Economics of Alternative Agriculture*

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I. Introduction

As alterative methods of producing agricultural commodities have been proposed and discussed, opinions from several different perspectives have been presented. In the brief time that we have today, I first want to present some of the reoccurring themes of that discussion. These are generalizations of ideas that I have heard expressed in discussions of alternative systems or read in the popular press's presentation of alternative production systems. This is followed by a review of a small group of studies that support or challenge our general statements. These are research projects that have investigated the economic impact that alternative systems may have on an individual farm business. Neither the list of statements nor the reviewed research is comprehensive and I'm sure that you will have others that could be added. Rather, both are presented to stimulate you thinking about alternative production systems and the economics associated with these systems. The presentation will conclude with some general summary comments.

II. General observations

In the numerous discussions and publications about alternative systems, it is useful to try and identify some common themes. The following list of five is certainly not complete but should serve as a useful starting point to begin thinking about the economics of alternative production systems that could be used on Indiana farms. Some examples include:

a. *Reduced tillage systems provide alternatives for reducing soil erosion and for improving income from the production of corn, soybeans, and wheat.* Several studies have investigated the economics of alternative tillage systems. We will look at one recently completed study.

b. *Increasing the use of forages such as alfalfa and other soil conserving crops will reduce the environmental damage caused by cultural practices.* The 1990 Food, Agriculture, Conservation and Trade Act includes provisions for encouraging farmer adoption of soil conserving crops such as alfalfa.

c. *Per acre yields of crops produced under alternative systems will be comparable to those of conventional systems.* By using animal manure, green manure crops, cover crops and rotations, needed crop nutrients can be provided using natural forms rather than inorganic fertilizers.

d. *Per acre returns from alternative production systems will be comparable to those of conventional production systems.* If there are yield reductions associated with alternative production systems, the reduced revenue will be offset by the lower cost of purchased inputs.

e. *Income will be less variable when using alternative production systems.* Reductions in variability may arise from two sources. The first is the greater number of different crops produced when using alternative methods of production. A second reason for reduced variability may be smaller yield variations with alternative production systems. Some proponents of alternative systems have suggested that crops grown under these systems are less susceptible to below normal rainfall during the growing season.

III. A review of selected alternative agriculture research.

Crop production requires alerting the natural environment. A diverse collection of plant species is replaced with the preferred species. Four different pest control techniques are identified by Duffy[1] as being available for crop production:

A. Mechanical - alternative methods of primary and secondary tillage

B. Cultural - the types of crops rotations used and seed selection

C. Chemical - include the use of commercial fertilizer and pesticides

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[1] Duffy, Michael, Roger Ginder, Stephen Nicholson "An Economic Analysis of the Rodale Conversion Project: Overview", Department of Economics, Iowa State University, Staff Paper 212, 1989.

D. Biological - uses manures, parasites and predators, allopathic effects, and other naturally occurring inputs

The studies that follow emphasize the use of the first three methods and report how combining these techniques in different ways will affect the economic out-come.

Alternative tillage systems

Pritchard[2], in a 1991 study, investigated the efficacy of filter strips as a sediment trap in the Finley Creek watershed located 15 miles north of Indianapolis in Boone and Hamilition counties. The predominate soil in the water shed was Crosby, making up 52 percent of the watershed. The other major soil in the watershed was Brookston with 34 percent. Miami, Patton, Mahalasville, and Whitaker make up 3 percent, 9 percent, 1 percent and 1/2 percent of the watershed, respectively. As part of this research, the profitability of using alternative tillage systems on these soils was estimated. The alternative tillage systems compared included a fall moldboard plow, fall chisel plow, spring moldboard plow, disc-field cultivator, ridge till, and no-till system.

The budgets prepared indicate that reduced tillage systems provide returns that are competitive with conventional systems. Figure 1 compares the gross margin[3] of alternative systems when they were used to produce continuous corn, a corn-soybean rotation and a corn-soybean-wheat rotation. For continuous corn, the returns for all systems are nearly the same. The ridge-till system provides the largest return. This advantage is achieved primarily because of reduced machinery operating costs. The reduced machinery operating costs associated with no-till were off-set by higher chemical costs providing a return below that of the ridge till but greater than the conventional system. For the corn-soybean rotation, the ridge till system provides the greatest return. The pattern of returns is the same for the corn-soybean-wheat

[2]Pritchard, Timothy W. "Improved water quality and agricultural production: Analysis of policy options in an Indiana watershed", unpublished M. S. Thesis, Purdue University, May, 1991.

[3]The gross margin is the return that remains after the direct costs of production (seed, fertilizer, chemical, machinery operation, and miscellaneous expenses) are subtracted from gross revenue.

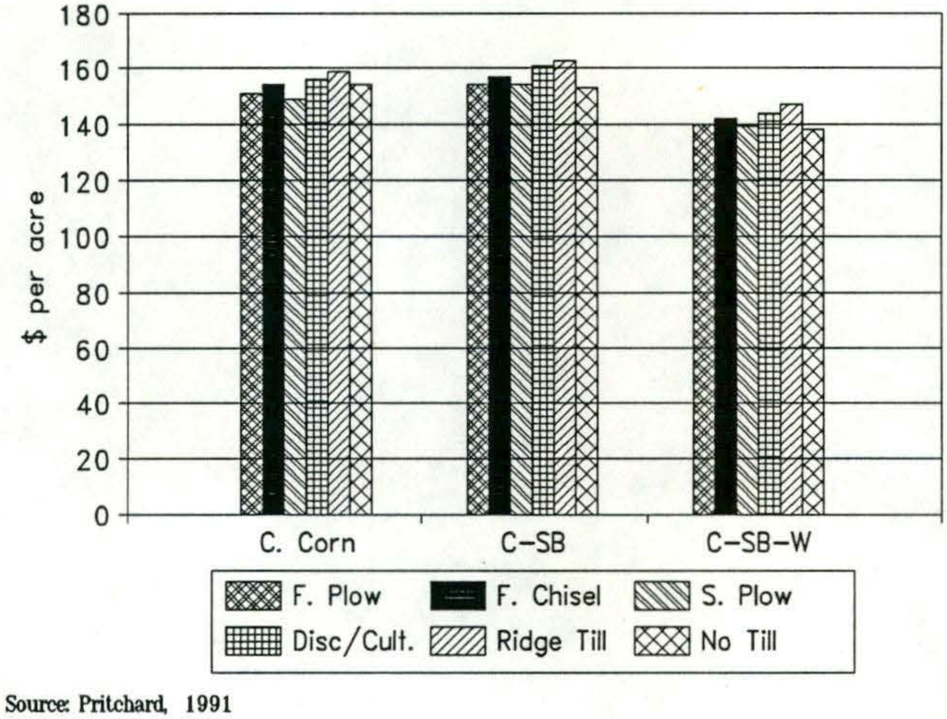

Figure 1. Gross margin using alternative tillage systems for the production of continuous corn, corn-soybean rotations, and corn-soybean-wheat rotations on Crosby soils, 1987.

rotation but the differences are less than in either of the other two rotations. The most noticeable difference about the corn-soybean-wheat alternative is the lower return for all systems. This is the result of including wheat in the rotation, a lower valued crop than corn or soybeans.[4]

Because of differences in the required quantity of labor and machinery investment, a more accurate estimate of the long term economic outcome associated with each alternative would be the return that remains after the expenses associated with the machinery investment and operator labor have been subtracted. Figure 2 presents the return for each tillage system after subtracting the machinery ownership and operator labor costs. The machinery ownership

[4]In this analysis the deficiency payment received for corn production was included in the analysis but the deficiency payment received for wheat was not included.

