An Economic Analysis of Alternative Farming Systems in Northeastern South Dakota

Mark Gene Leddy

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AN ECONOMIC ANALYSIS OF ALTERNATIVE
FARMING SYSTEMS IN NORTHEASTERN SOUTH DAKOTA

BY

MARK GENE LEDDY

A thesis submitted in partial fulfillment
of the requirements for the degree
Master of Science
Major in Economics
South Dakota State University
1987
AN ECONOMIC ANALYSIS OF ALTERNATIVE
FARMING SYSTEMS IN NORTHEASTERN SOUTH DAKOTA

This thesis is approved as a creditable and independent investigation by a candidate for the degree, Master of Science, and is acceptable for meeting the thesis requirements for this degree. Acceptance of this thesis does not imply that the conclusions reached by the candidate are necessarily the conclusions of the major department.

Dr. Thomas L. Dobbs

Dr. Ardelle A. Lundeen
Head, Economics Department

Date
ACKNOWLEDGEMENT

I wish to extend my sincere appreciation to Dr. Tom Dobbs for his guidance and suggestions throughout the writing of this thesis. His efforts were greatly appreciated. Appreciation is also extended to the members of my graduate committee, Dr. Don Taylor and Dr. Burt Pflueger, for their suggestions and assistance in the development of this thesis. I would also like to thank Dr. Jim Smolik, Plant Science Department, and Lyle Weiss, Research Assistant, for their contributions to this thesis research.

Most of all, thanks Susan!

MGL
ABSTRACT

This thesis research focused on the economic viability of alternative farming systems which forego chemical inputs and emphasize crop rotations and legumes.

The alternative farming systems were found to have distinctly lower direct cash costs of production. However, in one set of comparisons, these lower direct cash costs were not enough to offset the lower gross income received with the alternative system; thus, this system exhibited the lowest net return over costs. In the other set of comparisons, the lower direct costs were of sufficient magnitude for the alternative system to exhibit the highest net return over costs.

Sensitivity analyses were also conducted to observe the effects of changes in selected variables on net returns of the respective farming systems. When increased input prices, increased alternative system crop yields, or decreased Federal Government involvement in agriculture was assumed, the viability of the alternative systems improved relative to the other farming systems in most cases.

Livestock enterprises were also included in the analyses to determine what effect they have on the economic viability of the farming systems. The alternative system which included alfalfa hay in its crop rotation benefited relatively more than the other farming systems with the inclusion of a livestock enterprise.

The results of these analyses showed the alternative systems to have good prospects of being economically viable in the northeastern part of South Dakota.
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Chapter I

INTRODUCTION

Problem Statement

Farmers in recent years have been faced with increased costs of production and declining commodity prices. The USDA reported increased production costs of 10 to 15 percent per year in the five cropping seasons prior to 1983 (Culik, 1983). Much of this increase in costs was due to increases in the cost of fertilizer, fuel, and herbicides. This increase in costs has leveled off recently, but there is no certainty that operating costs will not rise significantly again in the future. Farmers have also come under increasing pressure to hold themselves accountable for the environmental impacts of their operations; the major impacts are soil erosion and run-off of fertilizers and pesticides (Papendick, Elliot, and Dahlgren, 1986). These factors have led many to consider alternatives other than the current conventional methods of farming.

An effective alternative farming system must respond to farmers' dissatisfaction with the large cash outlays that are required for inputs in current farming practices, a dissatisfaction that is becoming more pronounced during the current period of financial stress on the nation's farms (Buttel, et al, 1986). The system must also deal with the related environmental concerns.

The main emphasis of this thesis research is on analyzing the viability of a system which addresses many of these concerns, organic
farming, or, as it is becoming more popularly known, low-input farming.

The USDA (1980) defines organic farming as:

a production system which avoids or largely excludes the use of synthetically compounded fertilizers, pesticides, growth regulators, and livestock feed additives. To the maximum extent feasible, organic farming systems rely upon crop rotations, crop residues, animal manures, legumes, green manures, off-farm organic wastes, mechanical cultivation, mineral-bearing rocks, and aspects of biological pest control to maintain soil productivity and tilth, to supply plant nutrients, and to control insects, weeds, and other pests.

Although the main emphasis in this thesis is on organic farming, comparisons are also made involving conventional farming practices and reduced till farming practices. The specific reduced till farming systems examined were ridge till, minimum till and no till.

**Justification**

Interest in the use of an alternative system of agriculture has grown considerably in recent years. This interest has not been confined solely to farmers searching for ways to lower their production costs. There has also been an increasing interest shown by policy makers who are looking for alternatives to the current methods of farming which require huge federal subsidies to be profitable. The public in general has also shown an interest in farming systems which reduce the levels of off-site pollution attributable to agriculture. This public concern is typified by the recent passage of a groundwater protection law in Iowa. The bill calls for research into the protection of groundwater, with the major emphasis on protection from
agricultural chemical contamination. A tax was placed on nitrogen fertilizer and special fees were placed on pesticides to help pay for this program (American Journal of Alternative Agriculture, Winter 1987).

The main clientele of the research contained in this thesis are the producers of northeastern South Dakota. With the current financial stress in the farming community, many alternatives are being evaluated. This research project evaluated possible alternatives which have the potential of lowering costs of production to the producer and, at the same time, maintaining farm income.

Several studies have been done comparing the performance of organic farms and conventional farms in the Midwest. These studies have generally shown organic systems to be economically competitive with the current conventional methods of farming. These studies will be examined and reviewed in the "Review of Literature" section of this thesis. The results of these studies and others, along with research results from the Northeast Research Station at Watertown, South Dakota, were applied to northeastern South Dakota to determine the applicability of low input farming in this area.

Research Objectives

The overall objective of this thesis was to determine and compare net economic and net cash returns to farmers from using conventional and alternative farming systems. Both profitability and cash cost characteristics of the systems were compared.
Specific research objectives were to:

1) Develop a set of preliminary budgets for the organic farming system. Existing budgets for the conventional and reduced till systems were updated as necessary. Sensitivity analyses were then undertaken using these enterprise budgets.

2) Develop one or more typical farms for northeastern South Dakota to be used as the base from which to make the desired comparisons between conventional farming systems and alternative systems of agriculture.

3) Develop or adapt an existing model to be used to make whole-farm comparisons between the respective farming systems.

4) Make economic and financial comparisons of the various low-input, conventional, and reduced till systems, using the information and model developed in specific objectives 1, 2, and 3. This quantifiable information was supplemented with qualitative considerations which took farm operators' overall objectives and constraints into consideration.

Organization of Thesis

This thesis is organized into eight chapters. The introductory chapter puts forth the objectives and justification for this study. Chapter two contains a review of pertinent literature which gave particular insights into the formulation of the research design. Chapter three is divided into two major sections: economic theory and research design. The economic theory section contains a review of underlying theory, while the research design section contains an
outline of the procedures used to accomplish the objectives of this study. Chapter four presents the farming systems which were analyzed and the initial baseline results. Chapter five contains the sensitivity analyses which were conducted using the baseline results. Chapter six presents the results of the whole-farm analysis, including results of analyses with selected livestock enterprises. Chapter seven contains qualitative considerations which affect decisions to adopt alternative farming systems. The final chapter, chapter eight, contains a summary of the research findings and contains conclusions and recommendations for future research.
Chapter II

REVIEW OF LITERATURE

Research into the economic feasibility of organic farming as compared to conventional methods or reduced till methods of farming can be grouped into the following three major categories (Cacek and Langer, 1986):

(1) Direct comparisons of economic returns between systems.

(2) Analyses of economic returns based on research plot yield data.

(3) Modelling comparisons of the systems.

These methods were examined in the literature in order to gain insights into the formulation of the research design of this thesis research project.

Direct Comparisons

A study which used the direct comparison method was one conducted by Lockeretz, Shearer, and Kohl (1981). In this research, they analyzed the economic performance of 14 organic farms for the years 1974-1976, with each organic farm being paired with a nearby conventionally managed farm. The organic farms in this study were all at least 40 hectares in size. Each of the farms also had at least one livestock enterprise.

The study also included two additional years, 1977-1978, in which the results of the organic farms were compared with standard
production budgets for the area.

The analysis showed that the gross production per hectare was lower on the organic farms by between 6 and 17%. However, this lower value of production was offset by lower production costs on the organic farms. As a result, the net returns per hectare on organic and conventional farms were almost equal throughout the 5-year study.

The energy requirements for the systems were also compared. The organic system required only 40% as much energy per unit of value produced as the conventional system. The main source of difference between systems was the energy required for the manufacture of fertilizers for the conventional systems. Organic farmers also tended to use reduced till methods of farming, which require less fuel than conventional tillage.

**Research Plot Comparisons**

An example of analysis using experimental plot data was work done by Helmers, Atwood, and Langemeir (1984) at the University of Nebraska. The study covered the years 1975-1983.

This research compared various crop rotation systems to a base system, continuous corn. The rotational system which was used in this study was a corn, soybeans, corn, and oats/clover rotation. Research was done analyzing this rotation operated under differing management conditions, ranging from no chemical use to varying levels of chemical use. A 3-year "start up" period was incorporated in the analysis, in order to allow for the transition to the rotational system, especially
the organic system.

All but one of the rotational systems resulted in higher net returns than did continuous corn. The system for which net returns did not exceed those of continuous corn was a variation of the organic system in which the manure applied was charged at a full elemental fertilizer rate.

The organic systems had the lowest cash outlays, while the continuous corn system had the highest cash outlays. This indicates that there may be a cash flow benefit which accrues with the organic system.

A weakness of this study, as stated by the researchers, is that continuous corn may not be an appropriate base from which to make the comparisons. It may be desirable to use a corn/soybeans rotation or something similar as the base system.

Another example of research conducted using experimental plot data is that of Goldstein and Young (1987) at Washington State University. They made comparisons of net returns over variable costs for a low-input system called PALS (perpetuating-alternative-legume-system) versus a conventionally managed system. The comparison was made using 1986 economic conditions.

The conventional system contained a winter wheat, spring barley, winter wheat, spring peas rotation. PALS consisted of a spring peas + medic, medic, winter wheat rotation. Medic is a biennial legume which is self-seeding and was used to supply nitrogen and organic matter to the soil. The conventional rotation received normal
treatments of fertilizers, pesticides, and fungicides; pesticides and fungicides were limited to use on the spring peas only in PALS. No commercial fertilizer was applied in PALS.

Estimates of annual variable costs were made for each system. The annual variable costs of the conventional system were more than double those of PALS ($129.40/acre/yr. compared to $56.82/acre/yr.).

An analysis was also made of net returns per system under four different scenarios. This analysis examined the effect of the government farm program and varying yield assumptions on the profitability of the respective systems. The conventional system outperformed PALS with the government program assumptions, but PALS outperformed the conventional system when prevailing market prices were used.

The conclusion drawn by the authors was that the conventional system gave a pronounced economic advantage only with a combination of high support prices and high yield assumptions. PALS had the advantage of a large reduction in production costs, which reduces the financial risk borne by farmers.

A limitation of this study is that it is only in its initial stages and the results can only be viewed as preliminary.

Research that utilizes both of the aforementioned methods is being conducted at the Rodale Research Center in Kutztown, Pennsylvania. A conversion experiment is being conducted on experimental plots, in conjunction with the study of an existing beef operation in which organic farming techniques are used (Harwood, 1985).
Results at Rodale concur with the findings of Lockeretz, Shearer, and Kohl (1981) of a large reduction in energy usage due to the lack of use of fertilizers in the organic system. However, the Rodale research indicates that fuel use in the organic systems is almost double that of the conventional systems, which contradicts the findings of Lockeretz, Shearer, and Kohl. This increase in direct fuel usage is due to an increase in the use of mechanical cultivation for weed control.

The results of the conversion experiments show that until the integration efficiencies of the rotation take effect, corn yields will be dramatically reduced. This is due to the presence of weeds and the shortage of nitrogen in the soil. Once the effects of the rotation take effect, the yields begin increasing. The research at Rodale has not totally explained the benefits of rotations, but there appear to be efficiencies in nutrient uptake and release by soils farmed organically that account for significantly higher nutrient availability, which leads to the increased yields.

Research at the Rodale Center also indicates that rotations are effective in the suppression of weeds and the reduction of soil-borne diseases. These two factors are also involved in the increase in yields that are seen once a rotational system is established.

Modelling Comparisons

An example of research utilizing computer simulation is that of Dabbert and Madden (1986) at Pennsylvania State University. This work examined the trend in income of a farm in transition to an organic
system using a multi-year simulation model. This simulation model used linear programming to determine the most profitable combination of crops and livestock for an organic farming system under two transition scenarios. The study utilized data collected by the Rodale Research Center on an adjacent 117-hectare farm which has operated for several years using techniques consistent with organic farming practices.

The baseline condition of the farm was simulated assuming conventional farming practices. Two transitional models were then developed. The TRANS model assumed no yield reduction in the transition to an organic system. The second model, TRANS-L, assumed a 30% reduction in yield the first year and then a linear recovery of yields over the next three years.

The results of the study showed a 12.7% decline in farm income in the first year of the TRANS model and a 43% decline in farm income in the TRANS-L model. The incomes increased in both models during the transition and stabilized at a 7.3% reduction in farm income from the conventional baseline. This study showed that there may be severe short-term financial losses to a farm in the transition to an organic system and that these losses can vary significantly with different yield assumptions.

Overview

This review of literature was undertaken to gather insights into the formulation of the research design of this project. The articles which were cited in this chapter by no means represent an
exhaustive coverage of the literature which was reviewed for this thesis, but they are ones which provided particular insights into various methods of analysis which could be used and applied to the data available for this project. The research design which was developed for this thesis is contained in the following chapter, along with a review of pertinent economic theory.
Chapter III

METHODS OF ANALYSIS

This chapter is divided into two major sections: economic theory and research design. The economic theory section develops the underlying theory which was used in development of the research methodology and in analysis of research results. The research design section outlines the procedures which were used to accomplish the stated objectives of this thesis.

Economic Theory

This economic theory discussion will center on two considerations which affect decisions of the individual producer or firm: production concepts and cost concepts. The production concepts will be covered first, and then the cost considerations and their relationship to the production process will be covered.

Production Concepts

The initial starting point for this thesis research was the development of enterprise budgets. An enterprise budget is a listing of all estimated income and expenses associated with a specific enterprise to provide an estimate of its profitability (Kay, 1984). The basic technical relationship which underlies an enterprise budget is the production function (Boehlje and Eidman, 1984). An enterprise budget actually represents a single point on a production function.

A production function is defined as the relationship between
the quantities of various inputs used per period of time and the maximum quantity of the commodity that can be produced per period of time (Mansfield, 1979). Thus, an enterprise budget, which is presented in value terms, represents this input-output relationship for a single point on the production function.

The classic production function is upward sloping to the right. At some point it is assumed to reach a maximum point and then begin to decrease. This is due to the presence of a fixed input. A fixed input is defined as an input which is fixed throughout the production process. In agriculture, this fixed input is often land. As more and more variable inputs—which are defined as inputs whose level can be changed at the beginning of or during the production process—are added to the fixed input, a maximum output is eventually reached and production then begins to decline.

This leads to two important concepts related to the production function, average physical product (APP) and marginal physical product (MPP). APP is total physical product (TPP) divided by the amount of input used. APP is a measure of the efficiency of the variable input used in the production process (Doll and Orazem, 1984). Therefore, when APP is increasing, the technical efficiency of the production process is also increasing. MPP is the addition to total physical product (TPP) resulting from the last input used. MPP gives the slope of the production function. MPP can be determined for any point on the production function by taking the first derivative of the production function with respect to output.
The relationship between TPP, APP, and MPP can be represented graphically by Figure 3-1. At zero level of variable input use, TPP=APP=MPP=0. As variable inputs are added to the production process, TPP, APP, and MPP all begin increasing. MPP reaches its maximum point first. Once it reaches a maximum and begins decreasing, TPP continues increasing but at a decreasing rate. This is due to each additional unit of variable input adding a successively lower amount to total output. MPP=APP when APP is at a maximum. Once MPP drops below APP, APP also begins to fall. This is due to each successive input used adding less to output than the existing average output per unit of input; therefore, the average is pulled down. When MPP=0, TPP is at a maximum. When MPP becomes negative, TPP begins declining.

