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AN ECONOMIC EVALUATION OF ALTERNATIVE FINANCIAL STRATEGIES USED BY BEGINNING FARMERS TO ENTER AGRICULTURE.

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An economic evaluation of alternative
financial strategies used by beginning farmers
to enter agriculture

by

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CHAPTER 1. INTRODUCTION

American agriculture is characterized by the individual entrepreneur who operates a farm firm. This leads to a life cycle of the farm that closely parallels the life cycle of the farmer. Three stages in the life cycle of a farm have been identified as (1) the entry or establishment stage, (2) the growth and survival stage, and (3) the exit or disinvestment stage (21). This study is concerned with the first stage of the farm life cycle, the entry stage. In the entry stage the young man compares the opportunities in farming with other occupational alternatives and decides whether or not to begin farming. Once the decision to enter farming has been made, the beginning farmer must acquire the capital resources necessary to establish a viable farming enterprise.

The acquisition of the resources necessary to begin farming is not an easy task. Garlock states:

> Since World War II, growing concern has been voiced about the ability of young men to get started in farming and, if they do get started, about their ability to develop economic-sized units. This concern stems from the rapidly increasing capital requirements for efficient farming. Technological advances and the cost-price squeeze have increased the size of farm and the investment in livestock, machinery, and other production goods needed for efficient operation, and rising land values have driven up the required investment in real estate.
>
> Today the capital needed for typical farms of many kinds ranges from \$50,000 to \$100,000, and for some kinds it is much higher. How is the young farmer to get a foothold in an industry requiring so much capital? And if he does get started, how can be build up an operating unit of efficient size?
>
> It is important to find answers to these questions because our farm population includes a large proportion of older people who will soon be retiring from farming. Although some of their farms will be consolidated with other farms operated by

established farmers, many must be taken over by a younger generation not yet established in farming (33).

As capital requirements for successful farming increase, it becomes more and more difficult for a beginning farmer to acquire adequate capital to get started in farming. A. E. Jaenke, former Governor of the Farm Credit Administration, estimated in 1970, "To capitalize the typical, full-time commercial farm today costs about $250,000 -- a formidable obstacle to say the least" (47). Hottel and Barry provide some examples of the capital requirements for single proprietor operations with gross farm sales of $40,000 to $60,000 (see Table 1.1). These figures represent the capital requirements of an efficient-sized farm for a full-time farmer. Of course, a young farmer does not have to enter farming as a full-time farmer with an efficient-size, one-man unit, but these figures do give some indication of the tremendous amount of capital resources needed for full-time farming.

Table 1.1. Capital requirements for single proprietorship with $40,000 to $60,000 gross farm sales, 1976.[a]

Type of Farm	Land Value	Other Capital	Total Capital
Cash Grain	$293,643	$ 85,036	$378,679
Cotton	299,421	113,086	412,507
Livestock Ranch	458,806	113,750	572,556
Vegetable	174,022	72,290	246,312
Fruit and Nut	195,762	89,666	285,428

[a](46).

Former Secretary of Agriculture Earl Butz described the problem of the beginning farmer in the following manner:

> Getting started in farming now is entirely different from a generation ago. It now takes capital -- and lots of it -- to finance a viable farming operation. The old ladder -- starting as a hired man, moving up to tenant status, and then eventually acquiring ownership -- is no longer valid for many would-be farmers.
>
> The average farm in the United States today has assets of $163,200. Commercial farms with enough income potential to compete for the top-notch young talent probably need in the neighborhood of $150,000 to $300,000 (of assets).
>
> At the same time, farming is a high-risk enterprise, and a young man must be careful not to get in over his head. He has to be able to survive bad weather, the cattle cycle, floods, a swine disease, or perhaps a corn blight.
>
> The biggest limiting factor for the young farmer today is capital -- enough capital to assemble the land required to use his labor efficiently, plus enough machinery and livestock to utilize his productivity and management ability (23).

In the past years many young men have entered farming by means of the "agricultural ladder" (51). By using this method the young man started as a hired hand and through diligent work and wise spending, he accumulated enough savings to purchase a set of machinery. The second rung of the ladder was then for the young farmer to rent a farm. Next, the farmer would become a part-owner of real estate and eventually he would become a full owner of a farm. Even though the agricultural ladder process required some family sacrifices, the resource requirements were small enough that through this process a young man could eventually become a full owner of a farm. But with today's high capital requirements, it appears that the agricultural ladder is no longer a possible method of entry into farming. Boehlje states:

> ...with the substitution of capital for labor, the rapid price increase in durable resources (particularly land) and the expanding capital requirements of the economically viable farm firm, the 'agricultural ladder' is no longer a viable source of new entrants. Not only is it virtually impossible to acquire sufficient capital resources through this historically

> successful procedure, it also does not provide the financial and entrepreneurial training that is so important for a successful entrant in today's agriculture. However, alternative sources of new entrants and methods of entry have not been well identified (17).

The old saying, "The best way to get a farm is either inherit it or marry it," would be funnier if it weren't so true. Even inheritance may no longer be a way to obtain a viable farm. Often the farm, or part of it, must be sold to pay the estate taxes. In a 1968 study on the growth of the farm firm, Patrick and Eisgruber state:

> A starting farmer, of unproven managerial ability, would require equity capital of about $45,000 and a debt committment of around $75,000 to obtain a commercial farm without renting, taking traditional loan limits as given. Continued transfer of such amounts of capital through inheritance appears, in general, unlikely. This study indicates that servicing debts of this magnitude with int rest rates higher than three percent is possible only for above-average managers (66).

How, then, is a young man who wants to farm going to be able to enter agriculture? What are the methods of entry available and how do these methods affect the beginning farmer's financial variables, such as income, cash flow, net worth, and the chance of the new farm surviving? There is a great diversity of beginning farmer situations in terms of beginning equity position, off-farm employment opportunities, institutional constraints, family goals, etc. How does the beginning farmer's particular situation affect his financial variables? Is there adequate credit available for beginning farmers with limited financial resources? Or could agricultural lending institutions do a better job of providing credit to beginning farmers consistent with sound lending practices? What credit arrangements are available to help compensate for the young farmer's lack of financial equity?

It should be noted here that there have been attempts to provide special assistance to beginning farmers. The Farmers Home Administration (FmHA) helps beginning farmers and other farmers with limited resources who are unable to obtain adequate credit from commercial lenders. The FmHA is authorized by law to make loans only to those who are unable to obtain adequate credit from commercial lenders. FmHA borrowers agree to obtain their credit from other lenders when they reach or regain a position where they can do so (63). The FmHA may lend up to 100 percent of the value of a farm as determined by appraisers for farm ownership loans. However, a farm ownership loan may not exceed $200,000 ($300,000 if guaranteed by a conventional lender). A farm operating loan may not exceed $100,000 ($200,000 if guaranteed by a conventional lender.)

Recently, other legislation that was designed to provide assistance to beginning farmers has been debated (87, 88a). These bills were designed to provide young farmers with the necessary assistance to purchase family farm units.

Minnesota's Farm Security Act sets up a procedure for making special loans to help young people start farming. Under this law, $10 million of state funds have been earmarked for lending to young farmers to help them buy land. Another $1 million will come from local banks, since 10 percent of the funds to be lent to young farmers must come from local lending institutions. The act is an attempt to help guarantee a flow of young people into farming, with the loans to be used solely for land acquisition. A similar idea is the Saskatchewan Plan in Canada which allows young farmers to lease government land.

The overall objective of this study is to evaluate the financial strategies available to young farmers for entry into agriculture. In the process, some of the questions stated above will be answered. The results of this study should help young farmers make the decision of which financial strategies to use to enter farming. The specific objectives of this study are:

1. Review the theory of decision-making under uncertainty.

2. Develop a theoretical model of the beginning farmer's entry into agriculture.

3. Develop an empirical model of the beginning farm which can be used to evaluate the financial strategies used to enter farming.

4. Evaluate the financial strategies used for entry into farming in terms of income, cash flow, net worth, and risk position.

Chapter 2 reviews other studies that have considered the problems of the beginning farmer. Chapter 3 develops a theoretical model of the beginning farmer which considers the value of financial variables and the risk position of the beginning farm over the first few years of its existence. Chapter 4 presents the empirical model used in this study to evaluate the financial strategies used to enter farming. It also presents the financial strategies, the production alternative, the risk measurement, and the beginning farmer's situations considered in this study. It then indicates how the model may be altered to consider different financial strategies, production alternatives, risk measurements, and beginning farmer's situations. The results obtained from this numerical model are presented in Chapter 5. Finally, Chapter 6 presents a summary of this study and some conclusions that can be made from the results obtained.

CHAPTER 2. REVIEW OF PREVIOUS STUDIES

The studies that have been completed on the problems of beginning farmers consist mainly of two types. One type of study uses the survey or case study method to gather information on characteristics of beginning farmers (21, 30, 50, 61, 93). The second type of study that has been done is the programming of representative farms of beginning farmers to determine optimal farm plans (22, 39, 40, 41, 56, 60, 66, 82).

Brake and Wirth report on the history of the capital accumulation process on 110 Michigan farms (21). Information for this report was obtained by interviewing the 110 farmers during the summer of 1961. The survey questions concerned when they started farming, the resources they had when they started, how they got the capital to start farming, investments they had made since starting, the value of their assets at the time of the interview, and other related items. The answers to these questions do provide some insight into how these farmers got started in farming. Most farmers were raised on a farm (91 percent), so Brake and Wirth conclude that previous experience with farming is of great importance in deciding to farm. Working on the family farm was an important means of getting capital to start farming and was used by 57 percent of the surveyed farmers. Nonfarm jobs were used by 38 percent of these farmers to obtain funds to start farming. Some families received starting equity from gifts or inheritance, but this number was fairly small. However, in value terms, gifts or inheritances were in some cases, substantial. Credit was used by about 75 percent of the starting farmers to acquire initial resources.[1] Renting extra land was another important means of acquiring control of capital.

Brake and Wirth suggest a point that must be kept in mind when considering the results of their study. Selecting a group of farmers who were farming in 1961 and asking them how they came to their present position is somewhat different than selecting a group of beginning farmers and following their progress through time. Their study has nothing to say about drop-outs or factors affecting drop-outs from farming. Also, the farmers who were interviewed in 1961 had not all started farming at the same time. Some of them started prior to 1930 while others had started as recently as the 1950's. However, the results are useful in illustrating the process of capital acquisition and in indicating problems and relationships of a general nature.

A study of operator entry in Iowa farming during 1959 and 1960 provides descriptive information about the people who entered farming, the conditions under which they achieved entry, and the financial results experienced during the initial year of operation (50). Kaldor and Jetton obtained data for this study by personal interview of a sample of farm operators who entered farming in 1959 and 1960. A sample of 191 entrants was obtained from a statewide sample survey of nearly 7,000 farm operators. Beginning operator entrants in Iowa were typically young men (median age of 25 years) who were married and had lived on a

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[1]The importance of credit to capital acquisition and capital accumulation was evident in this study, as 97 percent of the farmers used credit of some sort at some time in their farm business.

farm the greater part of their lives. The "agricultural ladder" was not a means of entering farming in Iowa in 1959 and 1960. In the year preceding entry, about half of the beginning entrants were engaged primarily in nonfarm employment. A large proportion of the beginning entrants reported that they gave no thought to a career other than farming. Although most of the entrants had very limited financial resources of their own, a comparatively small proportion entered farming under a partnership arrangement. About 82 percent entered farming as single proprietors, while only 18 percent entered under a partnership arrangement. Nearly all the partnerships were father-son or other family arrangements. Most beginning entrants rented the land they operated the first year of farming. Beginning entrants farmed significantly smaller acreages than did the population of Iowa farmers. The amount of nonfarm work performed by beginning entrants during the initial year of farming was substantial. Nearly 25 percent of the total time devoted to income-generating activities by the beginning farmers was spent at nonfarm jobs. Beginning entrants frequently received family assistance in getting started in farming. About 68 percent of the group reported receiving family help during the initial year of farming. Net worth of most beginning entrants increased during the first year. For the group as a whole, the mean addition to net worth was about $2,700, from about $9,000 to about $11,700. Nearly 15 percent ended the first year with less net worth than they had at the beginning, while about 10 percent experienced increases of $6,000 or more. During the initial year of farming, beginning entrants had a mean net family income of $6,180.

Beginning entrant families allocated about 40 percent of their income to savings and about 60 percent to current consumption. This average propensity to save is somewhat higher than farm families generally. But beginning families frequently had a heavy debt load and were short of operating capital, so they were under considerable pressure to forego current consumption and build net worth. Although most beginning farm families made substantial savings during the first year of farming, this was often achieved by severely limiting current consumption and making a heavy sacrifice in terms of the current level of living (50).

In 1970, Epperson and Bell studied the problems of getting established in farming with special reference to credit in Alabama (30). Their study was directed toward: (1) ascertaining how beginning farmers are financing their farms, (2) determining lending institution policies concerning the beginning farmer, and (3) developing alternatives that would be helpful to the low-equity prospective farmer. They used the case study method to examine in detail eight successful farming operations with respect to the farm operator getting established in farming. They also used a mail survey to ascertain the lending policies of various lending institutions in Alabama. It was found that a combination of many factors was required for a beginning farmer to become successfully established. Among the most important were: (1) a genuine desire to farm along with an ambitious nature, and a cooperative and understanding wife, (2) farm career training, and (3) a rural background of both husband and wife, with the operator being raised in the area where he is beginning farming. Each of the eight farmers were assisted either directly or indirectly in getting started. Most of the financial assistance came just prior to, at inception, and during the early stages of the farm career. This financial assistance included family help, inheritance, or assistance from a friendly lender. The eight cases of successful farmers described in this study show that the obstacles to farm entry can be overcome. Most lenders reported that collateral was the criterion used most often for making a loan to a beginning farmer. Epperson and Bell suggest a need exists for the development of other criteria for making such loans that would lighten the burden of collateral while maintaining the same degree of security for the lending institution. Most of the operators studied had some risk involved in the leasing of land. A farm operator would be unwise to invest in production assets if he had a lack of security of tenure of the land on which he produces crops and livestock. Yet, in this study most operators who leased land had only one year agreements, several operators had no renewal privileges, and only two had provisions for safeguarding their capital improvements. Epperson and Bell suggest a need exists for reform in leasing agreements to provide security of tenure for successful establishment in farming by tenants. Of the operators studied, several felt a need to expand certain enterprises during the first and second years of farming, but they did not. The main reason given for not expanding was the risk involved. Only one farmer was denied credit that prevented him from expanding. The use of borrowed funds was not restricted by lenders, but the operators exercised internal capital rationing in order to reduce financial risk.

Epperson and Bell noted that the case study analysis only included those who appeared to be successfully established in farming. They suggest that if it had been possible to observe more cases of attempted farm entry, problems of acquiring financial assistance through credit probably would have been more apparent.

Mayer and Goldstein reported on factors which distinguish small businesses surviving the first two years of their existence from those which failed during this founding period (61). Even though they studied small businesses rather than farms, the factors they found for success are the same factors needed for successful entry into farming. Their report is based on the detailed observation of 81 small retail and service firms over a two year period. The operations of each enterprise were followed from the time of starting the venture through the end of its second year. Some of the firms did not last two years, while others came through the two year period with staisfactory records and good profit potential. Repeated contact with the firms made it clear that success or failure could not be attributed to single causes, but was generally the result of a combination of various factors. Mayer and Goldstein observed that undercapitalization, managerial incompetence, and personality defects appeared to doom an enterprise and cannot usually be compensated for by other assets. Adequate capital and managerial competence are essential for survival, but they must be supplemented by other factors, such as motivation, hard work, persistence, and flexibility. Mayer and Goldstein concluded that if there is any formula for business success, the ingredients consist largely of the ability to evaluate objectively, to plan carefully, and to be prepared emotionally to persist long enough to overcome temporary setbacks until the business reaches its full potential.

These survey type studies provide some insight into the factors which lead to the success or failure of a beginning farmer. But they do not provide beginning farmers with any information about how alternative financial strategies, farm plans, or beginning situations affect the beginning farmer's income, net worth, cash flow, or risk position over the first years of the farming operation. The next group of studies that are reviewed were attempts to provide some of this type of information to beginning farmers.

The Iowa State Agricultural Experiment Station published a series of Extension publications in the late 1950's that were designed to help young men choose between farming and nonfarm employment, and to provide optimum farm plans for the beginning farmer (39, 40, 41, 56).

In 1956, Heady, Loftsgard, Paulsen and Duncan developed optimum farm plans for beginning farmers on Tama-Muscatine soils (40). They assumed the beginning farmer had a 160 acre farm to rent and had all the machinery necessary to operate it. A linear programming model was used to maximize the returns to the farmer's labor and capital over a one year period. The model was allowed to choose from different crop rotations and different livestock enterprises to maximize returns under capital levels of $3,000, $5,000, $7,000, $10,000 and unlimited. Optimal solutions were determined under different fertility conditions, different crop rotations, different price levels, different lease considerations, and alternative labor constraints. The optimum farm plan varied greatly among the alternative resource situations.

Heady and Loftsgard determined optimal farm plans for a beginning farmer on a rented 160 acre farm on Cresco-Clyde soils in northeastern Iowa in 1957 (39). Optimal farm plans and associated profits for a one year period were determined by a linear programming model. They showed profit maximizing farm plans for various amounts of available capital and other resources, and then compared the returns from these farm plans with potential income from nonfarm employment in the same general area. Their study indicated that urban income was higher than income from nearly all farm situations considered. The only exceptions resulted when the farm situation included (1) livestock under "superior" management, (2) an unlimited supply of funds, and (3) a farm size greater than 240 acres with a livestock-share lease, or 160 acres or greater with a crop-share lease. All three conditions needed to exist for farm income to have been greater than nonfarm income.

Also in 1957, Mackie, Heady and Howell determined alternative farm plans and income opportunities for beginning farmers in central Iowa with varying resources and managerial ability (56). They assumed the beginning farmer had a 160 acre farm to rent and had all the machinery necessary to operate it. A linear programming model was used to determine the optimal combination of crops and livestock for different management and capital levels to maximize profits. The capital levels considered were \$3,000, \$7,500, \$10,000, \$15,000 and unlimited. Optimal farm plans were computed for the tenant with consideration for all limiting resources including land, labor, feed, buildings, capital, and management ability. They considered six levels of livestock management, three crop rotations, four levels of fertilization, and eight livestock enterprises.

The final study in this series on beginning farmers in Iowa was completed in 1958 by Heady, Mackie and Stoneberg (41). This study analyzed plans for a rented 160 acre farm on Marshall silt loam. A linear programming model was used to maximize returns over a one year period. Optimal farm plans were computed for different capital levels and two levels of managerial ability under both crop-share and livestock-share leases. Incomes possible for plans under the various resource, management, and leasing situations were compared with incomes from nonfarm employment opportunities. The "average" manager of 160 acres had less income than the wage income provided by full-time employment in manufacturing industries. By operating 267 acres under a livestock-share lease or 214 acres under a crop-share lease (with capital requirements of $24,700 and $28,125, respectively) the "average" farmer could have had income equal to the nonfarm wage income. The "above average" farmer had greater real income from farming than from the off-farm employment alternatives. Each of these four studies did not include any investment or financing activities, there was no consideration of the risk associated with each farm plan, there was no consideration of cash flow, and there was no consideration of time.

