck	Oct	pickup	1.00	0.66						0.86	1.44
Annual Total										2.87	19.49

[a]Machinery hours per acre are based on acres per hour reported in Doanes Agricultural Report 3-25-88.

[b]Machinery hours are multiplied by 1.3 to estimate labor hours. The 1.3 factor is taken from Langemeier, L.N., O.H. Buller, and J.C. Kasper, Labor Requirements for Eastern Kansas Crops, Kansas Agr. Exp. Sta. Bul. 587, June 1975.

[c]Variable costs are based on Fuller, Earl I. and Calvin W. Oornbush, Minnesota Farm Machinery Economic Cost Estimates Minnesota Extension Service.

[d]Tractor 1 and tractor 2 have 140 and 75 horse power respectively.

Table A18. No Herbicide and Shellow Preplant Incorporated Mechinery Operations for Narrow Row, 1988.

Machinery Operetion	Month	Size	Times Over	Mechinery Hours/Acre: Truck This Budget	Combine This Budget	Tractor 1[d]: One Time Over[a]	Tractor 1[d]: Thie Budget	Trector 2[d]: One Time Over[a]	Trector 2[d]: This Budget	Lebor Hours/ Acre Thie Budget[b]	Variable Cost $/Acre[c]
Disk	April	24ft	1.00			0.09	0.09			0.11	1.25
Fertilizer Buggy	April		1.00			0.07	0.07		0.00	0.09	3.19
Chisel Plow	April	17ft	1.00			0.13	0.13			0.18	1.84
Disk	May	24ft	1.00			0.09	0.09			0.11	1.25
Field Cult-ivete & herbicide	May	18ft	1.00			0.11	0.11			0.15	1.31
Plant-Drill	June	24ft	1.00					0.10	0.10	0.14	1.74
Combine	Oct	Lerge	1.00		0.20					0.26	5.92
Medium Truck	Oct	400bu	1.00	0.66						0.86	0.56
Light Truck	Oct	pickup	1.00	0.66						0.86	1.44
Annuel Total										2.74	18.50

[a]Mechinery hours per acre are based on acres per hour reported in Doanes Agricultural Report 3-25-88.

[b]Machinery hours are multiplied by 1.3 to estimate labor hours. The 1.3 factor is taken from Langemeier, L.N., O.H. Buller, and J.C. Kasper, Labor Requirements for Eastern Kensas Crops, Kanses Agr. Exp. Sta. Bul. 587, June 1975.

[c]Veriable costs are based on Fuller, Eerl I. end Celvin W. Dornbush, Minnesota Ferm Machinery Economic Cost Estimates Minnesote Extension Service.

[d]Tractor 1 and trector 2 heve 140 end 75 horse power respectively.

APPENDIX B

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Table B-1. Benefits and Costs of Alternative Herbicides for Cocklebur Control in Soybeans with Narrow Row 1986 50

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Table B-9. Benefits and Costs of Alternative Herbicides for Cocklebur Control in Soybeans with Wide with One Cultivation, 1988 58

Table B-1. Benefits and Costs of Alternative Herbicides for Cocklebur Control in Soybeans with Narrow Row 1986[a]

Herbicide and Application Method[b]	Dollars per Acre							
	COSTS OF WEED CONTROL (c)					Benefits of weed control[d]	Benefit minus cost	Benefit/cost Ratio
	Herbicide	Sprayer	Labor	Interest	Total			
Canopy[e] S PPI	15.31	0	0	0.92	16.23	96.01	79.78	5.92
Canopy Pre	15.31	0.44	0.55	0.98	17.28	98.74	81.46	5.71
Scepter[e] S PPI	13.71	0	0	0.82	14.53	86.00	71.46	5.92
Basagran Post + Liq N	6.9	0.44	0.55	0.47	8.36	103.74	95.38	12.40
Classic Post + Liq N	10.36	0.44	0.55	0.68	12.03	65.52	53.49	5.45
Scepter Post + Liq N	13.87	0.44	0.55	0.89	15.75	78.26	62.51	4.97
Rescue Post + Liq N	6.53	0.44	0.55	0.45	7.97	66.89	58.91	8.39

[a] Yields and herbicide data were collected at the Southeast Kansas Branch Experiment Station, Columbus, Kansas. See Kelley, Kenneth, "Comparison of Soybean Herbicides for Cocklebur Control in Narrow and Wide Row Spacings," 1987 Agricultural Research, Southeast Kansas Branch Station, Rpt. of Progress, Agr. Exp. Stn., Kansas State University, 1986.