These relationships between TPP, APP, and MPP can be used to describe three stages of production along a production function. Stage I begins at the zero variable input level and occurs throughout the section of the production function where MPP is greater than APP. The border between Stage I and Stage II occurs where MPP=APP. TPP is increasing throughout stage II, but APP and MPP are both decreasing. The border between Stage II and Stage III occurs where MPP=0 and TPP is at a maximum. TPP is decreasing throughout Stage III of the production process.

One decision to be made by the profit maximizing producer is how much output to produce. Stage III can be immediately eliminated because production can be increased by simply eliminating some of the variable inputs used. Stage I can be eliminated as a relevant area
Figure 3-1. Relationship Between TPP, APP, and MPP.
because APP is increasing throughout, which implies that an increase in the technical efficiency of the variable input can be achieved. A rational producer would not produce in this area, because production could be undertaken more efficiently at a higher output level. This leaves Stage II as the only rational choice. Variable input use will occur somewhere in Stage II, but to determine the exact position requires a knowledge of the output and input prices. This will be considered next.

If the output and input prices are known, two additional measures can be determined. These two measures are value of marginal product (VMP) and marginal factor cost (MFC). VMP is defined as the price of the output multiplied by the MPP of the last input used. This indicates the added value due to the last input used. MFC is the price of the last variable input used. This is a measure of the added cost resulting from the last input used. Profits are maximized at the point were VMP and MFC are equal. Therefore, the profit maximizing producer will continue adding the variable input as long as the VMP of the last unit is greater than the MFC of the last unit used.

Producers frequently face the question of how to combine two or more variable inputs to produce a desired level of output. There may be many combinations of the two inputs which will produce the same level of output. An isoquant is a curve which shows the varying combinations of inputs which will produce the same level of output. The quantity of one input is on the horizontal axis while the quantity of the other input is on the vertical axis.
The marginal rate of substitution (MRS) between the two inputs defines the slope of the isoquant. The MRS describes how one input substitutes for the other input in the production process while maintaining a constant output level.

With this given level of production, the profit maximizing producer will attempt to find the least cost combination of the two variable inputs. This is accomplished with the addition of the isocost curve to the analysis. An isocost curve shows equal cost outlays for various combinations of the two variable inputs. The slope of the isocost curve is equal to the input price ratio. The least cost combination of the two inputs is located where the isocost curve and the given isoquant are tangent (Figure 3-2).

This input substitution theory is related to various sensitivity analyses which were undertaken in this thesis research with the enterprise budgets. Input substitution is not an explicit consideration, but is rather an implicit one in this thesis. An example of this is the sensitivity analyses conducted on varying herbicide prices. What is implicitly being examined is the economics of herbicide control of weeds versus the use of more mechanical-intensive cultivation practices. When the price of herbicides is increased, the higher cost shifts the horizontal intercept of the isocost line to the left in Figure 3-3; Instead of isocost line I, the isocost line is now I'. Thus, the isocost line is no longer tangent to the original isoquant. If the cost outlay is allowed to increase until a new isocost line (I'') is tangent with the original isoquant, the new
Figure 3-2. Least Cost Combination of Two Inputs.
Figure 3-3. Isoquant Showing Input Substitution Between Mechanical Cultivation and Herbicide Use for Weed Control.
least cost combination of inputs will favor more mechanical cultivation and less herbicide use (a movement from point A to point B on Figure 3-3). Thus, a declining level of profits observed when the prices of herbicides increase can be viewed as partially due to the fact that the producer is no longer using the least cost combination of the two inputs—if he does not shift from A to B. In order to maximize profits, there must be a shift away from the heavy use of herbicides to the use of more mechanical cultivation with the higher herbicide price assumption (Figure 3-3). However, even with the shift, net profits will be lower than in the original situation (point A), if technical possibilities (the production function) remain unchanged.

Cost Concepts

The firm’s production function and the prices it pays for inputs determine the firm’s cost functions (Mansfield, 1979). The cost function relates the cost of production to various output rates, and these relevant output rates are determined by the firm’s production function.

There are various costs associated with the production of a product. These costs pertain to both the short-run and the long-run. In the short-run, there are both fixed and variable costs. Fixed costs are those which do not vary with the level of production. Variable costs are those that change with changing levels of output. In the long-run, all costs are variable, because it is possible to make adjustments in the level of usage of fixed inputs. These costs can be both cash and non-cash costs.
Total fixed costs (TFC) and total variable costs (TVC) combine to form the total cost (TC) of production. TFC is equal to a fixed amount and, therefore, is constant for varying levels of production. TVC is equal to the prices of the inputs used multiplied by the amounts of the respective inputs used. Therefore, TVC increases with increasing levels of output. TC is equal to the sum of TFC and TVC.

The average concepts of the above costs are important considerations. Average fixed cost (AFC) is equal to TFC divided by output. AFC declines with higher levels of output, because the fixed costs are spread over more and more output.

Average variable cost (AVC) is equal to TVC divided by output. AVC initially declines, but then normally begins to increase at higher output levels. This is due to the declining APP of the variable input at higher variable input use. Variable costs are represented in the enterprise budgets developed for this thesis research by the "direct costs". On a per unit of output basis, these costs constitute AVC, and are shown in the budgets as the "breakeven price per unit" for each crop enterprise. Consideration must be given to how costs were allocated per crop when interpreting these values, however.

Average total cost (ATC) is equal to TC divided by output. ATC decreases initially, but at higher levels of output it typically begins increasing and the curve takes on a U-shape. This is due to the effect of increasing AVC at higher output levels. ATC is represented in each enterprise budget by the "production and land costs ($/unit)" value.

ATC and AVC are important considerations for the individual
producer. In the long-run, the price the producer receives must be greater than ATC if a profit is to be earned. In the short-run situation, the producer's main concern is with AVC. The fixed costs must be paid regardless of what level of output the individual produces at. Therefore, if the producer is able to cover AVC in the short-run, production will take place and any return above AVC will be used to help pay the fixed obligations.

The other important cost consideration is marginal cost (MC). MC is the addition to total cost resulting from the use of the last input. The shape of the MC curve depends upon the underlying production function. Typically, the MC curve initially declines and then begins increasing at higher output levels. This is due to decreasing MPP of the variable input at higher output levels.

The revenue received by the producer must also be considered before the optimal level of production can be determined. Total revenue (TR) is equal to the price received for the output multiplied by the quantity sold. Marginal revenue (MR) is the addition to total revenue from the last unit of output sold. In a perfectly competitive market, MR is equal to the price of the output.

An individual producer's profit is equal to TR minus TC. There are many levels of production where profit may be earned, but the profit maximizing producer searches for the level of output which will maximize profits. That level is where MR=MC, when there are perfectly competitive market conditions.

These cost, revenue, and profit concepts can be related to the
enterprise budgets used in this thesis research by the use of two
diagrams. Figure 3-4 contains a plot of total cost at three output
levels for three of the farming systems compared in this study. The
horizontal axis depicts output per acre. This output per acre is shown
in monetary value terms, in order to place the different crop systems
on comparable bases. The vertical axis depicts total cost per acre in
dollar terms.

Based on the assumptions which were used in these particular
budgets, it appears that the conventional system (point C) may be
within Stage III of the production function. This is shown by the fact
that the same level of output could be produced at a lower total cost
to the producer, which is a characteristic of Stage III production.
This is assuming a constant technology for all farming systems.

The related average cost values are shown in Figure 3-5; these
values are located directly beneath the corresponding total cost values
in Figure 3-4. The alternative system (point A in Figure 3-4) exhibited
the highest ATC per unit of output. The conventional system exhibited
the next highest ATC, with the ridge till system (point R in Figure 3-
4) exhibiting the lowest ATC per unit of output. The enterprise
budgets show positive profits for all the respective systems in this
particular set of comparisons, which implies that the price received
for the output is greater than ATC for all systems.

A marginal cost value could be determined for only one range of
output, between points A and R in Figure 3-4. The marginal cost value
between points R and C is negative; thus, it ceases to have meaning.
Figure 3-4. Cost Comparison:

Cost Comparison:

Total cost.

Figure 3-5. Cost Comparison:

ATC, AVC, and AFC.
For this reason, marginal cost points are not shown in Figure 3-5. Nevertheless, it can be assumed that the ridge till system, because it has the highest net returns in the enterprise budgets, is operating closest to the profit maximizing point where MR=MC. The conventional system is operating where the MC of the last output produced is greater than its MR. This is due to the assumed production in Stage III. The alternative system is operating at a profitable level somewhere above the intersection of the MC curve and the ATC curve, but below the profit maximizing level where MR=MC.

Two important non-cash costs also need to be discussed briefly. These are opportunity costs and externalities.

Opportunity cost is defined as the return a resource can earn when it is used in its best alternative use. Thus, when a resource is used in a production process, the relevant cost is the return which could have been earned by employing the resource in its best alternative use. This concept was incorporated into the enterprise budgets in this thesis research by inclusion of land and labor charges. The land charge reflects an opportunity cost for the capital which is invested in the fixed input land. The labor charge reflects the opportunity cost of employing operator and/or family labor in the production process.

Another relevant cost consideration is the concept of externalities. Externalities occur when the private cost or benefit calculations of an individual producer or firm differ from the costs or benefits that accrue to society. The externalities can be broken into
two major classes--external diseconomies and external economies (Randall, 1981). External diseconomies occur when society or an individual is made worse off by a firm's activities. An often cited example is air pollution when no cost is imposed on the polluter. External economies occur when benefits to society accrue as a result of a firm's activities.

Two often cited external diseconomies of agriculture are soil erosion and run-off of fertilizers and pesticides (Papendick, Elliot, and Dahlgren, 1986). The individual farmer does not directly account for these externalities in his profit maximizing decisions, but society is negatively impacted by them. This thesis does not specifically deal with the issue of costs to society associated with these externalities, but it is recognized that the various farming systems have different externality implications. Economic rankings of the specific farming systems could conceivably change if the individual producers were forced to account for the externalities of their operations.

An example of producers being forced to account for their externalities is the earlier cited law passed in Iowa which imposes a tax on nitrogen fertilizer. This tax will have the effect of increasing the relative profitability of the alternative system, because no nitrogen fertilizer is used in this system. This can be shown by referring back to Figure 3-2. The same concept of optimum input combinations exists in this situation. The alternative system which uses legumes and manure to provide the nitrogen to the system would not be impacted by an increase in the cost of nitrogen
fertilizer, while the conventional and reduced till systems would be. With an increase in the cost of nitrogen fertilizer, the optimal combination of inputs when comparing organic sources of nitrogen and inorganic forms of nitrogen would now favor legumes more, relative to the situation before the tax was imposed.

**Research Design**

This portion of the chapter deals with the procedures used to accomplish the specific objectives of this thesis research.

The specific objectives of this thesis research were to:

1) Develop a set of preliminary budgets for the organic farming system. Existing budgets for the conventional and reduced till systems were updated as necessary. Sensitivity analyses were then undertaken using these enterprise budgets.

2) Develop one or more typical farms for northeastern South Dakota to be used as the base from which to make the desired comparisons between conventional farming systems and alternative systems of agriculture.

3) Develop or adapt an existing model to be used to make whole-farm comparisons between the respective farming systems.

4) Make economic and financial comparisons of the various low-input, conventional, and reduced till systems, using the information and model developed in specific objectives 1, 2, and 3. This quantifiable information was supplemented with qualitative
considerations which took farm operators’ overall objectives and constraints into consideration.

Specific Objective 1

The procedure used for specific objective 1 was the development of enterprise budgets. Various budgets for each crop were developed, each differing with the farming system used and the crop’s position in the rotation. The value of these budgets to the project is that "the farm budget can be used as a direct and effective method for determining the maximum economic production for any farm or for any production area" (Edwards, 1966).

The basis for the development of the enterprise budgets was the "Farming Systems Study" currently being conducted by South Dakota State University's Plant Science Department. That study is being conducted at the Northeast Research Farm at Watertown, South Dakota. That study consists of two sets of comparisons: Farming Systems Study 1 and Farming Systems Study 2. A brief description of each system will be given here. For a more detailed description of each system, the reader is directed to Chapter 4.

Farming Systems Study 1 (FSS1) is composed of three distinct farming systems: alternative (organic), conventional, and ridge till. The alternative system is a 4-year rotational system composed of oats, alfalfa, soybeans, and corn. No commercial fertilizers or pesticides are applied in this system. The conventional system consists of a corn, soybeans, and spring wheat rotation. This system is farmed using
conventional farming practices. Fertilizers and herbicides are applied using agronomically suggested rates. The ridge till system is also composed of a corn, soybeans, and spring wheat rotation. This system is operated using ridge till farming techniques. Fertilizers and herbicides are applied using agronomically suggested rates.

Farming Systems Study 2 (FSS2) is composed of four farming systems: alternative (organic), conventional, minimum till, and continuous no till winter wheat. The alternative system is operated using a 4-year rotation of oats, sweet clover, soybeans, and spring wheat. This system is operated under the same conditions as its counterpart in FSS1. The conventional system is composed of a barley, soybeans, and spring wheat rotation which utilizes the same practices as the conventional system in FSS1. The minimum till system is composed of a barley, soybeans, and spring wheat rotation. Tillage is kept to a minimum in this system. Commercial fertilizers and herbicides are applied using agronomically suggested rates. The no till winter wheat system is a continuous system in which winter wheat is planted repeatedley on the same plot using a no-till drill. This system is being questioned on grounds of agronomic viability and, therefore, will not receive an extended treatment in this thesis.

Data obtained from the study at the Northeast Research Farm was preliminary in nature, due to the fact that the study is only in its third year of operation. This is an especially important factor affecting the performance of the low-input system, because of the 3- to 5-year transition period which is typically associated with low-input
farming systems (USDA, 1980). For this reason, the low-input budgets were supplemented with information on yield relationships reported in the literature. The results for the conventional, ridge till, and minimum till systems were also supplemented with information from budgets previously generated for this area. Major sources of information for this were "Expected Production Costs for Major Crops in South Dakota" (Pflueger, 1985), machinery budgets developed by Dobbs, Thaden, and Peckham (1987) and by Allen (1986), and preliminary budgets developed for the "Farming Systems Study" by Thaden (1986a). By utilizing these sources of information, "normalized" budgets were specified for each system—reflecting typical yields and tillage practices. Budgets were also developed using 1986 results. The 1986 results were judged not to be reliable estimates of typical results, so an extended analysis was not conducted with them.

The budgets were placed on computer spreadsheets to facilitate sensitivity analyses in comparisons of the different farming systems. In sensitivity analyses, the data in question is altered to determine what effects, if any, changes will have on the results (Turban and Meridith, 1985). Sensitivity analyses were undertaken by varying input prices, yield assumptions, and changing government farm program assumptions.

These preliminary budgets were developed primarily by Lyle Weiss, Research Assistant, under the direction of Dr. Thomas Dobbs. The author of this thesis participated in decisions concerning budget assumptions, in the review of draft versions of these budgets, and in
the development of the microcomputer spreadsheets. These budgets are presented in SDSU Economics Research Report 87-5 (Dobbs, Weiss, and Leddy, 1987).

**Specific Objective 2**

Specific objective 2 dealt with the specification of a typical farm for the northeast area of South Dakota. A typical farm in this project is taken to be a representative farming operation in a particular region.

A typical farm was developed with data obtained from the South Dakota Agricultural Census Handbook (Rural Sociology Department, 1984) and South Dakota Agricultural Statistics (Ranek, 1985). The farm specified contains 640 total acres. This 640 acres was divided into 540 tillable acres, 60 acres of pasture, 20 acres of wasteland, and 20 acres for the building site.