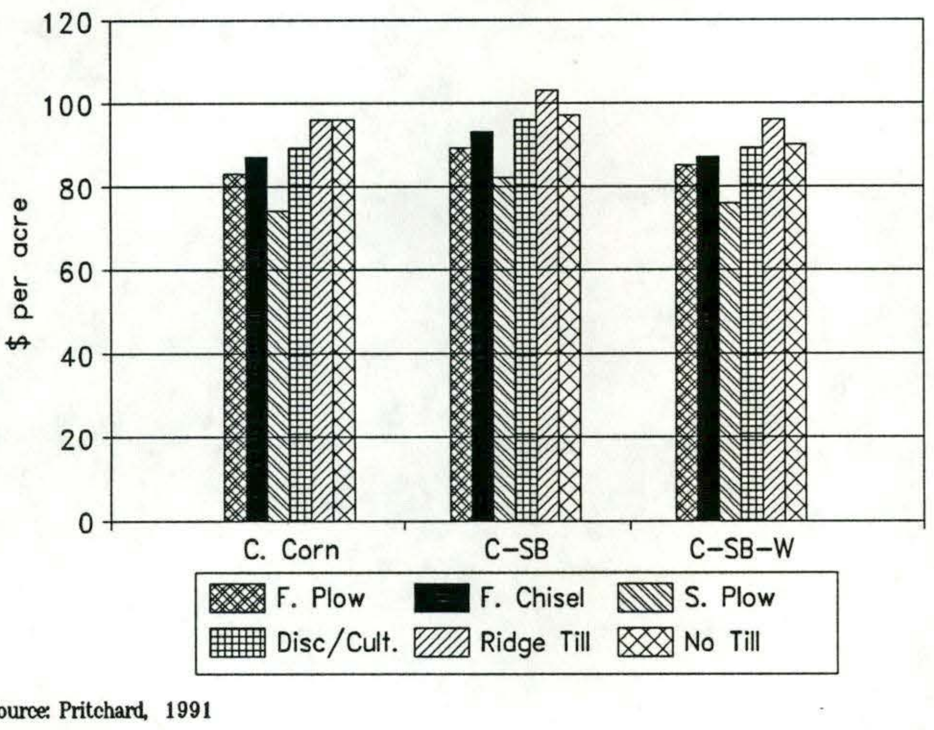

Figure 2. Return to land and management using alternative tillage systems for the production of continuous corn, corn-soybean rotations, and corn-soybean-wheat rotations on Crosby Soils, 1987.

costs include depreciation, insurance, property taxes, and interest on the machinery investment. After subtracting these expenses and operator labor, the return that remains represents the return for land and management. Accounting for overhead costs leads to more variation in the return from the various systems. For each cropping system, ridge till provides that greatest return. This is followed by no-till.

Similar results were found for the other soil types contained in the watershed (Table 1). These results suggest that over time, as farmers replace machinery, there would be movement towards the ridge till and no-till systems.

One environmental benefit associated with reduced tillage systems is the reduction in erosion that occurs because of increased ground cover. Erosion can also be reduced by changing crop rotations to include greater quantities of small grain and forages. The second study to be reviewed assesses the economic consequences of introducing alfalfa into rotations on Indiana farms.

Economic and environmental effects of increased alfalfa production

Lee, Foltz, and Martin[5] investigated the affect of introducing alfalfa into the crop rotation of Indiana farms. Two representative farms were developed. The first assumed a Drummer Silt Loam soil type, a highly productive soil. The second assumed a Clermont Silt Loam, a less productive soil. These researchers used an optimization model to determine the profit maximizing enterprise mix for both farms. The annualized cost of the additional machinery investment needed for hay production was subtracted from alfalfa returns since the analysis assumed that alfalfa was being added to a cash grain farm. The optimal crop rotation for both farms was the corn-soybean rotation. Alfalfa production was not included as part the profit maximizing solution for either farm.

Because alfalfa was not included as a crop in the optimal solution, the researchers performed additional investigations to determine the price and yield changes required to make alfalfa competitive with corn and soybeans. They also investigated the economic impact of requiring 25 percent of the farm to be planted to alfalfa.

In the case of high productivity soils, alfalfa entered the profit maximizing solution at a price of $86.50 per ton (with the assumed 5 ton yield) or at a yield of 7.33 ton per acre (with the assumed price of $70.00 per ton). The average annual per acre net return under the corn-soybean rotation was estimated to be $104.69 per acre for the 500 acre farm. When 25 percent of the farm was required to be planted to alfalfa, the average annual net return declined to $73.52 per acre. For the farm with lower productivity soils, alfalfa entered the optimal enterprise mix with a price of $84.50 (assuming a 3.5 ton per acre yield) or a yield of 4.5 tons per acre (with the assumed price of $70.00 per ton). The average annual net return per acre

[5] Lee, John G., John C. Foltz, and Marshall A. Martin, "Economic and Environmental Implications of Alfalfa Based Cropping Systems" paper presented at 1991 meetings of American Agricultural Economic Association, Kansas State University, Manhattan, KS. August 4-7, 1991.

under the corn-soybean rotation was estimated to be \$50.86. When 25 percent of the acreage was required to be in alfalfa, the average return declined to \$35.75 per acre.

In addition to investigating the economics of including alfalfa in the rotation, these researchers also used the EPIC (Erosion Productivity Impact Calculator) simulation model to assess the impact of increased alfalfa production on nitrogen and phosphorus losses and soil movement. Nitrogen losses could occur as organic nitrogen in sediment, NO_3 in the surface water (runoff), mineral nitrogen loss in subsurface flow, and mineral nitrogen loss in the percolate. Phosphorus loss can occur as soluble phosphorus in runoff or phosphorus lost with the sediment. Soil movement was measured using the universal soil loss equation and represents all soil movement not just the soil that leaves the farm.