[b] S. PPI represents Shallow Preplant Incorporated, Pre represents Preemergent, and Post represents Postemergent herbicide application.

[c] Herbicide costs are from Nilson et al. "Chemical Weed Control for Field Crops, Pastures, Rangeland, and Noncropland, 1988," Rpt. of Progress 530, Agr. Exp. Sta., Kansas State University, Jan. 1986. Machinery operating costs (fuel, repairs, and lubrication) are based on prices for new machinery from Fuller, Earl I, and Mark F. McGuire, Minnesota Farm Machinery Economic Cost Estimates for 1988, Minnesota Extension Service, University of Minnesota, AG-FO-2308, revised 1986. Time for machinery operations was multiplied by 1.3 to provide the hours of labor. Output price, seed price, interest rate, and wage rate are from Figuriski and Schlender, "Soybean Production in Eastern Kansas" KSU Farm Management Guide, MF-570, Dept. of Agr. Econ., Kansas State University, Revised Aug, 1986. Total costs include herbicide, sprayer, cultivator, and interest on half of variable costs. The labor costs used to control weeds are for the sprayer.

[d] Benefits are calculated as added yield multiplied by price per bushel. Added yields were obtained by subtracting the yields with no herbicide from the yields with herbicide application. The yield on the 'no herbicide' treatment was 14.1 bushels per acre.

[e] Treflan was applied to all treatments for grass control. Since the preplant herbicides for cocklebur control can be applied with Treflan, sprayer costs were not included in the preplant treatments.

Table B-2. Benefits and Costs of Alternative Herbicides for Cocklebur Control in Soybeans with WIDE ROW 1986[a]

Herbicide and Application Method[b]	Dollars per Acre							
	COSTS OF WEED CONTROL[c]					Benefits of weed control[d]	Benefit minus cost	Benefit/cost Ratio
	Herbicide	Sprayer	Labor	Interest	Total			
Canopy[e] S PPI	15.31	0	0	0.92	16.23	85.54	69.31	5.27
Canopy Pre	15.31	0.44	0.55	0.98	17.28	97.83	80.55	5.66
Scepter[e] S PPI	13.71	0	0	0.82	14.53	100.56	86.02	6.92
Basagran Post +Liq N	6.9	0.44	0.55	0.47	8.36	90.09	81.73	10.77
Classic Post + Liq N	10.36	0.44	0.55	0.68	12.03	62.34	50.30	5.18
Scepter Post + Liq N	13.87	0.44	0.55	0.89	15.75	83.27	67.51	5.29
Rescue Post + Liq N	6.53	0.44	0.55	0.45	7.97	30.49	22.51	3.82

[a] Yields and herbicide data were collected at the Southeast Kansas Branch Experiment Station, Columbus, Kansas. See Kelley, Kenneth, "Comparison of Soybean Herbicides for Cocklebur Control in Narrow and Wide Row Spacings," 1987 Agricultural Research, Southeast Kansas Branch Station, Rpt. of Progress, Agr. Exp. Stn., Kansas State University, 1987.

[b] S. PPI represents Shallow Preplant Incorporated, Pre represents Preemergent, and Post represents Postemergent herbicide application.

[c] Herbicide costs are from Nilson et al. "Chemical Weed Control for Field Crops, Pastures, Rangeland, and Noncropland, 1988," Rpt. of Progress 530, Agr. Exp. Sta., Kansas State University, Jan. 1986. Machinery operating costs (fuel, repairs, and lubrication) are based on prices for new machinery from Fuller, Earl I, and Mark F. McGuire, Minnesota Farm Machinery Economic Cost Estimates for 1988, Minnesota Extension Service, University of Minnesota, AG-FO-2308, revised 1986. Time for machinery operations was multiplied by 1.3 to provide the hours of labor. Output price, seed price, interest rate, and wage rate are from Figuriski and Schlender, "Soybean Production in Eastern Kansas" KSU Farm Management Guide, MF-570, Dept. of Agr. Econ., Kansas State University, Revised Aug, 1986. Total costs include herbicide, sprayer, cultivator, and interest on half of variable costs. The labor costs used to control weeds are for the sprayer.

[d] Benefits are calculated as added yield multiplied by price per bushel. Added yields were obtained by subtracting the yields with no herbicide from the yields with herbicide application. The yield on the 'no herbicide' treatment was 5.6 bushels per acre.