The livestock enterprises included in this analysis were a 50-head beef cow/calf operation, a 150-head wintering steers operation, and a 50-head dairy operation. These livestock enterprises were examined one at a time and not in combination. The need for livestock enterprises is to adequately generate the economic benefits of the low-input system (Cacek and Langer, 1986). Also, Lockeretz, Shearer, and Kohl (1981) found in their study that nine-tenths of the organic farmers had a substantial quantity of livestock, most commonly beef cattle, hogs, or dairy cattle. The major reason given for this was to utilize the forages produced in their rotational systems.

The major benefits of integrating animals into an agricultural
system include decentralized animal husbandry, closed nutrient cycles, improved environmental quality, local use of roughage, and low grade feedstuffs (Koepf, 1985).

The typical farms were then used as the bases from which to make the desired comparisons between systems. The tillable acreage was divided between the crops in the respective rotations of Farming Systems Study I and II, making the required allowances for government farm program acreage set aside requirements. This information, along with the previously developed enterprise budget information, was then entered into the selected analytic model.

Specific Objective 3

The analytic model chosen was FINPACK. This model is a computerized farm financial planning and analysis package developed by the Minnesota Extension Service. This model is currently being used extensively by the South Dakota Cooperative Extension Service in its farm financial management advisory capacity.

This model was chosen because it addressed many of the stated needs of this research project. Those needs included that of a model which would produce profitability and cash cost characteristics of alternative farming systems, facilitate the analysis of net economic and net cash returns of these systems, and incorporate the rotational effects of the farming systems. Additional sensitivity analyses were also made possible utilizing the FINPACK model and the assumed livestock enterprises. FINPACK also had the added advantage of being
readily available for use in this research project.

Consideration was also given to the use of a linear programming model. Linear programming and budgeting are not distinctly different procedures, but are the same procedure with differences allowed in (a) the number of opportunities considered and (b) the calculations involved (Heady and Candler, 1966). In linear programming, the objective is to maximize a linear criterion function subject to linear constraints. In the case of the Farming Systems Study, profit would be the desired criterion to be maximized. The presence of the linear constraints allows specific restrictions to be included in the model so as to limit, for example, the amount of labor used or the amount of acreage devoted to each crop.

It was decided that linear programming would not be the most appropriate model to use for this particular study. A major reason for this was the limited amount of data which was available for analysis. Budgeting procedures lend themselves to analysis of the data available to this study in a more cost-effect manner. Later, when additional budgets have been developed to allow for the simulation of differing rotational patterns, the use of linear programming may be justified. Under this scenario, for example, linear programming could be used to simultaneously determine optimal rotations and livestock complements. Further analyses could then be made utilizing these optimal combinations. This type of procedure would be similar to that used by Dabbert and Madden (1986) in their research which was covered in the "Review of Literature" section of this thesis.
FINPACK is composed of four programs designed to be used in farm analysis, planning, and financing. The four programs which comprise the FINPACK model are FINLRB, FINTRAN, FINFLO, and FINAN (Hawkins, et al, 1986).

The program which was utilized in this study was FINLRB. This program was used in the analysis of long range profitability, debt repayment capacity, potential net worth growth, return on investment, and labor hour requirements of the typical farm(s) operated under three alternative long-range plans. FINLRB allowed for the simultaneous comparison of the three farming systems in FSS1 and the three systems in FSS2 which were analyzed. The comparisons were made with the assumption that a complete transformation had been made to the respective farming system.

The enterprise budgets which were developed for each system were used as inputs into the model. FINLRB can be directed to utilize the data from a specified budget. By utilizing this feature, it was possible to incorporate the effects of the rotational system into the model's framework, since each budget was calculated with respect to its position in the system's rotation. This made it possible to evaluate the entire rotation's effect on costs of production.

Initially the FINTRAN program was to be used in the study. However, a decision was made later to leave it out of the analysis of the systems. This program projects farm cash flow for three years of business. Its major use is projecting cash flows for the transitional period when a major change is being implemented (Hawkins, et al, 1986).
This aspect would be useful in the analysis of a change from a conventional farming system to either a low-input system or a reduced till system. The transition period is an important consideration because, according to a USDA (1980) study:

Farmers who had previously farmed conventionally reported that crop yields were often markedly reduced during the first several years following the shift from chemical to organic farming. During this transition, severe weed infestations often occurred and crops were sometimes difficult to establish. Occasionally, the crops showed symptoms of nutrient deficiency. Farmers said that after the third or fourth year, as the rotations became established, yields began to increase and eventually equalled the yields they had obtained originally.

This transitional aspect will be left to other analysts and studies, however.

The remaining two programs, FINFLO and FINAN, were not utilized. These programs generate similar data to that generated by FINLRB and FINTRAN, but on a single-year planning horizon.

Specific Objective 4

Specific objective 4 was accomplished by analyzing the results of the sensitivity analyses with the enterprise budgets and by analyzing the whole-farm financial data produced by the FINLRB model. As stated earlier, sensitivity analyses were undertaken on input prices, yields, and government farm program assumptions. An analysis of these results showed the effects of changing factors on costs and profitability of each system, and it also gave an indication of the relative riskiness of each system. The output of the FINLRB program facilitated an analysis of long-run profitability of each of the
farming systems. Comparisons were made using profitability, liquidity, and solvency measures. Sensitivity analyses were also utilized to determine the effect of changes in certain variables on long-term profitability.

Various considerations of individual producers affect their decision to adopt or not adopt a method of farming other than conventional farming practices. Factors which often affect this decision include the following: health concerns, environmental concerns, and concern over the lack of effectiveness of chemicals (Lockeretz, et al., 1984). These and other qualitative considerations, such as risk and management complexities, were also included in the analysis of the feasibility of the alternative systems. This was accomplished by some limited producer interaction. The method used was a structured, but open-ended, interview with selected low-input farmers. Sources of information were producers in the Madison, S. D. area who had previously cooperated with research conducted by the SDSU Plant Science Department on low-input farming systems and selected producers in the northeast part of South Dakota.

Concluding Remarks

This economic theory and research design discussion covered the methodology which was used in this thesis. The economic theory served as the underlying basis for the analytical procedures. These procedures were then used to gather and analyze pertinent information to determine the economic viability of the respective farming systems.
weed control in this system.

The FSS1 conventional system is a system which is operated with farming practices which are consistent with practices typically used by farmers in the vicinity of the research farm. Both commercial fertilizers and herbicides are utilized in this system. The system is composed of a 3-year rotation of corn, soybeans, and spring wheat.

The FSS1 ridge till system is a system farmed with ridge till cultivation techniques. It is composed of a 3-year rotation of corn, soybeans, and spring wheat. In a ridge till system, ridges varying in height of 4 to 8 inches are built up in cultivation. The following crop is then planted directly on top of the ridges, with no tillage preceding planting. The ridges are leveled prior to the planting of the spring wheat, and then are built up with a fall cultivation of the spring wheat stubble to prepare for the planting of the corn the following spring. This system also utilizes both commercial fertilizers and herbicides.

The FSS2 alternative system is a 4-year rotation composed of oats/sweet clover, sweet clover, soybeans, and spring wheat. This system also is operated using no commercial fertilizers or pesticides. The sweet clover is included in the rotation as a green manure crop and, therefore, is not harvested. It is mowed and then chisel plowed.

The FSS2 conventional system is operated using the same techniques as its counterpart in FSS1. However, the rotation differs in this system in that it is composed of soybeans, spring wheat, and barley.
The FSS2 minimum till system is operated using a minimum amount of tillage. Tillage practices are limited to the use of chisel plowing in the fall, with no tillage prior to planting in the spring. Both commercial fertilizers and pesticides are used in this system. The system is a 3-year rotation consisting of soybeans, spring wheat, and barley.

The final system in FSS2 is a continuous no till winter wheat system. In this system, the winter wheat is continually planted using no till practices. A no till drill is used and the wheat is seeded directly into the stubble of the preceding winter wheat crop. Therefore, there are no tillage practices involved in the operation of this system. Both commercial fertilizers and herbicides are used in this system. As stated earlier, this system will not receive an extended analysis, because of the questions surrounding its agronomic viability.

**Budgeting Assumptions**

The initial enterprise budgets used in this thesis research were published in Economics Research Report 87-5, SDSU (Dobbs, Weiss, and Leddy, 1987). This publication contains the budgets which were developed using 1986 yield and tillage practices and the budgets which were developed using "normalized" assumptions. "Normalized" budgets have been used in the analysis of the farming systems because it was assumed that the 1986 results were too restrictive to be used in an extensive analysis. However, the 1986 budgets represented an effective
starting point from which to develop the "normalized" budgets. The major yield and product price assumptions used for the "normalized" budgets will be presented here. Further information on tillage and input price assumptions can be obtained from Economics Research Report 87-5.

**Yield Assumptions**

The "normalized" yield assumptions were developed using a variety of crop yield estimates for the northeast area of South Dakota. The specific sources used were: (1) "1986 Annual Progress Report, Northeast Research Station, Watertown, S.D." (Plant Science Department, SDSU, 1987); (2) "Expected Production Costs for Major Crops in South Dakota" (Pflueger, 1985); (3) "Budget Generator for Area 1 of South Dakota" (Allen, n.d.); (4) "Summary of Costs and Returns for Crops in Northeastern South Dakota" (Thaden, 1986b); (5) "Expected Production Costs for Farming Systems Study I and II" (Thaden, 1986a); and (6) estimates made by various SDSU faculty members. These sources were primarily used to make the estimates for the conventional, ridge till, minimum till, and no till budgets.

The only reliable source of information for yields of crops operated under a low-input/organic system in northeastern South Dakota was the Farming Systems Study. For this reason, yield estimates were based in part upon relationships found in the review of literature. Sources of this information were Lockeretz, Shearer, and Kohl (1981), Helmers, Atwood, and Langemeir (1984), and the USDA Report and Recommendations on Organic Farming (1980). After reviewing these
sources and consulting with various SDSU scientists, estimates for the alternate system budget yields were then made which appeared to have the likely long term relationship to "normalized" conventional system yields. The alternate system yields were assumed to be somewhat lower than conventional system yields because of possible yield reductions caused by nutrient deficiencies and weed pressures which may be present with an alternate farming system.

The yield estimates used for the "normalized" budgets are presented in Table 4-1.

**Product Price and Farm Program Assumptions**

The output prices used for the crops in the enterprise budgets were based on the assumption that the typical farm would be participating in the current farm program. For the non-farm program crop, alfalfa, an average or typical market price was assumed. A market price was also assumed for soybeans. These assumptions will be covered in the following discussion and appear in Table 4-2.

The projected 1987 loan rate was used as the estimated selling price per bushel for each of the program crops, except soybeans. The precise 1987 loan rates were not available when these budgets were developed, so an estimate was made using past differentials between South Dakota loan rates and the national loan rate. The 1987 loan rates have subsequently been released and are slightly different from the estimates in the budgets, but the differences are not significant. The loan rates were used for the estimated selling price, because the
Table 4-1. "Normalized" Yield Summary.

<table>
<thead>
<tr>
<th>Farming Systems Study I</th>
<th>Yield (bu. or ton)/Acre</th>
<th>Corn</th>
<th>Soybeans</th>
<th>S. Wheat</th>
<th>Oats</th>
<th>Alfalfa</th>
</tr>
</thead>
<tbody>
<tr>
<td>Alternative</td>
<td>75</td>
<td>28</td>
<td>70</td>
<td>3.6</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Conventional</td>
<td>82</td>
<td>30</td>
<td>42</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ridge Till</td>
<td>84</td>
<td>31</td>
<td>42</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Farming Systems Study II

<table>
<thead>
<tr>
<th></th>
<th>Yield (bu.)/Acre</th>
<th>Barley</th>
<th>Soybeans</th>
<th>S. Wheat</th>
<th>Oats</th>
<th>S. Clover</th>
</tr>
</thead>
<tbody>
<tr>
<td>Alternative</td>
<td>27.5</td>
<td>70</td>
<td>40</td>
<td>70</td>
<td>Not harvested</td>
<td></td>
</tr>
<tr>
<td>Conventional</td>
<td>70</td>
<td>30</td>
<td>42</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Minimum Till</td>
<td>65</td>
<td>30</td>
<td>42</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Table 4-2. Output Price Assumptions.

<table>
<thead>
<tr>
<th>Crop</th>
<th>Corn</th>
<th>Soybeans</th>
<th>Oats</th>
<th>Alfalfa</th>
<th>Barley</th>
<th>S. Wheat</th>
</tr>
</thead>
<tbody>
<tr>
<td>Selling Price</td>
<td>$1.66</td>
<td>$5.00</td>
<td>$.88</td>
<td>$30.00</td>
<td>$1.40</td>
<td>$2.37</td>
</tr>
<tr>
<td>($/unit)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Deficiency Payment</td>
<td>$2.10</td>
<td>n.a.</td>
<td>$.66</td>
<td>n.a.</td>
<td>$1.11</td>
<td>$2.10</td>
</tr>
<tr>
<td>($/bu.)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Base Yield</td>
<td>63</td>
<td>n.a.</td>
<td>53</td>
<td>n.a.</td>
<td>41</td>
<td>27</td>
</tr>
<tr>
<td>(bu/acre)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

¹Loan rate

n.a. = Not applicable
producer can place the crop under loan to the government and receive this price. It was assumed that the local market prices would not rise above this level during the marketing period for 1987 crops.

The deficiency payment was based on the "base yield" for the program crop in Codington County, which is the county in which the Northeast Research Station is located, and on the estimated deficiency payment per bushel for each crop.

The prices for alfalfa and soybeans were based on expected average or typical market prices for the northeast area of the State. Alfalfa is not a farm program crop, so this was the logical route for this crop. Soybeans are covered by the farm program, but are treated differently. Soybean producers are eligible for a loan rate, but there is no target price. The soybean price was above the loan rate at the time the budgets were developed and it was expected to remain that way, so a market price was assumed.

Since the assumption was made that producers would be participating in the government farm program, there was also an allowance made for the set aside acres which would then be required. The minimum acreage set aside for each crop was assumed. The set aside requirement for corn, oats, and barley was 20% of the crop acreage base in 1987. The minimum set aside requirement for spring wheat and winter wheat was 27.5% of the crop acreage base in 1987. In the FSS2 alternative system, it was assumed that the sweet clover acres would qualify as set aside acreage because they are utilized strictly as a green manure crop and no harvesting takes place.
Baseline Costs and Returns

The "baseline" results for this study were based upon the enterprise budgets which were developed for each farming system. These enterprise budgets were utilized within the framework of the typical farm which was developed for this research project.

As stated earlier, the typical farm was assumed to have 540 tillable acres. These 540 acres were then divided equally between the respective crops for each system, allowing for any set aside acres which were required. With the assumed minimum acreage set aside requirements, it was determined that the crop distribution for the alternative system in FSS1 was 120 acres for each crop, with 60 acres of set aside. The alternative system in FSS2 contained 135 acres per crop, with the set aside requirement being met by the sweet clover. The conventional, ridge till, and minimum till systems were composed of rotations which contained 149 acres per crop, with 93 acres of set aside. Table 4-3 presents the acreage distributions and set aside requirements for each crop in the respective farming systems.

Once the acreage distribution for each crop in the respective systems was specified, it was then possible to determine the net returns to each system.

A description of the measures examined will be given first, and this will be followed by an analysis of the respective systems in FSS1 and FSS2, based upon these measures. Results are presented in Table 4-4, which follows the description of the measures.

The first measure is "direct costs other than labor" per acre.
Table 4-3. FSS 1 and FSS 2 Set Aside Requirements and Rotation Distributions.