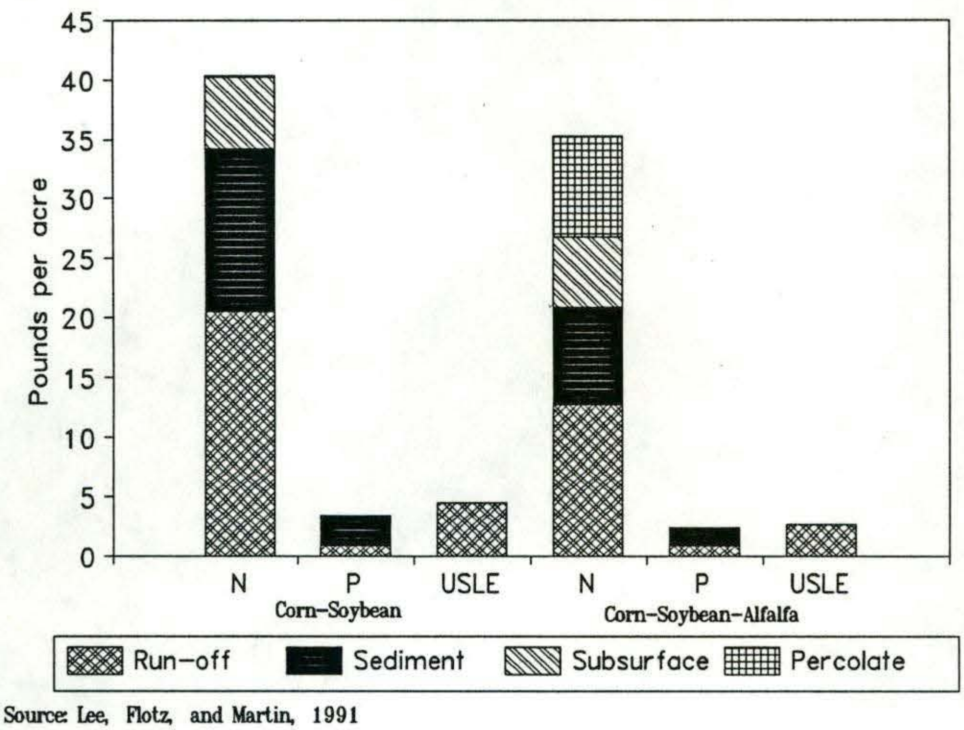

Figure 3. Nitrogen and phosphorus losses and soil movement for low productivity Indiana soil.

The effect of requiring 25% of the low productivity farm's crop acreage to be planted to alfalfa on the above environmental factors is presented in Figure 3. In this case, nitrogen, phosphate, and soil movements were reduced by increased alfalfa production. It should also be noted that while the total nitrogen loss was reduced, the type of nitrogen loss changed. Growing more alfalfa reduces losses through run off but increased the estimated loss due to percolation.

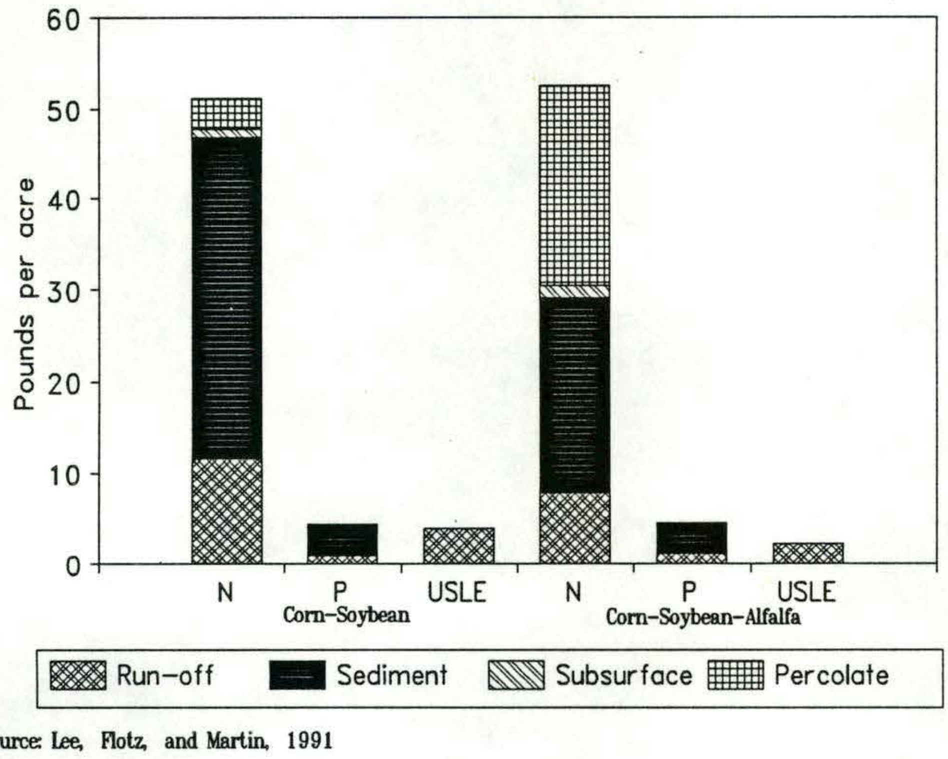

Figure 4. Nitrogen and phosphorus losses and soil movement for high productivity Indiana soil.

The effect of increased alfalfa production on these same environmental factors for the high productivity farm is presented in Figure 4. In this situation increasing alfalfa production did reduce the amount of soil movement as measured by USLE, but had little impact on phosphorus or nitrogen loss. However, again there were differences in the type of nitrogen lose experienced; that lost as part of the percolate increased while that lost with runoff decreased.

These results indicate the difficulty of identifying alternatives that are environmentally beneficial. In this example, planting a larger acreage of alfalfa aids in reducing soil movement but its effect on nitrogen and phosphorous losses depends on the soil type. These losses were reduced in one situation but not the other. It also points out that an alternative may not improve all environmental aspects. While increased alfalfa acreage on the lower productivity farm lowers the overall estimated nitrogen losses, it also changes the form in which losses occur. Assessing these differences will require careful judgements regarding their impact.

Alternative rotations and management systems, Indiana LISA project

This is an ongoing project that just completed its third year. One project objective is to evaluate the economic performance of various crop management systems under Indiana conditions. Four systems are included: 1) maximum yield, 2) conventional 3) reduced inputs 4) minimum input. The crop sequences considered include 1) continuous corn, 2) corn-soybean rotation, 3) corn-soybean-wheat rotation, and 4) corn-oat-canola rotation. For our discussion today, we will look at the preliminary results for the continuous corn, corn-soybean, and corn-soybean-wheat alternatives under the conventional and reduced input systems.

Corn, soybean, and wheat production for the conventional system followed the fertility and management recommendations from the extension service. A tillage system that utilized a chisel plow for primary tillage was assumed. This tillage was completed in the fall. Corn and soybean fertilizer was applied in the Spring both as broadcast and starter applications. Wheat phosphate and potash fertilizer was broadcast applied in the fall at planting time. Anhydrous ammonia with N-Serve was used as the nitrogen source for the wheat crop. Corn and soybean herbicides were broadcast applied. No herbicides were used in wheat production. For continuous corn, corn rootworm insecticide was band over the row. Corn was planted in 30-inch rows with a seeding rate of 24,000 plants per acre. A single cultivation was assumed for corn. Soybeans were drilled in 7-inch rows with a seeding rate of 1.2 bushel per acre.

Corn, soybean, and wheat production under the reduced input system also used a fall tillage system. Primary tillage was done with a moldboard plow. The seeding rate for corn was reduced to 22,000 plants and the seeding rate for soybeans was reduced to 1 bushel. Fertilizer application rates were also reduced and herbicides were band over the row. Corn and soybean crops were cultivated three times during the year. Fertilizer applications for corn and wheat were made at the time of planting. Urea was used as the nitrogen fertilizer for wheat in the reduced input system. Urea was applied in the fall and again in the spring. Red clover was seeded into the wheat in early Spring to help provide additional nitrogen for the following corn crop. The intent was to harvest the red clover twice after wheat harvest; however because of weather problems this did not work well. The quantity of inputs used for the two production systems when producing continuous corn, a corn-soybean rotation, and a corn-soybean-wheat rotation are presented in Table 2.