Martin and Plaxico analyzed the growth and capital accumulation of farms in Oklahoma and Texas (60). Linear programming techniques in a polyperiod framework were used to depict the growth of the farm. The effect of different farm operator objectives on the growth process was investigated. The effects on capital accumulation of variables such as tenure situations, starting farm size, capital rationing, and consumption levels were analyzed. Finally, minimum starting farm equity levels required to obtain various growth conditions over time were determined. These minimum starting farm equity requirements were computed by assuming that the starting farm resource situation consisted of a farm operator supplying 1900 hours of annual labor and nothing else. All other farm resources had to be purchased to generate capital to satisfy a family consumption function and accumulate additional capital if specified. Starting equity was minimized subject to specified constraints, but the farm was allowed to grow above the level required to fulfill the constraints. Minimum starting equity requirements were determined for different tenure situations, consumption levels, and growth objectives, and under conditions of constant and increasing land values. Martin and Plaxico's study introduced time into the analysis of the beginning farmer and they included investment alternatives over time. However, they did not consider the risk associated with each farm plan.

Another study which determined minimum resource requirements for specified returns was done by Brooks and Constable (22). They used a linear programming model to determine the minimum farm size required for an operator return of $5,500 per year and a return to capital investment of 7 percent per year. The farm types studied were dairy, beef cow-calf, beef feedlot, swine, cash grain crops, and laying hens. On the basis of the linear programming models, if a full-time farm business were to yield the minimum acceptable returns (with 1966 costs and prices), the business would have to sell at least $25,000 worth of product and have a capital investment of at least $78,000. Cash grain and dairy farms, which utilize a large land base, would require capital investments of $126,000 and $136,000, respectively, to meet the specified resource return objectives. Brooks and Constable developed optimal farm plans to satisfy the return objectives, but there is no consideration of the risk associated with these plans.

Thomas and Jensen developed guidelines for helping prospective farmers, in one area of Minnesota, appraise career opportunities in farming and to choose from alternative plans that they might want to follow in developing a successful farming career (82). Farm business growth patterns and financial results were developed over a ten year period for each of three levels of management -- excellent, good, and average. It was assumed that the beginning farmer started with $2,000 cash, a 240 acre farm rented on a crop-share lease, access to the use of his father's equipment, and $1,000 per year in off-farm earnings. Required consumption withdrawals varied among managerial levels and the year of the ten year period. Budgeting and linear programming were used to analyze the alternative situations. Yearly cash flow and net worth statements were calculated for the ten year period. Thomas and Jensen made no attempt to reflect the impact of year-to-year fluctuations in prices and yields in financial results.

Most of the research reviewed in this chapter were attempts to provide information about the problems of beginning farmers. Some of the research used the case study or survey method to analyze the factors that led to the success or failure of the beginning farmer. But two of these studies questioned established farmers about how they started in farming, and provided no information about the factors which lead to the failure of a beginning farmer (21, 30). One study questioned a sample of beginning farmers during their first year of operation about how they acquired the capital to start farming, but no follow-up study was done with this group to analyze the factors which lead to success or failure in farming (50). One study that did follow a group of starting entrepreneurs through the first two years of operation was reviewed (61). This study followed 81 small retail firms, and reported on factors which lead to success and those which lead to failure. Even though this study analyzed small retail firms, it is felt that the factors given for success or failure are some of the same factors which lead to the success or failure of the beginning farmer.

The other group of studies that were reviewed used programming techniques to analyze some of the problems of the beginning farmer. Some used a one period linear programming model of a beginning farmer to generate profit maximizing farm plans under various resource situations (39, 40, 41, 56). These studies did not consider some of the important aspects of the problems of the beginning farmer, such as the investment and financing alternatives available, the impact of time in the analysis, the cash flow during the year, and the risk associated with each farm plan. One study that was reviewed used a linear programming model to determine the minimum resource requirements necessary to meet certain return objectives (22). But again this study did not consider time, investment or financing alternatives, cash flow, or the risk associated with each farm plan. Another study used a multiperiod linear program which included investment activities to determine the minimum starting equity necessary to obtain certain growth conditions (60). However, this study did not consider the risk associated with each farm plan. The final study that was reviewed used budgeting and linear programming to determine optimal farm plans for the beginning farmer under various situations (82). This study considered investment alternatives and calculated yearly cash flows and net worth statements for a ten year period, but it too, did not consider the risk associated with each farm plan.

CHAPTER 3. MATHEMATICAL MODEL

Conceptualization of the Entry Process

The purpose of this chapter is to present a mathematical model of the entry process for the beginning farmer which can be used to evaluate the alternative financial strategies used to acquire the resources necessary to start farming. The first step in building the mathematical model is to conceptualize the entry process of the beginning farmer. A conceptualization of the entry process is needed in order to visualize the relationships between the decisions made by the beginning farmer and the results of these decisions in terms of the values of financial variables. Also, the effects of exogenous variables, such as institutional limits, government regulations, and prices, on certain decisions and financial variables can be readily seen. Finally, the conceptualization of the entry process helps define the interrelationships of the financial variables, which assists in defining the equations needed in the mathematical model of the beginning farmer.

Once a young man has decided to enter farming he has two decisions to make: (1) what production enterprise(s) to be engaged in, and (2) how to obtain the resources necessary to engage in the chosen enterprise(s). These two decisions are obviously interrelated. Figure 3.1 shows a flow chart of the entry process into agriculture, and how the production, marketing, investment, and financing decisions affect the financial situation of the beginning farmer.

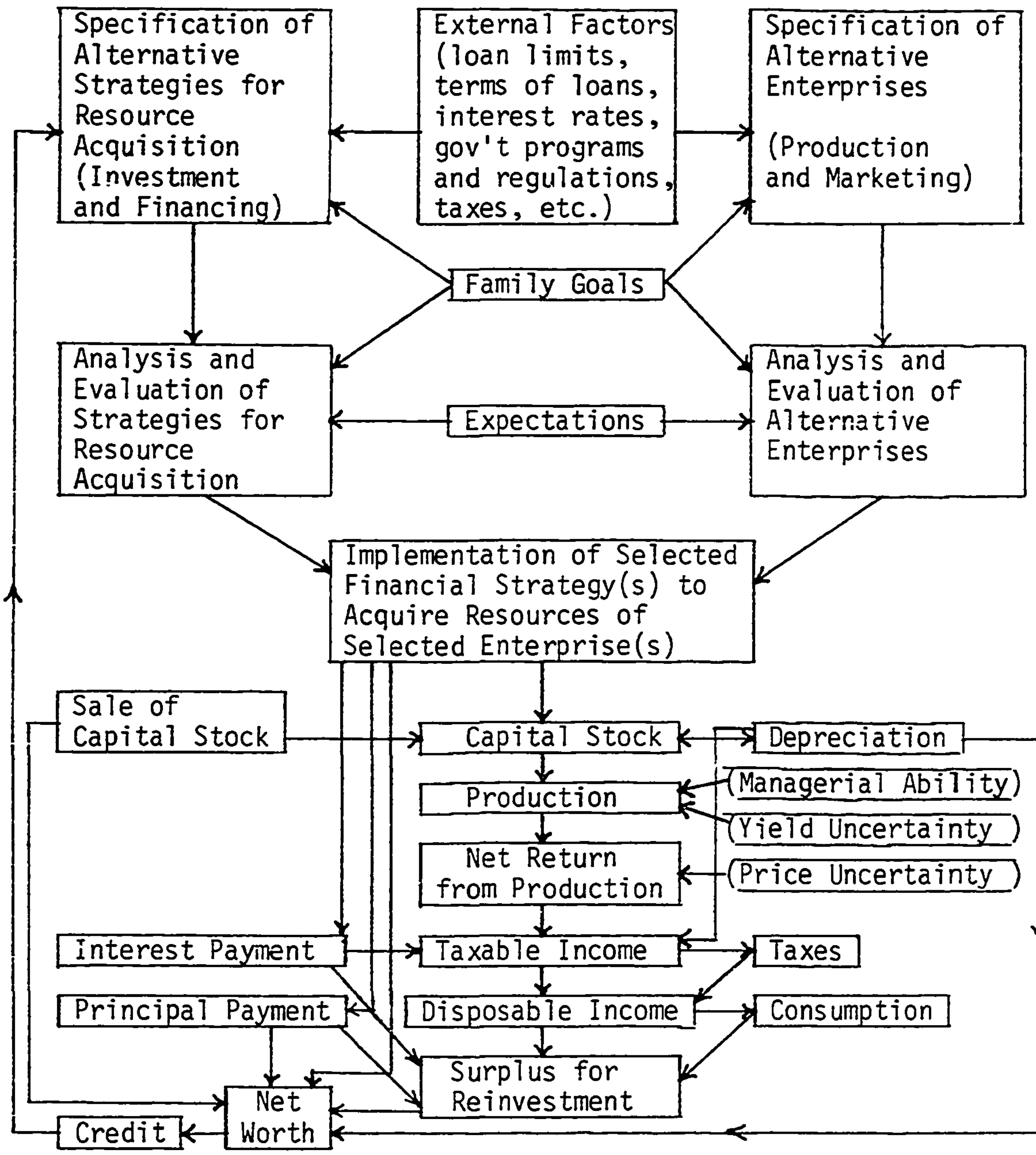

Figure 3.1. Flow chart of the entry process into agriculture.

The first steps in the decision process are to identify the resource acquiring strategies available to the beginning farmer and to identify the agricultural production enterprises he is willing to undertake. Both of these decisions are influenced by various external factors which are beyond the control of the beginning farmer, such as institutional loan limits, government regulations, etc. These decisions are also influenced by the farm family's goals. For example, if one goal is to avoid debt, then the list of resource acquiring strategies may not include borrowing. If a family goal is not to be involved in hog production, then the list of production enterprises will not include any hog production activities.

After the resource acquiring strategies available to the beginning farmer and the enterprises he is willing to undertake are identified, the next step in the decision process is to analyze and evaluate the alternative resource acquiring strategies and the alternative production enterprises. The farmer may analyze the alternative strategies and enterprises using partial budgets or whole farm budgets, and then make his decision. This study will develop a multiperiod linear programming model to analyze and evaluate the alternative resource acquiring strategies and the alternative production enterprises.

Based on the results of the analysis and evaluation of the alternative strategies and enterprises, the beginning farmer must decide which production enterprise(s) to undertake and which financial strategies to use to acquire the resources necessary for the enterprise(s). The implementation of the selected financial strategy to acquire the resources necessary for the selected enterprise(s) will affect the beginning farmer's capital stock, net worth, and the principal and interest payments he must make. The capital stock available to the farmer than constrains his production capacity and, along with his managerial ability and uncertain events which affect production, determines his production.

The beginning farmer's production and the prices of the products he produces then determine his net return from production. Prices for agricultural products are uncertain and this uncertainty makes the beginning farmer's net return from production uncertain. Net return from production plus returns from the sale of capital assets during the year, minus depreciation of capital stock which occurred during the year, minus the amount of interest payments made during the year, gives taxable income for the year. Taxable income determines the amount of taxes which must be paid through a progressive income tax function. Taxable income minus taxes gives disposable income. Disposable income determines the family's consumption level through a consumption function. Disposable income minus the amount used for consumption minus the amount of interest payments minus the amount of principal payments gives the cash surplus for reinvestment available at the end of the year.

Net worth at the end of the year is determined by which financial strategy was implemented, how much capital stock was sold during the year, how much depreciation was claimed during the year, how much debt was paid off during the year, and how much cash is available at the end of the year as surplus for reinvestment. This net worth position then affects the amount of credit available to the beginning farmer the next year. The amount of credit available may then alter the list of financial strategies available to acquire resources, which requires a new analysis and evaluation of resource acquiring strategies. This may lead to the implementation of new financial strategies at the start of the second year, and the cycle continues.

From the flow chart of the entry process, it can be seen that uncertainty in yields and prices affects the value of the beginning farmer's financial variables. The net return from production is an uncertain amount and this uncertainty is a source of risk for the beginning farmer. If the net returns from production are not sufficient to pay the fixed financial obligations of principal and interest payments, the beginning farmer's surplus for reinvestment (cash) will be negative. This means that he must borrow just to maintain his family's minimum consumption and to meet his fixed financial obligations. Two or three years of this will cause the beginning farmer to fail. The risk associated with agricultural production is very important to the beginning farmer's situation and must be taken into account in any model that attempts to evaluate the financial stategies used by beginning farmers to enter agriculture.

Consideration of Risk

Overview

The beginning farmer must choose which production enterprises to undertake, and which financial strategies to use to acquire the resources necessary for the production enterprises, under conditions of uncertainty.[1] This uncertainty in agricultural production arises from market forces, weather, disease, insect damage, and other factors which cannot be predicted or controlled. The yields and prices of agricultural products depend on these unpredictable factors. The uncertain yields affect the beginning farmer's production, and this uncertain production and uncertain prices determine the beginning farmer's net return from production, as shown in Figure 3.1. Thus, yield uncertainty and price uncertainty play a major role in determining the beginning farmer's income and his ability to pay his fixed financial obligations.

Many agricultural economic models used to study farm management problems are specified under assumed certainty. This does not mean that the future is known with certainy, but that farm management problems are analyzed assuming perfect knowledge of future yields and prices. For example, conventional linear programming used for many farm planning models can not accomodate uncertainty. Of course, assumed yields and prices can be changed in these models to see how

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[1]Traditionally, "'risk' and 'uncertainty' are distinguished based on the knowledge of the probability distributions of the outcomes; the practical difference between the two categories, risk and uncertainty, is that in the former the distribution of the outcome in a group of instances is known, while in the case of uncertainty this is not true. . . . With the increased acceptance of subjective knowledge, the distinction between risk and uncertainty is weaker, and the terms are often used interchangeably" (92). In this study risk and uncertainty refer to the situation that exists when outcomes of farm plans are not known with certainty.

the farm organization is affected by changes in these variables. But there is no measurement of the risk associated with each farm organization. As a result, the conventional linear programming solutions of farm organizations have often been rejected because the solutions may specify actions that lead to a higher degree of risk than many farm managers are willing to accept (20, 32, 75).

The alternative production enterprises and financial strategies available to the beginning farmer are difficult to evaluate using the certainty farm models commonly employed. The beginning farmer is usually in a higher risk position than established farmers because the new entrant has low equity and fixed financial obligations that must be paid. Higher capital requirements to enter farming and increasing market risks have increased the beginning farmer's risk of being unable to pay his fixed financial obligations. If the new farmer cannot pay his financial obligations, his new farm firm will not be able to survive. Therefore, the concept of risk is very important to the beginning farmer and must be incorporated in any model that proposes to evaluate the financial strategies used to enter farming.

Many methods have been developed to include risk and uncertainty in agricultural economic models. The vast volume of literature in this area will not be reviewed in this study. An excellent review of the literature on risk and uncertainty, with emphasis on applied and illustrative empirical studies in agricultural economics, is provided by Walker and Nelson (92). The theory of rational decision-making under uncertainty and programming models which have been developed from this theory are presented in the next parts of this section. This discussion will be expanded in the last section of this chapter to develop a mathematical model of the beginning farmer which allows the consideration of risk.

Decision-Making Under Uncertainty

The objective of the rational individual is to maximize utility. Utility is derived from present and prospective future consumption. Consumption, in turn, is a function of income. Utility can then be expressed as a function of income as:

$$U = f(X)$$

where X is the income earned from an investment prospect.

If this utility function is linear, it is given by:

$$U = a + bX \ .$$

The first derivative with respect to X gives the marginal utility of income and is:

$$\frac{dU}{dX} = b \ .$$

Marginal utility of income must always be positive, because the rational decision-maker always prefers more income to less, so $b > 0$. Figure 3.2 shows the general shape of the linear utility function.

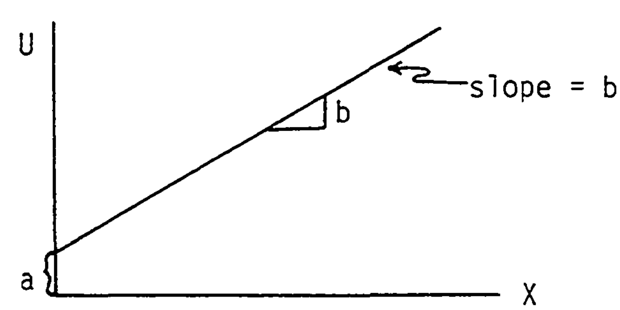


Figure 3.2. Linear utility function, $U = a + bX$.

The marginal utility of income is constant for the linear utility function and is given by the value of b.

If X is a risky prospect, the linear utility function can be written as:

$$U = a + b \cdot E(X) \; .$$

Since $E(X) = \mu_X$, the linear utility function may be rewritten in terms of the mean of X as :

$$U = a + b\mu_X$$

where μ_X = the mean of X.

$dU/d\mu_X$ must be positive ($b > 0$), which means that utility increases as μ_X increases. Conventional linear programming makes the assumption that maximizing income will maximize utility. It assumes that the decision-maker has a linear utility function and makes his investment decision based only on the expected return.

If the utility function is quadratic, it is given by:

$$U = a + bX + cX^2 \; .$$

The first derivative with respect to X gives marginal utility of income and is:

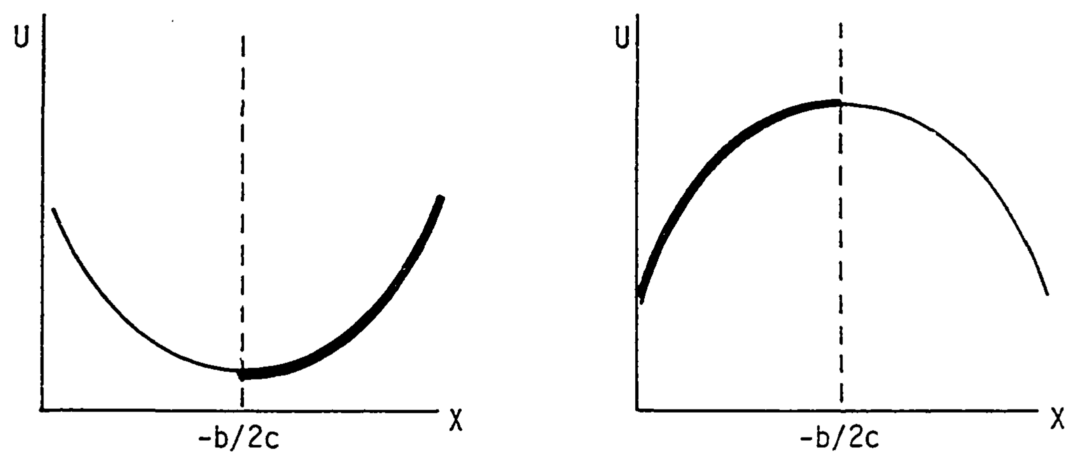
$$\frac{dU}{dX} = b + 2cX \; .$$

Marginal utility of income must always be positive for a rational producer, and this restriction, that $dU/dX > 0$, implies:

$$X > -b/2c \; , \quad \text{if } c > 0, \text{ and}$$

$$X < -b/2c \; , \quad \text{if } c < 0.$$

Within these ranges, X is the certainty equivalent of all risky prospects whose utility is equal to U (28). Figure 3.3 shows the general shape of the quadratic utility function when $c > 0$ and when $c < 0$. The bold part of each curve is the relevant portion of the utility function.



a. $c > 0$.

b. $c < 0$.

Figure 3.3. Quadratic utility function, $U = a + bX + cX^2$.

The second derivative with respect to X indicates whether the marginal utility is increasing or decreasing. The second derivative of the quadratic is:

$$\frac{d^2U}{dX^2} = 2c.$$

This second derivative shows that $c > 0$ implies increasing marginal utility of income as X increases and $c < 0$ implies decreasing marginal utility of income as X increases.