<table>
<thead>
<tr>
<th>Crop</th>
<th>Corn</th>
<th>Soybeans</th>
<th>Oats</th>
<th>Alfalfa</th>
<th>Barley</th>
<th>S. Wheat</th>
<th>S. Clover</th>
<th>Set Aside</th>
</tr>
</thead>
<tbody>
<tr>
<td>Set Aside</td>
<td>20</td>
<td>0</td>
<td>20</td>
<td>0</td>
<td>20</td>
<td>27.5</td>
<td>0</td>
<td>n.a.</td>
</tr>
<tr>
<td>Requirement (%)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Crop Distribution (Acres)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>FSS1</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Alternative</td>
<td>120</td>
<td>120</td>
<td>120</td>
<td>120</td>
<td></td>
<td></td>
<td></td>
<td>60</td>
</tr>
<tr>
<td>Conventional</td>
<td>149</td>
<td>149</td>
<td>149</td>
<td>149</td>
<td></td>
<td></td>
<td></td>
<td>93</td>
</tr>
<tr>
<td>Ridge Till</td>
<td>149</td>
<td>149</td>
<td>149</td>
<td>149</td>
<td></td>
<td></td>
<td></td>
<td>93</td>
</tr>
<tr>
<td>FSS2</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Alternative</td>
<td>135</td>
<td>135</td>
<td>135</td>
<td>135</td>
<td>135</td>
<td>0</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Conventional</td>
<td>149</td>
<td>149</td>
<td>149</td>
<td>149</td>
<td>149</td>
<td>93</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Minimum Till</td>
<td>149</td>
<td>149</td>
<td>149</td>
<td>149</td>
<td>149</td>
<td>93</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

n.a. = not applicable
This gives an indication of the required direct cash outlay per acre for each of the systems. These direct costs are variable costs which can be altered in the short run.

The next measure is "gross income" per acre. Gross income is equal to the yield times the price received plus the base yield times the deficiency payment per bushel of base yield. The deficiency payment is applicable only with government farm program crops.

The next three measures in the table are indicators of returns over costs per acre.

The first return measure is "income over all costs except land, labor, and management". It is equal to gross income minus all costs except charges for land, labor, and management. This is a short run measure which views land, labor, and management as fixed costs. Presentation of this measure allows individual producers to place their own opportunity cost on the use of operator and/or family labor and capital investment in the fixed asset land. It also is applicable when one assumes no opportunity cost on land, labor, and management in the short run.

The next measure is "income over all costs except land and management". This includes a charge for labor used in each system. Thus, this is a return over all variable and fixed costs except land and management. The inclusion of a labor charge affects some systems relatively more than others, because of the differences in labor requirements across systems.

The third measure is "income over all costs except management."
This is a long run measure which examines the profitability of each system when all costs are accounted for except a charge for the producer's management. The inclusion of a land charge affects all systems by the same absolute amount, because the land charge is calculated as a percentage of the land value per acre, and the farm land is valued equally across systems.

The final measure shown in Table 4-4 is "income over all costs except management" presented as an aggregate value for the 540 tillable acres of the typical farm.

An examination of the direct costs other than labor per acre showed for FSS1 that the alternative system had the lowest direct cost per acre at $42, followed by the conventional system with $63 and then the ridge till system with the highest cost per acre of $65. The direct costs other than labor for the alternative system were 33% less than in the conventional system and they were 36% less than in the ridge till system. In FSS2, the alternative system again had the lowest direct cost per acre ($30). This cost was 47% less than the $57 per acre cost of the conventional system and and it was 51% less than the $61 per acre cost of the minimum till system.

The lower direct costs in the alternative systems were brought about mainly by no use of chemical fertilizers or pesticides. There was also a reduction in costs due to lower yields in the alternative systems, which reduces the cost of storage and drying. It also should be noted that the application costs for manure was included in the FSS1 alternative system budget, but there was no cost included for the
Table 4-4. Results of Farming Systems Analyses Based upon "Normalized" Budgets

<table>
<thead>
<tr>
<th>System</th>
<th>Direct Costs</th>
<th>Other Than Gross Labor Costs</th>
<th>--------</th>
<th>Net Income Over--------</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Dollars/Acre</td>
<td>Except Land, Except Labor, and Land and Management</td>
<td>Dollars/Acre</td>
<td>Except Land, Except Labor, and Land and Management</td>
</tr>
<tr>
<td>Whole Farm, Net Income Over All Costs Except Management</td>
<td>Dollars/Acre</td>
<td>Except Land, Except Labor, and Land and Management</td>
<td>Dollars/Acre</td>
<td>Except Land, Except Labor, and Land and Management</td>
</tr>
<tr>
<td><strong>Farming Systems Study I</strong> 1</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1. Alternative (soybeans–corn–oats–alfalfa)</td>
<td>42</td>
<td>121</td>
<td>49</td>
<td>36</td>
</tr>
<tr>
<td>2. Conventional (corn–soybeans–s. wheat)</td>
<td>63</td>
<td>143</td>
<td>54</td>
<td>45</td>
</tr>
<tr>
<td>3. Ridge Till (corn–soybeans–s. wheat)</td>
<td>65</td>
<td>145</td>
<td>58</td>
<td>51</td>
</tr>
</tbody>
</table>

| **Farming Systems Study II** |              |                              |          |                        |
| 1. Alternative (soybeans–s. wheat–oats–s. clover) | 30           | 96                           | 41       | 31                     | 5        | 2,767                         |
| 2. Conventional (soybeans–s. wheat–barley)      | 57           | 124                          | 40       | 30                     | 4        | 2,126                         |
| 3. Minimum Till (soybeans–s. wheat–barley)     | 61           | 122                          | 38       | 30                     | 4        | 2,234                         |

1 Crops are shown in the order in which they occur in each rotation.

2 For farm with 540 tillable acres.
manure itself. If there was a charge included for the manure, the direct costs per acre in the alternative system would be higher. The higher costs in the ridge till and minimum till systems were due to the larger amounts of herbicides used in these systems. The reductions in direct tillage costs in these systems did not fully offset the higher costs for herbicides; thus, the direct costs per acre were higher.

The examination of FSS1 gross income showed the ridge till system having the highest gross income per acre ($145), followed closely by the conventional system ($143), with the alternative system having the lowest gross income ($121). The ridge till system gross income per acre was 20% higher than that for the alternative system, while the conventional system gross income was 18% higher than it was for the alternative system. In FSS2, the conventional system had the highest gross income per acre ($124), followed closely by the minimum till system ($122 per acre); the alternative system had the lowest gross income in this comparison ($96 per acre). The differences were slightly greater in FSS2, with the conventional system gross income being 29% higher than that for the alternative system and the minimum till system gross income being 27% higher than that for the alternative system.

The differences in gross income were due to two major factors: yield differences and composition of the rotations. The yields for all comparable crops were assumed to be lowest in the alternative systems. Thus, gross income was reduced because it is partially determined by yield times price received per unit of output. The composition of the
alternative system rotations also affected gross income. With the addition of a fourth crop to the rotations, acreage was shifted from the higher revenue producing crops, corn and soybeans, to lower revenue producing crops; thus a reduction was seen in gross income.

The income over all costs except land, labor, and management for FSS1 showed the ridge till system to have the highest return ($58 per acre), followed by the conventional system ($54 per acre) and then by the alternative system ($49 per acre). The ridge till system return was 18% higher than in the alternative system and 7% higher than in the conventional system, and the conventional return was 10% higher than in the alternative system. In FSS2, the alternative system exhibited the highest income per acre over all costs except land, labor, and management ($41), followed by the conventional system ($40 per acre) and then by the minimum till system ($38 per acre). The alternative system return was 2% greater than it was for the conventional system and 8% greater than for the minimum till system.

The next measure, income over all costs except land and management, gave the same ranking of the systems in FSS1, but the relative profitability changed. With this measure, the ridge till system return was $51 per acre, which was 42% higher than the alternative system return of $36 per acre and 13% higher than the conventional system return of $45 per acre. The conventional system return was 25% higher than the alternative system return. In FSS2, the alternative system, with an income over all costs except land and management of $31 per acre, still exhibited the highest return;
however, the return to the conventional and minimum till systems were equal ($30 per acre). The alternative system return was 3% higher than the conventional and minimum till systems return, with this measure.

The relative changes in returns were due to the labor intensiveness of each of the systems. The alternative system in FSS1 required a relatively large amount of labor and, thus, when a charge was included for labor usage, the alternative system was affected more than the conventional and ridge till systems. The alternative system in FSS2 was not as relatively labor intensive as the alternative system is in FSS1, because the sweet clover, which makes up one fourth of the rotation, requires very little labor due to the fact that it is not harvested. Thus, inclusion of the labor charge does little to change the comparative attractiveness of the alternative system in FSS2.

The final measure examined, income over all costs except management, which is presented both on a per acre basis and on a whole farm basis, maintained the same rankings for the respective systems as provided by the previous measure. The only difference is the inclusion of the opportunity charge for land, which was $26 per acre for the 540 tillable acres in each system. With inclusion of the land charge, the net income per acre for the systems in FSS1 was $25 per acre for the ridge till system, $19 per acre for the conventional system, and $10 per acre for the alternative system. Thus, all systems exhibited positive returns when all costs except management were included, but there were differences between systems, given the assumptions which were used in this analysis. The whole farm ridge till system income
over all costs except management was found to be $13,273, $7,888 greater than the alternative system return of $5,385 and $2,901 greater than the conventional system return of $10,372.

In FSS2, the income over all costs except management was found to be more uniform across systems. The alternative system income over all costs except management for the whole farm was $2,767, $533 higher than the minimum till system return of $2,234 and $641 higher than the conventional system return of $2,126.

**Summary of Baseline Results**

This analysis of the baseline results showed the alternative system to have distinctly lower direct cash costs in both FSS1 and FSS2. However, the reduction in direct cash costs was not large enough to offset the reduction in gross income in FSS1. Thus, the income over costs for the alternative system was lower than for both the conventional system and ridge till system--for all measures examined. In the alternative system of FSS2, the reduction in cash costs was greater than the reduction in total revenue; thus, the alternative system exhibited the highest income over costs, by all measures examined.

The important point here is that all systems exhibited positive income over all costs except management. The magnitude of the differences between systems is partially a function of the "normalized" yield assumptions used in this analysis; thus, at this stage of the SDSU research, undue weight should not be given to the magnitude of the
differences between systems.

In the FSSL analysis, the alternative system was more competitive when the charges for labor were not included. This may help allow for the alternative system to be justified by the individual producer when an important goal of the operation is to keep the family labor employed in agriculture. Sufficient returns must be generated to meet family living expenses, however.

The following chapter covers the sensitivity analyses which were undertaken to determine the affects on the various farming systems of altering selected variables.
Chapter V

SENSITIVITY ANALYSES WITH ENTERPRISE BUDGETS

Sensitivity analyses were undertaken to observe effects of changes in selected variables on returns of the respective farming systems. These sensitivity analyses play an important role in this thesis research. Since the overall research project is only in a preliminary stage, many of the relationships had to be estimated. Thus, the use of sensitivity analyses allow for comparison of the systems under alternative assumptions.

The first portion of this chapter contains the selected variables which were examined. In the subsequent portion of the chapter, results of the sensitivity analyses are presented.

Key Variables Examined

The sensitivity of returns to changes in the following parameters was examined:

(1) fertilizer prices;
(2) herbicide prices;
(3) fertilizer and herbicide prices together;
(4) yields;
(5) target prices;
(6) farm program acreage set aside requirements;
(7) existence of the farm program.

The results of sensitivity analyses with these parameters are reported in the remainder of this chapter. The sensitivity analyses are
divided into the following three major sections: input price analyses; yield analyses; and farm program analyses.

**Input Price Analyses**

The effect of changes in the prices of fertilizer and herbicide alone and of a simultaneous change in the price of fertilizer and herbicide on "income over all costs except management" was examined. These inputs were selected for analysis because they are petroleum based products and are therefore dependent on changes in the price of oil. Since oil has been subject to volatile price swings, it was desirable to determine the effect of changes in the price of these inputs on the profitability of the respective systems. The input prices were varied in increments of 25% in the sensitivity analyses. Thus, the discussion of results will center around these incremental changes. The sensitivity to changing fertilizer prices will be covered first.

The baseline situation for the normalized budgets of FSS1 and FSS2 was a price of $.18 per pound for nitrogen and $.18 per pound for phosphorous fertilizer. Price changes ranging from a 50% decrease to a 125% increase were examined. These percentage changes translate into a range of $.09 per pound to $.40 per pound for the nitrogen and phosphorous.

The alternative systems "income over all costs except management" returns were unchanged by the fertilizer price changes, because no inorganic fertilizers are used in those systems. Analysis
of FSS1 showed that the alternative system had a higher return than the conventional system by the time prices had increased by 75%. At this fertilizer price level, the conventional system return to the 540-acre farm had fallen to $5,046, while the alternative system return remained at $5,385. When the price of fertilizer increased by 125%, the ridge till system return of $4,396 was now also lower than the alternative system return. These relationships are shown in Figure 5-1.

The FSS2 analysis examined changes in fertilizer prices ranging from a 50% decrease to a 50% increase from the base case. In this case, the alternative system started out with the highest return. However, the conventional and minimum till systems had higher returns, $3,689 and $3,796, respectively, than the alternative system ($2,767) when prices declined by 25%. However, with a 50% increase in the price of fertilizer, the conventional and minimum till systems exhibited negative returns over all costs except management. This is shown in Figure 5-2.

The analysis of changing only herbicide prices for FSS1 involved changes ranging from a 50% decrease in prices to a 125% increase. This analysis showed the alternative system becoming more profitable than both the conventional and ridge till systems when prices increased by 125%. The returns at this level were $5,385 for the alternative system, $4,176 for the conventional system, and $3,893 for the ridge till system. The conventional system also becomes more profitable than the ridge till system at this level. This points out the heavier reliance on purchased herbicides in the ridge till system.
Figure 5-1. FSS1 Sensitivity Analysis:
Changes in fertilizer prices.
Figure 5-2. FSS2 Sensitivity Analysis:
Changes in fertilizer prices.

Conventional
Alternative
Minimum till
In FSS2, a 25% decrease in the prices of herbicides caused the conventional system return to increase to $3,835 and the minimum till system return to increase to $4,931. At this herbicide price level, both systems exhibited higher returns than the alternative system. However, it only required a 25% increase above base herbicide prices to cause the minimum till system to exhibit a negative return (-$464). At this herbicide price level, the conventional system still exhibited a slight positive return ($417).

The final input price sensitivity analysis involved examination of a simultaneous change in fertilizer and herbicide prices. The ranges examined were from a 50% decrease in prices to a 75% increase. In FSS1, an increase of 50% in these input prices resulted in the alternative system having a higher return than the conventional system ($5,385 compared to $4,342) and a return nearly equal to the ridge till system ($5,385 compared to $5,968). This is shown in Figure 5-3.

In FSS2, the range examined was from a 50% decrease in prices to a 25% increase. With a 25% decrease, the conventional system return increased to $5,224, while the minimum till system return increased to $6,320. At this input price level, both systems exhibited higher returns than the alternative system. However, with a 25% increase in price, both of these systems exhibited negative returns (-$971 and - $1,853, respectively). The changes in return were greatest in the minimum till system with this sensitivity analysis, which points out the heavier reliance on purchased chemical inputs in this system. These results are shown in Figure 5-4.
Figure 5-3. FSS1 Sensitivity Analysis:
Changes in fert. and herb. prices.

- □ Conventional
- + Alternative
- ◇ Ridge Till

Return per whole farm (Thousands)

Percent of baseline case

-0.5  -0.25  0  0.25  0.5  1  1.25  1.5  1.75
Figure 5-4. FSS2 Sensitivity Analysis:
Changes in fert. & herb. prices.
These sensitivity analyses showed for FSS1 that when the prices are increased on two of the major cash inputs, fertilizer and herbicides, the alternative system becomes relatively more profitable as compared to the conventional and ridge till systems. The price increases do not directly affect the alternative systems, because commercial fertilizers and pesticides are not used as inputs in these systems. In FSS2, relatively small increases in the prices of these two inputs caused the conventional and minimum till systems to exhibit negative "income over all costs except management".

**Yield Analyses**

As stated previously, the yields which were used for the "normalized" alternative system budgets were estimates based upon various sources of information, including preliminary results of the SDSU Farming Systems Study, relationships found in the literature, and judgments of various scientists. Thus, even though the normalized yields were "best estimates", they may not accurately reflect the long-term research trial yields. Therefore, it was desirable to examine different yield assumptions for the alternative systems and to analyze the effect of these varying assumptions on "income over all costs except management".

