RISK ANALYSIS OF REDUCED TILLAGE SOYBEANS AND GRAIN SORGHUM ROTATIONS IN NORTHEASTERN KANSAS USING STOCHASTIC DOMINANCE TECHNIQUES

By

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CHAPTER ONE

INTRODUCTION

Overview

Both economic and soil conservation concerns have lead to a growing interest in reduced tillage practices for the production of soybeans and grain sorghum in Northeastern Kansas. Various tillage methods are currently in use, depending to some degree upon the type of equipment that the farm operator has available for use. While the adoption of some tillage techniques may require the purchase of little or no additional equipment by the producer, others do. Therefore, these costs must be considered in the adoption process.

This study provides an economic analysis of two conservation tillage methods, ridge-till and no-till, and compares them with a typical conventional tillage system. These systems are currently being used and studied at the Cornbelt Experiment Field, located near Hiawatha, Kansas.

The no-till system studied allows planting to be achieved without disturbance of the residues from the previous crop. Since no preplant tillage is used, weed control must be achieved through use of herbicides, both between crop years and during the crop growing season. A weed-free environment is important to the growing crop in order for it to make full usage of water, nutrients, sunlight, and other resources. Cultivation is used to supplement herbicides for added weed control during the cropping season, however it may not be used between the crop years.

In the ridge-till system crops are planted on non-tilled ridges formed by the previous year's cultivation. Complete weed control, prior to planting, is less critical in ridge-till systems as compared to no-till because weeds in the seed furrow are physically eliminated during planting. This feature reduces weed management variability problems and allows reduced usage of herbicides. Cultivation and ridging provide weed control between rows making ridge-till systems suitable for banding of herbicides at planting. This helps to reduce the costs of production (Janssen, 1986).

A wide number of crop rotation systems are currently employed in Northeastern Kansas. This study will limit its consideration to three cropping systems: continuous cropped grain sorghum, grain sorghum grown after soybeans, and continuous cropped soybeans. Each of these cropping systems is examined for each of the three previously mentioned tillage systems, making a total of nine systems to be compared.

The risk effect of the selected tillage and rotational practices will be measured by examining the net return variability and the average annual net returns. First degree stochastic dominance (FSD), second degree stochastic dominance (SSD) and stochastic dominance with respect to a function (SDWRF) will also be used for determination of preferred systems of individual producers. FSD implies that an individual prefers more income to less income. SSD further implies that the individual receives more satisfaction from increases in low levels of income than increases at high levels of income. SDWRF is more specific than either FSD or SSD because it allows the researcher to examine the risk preferences at any risk aversion interval.

Statement of the Problem

Conservation tillage practices offer tremendous potential for reducing soil erosion. However, technical and economic questions persist about yield potential, cropping sequences, and nitrogen fertilizer rates as tillage is reduced. Conservation systems involve management of surface residue to minimize soil erosion and water loss while maintaining or improving yields. According to Lane (1976) conservation systems feature: (1) reduced number of tillage operations which offer many benefits to the producer including protection of the soil from wind and water erosion, conservation of moisture from rainfall, improvements in soil physical properties through less soil compaction, reduction in energy use, and lower labor requirements; (2) more flexibility in timing of field operations. (3) reduction of some production costs.

The reduction of tillage is the key feature of conservation production systems because disadvantages of tillage frequently exceed benefits. Conservation tillage emphasizes the use of crop residues to protect the soil from wind and water erosion. Crop residues are maintained on the soil surface by reducing the number of tillage trips across a field, and by selecting tillage implements that minimize residue incorporation. To compensate for the reduction in tillage, herbicides may be used for weed control.

Many studies have shown that the main benefit from tillage has been weed control. In areas of surplus spring rainfall, farmers till the soil to dry out the surface and permit more timely planting. Also tillage is sometimes effective for breaking crusts to allow seedling emergence. However research has found that tillage can destroy the structure of some soils and may actually make these soils more likely to crust. Therefore there may be tradeoffs which need to be correctly evaluated with regard to tillage benefits.

Row crops that have high yields and adequate weed control can be grown with limited tillage in Northeast Kansas. Grassy weed problems in reduced tillage corn and grain sorghum may occur after several years but they are most serious when those crops are grown continuously (Lundquist, 1986).

Objective of Study

The major objective of this study is the evaluation of economic potentials and associated risks of conventional and reduced tillage systems for production of grain sorghum and soybeans in Northeastern Kansas. The study will address the following questions: 1) Which cropping system of grain sorghum and/or soybeans provides the highest annual net returns in Northeastern Kansas? 2) How much risk is involved with each system? 3) What effect does reduced tillage practioes have upon yield risk and annual returns?

Specific study objectives are:

1) Identify technically feasible reduced tillage cropping systems which could potentially replace conventional tillage systems in Northeastern Kansas.

2) With recommendations from agronomists and agricultural experiment station personnel, establish typical cropping practices that would be followed in each cropping system.

3) Collect yield data from agricultural experiment stations for each cropping system.

4) Define a representative case farm for the study area using Kansas State University Farm Management data.

5) Establish an equipment complement that is capable of meeting tillage and planting requirements of the case farm within an optimum time period.

6) Estimate the variable and fixed costs of each system based upon characteristics of a typical Northeastern Kansas farm using an enterprise budget framework.

7) Examine potential risk by variance of yields, prices, and net returns for each system.

8) Use FSD, SSD, and SDWRF to provide a ranking of the cropping systems with consideration of risk.

Study Area

Yield data used in this study were collected at the Cornbelt Experiment Field, which is located near Hiawatha in Brown County, Kansas. Conventional preplant tillage for weed control and seedbed preparation has been compared to no-till planting since 1975 and ridge-till planting since 1980. Prior to 1980 the ridge-till plots were farmed using a till-plant system. This system differs from ridge-till because it includes at least one pre-plant tillage operation (disc, chisel, or both) each year. Statistical tests described in chapter 4 showed no significant difference between the till-plant yields generated in years 1975 through 1979 and the ridge-till yields generated in years 1980 through 1984. Therefore, the study uses the data from the till-plant system to generate net returns for the years 1975 through 1979 for the ridge-till system. Net returns to management were thus examined for all three planting methods (conventional, no-till, and ridge-till) for each of nine cropping rotations for the years 1975 through 1984.

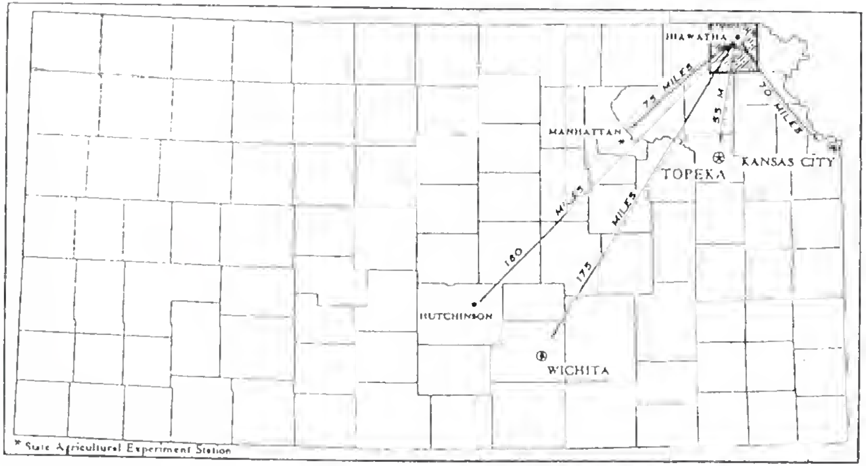
The cropping systems considered in this study are: conventional tillage continuous grain sorghum (CVGG), conventional tillage soybeans after grain sorghum (CVGS), conventional tillage continuous soybeans (CVSS), ridge-till continuous grain sorghum (RTGG), ridge-till soybeans after grain sorghum (RTGS), ridge-till continuous soybeans (RTSS), no-till continuous grain sorghum (NTGG), no-till soybeans after grain sorghum (NTGS), and no-till continuous soybeans (NTSS).

Soils of Study Area

Brown County is located in the northeastern corner of Kansas near the Missouri River (Figure 1.1). The soils of Brown county belong to the soil group, Argiudolls. These soils are found in southeastern Nebraska, eastern Kansas, northeastern Oklahoma, northeastern Missouri, southeastern Iowa and northern Illinois (see Figure 1.2). The county's soils can be divided into upland and lowland areas. The lowlands, located along streams, range from one-quarter to three-quarters of a mile in width and are generally level and fairly well drained. The uplands are subdivided into smooth to gently sloping areas, strongly sloping areas, and rough hilly areas.

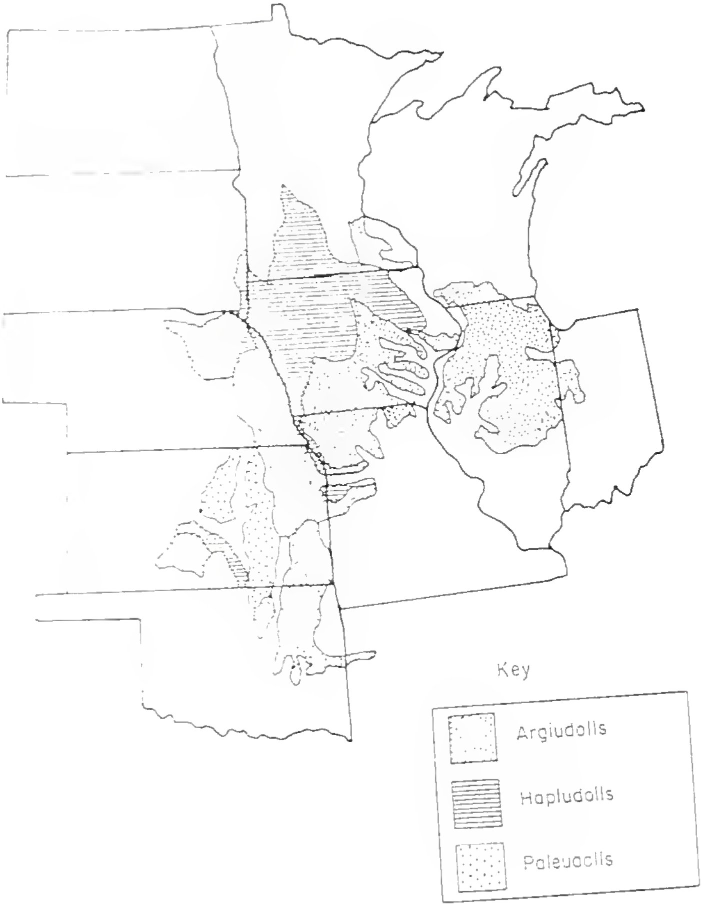
The soils of Brown County cover a wide range of use suitabilities and management requirements. Physical and chemical properties of a soil

Figure 1.1 Location of Brown County in Kansas



* State Agricultural Experiment Station

Figure 1.2 Areas where Hapludolls, Agriudolls, and Paleudolls are the dominant soils. (Adapted from National Atlas, Sheet 86, Soils, U.S. Geographic Survey, 1969.)



determine how plants grow and influence the types of management required. These properties vary widely in Brown County. Soil texture ranges from silty clay to gravelly loam. Some soils are rich in organic matter; some are not. Some need artificial drainage if used for cultivated crops. Most soils require lime and fertilizer, but in varying amounts.

Examples of the extremes in use suitability are Marshall silt loam and the Sogn soils. Marshall silt loam is a good soil for general farm crops. It is easily penetrated by air, water, and roots. The root zone is 5 to 6 feet deep. This soil responds to good management and can be kept highly fertile. The Sogn soils are suitable only for grasses. In a few places roots may find their way into cracks in the shattered bedrock, but in general the root zone is no more than 15 inches deep (Eikleberry and Templin, 1960).

The Experiment Field's soils are silty, windblown loess. Grundy silty clay loam, the dominant soil, has a black silty clay loam surface, usually more than 15 inches thick and a silty clay subsoil. It typically occupies ridge crests and tablelands of western and southeastern Brown county. The nearly level slopes have thick surface soil, which thins rapidly as slopes increase. Gradient terraces are usually needed to reduce sheet erosion, which is a serious hazard because subsoil absorbs water slowly. But the soils produce excellent yields of corn, grain sorghum and wheat under good management and adequate moisture (Long, 1985).

Climate of Study Area

About 75 percent of the annual precipitation comes during the normal growing season. Weather data is available from Horton, Kansas located within 10 miles of the experiment field. Figure 1.3 provides average monthly precipitation and Figure 1.4 gives the annual precipitation from 1900 to present. In May and June, 3 to 5 inches of rain may fall in 24 hours. This is the time when much of the cropland is freshly cultivated. The heavy rains produce a lot of runoff and are likely to cause floods and severe sheet and gully erosion. Average yearly rainfall is 35.07 inches. The normal date of the last frost in spring is April 25. The normal date for the first frost of fall is October 15 providing a growing season of 172 days.

Figure 1.3 Average Monthly Precipitation at Horton, Kansas

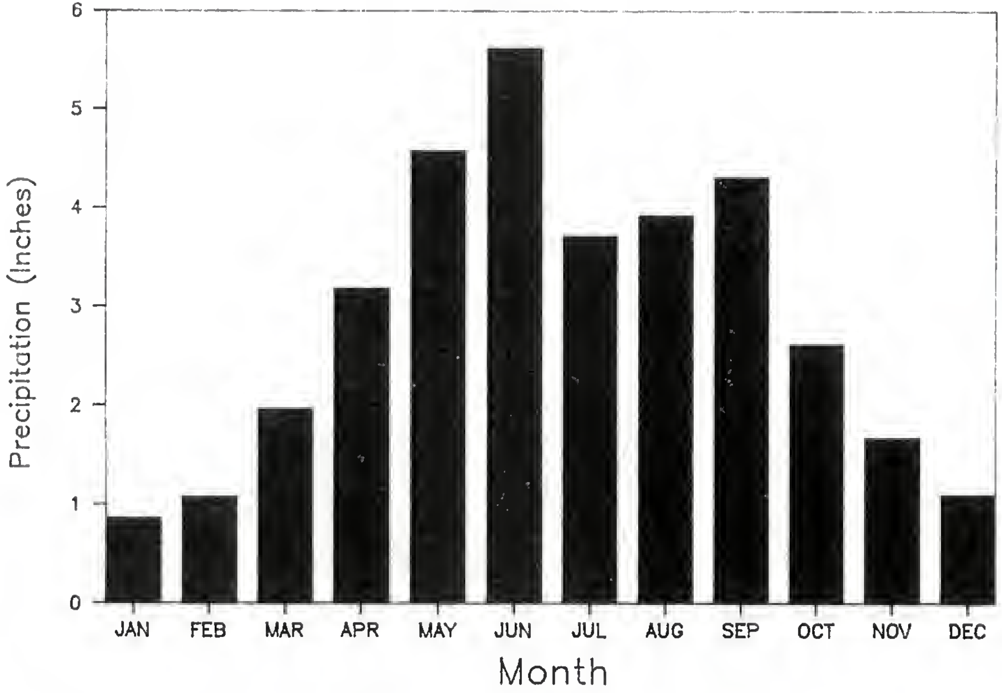
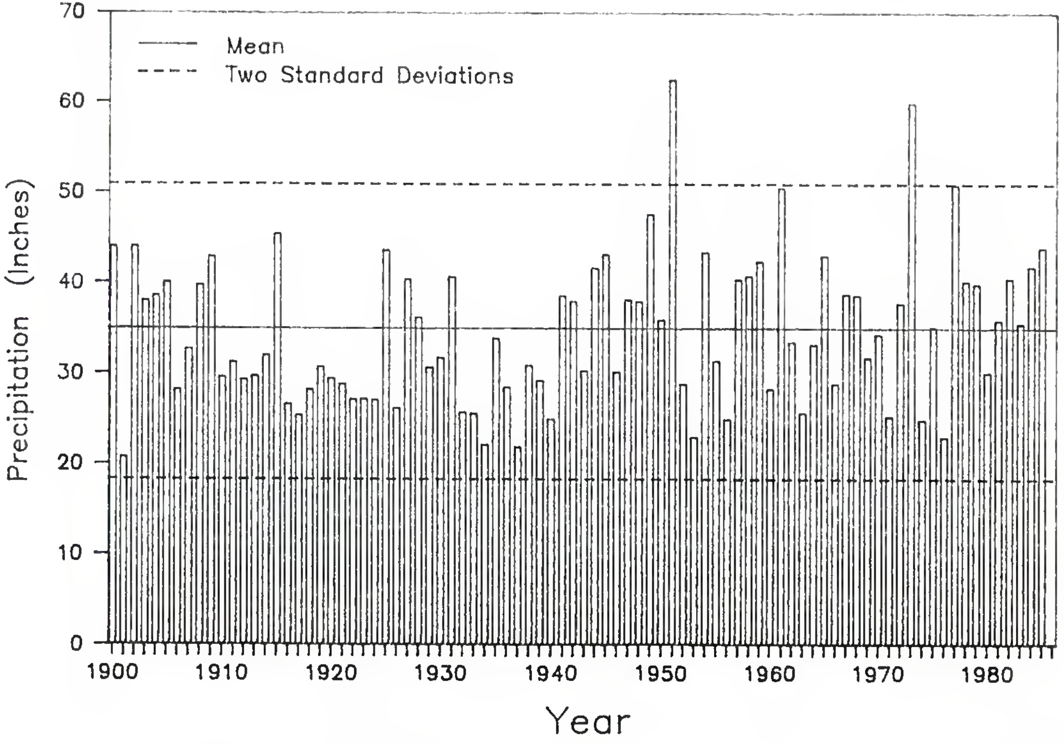


Figure 1.4 Annual Precipitation at Horton, Kansas



CHAPTER TWO

REVIEW OF LITERATURE

Within the past decade, American farmers have begun to change the way they till the soil. Instead of an almost complete reliance on the moldboard plow, conservation tillage practices that disturb the soil less and leave more residue on the soil surface have become much more popular.

The 1982 National Resources Inventory found 36 percent of U.S. cropland treated with one or more practices designed to curtail soil erosion. The predominant practice was conservation tillage. This practice was used on 24 percent of all cropland -- about 100 million acres. The other major conservation practice, terracing, was used on 7 percent of the nation's cropland. All other practices, such as contour farming and diversions, were found to be used on only a small fraction of the cropland base (cited by Anderson and Bills, 1986).

Early Conservation Practices

The recognition of the soil erosion problem dates back two and one-half centuries, when the United States was but a collection of British colonies. At the time settlers first came to America, labor was scarce and expensive, while land was plentiful and cheap. When soil eroded or was thought to be worn out, the typical farmer would abandon his farm and move west to new land or allow his land to lie fallow for several years until it became more productive. Conservation and fertilization of the soil cost more in labor usage than was returned to the farmer by improved yields (Rasmussen, 1982).

One of the first farm bulletins published by USDA found thousands of acres of valuable but eroded cropland abandoned each year. This bulletin, "Washed Soils: How to Prevent and Reclaim Them" was published in 1894. It urged farmers to save and use the land they had. H.H. Bennett's 1928 publication, "Soil Erosion -- A National Menace," awakened much public concern about the soil conservation problem. He has since been credited as "the Father of the Conservation Movement". The weaknesses of conventional tillage practices were emphasized in 1943 by E.H. Faulkner in his famous book, "Plowman's Folly." However the minimum tillage practices he advocated were not widely adopted because of the accompanying weed problems.

Early conservation practices were implemented only when soil losses were severe (Cosper, 1983). These programs usually involved the complete elimination of plowing. The reduction of soil losses, however was accompanied with a decrease in yield and an increase in weed associated problems.

Erosion

Rainfall related soil erosion on U.S. cropland acreage averages only 4.4 ton per acre per year. As a general rule, soil can regenerate itself if the annual erosion rate is less than 5 ton per acre. However, there are currently 36 million acres (9 percent of all cropland) which exceed 15 ton of soil erosion per year (Grano, 1985).

Continued erosion can cause two different types of damage: on-farm losses to soil productivity and off-farm pollution of air and water. It has been shown that erosion lowers yields on many soils through reductions in soil water holding capacity, rooting depth available for plant use, and water infiltration rate. Even with the addition of fertilizers, yields may not be completely restored. Erosion can also affect the quality of air and water (Batie, 1986). Agriculture is considered the main source of non-point source water pollution. In 6 of the 10 Environmental Protection Agency regions non-point sources are the main cause of water pollution (Myers, 1986). Soil particles in water runoff carry along fertilizer residues, pesticides, dissolved minerals, and animal wastes with associated bacteria.

Troeh et al. (1980) states that water erosion is a three step process. First, individual grains of soil are detached from the soil mass. Some of these particles float into soil voids, sealing the soil surface so water cannot readily infiltrate the soil. This in turn increases the amount of runoff water. Second, the detached grains are transported over the land surface and down slopes in the runoff water. Third, as the water slows, the soil grains fall out of suspension and are deposited as sediment.

With high erosive energy, water can detach and move larger soil particles. It can also move more soil particles. Thus erosive energy relates directly to the amount of soil carried off a field (Plaster, 1985). Plaster also lists four soil characteristics which affect erosive energy: (1) soil texture and structure, (2) slope, (3) soil cover, and (4) roughness of soil surface.

Surface residue protects the soil from detachment by water and wind. It minimizes surface crusting, allowing more water to infiltrate. It also reduces runoff velocity, thus water's ability to transport sediment. Surface residues control wind erosion by reducing wind energy and by protecting the soil surface (Mannering and Fenster, 1983). Wilhelm et al. (1986) find surface residues act as a mulch by reducing the rate of soil water loss and they modify the soil temperature.

Mannering and Fenster also find soil surface roughness can reduce erosion. The roughness increases water storage capacity in the plow layer and reduces velocity of runoff and rate of surface sealing. Surface roughness also lessens wind erosion by reducing wind energy.

Lane and Gaddis (1976) estimate soil losses per acre for three types of tillage systems. Slot-plant (no-till) has the lowest loss per acre of 0.5 ton per acre. Till-plant (similar to ridge-till) has an estimated loss per acre of 3.1 ton, while maximum-till (includes plowing) has a loss per acre of 10.7 ton.

Plaster (1985) sites two separate costs of soil erosion: the cost to the farmer and consumer of production losses, and the cost to the public of pollution and sedimentation.

The Soil Conservation Policy Task Force (1986) finds the productivity costs of erosion to be of four sorts: (1) the value of output lost because of the decline in soil productivity, (2) the costs to farmers of things done to offset the loss in productivity, (3) the cost of erosion reduction measures to avoid losses, (4) the cost of damage to growing crops.