If X is a risky prospect, the quadratic utility function may be written as:

$$U = a + b \cdot E(X) + c \cdot E(X^2) .$$

Since $E(X) = \mu_X$ and $E(X^2) = \mu_X^2 + \sigma_X^2$,[1] this quadratic utility function may be rewritten in terms of the mean and variance of X as:

$$U = a + b\mu_X + c\mu_X^2 + c\sigma_X^2$$

where μ_X = the mean of X and σ_X^2 = the variance of X about μ_X . Over the relevant range of the quadratic utility function, $\delta U/\delta\mu_X$ must be positive $(b > 0)$, which means that utility of income increases as μ_X increases, with σ_X^2 fixed. So if two prospects have the same variance, the one with the higher mean will be preferred (58, 59).

Since σ_X^2 is necessarily positive and $\delta U/\delta\sigma_X^2 = c$, increasing marginal utility of income $(c > 0)$ implies that variability of X is desired; the greater is σ_X^2 , the greater is U(X) when $c > 0$. On the other hand, decreasing marginal utility of income $(c < 0)$ implies that variability of X is disliked; the greater is σ_X^2 , the smaller is U(X) when $c < 0$ (28). These relationships are often used to define the

---

[1] The second moment about the mean is defined as $E\{(X-\mu_X)^2\} = \sigma_X^2$ (52). Expanding this expression we have:

$$E(X^2 - 2X\mu_X + \mu_X^2) = \sigma_X^2$$

$$E(X^2) - 2 \cdot E(X) \cdot \mu_X + \mu_X^2 = \sigma_X^2$$

$$E(X^2) - 2\mu_X\mu_X + \mu_X^2 = \sigma_X^2$$

$$E(X^2) - 2\mu_X^2 + \mu_X^2 = \sigma_X^2$$

$$E(X^2) - \mu_X^2 = \sigma_X^2$$

$$E(X^2) = \mu_X^2 + \sigma_X^2 .$$

"risk averter" and the "risk lover" (or risk preferrer). If the decision-maker has a quadratic utility function with $c > 0$, then he is a risk lover or risk preferrer. If $c < 0$, then the decision-maker is a risk averter. If $c = 0$, variability of X does not matter to the decision-maker and he has a linear utility function. A decision-maker with a linear utility function is referred to as risk neutral. For these reasons, the coefficient c in the quadratic utility function is often referred to as the coefficient of risk preference or risk aversion (57, 86).

With a quadratic utility function, discussion of uncertain prospects is often presented in terms of mean-variance or E,V analysis (58, 59, 75, 81, 90). The quadratic utility function given above implies a utility surface in the three dimensions U, μ_X, and σ_X^2. Holding utility constant, the function can be represented by a series of iso-utility curves in mean-variance space. Setting utility equal to a constant level, say U*, and rearranging terms, the curve of all mean-variance combinations which yield the same level of utility is given by:

$$\sigma_X^2 = \frac{U^*}{c} - \frac{a}{c} - \frac{b}{c}\mu_X - \mu_X^2 .$$

Such curves are known as E,V indifference curves since the decision-maker with a quadratic utility function would be indifferent between the alternative prospects whose mean and variance lie on the same indifference curve (28). The relevant range of the indifference curve is also defined by the coefficient of risk preference or risk aversion as:

$\mu_X > - b/2c$, for $c > 0$ (risk preferrer), and

$\mu_X < - b/2c$, for $c < 0$ (risk averter).

The rate of substitution or trade-off between the mean and variance at a constant level of utility is given by:

$$\frac{d\mu_X}{d\sigma_X^2} = - \frac{\partial U/\partial\sigma_X^2}{\partial U/\partial\mu_X} = - \frac{c}{b+2c\mu_X} = -c(b+2c\mu_X)^{-1} \ .$$

The term $(b+2c\mu_X)$ is the marginal utility of money $(\partial U/\partial\mu_X)$ and must be positive for the rational producer. Therefore, the rate of substitution between the mean and variance will be positive, zero, or negative within the relevant range as c is negative, zero, or positive, respectively. The rate of substitution will be positive for a risk averter ($c < 0$) because a risk averter requires an increase in mean value to compensate for an increase in variance if the level of utility is to remain constant. The rate of substitution will be negative for a risk preferrer ($c > 0$) because a risk preferrer requires a decrease in mean value to offset an increase in variance if the level of utility is to remain constant.

The rate of change in the rate of substitution of mean for variance is the marginal rate of substitution and is given by:

$$\frac{d^2\mu_X}{d(\sigma_X^2)^2} = \{2c^2(b+2c\mu_X)^{-2}\} \frac{d\mu_X}{d\sigma_X^2} \ .$$

The term in brackets is always positive because of the squared terms, and $d\mu_X/d\sigma_X^2$ is positive or negative as c is negative or positive. For a risk averter ($c < 0$) the marginal rate of substitution is increasing; as variance increases the decision-maker needs larger increases in the mean value to compensate for the increase in variance. The marginal rate of substitution for the risk preferrer ($c > 0$) is decreasing; as variance increases the decision-maker needs larger decreases in the mean value to offset the increase in variance.

The last three equations describe a family of indifference curves, given the decision-maker's values for the parameters a, b, and c. Figure 3.4 shows a family of indifference curves for a risk averter and a risk preferrer who have quadratic utility functions. The intercept of an indifference curve with the μ_X axis ($\sigma_X^2 = 0$) is the certainty equivalent of all mean-variance combinations on that indifference curve. The greater the degree of risk aversion of preference (the greater the value of $|c|$), the flatter the indifference curves.

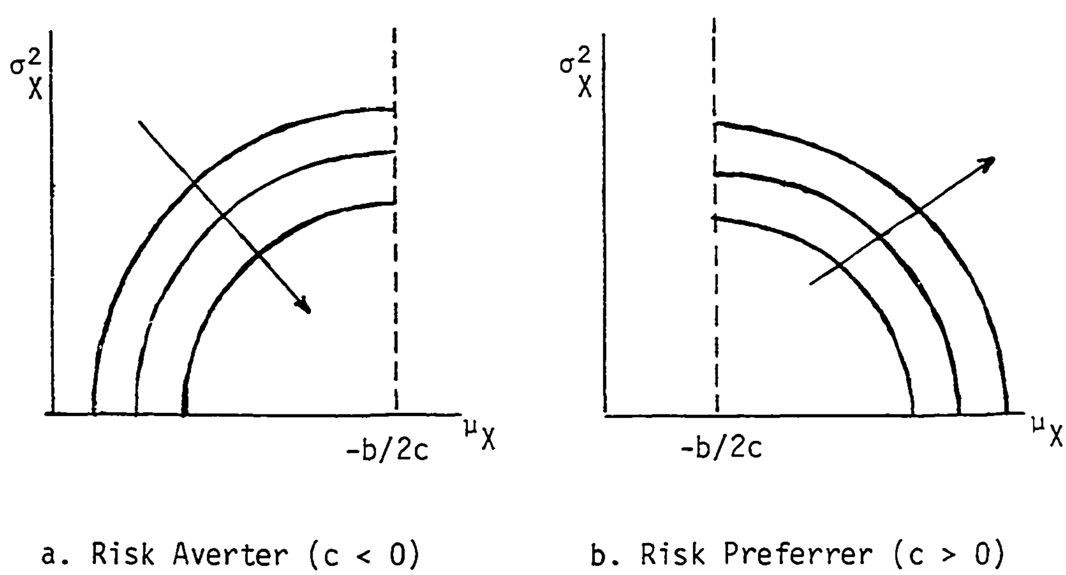


Figure 3.4. Family of indifference curves for a risk averter and a risk preferrer who have quadratic utility functions.

The quadratic utility function assumes that only the mean value and the variance of the risky prospect matter to the decision-maker. There are two situations when this assumption would be correct. The first situation occurs when the first two moments describe the distribution of the risky prospect fully, when the risky prospect has a normal distribution. The second situation occurs when the decision-maker bases his decision only on the mean and variance. The risky prospect may have moments beyond the second, but if a quadratic utility function is used the higher moments are assumed irrelevant to the decision-maker's choice. In E,V analysis moments beyond the second do not influence the decision-maker.

The mathematical calculation of the third moment (a measure of skewness) is possible only for a simple problem and is infeasible for a prospect with a large number of possible returns (90). Many analyses which consider risk are confined to the first two moments because of the difficulty of dealing mathematically with moments beyond the second. For distributions that are approximately normal, this approach may closely approximate individual attitudes toward risk. That is, the distribution with the greater variability would consistently represent the riskier prospect (90).

The pioneering work in E,V analysis was done by Markowitz (58, 59). His suggested decision criterion is known as an E,V efficient frontier. The mean and variance of each investment prospect available to the decision-maker are calculated. The set of prospects which have the highest expected return for a given level of risk or the lowest level of risk for a given level of expected return comprises the efficient frontier. E,V analysis does not lead to the choice of a single prospect, but rather to a family of prospects referred to as the efficient frontier. The general shape of an efficient frontier is illustrated in Figure 3.5.

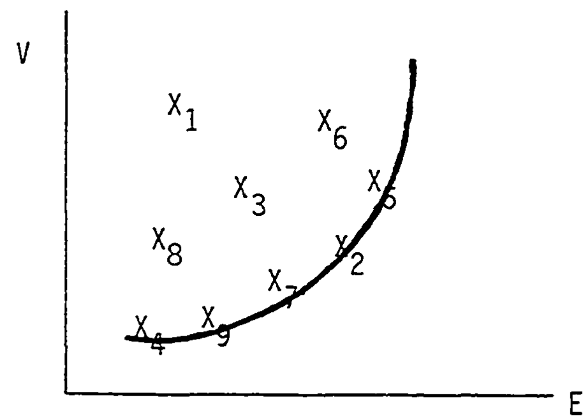


Figure 3.5. Efficient E,V frontier.

The decision-maker's indifference curves, which were shown in Figure 3.4, can then be transposed onto Figure 3.5. The point of tangency between the decision-maker's indifference curve and the efficient frontier defines the prospect that will maximize the decision-maker's utility.

E,V analysis was developed by Markowitz as a procedure for portfolio selection. The prospects were securities and portfolios of securities. The efficient frontier defined the efficient portfolios. The point of tangency between the investor's indifference curves and the efficient frontier defined the portfolio that maximized investor's utility. Agricultural economists have used E,V analysis to look at numerous farm management problems (32, 62, 74, 75, 79, 81). The prospects are alternative farm plans. The efficient frontier defines the efficient farm plans in terms of expected return and variance. The point of tangency between the farmer's indifference curve and the efficient frontier defines the farm plan that will maximize the farmer's utility. The next part of this section describes programming models that have been developed to generate the efficient frontier. After these models are described, a model of the beginning farmer which includes risk will be developed.

Single Period Programming Models

Quadratic programming has been suggested as a useful method to consider uncertainty in farm planning (32, 62, 79, 81). Quadratic programming generates the efficient E,V frontier of the alternative farm plans as discussed in the previous section. To generate the efficient E,V frontier, quadratic programming assumes that the farmer's utility is a function of expected income and the associated income variance. That is, as discussed before, the farmer orders his preferences among alternative farm plans on the basis of expected income, E, and the associated income variance, V. Quadratic programming further assumes that the farmer is a risk averter with convex indifference curves as shown in Figure 3.3, a. Along every indifference curve:

(1) $dE/dV > 0$, the farmer would prefer a farm plan with higher V only if E were also greater, and

(2) $d^2E/dV^2 > 0$, the expected income must increase more than the increase in variance.

Given these assumptions, the rational farmer restricts his choice among those farm plans which have a minimum variance given an expected level of income. Quadratic programming generates the set of feasible farm plans which have minimum variance, V, for a given level of expected income, E. An efficient frontier over the set of all feasible farm plans is shown in Figure 3.5. The point of tangency between the efficient E,V frontier and the farmer's indifference curve defines the farm plan that will maximize the farmer's utility. In Figure 3.6, segment OQ is the efficient E,V frontier and point P is the point of utility maximization. The farm plan which corresponds to point P is the optimal farm plan for the farmer with a utility function depicted by the indifference curves in Figure 3.6.

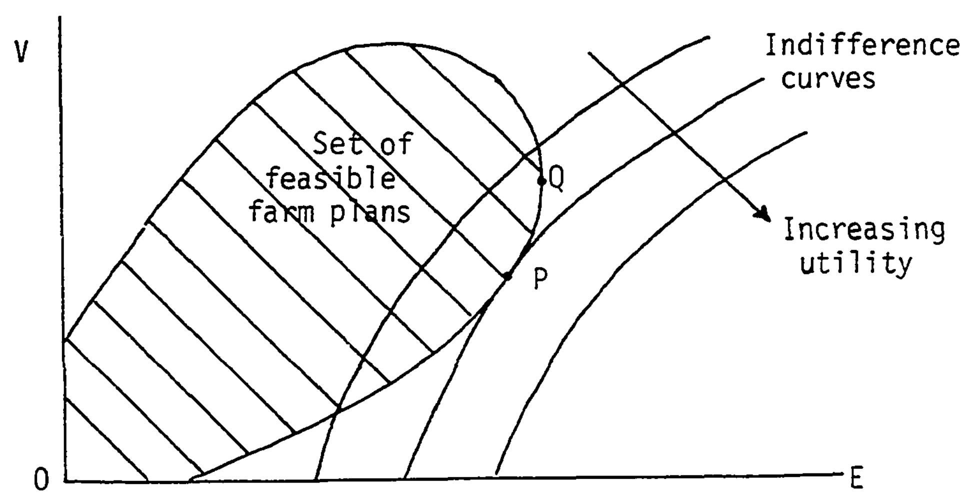


Figure 3.6. The optimal E,V farm plan.

The quadratic programming model can be formulated as:

$$\text{minimize } V = \sum_{j=1}^{n} \sum_{k=1}^{n} X_j \, X_k \, \sigma_{jk}$$

subject to:

$$\sum_{j=1}^{n} f_j X_j = \lambda \qquad \lambda = 0 \text{ to unbounded}$$

$$\sum_{j=1}^{n} a_{ij} X_j \leq b_i \qquad \text{for all } i,\ i = 1, \ldots, m$$

$$X_j \geq 0 \qquad \text{for all } j,\ j = 1, \ldots, n$$

where:

X_j = the level of activity j,

f_j = the expected return of activity j,

σ_{jk} = the covariance of returns between activity j and activity k when $j \neq k$ and the variance of return of activity j when $j = k$,

a_{ij} = the technical requirement of activity j for resource or constraint i,

b_i = the level of resource or constraint i,

n = the number of activities,

m = the number of constraints,

λ = a scalar.

The sum $\sum_{j=1}^{n} f_j X_j$ is the expected return, E, and $\sum_{j=1}^{n} \sum_{k=1}^{n} X_j X_k \sigma_{jk}$ is the expected variance, V. By parameterizing λ from zero to unbounded, a sequence of solutions is obtained of increasing expected return and variance until the maximum possible expected return under the resource constraints has been attained. In this manner the efficient E,V frontier is generated.

However, computer codes available for solving quadratic programming models have practical limits as to size and are expensive to solve. Hazell has developed a linear alternative to quadratic programming which can be solved using conventional linear programming codes (35). Hazell notes that the quadratic programming model requires knowing a priori the expected return for each activity (f_j; j = 1, 2, ... , n) and the corresponding variances and covariances (σ_{jk}; j, k = 1, 2, ... , n). As these parameters are unknown it is necessary to obtain estimates using time series or cross-sectional data of observed returns. To illustrate the standard estimation procedure, the variance V in the above model is replaced by:

$$\sum_{j=1}^{n} \sum_{k=1}^{n} X_j X_k \{1/s-1 \sum_{h=1}^{s} (c_{hj} - g_j)(c_{hk} - g_k)\}$$

where:

$h = 1, 2, \ldots , s$ denotes s observations in a random sample of returns, and

g_j (g_k) is the sample mean of the returns for activity j (k), measured as:

$$1/s \sum_{h=1}^{s} c_{hj} \qquad \text{for all } j ; j = 1, 2, \ldots , n.$$

Taking the summation over h to the left and factoring, the estimated variance is:

$$1/s-1 \sum_{h=1}^{s} \{\sum_{j=1}^{n} c_{hj} X_j - \sum_{j=1}^{n} g_j X_j\}^2 .$$

Hazell then notes that assuming the same sample data are available as for estimating the variance, the mean absolute income deviation A may be defined as:

$$A = 1/s \sum_{h=1}^{s} |\sum_{j=1}^{n} (c_{hj} - g_j) X_j|.$$

A is an unbiased estimator of the population mean absolute deviation. Hazell suggests that using A as a measure of uncertainty, it is reasonable to consider E and A as the crucial parameters in the selection of a farm plan and to define efficient E,A farm plans as those having minimum absolute income deviation for given expected income level E.

Hazell suggests that E,A criterion has an important advantage over the E,V criterion in that it leads to a linear programming model in deriving efficient E,A farm plans. To see this, he observes that in the above equation 1/s is a constant and it is therefore sufficient to minimize sA subject to the constraints of the quadratic programming model. To convert sA to a legitimate linear programming objective function, Hazell defines new variables:

$$y_h = \sum_{j=1}^{n} c_{hj} X_j - \sum_{j=1}^{n} g_j X_j \qquad \text{for all } h;\ h = 1, 2, \ldots, s.$$

subject to:

$$y_h = y_h^+ - y_h^-$$

$$y_h^+ , y_h^- \geq 0$$

that is, such that y_h are unrestricted in sign. Then, if y_h^+ and y_h^- are selected in some minimal way so that one or the other is zero, $|y_h| = y_h^+ + y_h^-$, $h = 1, 2, \ldots , s$. But, Hazell notes that this can be done concurrently while seeking optimal X_j ($j = 1, 2, \ldots , n$) in the following linear programming model.

$$\text{minimize } sA = \sum_{h=1}^{s} (y_h^+ + y_h^-)$$

subject to:

$$\sum_{j=1}^{n} (c_{hj} - g_j)\, X_j - y_h^+ + y_h^- = 0 \quad \text{for all } h;\ h = 1, 2, \ldots, s,$$

$$\sum_{j=1}^{n} f_j X_j = \lambda \qquad \lambda = 0 \text{ to unbounded,}$$

$$\sum_{j=1}^{n} a_{ij} X_j \leq b_i \qquad \text{for all } i;\ i = 1, 2, \ldots , m,$$

$$X_j\ ,\ y_h^+\ ,\ y_h^- \geq 0.$$

This model can be solved on conventional linear programming codes with the parametric option and provides a set of farm plans that are efficient for expected income E and mean absolute deviation A. Since the model minimizes sA, Hazell refers to it as the "Minimization of Total Absolute Deviations (MOTAD)" model.