The preliminary economic results for these three rotations using the average yield for this three-year trial (1989-91) are presented in Tables 3, 4, and 5. For the production of continuous corn, the reduced input system resulted in a lower per acre yield than the conventional system (139 bu. per acre for the conventional system and 120 bu. per acre for the reduced input system). Using a 5-year average Indiana corn price,[6] provides gross revenue of $304.41 per acre for the conventional system and $262.80 for the reduced input system. The lower revenue for the reduced input system is offset by lower per acre costs of inputs[7], resulting in nearly the same return to resources when deficiency payment revenue from the price support program for corn is not included. Including the additional deficiency payment revenue, resulted in the return for the conventional system exceeding those of the reduced input system by $7.80 per acre. When estimating returns with the government price support, the ASCS assigned yield was assumed to equal the 3-year average yield for the system, 5 percent set aside was required, and production costs for set aside were $13.57 per acre of set aside.

Other differences between the two systems included a lower per bushel production cost for the reduced input system but a larger labor requirement. The lower per bushel cost results from reducing per acre costs by 27 percent while yields declined by only 14 percent. These production costs did not include a charge for the additional labor required by the reduced input system. Including the additional 0.3 hours of labor required for the reduced input system at

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[6] Market year average corn prices for 1985 to 1989 were used. These average per bushel prices were 1985 - $2.20, 1986 - $1.53, 1987 - $2.08, 1988 - $2.65, 1989 - $2.47, for an overall average of $2.19.

[7] Input costs for seed, fertilizer, chemicals, etc. are based on 1992 estimates. See Doster, D. Howard and Craig L. Dobbins, "1992 Estimated Grain Crop Production Costs and Returns for Indiana", Purdue University Cooperative Extension Service CES Paper No. 250, February 1992.

$10.00 per hour adds an additional charge of $3.00 per acre. With the additional labor charge, the cost per bushel for the reduced input system is $0.97, $0.15 less than under the conventional system.

For the corn-soybean rotation, the return from each crop was estimated and then combined to obtain a per acre return for the rotation (Table 4). In estimating the return from soybeans, the 5-year average soybean price of $5.81 per bushel was used.[8] When deficiency payment revenue was not included, the returns for the entire rotation were slightly larger under the reduced input system -- $213.14 per acre compared to $210.22 per acre for the conventional system. When the income for the deficiency payment is included, the conventional system provides a slightly larger per acre return ($235.88 for the conventional system compared to $234.87 for the reduced input system). In this rotation, the conventional system provides the greatest per acre return for corn production. However, the reduced input system provides the greatest return for soybeans. Under the reduced input system, there was only a one bushel reduction in the average soybean yield while per acre costs are reduced by a little more than $24.50 per acre.

Again, the reduced input system required additional labor. If this additional labor is valued at $10 per hour, the two systems provide the same return when deficiency payments are not included. Including deficiency payments results in the conventional system providing a $4.01 per acre greater return.

The final rotation that will be discussed here is the corn-soybean-wheat rotation. As with the other crops, the wheat price used in the evaluation was a 5-year average price, $2.98 per bushel, for the years of 1985 to 1989.[9] The average yields for corn, soybeans and wheat were lower in the reduced input system for all three crops (Table 5). The largest difference was in the corn yields. In evaluating the reduced input system, 1.0 ton of red clover was assumed to

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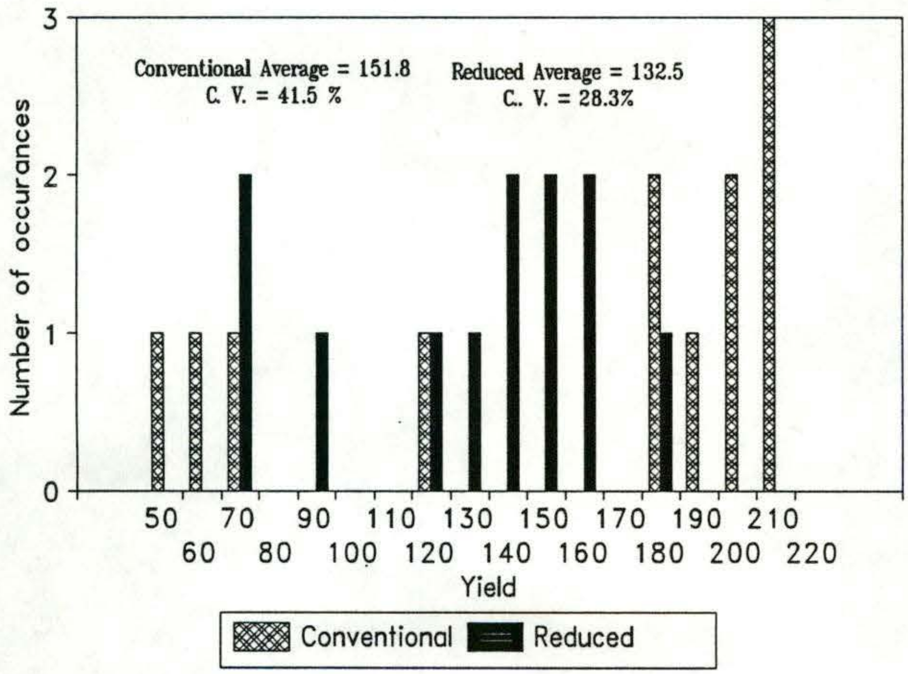
[8] Market year average soybean prices for 1985 to 1989 were used. These average per bushel prices were 1985 - $5.04, 1986 - $4.76, 1987 - $5.94, 1988 - $7.50, and 1989 - $5.79 for an overall average of $5.81.

[9] Market year average wheat prices for 1985 to 1989 were as follows: 1985 - $2.91, 1986 - $2.25, 1987 - $2.43, 1988 - $3.49, 1989 - $3.83, for an overall average of $2.98 per bushel.

be harvested. The conventional system provided the largest return to resources both when deficiency payment revenue was included and when it was not. Without deficiency payment income the conventional system provided a return to resources that was $13.66 per acre larger. With the deficiency payment revenue, the conventional return provided a $17.59 per acre larger return. All crops except soybeans had a greater return under the conventional system. Including a charge for the additional labor required by the reduced input system would provide an even greater advantage for the conventional system.



Source: Indiana Lisa Project

Figure 5. Distribution of corn yields for the corn-soybean rotation using conventional and reduced input systems.

These results indicate that under average prices and yields, reductions in inputs may provide returns similar to those that are achieved with conventional systems for some rotations. An additional important aspect of these production systems that still needs to be investigated is the distribution of returns that might occur with these alternative systems. Figure 5 illustrates the plot yields for corn in the corn-soybean rotation for these two systems. For some plots, the conventional system had larger yields than the reduced input system but the conventional system also resulted in lower yields. The coefficient of variation, a common measure of risk, was 41.5 percent for the conventional system and 28.3 percent for the reduced input system.[10]

The effect of these yield distributions on returns needs to be carefully investigated. If reduced input systems provide more stable income, a smaller mean return could still encourage adoption since the risk or income variability associated with the system is also less. This trade-off of risk and rewards is similar to a comparison of investing in the junk bond market with its high return and investing in a bank savings account with a relatively low return. The savings account has a small return but it is a safe investment. The junk bonds will give you a higher return but the chance of losing your investment is also higher.

Some indication of how alternative production systems may effect the variability of returns can be obtained by reviewing studies completed in other states. Two studies that have looked at the variability of the crop returns under alternative production systems include a study by Olson in Southeast Minnesota, and a study by Helmers, Langemeier, and Atwood in Nebraska.