[e] Treflan was applied to all treatments for grass control. Since the preplant herbicides for cocklebur control can be applied with Treflan, sprayer costs were not included in the preplant treatments.

Table B-3. Benefits and Costs of Alternative Herbicides for Cocklebur Control in Soybeans with Wide Row with Cultivation 1986[a]

Herbicide and Application Method[b]	Dollars per Acre								
	COSTS OF WEED CONTROL[c]						Benefits of weed control[d]	Benefit minus cost	Benefit/cost Ratio
	Herbicide	Sprayer	Cultivation	Labor	Interest	Total			
Canopy[e] S PPI	15.31	0	1.32	0.17	1.01	17.81	45.96	28.15	2.58
Canopy Pre	15.31	0.44	1.32	1.89	1.14	20.10	49.14	29.04	2.45
Sceptar[e] S PPI	13.71	0	1.32	1.34	0.98	17.35	48.69	31.33	2.81
Basagran +Liq H Post	6.9	0.44	1.32	1.89	0.63	11.18	63.25	52.06	5.6
Classic Post +Liq H	10.36	0.44	1.32	1.89	0.84	14.85	48.23	33.38	3.25
Scepter Post +Liq H	13.87	0.44	1.32	1.89	1.05	18.57	50.96	32.39	2.74
Rascue Post +Liq H	6.53	0.44	1.32	1.89	0.61	10.79	-0.46	-11.25	-0.04

[a] Yields and herbicide data were collected at the Southeast Kansas Branch Experiment Station, Columbus, Kansas. See Kelley, Kenneth, "Comparison of Soybean Herbicides for Cocklebur Control in Narrow and Wide Row Spacings," 1987 Agricultural Research, Southeast Kansas Branch Station, Rpt. of Progress, Agr. Exp. Stn., Kansas State University, 1987.

[b] S. PPI represents Shallow Preplant Incorporated, Pre represents Preemergent, and Post represents Postemergent herbicide application.

[c] Herbicide costs are from Nilson et al. "Chemical Weed Control for Field Crops, Pastures, Rangeland, and Noncropland, 1988," Rpt. of Progress 530, Agr. Exp. Sta., Kansas State University, Jan. 1986. Machinery operating costs (fuel, repairs, and lubrication) are based on prices for new machinery from Fuller, Earl I, and Mark F. McGuire, Minnesota Farm Machinery Economic Cost Estimates for 1988, Minnesota Extension Service, University of Minnesota, AG-FO-2308, revised 1986. Time for machinery operations was multiplied by 1.3 to provide the hours of labor. Output price, seed price, interest rate, and wage rate are from Figuriski and Schlander, "Soybean Production in Eastern Kansas" KSU Farm Management Guide, MF-570, Dept. of Agr. Econ., Kansas State University, Revised Aug, 1986. Total costs include herbicide, sprayer, cultivator, and interest on half of variable costs. The labor costs used to control weeds are for cultivation and sprayer.

[d] Benefits are calculated as added yield multiplied by price per bushel. Added yields were obtained by subtracting the yields with no herbicide from the yields with herbicide application. The yield on the 'no herbicide' treatment was 18.8 bushels per acre.

[e] Treflan was applied to all treatments for grass control. Since the preplant herbicides for cocklebur control can be applied with Treflan, sprayer costs were not included in the preplant treatments.

Table B-4. Benefits and Costs of Alternative Herbicides for Cocklebur Control in Soybeans with Narrow Row 1987[a]

Herbicide and Application Method[b]	Dollars per Acre: COSTS OF WEED CONTROL[c] Herbicide	Sprayer	Labor	Interest	Total	Benefits of weed control[d]	Benefit minus cost	Benefit /cost Ratio
Canopy Pre	15.00	0.39	0.55	0.96	16.90	56.95	40.06	3.37
Preview Pre	13.25	0.39	0.55	0.85	15.04	74.59	59.55	4.96
Scepter Pre	13.44	0.39	0.55	0.86	15.24	73.58	58.34	4.83
Basagran + Liq N Post	6.76	0.39	0.55	0.46	8.16	101.81	93.65	12.47
Classic Post +Liq N	10.15	0.39	0.55	0.67	11.76	60.98	49.23	5.19
Scepter Post + Liq N	13.59	0.39	0.55	0.87	15.40	14.82	58.26	4.74
Rescue Post + Liq N	6.40	0.39	0.55	0.44	7.78	7.20	27.00	4.47

[a] Yields and herbicide data were collected at the Southeast Kansas Branch Experiment Station, Columbus, Kansas. See Kelley, Kenneth, "Comparison of Soybean Herbicides for Cocklebur Control in Narrow and Wide Row Spacings," 1988 Agricultural Research, Southeast Kansas Branch Station, Rpt. of Progress, Agr. Exp. Stn., Kansas State University, 1988.