Sensitivity analyses with yields were conducted by setting the alternative system yields at particular levels in relationship to conventional baseline yields. Thus, a 10% lower yield for a specific crop indicates that the specified alternative system yield was assumed to be 10% lower than the conventional system yield. Oats and alfalfa
were treated somewhat differently, because there were no counterparts in the conventional systems. When these yields were altered, they were altered from the baseline alternative system yields.

The first FSS1 sensitivity analysis involved varying the yields of oats, corn, and soybeans. This was done in order to examine the effect of various yield assumptions on "income over all costs except management". The alfalfa yield was not altered because it was assumed here to be constant regardless of the kind of farming system used. The ranges examined were from a 20% decrease to a 10% increase in crop yields.

The results of this analysis showed that the alternative system maintained a positive return even with 20% lower crop yields. The return to the 540-acre farm at this yield level was $526. With a 10% increase in yields over the conventional system, the alternative system return was determined to be $11,033. This is slightly higher than the conventional system return of 10,372, but still below the ridge till system return of $13,273. These results are shown in Figure 5-5.

In the FSS2 analysis, the alternative system yields of oats, soybeans, and spring wheat were varied. The sweet clover was unaffected since it is not harvested. The results of this analysis showed that with a 15% decrease in alternative system yields, the alternative system return became negative (-$2,715). With a 10% increase in yields, the alternative system return increased to $8,774, which was a 117% increase over the baseline return. These results are shown in Figure 5-6.
Figure 5-5. FSS1 Sensitivity Analysis:

Varying alternative system yields.

Conventional  Alternative  Ridge Till

Percent of baseline case

Return per whole farm (Thousands)
Figure 5-6. FSS2 Sensitivity Analysis:
Varying alternative system yields.
These sensitivity analyses also gave insights into the transition to an alternative system. The 20% decline might be viewed as the initial situation when a transition occurs. The subsequent percentages can be thought of as a linear recovery of yields in subsequent years of operation under an alternative system. The linear recovery approach is similar to that used by Dabbert and Madden (1986), cited in the Review of Literature section of this thesis.

Another FSS1 sensitivity analysis involved the effect on "income over all costs except management" of changes in alternative system alfalfa yields, with the normalized soybean, oats, and corn yields held constant. The ranges examined were from a 20% decrease to a 15% increase in alfalfa yields.

The results of this analysis showed that with a 20% decrease in alfalfa yield, the alternative system return decreased from the baseline return ($5,385) to $2,793. With a 15% increase in yield, the alternative system return rose to $7,329, which was a 36% increase over the baseline level.

This was an important sensitivity analysis because the specification of the alfalfa yield greatly affects the profitability of the alternative system as compared to the conventional and ridge till systems. This is due to the alfalfa being present in the alternative rotation, but not being present in the conventional or ridge till system rotations. This analysis showed that as the alfalfa yield is increased by 20%, the alternative system return approached those of the conventional and ridge till systems.
Farm Program Analyses

Analyses were undertaken to determine the effect of the Federal Government's farm program on returns for the various systems. Sensitivity analyses were conducted with reductions in target prices, increases in set aside requirements, and total elimination of the farm program. The target price sensitivity analyses will be covered first.

Reductions in target prices were selected for analysis because there is currently concern over the large amount of government expenditure required for the current farm program. Reduction in target prices would reduce deficiency payments and, thus, government expenditures. Reductions selected for analysis were 5%, 10%, and 15% below 1987 target prices. It was assumed in the analyses that market prices still would not exceed the loan rates, so the loan rates continued to be used as the market prices for program crops. Market prices of soybeans and alfalfa were initially assumed to be the same as in the baseline case.

Results of these particular sensitivity analyses are presented using the "income over all costs except land and management" measure. This measure was used because it is often assumed that benefits from the farm program are capitalized into the value of the land. If farm program benefits decline, it is likely that corresponding adjustments would also occur in the prices of farmland. Therefore, to reflect the affects of these target price changes in a long-run perspective, the charge for land was not included in analyses of returns. The whole farm baseline return with this measure was $19,559 for the alternative
system, $24,413 for the conventional system, and $27,313 for the ridge till system.

The percentage reductions in "income over all costs except land and management" were similar across systems in FSS1. With a 5% reduction in target prices, the alternative and ridge till system returns declined by 8.4%, while the conventional system return declined by 9.4%. With a 15% decrease in target prices, the alternative and ridge till systems return declined by 25.2%, while the conventional system return decreased by 28.2%. Thus, there was little difference among systems in the percentage reductions in return due to decreasing target prices. However, the absolute decrease in return was less in the alternative system than in the conventional and ridge till systems. Return declined by $4,925 in the alternative system, while the return in the conventional and ridge till systems declined by $6,879. The reductions were equal in these two systems because the same crops and government program assumptions were utilized in both systems. The results of this analysis are shown in Figure 5-7.

In FSS2, the baseline "income over all costs except land and management" was $16,805 for the alternative system, $16,276 for the minimum till system, and $16,168 for the conventional system. The percentage reductions in income due to reductions in target prices were of a similar magnitude to the reductions found in FSS1. However, the alternative system in FSS2 was affected somewhat less than the conventional and minimum till systems by the reduction in target prices.
Figure 5-7. **FSS1 Sensitivity Analysis:**

Changes in target prices.

Return per whole farm (Thousands)

```
0.85  0.9  0.95  1

Conventional

Percent of baseline case

Alternative

Ridge Till
```
With a 5% reduction in target prices, the alternative system return decreased by 8.2%, the minimum till system return decreased by 10.3%, and the conventional system return decreased by 10.4%. With the 15% reduction in target prices, the alternative system return decreased by 24.5%, the minimum till system return decreased by 31%, and the conventional system return decreased by 31.2%. These percentage declines translate into a $4,120 reduction in return for the alternative system and a $5,039 reduction in return for the conventional and minimum till systems. Thus, in FSS2, the alternative system return decreased by the smallest amount, both on a percentage basis and on an absolute basis when the target prices were reduced. These results are shown in Figure 5-8.

Sensitivity analyses were also undertaken to determine the affect on the respective farming systems of changing the farm program set aside (unpaid) requirements. In FSS1, the corn and oats set aside requirements were assumed to increase from the baseline 20% to 27.5%, which would be equal to the spring wheat set aside requirement in 1987. The percentages were then increased by 2.5% increments until a maximum set aside requirement of 35% was reached. The same procedure was used for the oats and barley in FSS2.

The results of the FSS1 analysis showed that "income over all costs except land and management" declined by the smallest absolute amount in the alternative system ($3,076) when the maximum 35% set aside requirement was assumed; however, this was the largest percentage decline (15.7%) of the three systems in FSS1. The conventional system
Figure 5-8. FSS2 Sensitivity Analysis:

Changes in target prices.
return declined by $3,726, which was a 15.3% decline. The ridge till
system return declined by the largest absolute amount, $4,057, but this
was the smallest percentage decline (14.8%). These results are shown
in Figure 5-9.

The results of the FSS2 analysis showed the alternative system
return decreasing by the smallest absolute amount ($438) and also by
the smallest percentage amount (2.6%) when acreage set aside
requirements were increased to 35%. This was due to the presence of
the sweet clover in the FSS2 alternative rotation. In the baseline
situation, there were more acres of sweet clover in the rotation than
were required for set aside acres. Therefore, the sweet clover acres
were able to meet the requirements for the set aside acres until the
maximum 35% set aside level was reached. At that level, additional
acres were required for set aside, and the return to the alternative
system then declined. The conventional and minimum till system returns
decreased by much larger absolute amounts ($2,787 and $2,7987) when set
aside requirements were increased to 35%. The percentage decline in
return at this level was equal to 17.2% in both systems. These results
are shown in Figure 5-10.

A sensitivity analysis was also conducted to determine the
effect on the respective systems of the elimination of the current farm
program. In this analysis, the prices received for the crops were
adjusted in order to account for market price adjustments which would
likely take place in the absence of any government farm program. The
new "market" prices were set at particular percentages of 1987 target
Figure 5-9. FSS1 Sensitivity Analysis:

Changes in set aside requirements.

Return per whole farm (Thousands)

baseline 0.275 0.3 0.325 0.35

Conventional

set aside percentages

Alternative

Ridge Till
Figure 5-10. FSS2 Sensitivity Analysis:
Changes in set aside requirements.

Return per whole farm (Thousands)

- Baseline
- 0.275
- 0.3
- 0.325
- 0.35

Set aside percentages:
- Conventional
- Alternative
- Minimum till
prices or, in the absence of applicable target prices, baseline market prices. (The exception to this was the alfalfa price, which was held at the same level as the baseline price.) This approach was used in an attempt to maintain historical price relationships between crops. A 70% adjustment was used. The prices used in this sensitivity analysis appear in Table 5-1.

The results of the FSS1 analysis showed that the alternative system "income over all costs except land and management" declined by the smallest absolute amount ($11,950), but this was the highest percentage decline (61%). The ridge till system return declined by $13,862, which, at 51%, was the smallest percentage decline. The conventional system return declined by the largest absolute amount, $14,320, which was a 59% decline. These results are shown in Figure 5-11.

The FSS2 results showed that all three systems declined by almost identical absolute and percentage amounts. The alternative system "income over all costs except land and management" declined by $11,950, which was the highest absolute decline, as well as the highest percentage decline (71%). The minimum till system return declined by $11,443, which was a 70% reduction. The conventional system return declined by $11,141, the lowest absolute decline, as well as the lowest percentage decline (69%). These results are shown in Figure 5-12.

These farm program sensitivity analyses showed that in all cases except one, the returns in the alternative systems declined by the smallest absolute amount when the government farm program
Table 5-1. Price Assumptions Used For Sensitivity Analysis Showing No Farm Program

<table>
<thead>
<tr>
<th>Crop</th>
<th>Baseline Price (Target or Market) ($/unit)</th>
<th>Adjusted Price ($/unit)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Corn</td>
<td>$2.87</td>
<td>$2.01</td>
</tr>
<tr>
<td>Soybeans</td>
<td>$5.00</td>
<td>$3.50</td>
</tr>
<tr>
<td>Oats</td>
<td>$1.54</td>
<td>$1.08</td>
</tr>
<tr>
<td>Barley</td>
<td>$2.51</td>
<td>$1.76</td>
</tr>
<tr>
<td>S. Wheat</td>
<td>$4.47</td>
<td>$3.13</td>
</tr>
<tr>
<td>Alfalfa</td>
<td>$30.00</td>
<td>$30.00</td>
</tr>
</tbody>
</table>
Figure 5-11. FSS1 Sensitivity Analysis:
Elimination of farm program.

Return per whole farm (Thousands)

- [] Conventional
- [] Alternative
- [] Ridge Till
Figure 5-12. FSS2 Sensitivity Analysis:

Elimination of farm program.

Return per whole farm (Thousands)

<table>
<thead>
<tr>
<th>Policy assumptions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Conventional</td>
</tr>
<tr>
<td>Alternative</td>
</tr>
<tr>
<td>Minimum till</td>
</tr>
</tbody>
</table>

baseline  no program
provisions were varied. The only case in which the alternative system return did not decline by the smallest absolute amount was in the sensitivity analysis for complete elimination of the farm program in FSS2. A larger reduction in return in this analysis was caused by the assumptions that involved utilizing the sweet clover as the set aside acreage for the alternative system of FSS2. Thus, when set aside requirements were eliminated, the set aside acres in the other farming systems were included in the crop rotations, while the FSS2 alternative system had no actual set aside acres to place in production.

In FSS1, because the alternative system return was lowest in the baseline situation, these lower absolute reductions still resulted in the alternative system returns declining by the largest percentage amounts. In FSS2, the alternative system return was the highest in the baseline situation. Thus, lower absolute declines in return also resulted in the alternative system returns declining by the smallest percentage amounts; the exception was in the farm program elimination sensitivity analysis, where the alternative system exhibited the largest absolute and percentage declines.

Concluding Remarks

These sensitivity analyses were used to examine returns to the respective farming systems under alternative assumptions. Insights were gained into the relative profitability of the farming systems under assumptions other than those for the baseline situations. When increased input prices, increased alternative system yields, or decreased Federal Government involvement in agriculture was assumed,
the viability of the alternative systems improved relative to the other farming systems in most cases.

The following chapter contains baseline results from analyses with the FINPACK model. Additional sensitivity analyses were conducted utilizing that model, and the results of those analyses will also be presented in the following chapter.
Chapter VI

WHOLE FARM FINANCIAL ANALYSES

This chapter contains the assumptions which were used and the results which were obtained with the FINLRB program of FINPACK. The analyses with the FINLRB model utilized the enterprise budgets and parameters for the typical farm as inputs to the model. However, the FINLRB analyses included additional factors which were not present in the previous analyses. The use of the FINLRB model also facilitated the introduction of livestock enterprises into the analyses.

The selected financial measures examined and additional assumptions included will be covered first. This will be followed by presentation of the "crops systems only" results and sensitivity analyses. Then results and sensitivity analyses with livestock enterprises included will be presented.

FINLRB Model

The FINLRB model compares three alternative farm plans for a typical year in a long run setting. The assumption is made that any transitional stage to a system has been completed. This feature allows for the simultaneous comparison of the three farming systems in FSS1 in one analysis and the simultaneous comparison of the three farming systems selected for analysis in FSS2 in a separate analysis.

The FINLRB model projects profitability, liquidity, and solvency for the three alternative plans on a typical year basis. These financial measures provided an indication of the performance of
each farming system. Various measures were selected from this output and were analyzed to determine the financial feasibility of the farming systems. A description of the financial measures selected for analysis from the FINLRB output will be given here.

The first profitability measure examined was "profit or loss". It is equal to net cash farm income minus depreciation. Net cash farm income is equal to gross income minus cash operating expenses. The depreciation charge used was actual depreciation, obtained from the enterprise budgets. This measure can be viewed as a return to labor, management, and equity capital invested in the farm business.

The next profitability measure examined was "labor and management earnings". It is equal to profit minus interest on farm net worth. Interest on farm net worth is calculated as a 6% charge against net worth. This is equivalent to including an opportunity charge for the equity capital invested in the business. Therefore, this measure represents a return to the farm operator for investing labor and management skills in the farm business.

The final profitability measure examined was "rate of return on farm investment". It is equal to return divided by total farm investment. Return is calculated as profit plus farm interest paid, which gives a return to total farm investment. "Value of operator's labor and management" is then subtracted to arrive at "return on farm investment". Operator's labor is valued at $4 per hour up to 2500 hours of labor and operator's management is valued at 5% of gross farm income. This measure represents the actual return on the average
dollar invested in the farm business.

The first liquidity measure examined was "cash surplus or deficit". This measure is the projected amount of cash left over after all cash commitments have been accounted for. These cash commitments include cash farm expenses, taxes, family living expense, and principal payments. This measure provides an indication of the ability of a farm operation to generate sufficient cash to meet its financial commitments.

The other liquidity measure examined was "cash farm expense as a percent of income". This is calculated by dividing cash operating expenses by gross farm income. This measure shows the percentage of gross income required to meet cash operating expense requirements.

One solvency measure, "net worth change per year", was examined. It is calculated by subtracting family living expense and taxes from profit. This measure projects the amount net worth will change in a typical year.

One final summary measure was also used to analyze the farming systems; that measure was "annual labor hours required". This measure gives an estimate of the total labor hours required per year for each of the farming systems. This is an important consideration because of the differences in labor requirements between the farming systems.

The above measures were utilized to analyze and compare the respective farming systems. The results of analyses conducted utilizing these measures will be presented in the remainder of this chapter.
Case Farm

The baseline case farm was derived from the enterprise budgets, the typical farm assumptions, and additional assumptions needed for FINLRB. These assumptions, along with information on the selected livestock enterprises, will be covered first. This will be followed by presentation of the results obtained.