Hazell further observes that for a given farm plan,

$$y_h^+ = \left|\sum_{j=1}^{n} (c_{hj} - g_j)\ X_j\ \right|, \text{ when } \sum_{j=1}^{n} (c_{hj} - g_j)\ X_j > 0$$

$$= 0, \text{ otherwise.}$$

Thus, $\sum_{h=1}^{s} y_h^+$ is the sum of the absolute values of the positive total return deviations around the expected return based on sample returns. Similarly,

$$y_h^- = \left|\sum_{j=1}^{n} (c_{hj} - g_j)\ X_j\right|, \text{ when } \sum_{j=1}^{n} (c_{hj} - g_j)\ X_j < 0$$

$$= 0, \text{ otherwise.}$$

Thus, $\sum_{h=1}^{s} y_h^-$ is the sum of the absolute values of the negative total return deviations around the expected return based on sample returns. Hazell contends that it follows then that $\sum_{h=1}^{s} y_h^+$ must be exactly equal to $\sum_{h=1}^{s} y_h^-$ if g_j are the sample mean returns. Hazell then suggests an alternative formulation for the MOTAD model based on minimizing only the sum of the absolute values of the negative total return deviations,

$\sum_{h=1}^{s} y_h^-$. Hazell does this in the following linear programming model:

$$\text{minimize } \sum_{h=1}^{s} y_h^- ,$$

subject to:

$$\sum_{j=1}^{n} (c_{hj} - g_j) X_j + y_h^- > 0 \qquad \text{for all } h;\ h = 1, 2, \ldots , s,$$

$$\sum_{j=1}^{n} f_j X_j = \lambda \qquad \lambda = 0 \text{ to unbounded},$$

$$\sum_{j=1}^{n} a_{ij} X_j \leq b_i \qquad \text{for all } i;\ i = 1, 2, \ldots , m,$$

$$X_j ,\ y_h^- \geq 0.$$

This formulation can also be solved by conventional linear programming codes with the parametric option and leads to identical results as the first MOTAD model except that the numeric value of the objective function is 1/2 sA rather than sA. Hazell notes that while the first MOTAD formulation generally involves n + 2s real activities, the last MOTAD formulation requires only n + s real activities. Finally, Hazell notes that since both formulations have m + s + 1 constraints if the non-negativity constraints are ignored, the last MOTAD formulation is to be preferred in terms of computational efficiency in deriving efficient E,A farm plans.

Multi-Period Programming Models

The quadratic programming model discussed above generates an efficient E,V frontier for one time period. If returns occur over a number of future time periods, then the relevant decision variables become the net present value of future returns and the variance of the net present value of future returns (90). The decision variables can be determined by taking note of a theorem regarding the mean and the variance of a linear function of independent random variables (52).

Theorem 3.1. Let $X_1, X_2, \ldots, X_T$ be independent random variables with means $\mu_1, \mu_2, \ldots, \mu_T$ and variances of $\sigma_1^2, \sigma_2^2, \ldots, \sigma_T^2$ respectively. If $y = \sum_{t=1}^{T} a_t X_t$, where the a_t's are arbitrary constants, then:

$$\mu_y = \sum_{t=1}^{T} a_t \mu_t \text{ , and}$$

$$\sigma_y^2 = \sum_{t=1}^{T} a_t^2 \sigma_t^2 \text{ .}$$

Proof:

$$\mu_y = E(y) = E \{\sum_{t=1}^{T} a_t X_t\}$$

$$= \sum_{t=1}^{T} E(a_t X_t)$$

$$= \sum_{t=1}^{T} a_t \cdot E(X_t)$$

$$= \sum_{t=1}^{T} a_t \mu_t \text{ .}$$

$$\sigma_y^2 = E (y - \mu_y)^2$$

$$= E\{(\sum_{t=1}^{T} a_t X_t - \sum_{t=1}^{T} a_t \mu_t)^2\}$$

$$= E\{(\sum_{t=1}^{T} a_t (X_t - \mu_t))^2\}$$

$$= E\{\sum_{t=1}^{T} a_t^2 (X_t - \mu_t)^2 + 2 \sum_{t=1}^{T} \sum_{s=1}^{T} a_t a_s (X_t - \mu_t)(X_s - \mu_s)\}$$

$$= \sum_{t=1}^{T} a_t^2 \cdot E\{(X_t - \mu_t)^2\}$$

$$+ 2 \sum_{t=1}^{T} \sum_{s=1}^{T} a_t a_s \cdot E\{(X_t - \mu_t)(X_x - \mu_x)\}$$

$$= \sum_{t=1}^{T} a_t^2 \sigma_t^2 + 2 \sum_{t=1}^{T} \sum_{s=1}^{T} a_t a_s \sigma_{ts}$$

$$= \sum_{t=1}^{T} a_t^2 \sigma_t^2$$

Each of the covariances, σ_{ts}, is zero because of the independence of $X_1, X_2, \ldots, X_T$.

Now, if X_t is the return in period t and a_t is the discount factor for period t, then the present value of future returns is given by:

$$y = a_1X_1 + a_2X_2 + \ldots + a_TX_T$$

$$= \sum_{t=1}^{T} a_tX_t.$$

From Theorem 3.1, the mean value of the present value of the future returns is given by:

$$\mu_y = \sum_{t=1}^{T} a_t\mu_t ,$$

and the variance of the present value of the future returns is given by:

$$\sigma_y^2 = \sum_{t=1}^{T} a_t^2\sigma_t^2 .$$

The discount factor, a_t, is equal to $(1/1+\rho)^t$, where ρ is the risk-free interest rate. The risk-free rate is used because it is desired to isolate the time value of money. If a premium for risk is included in the discount factor there would be double counting for risk in the E,V analysis. That is, the returns from a prospect would be adjusted for risk in the discounting process, and then the probability distribution of the resulting present value would be used to judge the risk of the prospect. But this probability distribution was obtained using a risk-adjusted discount rate. This would result in adjusting for risk a second time in evaluating the relative dispersion of the probability distribution of present value. Because of the problems of double counting for risk, the appropriate interest rate to use is the risk-free rate (90).

Setting $a_t = (1/1+\rho)^t$, the present value of future returns is given by:

$$y = \sum_{t=1}^{T} (1/1+\rho)^t X_t$$

$$= \sum_{t=1}^{T} X_t/(1+\rho)^t .$$

The mean value of future returns is then given by:

$$\mu_y = \sum_{t=1}^{T} (1/1+\rho)^t \mu_t$$

$$= \sum_{t=1}^{T} \mu_t/(1+\rho)^t .$$

And the variance of future returns is given by:

$$\sigma_y^2 = \sum_{t=1}^{T} \{(1/1+\rho)^t\}^2 \sigma_t^2$$

$$= \sum_{t=1}^{T} (1/1+\rho)^{2t} \sigma_t^2$$

$$= \sum_{t=1}^{T} \sigma_t^2/(1+\rho)^{2t} .$$

The E,V analysis then proceeds as in the single period case. Utility is assumed to be a function of μ_y and σ_y^2 as given by a quadratic utility function. The E,V efficient frontier and the decision-maker's indifference curves are then drawn in μ_y and σ_y^2 space. The multiperiod quadratic programming model can then be formulated as:

$$\text{minimize } V = \sum_{t=1}^{T} \sum_{j=1}^{n} \sum_{k=1}^{n} \frac{X_{jt} X_{kt} \sigma_{jk}}{(1+\rho)^{2t}}$$

subject to:

$$\sum_{t=1}^{T} \sum_{j=1}^{n} \frac{f_{jt} X_{jt}}{(1+\rho)^{t}} = \lambda \qquad \lambda = 0 \text{ to unbounded}$$

$$\sum_{t=1}^{T} \sum_{j=1}^{n} a_{ijt} X_{jt} < b_{it} \qquad \begin{array}{l} \text{for all } i;\ i = 1, \ldots, m \\ \text{for all } t;\ t = 1, \ldots, t \end{array}$$

$$X_{jt} > 0$$

where:

X_{jt} = the level of activity j in year t,

f_{jt} = the expected return of activity j in year t,

σ_{jk} = the covariance of returns between activity j and activity k when j ≠ k, and the variance of returns of activity j when j = k,

a_{ijt} = the technical requirement of activity j for resource or constraint i in year t,

b_{it} = the level of resource or constraint i in year t,

ρ = the risk-free interest rate,

λ = a scalar,

n = the number of activities,

m = the number of constraints.

The sum $\sum_{j=1}^{n} f_{jt} X_{jt}$ is the expected return in year t, and the sum $\sum_{t=1}^{T} \sum_{j=1}^{n} f_{jt} X_{jt}/(1+\rho)^{t}$ is the present value of expected future returns. The sum $\sum_{j=1}^{n} \sum_{k=1}^{n} X_{jt} X_{kt} \sigma_{jk}$ is the expected variance in year t, so the objective function of the multiperiod quadratic programming model is to minimize the discounted variance of future returns. By parameterizing λ from zero to unbounded, a sequence of solutions are obtained of increasing present value of future returns and variance until the maximum possible expected present value of future returns under the resource constraints has been attained. In this manner the efficient E,V frontier for the multiperiod situation is generated.

As mentioned before, though, computer codes available for solving quadratic programming models have practical limits as to size and are expensive to solve. These problems are even greater for the multi-period model because the model size increases as more time periods are considered. By expanding Hazell's MOTAD model to a multiperiod MOTAD model a linear alternative to multiperiod quadratic programming can be developed which can be solved using conventional linear programming codes.

Hazell developed the MOTAD model by using the sum of the absolute values of the negative return deviations, $\sum_{h=1}^{s} y_h^-$, as an approximation of the variance of return. The absolute values of the negative return deviations were defined by the constraint:

$$\sum_{j=1}^{n}(c_{hj} - g_j)X_j + y_h^- > 0 \qquad \text{for all } h\,;\ h = 1, 2, \ldots , s.$$

This objective function and constraint defined the sum of the absolute values of the negative return deviations for one time period. By inserting a time subscript in this objective function and constraint, the sum of the absolute values of the negative return deviations for year t is defined as:

$$\sum_{h=1}^{s} y_{ht}^{-}$$

subject to:

$$\sum_{j=1}^{n}(c_{hj} - g_j)X_{jt} + y_{ht}^{-} > 0 \quad \text{for all } h;\ h = 1, 2, \ldots , s.$$

This value is then an approximation of the variance of expected returns in year t.

Using this sum of the absolute values of the negative return deviations for year t as an approximation of the variance of expected return for year t, the multiperiod MOTAD model can be formulated as:

$$\text{minimize} \quad \sum_{t=1}^{T} \sum_{h=1}^{s} y_{ht}^{-}/(1+\rho)^{2t}$$

subject to:

$$\sum_{j=1}^{n}(c_{hj} - g_j)X_{jt} + y_{ht}^{-} \geq 0 \quad \begin{array}{l}\text{for all } h;\ h = 1, \ldots , s\\ \text{for all } t;\ t = 1, \ldots , T\end{array}$$

$$\sum_{t=1}^{T} \sum_{j=1}^{n} f_{jt} X_{jt}/(1+\rho)^{t} = \lambda \quad \lambda = 0 \text{ to unbounded}$$

$$\sum_{j=1}^{n} a_{ijt} X_{jt} \leq b_{it} \quad \begin{array}{l}\text{for all } i;\ i = 1, \ldots , m\\ \text{for all } t,\ t = 1, \ldots , T\end{array}$$

$$X_{jt},\ y_{ht}^{-} \geq 0 .$$

where:

y_{ht}^{-} = the absolute value of the negative deviation from the expected return in year t based on sample observation of year h,

c_{hj} = the return of one unit of activity j in observation year h,

g_j = the sample mean return of activity j, defined as $1/s \sum_{h=1}^{s} c_{hj}$,

X_{jt} = the level of activity j in year t,

f_{jt} = the expected return from one unit of activity j in year t,

a_{ijt} = the technical requirement of activity j for resource or constraint i in year t,

b_{it} = the level of resource or constraint i in year t,

ρ = the risk-free discount rate,

λ = a scalar,

n = the number of activities,

m = the number of constraints.

By parameterizing λ from zero to unbounded, a sequence of solutions are obtained of increasing present value of future returns and absolute value of negative deviation until the maximum possible expected present value of future returns under the resource constraints has been attained. In this manner the efficient E,A frontier for the multi-period situation is generated.

Presentation of Results

E,V analysis or E,A analysis does not generate the optimal farm plan for a farmer to use to maximize utility. Rather, these methods of considering risk in farm management problems produce a set of efficient farm plans in terms of minimum risk (variance or absolute deviation) for a given level of return. The farm plan among this efficient set which will maximize the farmer's utility depends upon the farmer's utility function. Since farmers have different utility functions each individual farmer must choose that farm plan which maximizes his utility. As Hazell points out:

> Given a set of different farm plans the acceptability of any particular one to an individual farmer will depend on his preferences among various expected income and associated variance levels as described by his E,V utility function. When this function can be measured, a unique farm plan can be vigorously identified which offers the farmer highest utility. (This is the optimal farm plan in Figure 3.6.) However, since progress toward the specification of such utility functions is apparently slow, the better alternative for the immediate future seems to lie in obtaining the set of efficient farm plans and allowing the farmer to make the final choice. This approach is also more flexible in avoiding too rigid a specification of the utility function and perhaps compensates to some extent for situations where income variance is not the best measure of uncertainty. Further, if other socioeconomic factors enter the utility function in addition to E and V, the farmer is free to choose the plan he most prefers in relation to a multiplicity of goals (35).

By generating the efficient curve and then describing the farm plans associated with several points on this curve, the individual farmer is free to choose that farm plan which he believes will maximize his utility. Scott and Baker suggest a practical method to present the results of a quadratic program to a farmer and allow him to choose the optimal farm plan based on his own self-assessed E,V utility function (74). Besides presenting the efficient frontier and the farm plans associated with several points on this frontier, they suggest presenting some additional information to aid the farmer in making his decision. At each point they also present the value for expected income minus one standard deviation and the value for expected income minus 1.96 standard deviations. A farm plan for each point has a 0.95 probability of exceeding the income level of expected income minus one standard deviation, and it has a 0.975 probability of exceeding the income level of expected income minus 1.96 standard deviations. Presenting these two values to the farmer shows him the income level each farm plan is expected to exceed 95 percent and 97.5 percent of the time, respectively. These values give the farmer another measurement of the risk associated with each farm plan.

When the absolute deviation of expected return is used as a measure of risk and the efficient E,A frontier is generated, the same results can be presented to the farmer. The efficient E,A curve can be presented and the farm plans associated with several points on this curve can be described. The variance associated with each efficient E,A farm plan can be calculated and the income levels which have 0.95 probability and a 0.975 probability of being exceeded with each plan can be presented as suggested by Scott and Baker. In addition, other probabilities can be calculated which might be of more interest to the beginning farmer, such as the probability of exceeding a minimum income level required for survival.

The results obtained from a multiperiod model would be similar to the results discussed so far for the single period case. The present value of future returns and the absolute deviation of this value describe a point on the efficient E,A frontier. However, associated with each point on the efficient frontier will be a series of farm plans -- one for each period in the analysis. The expected income and associated variance can be calculated for each year in the analysis and the probabilities of exceeding certain income levels in each year can be determined. This would enable the farmer to see how the series of farm plans associated with a particular point on the efficient E,A curve affects the income and risk level of each year in the analysis. Again, the individual farmer must choose that series of farm plans which he believes will maximize his utility.

Mathematical Model of the Beginning Farmer

The model presented in this section expands the multiperiod MOTAD model presented in the last section to depict the entry process into agriculture. The purpose of this model is to show the relationships between the decisions made by the beginning farmer and the outcomes in terms of disposable income, cash position, net worth position, and risk position.

It is desired to determine the beginning farmer's disposable income, net worth position, and risk position at the end of each year of the first few years of farming (say T years) and to determine his cash flow position at periods within each year (say K periods). For example, if the within-year periods are quarters, then K equals 4, and if the within-year periods are semi-annual periods, then K equals 2. Therefore, the model has KT production periods. In the following mathematical model, the year time periods are denoted by subscripts t, r, or s, and the within-year time periods are denoted by superscripts k, b, or d. If a coefficient or variable has a within-year time period superscript it is located directly above the year subscript, so the within-year superscripts are "nested" with a year subscript. For example, the term X_{jt}^{k} refers to the level of production activity j in period k of year t.

The mathmatical model is presented below. A discussion of each equation is presented after the model.

(3.1) minimize: summation of discounted values of negative deviations

$$\sum_t \sum_k \sum_h y_{ht}^{k-}/(1+\rho)^{2t}$$

(3.2) subject to: absolute value of negative deviation (observation h in period k of year t)

$$\sum_i (c_{Mih}^{k} - g_{Mi}^{k})M_{it}^{k} + y_{ht}^{k-} > 0$$

(3.3) subject to: discounted returns

$$\sum_t DI_t/(1+\rho)^t = \lambda$$

(3.4) where: disposable income (year t)

$$DI_t = TI_t - TX_t$$

(3.5) where: taxable income (year t)

$$TI_t = \sum_k \sum_i \theta_{it}^{k} M_{it}^{k} + \sum_k \sum_j \varepsilon_{it}^{k} Z_{it}^{k} + \sum_k \sum_j \omega_{jt}^{k} W_{jt}^{k} - \sum_k \sum_j \phi_{jt}^{k} X_{jt}^{k} - \sum_k \sum_j V_{jt}^{k} - \sum_k \sum_j \eta_{jt}^{k} R_{jt}^{k} - \sum_j DP_{jt}$$

(3.6) where: taxes (year t)

$$TX_t = f_1(TI_t)$$

(3.7) subject to: consumption (period k of year t)

$$F_t^k = 1/K(22.96\ PL_t^{0.410}\ DI_t^{0.590}\ FS_t^{0.163})$$

(3.8) subject to: resource capacity (resource i in period k of year t)

$$\sum_j a_{ijt}^{k} X_{jt}^{k} + M_{it}^{k} + \sum_j b_{ijt}^{k} W_{jt}^{k} \leq B_{it}^{k} + Q_{it}^{k} + \sum_j \tau_{ijt}^{k} DA'^{k}_{jt}$$

(3.9) where: durable asset (asset j in period k of year t)

$$DA'^{\,k}_{jt} = x^{k}_{jt}\, DA^{(k-1)}_{jt} + I^{k}_{jt} + R^{k}_{jt} - S^{k}_{jt}$$

(3.10) subject to: borrowing capacity (loan type j in period k of year t)

$$N^{k}_{jt} + \sum_{r=0}^{t-1}\sum_{b=1}^{K} N^{b}_{jr} + \sum_{b=1}^{k-1} N^{b}_{jt} - \sum_{r=1}^{t-1}\sum_{b=1}^{K} P^{b}_{jr} - \sum_{b=1}^{k-1} P^{b}_{jt}$$

$$\leq \min \{\beta^{k}_{jt}\, NW_{t-1}\, ,\, L^{k}_{jt}\}$$

(3.11) subject to: borrowing capacity (total debt outstanding in period k of year t)

$$\sum_{j} N^{k}_{jt} + \sum_{r=1}^{t-1}\sum_{b=1}^{K}\sum_{j} N^{b}_{jr} + \sum_{b=1}^{k-1}\sum_{j} N^{b}_{jt} - \sum_{r=1}^{t-1}\sum_{b=1}^{K}\sum_{j} P^{b}_{jr}$$

$$- \sum_{b=1}^{k-1}\sum_{j} P^{b}_{jt} \leq \gamma^{k}_{t}\, NW_{t-1}$$

(3.12) where: net worth (year t)

$$NW_{t} = (1+\alpha_{t})(NW_{t-1} - C^{K}_{t-1}) - \sum_{j} DP_{jt} + \sum_{k}\sum_{j} \pi^{k}_{jt}\, I^{k}_{jt}$$

$$+ \sum_{k}\sum_{j} \pi^{k}_{jt}\, Y^{k}_{jt} - \sum_{k}\sum_{j} \pi^{k}_{jt}\, S^{k}_{jt} - \sum_{k}\sum_{j} N^{k}_{jt} + \sum_{k}\sum_{j} P^{k}_{jt} + C^{K}_{t}$$