The task force estimates the current value of prospective costs of erosion-induced productivity losses (item 1) for land planted to corn and soybeans to be about $40 million per year. Estimates of nutrient loss (a component of item 2) range from $1 billion annually (Larson et al., 1983) to roughly half as much, depending upon assumed fertilizer prices. Estimates for item 3 range from $800 million per year to $1.6 billion per year, depending upon the assumed rate of return to capital.

The Soil Conservation Policy Task Force identifies the off-site costs of erosion to include costs to: (1) recreational services, (2) water storage facilities, (3) navigational channels and harbors, (4) property values of lands near streams and lakes, (5) flood control and damage, (6) sedimentation of water conveyance facilities, (7) water treatment facilities, and (8) steam electric power plants. The task force provides a crude estimate of the costs to be $1.9 billion per year in 1980.

Crosson (1984) estimates productivity losses to have a present value of about $17 million. This is based upon the assumptions that corn and soybean yields decline 10 percent over 100 years, that the decline is in equal annual increments, that corn is priced at $3 per bushel and soybeans at $7, that there are 70 million acres in each crop each year, and the annual rate of discount is 10 percent. This estimate does not include the costs of additional fertilizers and other inputs farmers may use to compensate for the loss of soil productivity. Nor does it include the costs of terracing and other similar practices.

Reasons for Tillage

Tillage is an expensive and time consuming undertaking, therefore, tillage must provide significant benefit to farmers to warrant the expense. Plaster (1985) sites four common reasons for tillage: (1) weed control, (2) alterations of physical soil conditions, (3) crop residue management, and (4) seedbed preparation.

One of the most common uses of tillage is weed control, both before and after planting. Before planting, tillage prepares a weed-free seedbed that greatly simplifies weed control during the growing season. After planting, cultivation continues to destroy or bury emerging seedlings. A weed-free environment is important to the growing crop in order for it to make full usage of water, nutrients, sunlight, and other resources.

Tillage can be used to improve physical soil properties, however the improvement is often needed only to correct for problems caused by past tillage. Tillage during seedbed preparation stirs and loosens the soil, improves aeration, and creates a suitable environment for plant growth. Tilled soils will usually warm earlier in the spring and dry sooner, allowing earlier seeding and improved germination to occur. However, tillage can cause a long-term decline in physical structure. The decline in soil organic matter caused by tillage reduces the productive capacity of soils. Also the formation of tillage pans by soil compaction caused by wheel traffic, especially in wet soils, can restrict plant root growth.

After crop harvest, plant residues remain in the field. The amount of residue depends upon the type of crop, how well it grew, and how it was harvested. Plowing is often used to bury crop residues, resulting in a clean field that is easy to plant and cultivate. Present trends are to maintain some residue on the soil surface to save moisture and prevent erosion.

Seedbed preparation is perhaps the major reason for tillage. The objective of preparing a seedbed is to ensure that the soil meets the needs of the germinating seed. The seed needs a moist soil at the proper temperature with sufficient air for seed respiration and germination. The soil should be loose enough for good aeration, but compact enough around the seed for good soil/seed contact.

Johnson (1985) finds cultivation when combined with herbicides to be the most cost effective weed control program. Even where weeds have been controlled with chemicals, cultivation can increase yields. These yield increases may be partially related to breaking crusts, thus increasing water infiltration. Cultivation also often decreases soil erosion due to increased surface roughness and water infiltration. He adds that when cultivation is done the canopy is about to close over the soil and protect it from rainfall, so rainfall is unlikely to cause additional erosion problems.

Conventional Tillage

Christensen and Magleby (1983) define conventional tillage to consist of tillage systems where 100 percent of the topsoil is mixed or inverted by plowing, a power tiller, or multiple discings. Conventional tillage involves two stages. First, primary tillage breaks up the soil and buries crop residues. This is often done with a moldboard plow. Secondary tillage is later used to produce a fine seedbed and kill weeds by a series of operations that break up the soil into smaller and smaller chunks. Secondary tillage involves mixing implements like disks and harrows.

Conventional tillage leaves little residue remaining to protect the soil from erosion. Troeh provides a table (Table 2-1) that shows the proportion of original residue remaining on the surface after various tillage operations. The major technical problems with conventional tillage are that soil particles are broken down into small particles that erode more easily, and secondly, residue is removed from the soil surface.

Conservation Tillage

Troeh, et al. (1980) defines conservation tillage as a program of crop residue management aimed at increasing infiltration and reducing erosion and runoff. Plaster (1985) states that a conservation tillage field at planting time must have at least 30% of the soil surface covered by crop residues to be effective. This practice will reduce erosion by 40% to 50%.

Table 2.1 Effect of a Single Tillage Operation on Crop Residue Remaining on the Soil Surface

Implement	Percent Residue Remaining
Sweeps > 1.0 meter	90
Sweeps < 1.0 meter	85
Duckfoot cultivator	75
Rod weeder	90
Rod weeder with small shovels or sweeps	85
Skew treader	90
Chisel	75
One-way disk plow	50
Tandem disk	50
Moldboard plow	0

Conservation tillage is the lowest cost conservation method per ton of soil saved and is rapidly becoming the most widely accepted method for controlling soil losses.

There are many benefits to conservation tillage. Successful conservation tillage reduces soil and water losses by: (1) leaving appreciable crop residue on the soil surface; (2) leaving the surface rough, porous, cloddy, or ridged; or (3) a combination of the two (Mannering and Fenster, 1983). Brady (1984) lists several other advantages to conservation tillage: (1) decrease in water evaporation; (2) reduction of the time required for land preparation and planting; (3) cost benefits from the decrease in the number of tillage operations.

Research involving conservation tillage systems and different soils shows that these tillage techniques have certain limitations: (1) they are not adaptable to all soils; (2) they provide varied crop response on some soils but not on others, and (3) they require additional emphasis on crop management not associated with conventional tillage (Cosper, 1983).

Among the disadvantages to conservation tillage is the cost of herbicides to keep weeds under control. However this must be weighed against the savings of fuel from the lower energy requirements of the conservation tillage systems and other reductions in variable and fixed costs associated with reductions in tillage operations (Brady, 1984).

Ritchie and Follett (1983) site these concerns with conservation tillage. (1) Tillage has long been the primary method of weed control. Even with conventional tillage, weeds reduce crop yields by competing for the same water, nutrients, and other resources. Although herbicides can be substituted for tillage they are not available for all crops, also herbicides react differently in different soils and under different growing conditions. Environmental concerns can also be linked to herbicide usage.

(2) Diseases, insects, and nematode problems have also been linked to conservation tillage. Conventional tillage systems limit some of these organisms by controlling their habitats. Once again environmental concerns with chemical use exist.

(3) In general, surface-applied fertilizers will produce maximum yields of most crops in conservation tillage systems. Nitrogen fertilization is not a major problem with conservation tillage. Little research is available on the effects of conservation tillage on the availability of secondary nutrients and micronutrients.

(4) While some equipment for conventional tillage can be used for conservation tillage, additional equipment may have to be purchased.

Hinkle (1983) sites three additional difficulties: (1) Herbicide carry-over can reduce yields in sensitive crops. An example would be atrazine. Atrazine is used to control weeds when corn and grain sorghum are grown. When soybeans and small grains are planted the year following atrazine application injury can occur. (2) There can be unwanted interactions among various chemicals applied. (3) Off-site problems from pesticides found in runoff water. These chemicals can be found in surface, ground, and well water. In Iowa, where atrazine is applied to 95 percent of corn, monitoring turned up detectable amounts of the herbicide in all water examined (Hinkle, 1973).

Lindstrom et al. (1984) examine simulated runoff rates on conventional, reduced, and no-till cropping systems immediately after planting during the first and tenth years of continuous corn. Their trials showed that surface soil conditions under no-till systems were vulnerable to runoff. They recommend caution in assuming that no-till farming or crop residue by itself will solve water runoff problems.

Effects of Conservation Tillage upon Yield

Brady (1984) finds crop yields from conventional tillage and conservation tillage to be about the same on well-drained soils. However, Brady finds that certain soils -- the flat, dark colored, poorly drained soils of Indiana, Ohio and Illinois, for example -- produce lower crop yields under surface residue systems than under conventional tillage. He links the decrease in yield to higher bulk densities and reduced pore space attributable to the reduction of tillage. Although reduced porosity of well-drained soils apparently has no adverse effects on crop yields, this is not the case in poorly drained areas.

In contrast a study in Western Kansas by Williams (1986) found yields of both wheat and grain sorghum to be significantly higher from the conservation tillage systems than from the conventional tillage systems. He linked the yield increase to added soil moisture.

Unger and McCalla (1980) list a number of studies examining grain yields. They found that as a general rule, grain yields were little affected by tillage practices under conditions of adequate soil water, favorable precipitation, and good drainage, provided other factors such as soil fertility, weed control, and plant populations were equal.

Under conditions of limited soil water and limited precipitation or irrigation, crop yields were equal and often significantly higher with reduced and no-tillage systems than with conventional tillage.

Crosson (1981) draws an important distinction between short-term and long-term effects of conservation tillage upon crop yields. Over the long term, the lower rates of erosion can give conservation tillage a decisive yield advantage relative to conventional tillage. Whether this occurs depends upon the differential advantage of conservation tillage in reducing erosion and the amount of topsoil and nature of the under lying parent material.

Reed and Erickson (1985) studied yield differentials in the Great Plains. They found grain sorghum yields from conservation systems were consistently greater than the yields conventional tillage systems in western Kansas and Nebraska. Chemical conservation tillage, ecofallow, and no-till systems all outyielded conventional tillage.

Cultivation of row crops has always been a major method of weed control. Johnson (1985) cites studies in Illinois, Indiana, Mississippi, and Louisiana that show cultivation can increase yields even when there are not enough weeds to justify cultivation. Some yield increases have averaged in excess of 20 bushels of corn and 7 bushels per acre of soybeans.

Effects of Conservation Tillage Upon Yield in Eastern Kansas

A 7-year studies by Raney and Thierstein (1986a) in North Central Kansas has shown no-till treatments to be significantly superior over disk and undercut tillage treatments in grain sorghum following wheat by 14 bu/acre and 14 to 20 bu/acre respectively (LSD = 13.2bu /acre). A 2-

year study by Raney showed conventional (maximum) tillage to give a significant 7 bu/acre increase over reduced tillage and no-till treatments in continuous corn (Raney and Thierstein, 1986b).

No-till continuous soybeans yielded less than the conventional or reduced till soybeans in 1985 in East Central Kansas. The same trend was observed with corn in 1985, although there were no significant differences (Maddux and Barnes, 1986). In Southeast Kansas during the dry growing years of 1983 and 1984, grain sorghum and soybean yields were not affected by tillage systems. However in 1985, no rain for three weeks after planting resulted in poor weed control in no-till plots, thus lowering grain sorghum yields as compared to conventional and reduced tillage (Sweeney, 1986).

Economic Implications of Conservation Tillage

Even though adoption of conservation tillage may result in the reduction of yields, greater weed control problems, additional farm machinery, and a change in farming practices; many U.S. farmers have nonetheless modified their tillage strategies. This has been done for a variety of reasons including: the reduction of labor, fuel and machinery expenditures, increases in net returns, and decreases in the amount of soil loss.

The effect of conservation tillage upon net returns has been examined by several studies. Duffy and Hanthorn (1984) found returns to conservation tillage strategies were not significantly different from the returns of conventional tillage for U.S. corn farmers or for Midsouth and Southeast soybean farmers in 1980. Midwest conventional till soybean farmers accrued significantly higher returns, however than Midwest no-till soybean farmers, primarily as a result of higher yields.

Studies have shown that declines in production costs due to lower fuel, repair, and capital costs may be largely offset by increases in chemical costs for most crops including: corn, soybeans, grain sorghum, and wheat. (Klemme, 1983; Duffy and Hanthorn, 1984; Brady, 1984; Johnson et al., 1986). A common conclusion among these and other studies is that farm-level economic feasibility of reduced tillage systems depends in large part on managerial skills necessary to obtain yield levels equal to those from established, conventional tillage systems (Klemme, 1985).

Eventually, continuation of present amounts of erosion will reduce the productivity of the nation's cropland, in addition to imposing off-farm costs. One estimate of off-farm costs, given earlier, was $1.9 billion annually at 1980 prices. For on-farm costs through losses to soil productivity the annual cost was roughly $1.5 billion.

Klemme (1985) examines different tillage systems with corn and soybeans using experimental plot yield data from North Central Indiana. These returns are compared under both risk-neutral and risk averse scenarios using stochastic dominance. Under risk neutrality there was no distinct advantage to any tillage system over another when soil loss values were ignored. Risk averse farmers who place low values on soil losses may select tillage-intensive systems since they are second degree stochastically dominant over no-till in the production of corn and soybeans. If costs of $10-$15 associated with annual soil losses are added to the analysis, conventional tillage is eliminated by second degree stochastic dominance.

Williams (1986) examines different tillage systems with wheat and grain sorghum using experimental plot yield data in Western Kansas. These returns are compared for both risk-neutral and risk averse decision makers using stochastic dominance with respect to a function. The study found that managers classified as risk averse prefer conservation tillage systems for wheat and grain sorghum instead of the traditional conventional wheat-fallow cropping system. Higher yields in association with reduced energy and labor costs offset increased chemical costs of the conservation systems.

CHAPTER THREE

CONCEPTIONAL CONSIDERATIONS

Economics of Conservation Tillage

The potential of conservation tillage to reduce crop production costs is a major benefit. Particularly of importance are the reductions in energy costs. As with most agricultural innovations the benefits from the reduced costs will probably go largely to consumers. Only farmers who are "early adopters" of conservation tillage are likely to realize much gain for their efforts. Late adopters will be in the position of having to use the new system or risk being forced out of business (Giere, et al., 1980).

A major economic benefit of conservation tillage is the value added by the reduction of soil erosion. This study, however, does not consider these external costs of conventional tillage. External costs include both on-farm losses to soil productivity and off-farm pollution of air and water. It has been shown that erosion lowers the productivity of many soils through reductions in water holding capacity, rooting depth available for use, and water infiltration rates. Off site costs include pollution by sedimentation, and runoff fertilizer residues, pesticides, dissolved minerals, etc.

Enterprise Budgets

In the traditional theory of the firm, the goal of producers is assumed to be profit maximization. In analyzing each cropping system, this study does not solve for the profit maximization points, but assumes that the input levels used by the experiment station agronomists are near the optimal amount of use (marginal factor cost equals marginal value product). The enterprise budgets represent only one point on the production function facing the producer. This point is assumed to be at or near the profit maximization level.

Decision Theory

Traditional analyses of decision making situations has been divided into two classes: business risk and financial risk (Boehlje and Eidman, 1984). Business risk or uncertainty is defined as the inherent uncertainty in the firm independent of the way it is financed. The major sources of business risk in any production period are price and production uncertainty. Financial risk or uncertainty is defined as the added variability of net returns to owner's equity that result from the financial obligation associated with debt financing. This risk results from the concept of leverage. Leverage multiplies the potential financial return or loss that will be generated. The major source of financial risk is the cost and availability of credit. This study only examines business risk and uncertainty.

Agricultural producers operate in an uncertain decision making environment, therefore, agricultural economists have to incorporate uncertainties into their decision analysis. The Expected Utility Hypothesis has provided the basis for much of the current theory of decision making under uncertainty. The hypothesis states that choices made under uncertainty are affected by the decision maker's preferences and expectations, and that the decision rule used by decision makers is maximization of expected utility. Stochastic Dominance techniques have become a popular method for ranking alternative strategies of decision makers consistent with the Expected Utility Hypothesis. There are several different stochastic dominance models commonly used. First Degree Stochastic Dominance (FSD), Second Degree Stochastic Dominance (SSD), and Stochastic Dominance With Respect to a Function (SDWRF) will be discussed here.

Expected Utility Hypothesis

The Expected Utility Hypothesis dates back to Bernoulli's Principle of rational choice which was formulated by Daniel Bernoulli some 200 years ago. It was not until the 1940s when the work of von Neumann and Morgenstern showed Bernoulli's principle to be a logical deduction from a number of axioms (Anderson, Dillion, and Hardaker, 1977). The axioms can be expressed as follows:

1. Transitivity: if there exist three lotteries, 'a', 'b', and 'c', and if 'a' is preferred to 'b' and 'b' is preferred to 'c'; then 'a' is preferred to 'c'.
2. Continuity: if an individual has a preference for lottery 'a' over 'b' and 'b' over 'c'; then there exists some probability, p, such that he is indifferent between receiving 'b' and another lottery with probability '1-p' of receiving 'a' and probability 'p' of receiving 'c'.
3. Independence: if lottery 'a' is preferred to lottery 'b' and there exists another lottery 'c'; then a lottery with 'a' and 'c' is preferred to a lottery with 'b' and 'c' as long as the probabilities of receiving 'a' and 'b' are equal.

Bernoulli provided the means for ranking risky prospects in order of preference, the most preferred being the one with the highest expected utility. One of the most serious difficulties with using the Expected Utility Hypothesis is in accurately measuring a decision maker's preferences. The most direct way is to estimate a decision maker's utility function, which relates all of the possible outcomes of a choice to an exact representation of preferences. King and Robison (1984) list several reasons for inaccuracy in formulating utility functions: shortcomings in interview procedures, problems in statistical estimation, and the lack of knowledge by individuals about their own preferences.

Some of the problems with utility functions are overcome by using an efficiency criterion to order choices. Given specified restrictions on a decision maker's preferences, an efficiency criterion can provide a partial ordering of choices. The efficiency criterion divides the decision alternatives into two mutually exclusive sets. The efficient set contains the decision alternatives that were not dominated by any other alternative. The inefficient set contains the remaining alternatives which are not preferred by any of the decision makers.

An efficiency criterion applies for a particular class of decision makers, as defined by the set of restrictions placed upon their utility functions. If the restrictions are rather general in nature, the criterion can order alternatives, while requiring minimal information about the decision maker's preferences. If enough alternatives are eliminated, decision makers can make a final choice from the efficient alternatives.

A major problem with efficiency criteria, however, is the trade-off between the discriminatory power and the applicability of the criterion. Efficiency criteria that place few restrictions on preferences, and thus apply to most decision makers, may not eliminate many choices from consideration. Similarly, criteria that identify small efficient sets usually require more specific information about preferences of individuals.

First Degree Stochastic Dominance (FSD) is the most general efficiency criterion. The FSD criterion holds for decision makers who prefer more to less. This is the case when the slope of the decision maker's utility function is greater than zero (positive marginal utility). This criterion holds for most decision makers and thus tends to limit the usefulness of FSD, since the criterion often eliminates few of the choices under consideration. The FSD criterion can be formally stated as:

> Given two cumulative probability distributions, F(x) and G(x), associated with alternative management strategies, it can be shown that the expected utility of F is greater than G, if and only if,
>
> $[F(x)-G(x)] <$ or $= 0$, for all x, and $[F(x)-G(x)] < 0$ for some x.

Second Degree Stochastic Dominance (SSD) is more discriminating than FSD. SSD holds for all decision makers whose utility functions have positive, nonincreasing slopes at all outcome levels. These individuals are considered risk averse. SSD is a widely used efficiency criterion. It has more discriminatory power than FSD, and the risk averse assumption seems reasonable for many situations. However, the risk aversion assumption does not always hold. King and Robison (1984) list several studies indicating that risk preferring behavior may be more prevalent than was earlier believed. Also, even though SSD is more discriminating than FSD, it may still not effectively reduce the number of alternatives. SSD can be formally expressed as:

> Given two cumulative probability functions, F(x), and G(x), associated with alternative management strategies,

> it can be shown that for all risk averse decision makers, the expected utility of F is greater than G, if and only if,
>
> $$\int_{-\infty}^{x} [F(y)-G(y)]dy \le 0 \text{ for all } -\infty < x < \infty$$
> $$< 0 \text{ for some } x.$$

Stochastic Dominance With Respect to a Function (SDWRF) orders choices for decision makers facing uncertainty by setting upper and lower bounds to define an interval using the Pratt absolute risk aversion function $R(x)$. The absolute risk aversion function is defined by Pratt as:

$$R(x) = -U''(x)/U'(x)$$

$R(x)$ is the ratio of the rate of change of the slope over the slope of the decision maker's utility function $U(x)$. A particular value of R can be interpreted as the percent reduction in marginal utility per unit of x. If x is measured in dollars a value of $R(x) = 0.0001$ indicates that marginal utility is dropping at the rate of 0.01% per dollar.

SDWRF allows the researcher to examine classes of utility functions by defining a preference interval as desired. The preference interval is bounded by a lower risk aversion coefficient $R_1(x)$ and an upper risk aversion coefficient $R_2(x)$. FSD and SSD are restrictive cases of the SDWRF model. These cases include large preference intervals: FSD requires a large interval with $R_1(x) = -\infty$ and $R_2(x) = +\infty$ SSD requires the interval defined by $R_1(x) = 0$ and $R_2(x) = +\infty$ (Cochran, 1986). Dominance by SDWRF can be expressed as:

> Given two cumulative probability distributions, $F(y)$ and $G(y)$, associated with alternative management strategies, it can be shown that the expected utility of F is greater than the expected utility of G, if and only if, the utility function, $u_o(y)$ which minimizes

$$\int_{-\infty}^{+\infty} [G(y)-F(y)]u'(y)dy,$$

subject to

$$r_1(y) < -u''(y)/u'(y) < r_2(y)$$

For F to dominate G, the integral must be positive, which implies that expected utility of F(x) is always greater than the expected utility of G(x).

Comparison of Stochastic Dominance to Mean Variance Efficiency

Mean variance (EV) efficiency is the most widely used efficiency criterion. Like SSD, efficiency requires the decision makers to be averse to risk. Further, EV efficiency requires the outcome distributions to be normal. If these conditions are met, EV analysis provides the same efficient set as SSD.

King and Robison (1984) list several reasons why EV efficiency is widely used. EV efficiency is easy to use because means and variances of probability distributions are easy to work with. Much of the theoretical work on decision making under uncertainty has used the EV criterion. Also the EV criterion is easy to use with quadratic programming. By varying the expected value constraint parametrically, an EV efficient set can be identified. In contrast stochastic dominance requires pair-wise comparisons between alternatives which can not be incorporated into mathematical programming models.

Many of the problems with EV are similar to those of SSD. The decision maker is assumed to be risk averse. The EV efficient set often does not effectively reduce the number of decision alternatives. An additional problem, however, is EV's normality assumption, since much data considered by agricultural economists is skewed.