Alternative weed control methods[11]

In comparing chemical weed control and mechanical weed control methods in Minnesota, Olson estimated the expected returns from corn-soybean and corn-soybean-corn-alfalfa rotations. The farm was assumed to be located in Southeast Minnesota. Individual budgets were developed

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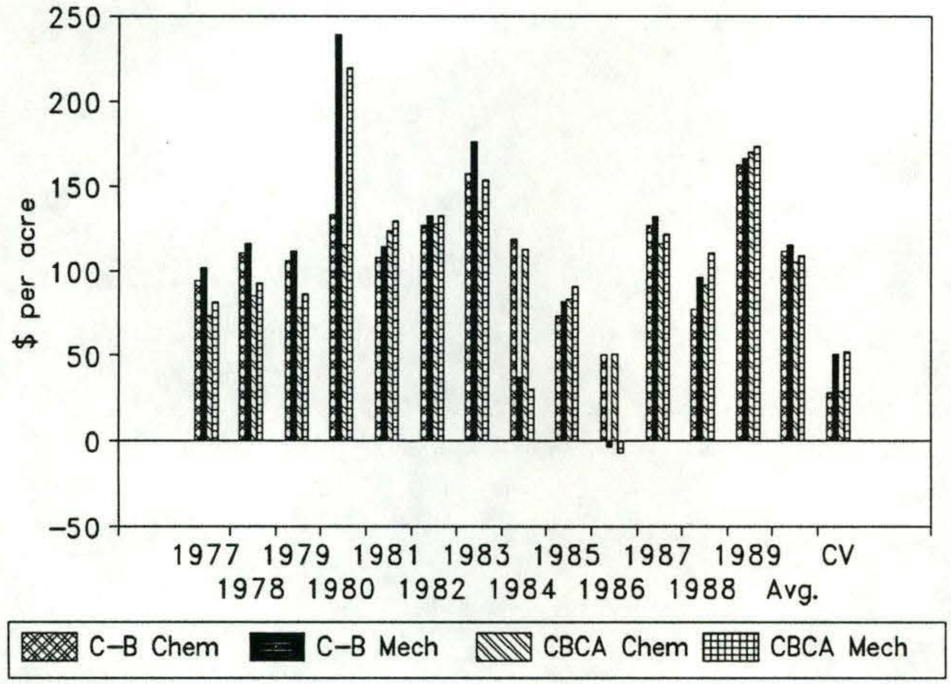
[10] The coefficient of variation measures the amount of variation relative to the average outcome. It is calculated by dividing the standard deviation (a measure of the variability in yields) by the average yield. Alternatives with larger coefficients of variation are viewed as more risky than those with smaller coefficients of variation because the variability of outcomes relative to the average outcome is greater.

[11]Olson, Kent D. "Modeling farm-level interactions between policy and sustainable agricultural practices". in Volume II: Targeting and Modeling approaches in the U. S. and Italy. Department of Agricultural and Applied Economics Staff Paper P91-23, June 1991

for each rotation using price and yield information for 1977-1989. These price and yield data were taken for the Southeast Minnesota farm business association summaries for the 1977-1989 period. The changes required to move from herbicide to mechanical weed control included reducing herbicide expenses and the associated application operation, adding a rotary hoe operation and adding an additional cultivation (one cultivation was used with the herbicide applications). When looking at the budgeted costs for corn following alfalfa in the corn-soybean-corn-alfalfa rotation, these changes in operations increased machinery operating costs by \$0.84 per acre and labor by 0.13 hours per acre. If labor is charged at \$10.00 per hour this would result in increased costs of \$2.14 per acre. Off-setting these increased costs was a reduction in herbicide costs of \$19.40. Combining production costs for these two systems with the prices and yields provided an average return of \$134 for corn following alfalfa with chemical weed control and \$138 per acre when using mechanical weed control. However the returns using mechanical weed control were more variable, having a coefficient of variation of 46 percent rather than 30 percent when chemical weed control was used. Similar results were obtained for corn in the corn-soybean rotation.

To provide a better comparison of the returns for these two systems and rotations, the annual return for the rotation was calculated. In this situation the return for the corn-soybean rotation with chemical weed control averaged \$111 per acre while this rotation with mechanical weed control averaged \$115 per acre. For the corn-soybean-corn-alfalfa rotation with chemical weed control, the average was \$105 per acre. The average for this rotation using mechanical weed control was \$109 per acre. In both rotations the average return for the mechanical weed control methods was greater than the chemical method. The annual return and the average for the rotations are presented in Figure 6. The mechanical methods of weed control while providing a larger return were also more variable. For the corn-soybean rotation, the coefficient of variation was 31 percent for chemical weed control and 58 percent for mechanical weed control. For the corn-soybean-corn-alfalfa rotation the chemical method of weed control had a coefficient of variation of 31 percent and mechanical method 56 percent. Is the increased return sufficient compensation for the increased variability?

When using these data in an optimization model that considered the variability of returns, the added return associated with mechanical weed control was not enough to off-set the



Source: Olson, 1991

Figure 6. Returns with mechanical and chemical weed control for corn-soybean and corn-soybean-corn-alfalfa rotation in Southeast Minnesota.

variability of yields and the alternatives that used herbicides were selected for use. That is, the value of herbicides in reducing yield variability and thus income variability was great enough that the model incurred the costs or forfeited the income benefits of mechanical weed control to avoid the variability.

Alternative cropping systems in east-central Nebraska[12]

A Nebraska study by Helmers, Langemeier, and Atwood also addressed the variability of returns when using alternative production systems. This study compared 13 cropping systems using yield data from experiments involving three rotations and three continuous crops. The experimental rotations were: 1) corn-soybeans-corn-oats/sweet clover produced using a) herbicides and inorganic fertilizer (HFROT), b) inorganic fertilizers only with no herbicides (FOROT) and c) organic fertilizers only with no inorganic fertilizers or herbicides (ORAPC). 2) corn-soybean rotation (C-SB) and a grain sorghum-soybean rotation (GS-SB) using conventional practices and 3) continuous corn (CC), continuous grain sorghum (CGS), and continuous soybeans (CSB) using conventional practices. For purposes of this review, those rotations which included grain sorghum will not be discussed.

Average corn yields for the period were the highest in the corn-soybean rotation, averaging 95.6 bu per acre. Corn yields using commercial fertilizer and insecticide and organic systems under longer-term rotations were intermediate (HFORT - 87.8 bu., FOROT - 83.5 bu., ORAPC - 81.6 bu.). The average corn yield was the lowest for the continuous corn at 72.2 bushel per acre. The corn yields received each year for the various rotations are illustrated in Figure 7.

Soybean yields were the highest for the corn-soybean rotation averaging 38.0 bushel per acre. Soybean yields for the commercial fertilizer and insecticide longer-term rotations were intermediate (HFORT - 36.0 bu., FOROT - 35.9 bu.) The lowest average soybean yield was received for the continuous soybeans, 33.7 bu., and soybeans raised in the corn-soybean-corn-oats/sweet clover rotation without inorganic fertilizer (ORAPC) with an average of 32.4 bu. The soybean yields received each year for the various rotations are illustrated in Figure 8.