(3.13) where: cash (period k of year t)

$$C^{k}_{t} = C^{(k-1)}_{t} + \sum_{i} \theta^{k}_{it}\, M^{k}_{it} + \sum_{j} \varepsilon^{k}_{jt}\, Z^{k}_{jt} + \sum_{j} \omega^{k}_{jt}\, W^{k}_{jt}$$

$$+ \sum_{j} \pi^{k}_{jt}\, S^{k}_{jt} + \sum_{j} N^{k}_{jt} - \sum_{j} \phi^{k}_{jt}\, X^{k}_{jt} - \sum_{j} \pi^{k}_{jt}\, I^{k}_{jt}$$

$$- \sum_{j} \pi^{k}_{jt}\, Y^{k}_{jt} - \sum_{j} D^{k}_{jt} - \sum_{j} \eta^{k}_{jt}\, R^{k}_{jt} - TX^{k}_{t}$$

(3.14) subject to: debt service requirement (loan type j in period k of year t)

$$D^{k}_{jt} = P^{k}_{jt} + V^{k}_{jt}$$

(3.15) where: principal payment requirement (loan type j in period k of year t)

$$P_{jt}^{k} = \sum_{r=1}^{t-1} \sum_{b=1}^{K} \nu_{jrt}^{bk} N_{jr}^{b} + \sum_{b=1}^{k-1} \nu_{jtt}^{bk} N_{jt}^{b}$$

(3.16) where: interest payment requirement (loan type j in period k of year t)

$$V_{jt}^{k} = \sum_{r=1}^{t-1} \sum_{b=1}^{K} \psi_{jrt}^{bk} (N_{jr}^{b} - \sum_{s=1}^{t-1} \sum_{d=1}^{K} \nu_{jrs}^{bd} N_{jr}^{b} - \sum_{d=1}^{k-1} \nu_{jrt}^{bd} N_{jr}^{b})$$

$$+ \sum_{b=1}^{k-1} \psi_{jtt}^{bk} (N_{jt}^{b} - \sum_{d=1}^{k-1} \nu_{jtt}^{bd} N_{jt}^{b})$$

(3.17) where: level of off-farm assets (asset type j in period k of year t)

$$Z_{jt}^{k} = Z_{jt}^{(k-1)} + Y_{jt}^{k} - S_{jt}^{k}$$

(3.18) subject to: marketing level (product i in period k of year t)

$$M_{jt}^{k} \leq \sum_{r=1}^{t-1} \sum_{b=1}^{K} \sum_{j} \xi_{ijr}^{b} X_{jt}^{b} + \sum_{b=1}^{k-1} \sum_{j} \xi_{ijt}^{b} X_{jt}^{b} - \sum_{r=1}^{t-1} \sum_{b=1}^{K} M_{1r}^{b}$$

$$- \sum_{b=1}^{k-1} M_{1t}^{b} + \sum_{r=1}^{t-1} \sum_{b=1}^{K} Q_{ir}^{b} + \sum_{b=1}^{k-1} Q_{it}^{b}$$

(3.19) where: depreciation (durable asset j in year t)

$$DP_{jt} = \delta_{jt} (\sum_{r=1}^{t-1} \sum_{k=1}^{K} \pi_{jr}^{k} I_{jr}^{k} - \sum_{r=1}^{t-1} \sum_{k=1}^{K} \pi_{jr}^{k} S_{jr}^{k})$$

(3.20) subject to: non-negativity conditions

$$y_{ht}^{k-}, M_{it}^{k}, I_{jt}^{k}, W_{jt}^{k}, X_{jt}^{k}, R_{jt}^{k}, S_{jt}^{k}, B_{it}^{k}, N_{jt}^{k},$$

$$DP_{jt}, Y_{jt}^{k}, Z_{jt}^{k}, C_{t}^{k} \geq 0$$

<u>Coefficients</u>

ρ = the risk free discount rate,

c_{Mih}^{k} = return from marketing one unit of agricultural product i in period k of observation year h,

g_{Mi}^{k} = sample mean return from marketing one unit of agricultural product i in period k,

λ = a scalar,

θ_{it}^{k} = return from marketing one unit of agricultural product i in period k of year t,

ε_{it}^{k} = return from one unit of off-farm asset j in period k of year t,

ω_{jt}^{k} = return from one unit of off-farm employment activity j in period k of year t,

ϕ_{jt}^{k} = production costs of one unit of production activity j in period k of year t,

η_{jt}^{k} = cost of one unit of rental or leasing activity j in period k of year t,

a_{ijt}^{k} = amount of resource i required by one unit of production activity j in period k of year t,

b_{ijt}^{k} = amount of resource i required by one unit of off-farm employment activity j in period k of year t,

τ_{ijt}^{k} = amount of resource i provided by one unit of durable asset j in period k of year t,

χ_{jt}^{k} = for durable asset j, equal to zero if obsolete or equal to one if not obsolete in period k of year t,

β_{jt}^{k} = proportion of net worth that can be borrowed for loans of type j in period k of year t,

γ_{t}^{k} = proportion of net worth that can be borrowed for all loans in period k of year t (debt-to-equity ratio required in period k of year t),

α_{t} = inflation rate during year t,

π_{jt}^{k} = investment or sale price of durable asset j or off-farm asset j in period k of year t,

ν_{jrt}^{bk} = proportion of loan type j, that was taken out in period b of year r, that must be paid in period k of year t,

ψ_{jrt}^{bk} = interest on loan type j, that was taken out in period b of year r, that must be paid in period k of year t,

ξ_{ijt}^{k} = yield of agricultural product i from one unit of production activity j in period k of year t,

δ_{jt} = depreciation rate of one unit of durable asset j in year t.

Decision Variables

M_{it}^{k} = level of agricultural product marketing activity i in period k of year t,

Q_{it}^{k} = level of agricultural product buying activity i in period k of year t,

W_{jt}^{k} = level of off-farm employment activity j in period k of year t,

X_{jt}^{k} = level of production activity j in period k of year t,

R_{jt}^{k} = level of rental or leasing activity j in period k of year t,

I_{jt}^{k} = level of investment in durable asset j in period k of year t,

S_{jt}^{k} = level of sale of durable asset j in period k of year t,

N_{jt}^{k} = level of borrowing through loan type j in period k of year t,

Y_{jt}^{k} = level of investment in off-farm asset j in period k of year t.

State Variables

y_{ht}^{k-} = absolute value of the negative deviation of sample observation h from the sample mean,

DI_{t} = level of disposable income in year t,

TI_{t} = level of taxable income in year t,

TX_{t}^{k} = level of taxes which must be paid in period k of year t,

Z_{jt}^{k} = level of off-farm asset j owned in period k of year t,

D_{jt}^{k} = level of debt service required on loan type j in period k of year t,

P_{jt}^{k} = level of principal payment requirement on loan type j in period k of year t,

V_{jt}^{k} = level of interest payment requirement on loan type j in period k of year t,

DP_{jt} = level of depreciation of asset j in year t,

F_{t}^{k} = level of family consumption in period k of year t,

PL_{t} = price index in year t (1960 = 100),

FS_{t} = family size in year t,

B_{it}^{k} = level of resource i provided by the beginning farmer in period k of year t,

DA'^{k}_{jt} = level of durable asset j available in period k of year t,

DA_{jt}^{k} = level of durable asset j owned in period k of year t,

NW_{t} = level of net worth at end of year t,

L_{jt}^{k} = institutional limit on loan type j in period k of year t,

C_{t}^{k} = level of cash on hand at end of period k of year t.

The objective function of the multiperiod MOTAD model is to minimize the summation of the discounted absolute values of negative deviations, as given by equation 3.1. ρ is the risk-free discount rate as was discussed previously. y_{ht}^{k-} is the absolute value of the negative deviation of sample observation h from the sample mean, and is defined by equation 3.2. c_{Mih}^{k} is the return from marketing one unit of agricultural product i in period k of observation year h. g_{Mi}^{k} is the sample mean return of one unit of agricultural product i for period k using the H observations, and is given by:

$$g_{Mi}^{k} = 1/H \sum_{h=1}^{H} c_{Mih}^{k} .$$

The term $(c_{Mih}^{k} - g_{Mi}^{k})$, then is the deviation of the sample observation return from the sample mean return for marketing one unit of agricultural product i in period k of observation year h. Multiplying this term by the level of marketing activity i in period k of year t (M_{it}^{k}) gives the total amount of deviation from the sample mean return due to marketing activity i in period k of year t using observation h. Summing this across all i marketing activities in period k of year t gives the total deviation from the sample mean return due to marketing activities using observation h. This is the total deviation from the sample mean due to all risky activities in this model using observation h. If this total deviation is positive, then the constraint given in equation 3.2 is satisfied with $y_{ht}^{k-} = 0$. If this total deviation is negative, then for the constraint in equation 3.2 to be satisfied, y_{ht}^{k-} must equal the absolute value of the negative deviation. The value of y_{ht}^{k-} is either zero or positive, and if it is positive it is the absolute value of the total negative deviations using observation h. This value is then used in the objective function given as equation 3.1.

To generate an efficient E,A frontier the objective function is minimized subject to a return level. Equation 3.3 constrains the return level, which is defined as the summation of the discounted values of the yearly disposable income levels, to be greater than or equal to λ. Lambda (λ) is a scalar which is parameterized from 0 to infinity (∞) to generate an efficient E,A frontier.

An attempt is made in this model to explicitly specify the allocation of income among taxes, consumption, and investment. To do this, equations must be specified which define taxable income and disposable income, which determine the taxes that must be paid on taxable income, and which specify the consumption response to disposable income. This is done in equations 3.4, 3.5, 3.6, 3.7, and 3.8. Equation 3.4 defines disposable income in year t as simply taxable income in year t minus the taxes which must be paid on this taxable income. Taxable income in year t is then defined by equation 3.5 as gross returns from all marketing activities, plus returns from all off-farm assets, plus earnings from off-farm employment, minus production expenses, minus all interest payments made, minus rental or leasing expenses, minus the total amount of depreciation which occurs during year t.

The taxes which must be paid on taxable income in year t are then defined by equation 3.6, as a function of taxable income. This function represents a discontinuous progressive tax structure which is given in Table 3.1.

Equation 3.7 gives the consumption response in period k of year t as a function of disposable income, price level, and family size. The total consumption for year t is given by the function in parenthesis and then is divided by k to give the consumption in each period. The consumption function given in parenthesis was estimated by Brake in 1968, using 1961 farm data (20). The consumption level is determined in current dollars because of the inclusion of the price level term in the function. Even though the consumption function was estimated

Table 3.1. Progressive income tax structure, disposable income, and consumption level for selected income levels, used in this model.

Selected Income Levels	Tax Obligation[a]	Marginal Tax Rate	Disposable Income	Level of Consumption[b]	Marginal Propensity to Consume
$ 4,000	$ 620	.155	$ 3,380	$ 4,363	1.091
8,000	1,380	.190	6,620	6,486	.655
12,000	2,260	.220	9,740	8,147	.532
16,000	3,260	.250	12,740	9,545	.466
20,000	4,380	.280	15,620	10,760	.422
24,000	5,660	.320	18,340	11,830	.393
28,000	7,100	.360	20,900	12,780	.371
32,000	8,660	.390	23,340	13,640	.352
36,000	10,340	.420	25,660	14,420	.336
40,000	12,140	.450	27,860	15,150	.332
44,000	14,060	.480	29,940	15,810	.317
52,000	18,060	.500	33,950	17,010	.300
64,000	24,420	.530	39,580	18,630	.287
76,000	31,020	.550	44,980	20,090	.270
88,000	37,980	.580	50,020	21,390	.258
100,000	45,180	.600	54,820	22,580	.248

[a]1975 Federal Income Tax Schedule Y.

[b](20).

using data from farmers in all stages of the farm life cycle and may overstate the consumption response of beginning farmers to disposable income, it is the only farm consumption function available that was estimated from empirical data. Table 3.1 shows the consumption level for various selected income levels.

Total uses of resource i in period k of year t are constrained to be less than or equal to total availability of resource i in period k of year t by equation 3.8. Uses of resource i in period k of year t are in production activities, marketing activities, and off-farm employment activities. Adding the amount of resource i used by all production activities in period k of year t, the amount of resource i used by marketing activity i in period k of year t, and the amount of resource i used by all off-farm employment activities in period k of year t, gives the total amount of resource i used in period k of year t, as represented by the left-hand side of equation 3.8. Resources are then provided from three sources: (1) some are provided in each period by the beginning farmer (such as labor), (2) some are bought in each period (such as livestock, feed, seed), and (3) some are provided by durable assets (such as land providing land capacity in all periods it is available, machinery providing machinery capacity in all periods it is available, livestock facilities providing capacity for feeding live-stock in all periods it is available). Adding the amount of resource i provided by the beginning farmer in period k of year t, the amount of resource i purchased in period k of year t, and the amount of resource i provided by durable assets in period k of year t gives total availability of resource i in period k of year t, as represented by the right-hand side of equation 3.8.

The level of durable asset j available in period k of year t is defined by equation 3.9 as the level of durable asset j owned in the previous period that is still available for use in period k of year t, plus the level of investment in durable asset j in period k of year t, plus the level of renting or leasing of durable asset j in period k of year t, minus the level of sale of durable asset j in period k of year t.

The amount of investment that the beginning farmer can undertake will be constrained, among other things, by his borrowing capacity. Equation 3.10 and 3.11 are borrowing capacity constraints. Equation 3.10 is a constraint on loan type j in period k of year t, while equation 3.11 is a constraint on total debt of the beginning farmer. The left-hand side of equation 3.10 represents the total amount of loan type j debt outstanding in period k of year t as the level of new borrowings of loan type j in period k of year t, plus the total amount borrowed through loan type j in all periods of previous years, plus the total amount borrowed through loan type j in the previous periods of year t, minus the total amount of principal paid on loan type j in all periods of previous years, minus the total amount of principal paid on loan type j in the previous periods of year t. This amount of outstanding debt is constrained to be less than or equal to the minimum of two institutional loan limits imposed on the beginning farmer by the institution making the loan of type j in period k of year t. The first loan limit is expressed as a percentage of net worth at the end of the previous year. The second loan limit is expressed as an absolute maximum amount that the lending institution will loan to the beginning farmer through loan type j in period k of year t. The lesser of these two limits is the total amount of loan type j debt outstanding that the beginning farmer is permitted in period k of year t.

A second constraint on borrowing capacity is presented in equation 3.11 as a constraint on the beginning farmer's debt-to-equity ratio. The beginning farmer's debt-to-equity ratio is constrained by lending institutions to be less than or equal to a specified level, expressed here as γ_t^k. Usually γ_t^k will be 1.0 or less to insure that the farmer has as much equity as debt in his total assets. The smaller γ_t^k is, the larger the percentage of equity capital invested in the farm business. The debt-to-equity constraint can be expressed as:

$$\frac{\text{Debt}}{\text{Equity}} \leq \gamma_t^k$$

$$\text{Debt} \leq \gamma_t^k \text{ (Equity)}$$

Equity is expressed as the net worth of the beginning farmer at the end of the previous year, NW_{t-1}. The right-hand side of the above equation is then identical to the right-hand side of equation 3.11. Total debt is expressed in the left-hand side of equation 3.11. The left-hand side of equation 3.10 expresses the total amount of loan type j debt outstanding in period k of year t. Summing this amount over all j loan types gives the total amount of debt outstanding. This is done in the left-hand side of equation 3.11 by summing each term in the left-hand side of equation 3.10 over all j loan types. Therefore, equation 3.11 represents the debt-to-equity ratio constraint on the beginning farmer.

The beginning farmer's net worth at the end of year t is defined by equation 3.12 as the value at the end of year t of the amount of the beginning farmer's equity held in noncash assets at the end of the previous year, minus the total amount of depreciation taken in year t, plus the total amount invested in durable assets during year t, plus the total amount invested in off-farm assets during year t, minus the total value of durable assets sold during year t, minus the total amount of new debt incurred during year t, plus the total amount of principal payments (debt reduction) made during year t, plus the amount of cash held by the beginning farmer at the end of year t.

The amount of cash on hand at the end of period k of year t is defined in equation 3.13 as the amount of cash on hand at the end of the previous period, plus the total returns from all agricultural product marketing activities during the period, plus the total returns from all off-farm assets held during the period, plus the total returns from all off-farm employment activities during the period, plus the total returns from all durable asset selling activities during the period, plus the total proceeds from all new borrowings during the period, minus the total expenses of all production activities engaged in during the year, minus the total costs of all durable asset investment during the period, minus the total costs of all off-farm asset investment during the period, minus the total amount of all debt servicing during the period, minus the total costs of all renting and leasing during the period, minus the total amount of taxes that must be paid during the period.

One of the uses of cash is the debt service requirement in period k of year t, which is defined in equation 3.14. The debt service requirement on loan type j in period k of year t is defined as the summation of the principal payment required on loan type j in period k of year t and the interest payment required on loan type j in period k of year t. The principal and interest payment requirements on loan type j in period k of year t are then defined in equations 3.15 and 3.16, respectively. Equation 3.15 defines the principal payment required on loan type j in period k of year t as the amount of principal which must be paid in period k of year t on loan type j that was taken out in all periods of all previous years plus the amount of principal which must be paid in period k of year t on loan type j that was taken out in all previous periods of year t. Equation 3.16 defines the interest payment required on loan type j in period k of year t as the amount of interest which must be paid in period k of year t on outstanding debt of loan type j that was taken out in all periods of all previous years plus the amount of interest which must be paid in period k of year t on outstanding debt of loan type j that was taken out in all previous periods of year t.

Equation 3.17 defines the level of off-farm asset j in period k of year t as the level of asset j in the previous period, plus the level of investment in asset j in the present period, minus the amount of asset j sold in the present period.

Equation 3.18 constrains the amount of agricultural product i marketed in period k of year t to be less than or equal to the amount available. The amount of agricultural product i available in period k of year t is the amount of product i produced in all periods of previous years, plus the amount of product i produced in previous periods of year t, minus the amount of product i marketed in all periods of previous years, minus the amount of product i marketed in previous periods of year t, plus the amount of product i bought in all periods of previous years, plus the amount of product i bought in previous periods of year t.

Depreciation of durable assets affected net worth as described in equation 3.12 and also affected taxable income as described in equation 3.5. Depreciation of durable asset j in year t is defined by equation 3.19. The term in parenthesis defines the dollar amount of durable asset j owned in year t as the total dollar amount invested in durable asset j in years before year t, minus the total dollar value of durable asset j sold in years before year t. Multiplying this value of durable assst j owned in year t by the depreciation rate of one unit of durable asset j in year t gives the depreciation of durable asset j in year t.

Finally, equation 3.20 constrains the value of certain variables to be non-negative.

This programming model of the beginning farmer can be used to evaluate the financial strategies used to acquire the resources to start farming. As λ in equation 3.3 is parameterized from zero to unbounded the efficient E,A frontier for the multiperiod MOTAD model of the beginning farmer is generated. This curve is unique for the activities included in the model, such as investment, financing, and production activities available, and for the values of the parameters in the model, such as beginning equity, required debt-to-equity ratio, production coefficients, and the consumption function of the farm family. The efficient farm plans associated with the points on the efficient E,A curve specify an investment, financing, production, and marketing plan over the T years of the analysis. The effects of these plans on cash flow, net worth, resource ownership, resource use, and family consumption, besides expected income and risk level can be obtained for each of the T years. The variance of each year's expected income can be calculated and the probability of exceeding certain income levels can be determined.

The next chapter describes in detail the numerical model developed from this mathematical programming model in terms of financial strategies, production activities, and parameter values that are considered. The following chapter then presents the results obtained from the empirical model used to evaluate the financial strategies used by beginning farmers to enter farming.