King and Robison (1984) compared strategy rankings for FSD, SSD, EV, MOTAD, and SDWRF. They found that FSD was ineffective in discriminating between alternatives. The efficient sets of SSD, EV analysis and MOTAD were identical even though the probability distributions were skewed. SDWRF allowed the possibility of risk preferring behavior at low return levels. Efficient sets of SDWRF were found for two preference intervals -- in one case the resulting efficient set was much smaller than the SSD efficient set while in the second case SDWRF reduced the set only slightly.

CHAPTER FOUR

PROCEDURE AND ASSUMPTIONS

Outline of Procedures

Stochastic dominance techniques are used to compare the variations of net returns to management of different cropping systems based upon a representative case farm in Northeast Kansas. The case farm is characterized according to data provided by the Northeast Kansas Farm Management Association.

This study considers net return distributions from nine different cropping systems based upon actual cropping practices for the years 1975 through 1984. The cropping systems involve two major Northeast Kansas crops, grain sorghum and soybeans, grown continuously and in a rotation with each other.

Enterprise budgets are used to determine the costs and returns of each cropping system. To form the budgets these steps are followed: (1) identification of the major operations which make up each cropping system practice, (2) determination of the machinery requirement for each system, and (3) formulation of an enterprise budget for each system based upon technical requirements and economic values.

Identification of the Cropping System Practices. A technically feasible cropping system is determined by identifying the operating inputs and the typical tillage techniques for each system. The operating inputs include the variable costs of production, such as seed, fertilizer and herbicides.

Determination of the Machinery Requirements. Using the timing and technical requirements of each field operation it is possible to obtain the machinery complement of the case farm for each cropping system. Tractors and implements are selected for each cropping system based upon the tillage requirements of each system. Schrock (1976) provides a work sheet to help determine tractor and implement size based upon farm size, planting and tillage constraints, and available field work days.

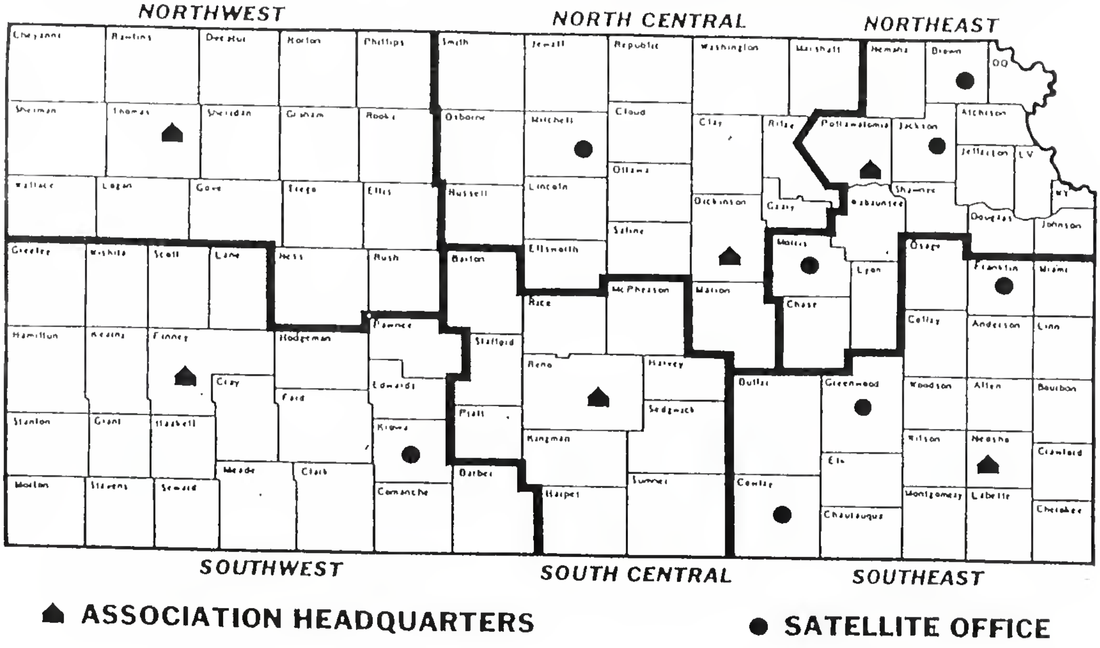
Formulation of Enterprise Budgets. To prepare the enterprise budgets, costs for labor, fuel, oil and repairs are calculated for each field operation in each of the cropping systems. The fixed costs of insurance, interest and depreciation are then determined for each item of machinery in all of the cropping systems. Finally the cost of the operating inputs are summed with the fixed costs to arrive at the total annual costs of production for each system.

Establishing Farm Size and Tenure.

Data from 230 predominantly cash crop dryland farms in the Northeast Kansas Farm Management Association was used to establish the size and tenure arrangements of the case farm (Figure 4.1). The average farm in the association was 785 acres. This figure was rounded to 800 acres for calculation ease. The average farm had 164 acres of wheat (20%), 215 acres of corn (27%), 189 acres of grain sorghum (24%) and 217 acres of soybeans (28%). Although wheat is a major component of a typical Northeastern Kansas farm, data concerning cropping practices was not available. Therefore this study ignored the wheat acreage in the analysis, thereby reducing the farm size to 640 acres (800 total acres less 164 acres of wheat then rounded to 640 acres).

Figure 4.1

KANSAS FARM MANAGEMENT ASSOCIATIONS



Owned land in the Northeast Association was shown to be 31% of the farmers' total acreage. The case farm's enterprise budgets assume 30% of the land is owned (192 acres) and 70% rented (448 acres).

The Cropping Systems.

In 1975 a research project was established at the Cornbelt Experiment Station in Northeastern Kansas near Powhattan to examine conservation tillage corn, grain sorghum and soybeans cropping systems. The cropping systems considered in this study are: conventional tillage continuous grain sorghum (CVGG), conventional tillage soybeans after grain sorghum (CVGS), conventional tillage continuous soybeans (CVSS), ridge till continuous grain sorghum (RTGG), ridge till soybeans after grain sorghum (RTGS), ridge till continuous soybeans (RTSS), no till continuous grain sorghum (NTGG), no till soybeans after grain sorghum (NTGS), and no till continuous soybeans (NTSS). Cropping systems involving corn are being considered by another study at the present time.

Table 4.1 Cropping Systems

1. Conventional Tillage Continuous Grain Sorghum ---------- CVGG
2. Conventional Tillage Soybeans After Grain Sorghum ------- CVGS
3. Conventional Tillage Continuous Soybeans --------------- CVSS
4. Ridge Tillage Continuous Grain Sorghum ----------------- RTGG
5. Ridge Tillage Soybeans After Grain Sorghum ------------- RTGS
6. Ridge Tillage Continuous Soybeans --------------------- RTSS
7. No Till Continuous Grain Sorghum ---------------------- NTGG
8. No Till Soybeans After Grain Sorghum ------------------ NTGS
9. No Till Continuous Soybeans -------------------------- NTSS

Ridge till and no till cropping systems substitute the use of herbicides for the spring tillage operations found in the conventional tillage systems.

Conventional tillage is defined as any tillage system in which 100 percent of the topsoil is mixed or inverted by plowing, a power tiller, or multiple discings. Conservation tillage will be defined as any tillage system that has at least 30% of the soil surface covered by crop residue at planting time.

Conventional Tillage. The conventional tillage system in this study makes use of disk tillage. From 1975-1979 the preplant tillage for the conventional till plots was to shred in the early spring if the plot contained grain sorghum stubble, chisel if the plot contained grain sorghum stubble, disc twice, and finally harrow 40% of the time. From 1980-1986 the preplant tillage for the conventional till plots was to shred in the early spring 50% of the time if the plot contained grain sorghum stubble, disc once, disc again 50% of the time, and finally field cultivate.

Herbicides were broadcast prior to the planting operation for both grain sorghum and soybeans. Grain sorghum was treated with 3.0 pound propachlor (Ramrod), an annual grass herbicide, and 1.5 pound atrazine, a broadleaf herbicide, in 83% of the years. 17% of years involved a treatment of 2.0 pound metolachlor (Dual), an annual grass herbicide, and 1.6 pound atrazine. Soybeans were treated with 3.0 pound Alachlor (Lasso), an annual grass herbicide, and .375 pound Metribuzin (Sencor), a broadleaf herbicide.

Ridge Tillage is a conservation tillage system adaptable to many types of soils including the somewhat poorly drained Grundy silty clay loam soils common to Northeast Kansas. A till planter with sweeps or disk openers is used for planting. During the planting operation, the top few inches of the ridge are removed, soil and residue are pushed aside, and seeding occurs in a cleared, raised seedbed. The ridge is maintained during the year with cultivations during the growing season.

Ridge planting is gaining interest in several areas of the state and country. Crops grown in soils that have a high clay content subsoil under a shallow topsoil may benefit from ridge planting not only because of better drainage and/or warmer spring soil temperatures (as compared with no till) but also from a deeper topsoil for rooting (Seeney and Sisson, 1985).

From 1975-1979 the ridge-till plots were farmed using a till-plant system. The preplant operations for the till-plant tillage was to shred in the early spring if the plot contained grain sorghum stubble. Also in four of the five years the plots planted to grain sorghum were chiseled. From 1980-1986 the only pre-plant field operation was to shred the grain sorghum stocks during one half of the years.

From 1975-1979, 2.7 pound of Bladex, a contact herbicide, was applied in April to all the till plant (ridge-till) plots. From 1980-1986 1.0 pound of Roundup, a contact herbicide, was applied in 83% for grain sorghum plots and 67% for soybean plots; 17% of years .25 pound of Paraquat, a contact herbicide, was applied to both grain sorghum and soybean plots. Prior to the planting operation herbicides were again broadcast for both grain sorghum and soybeans for all years. Grain sorghum was treated with 3.0 pound propachlor (Ramrod) and 1.5 pound atrazine in 83% of the years. 17% of years involved a treatment of 2.0 pound metolachlor (Dual) and 1.6 pound atrazine. Soybeans were treated with 3.0 pound Alachlor (Lasso) and .375 pound Metribuzin (Sencor).

No-Till farming is another very popular type of conservation tillage. In no-till farming the only soil manipulation required is the opening of a slit or trench wide enough to receive a seed followed by the covering of the seed with soil. No-till leaves almost all the previous crop residue on the surface, and reduces wind and water erosion to the minimum. This is the ultimate in reduced tillage systems and is the most heavily dependent upon the use of herbicides (Giere, et al, 1980).

From 1975-1979 the preplant operations for the no-till plots was to shred in the early spring if the plot contained grain sorghum stubble. From 1980-1986 shredding of grain sorghum stocks occurred during one half of the years. Herbicide treatment for the no-till plots was the same as the treatment occurring to the ridge-till plots.

Tables 4.2 - 4.4 list the required tillage operations for the study based upon the actual farming practices at the Cornbelt Experiment Field occur from 1980-1986. The tables are divided by 5 day intervals. The tables provide the field work hours per day, the percent of days available for the 5 day interval, the confidence level of days available, operations provided by both tractors and the combine. The confidence level is the percentage of years in which the study has this many or more field workdays. All confidences are at the 85% level except for the period May 16 through June 15 when the 85% level provided

Table 4.2 Timetable for Conventional-Till Farming Practice of Required Tillage Operations For All Crops By Five Day Intervals

Date	Field Hours	% Time Available	Conf Level	131 HP Tractor	160 HP Tractor	Combine
Apr 1	10	3/15	85		Shred	
Apr 6	10	3/15	85		Shred	
Apr 11	10	3/15	85		Shred	
Apr 16	10	4/15	85	Disk	Shred	
Apr 21	10	4/15	85	Disk	Shred	
Apr 26	10	4/15	85	Disk	Disk	
May 1	10	4/15	85	Disk	Disk	
May 6	12	4/15	85	Disk	Disk	
May 11	12	4/15	85	Disk	Disk	
May 16	12	3/15	77	Plant	F Cult	
May 21	12	3/15	77	Plant	F Cult	
May 26	12	3/15	77	Plant	F Cult	
Jun 1	12	4/15	72	Plant	F Cult	
Jun 6	12	4/15	72	Plant	F Cult	
Jun 11	12	4/15	72	Plant	Cult	
Jun 16	10	7/25	85	Plant	Cult	
Jun 21	10	7/25	85	Cult	Cult	
Jun 26	10	7/25	85	Cult	Cult	
Jul 1	10	7/25	85	Cult	Cult	
Jul 6	10	7/25	85	Cult	Cult	
Sep 16	7	3/10				Harv
Sep 21	7	3/10				Harv
Sep 26	7	3/10				Harv
Oct 1	7	3/10				Harv
Oct 6	7	3/10				Harv
Oct 11	7	3/10				Harv
Oct 16	7	3/10				Harv
Oct 21	7	3/10				Harv
Oct 26	7	3/10				Harv

Table 4.3 Timetable for Ridge-Till Farming Practice of Required Tillage Operations For All Crops By Five Day Intervals

Date	Field Hours	% Time Available	Conf Level	60 HP Tractor	170 HP Tractor	Combine
Apr 1	10	3/15	85		Shred	
Apr 6	10	3/15	85		Shred	
Apr 11	10	3/15	85		Shred	
Apr 16	10	4/15	85		Shred	
Apr 21	10	4/15	85		Shred	
Apr 26	10	4/15	85		Shred	
May 1	10	4/15	85			
May 6	12	4/15	85			
May 11	12	4/15	85			
May 16	12	3/15	77		Plant	
May 21	12	3/15	77		Plant	
May 26	12	3/15	77		Plant	
Jun 1	12	4/15	72		Plant	
Jun 6	12	4/15	72		Plant	
Jun 11	12	4/15	72	Cult	Plant	
Jun 16	10	7/25	85	Cult	Plant	
Jun 21	10	7/25	85	Cult	Cult	
Jun 26	10	7/25	85	Cult	Cult	
Jul 1	10	7/25	85	Cult	Cult	
Jul 6	10	7/25	85	Cult	Cult	
Sep 16	7	3/10				Harv
Sep 21	7	3/10				Harv
Sep 26	7	3/10				Harv
Oct 1	7	3/10				Harv
Oct 6	7	3/10				Harv
Oct 11	7	3/10				Harv
Oct 16	7	3/10				Harv
Oct 21	7	3/10				Harv
Oct 26	7	3/10				Harv

Table 4.4 Timetable for No-Till Farming Practice of Required Tillage Operations For All Crops By Five Day Intervals

Date	Field Hours	% Time Available	Conf Level	60 HP Tractor	131 HP Tractor	Combine
Apr 1	10	3/15	85		Shred	
Apr 6	10	3/15	85		Shred	
Apr 11	10	3/15	85		Shred	
Apr 16	10	4/15	85		Shred	
Apr 21	10	4/15	85		Shred	
Apr 26	10	4/15	85		Shred	
May 1	10	4/15	85			
May 6	12	4/15	85			
May 11	12	4/15	85			
May 16	12	3/15	77		Plant	
May 21	12	3/15	77		Plant	
May 26	12	3/15	77		Plant	
Jun 1	12	4/15	72		Plant	
Jun 6	12	4/15	72		Plant	
Jun 11	12	4/15	72	Cult	Plant	
Jun 16	10	7/25	85	Cult	Plant	
Jun 21	10	7/25	85	Cult	Cult	
Jun 26	10	7/25	85	Cult	Cult	
Jul 1	10	7/25	85	Cult	Cult	
Jul 6	10	7/25	85	Cult	Cult	
Sep 16	7	3/10				Harv
Sep 21	7	3/10				Harv
Sep 26	7	3/10				Harv
Oct 1	7	3/10				Harv
Oct 6	7	3/10				Harv
Oct 11	7	3/10				Harv
Oct 16	7	3/10				Harv
Oct 21	7	3/10				Harv
Oct 26	7	3/10				Harv

only 3 field workdays for this 31 day period. Seven field workdays were provided by allowing the confidence level to be at the 75% level for this time period.

Machine Complement Selection

Each cropping system requires a unique machinery complement to provide the required tillage operations. The machinery complement must match the tractor size to the horsepower requirements of the implement used for the tillage operation. This study develops a machinery complement for each system based only upon the needs of the system. This may overstate the costs of each system because rotations with fall crops allow more efficient usage of machinery by spreading annual fixed costs over more acres.

Schrock (1976) lists four steps in determining tractor size and implement width needed: (1) identify the critical job, (2) estimate the time available to do the job, (3) determine the size of machinery needed and finally (4) estimate the power requirements of the tillage implements.

Identify the Critical Job.

Equipment should have sufficient capacity to complete field operations within the optimum time period. Tractor size can then be determined by the most limiting tillage operation. The tractors must be large enough to allow both the required tillage operations and planting to occur during the optimal time period. The planting operation was the most limiting operation for all tillage systems. Optimum planting dates for grain sorghum in Northeastern Kansas are May 10 through June 20 and soybeans is between May 15 until

June 25 (Peterson, 1981 and 1984). Herbicide equipment was sized to match the planter in the equipment complement.

Timeliness in the completion of field operations can affect both crop quantity and quality. To avoid introducing additional variability into the analysis the equipment complement in this study may be slightly oversized to reduce the timeliness problem. In the conventional tillage systems a second disk was added to the equipment complement to make more efficient usage of the tractors.

In addition to determining tractor size, combine size must also be selected. When determining the combine size, capacity must be large enough to allow harvesting of the desired acreage within the required time period. he optimum time of harvest for soybeans and sorghum was assumed to occur during the 46 day period beginning September 15 and ending October 31.

Estimate the Time Available to do the Job. Determination of the time available for completion of a field operation requires an estimate to be made of the number of days weather will permit field work to occur. Buller et al., (1976) compiled a list of field work days available based upon the frequency of occurrence of suitable working days in a given year for several different locations in Kansas. Field work days refer to days when the soil moisture is at a level which is satisfactory to perform field operations. Tables 4.2 - 4.4 give the confidence levels used in this study. For harvesting 30% of the days are assumed to be suitable for work.

The number of work hours per day must also be determined. This study uses ten hour work days during the spring, 12 hour work days during the planting period, 10 hour work days during the summer, and 7 hours are available during the fall harvest. The total running time is determined by multiplying the work hours per day by the field work days available.

Finally it is necessary to schedule all of the desired tillage operations into the total time available. This may require more and/or larger equipment, also see the machinery selection worksheets in Appendices A, B, and C.

Sizing of the Machinery. The field capacity in acres per hour is determined by dividing the total acres covered by a particular field operation by the total running time available. Implement width can then be determined by this formula:

$$W = \frac{F \times 8.25}{S \times E} \quad (1)$$

where W is the implement swath width in feet, F is the field capacity in acres per hour, S is the speed in miles per hour and E is the field efficiency. Field efficiency estimates and speeds were found in the 1986 Ag Engineering Yearbook and are summarized in table 4.5.

Estimate Power Requirement. Once the size of the tillage implements has been determined it is necessary to determine the size of tractor(s) necessary to pull these implements. The PTO horsepower requirement for tractors is calculated by taking the implement width times the PTO horsepower requirement per foot of width (Schrock, 1976). The engine horsepower is approximately equal to the PTO horsepower divided by 86% (Bowers, 1977).

Table 4.5 Approximate Speeds and Field Efficiencies

Field Operation	Speed (mph)	Field Efficiency
Combine	4.0	70%
Conventional Till Planter w\ herbicide & insecticide application	5.0	60%
Disk	5.5	85%
Field Cultivator	5.0	85%
No Till Planter w\ herb. & insect.	5.0	60%
Ridge Till Cultivator	4.5	70%
Ridge Till Planter w\ herb. & insect.	5.0	60%
Row Crop Cultivator	4.5	70%
Shredder	5.0	80%

In the conventional-till systems the planting operation required a 131 horsepower tractor. This tractor will pull a 15.0 foot disc. 18.0 foot of width was still needed to complete the discing operation, requiring a 160 horsepower tractor. As shown in Table 4.6 all other machinery is not limiting. See machinery selection worksheets in Appendix A.

In the no-till systems the planting operation required a 131 horsepower tractor. This tractor is also used to shred and cultivate. A second tractor (60 horsepower) was needed to pull an additional cultivator (see Table 4.7 and Appendix B for machinery selection sheets).

In the ridge-till systems the planting operation required a 170 horsepower tractor. This tractor is also used to shred and cultivate. A second tractor (60 horsepower) was needed to pull an additional cultivator (see Table 4.8 and Appendix C for machinery selection worksheets).

Table 4.6 Equipment Complement for Case Farm (Conventional Tillage).

Implement	PTO HP per Foot	Max Width for 131 HP	Size in Study	Max Width for 160 HP	Size in Study
Shredder	10.0	11.9	----	13.8	12
Disk	7.5	15.0	15	18.3	18
Field Cultivator	5.0	22.5	----	27.5	24
Conventional Planter	6.3	18.0	18	22.0	----
w\ herbicide & insecticide attachments					
Cultivator	2.0	56.3	18	68.8	18
Combine & 20 ft header					

Table 4.7 Equipment Complement for Case Farm (No Till).

Implement	PTO HP per Foot	Max Width for 60 HP	Size in Study	Max Width for 131 HP	Size in Study
Shredder	10.0	5.4	----	11.9	12
No Till Planter	6.3	8.3	----	18.0	18
w\ herbicide & insecticide attachments					
Cultivator	2.0	25.8	18	56.3	18
Combine & 20 ft header					

Table 4.8 Equipment Complement for Case Farm (Ridge Till).

Implement	PTO HP per Foot	Max Width for 60 HP	Size in Study	Max Width for 170 HP	Size in Study
Shredder	10.0	11.3	----	13.8	12
Ridge Till Planter	7.5	15.0	----	18.3	18
w\ herbicide & insecticide attachments					
Ridge Till Cultivator	3.0	28.2	18	34.4	18
Combine & 20 ft header					

One concern with the machinery complements selected for the no-till and ridge-till systems was the necessity of a second tractor which is used only for cultivation. Because the planter width is 18 feet (6 rows) it is necessary to make the cultivator(s) the same width. Using the available time and this width made two cultivators a requirement.

Yields and Prices

Crop prices are the annual average from the northeastern district of the Kansas Crop and Livestock Reporting Service (see Appendix D). Yield data for grain sorghum and soybeans were obtained from the Cornbelt Experiment Station for the 10-year period in which the tillage system study was conducted. Analysis of variance procedure using Duncan's multiple range test were used to determine if the mean yield of each cropping system was significantly different at the $\alpha = 0.05$ level. No significant difference in yields was detected (see Table 5.12).