[b] S. PPI represents Shallow Preplant Incorporated, Pre represents Preemergent, and Post represents Postemergent herbicide application.

[c] Herbicide costs are from Nilson et al. "Chemical Weed Control for Field Crops, Pastures, Rangeland, and Noncropland, 1988," Rpt. of Progress 530, Agr. Exp. Stn., Kansas State University, Jan. 1987. Machinery operating costs (fuel, repairs, and lubrication) are based on prices for new machinery from Fuller, Earl I, and Mark F. McGuire, Minnesota Farm Machinery Economic Cost Estimates for 1987, Minnesota Extension Service, University of Minnesota, AG-FO-2308, revised 1987. Time for machinery operations was multiplied by 1.3 to provide the hours of labor. Output price, seed price, interest rate, and wage rate are from Figuriski and Schlender, "Soybean Production in Eastern Kansas" KSU Farm Management Guide, MF-570, Dept. of Agr. Econ., Kansas State University, Revised Aug, 1987. Total costs include herbicide, sprayer, cultivator, and interest on half of variable costs. The labor costs used to control weeds are for the sprayer.

[d] Benefits are calculated as added yield multiplied by price per bushel. Added yields were obtained by subtracting the yields with no herbicide from the yields with herbicide application. The yield on the 'no herbicide' treatment was 14.0 bushels per acre.

Table B-5. Benefite end Costs of Alternative Herbicides for Cocklebur Control in Soybeens with Wide Row 1987[a]

Herbicide and Applicetion Method[b]		Dollers per Acre							
		COSTS OF WEED CONTROL[c]					Benefits of weed control[d]	Benefit minus cost	Benefit /cost Retio
		Herbicide	Spreyer	lebor	interest	total			
Cenopy	Pre	15.00	0.39	0.55	0.96	16.90	71.06	54.17	4.21
Preview	Pre	13.25	0.39	0.55	0.85	15.04	58.46	43.42	3.89
Scepter	Pre	13.44	0.39	0.55	0.86	15.24	81.65	66.41	5.36
Basagran +Liq N	Post	6.76	0.39	0.55	0.46	8.16	82.15	73.99	10.07
Classic + Liq N	Post	10.15	0.39	0.55	0.67	11.76	66.02	54.27	5.62
Scepter +Liq N	Post	13.59	0.39	0.55	0.87	15.40	73.58	58.18	4.78
Rescue + Liq N	Post	6.40	0.39	0.55	0.44	7.78	41.33	33.55	5.31

[a] Yields and herbicide data were collected et the Southeast Kansas Branch Experiment Stetion, Columbus, Kansas. See Kelley, Kenneth, "Comparison of Soybean Herbicides for Cocklebur Control in Narrow and Wide Row Spacings," 1988 Agricultural Research, Southeast Kansas Branch Station, Rpt. of Progress, Agr. Exp. Stn., Kansas State University, 1988.

[b] S. PPI represents Shallow Preplant Incorporeted, Pre represents Preemergent, and Post represents Postemergent herbicide application.

[c] Herbicide costs are from Nilson et el. "Chemical Weed Control for Field Crops, Pastures, Rangeland, and Noncropland, 1988," Rpt. of Progress 530, Agr. Exp. Ste., Kansas State University, Jan. 1987. Machinery operating costs (fuel, repairs, end lubrication) are based on prices for new machinery from Fuller, Earl I, and Mark F. McGuire, Minnesote Farm Machinery Economic Cost Estimates for 1987, Minnesota Extension Service, University of Minnesote, AG-FO-2308, revised 1987. Time for machinery operations was multiplied by 1.3 to provide the hours of labor. Output price, seed price, interest rate, and wage rete ere from Figuriski and Schlender, "Soybeen Production in Eastern Kensas" KSU Farm Management Guide, MF-570, Dept. of Agr. Econ., Kenses Stete University, Revised Aug, 1987. Totel costs include herbicide, spreyer, cultivator, and interest on helf of veriable costs. The labor costs used to control weeds are for cultivation end spreyer.