The net returns for each rotation is presented in Table 6. Because of the relatively high net returns of soybeans during the study period, systems with a high proportion of soybeans had the highest average returns. The four-year rotations were next highest. There was little

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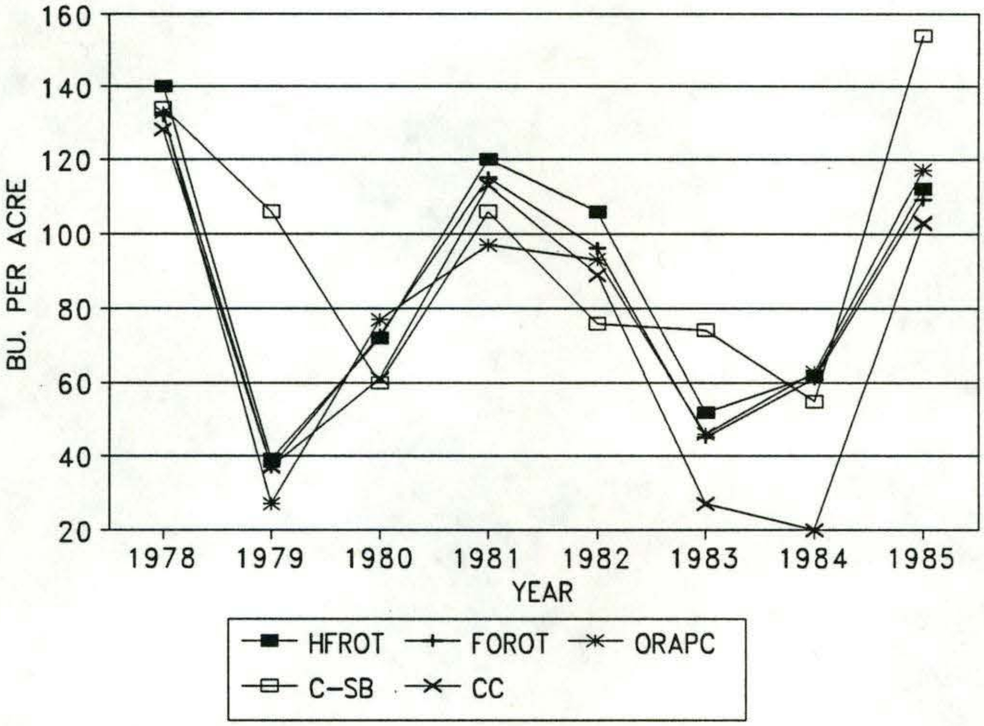
[12]Helmers, Glenn A., Michael R. Langemeier, and Joseph Atwood. "An Economic Analysis of alternative cropping systems for east-central Nebraska. American Journal of Alternative Agriculture 1(1986)4:153-158.



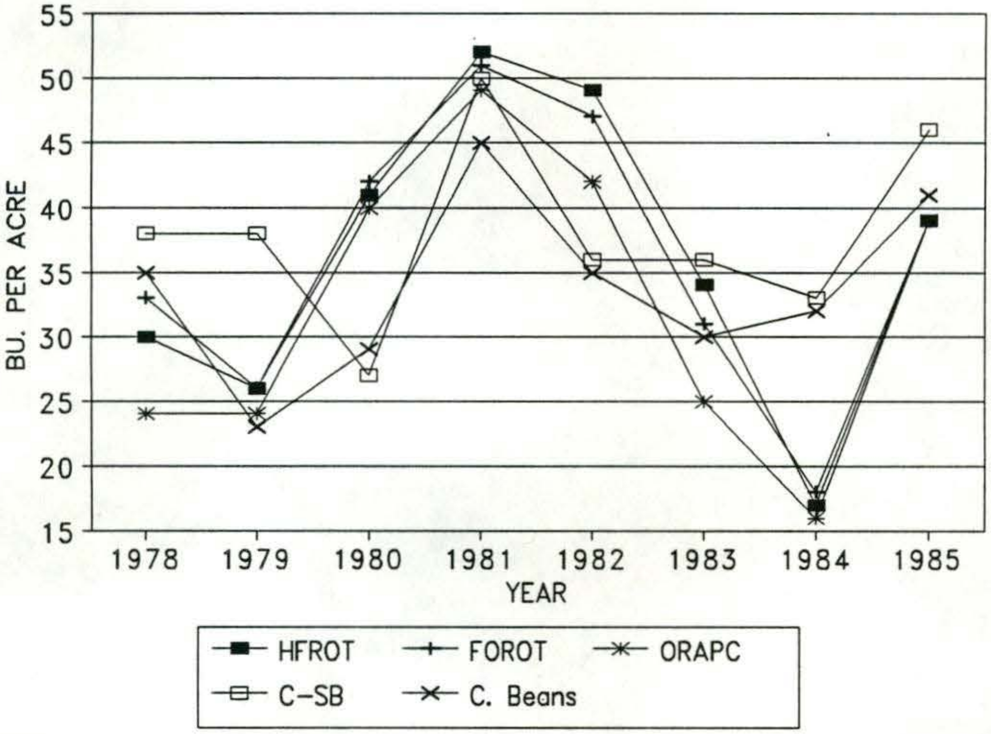
Source: Helmers, Langemeirer, and Atwood, 1986

Figure 7. Nebraska corn yields for alternative rotations and management systems.

difference among the systems which contained 4-year rotations, although they differ widely in treatments.

Four different measures of risk or income variability were reported by the authors (Table 6): 1) standard deviation, 2) skewness, 3) coefficient of variation, and 4) the number of years returns were less than $100 per acre.[13] Continuous soybeans provided the smallest coefficient of variation. This was followed by the corn-soybean rotation and then the four year rotations. The combination of continuous crops and continuous corn were the most variable. The organic

[13]Skewness indicates how the outcomes are bunched around the mean. If low values are bunched close to the mean but high values extend far above the mean, the distribution of returns has positive skewness. If the lower tail of the distribution is the extended one, then the distribution will have a negative skewness.



Source: Helmers, Langemeirer, and Atwood, 1986

Figure 8. Nebraska soybean yields for alternative rotations and management systems

system did not reduce variability relative to the other two alternatives indicating the low variability of returns for the organic system arises from the rotation, not the treatment. The number of years that the return dropped below $100 indicates that continuous corn is the most risky and the corn-soybean rotation the least. Skewness indicates that the corn-soybean rotation has an undesirable distribution of returns for farmers who are unwilling to accept even a small probability of large losses. The other rotations do not exhibit negative skewness.

The authors conclude that for this study area and time period, row crop rotations had substantially higher returns than continuously grown row crops. The four-year rotation involving a small grain had somewhat lower returns than the row crop rotations. For the four-year rotation, different chemical treatments had little influence on net returns. The lower cost of inputs for the organic system offset its lower yields within the four year rotation system.

Rotations had returns that were less variable than those of continuous crops. The organic alternative in which manure was charged only at its application cost performed well in the comparisons of profit and risk and had higher returns than the continuously cropped alternatives.

Summary

Based on these studies, let's try to summarize some things to think about.

1. There are alternative tillage methods for producing corn, soybeans and wheat that on average will provide a per acre yield that is comparable to that of conventional systems. Alternatives that use reduced tillage systems such as ridge-till and no-till appear to provide profitable alternatives compared to conventional tillage systems.