During the early years of the study, 1975 to 1979, field operations were somewhat different for the conventional tillage systems than during the later years, 1980 to 1984 (see Tables 4.9 to 4.10). Tillage practices were changed in 1979 by the elimination of a chiselling operation for both grain sorghum and soybeans. Also preplant herbicides for no-till systems were changed from 2.7 lb of atrazine per acre prior to 1980 to 1.0 lb of Roundup. Statistical differences in yield between the early years and the late years were not detected at $\alpha = 0.05$ for any of the cropping system in either grain sorghum or soybeans when analysis of variance was conducted. T-values were computed to test each of the individual systems and no significant differences were found. Even if differences did occur this study makes comparisons only between differ-

Table 4.9 Occurrence of Field Operations for Conventional-Till Sorghum

Field Operation	1975-79		1980-85	
	CVGG	CVGS	CVGG	CVGS
Stalk shredding	4/5	0/5	3/6	0/5
Discing (First)	5/5	5/5	6/6	6/6
Discing (Second)	4/5	4/5	3/6	3/6
Discing (Third)	0/5	0/5	1/6	1/6
Chisel	4/5	0/5	0/6	0/6
Harrow	2/5	2/5	0/6	0/6
Field Cultivate	0/5	0/5	6/6	6/6
Plant	5/5	5/5	6/6	6/6
Herbicide	5/5	5/5	6/6	6/6
Cultivate	5/5	5/5	6/6	6/6
Harvest	5/5	5/5	5/6	5/6

Table 4.10 Occurrence of Field Operations for Conventional-Till Soybeans

Field Operation	1975-79		1980-85	
	CVGS	CVSS	CVGS	CVSS
Stalk shredding	4/5	0/5	3/6	0/5
Discing (First)	5/5	5/5	6/6	6/6
Discing (Second)	4/5	4/5	3/6	1/6
Discing (Third)	0/5	0/5	0/6	0/6
Chisel	4/5	0/5	0/6	0/6
Harrow	1/5	1/5	1/6	1/6
Field Cultivate	0/5	0/5	6/6	6/6
Plant	5/5	5/5	6/6	6/6
Replant	0/5	0/5	1/6	1/6
Herbicide	5/5	5/5	6/6	6/6
Cultivate	5/5	5/5	6/6	6/6
Cultivate (Second)	1/5	1/5	0/6	0/6
Harvest	5/5	5/5	5/6	5/6

Table 4.11 Occurrence of Field Operations for No-Till Grain Sorghum

Field Operation	1975-79		1980-85	
	NTGG	NTGS	NTGG	NTGS
Stalk shredding	4/5	0/5	3/6	0/5
Herbicide	5/5	5/5	6/6	6/6
Plant	5/5	5/5	6/6	6/6
Herbicide	5/5	5/5	6/6	6/6
Cultivate	5/5	5/5	6/6	6/6
Harvest	5/5	5/5	5/6	5/6

Table 4.12 Occurrence of Field Operations for No-Till Soybeans

Field Operation	1975-79		1980-85	
	NTGS	NTSS	NTGS	NTSS
Stalk shredding	4/5	0/5	3/6	0/5
Herbicide	5/5	5/5	6/6	6/6
Plant	5/5	5/5	6/6	6/6
Replant	0/5	0/5	1/6	1/6
Herbicide	5/5	5/5	6/6	6/6
Cultivate	5/5	5/5	6/6	6/6
Cultivate (Second)	1/5	1/5	0/6	0/6
Harvest	5/5	5/5	5/6	5/6

Table 4.13 Occurrence of Field Operations for Ridge-Till Grain Sorghum

Field Operation	1975-79		1980-85	
	RTGG	RTGS	RTGG	RTGS
Stalk shredding	4/5	0/5	3/6	0/5
Discing	3/5	3/5	0/6	0/6
Chisel	4/5	1/5	0/6	0/6
Harrow	0/5	1/5	0/6	0/6
Herbicide	5/5	5/5	6/6	6/6
Plant	5/5	5/5	6/6	6/6
Herbicide	5/5	5/5	6/6	6/6
Cultivate	5/5	5/5	6/6	6/6
Harvest	5/5	5/5	5/6	5/6

Table 4.14 Occurrence of Field Operations for Ridge-Till Soybeans

Field Operation	1975-79		1980-85	
	RTGS	RTSS	RTGS	RTSS
Stalk shredding	4/5	0/5	3/6	0/5
Discing	2/5	0/5	0/6	0/6
Chisel	1/5	0/5	0/6	0/6
Harrow	1/5	0/5	0/6	0/6
Herbicide	5/5	5/5	6/6	6/6
Plant	5/5	5/5	6/6	6/6
Replant	0/5	0/5	1/6	1/6
Herbicide	5/5	5/5	6/6	6/6
Cultivate	5/5	5/5	6/6	6/6
Cultivate (Second)	1/5	1/5	0/6	0/6
Harvest	5/5	5/5	5/6	5/6

ent cropping systems and not between different cropping years, therefore differences in field operations will uniformly affect all the cropping systems.

Actual field operation for no-till and ridge-till systems are found in Tables 4.11 to 4.14.

Enterprise Budgets

Enterprise budgets are used to summarize all the annual operating expenses and machinery costs of each system. Each budget has three major sections. The first section of the budget determines the costs per acre for labor, fuel, oil and repairs based upon field operations. The second section of the budget determines the annual depreciation, insurance and interest for the machinery complement. The last section contains a summary of all costs associated with the farming system. This section has a traditional enterprise budget format. The last line of the budget contains an estimate of the net return to management to the farm manger and landlord for the farming system. A sample worksheet for constructing the enterprise budget is shown in Appendix G. Table 4.15 provides a sample of an enterprise budget.

Labor Cost (1)[1] per acre per field operation is equal to the wage rate per hour multiplied by the percentage of years the operation occurs divided by the field capacity (acres per hour) times the number of acres covered by the operation divided by the total crop acres. The summation of these costs for all tillage operations provides the labor cost per acre. The example below calculates the cost per acre of

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[1] Numbers in parenthesis indicate the line on the enterprise budget summary where this information is found.

Table 4.15 Sample Enterprise Budget

COST AND RETURNS TOTAL	SORGHUM	BEANS	
VARIABLE COSTS PER ACRE			
1. Labor	4.15	4.66	8.81
2. Seed	4.05	10.20	14.25
3. Herbicide	16.43	27.56	43.99
4. Insecticide	14.40	0.00	14.40
5. Fertilizer	30.17	13.86	44.03
6. Fuel	3.64	4.01	7.64
7. Oil	0.55	0.60	1.15
8. Equipment Repair	14.46	14.80	29.26
9. Custom Hire ($2.82 Fertilizer Appl.)	2.82	2.82	5.64
10. Interest (1/2 VC * rate)	6.35	5.50	11.84
Interest (Rented Land)	4.64	4.34	8.97
TOTAL VARIABLE COSTS (Owned Land)	97.00	84.01	181.01
TOTAL VARIABLE COSTS (Rented Land)	70.90	66.28	137.17
FIXED COSTS PER ACRE			
11. Real Estate Taxes ($0.50/$100 Land Value)			6.27
12. Interest on Land ($627*.06)			75.24
13. Share Rent SORG. (Gross * 40%)	91.45		91.45
Share Rent SOYB. (Gross * 40%)		73.12	73.12
14. Depreciation on Machinery			44.26
15. Interest on Machinery			41.87
16. Insurance and Housing			5.98
TOTAL FIXED COSTS (Owned Land)			173.63
TOTAL FIXED COSTS (Rented Land)			256.68
TOTAL COSTS PER ACRE (Owned Land)			354.63
TOTAL COSTS PER ACRE (Rented Land)			393.86
YIELD PER ACRE (Bu)	98.8	29.4	
PRICE PER BUSHEL	2.31	6.22	
GROSS RETURN PER ACRE	228.62	182.81	411.42
RETURNS OVER VARIABLE COSTS (Avg)			261.10
RETURNS OVER TOTAL COSTS (Owned Land)			56.79
RETURNS OVER TOTAL COSTS (Rented Land)			17.57
ANNUAL NET RETURNS PER ACRE (1 acre sorghum and 1 acre soybean)			29.33
NET RETURN TO MANAGEMENT (320 acre sorghum and 320 acre soybeans)			9,386

* Assumes landlord paying 2/5 of herbicide (17.60), 2/5 of insecticide (5.76), and 2/5 of fertilizer (17.61).

soybeans to shred stalks in a conventional tillage soybeans after grain sorghum rotation.

(2) Cost = \$/hr * occur / acres/hr * acres covered / total acres

\$0.52 = \$6.00 * 50% / 5.8 * 320 / 320

Labor is valued at \$6.00 per hour (Figurski and Beech, 1985). In this example the shredder covers 5.8 acres per hour (from machinery selection worksheet) and shredding occurs only 50% of the time (actual tillage practices at Powhattan). There are 320 total acres of soybeans and this shredder is used to shred all of the acreage. The conventional-till systems require discing to be done using two tractors and discs, thus the number of acres covered by the field operation is not equal to the total number of acres of the crop grown.

<u>Seed Expense</u> (2) is based upon actual seeding rates used on the plots. The seeding rate for grain sorghum was 5.5 lbs per acre and for soybeans 60 pounds per acre were used. Seed cost for grain sorghum averaged \$0.90 per pound, while soybeans averaged \$0.17 per pound (Figurski and Beech, 1985).

<u>Herbicide Cost</u> (3) is based upon actual herbicide application rates at the Corn Belt Experiment Station. Herbicides applied at planting are applied by the operator, however, herbicides applied before or after planting are assumed to be custom applied. The application rates and costs are summarized in Table 4.16. Prices of herbicide were given by Nilson, et al (1986).

Table 4.16 Chemical Application Rates (Pounds Active Per Acre)

	Type[2]	Conv Sorghum	Ridge Till Sorghum	No Till Sorghum	Conv Soybeans	Ridge Till Soybeans	No Till Soybeans
Propachlor (Ramrod)	G	3.000	3.000	3.000			
Atrazine 4L	B	1.500	1.500	1.500			
Metolachlor (Dual 8E)	G	2.000	2.000	2.000			
Glyphosate (Roundup)	C		1.000	1.000		1.000	1.000
Paraquat	C		0.250	0.250		0.250	0.250
2,4-D	B		0.500			0.500	
Alachlor (Lasso EC)	G				3.000	3.000	3.000
Metribuzin (Sencor 4)	B				0.375	0.375	0.375
Furidan	I	9.000	9.000	9.000			

[2] Types of herbicides: (G - Grass, B - Broadleaf, C - Contact, I - Insecticide)

Insecticide Cost (4) is also based upon the actual application rates at the Corn Belt Experiment Station. The only insecticide applied is Furidan, which is applied at 9 pounds per acre to the acres containing grain sorghum.

Fertilizer Cost (5) per acre is based upon the actual fertilizer application rates at the Corn Belt Experiment Station. Grain sorghum acreages received 128 pounds of nitrogen and 40 pounds of P205. Only 40 pounds of P205 was applied to the soybeans acreages. All fertilizer is assumed to be custom applied. Nitrogen rates used at the experiment field are approximately 40 pounds per acre higher than typically used by farmers in this region.

Fuel Cost (6) per acre per field operation is equal to the price of fuel ($0.96) times the occurrence percentage times the fuel use (liters per hectare) converted to gallons per acre times the number of acres covered by the operation divided by the total crop. By summing these costs for all the tillage operations in the system the fuel cost per acre is obtained. Oil and Lubricant cost (7) was assumed to be 15% of the fuel cost (Kletke, 1979). Below is an example showing the calculations for the fuel cost per acre of soybeans to shred stalks in a conventional tillage soybeans after grain sorghum rotation.

(3) Cost = $/Gal * %-age * fuel / 9.353 * acres covered / total acres

$0.37 = $0.96 * 50% * 7.3 / 9.353 * 320 / 320

The fuel price used is the average price in cents per gallon for No. 2 diesel fuel, excluding tax for Kansas in 1985 (USDA, 1986). Fuel consumption in gallons per acre was obtained from a survey of Kansas agricultural producers (Schrock, 1985). In the above example the shredder is used 50% of the years over the entire soybean acreage. The tractor consumes 7.3 liters of fuel per hectare which converts to 0.78 gallon per acre.

Repair Cost (8) per acre is estimated based upon the number of hours the tractor and tillage implement are used in each field operation. Rotz (1985) shows the total accumulated repair cost for each piece of equipment is equal to the list price multiplied by the a repair coefficient (RC1) times accumulated use (thousands of hours) raised the power of a second repair coefficient (RC2).

Repair costs for some machines tend to be more uniform over their life than those of other machines. Repair costs tend to increase with the machine age, however not at the same rate for all machines. Rotz's assigns a coefficient (RC2) to each type of machine to allow for the differences between machines. Since the cost changes with the machine age it is necessary to determine each machine's age. This study assumes all existing machinery to be at an age equal to one half of its depreciable life. Previously non-existing machinery includes the openers for the planter in the ridge-till and no-till systems and the ridge-till cultivator.

For convenience, this study uses the average repair cost per hour of use for computing repair costs per acre. The example below computes the total repair cost of shredding prior to planting soybeans in the conventional soybeans after grain sorghum rotation. Equation 4 computes the repair cost per hour associated with the implement and equation 5 computes the repair cost per hour associated with the tractor. Equation 6 computes the total repair cost per hour and finally equation 7 computes the total repair cost associated with the field operation.

$$\text{(4)}\quad \text{Implement Repair Per Hour} = (\text{List} * \text{RC1} * (\text{Life}/1000)\text{\^{}RC2})/\text{Life}$$

$$= (\$4488 * 0.23 * (2000/1000)\text{\^{}}1.4)/2000$$
$$= \$1.36 \text{ per hour}$$

$$\text{(5)}\quad \text{Tractor Repair Per Hour} = (\text{List} * \text{RC1} * (\text{Life}/1000)\text{\^{}RC2})/\text{Life}$$

$$= (\$64137 * 0.01 * (10000/1000)\text{\^{}}2)/10000$$
$$= \$6.41 \text{ per hour}$$

(6) Total Repair / Hour = Implement Repair / Hr + Tractor Repair / Hr

= \$1.36 + \$6.41
= \$7.77 per hour

(7) Total Repair = Repair / Hr * Hours Use / Acres Covered * Occur

= \$7.77 * 27.5 / 320 * 50%
= \$0.33 per acre

where List is the 1985 list price of the machine, Life is the estimated life of the machine, Acres Covered are the number of acres covered by this field operation, and Occur is the percentage of the years that the field operation was needed.

Custom Hire (9) includes the cost associated with the application of fertilizer in all the systems and herbicides applications that occur before or after planting. Herbicides applied at planting are applied by the operator. This study assumes that the tenant pays all custom application expenses. All fertilizer is assumed to be custom applied as is all herbicide applications which are not done with the planting operation. Fertilizer custom rates for application of liquid fertilizer in Northeast Kansas averaged \$2.82 per acre. Rates for herbicide application averaged \$3.04 per acre (Kansas Custom Rates, 1985).

Interest Expense (10) is assumed to be equal to one half the sum of the variable cost items times the interest rate (Figurski and Beech, 1985).

Total Variable Cost of rented land is less than the costs of owned land because the landlord is assumed to pay 2/5 of the cost of all yield increasing inputs. This includes fertilizer, herbicide and insecticide.

Real Estate Taxes (11) on owned land are \$0.50 per \$100.00 of land value. Land value is assumed to be \$627.00 per acre. Langemeier (1986) gives the 1984 weighted average land value for the Northeastern Farm Management Association to be \$777.00 per acre. The Federal Reserve Bank of Kansas City estimated that farm land in the Kansas and surrounding states decreased in value 19.3% during 1984 (Kansas City Reserve Bank, 1986). Discounting the land value accordingly farm land in Northeastern Kansas can be estimated at \$627.00.

Interest on Land (12) is calculated using a 6% opportunity cost.

Share Rent (13) is equal to the yield multiplied by the landlord's share multiplied by the price. The landlord's sharerent of the harvested crop is 40% which is typical in northeast Kansas. The yield is the average yield from 1975 to 1984 obtained from the Corn Belt Experiment Station.

The Annual Depreciation for Machinery (14) requires a number of assumptions to be made regarding the machinery complement. The case farm is assumed to already have all of the equipment necessary for conventional tillage. Unless the equipment would have to be purchased it was assumed to be aged one half of its depreciable life, all purchased equipment was assumed to be new. Depreciable life was assumed to be 10 years for tractors and combines, 12 years for planting equipment, and 14 years for all other equipment.

The depreciable value for each machinery item was the 1986 list price adjusted for the age of the equipment. The depreciable value is equal to the purchase price (85% of the list price) discounted by a ratio of price indexes for tractors and implements for the appropriate year (Agricultural Outlook, 1975-1986). The salvage value was assumed to be a percentage of the depreciable value (Mohasci 1982). Annual depreciation is calculated using the straight line method. Table 4.17 shows the annual depreciation for the conventional soybeans after grain sorghum equipment complement. The example below calculates the annual depreciation for a 12 foot shredder found in the conventional tillage soybeans after grain sorghum rotation.

(8) Depr Value = List * (1 - Discount) * Beg Index / End Index
$2,467.40 = 4464 * (1 - 15.0%) * 119 / 183

(9) Salv Value = Depr Value * Remain Value Percentage
$266.48 = 2467.40 * 10.8%

(10) An Depr = (Depr Value - Salv Value) / Life
$157.21 = (2467.40 - 266.48) / 14

Annual Interest on Machinery (15) is based upon the average value of machinery (one half the depreciable value of the equipment). The interest rate used is assumed to be 14%. Insurance and Housing (16) is assumed to be 1% of the depreciable value. Table 4.17 shows the annual interest and insurance and housing costs associated with the conventional soybeans after grain sorghum rotation. Costs for other tillage systems are discussed in Chapter 5.

Table 4.17 Equipment List Price, Depreciation, Insurance, Interest
Conventional Tillage Systems

IMPLEMENT, SIZE	LIST PRICE	DEPREC VALUE	SALVAGE VALUE	ANNUAL DEPREC	ANNUAL INSURE	ANNUAL INTEREST
2WD Tractor, 131 HP	$52,576	$38,611	$11,390	$2,722	$386	$2,703
2WD Tractor, 160 HP	64,137	47,101	13,895	3,321	471	3,297
Shredder, 12 Foot	4,464	2,496	270	159	25	175
Disc, 15 Foot	6,498	3,634	392	232	36	254
Disc, 18 Foot	10,736	6,004	648	383	60	420
Field Cult., 24 Foot	9,513	5,320	575	339	53	372
Planter, 18 Foot	14,904	9,245	1,285	663	92	647
Cultivator, 18 Foot	3,924	2,194	237	140	22	154
Cultivator, 18 Foot	3,924	2,194	237	140	22	154
Combine	104,695	76,860	14,526	6,233	769	5,380
Total Annual Cost				$14,331	$1,937	$13,556

Total Fixed Cost on owned land is equal to the sum of lines 11, 12, 14, 15 and 16 on the enterprise budget (see table 4-17). Rented land combines lines 13 through 16. Total Costs per Acre are equal to Fixed Costs added to Variable Costs. Gross Return per Acre are calculated by multiplying yield times the average price. Returns Over Variable Costs are equal to Gross Returns minus Total Variable Costs. Returns Over Total Costs are equal to Gross Return minus Total Costs. Annual Net Returns Per Acre is the weighted average Return Over Total Cost, with 30% of the land owned and 70% rented. Therefore, 2/5 of the crop goes to the landlord on 70% of the land. Net Return to Management is found by multiplying the Annual Net Returns Per Acre by the number of crop acres. Net returns to management reflect net returns after the deduction of all labor costs, interest expenses, and a return to owned land.

CHAPTER FIVE

ANALYSIS

Using 1985 cost of production estimates from the enterprise budgets developed for the case farm, net return to management is calculated for each of the nine cropping systems using ten year average prices and yields. Comparisons are first made of the input requirements for each cropping system, then yield, price and income variability are examined, and finally stochastic dominance techniques are used to examine the risk associated with each cropping system.

ANNUAL FIELD OPERATIONS

Table 5.1 summarizes annual crop acres and field operations required by each cropping system. Fertilizer application is custom applied for all cropping systems. Chemical applications occurring on the day of planting are applied by the operator, however all other chemical applications occurring before or after planting are assumed to be custom applied.

As a general rule, required tillage operations are the same regardless of the crop combinations grown for cropping systems with the same tillage method. For example, conventional-till continuous grain sorghum (CVGG), conventional-till grain sorghum after soybeans (CVGS) and conventional-till continuous soybeans (CVSS) all require the same tillage operations. There is one exception to the above: during one half of the years fields containing sorghum stubble were shredded prior to planting for all tillage systems. Thus continuous grain sorghum

Table 5.1 Annual Field Operations By Cropping System.

	CROPPING SYSTEM								
	CVGG	NTGG	RTGG	CVGS	NTGS	RTGS	CVSS	NTSS	RTSS
Annual Acres									
Sorg	640	640	640	320	320	320	0	0	0
Beans	0	0	0	320	320	320	640	640	640
CROP ACRES	640	640	640	640	640	640	640	640	640
OPERATION									
Pre-plant Tillage									
Sorg	3.0	0.5	0.5	2.5	0.0	0.0	0.0	0.0	0.0
Beans	0.0	0.0	0.0	3.0	0.5	0.5	2.5	0.0	0.0
Chemical									
Sorg	0.0	1.0	1.0	0.0	1.0	1.0	0.0	0.0	0.0
Beans	0.0	0.0	0.0	0.0	1.0	1.0	0.0	1.0	1.0
Planting/Chemical									
Sorg	1.0	1.0	1.0	1.0	1.0	1.0	0.0	0.0	0.0
Beans	0.0	0.0	0.0	1.0	1.0	1.0	1.0	1.0	1.0
Cultivation									
Sorg	1.0	1.0	1.0	1.0	1.0	1.0	0.0	0.0	0.0
Beans	0.0	0.0	0.0	1.0	1.0	1.0	1.0	1.0	1.0
SUB-TOTAL	5.0	3.5	3.5	9.5	6.5	6.5	4.5	3.0	3.0
Fertilizer									
Sorg	1.0	1.0	1.0	1.0	1.0	1.0	0.0	0.0	0.0
Beans	0.0	0.0	0.0	1.0	1.0	1.0	1.0	1.0	1.0
Harvest									
Sorg	1.0	1.0	1.0	1.0	1.0	1.0	0.0	0.0	0.0
Beans	0.0	0.0	0.0	1.0	1.0	1.0	1.0	1.0	1.0
TOTAL	7.0	5.5	5.5	13.5	10.5	10.5	6.5	5.0	5.0
ACRES COVERED	4480	3520	3520	4320	3360	3360	4160	3200	3200

and the soybean acres of the soybean/grain sorghum systems have an additional 0.5 tillage operations more than continuous soybean systems and the grain sorghum acres of the soybean/grain sorghum systems.