CHAPTER 4. THE EMPIRICAL MODEL

Overview

The empirical model presented in this chapter is developed from the mathematical model of the beginning farmer presented in Chapter 3. The objective function minimizes the summation of the discounted values of the negative deviations resulting from agricultural product selling activities. In other words, the only risky activities in the model are agricultural product selling activities; it is assumed the variation in income is caused by the variation in agricultural product prices. Investment and financing activities are provided for acquiring machinery, land, cattle feeding facilities, hog farrowing facilities, and hog feeding facililties. Crop and livestock production activities are included. Marketing activities are provided for selling agricultural products produced and buying activities are provided for acquiring agricultural products required by the production activities. There are also activities included for investment in off-farm assets (savings account), off-farm employment, crop storage, short-term borrowing, renting land, tax paying, and family consumption withdrawals. Restraints which specify the amount of resources available, impose restrictions on the level of certain activities, provide accounting of several financial variables, and require the payment of financial obligations, taxes, and consumption are included.

The model proposes to depict the first five years of a farm firm's existence. A year is defined as January 1 through December 31. There is also an initial period which allows investment in machinery, land,

and livestock facilities before the first year of operation. This period is necessary to provide these assets to be used in the first year of operation. Each of the five years is divided into two periods; each period is six months in length. Some activities occur in each period (selling grain, storing grain, selling market livestock, buying feeder livestock, short-term borrowing, etc.) and some activities occur each year (paying taxes, paying long-term debt obligations, crop production, land investment, machinery investment, livestock facilities investment, etc.).

The years are tied together in several ways. Investment in machinery provides crop production capacity and depreciation deductions in future years. Investment in land provides land for crop production in future years. Investment in livestock facilities provides hog farrowing capacity and hog and cattle feeding capacity in future years. Financing the purchase of machinery, land, and livestock facilities creates debt repayment obligations in future years. These investment and financing activities also create asset and debt values in future years' balance sheets. Crops harvested in the second period of one year can be stored and marketed or used in the first period of the next year. Calves placed on feed in one year are marketed in the next year. Yearling cattle placed on feed in the fall of one year are marketed in the spring of the next year. Cash not used in one period is transferred to the following period. Nearly all activities affect the net worth in any one year, which in turn affects the amount of borrowing that can be undertaken in the next year.

Machinery Investment

Machinery investment activities provided in period 0 and in year 2 through year 5 allow the beginning farmer to buy three types of crop production systems, two types of combines, and a silage harvester. The three crop production systems provide the necessary machinery to grow crops. The labor intensive crop production system is the least expensive, gives the lowest crop production capacity, and uses the most labor per acre of use. The capital intensive crop production system is the most expensive, gives the largest crop production capacity, and uses the least labor per acre of use. The intermediate crop production system is intermediate in all three aspects. Appendix Table A.1 shows the investment cost, the crop production capacity, and the machinery included in each crop production system. The two combine types can be used to harvest oats, soybeans, and corn. The labor intensive combine is the less expensive, gives the smaller harvest capacity, and uses more labor per acre of use. The capital intensive combine is the more expensive, gives the larger harvest capacity, and uses less labor per acre of use. Appendix Table A.1 shows the investment cost and harvesting capacity of both combines. One type of silage harvester can be used to harvest corn as silage. The investment cost and harvesting capacity of this silage harvester are given in Appendix Table A.1.

Table 4.1 presents the tableau of machinery buying activities in period 0. Buying a crop production system, a combine, or a silage harvester creates a machinery debt equal to the cost of investment which must be paid by one of the machinery financing activities in period 0.

Table 4.1. Machinery investment activities in period 0.

Row	Row Type	RHS	Buy Crop Production System*	Buy Combine*	Buy Silage Harvester*
Machinery Debt, period 0	E	0	-a	-a	-a
Crop Production Capacity, year 1	L	0	-b		
⋮	⋮	⋮	⋮		
Crop Production Capacity, year 5	L	0	-b		
Oat Harvesting Capacity, year 1	L	0		-c	
⋮	⋮	⋮		⋮	
Oat Harvesting Capacity, year 5	L	0		-c	
Soybean Harvesting Capacity, year 1	L	0		-d	
⋮	⋮	⋮		⋮	
Soybean Harvesting Capacity, year 5	L	0		-d	
Corn Harvesting Capacity, year 1	L	0		-e	
⋮	⋮	⋮		⋮	
Corn Harvesting Capacity, year 5	L	0		-e	
Silage Harvesting Capacity, year 1	L	0			-f
⋮	⋮	⋮			⋮
Silage Harvesting Capacity, year 5	L	0			-f
Intermediate Asset Accounting Row, period 0	E	0	-a	-a	-a
⋮	⋮	⋮	⋮	⋮	⋮
Intermediate Asset Accounting Row, year 5	E	0	-g	-g	-g
Depreciation Accounting Row, period 0	E	0	-h	-h	-h
⋮	⋮	⋮	⋮	⋮	⋮
Depreciation Accounting Row, year 5	E	0	-h	-h	-h

*a: initial investment price, b: crop production capacity, c: oat harvesting capacity, d: soybean harvesting capacity, e: corn harvesting capacity, f: silage harvesting capacity, g: intermediate asset value, h: depreciation value.

Buying a crop production system creates crop production capacity in all future years. Buying a combine creates harvest capacity in all future years, and buying the silage harvester creates silage harvesting capacity in all future years.

Table 4.2 presents the tableau of machinery buying activities in year t, t = 2,3,4,5. Buying a crop production system, a combine, or a silage harvester creates a machinery debt equal to the investment cost which must be paid by one of the machinery financing activities in year t. Buying a crop production system in year t creates crop production capacity in year t and in all future years. Buying a combine in year t creates crop harvesting capacity in year t and in all future years, and buying the silage harvester in year t creates silage harvesting capacity in year t and all future years.

Buying a crop production system, a combine, or the silage harvester creates intermediate assets and depreciation deductions in the year it is purchased and future years. Accounting rows are provided in period 0 and all years for intermediate assets and accounting rows are provided in all years for depreciation. These accounting rows are shown in Table 4.1 and Table 4.2. Depreciation is an accounting convenience used to prorate the cost of an asset with an expected life of more than one year over its projected life. Ideally, depreciation should reflect the actual decline in the value of the asset over time (45). But different assets depreciate at various rates due to the effects of use, maintenance, and obsolescence. Also, it is almost impossible to accurately reflect the true depreciation with any of the methods of

Table 4.2. Machinery investment activities in year t, t=2, 3, 4, 5.

Row	Row Type	RHS	Buy Crop Production System*	Buy Combine*	Buy Silage Harvester*
Machinery Debt, year t	E	0	-a	-a	-a
Crop Production Capacity, year t	L	0	-b		
⋮	⋮	⋮	⋮		
Crop Production Capacity, year 5	L	0	-b		
Oat Harvesting Capacity, year t	L	0		-c	
⋮	⋮	⋮		⋮	
Oat Harvesting Capacity, year 5	L	0		-c	
Soybean Harvesting Capacity, year t	L	0		-d	
⋮	⋮	⋮		⋮	
Soybean Harvesting Capacity, year 5	L	0		-d	
Corn Harvesting Capacity, year t	L	0		-e	
⋮	⋮	⋮		⋮	
Corn Harvesting Capacity, year 5	L	0		-e	
Silage Harvesting Capacity, year t	L	0			-f
⋮	⋮	⋮			⋮
Silage Harvesting Capacity, year 5	L	0			-f
Intermediate Asset Accounting Row, year t	E	0	-g	-g	-g
⋮	⋮	⋮	⋮	⋮	⋮
Intermediate Asset Accounting Row, year 5	E	0	-g	-g	-g
Depreciation Accounting Row, year t	E	0	-h	-h	-h
⋮	⋮	⋮	⋮	⋮	⋮
Depreciation Accounting Row, year 5	E	0	-h	-h	-h

*a: initial investment price, b: crop production capacity, c: oat harvesting capacity, d: soybean harvesting capacity, e: corn harvesting capacity, f: silage harvesting capacity, g: intermediate asset value, h: depreciation value.

computing depreciation approved by the Internal Revenue Service (45). Charging depreciation reduces taxable income, but it does not reduce cash. By reducing the tax obligation, charging depreciation actually increases cash. This makes the choice of the method used for computing depreciation very important.

Two methods of computing depreciation are considered in this model; the straight-line method and the double-declining-balance method, which is a method of accelerated depreciation. Two activities are provided for the investment in each crop production system, each combine, and the silage harvester: one depreciates the asset using the straight-line method while the other activity depreciates the asset using the double-declining-balance method. The formula for calculating depreciation in year t using the straight-line method is:

$$DP_t = IC/n$$

where: DP_t = depreciation in year t,

IC = investment cost,

n = the expected life of the asset, which is assumed to be 10 years in this model.

The straight-line method provides the same amount of depreciation during each year of the asset's life. The depreciation schedules using the straight-line method for each asset are built into the machinery investment activities which use the straight-line method as shown in Table 4.1 and Table 4.2. The formula for calculating depreciation in year t using the double-declining-balance method is:

$$DP_t = (2/n)R_t$$

where: DP_t = depreciation in year t,

R_t = remaining book value at the beginning of year t,

n = the expected life of the asset, which is assumed to be 10 years in this model.

The double-declining-balance method provides depreciation during year t which is 20 percent of the remaining book value at the beginning of year t. The depreciation schedules using the double-declining-balance method for each asset are built into the machinery investment activities which use the double-declining-balance method as shown in Table 4.1 and Table 4.2.

Investment in machinery in period 0 adds to the intermediate assets of the beginning farmer at the end of period 0 and all future years. The intermediate asset value at the end of period 0 is the cost of the investment since no depreciation occurs during period 0. The intermediate asset value at the end of any future year is the intermediate asset value at the end of the previous year minus the amount of depreciation which occurs during the year. The intermediate assets created in each year by machinery investment activities in period 0 are shown in Table 4.1.

Investment in machinery in year t adds to the intermediate assets of the beginning farmer at the end of year t and all future years. The intermediate asset value at the end of year t is the cost of investment minus the depreciation which occurs during year t. The intermediate asset value at the end of any future year is the intermediate asset value at the end of the previous year minus the amount of depreciation which occurs during the year. The intermediate asset values created in each year by machinery investment activities in year t are shown in Table 4.2.

Machinery Financing

Three activities are provided in year t, t=0,2,3,4,5, to pay for machinery purchases in year t. Table 4.3 shows the three machinery financing activities provided in each year. Machinery investment may be financed by paying cash, using an intermediate-term loan, or using dealer credit. Each of these three activities provides one dollar to satisfy the machinery debt created by the machinery investment activities in year t. Paying cash for machinery in year t uses cash in the first period of year t. Using an intermediate-term loan to pay for machinery creates a machinery intermediate-term debt which must be paid within four years. An interest rate of 9 percent is charged each year on the unpaid balance of the machinery intermediate-term debt. Using dealer credit to finance machinery investment creates a machinery dealer debt which must be paid in four years. An interest rate of 12 percent is charged each year on the unpaid balance of the machinery dealer debt.[1] Using an intermediate-term loan or dealer credit to finance machinery investment in year t also adds to the

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[1]The terms of a machinery intermediate-term loan depends on the institution making the loan and its evaluation of the beginning farmer. Likewise, the terms of a machinery dealer loan varies among dealers. The terms used in this model are considered to be representative of the terms of machinery loans.

Table 4.3. Machinery financing activities in year t, t=0,2,3,4,5.

Row	Row Type	RHS	Pay Cash	Inter-mediate Loan	Dealer Loan
Machinery Debt, year t	E	0	1	1	1
Cash, first period of year t	L	0	1		
Intermediate Loan, year t, Principal Repayment	G	0		-1	
Intermediate Loan, year t, Interest Payment, year t+1	G	0		-1	
Intermediate Loan, year t, Interest Payment, year t+2	G	0		-1	
Intermediate Loan, year t, Interest Payment, year t+3	G	0		-1	
Intermediate Loan, year t, Interest Payment, year t+4	G	0		-1	
Dealer Loan, year t, Principal Repayment	G	0			-1
Dealer Loan, year t, Interest Payment, year t+1	G	0			-1
Dealer Loan, year t, Interest Payment, year t+2	G	0			-1
Dealer Loan, year t, Interest Payment, year t+3	G	0			-1
Dealer Loan, year t, Interest Payment, year t+4	G	0			-1
Intermediate Debt Accounting Row, year t	E	0		-1	-1
Intermediate Debt Accounting Row, year t+1	E	0		-1	-1
Intermediate Debt Accounting Row, year t+2	E	0		-1	-1
Intermediate Debt Accounting Row, year t+3	E	0		-1	-1
Intermediate Debt Accounting Row, year t+4	E	0		-1	-1

intermediate debt in the beginning farmer's balance sheet at the end of year t and the next four years.

The activities which pay the principal and interest charges of the machinery intermediate-term loan of year t and the machinery dealer loan of year t are shown in Table 4.4. These activities are provided in each of the four years following year t. Paying one dollar of the principal of machinery intermediate-term loan of year t satisfies one dollar of intermediate-term debt created in year t. Paying one dollar of the principal of machinery intermediate-term loan of year t also reduces by one dollar the amount of outstanding intermediate debt in future years on which interest must be paid. Paying one dollar of the principal of machinery intermediate-term loan of year t also reduces the amount of intermediate-term debt in the beginning farmer's balance sheet at the end of the year it is paid and future years by one dollar. Finally, paying one dollar of the principal of machinery intermediate-term loan uses one dollar of cash during the first period of the year it is paid. Interest must be paid on the outstanding debt of machinery intermediate-term loans. Paying interest on one dollar of outstanding debt of machinery intermediate-term loans uses nine cents of cash in the first period of the year it is paid and reduces taxable income in the year it is paid by nine cents.

Paying one dollar of the principal of machinery dealer loan of year t satisfies one dollar of dealer debt created in year t. Paying one dollar of the principal of machinery dealer loan of year t also reduces the amount of outstanding dealer debt in future years on which

Table 4.4. Tableau of activities which pay principal and interest on intermediate and dealer loans.

Row	Row Type	RHS	Pay Principal on Intermediate Loan in year: t+1	t+2	t+3	t+4	Pay Interest on Intermediate Loan in year: t+1	t+2	t+3	t+4
Intermediate Loan, year t										
Principal Repayment	G	0	1	1	1	1				
Interest Payment, year t+1	G	0					1			
Interest Payment, year t+2	G	0	1					1		
Interest Payment, year t+3	G	0	1	1					1	
Interest Payment, year t+4	G	0	1	1	1					1
Dealer Loan, year t										
Principal Repayment	G	0								
Interest Payment, year t+1	G	0								
Interest Payment, year t+2	G	0								
Interest Payment, year t+3	G	0								
Interest Payment, year t+4	G	0								
Intermediate Debt Accounting Row										
year t+1	E	0	1							
year t+2	E	0	1	1						
year t+3	E	0	1	1	1					
year t+4	E	0	1	1	1	1				
Cash, first period of year t+1	L	0	1				.09			
Income Accounting Row, year t+1	E	0					.09			
Cash, first period of year t+2	L	0		1				.09		
Income Accounting Row, year t+2	E	0						.09		
Cash, first period of year t+3	L	0			1				.09	
Income Accounting Row, year t+3	E	0							.09	
Cash, first period of year t+4	L	0				1				.09
Income Accounting Row, year t+4	E	0								.09

Table 4.4 (continued).

Row	Pay Principal on Dealer Loan in year:				Pay Interest on Dealer Loan in year:			
	t+1	t+2	t+3	t+4	t+1	t+2	t+3	t+4
Intermediate Loan, year t								
Principal Repayment								
Interest Payment, year t+1								
Interest Payment, year t+2								
Interest Payment, year t+3								
Interest Payment, year t+4								
Dealer Loan, year t								
Principal Repayment	1	1	1	1				
Interest Payment, year t+1					1			
Interest Payment, year t+2	1					1		
Interest Payment, year t+3	1	1					1	
Interest Payment, year t+4	1	1	1					1
Intermediate Debt Accounting Row								
year t+1	1							
year t+2	1	1						
year t+3	1	1	1					
year t+4	1	1	1	1				
Cash, first period of year t+1	1				.12			
Income Accounting Row, year t+1					.12			
Cash, first period of year t+2		1				.12		
Income Accounting Row, year t+2						.12		
Cash, first period of year t+3			1				.12	
Income Accounting Row, year t+3							.12	
Cash, first period of year t+4				1				.12
Income Accounting Row, year t+4								.12

interest must be paid by one dollar. Paying one dollar of the principal of machinery dealer loan of year t also reduces the amount of intermediate-term debt in the beginning farmer's balance sheet at the end of the year it is paid and future years by one dollar. Finally, paying one dollar of the principal of machinery dealer loan uses one dollar of cash in the first period of the year it is paid. Interest must be paid on the outstanding debt of machinery dealer loans. Paying interest on one dollar of outstanding debt of machinery dealer loans uses 12 cents of cash in the first period of the year it is paid and reduces taxable income in the year it is paid by 12 cents.

Land Investment and Financing

Fourteen land purchase plans are considered in this model. Seven plans require a down payment of 20 percent of the purchase price and an interest payment of 8 percent of the unpaid principal each year. These seven plans are shown in Table 4.5. Plan A and Plan B are known as Springfield plans, which means an equal principal payment is required each year. Plan A has a loan length of 20 years while Plan B has a loan length of 15 years. This means that Plan A has a lower principal and total payment than Plan B in each year. But over the length of the loan, Plan B has a lower total interest charge and a lower total cost than Plan A. Plan C is a variation of the Springfield plan which provides for deferred principal payments. Only interest is paid for the first three years of the loan and then over the next 15 years Plan C is identical to Plan B. Paying only interest charges in the first three years reduces the amount of cash needed for debt

Table 4.5. Repayment plans for land with a down payment of 20 percent and an 8 percent interest rate ($1,000 per acre and $800 principal).

Year	Plan A			Plan B			Plan C			Plan D		
	Prin.	Int.	Total	Prin.	Int.	Total	Prin.	Int.	Total	Prin.	Int.	Total
1	40.00	64.00	104.00	53.34	64.00	117.34	0.00	64.00	64.00	17.49	64.00	81.49
2	"	60.80	100.80	"	59.73	113.07	0.00	64.00	64.00	18.89	62.60	"
3	"	57.60	97.60	"	55.47	108.81	0.00	64.00	64.00	20.40	61.09	"
4	"	54.40	94.40	"	51.20	104.54	53.34	64.00	117.34	22.03	59.46	"
5	"	51.20	91.20	"	46.93	100.27	"	59.73	113.07	23.79	57.70	"
6	"	48.00	88.00	"	42.66	96.00	"	55.47	108.81	25.70	55.79	"
7	"	44.80	84.80	"	38.40	91.74	"	51.20	104.54	27.75	53.74	"
8	"	41.60	81.60	"	34.13	87.47	"	46.93	100.27	29.97	51.52	"
9	"	38.40	78.40	"	29.86	83.20	"	42.66	96.00	32.37	49.12	"
10	"	35.20	75.20	"	25.60	78.94	"	38.40	91.74	34.96	46.53	"
11	"	32.00	72.00	"	21.33	74.67	"	34.13	87.47	37.76	43.73	"
12	"	28.80	68.80	"	17.06	70.40	"	29.86	83.20	40.78	40.71	"
13	"	25.60	65.60	"	12.79	66.13	"	25.60	78.94	44.04	37.45	"
14	"	22.40	62.40	"	8.53	61.87	"	21.33	74.67	47.56	33.93	"
15	"	19.40	59.40	"	4.26	57.60	"	17.06	70.40	51.37	30.12	"
16	"	16.00	56.00				"	12.79	66.13	55.48	26.01	"
17	"	12.80	52.80				"	8.53	61.87	59.92	21.57	"
18	"	9.60	49.60				"	4.26	57.60	64.71	16.78	"
19	"	6.40	46.40							69.89	11.60	"
20	"	3.20	43.20							75.48	6.01	"
Total	800.00	672.00	1472.00	800.10	511.95	1312.05	800.10	703.95	1504.05	800.34	829.46	1629.80

Table 4.5 (continued).