Basic Assumptions

The FINLRB analyses included costs and returns for the entire 640 acre typical farm. The previous analyses considered only the 540 tillable acres. Inclusion of the 60 acres of pasture, 20 acres of wasteland, and 20 acres of building site affected balance sheet formulation, net returns, and forage production of the farming systems.

The FINLRB model also required the specification of an initial balance sheet for the farming systems. This balance sheet was then utilized in the computation of various financial measures. The balance sheet required input on current assets, intermediate assets, long term assets, current liabilities, intermediate liabilities, and long term liabilities. The assumptions used for the specification of these inputs will be covered here.

Current assets, such as cash, securities, and crop inventory, were assumed to be constant values across all farming systems.

Intermediate assets were assumed to be investments in machinery and equipment for each of the farming systems. Machinery investment for each system was determined from (a) annual acres of use derived from the "normalized" tillage practices specified for the enterprise
budgets and (b) average values for each machine in Economics Pamphlet 153 (Allen, 1986) and Economics Pamphlet 87-2 (Dobbs, Thaden and Peckham, 1987). Annual acres of use for each machine was then compared to the average annual usage value in Economics Pamphlet 153, and a conversion factor was derived and used to specify an average investment for each machine. Average investments for each machine were then summed to obtain an average total investment in machinery and equipment. This method was utilized to account for the different tillage practices and machines required in each of the farming systems.

Long term assets were assumed to be the value of farmland and buildings. This included a valuation not only of the assumed tillable acres, but also a value was included for the assumed pasture, wasteland, and farmstead acres specified in the typical farm.

Current liabilities were derived from the current asset level. A constant current asset to current liability ratio of 1.5 was assumed for all farming systems.

Intermediate liabilities were derived from relationships available in the South Dakota Agricultural Statistics Handbook (Ranek, 1987). The average ratio of non-real estate debt and Commodity Credit Corporation loans to total assets for South Dakota in 1985 was .193. This ratio was multiplied by total assets for each farming system to determine total current and intermediate liabilities. The value for the current liabilities was then subtracted from this value to derive intermediate liabilities.

The value for long term liabilities was also determined in this
manner. The ratio of real estate debt to total assets in 1985 was .12. This ratio was then multiplied by total assets to derive the long term liabilities value.

The above values were developed for each of the farming systems in order to account for any differences among systems in investment requirements. With development of these values, and with use of the enterprise budgets and typical farm assumptions, it was then possible to develop a baseline situation for the FINLWB model.

Livestock Assumptions

The presence of livestock enterprises is often considered crucial to the optimum performance of alternative farming systems. Therefore, livestock enterprises were included in the analysis to examine interactions and to determine effects of various livestock enterprises on financial viability of the farming systems.

The livestock enterprises selected for analysis were (a) a 50-head beef cow/calf operation, (b) a 150-head wintering steers operation, and (c) a 50-head dairy operation. These enterprises were chosen because they are typical enterprises for this area of South Dakota and they utilize forages in their rations. Costs and returns for the livestock enterprises were derived from FINPACK budgets for the northeast area of South Dakota. The livestock prices in these budgets were updated to reflect 1987 conditions.

The inclusion of livestock enterprises also required adjustment of initial balance sheet levels. In specifying these new
levels, it was assumed that any transitional stage involved with the addition of a livestock enterprise was complete.

Current assets were assumed to remain constant for each livestock enterprise. Intermediate assets were increased to account for livestock inventories and additional machinery and equipment required for each livestock enterprise. Long term assets were increased to account for additional buildings and facilities required for each livestock enterprise.

Liability levels for each livestock enterprise were adjusted to maintain the liability to asset relationships utilized in the baseline situation.

Presentation of results obtained with addition of the livestock enterprises will follow the "crop systems only" results.

**Results: Crop Systems Only**

Baseline results for FSS1 and FSS2 will be presented using the profitability, liquidity, and solvency measures which were defined earlier in this chapter, with FSS1 results presented first. Tables 6-2 and 6-3, located at the end of this chapter, contain a summary of baseline results for all systems examined.

**Baseline Results**

An examination of profits showed the ridge till system exhibiting the highest profit level ($24,607), followed by the conventional system ($23,402); the alternative system exhibited the lowest profit level ($21,473). This measure showed the ridge till
system having a 14.6% higher profit than the alternative system and a 5% higher profit than the conventional system. The conventional system profit was 9% higher than the alternative system.

"Labor and management earnings" showed the same ranking of systems. The ridge till system had the highest return with this measure ($11,218), followed by the conventional system ($9,622) and then the alternative system ($7,386). The returns were lower with this measure for all systems, because of the inclusion of the opportunity charge for equity capital used in the farm operation. Figure 6-1 contains a comparison of profit and labor and management earnings.

The final profitability measure examined was "rate of return on farm investment" (ROI). The ridge till system exhibited the highest ROI (8.9%), followed by the conventional system (8.3%); the alternative system exhibited the lowest ROI (7.1%). Differences in ROI are caused by differences in the amount of return and the amount of total investment in each farming system.

The first liquidity measure examined, "cash surplus or deficit", showed all systems exhibiting cash surpluses. The ridge till system had the largest surplus ($3,514), followed by the conventional system ($2,610) and then the alternative system ($1,181).

The other liquidity measure examined, "cash farm expense as a percent of income", showed the alternative system having the lowest percentage (54.6%). The conventional and ridge till systems had nearly identical percentages, 60.5% and 60.7%, respectively. The lower proportion of cash expenses in the alternative system was due to lower
Figure 6-1. FSS1—Crop Systems Only Analysis:
Profit—lbr. & mgmt. earnings comparison

- Conventional
- Alternative
- Ridge till
reliance on purchased inputs.

The solvency measure which was examined, "net worth change per year", showed all systems exhibiting positive net worth changes. The ridge till system had the highest change ($4,262), followed by the conventional system ($3,380) and then the alternative system ($1,968).

Total labor hour requirements for each system varied by a large amount. The alternative system required the highest amount of labor, 1,169 hours. This was 348 hours more than the conventional system requirement of 821 hours and 444 hours more than the ridge till system requirement of 725 hours. A charge for operator and/or family labor required was included in the analyses conducted with the enterprise budgets, but a charge for this labor was only included in the "rate of return on investment" analyses of the FINLRB model.

An examination of FSS2 results showed the alternative system having the highest profit ($16,737), with the conventional system being only slightly lower ($16,294); the minimum till system had the lowest profit ($14,331). Alternative system profit was 3% higher than the profit of the conventional system and 17% higher than the profit of the minimum till system.

"Labor and management earnings" showed the same ranking of systems. The opportunity charge for equity capital was similar across systems. The opportunity charge was $13,892 in the conventional system, with the alternative and the minimum till systems having slightly lower charges of $13,572 and $13,474, respectively. Figure 6-2 contains a comparison of profit and labor and management earnings for
Figure 6-2. FSS2-Crop Systems Only Analysis:
Profit-lbr. & mgmt. earnings comparison

- Conventional
- Alternative
- Minimum till
these systems.

"Rate of return on farm investment" was similar across systems. The alternative system had the highest ROI (6.2%), followed closely by the conventional system (6.1%); the minimum till system had the lowest ROI (5.9%).

"Cash surplus or deficit" showed all systems having a cash deficit. The alternative system had the lowest deficit (-$2,257). The conventional system had a deficit of -$2,599 and the minimum till system had the highest cash deficit (-$4,113). These results suggest that these systems may have difficulties meeting all of the cash commitments required for operation and family living.

"Cash farm expense as a percent of income" showed the alternative system to have a significantly lower percentage (55.2%) than the conventional system (64.7%) and the minimum till system (68.5%). Differences in this measure are partially due to the use of more labor intensive methods in the alternative farming systems. Since the cost of labor is not included as a cash expense in this analysis, the use of labor intensive methods will result in a lower cash expense as a percentage of income for the alternative farming systems.

"Net worth change per year" was negative for all systems. The alternative system had the smallest decline (-$1,499), followed by the conventional system (-$1,823). The minimum till system had the largest decrease in net worth (-$3,360). This indicates that in a typical year the owner’s equity in the farm business will be decreased in order to farm with any of these systems and to meet living expenses.
The alternative system had the largest labor hour requirement (1,048 hours), which was 69 hours more than the requirement of 979 hours for the conventional system and 290 hours more than the requirement of 758 hours for the minimum till system.

**Sensitivity Analyses**

Sensitivity analyses were also conducted by altering selected input variables of the "crop systems only" situation of the FINLRB program. These sensitivity analyses were only conducted with FSS1, because it was assumed that similar results would be obtained with an analysis of FSS2.

An analysis was conducted to determine the affect of varying debt levels on profit of the farming systems in FSS1. The baseline situation was a .31 debt to asset ratio. Sensitivity analyses were conducted examining debt to asset ratios of .10 and .50. The results of this analysis showed that the alternative system profit increased by the largest percentage (31.3%) with a lower debt to asset ratio, but it also decreased by the largest percentage (28.6%) with a higher debt to asset ratio. The ridge till system was affected least by the changing debt to asset ratios. The ridge till system exhibited a 25.6% increase in profit with a .10 debt to asset ratio and a 23.5% decrease in profit with a .50 debt to asset ratio. The conventional system fell between the other two systems, with a 27.9% increase in profit and a 25.5% decrease in profit.

The alternative system was affected most by these changes because interest payments per year made up a larger percentage of cash
farm expenses in the alternative system than in the conventional and
ridge till systems. Interest payments per year are a function of the
debt level. Thus, when the debt level was changed, the greatest
percentage change in cash farm expense was in the alternative system.
This higher percentage change in cash farm expense translated into a
higher percentage change in profit, because profit is equal to gross
income minus cash farm expense and depreciation. The effect of
changing the debt to asset ratio on profit is shown in Figure 6-3.

Sensitivity analyses were also conducted to observe the effect
on profitability of the FSS1 alternative system to changing alfalfa hay
prices. A $5 decrease and $5 and $10 increases in hay price were
examined (the baseline alfalfa hay price was $30 per ton). With a $5
decrease in the price of alfalfa hay, the profit of the alternative
system declined by 10%. With a $5 increase, the profit of the
alternative system increased from $21,473 (the baseline level) to
$23,633, a level slightly higher than the profit in the conventional
system. With a $10 increase in the price of alfalfa hay, the profit of
the alternative system increased by 20% (to $25,793), a level higher
than the profit in the ridge till system. These results are shown in
Figure 6-4.

A sensitivity analysis was also conducted to observe the
potential effect on each farming system of FSS1 of elimination of the
Federal system of price supports and subsidies. In this analysis,
prices received for the crops were assumed to be the "selling prices"
specified in the enterprise budgets. In the case of the government
Figure 6-3. FSS1—Crop Systems Only Analysis:

Effect of varying debt levels.

![Bar chart showing profit (thousands) for baseline, 0.10 D/A, and 0.50 D/A debt levels for conventional, alternative, and ridge till systems.]

- Conventional
- Alternative
- Ridge till
Figure 6-4. FSS1—Crop Systems Only Analysis:
Effect of changing hay prices.

<table>
<thead>
<tr>
<th>Profit (Thousands)</th>
<th>baseline ($30)</th>
<th>$5 decrease</th>
<th>$5 increase</th>
<th>$10 increase</th>
</tr>
</thead>
<tbody>
<tr>
<td>Conventional</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Alternative</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ridge till</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
farm program crops, these were the loan rates. With alfalfa and soybeans, the prices used were the assumed market prices.

These are different price assumptions than those used for the similar sensitivity analysis conducted with the enterprise budgets and discussed in Chapter 5. This analysis reflects a probable initial situation before any price adjustments take place. This current market prices approach is similar to that used by Goldstein and Young (1987), cited in the Review of Literature section of this thesis. The prices utilized in this sensitivity analysis appear in Table 4-2 in Chapter 4.

In this analysis, the conventional system profit decreased by the largest percentage (52%), while the ridge till system declined by the next largest percentage (50%); the alternative system profit declined by the smallest percentage (40%). These percentages changes resulted in the alternative system having the highest profit level ($13,317), followed by the ridge till system ($12,197). The conventional system had the lowest profit level ($11,191) with elimination of the Federal farm program assumptions. The results of this analysis are shown in Figure 6-5.

Results: Addition of Livestock Enterprises

Livestock enterprises were included in the analysis to determine what effect they have on the financial viability of the farming systems. The emphasis of the discussion of livestock enterprises will be on relative changes in profitability of the farming systems due to the addition of each livestock system, and not on the
Figure 6-5. FSS1—Crop Systems Only Analysis:

Effect of elimination of farm program

Profit (Thousands)

baseline

Conventional

Policy assumption

Alternative

no program

Ridge till
resulting absolute profit levels. The discussion will center around the results obtained for FSS1. Baseline results for the addition of each livestock enterprise are contained in Tables 6-2 and 6-3, located at the end of this chapter.

The forage requirement and manure production of each livestock enterprise were also examined. Results of this analysis will be presented in the "Resource Balancing" section of this chapter.

**Beef Cow/calf Enterprise**

The addition of a 50-head beef cow/calf enterprise resulted in the alternative system's profit increasing by a larger amount than did the profit of the conventional and ridge till systems. The profit increase for the alternative system was $4,314, while the conventional and ridge till systems profit increased by $3,743 and $3,749, respectively. There is not a large absolute difference in the increases; however, the profit increase was 15% greater for the alternative system than for the conventional and ridge till systems.

Differences in increases in profit were due to the alternative system producing the required forage, while the conventional and ridge till systems were forced to purchase hay to meet the forage requirements of the livestock. The purchase price of hay was assumed to be $5 per ton greater than the sale price to reflect a transportation charge.

A sensitivity analysis was also conducted with changing alfalfa hay prices when the cow/calf enterprise was included. A $5 decrease and $5 and $10 increases in prices were examined here, as earlier in
this chapter. The $5 decrease in price resulted in the alternative system profit declining by 6%, and the profit of the conventional and ridge till systems increasing by 2%. The $5 increase (to $35 per ton) in price resulted in the alternative system return increasing by $1,585. At this hay price level, the alternative system profit was greater than the conventional system profit. With a $10 increase in the price of hay (to $40 per ton), the alternative system profit increased by $3,770. At this hay price level, the alternative system profit was greater than both the ridge till and the conventional system profits. Increases in hay prices had the effect of increasing the profit level of the alternative system and decreasing the profit levels of the conventional and ridge till systems because these latter systems were purchasers of hay. The results of this sensitivity analysis are shown in Figure 6-6.

**Wintering Steers Enterprise**

The addition of a 150-head wintering steers enterprise had a greater effect on profits of the alternative system than it did on profits of the conventional and ridge till systems. The increase in relative profitability of the alternative system was not as great with this system as it was with the addition of the cow/calf system, however. This difference was caused by there being less hay required for the wintering steers enterprise; thus, the conventional and ridge till systems were not required to purchase as much hay to meet forage requirements. The alternative system profit increased by $6,043, while
Figure 6-6. FSS1—Beef cow/calf Analysis:

Effect of changing hay prices.

<table>
<thead>
<tr>
<th>Profit (Thousands)</th>
<th>baseline ($30)</th>
<th>$5 decrease</th>
<th>$5 increase</th>
<th>$10 increase</th>
</tr>
</thead>
<tbody>
<tr>
<td>Change from baseline</td>
<td>Conventional</td>
<td>Alternative</td>
<td>Ridge till</td>
<td></td>
</tr>
</tbody>
</table>
the conventional and ridge till systems profit increased by $5,660. The profit increase was 6.7% greater for the alternative system than for the conventional and ridge till systems.

A sensitivity analysis was also conducted by varying the price of alfalfa hay. With a $5 decrease in the price of hay (to $25 per ton), the profit of the alternative system decreased by 6.4%. A $5 increase in the price of hay caused alternative system profit to increase by 6.5% and to also surpass profit for the conventional system. With a $10 increase in price, the alternative system profit increased by 13% and became greater than the profit for the ridge till system. Profit levels with varying hay price assumptions are shown in Figure 6-7.