[d] Benefits are calculeted as added yield multiplied by price per bushel. Added yields were obtained by subtracting the yields with no herbicide from the yields with herbicide applicetion. The yield on the 'no herbicide' treetment was 13.2 bushels per ecre.

Teble B-6. Benefits end Costs of Alternative Herbicidee for Cocklebur Control in Soybeens with Wide Row with Cultivetion 1987[a]

Herbicide end Appl-icetion Method[b]	Dollers per Acre								
	COSTS OF WEED CONTROL[c]								
	Herbicide	Sprayer	Cultiv-etion	Lebor	Interest	Totel	Benefite of weed control[d]	Benefit minus cost	Benefit/ Cost Retio
Cenopy Pre	15.00	0.39	1.11	1.89	1.10	19.49	75.10	55.60	3.85
Preview Pre	13.25	0.39	1.11	1.89	1.00	17.64	73.58	55.95	4.17
Scepter Pre	13.44	0.39	1.11	1.89	1.01	17.84	53.42	35.58	2.99
Basagran Post +Liq N	6.76	0.39	1.11	1.89	0.61	10.76	75.60	64.84	7.03
Classic Post + liq N	10.15	0.39	1.11	1.89	0.81	14.35	68.54	54.19	4.78
Scepter Post + liq N	13.59	0.39	1.11	1.89	1.02	18.00	71.57	53.57	3.98
Rescue Post + liq N	6.40	0.39	1.11	1.89	0.59	10.38	46.87	36.49	4.52

[a] Yields end herbicide dete were collected et the Southeest Kenses Brench Experiment Station, Columbus, Kanses. See Kelley, Kenneth, "Comparison of Soybean Herbicides for Cocklebur Control in Narrow end Wide Row Spacings," 1988 Agricultural Research, Southeast Kansas Brench Station, Rpt. of Progress, Agr. Exp. Stn., Kenses State University, 1988.

[b] S. PPI represents Shellow Preplent Incorporeted, Pre represents Preemergent, end Post represents Postemergent herbicide epplicetion.

[c] Herbicide costs ere from Nilson et el. "Chemicel Weed Control for Field Crops, Pestures, Rangeland, end Noncroplend, 1988," Rpt. of Progress 530, Agr. Exp. Sta., Kenses State University, Jen. 1987. Machinery opereting costs (fuel, repairs, end lubricetion) ere based on prices for new machinery from Fuller, Eerl I, end Merk F. McGuire, Minnesote Ferm Mechinery Economic Cost Estimates for 1987, Minnesote Extension Service, University of Minnesote, AG-FO-2308, revised 1987. Time for machinery operations wes multiplied by 1.3 to provide the hours of lebor. Output price, seed price, interest rete, end wege rete ere from Figuriski end Schlender, "Soybeen Production in Eestern Kensas" KSU Ferm Management Guide, MF-570, Dept. of Agr. Econ., Kanses State University, Revised Aug, 1987. Totel costs include herbicide, spreyer, cultivetor, end interest on helf of verieble costs. The lebor costs used to control weeds ere for the spreyer end cultivetor.

[d] Benefits ere calculeted es edded yield multiplied by price per bushel. Added yields were obteined by subtracting the yields with no herbicide from the yields with herbicide application. The yield on the 'no herbicide' treatment wes 19.1 bushels per ecre.

Teble 8-7. Benefits end Coets of Alternative Nerbicidee for Cocklebur Control in Soybeens with Nsrrow Row 1988[a]

Nerbicide and Application Method[b]		Dollers per Acre							
		COSTS OF WEED CONTROL[c]					Benefits of weed control[d]	Benefit minus cost	Benefit /cost Ratio
		Herbicide	Sprayer	Labor	Interest	Total			
Cenopy[e]	S.PPI	15.25	0.00	0.00	0.92	16.17	163.40	147.24	10.11
Scepter[e]	S.PPI	13.26	0.00	0.00	0.80	14.06	134.03	119.98	9.54
Canopy	Pre	15.25	0.43	0.55	0.97	17.20	170.93	153.73	9.94
Preview	Pre	13.25	0.43	0.55	0.85	15.08	165.66	150.58	10.98
Scepter	Pre	13.26	0.43	0.55	0.85	15.09	114.46	99.36	7.58
Besagren + Liq N	Post	6.74	0.43	0.55	0.46	8.18	164.91	156.72	20.15
Clessic + liq N	Post	10.33	0.43	0.55	0.68	11.99	175.45	163.46	14.63
Scepter + liq N	Post	13.44	0.43	0.55	0.87	15.29	161.14	145.86	10.54
Rescue + Liq N	Post	6.18	0.43	0.55	0.43	7.59	119.73	112.14	15.78