Year	Plan E Prin.	Plan E Int.	Plan E Total	Plan F Prin.	Plan F Int.	Plan F Total	Plan G Prin.	Plan G Int.	Plan G Total
1	29.47	64.00	93.47	0.00	64.00	64.00	14.04	64.00	78.04
2	31.83	61.64	"	0.00	64.00	64.00	19.65	62.88	82.53
3	34.37	59.10	"	0.00	64.00	64.00	25.26	61.30	86.56
4	37.12	56.35	"	29.47	64.00	93.47	30.88	59.28	90.16
5	40.09	53.38	"	31.83	61.64	"	36.49	56.81	93.30
6	43.30	50.17	"	34.37	59.10	"	42.11	53.89	96.00
7	46.76	46.71	"	37.12	56.35	"	47.72	50.53	98.25
8	50.50	42.97	"	40.09	53.38	"	53.33	46.71	100.04
9	54.54	38.93	"	43.30	50.17	"	58.95	42.44	101.39
10	58.91	34.56	"	46.76	46.71	"	64.56	37.73	102.29
11	63.62	29.85	"	50.50	42.97	"	70.18	32.56	102.74
12	68.71	24.76	"	54.54	38.93	"	75.79	26.95	102.74
13	74.21	19.26	"	58.91	34.56	"	81.40	20.88	102.28
14	80.14	13.33	"	63.62	29.85	"	87.02	14.37	101.39
15	86.55	6.92	"	68.71	24.76	"	92.63	7.41	100.04
16				74.21	19.26	"			
17				80.14	13.33	"			
18				86.55	6.92	"			
19									
20									
Total	800.12	601.93	1402.05	800.12	793.93	1594.05	800.01	637.74	1437.75

servicing in these years as compared with Plan A and Plan B. However, over the length of the loan Plan C has a higher total interest charge and a higher total cost than both Plan A and Plan B.

Plan D and Plan E are known as Standard plans, which means an equal total payment is required each year. Over the length of the loan the principal payment increases while the interest payment decreases. Plan D has a loan length of 20 years while Plan E has a loan length of 15 years. This means that Plan D requires a lower total payment than Plan E each year, but over the length of the loan Plan D has a higher total interest charge and a higher total charge than Plan E. A variation of the Standard plan which provides for deferred principal payments is given by Plan F. Only the interest charge is paid in the first three years of the loan and then over the next 15 years Plan F is identical to Plan E.

Plan G is an increasing principal payment plan. This plan requires the principal payment to increase by 40 percent of the first year's principal payment in each year (68). That is, if the first year's payment is P_1, then the second year's principal payment is $1.4P_1$, the third year's principal payment is $1.8P_1$, and the nth year's principal payment is $\{1+.4(n-1)\}P_1$. The total principal payment over the length of the loan is $\sum_{n=1}^{N} \{1+.4(n-1)\}P_1$ where N is the length of the loan. The first year's principal payment, P_1, then is found by dividing the total principal required by the value $\sum_{n=1}^{N}\{1+.4(n-1)\}$. Each year's principal payment then determined by the formula:

$$P_n = \{1+.4(n-1)\}P_1$$

where: P_n = nth year's principal payment,

P_1 = first year's principal payment.

The interest payment in each year is again 8 percent of the unpaid balance. This type of increasing principal repayment plan would require less cash for debt servicing in the beginning years. The amount of cash required for debt servicing would gradually increase as, hopefully, the beginning farmer's repayment capacity increases.

The second set of land purchase plans is shown in Table 4.6. These seven plans require a down payment of 15 percent of the purchase price and an interest payment of 9 percent of the unpaid balance each year. Plan H and Plan I are Springfield plans with a loan length of 20 years and 15 years, respectively. Plan J is a variation of the Springfleld plan which is identical to Plan I, except that the principal payments are deferred for three years. Plan K and Plan L are Standard plans with a loan length of 20 and 15 years, respectively. Plan M is a variation of the Standard plan which is identical to Plan L except that the principal payments are deferred for three years. Plan N is an increasing principal payment plan with a loan length of 15 years. The principal payments are calculated as explained in the discussion of Plan G.

The land buying activities which incorporate these 14 repayment plans in the empirical model are shown in Table 4.7. The first seven land buying activities each add to long-term principal payment constraints for 8 percent loans in future years by the amount given by the corresponding repayment plans. Each of these plans requires a

Table 4.6. Repayment plans for land with a down payment of 15 percent and a 9 percent interest rate ($1,000 per acre and $850 principal).

Year	Plan H			Plan I			Plan J			Plan K		
	Prin.	Int.	Total	Prin.	Int.	Total	Prin.	Int.	Total	Prin.	Int.	Total
1	42.50	76.50	119.00	56.67	76.50	133.17	0.00	76.50	76.50	16.62	76.50	93.12
2	"	72.68	115.18	"	71.40	128.07	0.00	76.50	76.50	18.11	75.01	"
3	"	68.85	111.35	"	66.30	122.97	0.00	76.50	76.50	19.74	73.38	"
4	"	65.03	107.53	"	61.20	117.87	56.67	76.50	133.17	21.52	71.60	"
5	"	61.20	103.70	"	56.10	112.77	"	71.40	128.07	23.46	69.66	"
6	"	57.38	99.88	"	51.00	107.67	"	66.30	122.97	25.57	67.55	"
7	"	53.55	96.05	"	45.90	102.57	"	61.20	117.87	27.87	65.25	"
8	"	49.73	92.23	"	40.80	97.47	"	56.10	112.77	30.38	62.74	"
9	"	45.90	88.40	"	35.70	92.37	"	51.00	107.67	33.11	60.01	"
10	"	42.08	84.58	"	30.60	87.27	"	45.90	102.57	36.09	57.03	"
11	"	38.25	80.75	"	25.50	82.17	"	40.80	97.47	39.04	53.78	"
12	"	34.43	76.93	"	20.40	77.07	"	35.70	92.37	42.88	50.24	"
13	"	30.60	73.10	"	15.30	71.97	"	30.60	87.27	46.74	46.38	"
14	"	26.78	69.28	"	10.20	66.87	"	25.50	82.17	50.95	42.17	"
15	"	22.95	65.45	"	5.10	61.77	"	20.40	77.07	55.53	37.59	"
16	"	19.13	61.63				"	15.30	71.97	60.53	32.59	"
17	"	15.30	57.80				"	10.20	66.87	65.98	27.14	"
18	"	11.48	53.98				"	5.10	61.77	71.92	21.20	"
19	"	7.65	50.15							78.39	14.73	"
20	"	3.83	46.33							85.44	7.68	"
Total	850.00	803.30	1653.30	850.05	612.00	1462.05	850.05	841.50	1691.55	850.17	1012.23	1862.40

Table 4.6 (continued).

Year	Plan L Prin.	Plan L Int.	Plan L Total	Plan M Prin.	Plan M Int.	Plan M Total	Plan N Prin.	Plan N Int.	Plan N Total
1	28.95	76.50	105.45	0.00	76.50	76.50	14.91	76.50	91.41
2	31.56	73.89	"	0.00	76.50	76.50	20.88	75.16	96.04
3	34.40	71.05	"	0.00	76.50	76.50	26.84	73.28	100.12
4	37.49	67.96	"	28.95	76.50	105.45	32.81	70.86	103.67
5	40.87	64.58	"	31.56	73.89	"	38.77	67.91	106.68
6	44.54	60.91	"	34.40	71.05	"	44.74	64.42	109.16
7	48.55	56.90	"	37.49	67.96	"	50.70	60.39	111.09
8	52.92	52.53	"	40.87	64.58	"	56.67	55.83	112.50
9	57.69	47.76	"	44.54	60.91	"	62.63	50.73	113.36
10	62.88	42.57	"	48.55	56.90	"	68.60	45.09	113.69
11	68.54	36.91	"	52.92	52.53	"	74.56	38.92	113.48
12	74.71	30.74	"	57.69	47.76	"	80.53	32.21	112.74
13	81.43	24.02	"	62.88	42.57	"	86.49	24.96	111.45
14	88.76	16.69	"	68.54	36.91	"	92.46	17.18	109.64
15	96.75	8.70	"	74.71	30.74	"	98.42	8.86	107.28
16				81.43	24.02	"			
17				88.76	16.69	"			
18				96.75	8.70	"			
19									
20									
Total	850.04	731.71	1581.75	850.04	961.21	1811.25	850.01	762.30	1612.31

Table 4.7. Tableau of land purchasing activities in year t, t=0,1,2,3,4,5.

Row	Row Type	RHS	Buy Land 8% Loan 20% Down*	Buy Land 9% Loan 15% Down*
Principal Repayment on 8% Long-Term Loans, year t+1	G	0	$-a_1$	
Principal Repayment on 8% Long-Term Loans, year t+2	G	0	$-a_2$	
Principal Repayment on 8% Long-Term Loans, year t+3	G	0	$-a_3$	
Principal Repayment on 8% Long-Term Loans, year t+4	G	0	$-a_4$	
Principal Repayment on 8% Long-Term Loans, year t+5	G	0	$-a_5$	
Interest Payment on 8% Long-Term Loans, year t+1	E	0	-800	
⋮	⋮	⋮	⋮	
Interest Payment on 8% Long-Term Loans, year 5	E	0	-800	
Principal Repayment on 9% Long-Term Loans, year t+1	G	0		$-b_1$
Principal Repayment on 9% Long-Term Loans, year t+2	G	0		$-b_2$
Principal Repayment on 9% Long-Term Loans, year t+3	G	0		$-b_3$
Principal Repayment on 9% Long-Term Loans, year t+4	G	0		$-b_4$
Principal Repayment on 9% Long-Term Loans, year t+5	G	0		$-b_5$
Interest Payment on 9% Long-Term Loans, year t+1	E	0		-850
⋮	⋮	⋮		⋮
Interest Payment on 9% Long-Term Loans, year 5	E	0		-850
Long-Term Assets Accounting Row, year t	E	0	-1000	-1000
⋮	⋮	⋮	⋮	⋮
Long-Term Assets Accounting Row, year 5	E	0	-1000	-1000
Long-Term Debt Accounting Row, year t	E	0	-800	-850
⋮	⋮	⋮	⋮	⋮
Long-Term Debt Accounting Row, year 5	E	0	-800	-850
Cash, first period of year t	L	0	200	150
Land Transfer Row, year t to year t+1	L	0	-1	-1

* a_i: appropriate principal repayment in year t+1 from Table 4.5, b_i: appropriate principal repayment in year t+1 from Table 4.6.

20 percent down payment, so each one uses $200 of cash in the first period of year t. This leaves an unpaid balance of $800 which is added to the long-term interest payment constraints for 8 percent loans in future years. These activities also add $800 to long-term debt in the beginning farmer's balance sheet at the end of year t and all future years. The second seven land buying activities correspond to repayment Plan H through Plan N. Each of these activities add to long-term principal payment constraints for 9 percent loans in future years by the amount given by the corresponding repayment plans. Each of these plans requires a 15 percent down payment, so each one uses $150 of cash in year t. This leaves an unpaid balance of $850 which is added to the long-term interest payment constraints for 9 percent loans in future years. These activities also add $850 to long-term debt in the beginning farmer's balance sheet at the end of year t and all future years. All 14 land buying activities in year t add $1,000 to long-term assets in the beginning farmer's balance sheet at the end of year t and all future years. Each land buying activity in year t adds one acre of land to the transfer row which transfers land from year t to year t+1.

The assumed purchase price of one acre of land in this model is $1,000 and the unit of activity of each land buying activity is one acre. If a different land price is used it is not necessary to recalculate each repayment plan and revise the corresponding land buying activities. Rather, the unit of activity can be changed and the amount of land added to the land transfer row can be revised. For example, if the assumed land price was \$2,000 instead of \$1,000 then the unit of activity of each land buying activity would be one-half an acre and each land buying activity would add .5 of an acre to the land transfer row.

Livestock Facility Investment and Financing

Livestock enterprises considered in this model are cattle feeding, hog farrowing, and hog feeding. Cattle feeding facilities considered are open-lot with windbreak fence, open-lot with shed, cold confinement slotted floor barn, and warm confinement slotted floor barn. The investment costs for these cattle feeding facilities are given in Appendix Table A.2 through Appendix Table A.5. Hog farrowing facilities considered are pasture system, partial confinement system, and total confinement system. The investment costs for these hog farrowing facilities are given in Appendix Tables A.6, A.7, and A.8. Hog feeding facilities considered are pasture system, partial confinement system, and total confinement system. The investment costs for these hog feeding facilities are given in Appendix Tables A.9, A.10, and A.11.

Five repayment plans for financing each livestock facility are considered. Each repayment plan for the cattle feeding facilities finances the investment of one head capacity of a cattle feeding facility, each repayment plan for the hog farrowing facilities finances the purchase of one sow space of a hog farrowing facility, and each repayment plan for the hog feeding facilities finances the purchase of one head capacity of a hog feeding facility. The five repayment plans for financing the investment in the four cattle feeding facilities are given in Table 4.8 through Table 4.11. The five repayment plans for financing the investment in the three hog farrowing systems are given in Tables 4.12, 4.13, 4.14. The five repayment plans for financing the investment in the three hog feeding systems are given in Tables 4.15, 4.16, and 4.17. Each repayment plan requires a down payment of 20 percent of the purchase price and an annual interest payment of 9 percent of the unpaid balance. Plan A in each case is a Springfield plan which requires an equal principal payment in each year over the length of the loan. Plan B is a variation of the Springfield plan which defers the first principal payment for two years. Plan C is a Standard plan which requires an equal total payment in each year over the length of the loan. Plan D is a variation of the Standard plan which defers the first principal payment for two years. Plan E is an increasing payment plan which requires the principal payment to increase each year by 40 percent of the first year's principal payment.

The activities which acquire livestock facilities in period 0 are shown in Table 4.18. Five activities, one for each repayment plan, are provided for investment in each livestock facility in period 0. The five investment activities for each livestock facility add to long-term principal payment constraints for 9 percent loans in future years by the amount given in the corresponding repayment plan.

Once a livestock facility is purchased it can be depreciated using the straight-line method or the double-declining-balance method. The expected life of each cattle feeding facility is 10 years, so depreciation using both method is calculated using an expected life of 10 years.

Table 4.8. Repayment plans for open-lot with windbreak fence cattle feeding facility ($192.00 cost per head capacity, 20% down payment, 9% interest rate, $153.60 principal).

	Plan A			Plan B			Plan C		
Year	Prin.	Int.	Total	Prin.	Int.	Total	Prin.	Int.	Total
1	15.36	13.83	29.19	0.00	13.83	13.83	10.11	13.83	23.94
2	"	12.45	27.81	0.00	13.83	13.83	11.02	12.92	"
3	"	11.06	26.42	15.36	13.83	29.19	12.01	11.93	"
4	"	9.68	25.04	"	12.45	27.81	13.10	10.84	"
5	"	8.30	23.66	"	11.06	26.42	14.27	9.67	"
6	"	6.92	22.28	"	9.68	25.04	15.56	8.38	"
7	"	5.53	20.89	"	8.30	23.66	16.96	6.98	"
8	"	4.15	19.51	"	6.92	22.28	18.48	5.46	"
9	"	2.77	18.13	"	5.53	20.89	20.15	3.79	"
10	"	1.39	16.75	"	4.15	19.51	21.96	1.98	"
11				"	2.77	18.13			
12				"	1.39	16.75			
Total	153.60	76.08	229.68	153.60	103.74	257.34	153.62	85.78	239.40

Table 4.8 (continued).

	Plan D			Plan E		
Year	Prin.	Int.	Total	Prin.	Int.	Total
1	0.00	13.83	13.83	5.49	13.83	19.32
2	0.00	13.83	13.83	7.68	13.33	21.01
3	10.11	13.83	23.94	9.87	12.64	22.51
4	11.02	12.92	"	12.07	11.75	23.85
5	12.01	11.93	"	14.26	10.67	24.93
6	13.10	10.84	"	16.46	9.38	25.84
7	14.27	9.67	"	18.65	7.90	26.55
8	15.56	8.38	"	20.85	6.22	27.07
9	16.96	6.98	"	23.04	4.35	27.39
10	18.48	5.46	"	25.23	2.27	27.50
11	20.15	3.79	"			
12	21.96	1.98	"			
Total	153.62	113.44	267.06	153.60	92.34	245.94

Table 4.9. Repayment plans for open-lot with shed cattle feeding facility ($238.15 cost per head capacity, 20% down payment, 9% interest rate, $190.52 principal).

Year	Plan A			Plan B			Plan C		
	Prin.	Int.	Total	Prin.	Int.	Total	Prin.	Int.	Total
1	19.06	17.15	36.21	0.00	17.15	17.15	12.54	17.15	29.69
2	"	15.43	34.49	0.00	17.15	17.15	13.67	16.02	"
3	"	13.72	32.78	19.06	17.15	36.21	14.90	14.79	"
4	"	12.00	31.06	"	15.43	34.49	16.24	13.45	"
5	"	10.29	29.35	"	13.72	32.78	17.70	11.99	"
6	"	8.57	27.63	"	12.00	31.06	19.30	10.39	"
7	"	6.85	25.91	"	10.29	29.35	21.03	8.66	"
8	"	5.14	24.20	"	8.57	27.63	22.93	6.76	"
9	"	3.42	22.48	"	6.85	25.91	24.99	4.70	"
10	"	1.71	20.77	"	5.14	24.20	27.24	2.45	"
11				"	3.42	22.48			
12				"	1.71	20.77			
Total	190.60	94.28	284.88	190.60	128.58	319.18	190.54	106.36	296.90

Table 4.9 (continued).

Year	Plan D Prin.	Plan D Int.	Plan D Total	Plan E Prin.	Plan E Int.	Plan E Total
1	0.00	17.15	17.15	6.80	17.15	23.95
2	0.00	17.15	17.15	9.53	16.53	26.06
3	12.54	17.15	29.69	12.25	15.68	27.93
4	13.67	16.02	"	14.97	14.57	29.54
5	14.90	14.79	"	17.69	13.23	30.92
6	16.24	13.45	"	20.41	11.64	32.05
7	17.70	11.99	"	23.13	9.80	32.93
8	19.30	10.39	"	25.86	7.72	33.58
9	21.03	8.66	"	28.58	5.39	33.97
10	22.93	6.76	"	31.30	2.82	34.12
11	24.99	4.70	"			
12	27.24	2.45	"			
Total	190.54	140.66	331.20	190.52	114.53	305.05

Table 4.10. Repayment plans for cold confinement slotted floor barn cattle feeding facility ($302.23 cost per head capacity, 20% down payment, 9% interest rate, $241.79 principal).

	Plan A			Plan B			Plan C		
Year	Prin.	Int.	Total	Prin.	Int.	Total	Prin.	Int.	Total
1	24.18	21.76	45.94	0.00	21.76	21.76	15.92	21.76	37.68
2	"	19.59	43.77	0.00	21.76	21.76	17.35	20.33	"
3	"	17.41	41.59	24.18	21.76	45.94	18.91	18.77	"
4	"	15.24	39.42	"	19.59	43.77	20.61	17.07	"
5	"	13.06	37.24	"	17.41	41.59	22.47	15.21	"
6	"	10.88	35.06	"	15.24	39.42	24.49	13.19	"
7	"	8.71	32.89	"	13.06	37.24	26.69	10.99	"
8	"	6.53	30.71	"	10.88	35.06	29.10	8.58	"
9	"	4.35	28.53	"	8.71	32.89	31.72	5.96	"
10	"	2.18	26.36	"	6.53	30.71	34.57	3.11	"
11				"	4.35	28.53			
12				"	2.18	26.36			
Total	241.80	119.71	361.51	241.80	163.23	405.03	241.83	134.97	376.80

Table 4.10 (continued).