Cropping systems grown using the no-till tillage method and ridge-till method require the same number of operations for a given cropping sequence. For example, no-till continuous grain sorghum requires the same number of tillage operations and chemical applications as ridge-till continuous grain sorghum.

Cropping systems farmed with conventional tillage require 2.5 preplant tillage operations (conventional systems with grain sorghum stubble require 3.0) as compared with conservation tillage (no-till and ridge-till) systems which require no preplant tillage (except for shredding of grain sorghum stubble). However, conservation tillage systems do require an additional application of a contact herbicide prior to planting. Thus the net savings in field operations by the conservation tillage systems is 2.5 field operations or 1600 acres.

ENTERPRISE BUDGETS

The enterprise budgets from the nine cropping systems are listed in Tables 5.2 - 5.10. Ten year average yields from the Cornbelt Experiment Station, and annual average prices from the Northeast crop reporting district of the Kansas Crop and Livestock Reporting Service are combined with 1985 cost of production estimates to generate the net return to management for each cropping system. Gross income, selected costs, and net returns from the enterprise budgets are summarized in Table 5.11. Specific yield and price data can be found later in this chapter on page 84 and in Appendix D.

Table 5.2 Conventional Continuous Grain Sorghum Enterprise Budget

COSTS AND RETURNS	SORGHUM
VARIABLE COSTS PER ACRE	
1. Labor	4.66
2. Seed	4.05
3. Herbicide	16.43
4. Insecticide	14.40
5. Fertilizer	30.17
6. Fuel	4.01
7. Oil	0.60
8. Equipment Repair	14.80
9. Custom Hire ($2.82 Fertilizer Application)	2.82
10. Interest (1/2 VC * 14%)	6.44
Interest (Rented Land)	4.73
TOTAL VARIABLE COSTS (Owned Land)	98.37
TOTAL VARIABLE COSTS (Rented Land)	72.26
FIXED COSTS PER ACRE	
11. Real Estate Taxes ($0.50/$100 Land Value)	3.14
12. Interest on Land ($627*.06)	37.62
13. Share Rent SORG. (Gross Return * 40%)	92.69
Share Rent SOYB.	0.00
14. Depreciation on Machinery	22.13
15. Interest on Machinery	20.94
16. Insurance and Housing	2.99
TOTAL FIXED COSTS (Owned Land)	86.81
TOTAL FIXED COSTS (Rented Land)	138.74
TOTAL COSTS PER ACRE (Owned Land)	185.18
TOTAL COSTS PER ACRE (Rented Land)	211.01
YIELD PER ACRE (Bu)	100.2
PRICE PER BUSHEL	2.31
GROSS RETURN PER ACRE	231.72
RETURNS OVER VARIABLE COSTS (Avg)	151.62
RETURNS OVER TOTAL COSTS (Owned Land)	46.53
RETURNS OVER TOTAL COSTS (Rented Land)	20.71
ANNUAL NET RETURNS PER ACRE (Average for 1 acre of sorghum)	28.46
NET RETURN TO MANAGEMENT (640 acres of grain sorghum)	18,213

* Assumes landlord paying 2/5 of herbicide (6.57), 2/5 of insecticide (5.76), and 2/5 of fertilizer (12.07).

Table 5.3 No-Till Continuous Grain Sorghum Enterprise Budget

COST AND RETURNS	SORGHUM
VARIABLE COSTS PER ACRE	
1. Labor	3.11
2. Seed	4.05
3. Herbicide	36.06
4. Insecticide	14.40
5. Fertilizer	30.17
6. Fuel	2.24
7. Oil	0.34
8. Equipment Repair	11.23
9. Custom Hire ($2.82 fertilizer and $3.04 herbicide)	5.86
10. Interest (1/2 VC * 14%)	7.52
Interest (Rented Land)	5.26
TOTAL VARIABLE COSTS (Owned Land)	114.98
TOTAL VARIABLE COSTS (Rented Land)	80.47
FIXED COSTS PER ACRE	
11. Real Estate Taxes ($0.50/$100 Land Value)	3.14
12. Interest on Land ($627 * 0.06)	37.62
13. Share Rent SORG. (Gross * 40%)	93.30
Share Rent SOYB.	0.00
14. Depreciation on Machinery	17.48
15. Interest on Machinery	16.16
16. Insurance and Housing	2.31
TOTAL FIXED COSTS (Owned Land)	76.70
TOTAL FIXED COSTS (Rented Land)	129.24
TOTAL COSTS PER ACRE (Owned Land)	191.68
TOTAL COSTS PER ACRE (Rented Land)	209.71
YIELD PER ACRE (Bu)	100.8
PRICE PER BUSHEL	2.31
GROSS RETURN PER ACRE	233.24
RETURNS OVER VARIABLE COSTS (Avg)	142.42
RETURNS OVER TOTAL COSTS (Owned Land)	41.56
RETURNS OVER TOTAL COSTS (Rented Land)	23.53
ANNUAL NET RETURNS PER ACRE (Average for 1 acre grain sorghum)	28.94
NET RETURN TO MANAGEMENT (640 acres grain sorghum)	18,522

* Assumes landlord paying 2/5 of herbicide (14.42), 2/5 of insecticide (5.76), and 2/5 of fertilizer (12.07).

Table 5.4 Ridge-Till Continuous Grain Sorghum Enterprise Budget

COST AND RETURNS	SORGHUM
VARIABLE COSTS PER ACRE	
1. Labor	3.11
2. Seed	4.05
3. Herbicide	35.82
4. Insecticide	14.40
5. Fertilizer	30.17
6. Fuel	2.24
7. Oil	0.34
8. Equipment Repair	12.69
9. Custom Hire ($2.82 fertilizer and $3.04 herbicide)	5.86
10. Interest (1/2 VC * 14%)	7.61
Interest (Rented Land)	5.36
TOTAL VARIABLE COSTS (Owned Land)	116.29
TOTAL VARIABLE COSTS (Rented Land)	81.88
FIXED COSTS PER ACRE	
11. Real Estate Taxes ($0.50/$100 Land Value)	3.14
12. Interest on Land ($627 * .06)	37.62
13. Share Rent SORG. (Gross * 40%)	90.69
Share Rent SOYB.	0.00
14. Depreciation on Machinery	19.90
15. Interest on Machinery	18.65
16. Insurance and Housing	2.66
TOTAL FIXED COSTS (Owned Land)	81.97
TOTAL FIXED COSTS (Rented Land)	131.79
TOTAL COSTS PER ACRE (Owned Land)	198.27
TOTAL COSTS PER ACRE (Rented Land)	213.79
YIELD PER ACRE (Bu)	98.0
PRICE PER BUSHEL	2.31
GROSS RETURN PER ACRE	226.72
RETURNS OVER VARIABLE COSTS (Avg)	134.51
RETURNS OVER TOTAL COSTS (Owned Land)	28.45
RETURNS OVER TOTAL COSTS (Rented Land)	12.93
ANNUAL NET RETURNS PER ACRE (Average for 1 acre sorghum)	17.59
NET RETURN TO MANAGEMENT (640 acres grain sorghum)	11,256

* Assumes landlord paying 2/5 of herbicide (14.33), 2/5 of insecticide (5.76), and 2/5 of fertilizer (12.07).

Table 5.5 Conventional Grain Sorghum - Soybean Enterprise Budget

COST AND RETURNS TOTAL	SORGHUM	BEANS	
VARIABLE COSTS PER ACRE			
1. Labor	4.15	4.66	8.81
2. Seed	4.05	10.20	14.25
3. Herbicide	16.43	27.56	43.99
4. Insecticide	14.40	0.00	14.40
5. Fertilizer	30.17	13.86	44.03
6. Fuel	3.64	4.01	7.64
7. Oil	0.55	0.60	1.15
8. Equipment Repair	14.46	14.80	29.26
9. Custom Hire ($2.82 Fertilizer Appl.)	2.82	2.82	5.64
10. Interest (1/2 VC * 14%)	6.35	5.50	11.84
Interest (Rented Land)	4.64	4.34	8.97
TOTAL VARIABLE COSTS (Owned Land)	97.00	84.01	181.01
TOTAL VARIABLE COSTS (Rented Land)	70.90	66.28	137.17
FIXED COSTS PER ACRE			
11. Real Estate Taxes ($0.50/$100 Land Value)			6.27
12. Interest on Land ($627*.06)			75.24
13. Share Rent SORG. (Gross * 40%)	91.45		91.45
Share Rent SOYB. (Gross * 40%)		73.12	73.12
14. Depreciation on Machinery			44.26
15. Interest on Machinery			41.87
16. Insurance and Housing			5.98
TOTAL FIXED COSTS (Owned Land)			173.63
TOTAL FIXED COSTS (Rented Land)			256.68
TOTAL COSTS PER ACRE (Owned Land)			354.63
TOTAL COSTS PER ACRE (Rented Land)			393.86
YIELD PER ACRE (Bu)	98.8	29.4	
PRICE PER BUSHEL	2.31	6.22	
GROSS RETURN PER ACRE	228.62	182.81	411.42
RETURNS OVER VARIABLE COSTS (Avg)			261.10
RETURNS OVER TOTAL COSTS (Owned Land)			56.79
RETURNS OVER TOTAL COSTS (Rented Land)			17.57
ANNUAL NET RETURNS PER ACRE (1 acre sorghum and 1 acre soybean)			29.33
NET RETURN TO MANAGEMENT (320 acre sorghum and 320 acre soybeans)			9,386

* Assumes landlord paying 2/5 of herbicide (17.60), 2/5 of insecticide (5.76), and 2/5 of fertilizer (17.61).

Table 5.6 No-Till Grain Sorghum - Soybean Enterprise Budget

COST AND RETURNS	SORGHUM	SOYBEAN	TOTAL
VARIABLE COSTS PER ACRE			
1. Labor	2.67	3.11	5.79
2. Seed	4.05	10.20	14.25
3. Herbicide	36.06	47.20	83.26
4. Insecticide	14.40	0.00	14.40
5. Fertilizer	30.17	13.86	44.03
6. Fuel	1.87	2.24	4.11
7. Oil	0.28	0.34	0.62
8. Equipment Repair	10.98	11.23	22.21
9. Custom Hire ($2.82 fert & $3.04 herb)	5.86	5.86	11.72
10. Interest (1/2 VC * 14%)	7.44	6.58	14.03
Interest (Rented Land)	5.19	4.87	10.06
TOTAL VARIABLE COSTS (Owned Land)	113.79	100.62	214.41
TOTAL VARIABLE COSTS (Rented Land)	79.28	74.49	153.77
FIXED COSTS PER ACRE			
11. Real Estate Taxes ($0.50/$100 Land Value)			6.27
12. Interest on Land ($627 * 0.06)			75.24
13. Share Rent SORG. (Gross * 40%)	94.40		94.40
Share Rent SOYB. (Gross * 40%)		72.77	72.77
14. Depreciation on Machinery			34.96
15. Interest on Machinery			32.31
16. Insurance and Housing			4.62
TOTAL FIXED COSTS (Owned Land)			153.39
TOTAL FIXED COSTS (Rented Land)			239.06
TOTAL COSTS PER ACRE (Owned Land)			367.81
TOTAL COSTS PER ACRE (Rented Land)			392.83
YIELD PER ACRE (Bu)	102.0	29.3	
PRICE PER BUSHEL	2.31	6.22	
GROSS RETURN PER ACRE	236.00	181.94	417.93
RETURNS OVER VARIABLE COSTS (Avg)			328.29
RETURNS OVER TOTAL COSTS (Owned Land)			50.12
RETURNS OVER TOTAL COSTS (Rented Land)			25.10
ANNUAL NET RETURNS PER ACRE (Avg)			32.61
NET RETURN TO MANAGEMENT (320 acre sorghum and 320 acre soybeans)			10,435

* Assumes landlord paying 2/5 of herbicide (33.30), 2/5 of insecticide (5.76), and 2/5 of fertilizer (17.61).

Table 5.7 Ridge-Till Grain Sorghum - Soybean Enterprise Budget

COST AND RETURNS	SORGHUM	SOYBEAN	TOTAL
VARIABLE COSTS PER ACRE			
1. Labor	2.67	3.11	5.79
2. Seed	4.05	10.20	14.25
3. Herbicide	35.82	46.96	82.78
4. Insecticide	14.40	0.00	14.40
5. Fertilizer	30.17	13.86	44.03
6. Fuel	1.87	2.24	4.11
7. Oil	0.28	0.34	0.62
8. Equipment Repair	12.39	12.69	25.08
9. Custom Hire ($2.82 fert & $3.04 herb)	5.86	5.86	11.72
10. Interest (1/2 VC * 14%)	7.53	6.67	14.19
Interest (Rented Land)	5.28	4.97	10.24
TOTAL VARIABLE COSTS (Owned Land)	115.05	101.93	216.98
TOTAL VARIABLE COSTS (Rented Land)	80.64	75.90	156.54
FIXED COSTS PER ACRE			
11. Real Estate Taxes ($0.50/$100 Land Value)			6.27
12. Interest on Land ($627 * .06)			75.24
13. Share Rent SORG. (Gross * 40%)	95.32		95.32
Share Rent SOYB. (Gross * 40%)		75.29	75.29
14. Depreciation on Machinery			39.80
15. Interest on Machinery			37.31
16. Insurance and Housing			5.33
TOTAL FIXED COSTS (Owned Land)			163.95
TOTAL FIXED COSTS (Rented Land)			253.05
TOTAL COSTS PER ACRE (Owned Land)			380.92
TOTAL COSTS PER ACRE (Rented Land)			409.58
YIELD PER ACRE (Bu)	103.0	30.3	
PRICE PER BUSHEL	2.31	6.22	
GROSS RETURN PER ACRE	238.31	188.22	426.53
RETURNS OVER VARIABLE COSTS (Avg)			335.56
RETURNS OVER TOTAL COSTS (Owned Land)			45.60
RETURNS OVER TOTAL COSTS (Rented Land)			16.94
ANNUAL NET RETURNS PER ACRE (Avg)			25.54
NET RETURN TO MANAGEMENT (320 acre sorghum and 320 acre soybeans)			8,173

* Assumes landlord paying 2/5 of herbicide (33.11), 2/5 of insecticide (5.76), and 2/5 of fertilizer (17.61).

Table 5.8 Conventional Continuous Soybeans Enterprise Budget

COST AND RETURNS	BEANS
VARIABLE COSTS PER ACRE	
1. Labor	4.15
2. Seed	10.20
3. Herbicide	27.56
4. Insecticide	0.00
5. Fertilizer	13.86
6. Fuel	3.64
7. Oil	0.55
8. Equipment Repair	14.46
9. Custom Hire ($2.82 Fertilizer Application)	2.82
10. Interest (1/2 VC * 14%)	5.41
Interest (Rented Land)	4.25
TOTAL VARIABLE COSTS (Owned Land)	82.64
TOTAL VARIABLE COSTS (Rented Land)	64.91
FIXED COSTS PER ACRE	
11. Real Estate Taxes ($0.50/$100 Land Value)	3.14
12. Interest on Land ($626 * .06)	37.62
13. Share Rent SORG.	0.00
Share Rent SOYB. (Gross Return * 40%)	71.73
14. Depreciation on Machinery	22.13
15. Interest on Machinery	20.94
16. Insurance and Housing	2.99
TOTAL FIXED COSTS (Owned Land)	86.81
TOTAL FIXED COSTS (Rented Land)	117.79
TOTAL COSTS PER ACRE (Owned Land)	169.45
TOTAL COSTS PER ACRE (Rented Land)	182.70
YIELD PER ACRE (Bu)	28.8
PRICE PER BUSHEL	6.22
GROSS RETURN PER ACRE	179.32
RETURNS OVER VARIABLE COSTS (Avg)	109.09
RETURNS OVER TOTAL COSTS (Owned Land)	9.87
RETURNS OVER TOTAL COSTS (Rented Land)	-3.37
ANNUAL NET RETURNS PER ACRE (Average cost for 1 acre soybeans)	0.60
NET RETURN TO MANAGEMENT (640 acres soybeans)	383

* Assumes landlord paying 2/5 of herbicide (11.03), 2/5 of insecticide (0.00), and 2/5 of fertilizer (5.55)

Table 5.9 No-Till Continuous Soybeans Enterprise Budget

COST AND RETURNS	SOYBEANS
VARIABLE COSTS PER ACRE	
1. Labor	2.67
2. Seed	10.20
3. Herbicide	47.20
4. Insecticide	0.00
5. Fertilizer	13.86
6. Fuel	1.87
7. Oil	0.28
8. Equipment Repair	10.98
9. Custom Hire ($2.82 fertilizer and $3.04 herbicide)	5.86
10. Interest (1/2 VC * 14%)	6.50
Interest (Rented Land)	4.80
TOTAL VARIABLE COSTS (Owned Land)	99.43
TOTAL VARIABLE COSTS (Rented Land)	73.30
FIXED COSTS PER ACRE	
11. Real Estate Taxes ($0.50/$100 Land Value)	3.14
12. Interest on Land ($627 * 0.06)	37.62
13. Share Rent SORG.	0.00
Share Rent SOYB. (Gross * 40%)	72.53
14. Depreciation on Machinery	17.48
15. Interest on Machinery	16.16
16. Insurance and Housing	2.31
TOTAL FIXED COSTS (Owned Land)	76.70
TOTAL FIXED COSTS (Rented Land)	108.47
TOTAL COSTS PER ACRE (Owned Land)	176.13
TOTAL COSTS PER ACRE (Rented Land)	181.76
YIELD PER ACRE (Bu)	29.2
PRICE PER BUSHEL	6.22
GROSS RETURN PER ACRE	181.31
RETURNS OVER VARIABLE COSTS (Avg)	100.18
RETURNS OVER TOTAL COSTS (Owned Land)	5.19
RETURNS OVER TOTAL COSTS (Rented Land)	-0.45
ANNUAL NET RETURNS PER ACRE (Average for 1 acre soybeans)	1.24
NET RETURN TO MANAGEMENT (640 acres soybeans)	793

* Assumes landlord paying 2/5 of herbicide (18.88), 2/5 of insecticide (0.00), and 2/5 of fertilizer (5.55).

Table 5.10 Ridge-Till Continuous Soybeans Enterprise Budget

COST AND RETURNS	SOYBEANS
VARIABLE COSTS PER ACRE	
1. Labor	2.67
2. Seed	10.20
3. Herbicide	46.96
4. Insecticide	0.00
5. Fertilizer	13.86
6. Fuel	1.87
7. Oil	0.28
8. Equipment Repair	12.39
9. Custom Hire ($2.82 fertilizer and $3.04 herbicide)	5.86
10. Interest (1/2 VC * 14%)	6.59
Interest (Rented Land)	4.88
TOTAL VARIABLE COSTS (Owned Land)	100.68
TOTAL VARIABLE COSTS (Rented Land)	74.65
FIXED COSTS PER ACRE	
11. Real Estate Taxes ($0.50/$100 Land Value)	3.14
12. Interest on Land ($627 * 0.06)	37.62
13. Share Rent SORG.	0.00
Share Rent SOYB. (Gross * 40%)	71.06
14. Depreciation on Machinery	19.90
15. Interest on Machinery	18.65
16. Insurance and Housing	2.66
TOTAL FIXED COSTS (Owned Land)	81.97
TOTAL FIXED COSTS (Rented Land)	112.28
TOTAL COSTS PER ACRE (Owned Land)	182.66
TOTAL COSTS PER ACRE (Rented Land)	186.93
YIELD PER ACRE (Bu)	28.6
PRICE PER BUSHEL	6.22
GROSS RETURN PER ACRE	177.64
RETURNS OVER VARIABLE COSTS (Avg)	95.18
RETURNS OVER TOTAL COSTS (Owned Land)	-5.02
RETURNS OVER TOTAL COSTS (Rented Land)	-9.29
ANNUAL NET RETURNS PER ACRE (Average for 1 acre of soybeans)	-8.01
NET RETURN TO MANAGEMENT (640 acres of soybeans)	(5,123)

* Assumes landlord paying 2/5 of herbicide (18.78), 2/5 of insecticide (0.00), and 2/5 of fertilizer (5.55).

Table 5.11 Income, Returns, and Selected Costs by Cropping System.

	CROPPING SYSTEM								
	CVGG	NTGG	RTGG	CVGS	NTGS	RTGS	CVSS	NTSS	RTSS
Gross Income	148298	149275	145101	131655	133738	136488	114766	116040	113692
Variable Costs									
(Owned)	18887	22077	22328	17377	20584	20830	15867	19091	19331
(Rented)	32373	36051	36683	30726	34444	35064	29080	32837	33445
Fixed Costs									
(Owned)	16668	14726	15739	16668	14726	15739	16668	14726	15739
(Rented)	62157	57899	59094	57497	53549	56683	52768	48593	50300
Total Costs	130085	130753	133845	122269	123303	128316	114383	115247	118815
NET RETURN	18213	18522	11256	9386	10435	8173	383	793	-5123
Labor	2983	1993	1993	2818	1852	1852	2653	1711	1711
Fuel/Oil	2949	1648	1648	2813	1512	1512	2676	1376	1376
Chemical	14205	23252	23143	13453	22500	22391	12701	21748	21638
SUBTOTAL	20137	26894	26785	19084	25864	25755	18030	24834	24725
Fertilizer	13903	13903	13903	10146	10146	10146	6388	6388	6388
SUBTOTAL	34041	40797	40688	29229	36010	35900	24418	31223	31113
Repair	9469	7186	8121	9362	7108	8026	9255	7030	7932
Deprec	14164	11186	12736	14164	11186	12736	14164	11186	12736
Interest	13399	10340	11939	13399	10340	11939	13399	10340	11939
TOTAL	71073	69509	73483	66155	64644	68601	61237	59778	63720

RESULTS BY CROPPING SYSTEM

No-till continuous grain sorghum (NTGG) generated the highest average net return to management of $18,522 followed by conventional continuous grain sorghum (CVGG) which generated a net return of $18,213 (see Table 5.11). NTGG also produced the highest gross return per acre ($149,275). Since the yields of CVGG and ridge-till continuous grain sorghum (RTGG) are not statistically different (Table 5.12), the gross returns of these systems (yield times price) are not statistically different either. NTGG lowered labor and fuel costs when compared to CVGG by $2,291. Repair costs, depreciation and interest were also lowered by $8,320. However these savings were offset $9,047 because of higher chemical costs associated with the preplant herbicide application of the NTGG.

Ridge-till continuous grain sorghum (RTGG) had the third highest net return of $11,256. This system provided the same savings of labor and fuel costs as NTGG, since the same field operations occurred. RTGG required higher repair, depreciation and interest costs due to the special machinery needed for ridge tillage. When compared to CVGG these costs were reduced by $4,236, however when compared to NTGG costs were increased by $4,084. The higher chemical costs of preplant herbicide application increased the cost by $8,938 when compared to CVGG.