2. Alternatives may solve one problem only to create another. Many of the alternatives reduce purchased inputs but require greater amounts of labor for management and production. Depending on when this labor is required and the quantity of labor that is available, these changes may or may not improve income. Other alternatives require changing the crop in a rotation. While the return for an individual crop in the new rotation may be the same as with the conventional system, what has happened to the returns for the whole system? In assessing changes to rotations, the return for all crops in the rotation need to be considered simultaneously.

3. Per acre yields achieved under the alternative systems contained in the reviewed studies were lower than those of conventional systems, but the per acre return in some situations was comparable. This indicates that the reduced revenue was offset by lower production costs. What might be the economic outcome on your farm?

4. The income variability of the alternative systems needs more study. If the variability of an alternative is greater than conventional systems, managers will expect to receive a greater return for taking these risks. An alternative that provides comparable returns will not encourage adoption of alternative systems if it has increased income variability. If the income variability for the alternative system is less, it is important to know the reason

that it is less. Is it because of the combination of crops or is it because of the reduced level of input purchases?

5. The site specific nature of the production process needs to be remembered. Soil movement can be reduced by using crops such as alfalfa but the effect on this and other environmental variables will depend on the characteristics of the site. How will an alternative effect the environment aspects of your farm operation? How will it influence the economic return?

Table 1. Estimated per acre gross margin and return to land and management from the production of corn-soybean rotations using alternative tillage systems, Finely Creek watershed, 1987.[a]

	TILLAGE SYSTEM					
SOIL TYPES[b]	FALL PLOW	FALL CHISEL	SPRING PLOW	DISC F-CULT	RIDGE TILL	NO TILL
			GROSS MARGIN			
Br	137	136	122	140	147	136
CrA	88	92	81	95	103	96
CsB2:2-6% slope	78	83	72	85	93	87
MmC2:6-12% slope	63	71	62	75	81	86
MmB2:2-6% slope	82	90	77	94	102	105
Pn	154	153	138	156	163	152
Wh	117	121	110	124	129	123
Ma	154	153	138	156	163	152
			RETURN TO LAND AND MANAGEMENT			
Br	127	126	115	129	135	127
CrA	85	88	79	90	96	92
CsB2:2-6% slope	76	79	70	81	88	83
MmC2:6-12% slope	62	68	61	71	76	80
MmB2:2-6% slope	79	85	76	89	95	98
Pn	143	141	130	145	150	142
Wh	111	114	106	117	120	116
Ma	143	141	130	145	150	142

Source: Pritchard, 1991

[a] The gross margin is calculated by subtracting the direct costs of production (seed, fertilizer, chemicals, etc.) from gross revenue. The return which remains can be used to pay the overhead costs of machinery ownership, operator labor, and land. The return to land and management subtracts machinery ownership costs and operator labor from the gross margin.

[b] Soil types are as follows:

Br	Brookston
CrA	Crosby with 0 to 3 percent slope
CsB2	Crosby with 2 to 6 percent slop
MmC2	Miami silt loam with slope of 6-12%
MmB2	Miami silt loam with slope of 2-6%
Pn	Patton silty day loam
Wh	Whitaker loam with slopes less than 2 percent
Ma	Mahalasville silty day loam

Table 2. Production systems for continuous corn, corn-soybean rotation, and corn-soybean-wheat rotations, 1989-1991.

	CONTINUOUS CORN	
	CONVENTIONAL SYSTEM	REDUCED INPUT SYSTEM
Nitrogen[a]	176 LBS.	103
P_2O_5[b]	24 LBS.	12
K_2O[c]	74 LBS.	12
Herbicides[d]	Broadcast	Band
Seed	26,000	22,000
Cultivation	1	3
Rootworm Insecticide	Band	Band

	CORN - SOYBEANS ROTATION			
	CONVENTIONAL SYSTEM		REDUCED INPUT SYSTEM	
	CORN	SOYBEANS	CORN	SOYBEANS
Nitrogen[e]	156	--	103	--
P_2O_5 [f]	24	30	12	--
K_2O [g]	54	60	12	--
Herbicide[h]	Broadcast	Broadcast	Band	Band
Seed	26,000	1.2 bu	22,000	1.0 bu
Cultivation	1	0	3	3

	CORN - SOYBEAN - WHEAT ROTATION					
	CONVENTIONAL SYSTEM			REDUCED INPUT SYSTEM		
	Corn[a]	Soybeans[b]	Wheat	Corn[a]	Soybeans	Wheat
Nitrogen[i]	156	--	110	103	--	90
P_2O_5 [j]	24	30	90	12	--	20
K_2O [k]	54	60	60	12	--	--
Herbicide[l]	Broadcast	Broadcast	--	Band	Band	--
Seed	26,000 plants	1.2 bu	1.5 bu	22,000 plants	1.0 bu	1.5 bu 10 lb red clover
Cultivation	1	--	--	3	3	--

[a] Anhydrous ammonia was applied prior to planting in the conventional system and sidedressed 5 weeks after planting in the reduced input system.

[b] P_2O_5 applications were made in the form of a 6-24-24 starter fertilizer application. In the conventional system, 100 lbs. were applied. In the reduced input system, 50 lbs. were applied.

[c] For the conventional system, 50 lbs. of potash per acre was spring applied in the form of muriate of potash (0-0-60). Additional K was provided by the starter application. For the reduced input system, the only potassium application made was from the 50 lbs. of starter fertilizer (6-24-24).

[d] Herbicide for the conventional system included the application of 0.75 qt. of Atrizine, 0.75 qt. of 24-D, 1.75 qt. of Lasso, 1.0 qt. of Bladex and 1.0 qt. of crop oil concentrate. Herbicides for the reduced system included 1.75 qt. of Lasso.

[e] When grown in rotation with soybeans, nitrogen applications for corn were reduced 20 lbs. per acre under the conventional system. In the reduced input system, the nitrogen application rate used for continuous corn was also used for rotation corn.

[f] The same starter applications used for continuous corn were used for rotation corn. A spring application of 30 lbs. of phosphate in the form of triple super phosphate (0-46-0) was applied to soybeans applied for the conventional system. This application was not made to soybeans for the reduced input system.

[g] The same starter application used for continuous corn was used for rotation corn. A spring application of 60 lbs. of potassium in the form of muriate of potash (0-0-60) was applied to soybeans for the conventional system. This application was not made to soybeans for the reduced input system.

[h] Herbicides for corn were the same as under continuous corn production. Soybean herbicides were 2.0 qt. of Lasso and 0.50 lb. of Lexone for the conventional system. For the reduced input system, 1.75 qt. of Lasso was used.

[i] Nitrogen applications for corn were the same as those used in the corn-soybean rotation. Nitrogen applications for wheat in the conventional system was made in the fall using anhydrous ammonia and N-serve. The nitrogen applications for the reduced input system included 30 lbs. of N in the fall and 60 lbs. in the spring. These applications were made using urea.

[j] The same application used in the corn-soybean rotation was used for corn and soybeans in this rotation. An application of 90 lbs. of phosphorus per acre in the form of triple super phosphate (0-46-0) was made for wheat at planting time for the conventional system. This was reduced to 20 lbs. in the reduced input system.

[k] The same application used in the corn-soybean rotation was used for corn and soybeans in this rotation. An application of 60 lbs. of potassium was applied to wheat at planting time in the form of muriate of potash (0-0-60). This application was not made in the reduced input alternative.