Dairy Cow Enterprise

The addition of the 50-head dairy cow operation to the analysis increased labor hour requirements by a large amount (3,250 hours). In order to bring operator labor required in line with requirements of the other systems, a labor charge for 2,500 hours of hired labor was included in this analysis.

Profit for the alternative system increased relatively more than it did for the conventional and ridge till systems when a dairy enterprise was added. Profit increased by $21,347 in the alternative system, while the profit increase for the conventional and ridge till systems was $20,352. The absolute increase in profit of the alternative system compared to the conventional and ridge till systems was greatest with this livestock enterprise. However, because of the
Figure 6-7. FSS1—Wintering Steers Analysis:
Effect of changing hay prices.
larger values involved, the increase in profit for the alternative system was only 4.9% greater than for the conventional and ridge till systems. This is the smallest percentage advantage in profit increase for the alternative system of the three livestock enterprises examined.

A sensitivity analysis was also conducted by varying the price of hay. With a $5 decrease in the price of hay, the profit of the alternative system declined by 3%. However, with a $5 increase in the price of hay, the profit of alternative system increased by 3% and exceeded the profit of the conventional system by $1226 and the ridge till system by $21. The results of this sensitivity analysis are shown in Figure 6-8.

**Resource Balancing**

The addition of livestock enterprises to farming systems allows for on-farm utilization of forages produced and results in the production of an often overlooked resource, manure. Analyses were conducted to determine the ability of each livestock enterprise to meet the requirement for manure as fertilizer in the FSSL alternative system and to utilize the hay produced by this system.

The amount of economically recoverable manure produced for each livestock species was obtained from the publication "Estimating U.S. Livestock and Poultry Manure and Nutrient Production" (Van Dyne and Gilbertson, 1978). Coefficients which were obtained from this publication appear in Appendix A. The baseline situation for each livestock enterprise was examined, along with increased numbers of
Figure 6-8. FSS1—Dairy Cow Analysis:
Effect of changing hay prices.

<table>
<thead>
<tr>
<th>Profit (Thousands)</th>
<th>baseline ($30)</th>
<th>$5 decrease</th>
<th>$5 increase</th>
<th>$10 increase</th>
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<tbody>
<tr>
<td>Change from baseline</td>
<td>Conventional</td>
<td>Alternative</td>
<td>Ridge till</td>
<td></td>
</tr>
</tbody>
</table>
livestock.

Results of this analysis showed that none of the livestock enterprises, with the initial assumptions, met the manure requirement of 240 tons dry matter per year for the FSS1 alternative system. An analysis was then conducted to see the effect of increasing livestock numbers. The dairy operation met the manure requirement when the number of cows was increased to 125 head (from 50 head). The wintering steers enterprise met the manure requirement when the number of steers was increased to 400 head (from 150 head). The majority (90%) of manure production by the cow/calf system was assumed to be economically unrecoverable. Therefore, the cow/calf operation did not approach the requirement for manure production when realistic assumptions were made. Results of the manure requirement analysis are shown in Table 6-1.

Table 6-1 also contains results of the analysis comparing alfalfa hay production per year in the FSS1 alternative system and the amount of hay required per year for each livestock enterprise. The amount of forage required by each livestock enterprise is expressed as an "alfalfa hay equivalent" value in the FINPACK livestock budgets. Thus, the actual comparison is between the alfalfa hay produced and the forage requirements of the livestock expressed in alfalfa hay equivalents. This forage requirement does not include the pasture grazing which is required.

When the dairy numbers were increased to 125 head, the level which effectively balanced manure requirements and production, hay
Table 6-1. Forage and Manure Resource Balancing Comparison.

<table>
<thead>
<tr>
<th></th>
<th>Cow/calf</th>
<th>Livestock Enterprise</th>
<th>Dairy cow</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>(head)</td>
<td>W. steers</td>
<td>(head)</td>
</tr>
<tr>
<td></td>
<td>50*</td>
<td>100</td>
<td>200</td>
</tr>
<tr>
<td></td>
<td>150*</td>
<td>300</td>
<td>400</td>
</tr>
<tr>
<td></td>
<td>50*</td>
<td>100</td>
<td>125</td>
</tr>
<tr>
<td>Manure (tons dry matter)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(a) produced</td>
<td>4</td>
<td>8</td>
<td>16</td>
</tr>
<tr>
<td>(b) required</td>
<td>240</td>
<td>240</td>
<td>240</td>
</tr>
<tr>
<td>(c) surplus or deficit</td>
<td>-236</td>
<td>-232</td>
<td>-224</td>
</tr>
<tr>
<td></td>
<td>-148</td>
<td>-57</td>
<td>4</td>
</tr>
<tr>
<td></td>
<td>-142</td>
<td>-44</td>
<td>5</td>
</tr>
<tr>
<td>Hay (tons)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(a) produced</td>
<td>432</td>
<td>432</td>
<td>432</td>
</tr>
<tr>
<td>(b) required</td>
<td>115</td>
<td>230</td>
<td>460</td>
</tr>
<tr>
<td>(c) surplus or deficit</td>
<td>317</td>
<td>202</td>
<td>-28</td>
</tr>
<tr>
<td></td>
<td>356</td>
<td>279</td>
<td>228</td>
</tr>
<tr>
<td></td>
<td>233</td>
<td>34</td>
<td>-66</td>
</tr>
</tbody>
</table>

*Baseline situation
required exceeded hay produced by 66 tons. With 400 head of steers, which effectively balanced manure produced and required, the amount of hay produced exceeded the amount used by 228 tons. An increase to 200 head in the cow/calf operation resulted in the hay requirement exceeding production by 28 tons; keep in mind, however, that even 200 head was not nearly enough to produce the required manure.

A comparison was also made of the amounts of labor required for each enterprise of FSS1 and FSS2. This was conducted because a charge for the operator's labor was only included in the rate of return analyses in the FINLRB model. However, as stated earlier, a charge for 2,500 hours of labor in the dairy operation was included in the analysis of that system, because of the large amount of labor required.

Figure 6-9 contains the FSS1 labor requirement comparison and Figure 6-10 contains the FSS2 labor requirement comparison. These figures show all labor required over the course of a year, including the labor hired for the dairy enterprise. The requirements are for the baseline situations with each farming system and livestock enterprise. The labor requirements for the "crop systems only" situation were covered earlier in this chapter. Addition of livestock enterprises to the analysis did not change the respective rankings of the farming systems, because additional labor required due to the inclusion of the livestock enterprise was assumed to be constant across farming systems for each livestock enterprise.
Figure 6-9. FSS1 Analysis:
Labor hour requirements comparison.

- Crop only
- Cow/calf
- W. Steers
- Dairy

Legend:
- Conventional
- Alternative
- Ridge till
Figure 6-10. FSS2 Analysis:
Labor hour requirement comparison.

- Crop only
- Cow/calf
- W. Steers
- Dairy

Legend:
- Conventional
- Alternative
- Minimum till
Summary of FINLRB Results

The baseline "crop systems only" results showed all systems of FSS1 to be financially viable in a typical year in a long run setting. The ridge till system consistently had the highest ranking in the profitability measures; however, there were not large differences between systems. When comparisons between systems are made, consideration must be given to the fact that the only profitability measure to account for differences in labor requirements was "rate of return on farm investment". These differences in labor requirements between farming systems were shown to be significant. The liquidity and solvency measures also indicated that all systems would be feasible in a long run setting. Of course, these results were influenced by initial assumptions about debt and asset levels.

In FSS2, the profitability measures indicated positive returns for all systems. The alternative system exhibited the highest return, but the differences between systems were small. However, the liquidity and solvency measures indicated that these systems may have difficulty maintaining financially viable operations in a long run situation.

The addition of the livestock enterprises to the FSS1 analyses resulted in the profitability of the alternative system increasing relatively more than the profitability of the conventional and ridge till systems. Differences in increases in profit were due to the alternative system producing all hay required for the baseline livestock enterprises, while the conventional and ridge till systems had to purchase hay to meet livestock requirements.
Table 6-2. Summary of selected FINLRB measures for the systems analyzed in FSSI.

<table>
<thead>
<tr>
<th>Measures</th>
<th>Crops Only</th>
<th>Beef Cow/calf</th>
<th>W. Steers</th>
<th>Dairy Cow</th>
</tr>
</thead>
<tbody>
<tr>
<td>Profit ($)</td>
<td>23402</td>
<td>21473</td>
<td>24607</td>
<td>27145</td>
</tr>
<tr>
<td>Labor &amp; Mgt Earnings ($)</td>
<td>9622</td>
<td>7386</td>
<td>11218</td>
<td>11782</td>
</tr>
<tr>
<td>ROI</td>
<td>8.3%</td>
<td>7.2%</td>
<td>8.9%</td>
<td>8.4%</td>
</tr>
<tr>
<td>Cash Surplus Or Deficit ($)</td>
<td>2610</td>
<td>1181</td>
<td>3514</td>
<td>5796</td>
</tr>
<tr>
<td>Cash Farm Exp. As % of Inc.</td>
<td>60.5%</td>
<td>54.6%</td>
<td>60.7%</td>
<td>61.0%</td>
</tr>
<tr>
<td>Net Worth Change /Year ($)</td>
<td>3380</td>
<td>1969</td>
<td>4262</td>
<td>6613</td>
</tr>
<tr>
<td>Annual Labor Hours Required(hrs)</td>
<td>821</td>
<td>1169</td>
<td>725</td>
<td>1221</td>
</tr>
<tr>
<td>Measures</td>
<td>Crops Only</td>
<td>Beef Cow/calf</td>
<td>W. Steers</td>
<td>Dairy Cow</td>
</tr>
<tr>
<td>-------------------------------</td>
<td>------------</td>
<td>---------------</td>
<td>-----------</td>
<td>-----------</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Profit($)</td>
<td>16294</td>
<td>16737</td>
<td>14331</td>
<td>20270</td>
</tr>
<tr>
<td>Labor &amp; Mgt Earnings($)</td>
<td>2402</td>
<td>3165</td>
<td>857</td>
<td>4795</td>
</tr>
<tr>
<td>R.O.I.</td>
<td>6.1%</td>
<td>6.2%</td>
<td>5.9%</td>
<td>6.4%</td>
</tr>
<tr>
<td>Cash Surplus Or Deficit($)</td>
<td>-2599</td>
<td>-2257</td>
<td>-4113</td>
<td>623</td>
</tr>
<tr>
<td>Cash Farm Exp. As % of Inc.</td>
<td>64.7%</td>
<td>55.2%</td>
<td>68.5%</td>
<td>64.1%</td>
</tr>
<tr>
<td>Net Worth Change /Year($)</td>
<td>-1823</td>
<td>-1499</td>
<td>-3360</td>
<td>1488</td>
</tr>
<tr>
<td>Annual Labor Hours Required(hrs)</td>
<td>979</td>
<td>1048</td>
<td>758</td>
<td>1379</td>
</tr>
<tr>
<td></td>
<td></td>
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<td></td>
<td></td>
</tr>
</tbody>
</table>
Chapter VII

FARMER PERSPECTIVES

Personal interviews were conducted with selected low-input farmers to ascertain, in a qualitative way, factors which may be involved with adoption and success of alternative farming systems. These interviews were limited in number and scope; a total of seven farmers were interviewed. However, these interviews gave insights into factors which are sometimes difficult to capture in research plot and enterprise budget comparisons.

Five of the farmers interviewed were located in the northeast part of South Dakota. These farmers were selected from a mailing list of organic farmers and from names provided by a County Extension Agent. The remaining two farmers were from the Madison, South Dakota area. They had previously cooperated with the SDSU Plant Science Department on research involving low-input farming systems. Questions were designed to determine the following: factors involved in the adoption of and continued use of low-input farming systems; typical livestock enterprises; and typical crops and rotations. The questionnaire used in this survey appears in Appendix B. This chapter will present some of the insights gained from this survey.

General Characteristics

Farmers interviewed were in various stages of adoption of low-input farming systems. Adoption stages ranged from 3 years, in which the farmers were still in a transitional stage, to approximately 35
years, for a farmer who had never adopted chemical-intensive farming methods.

Methods used in the low-input farming operations varied considerably between farm operators. The use of chemical pesticides and inorganic fertilizers ranged from no use by some farmers to use of minimal amounts by others. The low-input farmers interviewed typically utilized more intensive tillage practices than conventional farmers to substitute for use of herbicides in their operations. Thus, there was little use of reduced tillage farming practices by these farmers. Their tillage practices differed from their conventional neighbors only in intensity. Inorganic fertilizers were replaced in the low-input farming systems by purchased organic fertilizers, application of livestock manure, and inclusion of legumes in crop rotations. When inorganic fertilizers were applied, they were typically applied with the crops at planting and were utilized as a "starter" fertilizer.

Factors Involved in the Adoption of and Continued Use of Low-Input Farming Systems

A reason often cited for the adoption of low-input farming systems was the desire to reduce direct costs of production. All farmers interviewed indicated that their direct costs of production with low-input farming systems were lower than with conventional systems. This reported lower direct cost of production is consistent with the results obtained in the enterprise budgets for alternative farming systems of FSS1 and FSS2. The farmers also indicated that their goal was not yield maximization; instead, it was profit
maximization. Their perception was that this goal was being attained through the use of low-input farming systems, because they felt that the reductions in cost of production were greater than any reductions in gross income.

Another major factor involved in the adoption of and continued use of low-input farming systems was concern with health related factors. The most frequently mentioned health concern was the hazards with farmer exposure to chemical pesticides and inorganic fertilizers. Other health concerns centered around family health, water pollution, livestock health, and the environment in general.

Another commonly cited beneficial aspect of low-input farming systems was the improvement in soil tilth. The majority of farmers interviewed felt that soil tilth increased after the adoption of a low-input farming system. The perceived reasons for this improvement were increases in the populations of soil micro-organisms, due to reduced chemical applications to the soil, and an increase in soil organic matter, due to the application of livestock manure and utilization of green manure crops. These farmers felt that this increase in soil tilth translated into lower costs for tillage operations.

Typical Livestock Enterprises

The typical livestock enterprises found among low-input farmers were dairy cows, hogs, beef cows, and feeder steers. These livestock enterprises are similar to those found by Lockeretz, Shearer, and Kohl (1981) in their survey of organic farmers in the western Corn Belt.
However, these livestock enterprises are also commonly found among conventional farmers in this area of South Dakota. Major reasons given for the presence of livestock enterprises were to utilize the forages produced on the farm and to provide manure for use on crops.

One of the major benefits farmers cited for low input farming systems was the improvements which were seen in the health of their livestock. Farmers interviewed indicated that the health of their herds improved considerably after they began reducing the amount of chemicals utilized in their farming systems. This improvement in health reportedly resulted in lower costs for medication and veterinary services and reductions in death losses.

A concern was expressed with weed pressures which developed on some of the areas where livestock manure was applied to fields. A method which is being utilized or considered by some farmers to address this problem is composting the manure before applying it to the fields. Composting consists of collecting manure in piles and allowing it to rot before field application. This procedure is done to allow heat to destroy some of the weed seeds present in the manure. However, the piles must be aerated so that an excessive amount of heat is not generated in the piles. Farmers who utilized compost indicated that it is an excellent source of fertilizer and humus for the soil. A drawback of composting manure is that it requires a large amount of labor for the composting procedures.

Typical Crops and Rotations

A typical rotation of these low-input farmers consisted of
small grains, row crops, and alfalfa or sweet clover. The small grains most often seen in the rotations were spring wheat and oats. Rye was present in two rotations and was utilized because of its weed suppressing characteristics. The most prevalent row crops were corn and soybeans. Corn was present more often than soybeans, which is also typical for conventional farmers in this area of the state. Corn was normally utilized as feed for livestock enterprises. Alfalfa or sweet clover was included in the rotations because of their nitrogen fixation properties. Alfalfa was normally utilized as a forage for livestock, while sweet clover typically served as a green manure crop. Also seen in some rotations were specialty crops—such as pop corn, lentils, and edible beans—which were grown specifically for sale into the organic foods market.