No-till grain sorghum after soybeans (NTGS) generated the fourth highest net return of $10,435 and Conventional till grain sorghum after soybeans (CVGS) generated the fifth highest net return of $9,386. NTGS lowered labor and fuel costs $2,267 when compared to CVGS. Repair cost, depreciation and interest were also lowered by $8,291. The higher chemical costs of NTGS offset this savings by $9,047.

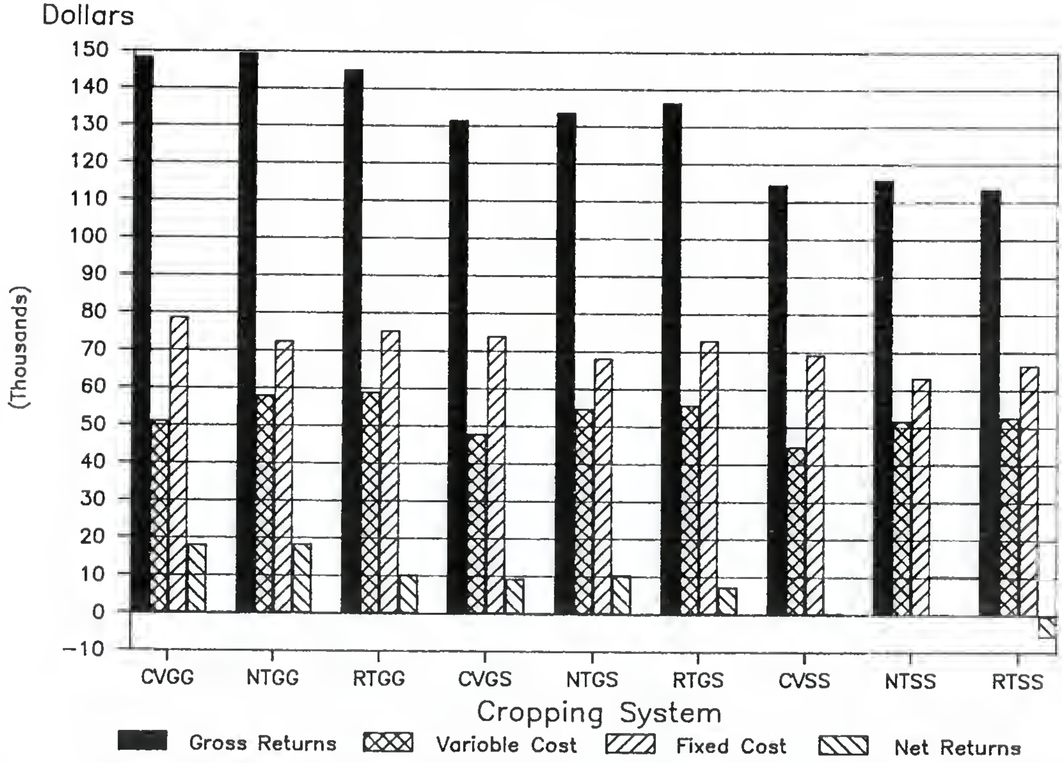
Ridge-till grain sorghum after soybeans (RTGS) had the six highest net return of $8,173. This system provided the same savings of labor and fuel costs as NTGS, however higher repair, depreciation and interest costs of the ridge-till equipment increased the cost when compared to NTGS by $4,067. The higher chemical costs of preplant herbicide application increased the cost of RTGS by $8,938 when compared to the conventional-till system.

The continuous soybean cropping systems consistently achieved the lowest net return to management. The only year these systems outperformed the continuous grain sorghum cropping systems was 1976. This result was unexpected, because typical farm practices include soybean acreages. Yields for sorghum are on average approximately 20 bushel per acre greater than farm yields in the area. Examination of experiment field practices found a 40 lbs/acre higher application rate of nitrogen fertilizer to occur on the experiment station plots as compared with typical farm practices. There are also intangible benefits to the planting of soybeans most notably through benefits in plant available nitrogen.

Cost savings for the conservation continuous soybean systems were similar to those described above, with net return rankings in this order: no-till continuous soybeans (NTSS), conventional continuous soybeans (CVSS), followed by ridge-till continuous soybeans (RTSS).

Figure 5.1 provides a summary of gross returns, total variable, total fixed, and net return to management for all cropping systems.

Figure 5.1 Returns and Costs by Cropping System



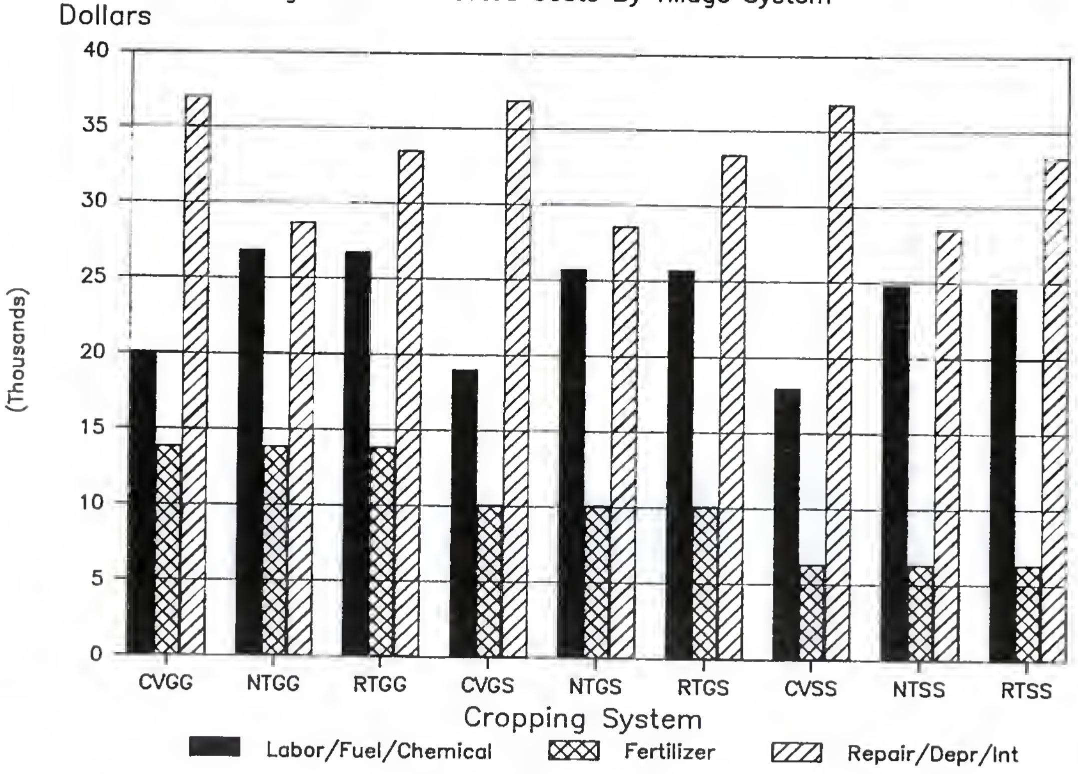
Total fixed costs for owned land range from \$16,668 in the conventional-till systems to \$14,725 in the no-till systems. Total fixed costs for owned land include land costs and machinery costs. Land costs are constant for all tillage system considered, thus the only differences in fixed costs arise from the costs of depreciation, interest, insurance and housing for the machinery complements. Fixed costs for rented land include the crop share that goes to landlord instead of land costs. Since this varies with gross returns it is difficult to compare these costs.

Figure 5.2 compares the total costs of selected inputs. Costs are shown in bar graphs for the inputs: labor/fuel/chemicals, fertilizer, and repairs/depreciation/interest. Total labor, fuel, and chemical costs are less for conventional-till cropping systems than for the no-till and ridge-till cropping systems. Total fertilizer costs remain unchanged regardless of the tillage system used. However, total repair, depreciation, and interest costs when ranked by tillage practice from lowest to highest are: no-till, ridge-till, conventional-till.

RISK ANALYSIS

Traditional analyses of decision making situations has been divided into two classes: business risk and financial risk (Boehlje and Eidman, 1984). This study will examine only business risk and uncertainty. Business risk and uncertainty is the inherent uncertainty in the firm independent of the way it is financed. The major sources of business risk in any production period are price and yield uncertainty. Prices of farm products are achieved by supply and demand factors, thus fluctuations in this factor is beyond the control of the farm manager.

Figure 5.2 Selected Costs By Tillage System



Yield variability is due in part to crop management practices as well as exogenous factors, such as, weather cycles and insect/disease problems.

When comparing the risk associated with each of the cropping systems, examination of yield, price, and net return variability associated with each system is done to estimate the differences in risk. This paper compares yield and price variability with use of the standard deviation and coefficient of variation statistics.

It is difficult to compare standard deviations when the probability distributions have different expected values. However, the coefficient of variation can be used to measure the variability relative to the expected value of the probability distribution. This measure is found by dividing the standard deviation by the mean. Small coefficients of variation show that the distribution has less variability in relation to its expected value, thus having a lower risk per dollar of expected return.

YIELD AND PRICE VARIABILITY ANALYSIS

Table 5.12 contains the results of the yield and price variability analysis. Average grain sorghum yields ranged from 98.0 to 103.0 bushels per acre, while soybean yields ranged from 28.6 to 30.3 bushels. Analysis of variance procedures found no significant difference in yields at the $\alpha = 0.05$ level when comparing the nine cropping systems. Similarly Fischer's LSD finds no significant differences for both grain sorghum and soybean yields at the $\alpha = 0.05$ level. Fischer's LSD provides the least significant difference between any two pair of means in a given experiment with significance of $(1-\alpha)\%$. The least significant difference for grain sorghum yield was 6.6 bushels per

Table 5.12 Yield, Price, and Net Return Variability by Cropping System from 1975 to 1984.

	CROPPING SYSTEM								
	CVGG	NTGG	RTGG	CVGS	NTGS	RTGS	CVSS	NTSS	RTSS
YIELDS (bu/acre)									
Sorghum									
Mean	100.2	100.3	98.0	98.8	102.0	103.0			
Std Dev	22.2	24.6	17.0	26.2	23.6	21.4			
Cof Var	0.222	0.245	0.173	0.265	0.231	0.208			
LSD	6.6								
Soybean									
Mean				29.4	29.3	30.3	28.8	29.2	28.6
Std Dev				10.2	9.4	9.5	10.2	10.1	9.2
Cof Var				0.347	0.321	0.314	0.354	0.346	0.322
LSD				3.1					
PRICES (Dollars)									
Sorghum									
Mean	$2.31	2.31	2.31	2.31	2.31	2.31			
Std Dev	$0.38	0.38	0.38	0.38	0.38	0.38			
Cof Var	0.16	0.16	0.16	0.16	0.16	0.16			
Soybean									
Mean				$6.22	6.22	6.22	6.22	6.22	6.22
Std Dev				$0.91	0.91	0.91	0.91	0.91	0.91
Cof Var				0.15	0.15	0.15	0.15	0.15	0.15
NET RETURNS (1985 Dollars)									
Mean	$16182	16918	10114	7170	8709	6345	-2092	-1870	-7393
Std Dev	$21120	26285	19578	23391	23585	21348	26141	24866	23404
Cof Var	1.31	1.55	1.94	3.26	2.71	3.36			

acre, thus the grain sorghum yields for any two cropping systems must differ by more than 6.6 bushels per acre to indicate a statistical difference. Soybeans had an LSD of 3.1 bushels per acre.

Grain sorghum yield coefficients of variation range from .173 to .265 while for soybean coefficients range from .314 to .354. Thus indicating grain sorghum yields to be less variable relative to soybean yields.

Prices for grain sorghum averaged $2.31 while prices for soybeans averaged $6.22 for the same time period. A comparison of these prices reveals that the grain sorghum price has a slightly higher variability as measured by the coefficient of variation. The coefficient of variation for grain sorghum prices is .165 versus .146 for soybeans.

NET RETURN VARIABILITY ANALYSIS

The ridge-till continuous grain sorghum system (RTGG) has the lowest standard deviation of net returns, but only the third highest average net return (Table 5.12). No-till continuous grain sorghum system (NTGG) has the highest average net return, however it also has the highest standard deviation.

The coefficient of variation provides a simple comparison of the mean and standard deviation for each system. Conventional-till continuous grain sorghum (CVGG) has the lowest coefficient of variation, 1.31, followed by NTGG and RTGG, which have coefficients of 1.15 and 1.94 respectively.

Table 5.13 lists the annual net returns by cropping system over the years 1975 to 1985. Conventional-till continuous grain sorghum (CVGG) had only 2 years of 10 with negative returns totaling $8,658 in losses.

Table 5.13 Yearly Net Returns By Cropping System

YEAR	CVGG	NTGG	RTGG	CVGS	NTGS	RTGS	CVSS	NTSS	RTSS
1975	-6345	-4333	-10581	-16640	-16358	-14877	-16557	-15074	-19078
1976	5497	4406	-3077	-12959	-12799	-16563	-17658	-16657	-26013
1977	2677	-6152	-11143	15938	13627	9858	27680	28743	19283
1978	3033	8993	-2167	-2560	-4463	-5711	-17995	-15442	-17832
1979	48621	58708	38211	42370	36611	33274	16455	16770	8432
1980	-2313	33757	19943	-3034	16423	15055	11810	2942	10561
1981	46869	49926	25070	37352	41885	30978	30314	28464	19403
1982	40084	36207	39286	34400	37033	35289	19422	21237	9529
1983	5043	-21296	-6606	-17965	-18868	-17197	-41942	-39930	-43435
1984	18650	8970	12201	-5203	-5996	-6658	-32443	-29754	-34778
MEAN	16182	16918	10114	7170	8709	6345	-2092	-1870	-7393
STD. DEV.	21120	26285	19578	23391	23585	21348	26141	24866	23404
COEFF VAR	1.31	1.55	1.94	3.26	2.71	3.36			
MIN	-6345	-21296	-11143	-17965	-18868	-17197	-41942	-39930	-43435
MAX	48621	58708	39286	42370	41885	35289	30314	28743	19403
TOT. NEG.	8658	31781	33574	58360	58484	61006	126595	116856	141136
YRS. NEG.	2	3	5	6	5	5	5	5	5

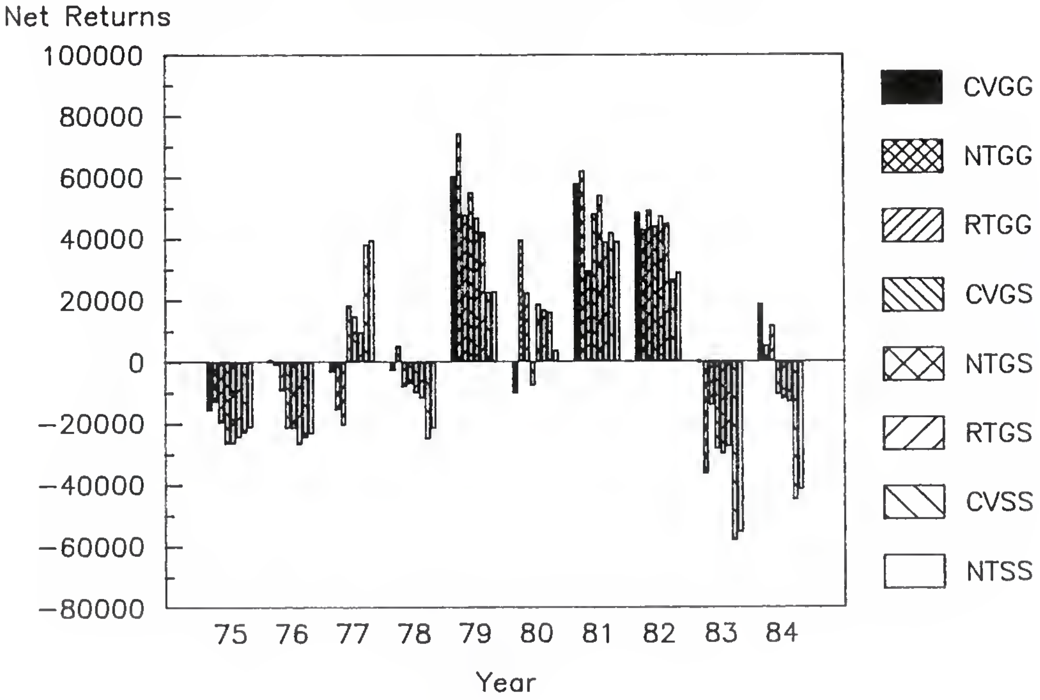
Conventional-till grain sorghum after soybeans (CVGS) had the most years negative, 6, with a total of $59,360 in losses. The continuous soybean systems all provided negative average returns ranging from an average loss of $2,092 to $7,393. The largest loss to occur in a single year was $43,435 by the ridge-till continuous soybean system (RTSS). The highest return in a single year was $58,708 provided by the NTGG system.

The bar graph in figure 5.3 provides a graphical view of the results of each cropping system during the study period. Cropping systems from left to right in each year are: CVGG, NTGG, RTGG, CVGS, NTGS, RTGS, CVSS, and NTSS.

STOCHASTIC DOMINANCE ANALYSIS

Stochastic dominance analysis is a popular method of selecting efficient strategies by researchers through comparisons of cumulative probability distributions of possible incomes for each strategy. Stochastic dominance is particularly useful since it does not require the underlying distribution to have a normal distribution and, therefore, is more flexible that E-V analysis. In this study, stochastic dominance with respect to a function (SDWRF) is used in addition to first degree stochastic dominance (FSD) and second degree stochastic dominance (SSD) criterium because it is more flexible and has greater discriminating power than both FSD and SSD. Further SDWRF does not require the specification of the decision maker's utility function.

Figure 5.3 Annual Net Returns for 1975–1984



SDWRF orders choices for decision makers facing uncertainty by setting upper and lower bounds to define an interval using the Pratt absolute risk aversion function, R(x). R(x) is defined by Pratt as

$R(x) = -U''(x)/U'(x)$

which is the ratio of the derivatives of the decision maker's utility function U(x). The SDWRF classes of utility functions can be established by using risk preference intervals bounded by a lower risk aversion coefficient $R_1(x)$ and an upper risk aversion coefficient $R_2(x)$.

Seven risk aversion coefficient intervals were used for the SDWRF analysis (Table 5.14). These intervals were arbitrarily assumed. King and Robison (1981) suggested that most intervals should be established between the range of -0.0001 to 0.001. Risk neutral behavior would generally be exhibited within the range of -0.00001 and 0.00001. Those above this range would exhibit more risk-averse behavior, whereas those below would exhibit more risk-seeking behavior. The solutions to the risk aversion intervals are found using an optimal control algorithm developed by Raskin, Goh, and Cochran (1986).

Stochastic dominance analysis was used to find the first degree (FSD), second degree (SSD), and stochastic dominance with respect to a function (SDWRF) efficient sets (Table 5.14). No system dominated all others by first degree criteria. The conventional-till and no-till continuous grain sorghum systems were second degree efficient. Further analysis using SDWRF determined that no-till continuous grain sorghum (NTGG) would be preferred by risk seeking managers, whereas risk averse individuals would prefer the conventional-till continuous grain sorghum (CVGG).

Table 5.14 Stochastic Dominance Analysis Results[1]

	$R_1(x)$	$R_2(x)$	CVGG	NTGG	RTGG	CVGS	NTGS	RTGS	CVSS	NTSS	RTSS
FSD	$-\infty$	$+\infty$	X	X	X		X	X			
SSD	0.0	$+\infty$	X	X							
SDWRF											
	-0.00005	-0.00001		X							
	-0.00001	0.0		X							
	0.0	0.00001	X	X							
	-0.00001	0.00001	X	X							
	0.00001	0.00005	X								
	0.00005	0.0001	X								
	0.0001	0.001	X								

[1] Systems denoted by X are in the efficient set.

SENSITIVITY ANALYSIS.

Sensitivity analysis was used to identify the magnitude of the parallel shift of the dominant distribution (CVGG) that is necessary to eliminate its dominance and produce an efficient set which would contain both the previously dominant distribution and the specified alternative. In the interval, (0.00001,0.00005), which applies to individuals with moderate risk aversion, the results are particularly sensitive to production costs or yield difference between the conventional-till and no-till continuous grain sorghum systems. If the cumulative probability distribution for the CVGG is lowered by a parallel shift of $375 it no longer dominates NTGG. Dividing by 640 acres results in an equivalent $0.59 per acre. Dividing again by the average price for grain sorghum, $2.31, results in .25 bushel per acre decrease in the yield of CVGG for NTGG to be in the efficient set. RTGG is also particularly sensitive to increases in net returns or reductions of cost. For the more strongly risk averse interval (0.00005,0.0001) the CVGG distribution must be shifted by $4,400 for NTGG and by $5,500 for RTGG to be in the efficient set. Other systems are compared in Tables 5.15 and 5.16.

Table 5.15 Sensitivity Analysis for the Interval <0.00001,0.00005>

Dominant System		Compared System	Decrease In Net Return Of Dominant System	Cost Per Acre	Bushels Per Acre
CVGG	<-->	NTGG	375	0.59	0.25
CVGG	<-->	RTGG	5,200	8.13	3.52
CVGG	<-->	NTGS	8,000	12.50	5.41
CVGG	<-->	CVGS	9,500	14.84	6.43
CVGG	<-->	RTGS	9,700	15.16	6.56
CVGG	<-->	NTSS	19,000	29.69	12.85
CVGG	<-->	CVSS	19,500	30.47	13.19
CVGG	<-->	RTSS	23,800	37.19	16.10

Table 5.16 Sensitivity Analysis for the Interval <0.00005,0.0001>

Dominant System		Compared System	Decrease In Net Return Of Dominant System	Cost Per Acre	Bushels Per Acre
CVGG	<-->	NTGG	4,400	6.88	2.98
CVGG	<-->	RTGG	5,500	8.59	3.72
CVGG	<-->	NTGS	10,100	15.78	6.83
CVGG	<-->	RTGS	10,800	16.88	7.31
CVGG	<-->	CVGS	10,900	17.03	7.37
CVGG	<-->	NTSS	23,100	36.09	15.63
CVGG	<-->	CVSS	24,700	38.59	16.71
CVGG	<-->	RTSS	27,700	43.28	18.74

Banding of Herbicides in Ridge-Till Systems.