[a] Yields and herbicide data were collected at the Southeest Kenses Branch Experiment Station, Columbus, Kansas. See Kelley, Kenneth, "Comparison of Soybeen Herbicides for Cocklebur Control in Nerrow end Wide Row Specings," 1989 Agriculturel Research, Southeast Kanses Branch Station, Rpt. of Progress 571, Agr. Exp. Stn., Kansas State University, 1989.

[b] S. PPI represents Shallow Preplant Incorporsted, Pre represents Preemergent, end Post represents Postemergent herbicide application.

[c] Nerbicide coste ere from Nilson et el. "Chemicel Weed Control for Field Crops, Pastures, Rangeland, and Noncropland, 1988," Rpt. of Progress 530, Agr. Exp. Ste., Kensas State University, Jan. 1988. Machinery opereting coste (fuel, repairs, and lubrication) are based on prices for new machinery from Fuller, Eerl I, end Merk F. McGuire, Minnesota Ferm Machinery Economic Cost Estimates for 1988, Minnesote Extension Service, University of Minnesote, AG-FO-2308, revised 1988. Time for machinery operations was multiplied by 1.3 to provide the houre of lebor. Output price, seed price, intereet rete, snd wage rete is from Figuriski end Schlender, "Soybeen Production in Eastern Kansas" KSU Farm Management Guide, MF-570, Dept. of Agr. Econ., Kenses State University, Revised Aug, 1988. Totel costs include herbicide, spreyer, end interest on helf of verieble costs. The labor costs used to control weeds are for the sprayer.

[d] Benefits ere celculeted es added yield multiplied by price per bushel. Added yields were obtained by subtracting the yields with no herbicide from the yields with herbicide applicetion. The yield on the 'no herbicide' treetment wes 9.0 bushele per ecre.

[e] Trefler wes epplied to ell treatments for grase control. Since the preplent herbicides for cocklebu control csn be applied with Treflan, spreyer costs were not included in the preplent treatmen s.

Table B-8. Benefits and Costs of Alternative Herbicides for Cocklebur Control in Soybeans with Wide Row 1988[a]

	Dollars per Acre							
Herbicide and Application Method[b]	COSTS OF WEED CONTROL[c]					Benefits of weed control[d]	Benefit minus cost	Benefit/ Cost Ratio
	Herbicide	Sprayer	Labor	Interest	Total			
Canopy[e] S.PPI	15.25	0.00	0.00	0.92	16.17	115.96	99.80	7.17
Scepter[e] S.PPI	13.26	0.00	0.00	0.80	14.06	106.17	92.12	7.55
Canopy Pre	15.25	0.43	0.55	0.97	17.20	103.16	85.96	6.00
Preview Pre	13.25	0.43	0.55	0.85	15.08	117.47	102.38	7.79
Scepter Pre	13.26	0.43	0.55	0.85	15.09	105.42	90.33	6.98
Basagran + Liq N Post	6.74	0.43	0.55	0.46	8.18	123.49	115.31	15.09
Classic +liq N Post	10.33	0.43	0.55	0.68	11.99	116.72	104.73	9.74
Scepter +liq N Post	13.44	0.43	0.55	0.87	15.29	115.96	100.68	7.59
Rescue +Liq N Post	6.18	0.43	0.55	0.43	7.59	56.48	48.89	7.44

[a] Yields and herbicide data were collected at the Southeast Kansas Branch Experiment Station, Columbus, Kansas. See Kelley, Kenneth, "Comparison of Soybean Herbicides for Cocklebur Control in Narrow and Wide Row Spacings," 1989 Agricultural Research, Southeast Kansas Branch Station, Rpt. of Progress 571, Agr. Exp. Stn., Kansas State University, 1989.

[b] S. PPI represents Shallow Preplant Incorporated, Pre represents Preemergent, and Post represents Postemergent herbicide application.