The rotational pattern of these crops was generally better developed by those operators who had been utilizing a low-input system for longer periods of time. Rotations of these farmers were typically three to four years in length. When alfalfa was in the rotation, it was typically grown for three years before being rotated. This practice was followed to spread the cost of seeding the alfalfa over a longer period of time. Those farmers who were still in transitional stages to low-input farming systems did not have well established rotations, because they were still experimenting with different rotations to find the best combinations of crops for their specific operations.
Concluding Remarks

These interviews, although quite limited in number, gave insights into how certain farmers perceived the effectiveness of their low-input farming systems. Farmers indicated that the health of their livestock improved and the tilth of their soil improved. Most felt that there was little reduction in yields with adoption of a low-input farming system.

Many of the current practitioners of low-input farming are strong advocates of the practice. In spite of some potential interviewee bias, much could be learned from a more extensive set of interviews with low-input farmers and from evaluation of such farmers' actual crop and livestock costs and returns.
Chapter VIII

PROSPECTS FOR ALTERNATIVE FARMING SYSTEMS

The overall objective of this thesis was to determine and compare net economic and net cash returns to farmers using conventional and alternative farming systems. Both profitability and cash cost characteristics of the systems were compared. The main emphasis of this thesis research was on analyzing the viability of low-input (organic) farming systems. However, two reduced till farming systems, ridge till and minimum till, were also examined.

The main source of data for this thesis research was the "Farming Systems Study" which is under the direction of the SDSU Plant Science Department at the Northeast Research Farm, Watertown, S.D. This study is comprised of two sets of comparisons: Farming Systems Study 1 (FSS1), which is composed of alternative, conventional, and ridge till rotations; and Farming Systems Study 2 (FSS2), which is composed of alternative, conventional, minimum till, and no till winter wheat rotations.

"Normalized" enterprise budgets were developed for the farming systems based on (a) information obtained from the Farming Systems Study, (b) budgets previously developed for this area, and (c) relationships reported in the literature. These baseline budgets were then used to make initial comparisons of the farming systems. Results of these analyses were presented in Chapter 4. Sensitivity analyses were then conducted by altering selected variables in these baseline
budgets. Results of these analyses were presented in Chapter 5. A computer model, FINLRB, was then used to make whole farm financial comparisons of the systems. Results of these comparisons were presented in Chapter 6. A limited number of low-input farmers were interviewed to determine factors which are involved with the adoption and success of alternative farming systems. Insights gained from these interviews were presented in Chapter 7.

The following section of this chapter contains a summary of the results obtained in these analyses.

**Summary of Budget and Whole Farm Analyses**

The "baseline" enterprise budget analyses were conducted within the framework of a typical farm specified for the northeast area of South Dakota. The typical farm was assumed to have 540 tillable acres. It was also assumed that the typical farm would be participating in the current (1987) Federal farm program; therefore, the results reflect utilization of 1987 farm program provisions.

The "baseline" results showed the alternative system to have distinctly lower direct cash costs of production in both FSS1 and FSS2. These lower direct cash costs were primarily due to the fact that purchased fertilizers and pesticides were not used in the alternative systems.

The lower direct cash costs were not enough to offset the lower gross income received in the FSS1 alternative system; thus, this system exhibited the lowest net returns (for all measures examined) in FSS1. However, the system did exhibit positive "income over all costs
except management" ($5,385 per year for the whole farm). The ridge till system exhibited the highest income over all costs except management in FSS1 ($13,273), followed by the conventional system ($10,372). The alternative system net return approached the net return to these systems when a charge for operator and/or family labor was not included in the analysis.

In FSS2, the lower direct cash costs were of sufficient magnitude for the alternative system to exhibit the highest income over all costs except management ($2,767). The net returns were quite similar for each system in the FSS2 comparison, with the conventional system having an income over all costs except management of $2,234 and the minimum till system having $2,216. The results obtained for the no till winter wheat system were not included in the analyses because of questions surrounding the long term agronomic viability of that system.

Sensitivity analyses were undertaken to observe effects of changes in selected variables on net returns of the farming systems. These sensitivity analyses were divided into three major sections: input price analyses; yield analyses; and farm program analyses.

The effects of changes in the price of fertilizer and herbicide alone and of a simultaneous change in the price of fertilizer and herbicide on income over all costs except management were examined. These price changes had no effect on the returns of the alternative systems because no herbicides or commercial fertilizers are used in these systems.

In FSS1, the greatest effect on net returns of the conventional
and ridge till systems was seen with the simultaneous change of fertilizer and herbicide prices. With a 50% increase in these prices, the alternative system income over all costs except management ($5,385) was greater than the conventional system net return ($4,342) and almost equal to the ridge till system net return ($5,968). When these inputs were examined alone, it required much larger increases in chemical input prices for the alternative system net return to approach those of the conventional and ridge till systems.

Changes in profitability rankings were observed in FSS2 with smaller percentage changes in prices, because income over all costs except management was of a similar magnitude for all systems in the baseline situation. With a 25% decrease in prices for the fertilizers and herbicides, either alone or together, the income over all costs except management for the conventional and minimum till system became more than the net return for the alternative system. However, with relatively small increases in prices of these inputs, the conventional and minimum till systems exhibited negative income over all costs except management.

Yield sensitivity analyses were conducted by setting alternative system yields at particular levels in relationship to conventional system baseline yields. If there were no counterpart crops in the conventional systems, yields were altered from the baseline alternative system yields.

In FSS1, alternative system yields were varied on corn, oats, and soybeans, with the alfalfa yield left unchanged. The range
examined was from 20% below conventional system or baseline yields to 10% above those yields. The results of this analysis showed the alternative system maintaining positive income over all costs except management even with 20% lower yields. With 10% higher yields, the alternative system net return exceeded the net return of the conventional system, but it remained below that of the ridge till system.

Alternative system yields were varied for oats, soybeans, and spring wheat in FSS2. The sweet clover yield was left unchanged because that crop is not harvested. When alternative system yields were 15% lower than conventional system or baseline yields, income over all costs except management for the alternative system became negative. However, with yields 10% higher than conventional or baseline yields, alternative system net return was 115% higher than in the baseline situation.

The final group of sensitivity analyses conducted was with Federal Government farm program assumptions. Changes were made in target price levels, in set aside requirements, and in the very existence of the Federal farm program. Results of these analyses were presented using the "income over all costs except land and management" measure.

In FSS1, the alternative system net return declined the least, in absolute terms, in all of the farm program analyses examined. However, because net return was lowest in the alternative system, in the baseline situation, these absolute decreases resulted in the
alternative system net return decreasing by the largest percentage amount in all cases.

The alternative system net return declined the least--both in absolute amounts and on percentage bases--for the target price and set aside analyses with FSS2. The alternative system net return declined by the largest absolute and percentage amounts when elimination of the farm program was considered; however, the differences among farming systems in reductions in net returns were not large in this particular analysis.

Whole farm financial analyses were also conducted with the use of the FINLRB model. The FINLRB model projects profitability, liquidity, and solvency for three alternative farm plans, on a typical year basis. This model utilized the enterprise budgets and typical farm parameters as inputs, along with initial balance sheets specified for each farming system. These balance sheets accounted for differences in investment required by the respective farming systems. The FINLRB model also facilitated the introduction of livestock enterprises into the analyses.

The measures examined showed all systems in FSS1 to be financially viable for a typical year in a long run setting. The ridge till system had the highest profitability ranking for all measures examined; it was followed by the conventional system. The alternative system had the lowest ranking with the profitability measures; however, there were not large differences between systems with these measures. The liquidity and solvency measures also showed all systems to be
viable in a typical year in a long run setting (given initial balance sheet assumptions).

The alternative system ranked the highest in FSS2 for all profitability measures examined. The conventional and minimum till systems ranked slightly lower. In this analysis, the liquidity and solvency measures indicated that all three systems may have difficulty maintaining long term financial viability, given the balance sheet assumptions which were utilized.

Sensitivity analyses were also conducted with the FINLRB model. Selected variables were altered to determine their effect on relative profitability of the various farming systems in FSS1.

An analysis was conducted by varying alfalfa hay prices. Results of this analysis showed the alternative system exhibiting greater profit than the conventional system when alfalfa hay price was increased by $5 per ton and greater profit than the ridge till system when the price of alfalfa hay was increased by $10 per ton.

A sensitivity analysis was also conducted with the farm program assumptions. The analysis involved complete elimination of the Federal farm program. This analysis was similar to the one conducted with the enterprise budgets; however, different price assumptions were used in this analysis. When elimination of the farm program was analyzed with FINLRB, corn, spring wheat, and oats were assumed "sold" at the current Government loan rate and soybeans and alfalfa were assumed sold at (baseline) market prices. Results of this analysis were consistent with the results found for FSS1 with the enterprise budgets in that the
alternative system profit declined by the smallest absolute amount. However, in this analysis, the smaller decrease in profit resulted in the alternative system exhibiting the highest profit after elimination of the farm program. In contrast, there was no change in ranking of the farming systems of FSS1 in the enterprise budget analysis.

The livestock enterprises which were included in the farming systems analyses were (a) a 50-head beef cow/calf operation, (b) a 150-head wintering steers operation, and (c) a 50-head dairy operation.

The addition of livestock enterprises to the FSS1 analyses resulted in the alternative system profit increasing relatively more than it did in the conventional and ridge till systems. In FSS2, the increases in profit were the same for all systems because none of the "alfalfa hay equivalent" requirements of the livestock were provided by these systems; thus, all systems purchased the same amount of forage. This contrasts with FSS1, where the alternative system met the "alfalfa hay equivalent" requirements of all baseline livestock enterprises.

Personal interviews were conducted with selected low-input farmers to ascertain, in a qualitative way, factors which may be involved with adoption and success of low-input farming systems. The low-input farmer interviews were limited in number and scope; nevertheless, they gave insights into how certain farmers perceived the effectiveness of their low-input farming systems.

Most of the farmers felt that they experienced little reduction in yields with the adoption of a low-input farming system. The farmers also indicated that the tilth of their soil improved and the health of
their livestock improved.

Conclusions

The results of these analyses showed that all farming systems exhibited positive income over all costs except management in the baseline situations. When the results of the FINLRRB model were included, the profitability measures also indicated positive returns for all systems; however, the liquidity and solvency measures gave some indication that the farming systems of FSS2 may have difficulty maintaining financially viable operations in the long run.

The major emphasis of this thesis research was on analyzing the economic viability of low-input farming systems. These systems were shown to have distinctly lower direct cash costs of production compared to conventional and reduced till farming systems. These lower direct cash costs imply reduced financial risk for the alternative systems.

The alternative system was shown to have a somewhat lower net return in the FSS1 analysis; however, this system exhibited a positive net return, even when all costs except operator management were accounted for. When a charge for labor was not included in the analyses, the net returns of the alternative system in FSS1 approached those of the conventional and ridge till systems. This may allow justification of the alternative system by the individual producer if an important goal of the operator is to keep family labor employed in agriculture. However, the system still must generate a sufficient return to provide for family living expenses.
The alternative system had the highest income over all costs except management in the FSS2 analysis; however, the net returns were very similar for all systems in this analysis.

The sensitivity analyses which were conducted indicated that when certain changes were made in selected variables, the FSS1 alternative system net return approached those of the conventional and ridge till systems. When some of the same analyses were conducted with FSS2, the alternative system increased its net return advantage over the conventional and minimum till systems. These sensitivity analyses provided insights into the relative profitability of the farming systems under assumptions other than those used in the baseline situations. One must keep in mind that baseline assumptions were preliminary in nature.

The inclusion of the livestock enterprises in the whole farm analyses benefited the alternative system relatively more than the other farming systems in FSS1. This was due to the alternative system producing alfalfa hay which was required as forage for the livestock. When increased alfalfa hay prices were examined, the relative advantage of the alternative system became greater.

The inclusion of livestock enterprises in the FSS2 analysis benefited all systems by the same absolute amount. This was because none of these systems produced the required forage for the livestock.

The results of these analyses showed the alternative systems to have good prospects of being economically viable in the northeastern part of South Dakota. This conclusion is reinforced by the presence of
a number of low-input farmers in this area of the state. Several who were interviewed expressed satisfaction with results obtained with their low-input farming systems.

**Recommendations For Further Research**

An important aspect involved in the adoption of a low-input system of farming is the transitional effect. This transitional aspect was addressed in the "Research Design" section of this thesis, but no analysis was conducted on this aspect. Research is needed on transition aspects, because possible short term reductions in returns may be severe enough to inhibit adoption of low-input farming systems.

More extensive sensitivity analyses could be conducted with yield assumptions to gather additional insights into these transition effects. Also, additional insights could be garnered through the use of more extensive farmer interviews, to determine more precisely the transition effects experienced by actual practitioners of low-input farming.

Another important area to examine is that of optimal rotations for alternative systems. The research in this thesis was confined to examining results for two particular rotational patterns for alternative systems. The analyses indicated that the alternative systems exhibited positive returns over all costs except management. However, the rotation patterns assumed may not be the optimal (profit maximizing) ones.

Further research could be done in this area with the specification of additional budgets, which would allow the comparison
of different rotation patterns. The analysis could be facilitated by the use of linear programming. Optimal rotations, as well as optimal livestock complements for the alternative farming systems, could thereby be determined. Additional insights into what rotations are being utilized by practicing low-input farmers could also be obtained through a more extensive farmer survey.


### COEFFICIENTS USED TO ESTIMATE MANURE PRODUCTION FOR RESOURCE BALANCING ANALYSIS.

<table>
<thead>
<tr>
<th>Livestock Specie</th>
<th>Production Period</th>
<th>Manure Production (after losses from storage &amp; handling)</th>
<th>Manure Which Is Economically Recoverable</th>
</tr>
</thead>
<tbody>
<tr>
<td>Beef Cows</td>
<td>365 Days</td>
<td>1,971 pounds per animal per production period</td>
<td>164</td>
</tr>
<tr>
<td>Feeder Cattle</td>
<td>180 Days</td>
<td>1,222 pounds per animal per production period</td>
<td>1,222</td>
</tr>
<tr>
<td>Dairy Cattle</td>
<td>365 Days</td>
<td>4,357 pounds per animal per production period</td>
<td>3,922</td>
</tr>
</tbody>
</table>

APPENDIX B

QUESTIONNAIRE USED IN LOW-INPUT FARMER SURVEY.

SOUTH DAKOTA STATE UNIVERSITY
ECONOMICS DEPARTMENT

Interviewer: ________________
Date: ________________

1. Operator ________________ Address __________________________

2. Size of farm:
   Owned ____________________
   Rented ____________________

3. Land Use, 1987 (or most recent typical year: ___)

   Land Use        Acres
   Spring Wheat    ___
   Winter Wheat    ___
   Oats            ___
   Barley          ___
   Corn Grain      ___
   Silage          ___
   Soybeans        ___
   Alfalfa         ___
   Others(specify): ___

   Pasture ___
   Set aside ___
   Idle Acres* ___
   Total ___

*(other than set aside)

4. What are your typical livestock enterprises?
5. Describe method and purpose of your low-input or "organic" farming system(s). How long have you been involved with this system(s)? Specifically address your use of chemical fertilizers, herbicides, and pesticides.

6. What crop rotations do you utilize? What is your rationale for this rotation? Is this rotation pattern affected by the current farm program? If so, how?

7. Do you use reduced tillage practices in your operation? Describe type(s). How long have you used such practices?

8. What factors led you to become involved in this type of alternative farming system? List in order of importance.
9. What are the advantages you have found using this system?

10. (a) What special problems have you encountered with this farming system?

(b) What do you see as the biggest problem in making a transition from conventional farming practices to this system of agriculture?

11. How do you solve problems of weed and insect control and fertility of the soil?
12. How do low-input farming and reduced-till practices interact? Are these practices complementary or conflicting?

13. Are livestock enterprises important to your farming system? If yes, explain how, and have they changed with the conversion to your present system of farming?

14. Have your marketing practices and channels changed with the adoption of the low-input system? Explain.

15. Do you intend to continue with low-input farming systems? If not, why? If yes, are there further changes you plan to make?

16. Any other additional comments?