The results of this study are sensitive to herbicide combinations. Herbicide were all applied using a broadcast method. Many farmers in eastern Kansas employing ridge-till systems use band application of herbicides. In banding herbicides are applied only to the ridge where the plants are grown. This practice greatly reduces the cost of herbicides (13% for RTGG, 18% for RTGS, and 23% for RTSS for the case farm). Cultivation during the growing season provides weed control between the rows. Since this cultivation is included in the ridge-till systems of this study there are no additional costs. Provided weed control is maintained by the cultivation operation there should also be no difference in yields from systems using band application of herbicides and systems using broadcast application.

Simulated net returns using band application of herbicides are shown in parentheses in Table 5.17 (assumes herbicides are applied in a 22 inch band). Banding reduces costs $2,944 in the RTGG system, $3,942 in the RTGS system, and $4,939 in the RTSS system. There were no differences in the stochastic dominance analysis when comparing band application of herbicides to broadcast application.

Results of a 2-year study by Janssen and Regehr (1986) found that when no herbicides are applied prior to planting, yields were reduced an average of 13 bushel per acre in grain sorghum and 3 bushel per acre in soybeans.

Simulated net returns using band application of herbicides and no-preplant herbicide application are shown in parentheses in Table 5.18.

Table 5.17 Effects upon Returns and Selected Costs of Band Application of Herbicides to Ridge-Till Systems.[2]

	CROPPING SYSTEM								
	CVGG	NTGG	(BANDED) RTGG	CVGS	NTGS	(BANDED) RTGS	CVSS	NTSS	(BANDED) RTSS
Gross Income	148298	149275	145101	131655	133738	136488	114766	116040	113692
Variable Costs									
(Owned)	18887	22077	(21016) 22328	17377	20535	(19073) 20830	15867	19091	(17129) 19331
(Rented)	32373	36051	(34846) 36683	30726	34376	(32604) 35064	29080	32837	(30362) 33445
Fixed Costs									
(Owned)	16668	14726	15739	16668	14726	15739	16668	14726	15739
(Rented)	62157	57899	59094	57497	53549	56683	52768	48593	50300
Total Costs	130085	130753	(130695) 133845	122269	123185	(124098) 128316	114383	115247	(113530) 118815
NET RETURN	18213	18522	(14406) 11256	9386	10552	(12390) 8173	383	793	(162) -5123
Chemical Cost									
Banded	14205	23252	20199	13453	22391	18449	12701	21748	16699
Broadcast	14205	23252	23143	13453	22391	22391	12701	21748	21638
Savings	0	0	2944	0	0	3942	0	0	4939

[2] Numbers in parentheses are for systems with band application of herbicides.

Table 5.18 Effects upon Returns and Selected Costs of No Preplant Herbicides on Ridge-Till Systems.[3]

	CROPPING SYSTEM								
	CVGG	NTGG	(BANDED) RTGG	CVGS	NTGS	(BANDED) RTGS	CVSS	NTSS	(BANDED) RTSS
Gross Income	148298	149275	(125857) 145101	131655	133738	(120895) 136488	114766	116040	(101749) 113692
Variable Costs (Owned)	18887	22077	(16406) 22328	17377	20535	(14463) 20830	15867	19091	(12520) 19331
(Rented)	32373	36051	(27810) 36683	30726	34376	(25568) 35064	29080	32837	(23326) 33445
Fixed Costs (Owned)	16668	14726	15739	16668	14726	15739	16668	14726	15739
(Rented)	62157	57899	(53706) 59094	57497	53549	(52317) 56683	52768	48593	(46956) 50300
Total Costs	130085	130753	(113662) 133845	122269	123185	(108087) 128316	114383	115247	(98541) 118815
NET RETURN	18213	18522	(12195) 11256	9386	10552	(12808) 8173	383	793	(3208) -5123
Chemical Cost									
Banded No Preplant			11261			9511			7762
Banded Preplant			20199			18449			16699
Broadcast	14205	23252	23143	13453	22391	22391	12701	21748	21638
Savings Compared to Broadcast			12152			12880			13876

[3] Numbers in parentheses are for systems using no preplant herbicides.

No preplant herbicide application reduced the cost of herbicides by $12,152 in the RTGG system, $12,880 in the RTGS system, and $13,876 in the RTSS system. This savings was offset, however by a reduction in average gross returns. Gross returns for the RTGG system was lowered by $19,244, RTGS was lowered by $15,593, and RTSS system was lowered by $11,943. There were no changes in the rankings of the stochastic dominance analysis.

IMPLICATIONS OF GOVERNMENT PROGRAMS.

There are two major facets of the current farm programs that need to be considered with this analysis. The effect of income subsidies upon net returns and the pending requirement of a whole farm conservation plan.

Income Subsidies. The 1985 farm law set minimum target prices and loan rates through the 1990 crop year. The law has given the Secretary of Agriculture authority to reduce loan rates from the high levels typical of the past few years. The law practically eliminates the government's traditional role of furnishing a floor to the market price through commodity loan programs if it is the Secretary's desire. Because of less market price support, the new law provides for higher government payments to compensate farmers participating in the commodity programs for the loss of revenue.

The effects of the farm programs upon the two commodities studied here varies greatly. Soybeans are a non program crop, since there is no target price nor cash payment made to the producer. Grain sorghum, however, is a program crop. For the 1987 production year the target price for grain sorghum is $2.88 per bushel while the announced loan rate is $1.74 per bushel. The deficiency payment made to the producer is the difference between the target price and the market price for the coinciding marketing year. The estimated deficiency payment for the 1987 production year is $1.14 per bushel. To receive the deficiency payment the farmer must comply with the provisions of the current farm law. To comply only 80% of the feed grain base acreage (based upon past years crops) may be planted to grain sorghum and/or corn. The remaining 20% of the feed grain base acreage must be retired from the production of any agricultural products and meet conservation requirements established by the USDA.

The features of this program give considerable advantage to grain sorghum production. When the cash payments are considered, participation in the government program is the best alternative. For the remaining farm acres (acres not designated as feed grain or wheat base acreages) non program crops such as soybeans can be grown.

Conservation Compliance. Also under the provisions of current farm law, all farms must have a conservation plan developed by January 1, 1990. The conservation plan must be applied before January 1, 1995. Conservation compliance will be required on all highly erodible land in production of agricultural commodities. The USDA defines highly erodible land as soil which has potential to erode at eight times its tolerable erosion rate. Of the 400 million acres of cropland, 118 million acres are classed as highly erodible. The Soil Conservation Office is the only place that can tell farmers whether their land fits this category. This office and local soil conservation districts will be involved in the approval of the conservation plans.

Failure to meet the requirements of conservation compliance can result in denial of farm program participation, federal crop insurance benefits, FmHA loans, and storage payments. This applies to all land in the farming operation not just the erodible land.

Adjusting Grain Sorghum Yields.

In the discussion of grain sorghum yields on page 79 it was noted that the experimental plot yields for grain sorghum were on average, 20 bushel per acre greater than typical farm yields in the area. This was linked to a 40 lbs/acre higher application rate of nitrogen fertilizer on the grain sorghum acres than is typically used by farmers. After adjusting the net return distributions of the cropping systems containing grain sorghum to include a 20 bushel per acre decrease in grain sorghum yield and a 40 lbs/acre decrease in the application rate of nitrogen fertilizer the efficient sets from the stochastic dominance analysis were modified greatly. Table 5.19 shows the simulated returns and costs in parentheses after adjustments for fertilizer application and yields. Note that due to changes in landlord income there are also changes to the fixed costs associated with the rented land. Table 5.20 contains the adjusted net return distributions and their associated means, standard deviations, and coefficients of variation.

Table 5.21 contains the results of the stochastic dominance analysis. The FSD efficient set includes all of the cropping systems, but RTGG and RTSS. SSD reduces the efficient set to include: CVGG, CVGS, NTGS, and RTGS. In the moderate risk aversion interval <0.00001,0.00005> both CVGG and NTGS are efficient. In the more risk averse interval <0.00005,0.0001> only CVGG is efficient.

Table 5.19 Effect upon Returns and Costs After Yield Adjustment[4]

	CROPPING SYSTEM								
	CVGG	NTGG	RTGG	CVGS	NTGS	RTGS	CVSS	NTSS	RTSS
Gross Income	(118730 148298	119707 149275	115533 145101	116871 131655	118954 133738	121704) 136488	114766	116040	113692
Variable Costs									
(Owned)	(18001) 18887	(21191) 22077	(21442) 22328	(16934) 17377	(20092) 20535	(20387) 20830	15867	19091	19331
(Rented)	(31133) 32373	(34811) 36051	(35443) 36683	(30106) 30726	(33756) 34376	(34444) 35064	29080	32837	33445
Fixed Costs									
(Owned)	16668	14726	15739	16668	14726	15739	16668	14726	15739
(Rented)	(49738) 62157	(45480) 57899	(41287) 53706	(51288) 57497	(47340) 53549	(46108) 52317	52768	48593	46956
Total Costs	(115541 130085	116209 130753	119301 133845	114997 122269	115913 123185	121044) 128316	114383	115247	118815
NET RETURN	(3189) 18213	(3498) 18522	(-3768) 11256	(1874) 9386	(3040) 10552	(661) 8173	383	793	-5123

[4] Numbers in parentheses are for systems after yield adjustments.

Table 5.20 Yearly Net Returns By Cropping System With Yield Adjustment

YEAR	CVGG	NTGG	RTGG	CVGS	NTGS	RTGS	CVSS	NTSS	RTSS
1975	-25139	-23128	-29376	-26037	-25755	-24275	-16557	-15074	-19078
1976	-9796	-10887	-18370	-20605	-20445	-24209	-17658	-16657	-26013
1977	-11418	-20246	-25237	8890	6580	2811	27680	28743	19283
1978	-12997	-7037	-18196	-10575	-12478	-13726	-17995	-15442	-17832
1979	30195	40282	19786	33157	27398	24061	16455	16770	8432
1980	-27098	8972	-4842	-15426	4031	2662	11810	2942	10561
1981	27430	30486	5630	27632	32165	21259	30314	28464	19403
1982	17327	13449	16529	23022	25654	23911	19422	21237	9529
1983	-18267	-44606	-29917	-29620	-30523	-28852	-41942	-39930	-43435
1984	-329	-10009	-6778	-14692	-15485	-16147	-32443	-29754	-34778
MEAN	-3009	-2272	-9077	-2425	-886	-3251	-2092	-1870	-7393
STD. DEV.	21000	25743	18273	23473	23342	20999	26141	24866	23404
COEFF VAR									
MIN	-27098	-44606	-29917	-29620	-30523	-28852	-41942	-39930	-43435
MAX	30195	40282	19786	33157	32165	24061	30314	28743	19403
TOT. NEG.	105044	115912	132715	116955	104687	107209	126595	116856	141136
YRS. NEG.	7	6	7	6	5	5	5	5	5

Sensitivity analysis finds the efficient sets much more sensitive to small changes in net returns. In the moderate risk aversion interval <0.00001,0.00005> RTGS will be in the efficient set if the NTGS distribution is shifted down by $700. In the more risk averse interval <0.00005,0.00001> a reduction of the CVGG distribution by $1,300 is all that is required to place all the grain sorghum after soybean rotations in the efficient set. Tables 5.22 and 5.23 contain some of the results of the sensitivity analysis.

As was noted earlier current government programs give significant advantages to the production of grain sorghum over soybeans. When commodity programs are considered in the analysis grain sorghum cropping sequences are still preferred.

Table 5.21 Stochastic Dominance Analysis Results With Adjusted Yields[5]

	$R_1(x)$	$R_2(x)$	CVGG	NTGG	RTGG	CVGS	NTGS	RTGS	CVSS	NTSS	RTSS
FSD	$-\infty$	$+\infty$	X	X		X	X	X	X	X	
SSD	0.0	$+\infty$	X			X	X	X			
SDWRF											
	-0.00005	-0.00001		X			X		X		
	-0.00001	0.0					X				
	0.0	0.00001					X				
	-0.00001	0.00001					X				
	0.00001	0.00005	X				X				
	0.00005	0.0001	X								
	0.0001	0.001	X								

---

[5] Systems denoted by X are in the efficient set.

Table 5.22 Sensitivity Analysis for the Interval <0.00001,0.00005>

Dominant System		Compared System	Decrease In Net Return Of Dominant System	Cost Per Acre
NTGS	<-->	CVGG	0	0.00
NTGS	<-->	RTGS	700	1.09
NTGS	<-->	CVGS	1,000	1.56
NTGS	<-->	NTSS	1,400	2.19
NTGS	<-->	NTGG	1,900	2.97
NTGS	<-->	CVSS	1,900	2.97
NTGS	<-->	RTGG	4,500	7.03
NTGS	<-->	RTSS	6,200	9.69

Table 5.23 Sensitivity Analysis for the Interval <0.00005,0.0001

Dominant System		Compared System	Decrease In Net Return Of Dominant System	Cost Per Acre
CVGG	<-->	NTGS	300	0.47
CVGG	<-->	RTGS	900	1.41
CVGG	<-->	CVGS	1,300	2.03
CVGG	<-->	NTSS	3,700	5.78
CVGG	<-->	RTGG	4,300	6.72
CVGG	<-->	NTGG	4,600	7.19
CVGG	<-->	CVSS	5,300	8.28
CVGG	<-->	RTSS	8,200	12.81

CHAPTER SIX

SUMMARY AND CONCLUSIONS

Conservation tillage offers tremendous potential for reducing soil erosion. Technical and economic question persist about yield potential, cropping sequences, and other production decisions. This study evaluated the economic potential and associated risk of conventional and conservation systems for the production of grain sorghum and soybeans in Northeastern Kansas.

A representative 640 acre case farm was established to provide comparisons of income potentials and variability of contentional-till, no-till, and ridge-till in Northeastern Kansas. The study assumed that farmers could duplicate the yields achieved for similar cropping systems currently studied at the Cornbelt Experiment Station. Input levels were identified by agronomists and Experiment Station Personnel.

An equipment complement was selected to meet the optimal tillage and planting requirements of the conventional-till grain sorghum after soybean rotation. When adopting alternative cropping systems, additional equipment is added as needed to meet the requirements of the system.

Variable and fixed costs were then estimated in an enterprise budget format. Yield and price data was used to calculate net returns to management for each system. Analysis of variance of yield and price provided estimates of the differences between cropping systems. Finally stochastic dominance with respect to a function was used in discriminating between the net returns of the cropping systems.

RESULTS AND CONCLUSIONS

Enterprise budget analysis found no-till systems for grain sorghum and soybeans to have slightly higher average net returns when compared to conventional tillage practices. However, the standard deviation were also higher for the no-till systems in the continuous grain sorghum and grain sorghum after soybeans rotation.

Stochastic dominance with respect to a function analysis found conventional tillage continuous grain sorghum to be preferred by highly risk averse individuals, while risk seeking individuals would prefer no-tillage continuous grain sorghum. For risk neutral individuals SDWRF did not distinguish significantly between the two systems. Sensitivity analysis, however found differences between the tow systems to be very sensitive to yield variation.

Costs were slightly lower for the conventional-till system, and yields for the no-till and ridge-till systems were not significantly higher. Because of higher production costs ridge-till systems performed consistently worse than the conventional-till and no-till counterparts.

Sensitivity analysis of the effects of band application of herbicides found no differences in the rankings of the systems. When net return distributions for cropping systems containing grain sorghum were adjusted to represent the county average grain sorghum yields conservation till grain sorghum after soybean and no-till continuous soybean systems were preferred. However, when current government commodity programs were considered in the analysis the grain sorghum systems were preferred.

LIMITATIONS OF STUDY

A major limitation of this study is the dependence upon the case farm which relies heavily upon assumptions about farm size and the machinery complement. It is difficult to obtain realistic tillage and planting constraints, which are a major factor in determining the machinery complement.

This study does not consider the management ability of the operator. It is assumed that the operator can replecate the yields achieved at the experiment station. The yields of the conservation tillage systems are particularly sensitive to one farming operation -- planting. With conventional tillage systems if soils structure is damaged by a tillage operation another tillage operation can be used to correct the mistake. A common example is soil compaction caused by working soils that are too wet. An additional disk operation can be added to help restore the soil properties. With conservation tillage if the farmer lacks the skills needed to consistently obtain the necessary yields then this system will not preform well for him.

FUTURE RESEARCH NEEDS

The results and limitation of this study provide for further research needs. Better knowledge of planting and tillage constraints could lead to the selection of more realistic equipment complements. Examination of the effects of band application of herbicides could add ridge-till systems to the efficient set. Further examination of the consequences and value of long-term erosion could make the adoption of conservation tillage practices appear more economical. What cost would need to be assigned to soil loss for conservation tillage systems to dominate the conventional till continuous grain sorghum system? An examination of crop insurance levels could also provide new ordering by the stochastic dominance procedure.

Appendices

Appendix A

Appendix A contains the machinery selection worksheets for the conventional tillage systems (Schrock, 1976). In the conventional-till systems the planting operation was the critical operation for determining the size of the 131 horsepower tractor. This tractor must also be used to disc and will pull upto a 15.0 foot disc leaving 18.0 foot of width for the remaining tractor to do in order to complete the discing operation. This operation was also limiting and required a 160 horsepower tractor. Tables A-1 to A-9 give the worksheets containing the calculations for the implement sizes.

Table A-1 Machinery Selection Worksheet For Conventional-Till Systems

Identify the Critical Job		
Description		Shreading
Amount		320 Acres
Estimate the Time Available		
Desired Period	Apr 1 - Apr 24	24 Days
Percentage of Time Available for Work		23.3%
Available Working Days		5.6 Days
Hours per Day		10 Hrs.
Total Running Time		56.0 Hrs.
Size the Machinery to do the Job		
Field Capacity Needed		5.7 A/Hr
Speed		5.0 MPH
Field Efficiency		80.0%
Required Width		11.8 Feet
Estimate the Power Requirements		
Required Width		12.0 Feet
PTO HP Per Ft. of Width		10 HP/FT
PTO Horsepower		120 HP
Engine Horsepower		140 HP

12 Foot Shreader
160 HP Tractor

Table A-2 Machinery Selection Worksheet For Conventional-Till Systems

Identify the Critical Job		
Description		1st Discing
Amount		405 Acres
Estimate the Time Available		
Desired Period	Apr 16 - May 3	18 Days
Percentage of Time Available for Work		26.7%
Available Working Days		4.8 Days
Hours per Day		10 Hrs.

Total Running Time		48.0 Hrs.
Size the Machinery to do the Job		
Field Capacity Needed		8.4 A/Hr
Speed		5.5 MPH
Field Efficiency		85.0%
Required Width		14.9 Feet
Estimate the Power Requirements		
Required Width		14.9 Feet
PTO Horsepower per Ft. of Width		7.5 H.P.
Required PTO Horsepower		112 HP
Required Engine Horsepower		130 HP

15 Foot Disc
131 HP Tractor

Table A-3 Machinery Selection Worksheet For Conventional-Till Systems

Identify the Critical Job	
Description	1st Discing
Amount	235 Acres
Estimate the Time Available	
Desired Period Apr 25 - May 3	9 Days
Percentage of Time Available for Work	26.7%
Available Working Days	2.4 Days
Hours per Day	10 Hrs.
Total Running Time	24.0 Hrs.
Size the Machinery to do the Job	
Field Capacity Needed	9.8 A/Hr
Speed	5.5 MPH
Field Efficiency	85.0%
Required Width	17.3 Feet
Estimate the Power Requirements	
Required Width	18 Feet
PTO Horsepower per Ft. of Width	7.5 H.P.
Required PTO Horsepower	135 HP
Required Engine Horsepower	157 HP

18 Foot Disc
160 HP Tractor

Table A-4 Machinery Selection Worksheet For Conventional-Till Systems

Identify the Critical Job		
Description		2nd Discing
Amount		325 Acres
Estimate the Time Available		
Desired Period	May 4 - May 15	12 Days
Percentage of Time Available for Work		26.7%
Available Working Days		3.2 Days
Hours per Day		12 Hrs.

Total Running Time		38.4 Hrs.
Size the Machinery to do the Job		
Field Capacity Needed		8.5 A/Hr
Speed		5.5 MPH
Field Efficiency		85.0%
Required Width		14.9 Feet
Estimate the Power Requirements		
Required Width		15 Feet
PTO Horsepower per Ft. of Width		7.5 H.P.
Required PTO Horsepower		112 HP
Required Engine Horsepower		130 HP

15 Foot Disc
131 HP Tractor

Table A-5 Machinery Selection Worksheet For Conventional-Till Systems

Identify the Critical Job		
Description		2nd Discing
Amount		315 Acres
Estimate the Time Available		
Desired Period	May 4 - May 14	11 Days
Percentage of Time Available for Work		26.7%
Available Working Days		2.9 Days
Hours per Day		12 Hrs.
Total Running Time		35.2 Hrs.
Size the Machinery to do the Job		
Field Capacity Needed		8.9 A/Hr
Speed		5.5 MPH
Field Efficiency		85.0%
Required Width		15.8 Feet
Estimate the Power Requirements		
Required Width		18 Feet
PTO Horsepower per Ft. of Width		7.5 H.P.
Required PTO Horsepower		135 HP
Required Engine Horsepower		157 HP

18 Foot Disc
160 HP Tractor

Table A-6 Machinery Selection Worksheet For Conventional-Till Systems

Identify the Critical Job		
Description		Field Cultivate
Amount		640 Acres
Estimate the Time Available		
Desired Period	May 15 - Jun 9	26 Days
Percentage of Time Available for Work		16.7%
Available Working Days		4.3 Days
Hours per Day		12 Hrs.

Total Running Time		52 Hrs.
Size the Machinery to do the Job		
Field Capacity Needed		12.3 A/Hr
Speed		5.0 MPH
Field Efficiency		85.0%
Required Width		23.9 Feet
Estimate the Power Requirements		
Required Width		24 Feet
PTO Horsepower per Ft. of Width		5 HP/Ft.
Required PTO Horsepower		119 HP
Required Engine Horsepower		139 HP

24 Foot Field Cultivator
160 HP Tractor

Table A-7 Machinery Selection Worksheet For Conventional-Till Systems

Identify the Critical Job		
Description		Planting
Amount		640 Acres
Estimate the Time Available		
Desired Period	May 16 - June 20	36 Days
Percentage of Time Available for Work		22.6%
Available Working Days		8.1 Days
Hours per Day		12 Hrs.

Total Running Time		97.5 Hrs.
Size the Machinery to do the Job		
Field Capacity Needed		6.6 A/Hr
Speed		5.0 MPH
Field Efficiency		60.0%
Required Width		18.0 Feet
Estimate the Power Requirements		
Required Width		18.0 Feet
Draft Per Ft. of Width		350 Lb
Speed		5 MPH
Required Drawbar Horsepower		84 HP
Engine Horsepower		131 HP

18 Foot Planter
131 HP Tractor

Table A-8 Machinery Selection Worksheet For Conventional-Till Systems

Identify the Critical Job		
Description		Cultivate
Amount		640 Acres
Estimate the Time Available		
Desired Period	Jun 16 - Jul 10	25 Days
Percentage of Time Available for Work		20.0%
Available Working Days		5.0 Days
Hours per Day		10 Hrs.