[c] Herbicide costs are from Nilson et al. "Chemical Weed Control for Field Crops, Pastures, Rangeland, and Noncropland, 1988," Rpt. of Progress 530, Agr. Exp. Sta., Kansas State University, Jan. 1988. Machinery operating costs (fuel, repairs, and lubrication) are based on prices for new machinery from Fuller, Earl I, and Merk F. McGuire, Minnesota Farm Machinery Economic Cost Estimates for 1988, Minnesota Extension Service, University of Minnesota, AG-FO-2308, revised 1988. Time for machinery operations was multiplied by 1.3 to provide the hours of labor. Output price, seed price, interest rate, and wage rate is from Figuriski and Schlender, "Soybean Production in Eastern Kansas" KSU Farm Management Guide, MF-570, Dept. of Agr. Econ., Kansas State University, Revised Aug, 1988. Total costs include herbicide, sprayer, cultivator, and interest on half of variable costs. Interest and total costs are calculated with and without labor. The labor costs used to control weeds are for cultivation and for sprayer.

[d] Benefits are calculated as added yield multiplied by price per bushel. Added yields were obtained by subtracting the yields with no herbicide from the yields with herbicide application. The yield on the 'no herbicide' treatment was 5.8 bushels per acre.

[e] Treflan was applied to all treatments for grass control. Since the preplant herbicides for cocklebur control can be applied with Treflan, sprayer costs were not included in the preplant treatments.

Table B-9. Benefita and Costs of Alternative Herbicidea for Cocklebur Control in Soybeans with Wide with One Cultivation, 1988[a]

Herbicide and Application Method[b]		Dollars per Acre								
		COSTS OF WEED CONTROL[c]						Benefits of weed control[d]	Benefit minus cost	Benefit/ Cost Rstio
		Herbicide	Sprsyer	Culti-vator	Labor	Interest	Total			
Canopy[e]	S.PPI	15.25	0.00	1.23	1.34	1.07	18.89	90.36	71.47	4.78
Scepter[e]	S.PPI	13.26	0.00	1.23	1.34	0.95	16.78	71.54	54.76	4.26
Canopy	Pre	15.25	0.43	1.23	1.89	1.13	19.93	95.63	75.70	4.80
Preview	Pre	13.25	0.43	1.23	1.89	1.01	17.81	81.32	63.52	4.57
Scepter	Pre	13.26	0.43	1.23	1.89	1.01	17.82	85.84	68.02	4.82
Bassgrsn +Liq N	Post	6.74	0.43	1.23	1.89	0.62	10.91	117.47	106.56	10.77
Classic +liq N	Post	10.33	0.43	1.23	1.89	0.83	14.71	128.76	114.05	8.75
Scepter +liq N	Post	13.44	0.43	1.23	1.89	1.02	18.01	136.29	118.28	7.57
Rescue +Liq N	Post	6.18	0.43	1.23	1.89	0.58	10.31	40.66	30.35	3.94

[a] Yields and herbicide deta were collected at the Southeast Kansas Branch Experiment Station, Columbus, Kanaas. See Kelley, Kenneth, "Comparison of Soybean Herbicides for Cocklebur Control in Narrow and Wide Row Spacings," 1989 Agricultural Resesrch, Southeast Kansas Branch Station, Rpt. of Progress 571, Agr. Exp. Stn., Kansas State University, 1989.

[b] S. PPI represents Shallow Preplant Incorporated, Pre represents Preemergent, and Post representa Postemergent herbicide application.

[c] Herbicide costs are from Nilson et al. "Chemical Weed Control for Field Crops, Pastures, Rangelsnd, and Noncropland, 1988," Rpt. of Progress 530, Agr. Exp. Sta., Kansas State University, Jan. 1988. Machinery operating costs (fuel, repairs, and lubrication) are based on prices for new machinery from Fuller, Earl I, and Mark F. McGuire, Minnesota Farm Machinery Economic Coat Estimates for 1988, Minnesota Extension Service, Univeraity of Minnesota, AG-FO-2308, revised 1988. Time for machinery operations was multiplied by 1.3 to provide tha hours of labor. Output price, seed price, interest rate, and wage rate is from Figuriski and Schlender, "Soybean Production in Eastern Ksnsas" KSU Farm Management Guide, MF-570, Dept. of Agr. Econ., Kansas State University, Revised Aug, 1988. Total costs include herbicide, sprayer, cultivator, and interest on half of variable costs. Interest and total costs are calculated with and without labor. The labor costs used to control weeds are for cultivation and for sprayer.