[l] The same herbicide applications used for the corn-soybean rotation were used for corn and soybeans in this rotation.

Table 3. Return to resources for continuous corn production using conventional and reduced input systems.

	CONVENTIONAL SYSTEM	REDUCED INPUT SYSTEM
Yield (bu/a)	139	120
Price ($/bu)	$ 2.19	$ 2.19
Revenue	$304.41	$262.80
Fertilizer	41.34	19.89
Herbicides	28.58	10.23
Insecticides	13.49	13.49
Seed	20.46	17.05
Machinery Fuel & Repair	22.67	28.66
Drying	12.89	11.13
Interest & Miscellaneous	$ 16.86	$ 13.48
	$156.29	$113.93
Resource Return[a]	$148.12	$148.87
Return to Resources With Price Support[b]	$202.31	$194.51
Cost/Bu	$1.12	$0.95
Direct Labor	3.0 HRS	3.3 HRS

[a] The income from deficiency payments are not included. This return represents the return to land, operator labor, and the capital investment in land and machinery required to undertake production.

[b] Income from deficiency payments is included. In estimating this return, the ASCS assigned yield is assumed to equal the 3-year average yield, a 5 percent set aside requirement was in effect, and the cost of set aside production was $13.57 per acre of set aside. This return represents the return to land, operator labor, and the capital investment in land and machinery required to undertake production.

Table 4. Return to resources for a corn-soybean rotation using conventional and reduced input systems.

	ROTATION CORN - SOYBEANS CONVENTIONAL SYSTEM		
	CORN	SOYBEANS	AVERAGE
Yield (bu/a)	152	50	
Price ($/bu)	$ 2.19	$ 5.81	
Revenue	$332.88	$290.50	$311.69
Fertilizer	38.38	13.80	26.09
Herbicides	20.72	22.80	21.76
Seed	20.46	11.12	15.79
Machinery Fuel & Repair	21.10	14.94	18.02
Drying	11.33	--	5.67
Interest & Misc.	$ 15.69	$ 12.60	$ 14.15
	$127.69	$ 75.26	$101.48
Return to Resources[a]	$205.19	$215.24	$210.22
Return to Resources With Price Support[b]	$256.52	$215.24	$235.88
Cost/Bu	$ 0.84	$ 1.51	--
Direct Labor			2.7 HRS
	ROTATION CORN - SOYBEANS REDUCED INPUT SYSTEM		
	CORN	SOYBEANS	AVERAGE
Yield (bu/a)	132	49	
Price ($/bu)	$ 2.19	$ 5.81	
Revenue	$289.08	$284.69	$286.88
Fertilizer	19.85	--	9.93
Herbicides	10.24	10.24	10.24
Seed	17.05	9.50	13.28
Machinery Fuel & Repair	27.28	19.34	23.31
Drying	9.84	--	4.92
Interest & Misc.	$ 12.56	$ 11.59	$ 12.08
	$ 96.82	$ 50.67	$ 73.75
Return to Resources	$192.26	$234.02	$213.14
Return to Resources With Price Support	$235.73	$234.02	$234.87
Cost/Bu	$ 0.73	$ 1.03	--
Labor			3.0 HRS

[a] The income from deficiency payments are not included. This return represents the return to land, labor, and the capital investment required to undertake production.

[b] Income from deficiency payments is included. In estimating this return, the ASCS assigned yield is assumed to equal the 3-year average yield, a 5 percent set aside requirement was in effect, and the cost of set aside production was $13.57 per acre of set aside. This return represents the return to land, labor, and the capital investment required to undertake production.

Table 5. Return to resources for corn-soybean-wheat rotation using conventional and reduced input systems.

	CORN - SOYBEANS - WHEAT ROTATION CONVENTIONAL SYSTEM			
	CORN	SOYBEANS	WHEAT	AVERAGE
Yield (bu/a)	160	52	57	
Price ($/bu)	$ 2.19	$ 5.81	$ 2.98	
Revenue	$350.40	$302.12	$169.86	$274.13
Fertilizer	38.38	13.80	46.58	32.92
Herbicides	20.72	22.80	--	14.51
Seed	20.46	11.12	9.75	13.78
Machinery Fuel & Repair	22.92	16.38	16.25	18.52
Drying	11.93	--	--	3.98
Interest & Misc.	$ 15.95	$ 12.77	$ 10.53	$ 13.08
	$130.36	$ 76.87	$ 83.11	$ 96.78
Return to Resources[a]	$220.04	$225.25	$ 86.75	$177.35
Return to Response With Price Support[b]	$270.63	$225.25	$128.25	$208.04
Cost/Bu	$ 0.68	$ 1.48	$ 1.46	--
Labor (hrs)				2.7 HRS
	CORN - SOYBEAN - WHEAT ROTATION REDUCED INPUT SYSTEM			
	CORN	SOYBEANS	WHEAT/RED CLOVER	AVERAGE
Yield (bu/a)	137	49	54/1.0	
Price ($/bu)	$ 2.19	$ 5.81	$2.98/44	
Revenue	$300.03	$284.69	$204.92	$263.21
Fertilizer	19.85	--	25.82	15.22
Herbicides	10.24	10.24	--	6.83
Seed	17.05	9.50	40.15	22.23
Machinery Fuel & Repairs	29.68	21.16	27.37	26.07
Drying	10.21	--	--	3.40
Interest & Misc.	12.74	11.64	8.91	11.10
	$ 99.77	$ 52.54	$102.25	$ 84.85
Return to Resources[a]	$200.26	$232.15	$ 58.67	$163.69
Return to Resources With Price Support[b]	$243.33	$232.15	$95.86	$190.45
Cost/Bu	$0.73	$1.07	--	
Labor (hrs)				3.1

[a] The income from deficiency payments are not included. This return represents the return to land, labor, and the capital investment required to undertake production.

[b] Income from deficiency payments is included. In estimating this return, the ASCS assigned yield is assumed to equal the 3-year average yield, a 5 percent set aside requirement was in effect, and the cost of set aside production was $13.57 per acre of set aside. This return represents the return to land, labor, and the capital investment required to undertake production.

Table 6. Average annual net returns and measures of risk for alternative Nebraska cropping systems, 1978-1985.

ALTERNATIVE[a]	AVERAGE	STANDARD DEVIATION	SKEWNESS	C.V.	YRS RETURN < 100
HFROT	\$111.79	\$ 59.61	0.06	0.53	4
FOROT	114.64	60.24	0.16	0.53	3
ORAPC	114.88	59.11	0.04	0.51	3
C-SB	175.15	73.37	-0.36	0.42	2
CC-CSB	112.77	83.09	0.55	0.72	3
CC	73.64	117.69	0.26	1.60	6
CSB	163.90	58.04	0.54	0.35	0

[a] HFROT = a four-year rotation of corn-soybeans-corn-oats/sweet closer using herbicide and inorganize fertilizer
FOROT = four-year rotation with inorganize fertilizer and no herbicides
ORAPC = four-year rotation with organize fertilizer and no herbicides
C-SB = a corn-soybean rotation
CC-SB = a combination of continuous corn and continuous soybeans
CC = continuous corn
CSB = continuous soybeans.

Source: Helmes, Langemeirer, Atwood, 1986.