Total Running Time		50.0 Hrs.
Size the Machinery to do the Job		
Field Capacity Needed		12.8 A/Hr
Speed		4.5 MPH
Field Efficiency		70.0%
Required Width		33.5 Feet
Estimate the Power Requirements		
Required Width		18.0 Feet
Draft Per Ft. of Width		120 Lb
Speed		4.5 MPH
Required Drawbar Horsepower		26 HP
Engine Horsepower		41 HP

(2) 18 Foot Cultivators
160 HP Tractor
131 HP Tractor

Table A-9 Machinery Selection Worksheet For Conventional-Till Systems

Identify the Critical Job	
Description	Harvesting
Amount	640 Acres
Estimate the Time Available	
Desired Period Sep 16 - Oct 31	46 Days
Percentage of Time Available for Work	30.0%
Available Working Days	13.8 Days
Hours per Day	7 Hrs.
Total Running Time	96.6 Hrs.
Size the Machinery to do the Job	
Field Capacity Needed	6.6 A/Hr
Speed	4.0 MPH
Field Efficiency	70.0%
Required Width	19.5 Feet
Estimate the Power Requirements	
Required Width	20.0 Feet

20 Foot Header

Appendix B

Appendix B contains the machinery selection worksheets for the conventional tillage systems (Schrock, 1976). In the no-till systems the planting operation was also the limiting operation for the selection of the 131 horsepower tractor. This tractor is also used to shred and cultivate. A second tractor is needed to pull an additional cultivator. Tables B-1 to B-4 give the worksheets containing the calculations for the implement sizes.

Table B-1 Machinery Selection Worksheet For No-Till Systems

Identify the Critical Job		
Description		Shreading
Amount		320 Acres
Estimate the Time Available		
Desired Period	Apr 1 - Apr 30	30 Days
Percentage of Time Available for Work		23.3%
Available Working Days		7.0 Days
Hours per Day		10 Hrs.

Total Running Time		70 Hrs.
Size the Machinery to do the Job		
Field Capacity Needed		4.6 A/Hr
Speed		5.5 MPH
Field Efficiency		85.0%
Required Width		8.1 Feet
Estimate the Power Requirements		
Required Width		12.0 Feet
PTO HP Per Ft. of Width		10 HP/FT
PTO Horsepower		120 HP
Engine Horsepower		140 HP

12 Foot Shreader
131 HP Tractor

Table B-2 Machinery Selection Worksheet For No-Till Systems

Identify the Critical Job		
Description		Planting
Amount		640 Acres
Estimate the Time Available		
Desired Period	May 16 - June 20	36 Days
Percentage of Time Available for Work		22.6%
Available Working Days		8.1 Days
Hours per Day		12 Hrs.

Total Running Time		97.5 Hrs.
Size the Machinery to do the Job		
Field Capacity Needed		6.6 A/Hr
Speed		5.0 MPH
Field Efficiency		60.0%
Required Width		18.0 Feet
Estimate the Power Requirements		
Required Width		18.0 Feet
Draft Per Ft. of Width		350 Lb/Ft
Speed		5 MPH
Required Drawbar Horsepower		84 HP
Engine Horsepower		131 HP

18 Foot Planter
131 HP Tractor

Table B-3 Machinery Selection Worksheet For No-Till Systems

Identify the Critical Job		
Description		Cultivate
Amount		640 Acres
Estimate the Time Available		
Desired Period	Jun 16 - Jul 10	25 Days
Percentage of Time Available for Work		20.0%
Available Working Days		5.0 Days
Hours per Day		10 Hrs.

Total Running Time		50.0 Hrs.
Size the Machinery to do the Job		
Field Capacity Needed		12.8 A/Hr
Speed		4.5 MPH
Field Efficiency		70.0%
Required Width		33.5 Feet
Estimate the Power Requirements		
Required Width		18.0 Feet
Draft Per Ft. of Width		120 Lb
Speed		4.5 MPH
Required Drawbar Horsepower		26 HP
Engine Horsepower		39 HP

(2) 18 Foot Cultivators
60 HP Tractor
131 HP Tractor

Table B-4 Machinery Selection Worksheet For No-Till Systems

Identify the Critical Job		
Description		Harvesting
Amount		640 Acres
Estimate the Time Available		
Desired Period	Sep 16 - Oct 31	46 Days
Percentage of Time Available for Work		30.0%
Available Working Days		13.8 Days
Hours per Day		7 Hrs.

Total Running Time		96.6 Hrs.
Size the Machinery to do the Job		
Field Capacity Needed		6.6 A/Hr
Speed		4.0 MPH
Field Efficiency		70.0%
Required Width		19.5 Feet
Estimate the Power Requirements		
Required Width		24.0 Feet

20 Foot Header

Appendix C

Appendix C contains the machinery selection worksheets for the ridge-till systems (Schrock). In the ridge-till systems the planting operation was the limiting operation in the determination of the size of the 170 horsepower tractor. This tractor is also used to shred and cultivate. A second tractor tractor was needed to pull an additional cultivator. Tables C-1 to C-4 give the worksheets containing the calculations for the implement sizes.

Table C-1 Machinery Selection Worksheet For Ridge-Till Systems

Identify the Critical Job		
Description		Shreading
Amount		320 Acres
Estimate the Time Available		
Desired Period	Apr 1 - Apr 30	30 Days
Percentage of Time Available for Work		23.3%
Available Working Days		7.0 Days
Hours per Day		10 Hrs.

Total Running Time		70 Hrs.
Size the Machinery to do the Job		
Field Capacity Needed		4.6 A/Hr
Speed		5.5 MPH
Field Efficiency		85.0%
Required Width		8.1 Feet
Estimate the Power Requirements		
Required Width		12.0 Feet
Draft Per Ft. of Width		10 Lb
PTO Horsepower		120 HP
Engine Horsepower		140 HP

12 Foot Shreader
170 HP Tractor

Table C-2 Machinery Selection Worksheet For Ridge-Till Systems

Identify the Critical Job		
Description		Planting
Amount		640 Acres
Estimate the Time Available		
Desired Period	May 16 - June 20	36 Days
Percentage of Time Available for Work		22.6%
Available Working Days		8.1 Days
Hours per Day		12 Hrs.

Total Running Time		97.5 Hrs.
Size the Machinery to do the Job		
Field Capacity Needed		6.6 A/Hr
Speed		5.0 MPH
Field Efficiency		60.0%
Required Width		18.0 Feet
Estimate the Power Requirements		
Required Width		18.0 Feet
Draft Per Ft. of Width		450 Lb
Speed		5 MPH
Required Drawbar Horsepower		108 HP
Engine Horsepower		169 HP

18 Foot Planter
170 HP Tractor

Table C-3 Machinery Selection Worksheet For Ridge-Till Systems

Identify the Critical Job		
Description		Cultivate
Amount		640 Acres
Estimate the Time Available		
Desired Period	Jun 16 - Jul 10	25 Days
Percentage of Time Available for Work		20.0%
Available Working Days		5.0 Days
Hours per Day		10 Hrs.
Total Running Time		50.0 Hrs.
Size the Machinery to do the Job		
Field Capacity Needed		12.8 A/Hr
Speed		4.5 MPH
Field Efficiency		70.0%
Required Width		33.5 Feet
Estimate the Power Requirements		
Required Width		18.0 Feet
Draft Per Ft. of Width		120 Lb
Speed		4.5 MPH
Required Drawbar Horsepower		26 HP
Engine Horsepower		39 HP

(2) 18 Foot Cultivators
170 HP Tractor
60 HP Tractor

Table C-4 Machinery Selection Worksheet For Ridge-Till Systems

Identify the Critical Job		
Description		Harvesting
Amount		640 Acres
Estimate the Time Available		
Desired Period	Sep 16 - Oct 31	46 Days
Percentage of Time Available for Work		30.0%
Available Working Days		13.8 Days
Hours per Day		7 Hrs.

Total Running Time		96.6 Hrs.
Size the Machinery to do the Job		
Field Capacity Needed		6.6 A/Hr
Speed		4.0 MPH
Field Efficiency		70.0%
Required Width		19.5 Feet
Estimate the Power Requirements		
Required Width		20.0 Feet

20 Foot Header

Appendix D

List prices for tractors and implements were the average of prices obtained from area dealers for several major brands. Input prices were obtained from local suppliers and USDA. Crop prices are the average annual prices for the north central crop reporting district of Kansas.

Table D.1 Equipment Prices

Equipment	Conv.	Ridge	No-Till	Price
2WD Tractor, 170 H.P.		X		$66,659
2WD Tractor, 160 H.P.	X			64,137
2WD Tractor, 131 H.P.	X		X	52,576
2WD Tractor, 60 H.P.		X	X	22,215
Shredder, 12 Ft.	X	X	X	4,464
Disc, 15 Ft.	X			6,498
Disc, 18 Ft.	X			10,736
Field Cultivator, 24 Ft.	X			9,513
Planter, 18 Ft. (6 row) w/ herbicide attachment	X	X	X	14,904
No-Till Openers			X	1,783
Ridge-Till Attachment		X		5,432
Cultivator, 18 Ft. (6 row)	X		X	3,924
Ridge-Till Cultivator, 18 Ft. (6 row)		X		8,167
Combine, 20 Ft. Header	X	X	X	104,659

Table D.2 Input Costs

Product	Average Cost
NH3	$230.67/ton
Liquid 10-34-0	235.67/ton
Propachlor (Ramrod FL)	17.00/gal
Atrazine 4L	9.45/gal
Metolachlor (Dual 8E)	54.20/gal
Roundup	87.60/gal
Paraquat	55.00/gal
2,4-D (LVE)	11.40/gal
Alachlor (Lasso EC)	23.00/gal
Metribuzin (Sencor 4)	110.00/gal

Table D.3 Season Average Prices, Kansas Northeast District

Year	Grain Sorghum	Soybeans
1975	2.27	4.80
1976	1.89	6.55
1977	1.76	5.68
1978	1.97	6.64
1979	2.23	5.95
1980	2.92	7.56
1981	2.34	5.83
1982	2.70	5.60
1983	2.76	7.81
1984	2.29	5.78

Appendix E

This appendix contains estimated life and repair factors for farm machinery as given by Rotz (1985). These values are used to calculate the repair costs in Chapter 4.

Table E.1 Estimated Life and Repair Factors for Machinery (Rotz)

Machine	Estimated Life	Repair RC1	Factors RC2
Tractors			
2 wheel drive	10000	.010	2.0
4 wheel drive	10000	.010	2.0
Tillage			
moldboard plow	2000	.43	1.8
disk harrow	2000	.18	1.7
chisel plow	2000	.38	1.4
field cultivator	2000	.30	1.4
rotary hoe	2000	.23	1.4
row crop cultivator	2000	.22	2.2
Planting			
row crop planter	1200	.54	2.1
grain drill	1200	.54	2.1
Harvesting			
corn picker	2000	.14	2.3
combine	2000	.12	2.1
mower	2000	.46	1.7
Miscellaneous			
fertilizer spreader	1200	.95	1.3
boom type sprayer	1500	.41	1.3

Appendix F

Table F.1 gives the remaining value percentages of machinery by Mohaski (1982) used in Chapter 4 to calculate the salvage values. Table F.2 gives the index values used in calculating the depreciable values of farm machinery in Chapter 4.

Table F.1 Remaining Value of Machinery in Percent (Mohaski et al.)

Life	Tractor	Combine	Other
8	34.9	24.1	22.6
9	32.1	21.3	20.0
10	29.5	18.9	17.7
11	27.2	16.7	15.7
12	25.0	14.8	13.9
13	23.0	13.1	12.3
14	21.2	11.6	10.8
15	19.5	10.2	9.6

Table F.2 Index Values for Farm Machinery (Ag Outlook)

Year	Tractor	Other
1979	122	119
1980	136	132
1981	152	146
1982	165	160
1983	174	171
1984	181	180
1985	178	183
1986 (est.)	175	184

Appendix G

This appendix contains an example of the worksheets used to calculate an enterprise budget. Table G.1 calculates the herbicide costs per acre, Table G.2 calculates the insecticide costs, and Table G.3 calculates the fertilizer costs. Table G.4 calculates the labor, fuel, oil, and repair costs per acre by field operation. Table G.5 calculates the depreciable value for each piece of machinery. Table G.6 calculates the depreciation, interest and insurance for each machinery item. Table G.7 provides the enterprise budget summary.

Table G.1 Herbicide Costs for Conventional-Till Systems

Input	$ Per Unit	Unit	Lb Active	Occur	Sorg Quan	Bean Quan	Sorg Cost	Bean Cost
Propachlor	17.00	Gal	4.0	83.3%	3.0		10.63	0.00
Atrazine 4L	9.45	Gal	4.0	100.0%	1.5		3.54	0.00
Metolachlor	54.20	Gal	8.0	16.7%	2.0		2.26	0.00
Alachlor	23.00	Gal	4.0	100.0%		3.0	0.00	17.25
Metribuzin	110.00	Gal	4.0	100.0%		3/8	0.00	10.31
Total							16.43	27.56

Table G.2 Insecticide Costs for Conventional-Till Systems

Input	$ Per Unit	Unit	Lb Active	Occur	Sorg Quan	Bean Quan	Sorg Cost	Bean Cost
Furidan 15G	1.60	Lb	1.0	100.0%	9.0	0.0	14.40	0.00
Total							14.40	0.00

Table G.3 Fertilizer Costs for Conventional-Till Systems

Input	$ Per Unit	Unit	% N	% P205	Sorg Quan	Bean Quan	Sorg Cost	Bean Cost
NH3	230.67	Ton	82.2%	0.0%	0.0707	0.0000	16.31	0.00
10-34-0	235.67	Ton	10.0%	34.0%	0.0588	0.0588	13.86	13.86
Total Fertilizer Cost							30.17	13.86

Nitrogen Rate for Grain Sorghum	128 Pounds N Per Acre
P205 Rate for Grain Sorghum	40 Pounds P205 Per Acre
Nitrogen Rate for Soybeans	0 Pounds N Per Acre
P205 Rate for Soybeans	40 Pounds P205 Per Acre

Table G.4 Example Worksheet for Calculation of Labor, Fuel, Oil, and Repair Costs for Conventional-Till Grain Sorghum

Oper.	Occur (%)	Sorg. Acres	Field Cap	Sorg Hr	Impl No	Trac No	Rep $/Hr	Labr Cost	Fuel Cost	Oil Cost	Rep Cost
Shred	50%	0.0	5.8	0.0	I1	T2	7.77	0.00	0.00	0.00	0.00
1st Disc	100%	202.5	8.5	23.8	I2	T1	7.16	0.45	0.51	0.08	0.84
1st Disc	100%	117.5	10.2	11.5	I3	T2	9.55	0.22	0.30	0.04	0.94
2nd Disc	50%	162.5	8.5	9.6	I2	T1	7.16	0.18	0.21	0.03	0.21
2nd Disc	50%	157.5	10.2	7.7	I3	T2	9.55	0.14	0.20	0.03	0.23
Fert	100%	320.0									
Fld Cult	100%	320.0	12.4	25.9	I4	T2	10.18	0.49	0.55	0.08	0.82
Planting	100%	320.0	6.5	48.9	I5	T1	15.09	0.92	0.48	0.07	2.31
Herb	100%	320.0									
Insect	100%	320.0									
Cult	100%	160.0	6.9	23.3	I6	T1	7.24	0.44	0.20	0.03	1.05
Cult	100%	160.0	6.9	23.3	I7	T2	8.40	0.44	0.20	0.03	1.22
Harvest	100%	320.0	6.8	47.1	C1		46.39	0.88	1.00	0.15	6.83
								4.15	3.64	0.55	14.46

Table G-5 Equipment List Price, Depreciable Base, and Purchase Year for Conventional-Till Grain Sorghum

NO	IMPLEMENT	LIST PRICE	LIFE (YR)	LIFE (HR)	YEAR PURC	BEGIN IDX	END IDX	REMAI VALUE	DEPREC VALUE
T1	2WD Tractor	$51,690	10	10000	1981	152	178	29.5%	$38,162
T2	2WD Tractor	63,057	10	10000	1981	152	178	29.5%	46,554
I1	Shredder	4,488	14	2000	1979	119	183	10.8%	2,467
I2	Disc	6,534	14	2000	1979	119	183	10.8%	3,592
I3	Disc	10,795	14	2000	1979	119	183	10.8%	5,934
I4	Field Cultivator	9,565	14	2000	1979	119	183	10.8%	5,258
I5	Planter	14,985	12	1200	1980	132	183	13.9%	9,138
I6	Cultivator	3,945	14	2000	1979	119	183	10.8%	2,169
I7	Cultivator	3,945	14	2000	1979	119	183	10.8%	2,169
C1	Combine	102,895	10	2000	1981	152	178	18.9%	75,966

Table G-6 Equipment Annual Depreciation, Insurance, and Interest for Conventional-Till Grain Sorghum

IMPLEMENT	DEPREC VALUE	SALVAGE VALUE	ANNUAL DEPREC	ANNUAL INSURE	ANNUAL INTEREST
2WD Tractor	$38,162	$11,258	$2,690	$382	$2,671
2WD Tractor	46,554	13,733	3,282	466	3,259
Shredder	2,467	266	157	25	173
Disc	3,592	388	229	36	251
Disc	5,934	641	378	59	415
Field Cultivator	5,258	568	335	53	368
Planter	9,138	1,270	656	91	640
Cultivator	2,169	234	138	22	152
Cultivator	2,169	234	138	22	152
Combine	75,966	14,358	6,161	760	5,318
			------	------	------
			$14,164	$1,914	$13,399

Table G.7 Conventional Grain Sorghum - Soybean Enterprise Budget

COST AND RETURNS	SORGHUM	BEANS	TOTAL
VARIABLE COSTS PER ACRE			
1. Labor	4.15	4.66	8.81
2. Seed	4.05	10.20	14.25
3. Herbicide	16.43	27.56	43.99
4. Insecticide	14.40	0.00	14.40
5. Fertilizer	30.17	13.86	44.03
6. Fuel	3.64	4.01	7.64
7. Oil	0.55	0.60	1.15
8. Equipment Repair	14.46	14.80	29.26
9. Custom Hire ($2.82 Fertilizer Appl.)	2.82	2.82	5.64
10. Interest (1/2 VC * rate)	6.35	5.50	11.84
Interest (Rented Land)	4.64	4.34	8.97
TOTAL VARIABLE COSTS (Owned Land)	97.00	84.01	181.01
TOTAL VARIABLE COSTS (Rented Land)	70.90	66.28	137.17
FIXED COSTS PER ACRE			
11. Real Estate Taxes ($0.50/$100 Land Value)			6.27
12. Interest on Land ($627*.06)			75.24
13. Share Rent SORG. (Gross * 40%)	91.45		91.45
Share Rent SOYB. (Gross * 40%)		73.12	73.12
14. Depreciation on Machinery			44.26
15. Interest on Machinery			41.87
16. Insurance and Housing			5.98
TOTAL FIXED COSTS (Owned Land)			173.63
TOTAL FIXED COSTS (Rented Land)			256.68
TOTAL COSTS PER ACRE (Owned Land)			354.63
TOTAL COSTS PER ACRE (Rented Land)			393.86
YIELD PER ACRE (Bu)	98.8	29.4	
PRICE PER BUSHEL	2.31	6.22	
GROSS RETURN PER ACRE	228.62	182.81	411.42
RETURNS OVER VARIABLE COSTS (Avg)			261.10
RETURNS OVER TOTAL COSTS (Owned Land)			56.79
RETURNS OVER TOTAL COSTS (Rented Land)			17.57
ANNUAL NET RETURNS PER ACRE (1 acre sorghum and 1 acre soybean)			29.33
NET RETURN TO MANAGEMENT (320 acre sorghum and 320 acre soybeans)			9,386

* Assumes landlord paying 2/5 of herbicide (17.60), 2/5 of insecticide (5.76), and 2/5 of fertilizer (17.61).

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RISK ANALYSIS OF REDUCED TILLAGE SOYBEANS AND GRAIN SORGHUM ROTATIONS IN NORTHEASTERN KANSAS USING STOCHASTIC DOMINANCE TECHNIQUES

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Conservation tillage offers tremendous potential for reducing soil erosion. Technical and economic question persist about yield potential, cropping sequences, and other production decisions. This study evaluates the economic potential and associated risk of conventional and reduced tillage systems for the production of grain sorghum and soybeans in Northeastern Kansas.

A representative 640 acre case farm is established to provide comparisons of income potential and variability of contentional-till, no-till, and ridge-till in Northeastern Kansas. The study assumed that farmers could duplicate the yields achieved for similar cropping systems currently studied at the Cornbelt Experiment Station. Input levels were identified by agronomists and Experiment Station Personnel.

An equipment complement was selected to meet the optimal tillage and planting requirements of the conventional-till grain sorghum after soybean rotation. When adopting alternative cropping systems, additional equipment is added as needed to meet the requirements of the system.

Variable and fixed costs were then estimated in an enterprise budget format. Yield and price data was then used to calculate net returns to management for each system. Analysis of variance of yield and price provided estimates of the differences between cropping systems. Finally stochastic dominance with respect to a function was used in discriminating between the net returns of the cropping systems.

Enterprise budget analysis found no-till systems for grain sorghum and soybeans to have slightly higher average net returns when compared to conventional tillage practices. However, the standard deviation were also higher for the no-till systems in the continuous grain sorghum and grain sorghum after soybeans rotation.

Stochastic dominance with respect to a function analysis found conventional tillage continuous grain sorghum to be preferred by highly risk averse individuals, while risk seeking individuals would prefer no-tillage continuous grain sorghum. For risk neutral individuals SDWRF did not distinguish significantly between the two systems. Sensitivity analysis, however found differences between the tow systems to be very sensitive to yield variation.

Costs were slightly lower for the conventional-till system, and yields for the no-till and ridge-till systems were not significantly higher. Because of higher production costs ridge-till systems performed consistently worse than the conventional-till and no-till counterparts.

Sensitivity analysis of the effects of band application of herbicides found no differences in the rankings of the systems. When net return distributions for cropping systems containing grain sorghum were adjusted to represent the county average grain sorghum yields conservation till grain sorghum after soybean and no-till continuous soybean systems were preferred. However, when current government commodity programs were considered in the analysis the grain sorghum systems were preferred.