[d] Benefits are calculated as added yield multiplied by price per bushel. Added yields were obtained by subtracting the yields with no herbicide from the yields with herbicide application. The yield on the 'no herbicide' treatment was 10.8 bushels per acre.

[e] Treflan was applied to all treatments for grass control. Since the preplant herbicides for cocklebur control can be applied with Treflan, sprayar costs were not included in the preplant treatments.

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WEED INTERFERENCE IN SOYBEANS: A BIOECONOMIC ANALYSIS OF COCKLEBUR CONTROL USING ALTERNATIVE HERBICIDES AND MANAGEMENT SYSTEMS

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ABSTRACT

The productivity of different herbicides and row spacings for cocklebur (Xanthium strumarium) control in soybeans at the Columbus Experiment Station in Kansas was economically evaluated with three years data. Alternative herbicide applications were done with the following trade names, Canopy preplant incorporated and preemerge, Scepter preplant incorporated, preemerge, and postemerge, Preview preemerge, Basagran postemerge, Classic postemerge, and Rescue postemerge. Each of the postemerge application herbicide also carried one quart of 28% liquid nitrogen solution as a surfactant. Trifluralin (Treflan) was applied in all the plots to control annual grasses. The management systems referred in this study involves narrow row spaced plots of 18 centimeter width, wide row spaced plots of 76 centimeter width, and wide rows with one row cultivation . The objectives of this interdisciplinary approach to weed research were:

1) to determine the efficacy of alternative herbicides and resulting soybean yields under three management systems,

2) to examine the economic benefit and cost of alternative herbicides and management systems, and

3) to determine whether the economic optimum is identical to the biological optimum.

On economically evaluating the productivity of different herbicides and row spacings for cocklebur control in soybeans for Southeast Kansas, cocklebur was seen to be moderately controlled in all the plots. Nevertheless, the narrow rows and the wide rows cultivated once yielded a 92 or higher percentage of control on average over the three years.

Treatment wise, postemergence resulted in a 98% repression of cocklebur generally; except in the 1988 plots, a preemergence yielded the same result. Yields were better in the herbicidal plots than in the control plot where no herbicide was applied for cocklebur control. In 1986, the highest yield of 36.9 bushels was observed in Basagran treated narrow row plots. In 1987 also, Basagran peaked in narrow rows yielding 34.2 bushels per acre. But in 1987, two consecutively higher yields were observed in wide with cultivation plots with Canopy applied preemerge and Basagran applied postemerge . In 1988, Classic applied in narrow rows yielded the highest gross return of 32.3 bushels. On analyzing the itemized cost description among the different management systems, Canopy applied preemerge costed the maximum with $17.28 for narrow and wide rows and $20.10 for wide row with one row cultivation. Annual analysis led to the conclusion that Canopy applied preemerge in a wide with cultivation management system was the most expensive herbicide in the study. Total benefits show the same assumption as seen in the biological data. Basagran in narrow rows showed the highest benefit for 1986 and 1987 with $103.74 and $101.81 respectively and Classic in narrow rows was highest for 1988 with $175.45 benefit. Benefit cost estimation proved Basagran to be the most cost effective herbicide in this experiment although the biological results in 1988 showed Classic applied postemerge as the best for that year when applied in narrow row spacings. In 1988, Basagran applied postemerge in narrow rows was the best with a benefit cost ratio of 20.15:1.

Of the three management systems, narrow row spacings (18 centimeter), wide row spacings (76 centimeter), and wide row spacing with one cultivation, narrow row spacings yielded the highest profitability level in majority of the plot treatments. Across years and treatments, narrow row plots gave $92.93 per acre net benefits on an average whereas the wide rows and the wide rows with one cultivation gave $73.13 and $54.52 net benefits per acre respectively. The result is in conformity with the observation that the higher density of soybean plants in narrow row spacings makes the potential yield more sensitive to competition from weeds, implying that the larger the number of soybean plants per acre, the greater is the response to effective weed control. The net benefits are also higher in narrow row production systems as row cultivation is not required.

The type of herbicide with the highest net benefits was found by averaging out across management systems and years. Basagran (bentazon) applied postemerge was found to yield highest net benefits with an average of $93.36 per acre. The second best was Canopy (metribuzin + chlorimuron ethyl) with $82.62 per acre when applied as a preplant incorporated.