Year	Plan D Prin.	Plan D Int.	Plan D Total	Plan E Prin.	Plan E Int.	Plan E Total
1	0.00	21.76	21.76	8.64	21.76	30.40
2	0.00	21.76	21.76	12.09	20.98	33.07
3	15.92	21.76	37.68	15.54	19.90	35.44
4	17.35	20.33	"	19.00	18.50	37.50
5	18.91	18.77	"	22.45	16.79	39.24
6	20.61	17.07	"	25.91	14.77	40.68
7	22.47	15.21	"	29.36	12.44	41.80
8	24.49	13.19	"	32.81	9.79	42.60
9	26.69	10.99	"	36.27	6.84	43.11
10	29.10	8.58	"	39.72	3.58	43.30
11	31.72	5.96	"			
12	34.57	3.11	"			
Total	241.83	178.49	420.32	241.79	145.35	387.14

Table 4.11. Repayment plans for warm confinement slotted floor barn cattle feeding facility ($346.43 cost per head capacity, 20% down payment, 9% interest rate, $277.15 principal).

Year	Plan A			Plan B			Plan C		
	Prin.	Int.	Total	Prin.	Int.	Total	Prin.	Int.	Total
1	27.72	24.95	52.67	0.00	24.95	24.95	18.24	24.95	43.19
2	"	22.45	50.17	0.00	24.95	24.95	19.89	23.30	"
3	"	19.96	47.68	27.72	24.95	52.67	21.68	21.51	"
4	"	17.46	45.18	"	22.45	50.17	23.63	19.56	"
5	"	14.97	42.69	"	19.96	47.68	25.75	17.44	"
6	"	12.47	40.19	"	17.46	45.18	28.07	15.12	"
7	"	9.98	37.70	"	14.97	42.69	30.60	12.59	"
8	"	7.48	35.20	"	12.47	40.19	33.35	9.84	"
9	"	4.99	32.71	"	9.98	37.70	36.35	6.84	"
10	"	2.49	30.21	"	7.48	35.20	39.62	3.57	"
11				"	4.99	32.71			
12				"	2.49	30.21			
Total	277.20	137.20	414.40	277.20	187.10	464.30	277.18	154.72	431.90

Table 4.11 (continued).

Year	Plan D Prin.	Plan D Int.	Plan D Total	Plan E Prin.	Plan E Int.	Plan E Total
1	0.00	24.95	24.95	9.90	24.95	34.85
2	0.00	24.95	24.95	13.86	24.05	37.91
3	18.24	24.95	43.19	17.82	22.81	40.63
4	19.89	23.30	"	21.78	21.20	42.98
5	21.68	21.51	"	25.74	19.24	44.98
6	23.63	19.56	"	29.69	16.93	46.62
7	25.75	17.44	"	33.65	14.25	47.90
8	28.07	15.12	"	37.61	11.23	48.84
9	30.60	12.59	"	41.57	7.84	49.41
10	33.35	9.84	"	45.53	4.10	49.63
11	36.35	6.85	"			
12	39.62	3.57	"			
Total	277.18	204.62	481.80	277.15	166.60	443.75

Table 4.12. Repayment plans for pasture farrowing system ($313.48 cost per sow capacity, 20% down payment, 9% interest rate, $250.78 principal).

Year	Plan A Prin.	Plan A Int.	Plan A Total	Plan B Prin.	Plan B Int.	Plan B Total	Plan C Prin.	Plan C Int.	Plan C Total
1	31.35	22.57	53.92	0.00	22.57	22.57	22.74	22.57	45.31
2	"	19.75	51.10	0.00	22.57	22.57	24.79	20.52	"
3	"	16.93	48.28	31.35	22.57	53.92	27.02	18.29	"
4	"	14.11	45.46	"	19.57	51.10	29.45	15.86	"
5	"	11.28	42.63	"	16.93	48.28	32.10	13.21	"
6	"	8.46	39.81	"	14.11	45.46	34.99	10.32	"
7	"	5.64	36.99	"	11.28	42.63	38.14	7.17	"
8	"	2.82	34.17	"	8.46	39.81	41.57	3.74	"
9				"	5.64	36.99			
10				"	2.82	34.17			
Total	250.80	101.56	352.36	250.80	146.70	397.50	250.80	111.68	362.48

Table 4.12 (continued).

Year	Plan D			Plan E		
	Prin.	Int.	Total	Prin.	Int.	Total
1	0.00	22.57	22.57	13.06	22.57	35.63
2	0.00	22.57	22.57	18.29	21.40	39.69
3	22.74	22.57	45.31	23.51	19.75	43.26
4	24.79	20.52	"	28.74	17.63	46.37
5	27.02	18.29	"	33.96	15.05	49.01
6	29.45	15.86	"	39.18	11.99	51.17
7	32.10	13.21	"	44.41	8.47	52.88
8	34.99	10.32	"	49.63	4.47	54.10
9	38.14	7.17	"			
10	41.57	3.74	"			
Total	250.80	156.82	407.62	250.78	121.33	372.11

Table 4.13. Repayment plans for partial confinement farrowing system ($869.20 cost per sow capacity, 20% down payment, 9% interest rate, $695.36 principal).

Year	Plan A Prin.	Plan A Int.	Plan A Total	Plan B Prin.	Plan B Int.	Plan B Total	Plan C Prin.	Plan C Int.	Plan C Total
1	86.92	62.58	149.50	0.00	62.58	62.58	63.06	62.58	125.64
2	"	54.76	141.68	0.00	62.58	62.58	68.73	56.91	"
3	"	46.94	133.86	86.92	62.58	149.50	74.92	50.72	"
4	"	39.11	126.03	"	54.76	141.68	81.66	43.98	"
5	"	31.92	118.84	"	46.94	133.86	89.01	36.63	"
6	"	23.47	110.39	"	39.11	126.03	97.02	28.62	"
7	"	15.65	102.57	"	31.92	118.84	105.75	19.89	"
8	"	7.82	94.74	"	23.47	110.39	115.27	10.37	"
9				"	15.65	102.57			
10				"	7.82	94.74			
Total	695.36	282.25	977.61	695.36	407.41	1102.77	695.42	309.70	1005.12

Table 4.13 (continued).

Year	Plan D			Plan E		
	Prin.	Int.	Total	Prin.	Int.	Total
1	0.00	62.58	62.58	36.22	62.58	98.80
2	0.00	62.58	62.58	50.70	59.32	110.02
3	63.06	62.58	125.64	65.19	54.76	119.95
4	68.73	56.91	"	79.68	48.89	128.57
5	74.92	50.72	"	94.16	41.72	135.88
6	81.66	43.98	"	108.65	33.25	141.90
7	89.01	36.63	"	123.14	23.47	146.61
8	97.02	28.62	"	137.62	12.39	150.01
9	105.75	19.89	"			
10	115.27	10.37	"			
Total	695.42	434.86	1130.28	695.36	336.38	1031.74

Table 4.14. Repayment plans for total confinement farrowing system ($2007.40 cost per sow capacity, 20% down payment, 9% interest rate, $1605.92 principal).

	Plan A			Plan B			Plan C		
Year	Prin.	Int.	Total	Prin.	Int.	Total	Prin.	Int.	Total
1	200.74	144.53	345.27	0.00	144.53	144.53	145.62	144.53	290.15
2	"	126.47	327.21	0.00	144.53	144.53	158.72	131.43	"
3	"	108.40	309.14	200.74	144.53	345.27	173.01	117.14	"
4	"	90.33	291.07	"	126.47	327.21	188.58	101.57	"
5	"	72.27	273.01	"	108.40	309.14	205.55	84.60	"
6	"	54.20	254.94	"	90.33	291.07	224.05	66.10	"
7	"	36.13	236.87	"	72.27	273.01	244.21	45.94	"
8	"	18.07	218.81	"	54.20	254.94	266.19	23.96	"
9				"	36.13	236.87			
10				"	18.07	218.81			
Total	1605.92	650.40	2256.32	1605.92	939.46	2545.38	1605.93	715.27	2321.20

Table 4.14 (continued).

Year	Plan D			Plan E		
	Prin.	Int.	Total	Prin.	Int.	Total
1	0.00	144.53	144.53	83.64	144.53	228.17
2	0.00	144.53	144.53	117.10	137.01	254.11
3	145.62	144.53	290.15	150.55	126.47	277.02
4	158.72	131.43	"	184.01	112.92	296.93
5	173.01	117.14	"	217.47	96.36	313.83
6	188.58	101.57	"	250.92	76.78	327.70
7	205.55	84.60	"	284.38	54.20	338.58
8	224.05	66.10	"	317.84	28.61	346.45
9	244.21	45.94	"			
10	266.19	23.96	"			
Total	1605.93	1004.33	2610.26	1605.91	776.88	2382.79

Table 4.15. Repayment plans for pasture hog feeding system ($56.23 cost per head capacity, 20% down payment, 9% interest rate, $44.98 principal).

	Plan A			Plan B			Plan C		
Year	Prin.	Int.	Total	Prin.	Int.	Total	Prin.	Int.	Total
1	5.62	4.05	9.67	0.00	4.05	4.05	4.08	4.05	8.13
2	"	3.54	9.16	0.00	4.05	4.05	4.45	3.68	"
3	"	3.04	8.66	5.62	4.05	9.67	4.85	3.28	"
4	"	2.53	8.15	"	3.54	9.16	5.28	2.85	"
5	"	2.03	7.65	"	3.04	8.66	5.76	2.37	"
6	"	1.52	7.14	"	2.53	8.15	6.28	1.85	"
7	"	1.01	6.63	"	2.03	7.65	6.84	1.29	"
8	"	0.51	6.13	"	1.52	7.14	7.46	0.67	"
9				"	1.01	6.63			
10				"	0.51	6.13			
Total	44.96	18.23	63.19	44.96	26.33	71.29	45.00	20.04	65.04

Table 4.15 (continued).

Year	Plan D Prin.	Plan D Int.	Plan D Total	Plan E Prin.	Plan E Int.	Plan E Total
1	0.00	4.05	4.05	2.34	4.05	6.39
2	0.00	4.05	4.05	3.28	3.84	7.12
3	4.08	4.05	8.13	4.22	3.54	7.76
4	4.45	3.68	"	5.15	3.16	8.31
5	4.85	3.28	"	6.09	2.70	8.79
6	5.28	2.85	"	7.03	2.15	9.18
7	5.76	2.37	"	7.97	1.52	9.49
8	6.28	1.85	"	8.90	0.80	9.70
9	6.84	1.29	"			
10	7.46	0.67	"			
Total	45.00	28.14	73.14	44.98	21.76	66.74

Table 4.16. Repayment plans for partial confinement hog feeding system ($48.85 cost per head capacity, 20% down payment, 9% interest rate, $39.08 principal).

Year	Plan A			Plan B			Plan C		
	Prin.	Int.	Total	Prin.	Int.	Total	Prin.	Int.	Total
1	4.89	3.52	8.41	0.00	3.52	3.52	3.54	3.52	7.06
2	"	3.08	7.97	0.00	3.52	3.52	3.86	3.20	"
3	"	2.64	7.53	4.89	3.52	8.41	4.21	2.85	"
4	"	2.20	7.09	"	3.08	7.97	4.59	2.47	"
5	"	1.76	6.65	"	2.64	7.53	5.00	2.06	"
6	"	1.32	6.21	"	2.20	7.09	5.45	1.61	"
7	"	0.88	5.77	"	1.76	6.65	5.94	1.12	"
8	"	0.44	5.33	"	1.32	6.21	6.49	0.57	"
9				"	0.88	5.77			
10				"	0.44	5.33			
Total	39.12	15.84	54.96	39.12	22.88	62.00	39.08	17.40	56.48

Table 4.16 (continued).

Year	Plan D Prin.	Plan D Int.	Plan D Total	Plan E Prin.	Plan E Int.	Plan E Total
1	0.00	3.52	3.52	2.04	3.52	5.56
2	0.00	3.52	3.52	2.85	3.33	6.18
3	3.54	3.52	7.06	3.66	3.08	6.74
4	3.86	3.20	"	4.48	2.75	7.23
5	4.21	2.85	"	5.29	2.35	7.64
6	4.59	2.47	"	6.11	1.87	7.98
7	5.00	2.06	"	6.92	1.32	8.24
8	5.45	1.61	"	7.73	0.70	8.43
9	5.94	1.12	"			
10	6.49	0.57	"			
Total	39.08	24.44	63.52	39.08	18.92	58.00

Table 4.17. Repayment plans for total confinement hog feeding system ($62.63 cost per head capacity, 20% down payment, 9% interest rate, $50.10 principal).

	Plan A			Plan B			Plan C		
Year	Prin.	Int.	Total	Prin.	Int.	Total	Prin.	Int.	Total
1	6.26	4.51	10.77	0.00	4.51	4.51	4.54	4.51	9.05
2	"	3.95	10.21	0.00	4.51	4.51	4.95	4.10	"
3	"	3.38	9.64	6.26	4.51	10.77	5.40	3.65	"
4	"	2.82	9.08	"	3.95	10.21	5.88	3.17	"
5	"	2.26	8.52	"	3.38	9.64	6.41	2.64	"
6	"	1.69	7.95	"	2.82	9.08	6.99	2.06	"
7	"	1.13	7.39	"	2.26	8.52	7.62	1.43	"
8	"	0.57	6.83	"	1.69	7.95	8.30	0.75	"
9				"	1.13	7.39			
10				"	0.57	6.83			
Total	50.08	20.31	70.39	50.08	29.33	79.41	50.09	22.31	72.40

Table 4.17 (continued).

Year	Plan D Prin.	Plan D Int.	Plan D Total	Plan E Prin.	Plan E Int.	Plan E Total
1	0.00	4.51	4.51	2.61	4.51	7.12
2	0.00	4.51	4.51	3.65	4.27	7.92
3	4.54	4.51	9.05	4.70	3.95	8.65
4	4.95	4.10	"	5.74	3.52	9.26
5	5.40	3.65	"	6.78	3.01	9.79
6	5.88	3.17	"	7.83	2.40	10.23
7	6.41	2.64	"	8.87	1.69	10.56
8	6.99	2.06	"	9.92	0.89	10.81
9	7.62	1.43	"			
10	8.30	0.75	"			
Total	50.09	31.33	81.42	50.10	24.24	74.34

Table 4.18. Tableau of livestock facility investment and financing activities in period 0.

Row	Row Type	RHS*	Buy Livestock Facility*	Depr. Livestock Facility* Straight-Line	Depr. Livestock Facility* Double-Declining-Balance
Cash, period 0	L	a		c	c
Livestock Facility Transfer Row, period 0	E	0	-1	1	1
Principal Repayment on 9% Long-Term Loans, year 1	G	0	b_1		
Principal Repayment on 9% Long-Term Loans, year 2	G	0	b_2		
Principal Repayment on 9% Long-Term Loans, year 3	G	0	b_3		
Principal Repayment on 9% Long-Term Loans, year 4	G	0	b_4		
Principal Repayment on 9% Long-Term Loans, year 5	G	0	b_5		
Interest Payment on 9% Long-Term Loans, year 1	E	0		-d	-d
⋮	⋮	⋮		⋮	⋮
Interest Payment on 9% Long-Term Loans, year 5	E	0		-d	-d
Long-Term Assets Accounting Row, period 0	E	0		$-e_0$	$-e_0$
⋮	⋮	⋮		⋮	⋮
Long-Term Assets Accounting Row, year 5	E	0		$-e_5$	$-e_5$
Long-Term Debt Accounting Row, period 0	E	0		-d	-d
⋮	⋮	⋮		⋮	⋮
Long-Term Debt Accounting Row, year 5	E	0		-d	-d
Depreciation Accounting Row, year 1	E	0		-f	$-g_1$
⋮	⋮	⋮		⋮	⋮
Depreciation Accounting Row, year 5	E	0		-f	$-g_5$
Livestock Facility Capacity, year 1	L	0		-1	-1
⋮	⋮	⋮		⋮	⋮
Livestock Facility Capacity, year 5	L	0		-1	-1

* a: initial cash position, b_t: appropriate principal payment in year t, c: down payment (20% of investment price), d: debt (80% of investment price), e_t: long-term asset value in year t, f: straight-line depreciation value, g_t: double-declining-balance depreciation value in year t.

The items included in each hog farrowing facility and hog feeding facility are divided into those with an expected life of eight years and those with an expected life of fifteen years to more accurately reflect the depreciation of these facilities. The expected life of each item in the hog facilities is identified in Appendix Table A.6 through Appendix Table A.11. The straight-line depreciation schedule and the double-declining-balance depreciation schedule using these expected life figures for each hog farrowing facility are given in Table 4.19. The two depreciation schedules for the hog feeding facilities are given in Table 4.20.

Two activities, one for each depreciation method, are provided for each livestock facility as shown in Table 4.18. When one unit of a livestock facility is acquired in period 0 through one of the five investment activities it is transferred to one of the two depreciation activities. Each repayment plan requires a down payment of 20 percent of the purchase price, so each depreciation activity uses an amount of cash in period 0 equal to 20 percent of the purchase price to pay the down payment. This leaves an unpaid balance of 80 percent of the purchase price which is added to the long-term interest payment constraints for 9 percent loans in future years. These activities also add an amount equal to 80 percent of the purchase price to long-term debt in the beginning farmer's balance sheet at the end of period 0 and all future years. Depreciation values are added to the depreciation accounting rows of future years according to the method of depreciation used. An amount equal to the purchase price of one unit of

Table 4.19. Depreciation schedules for hog farrowing facilities.

	Pasture						Partial Confinement					
	Straight-Line			Double-Declining-Balance			Straight-Line			Double-Declining-Balance		
Year	8-yr. Items	15-yr. Items	Total	8-yr. Items	15-yr. Items	Total	8-yr. Items	15-yr. Items	Total	8-yr. Items	15-yr. Items	Total
1	37.84	0.72	38.56	75.67	1.44	77.11	57.00	27.55	84.55	114.00	55.08	169.08
2	"	"	"	56.75	1.25	58.00	"	"	"	85.50	47.72	133.22
3	"	"	"	42.56	1.08	43.64	"	"	"	64.11	41.36	105.47
4	"	"	"	31.93	0.94	32.87	"	"	"	48.11	35.87	83.98
5	"	"	"	23.94	0.81	24.75	"	"	"	36.07	31.07	67.14
6	"	"	"	17.95	0.70	18.65	"	"	"	27.04	26.90	53.94
7	"	"	"	13.47	0.61	14.08	"	"	"	20.09	23.35	43.64
8	"	"	"	10.11	0.53	10.64	"	"	"	15.23	20.25	35.48
9		"	0.72		0.46	0.46		"	27.55		17.56	17.56
10		"	"		0.40	0.40		"	"		15.21	15.21
11		"	"		0.34	0.34		"	"		13.18	13.18
12		"	"		0.30	0.30		"	"		11.40	11.40
13		"	"		0.26	0.26		"	"		9.92	9.92
14		"	"		0.22	0.22		"	"		8.59	8.59
15		"	"		0.19	0.19		"	"		7.44	7.44

Table 4.19 (continued).

Year	Total Confinement					
	Straight-Line			Double-Declining-Balance		
	8-yr. Items	15-yr. Items	Total	8-yr. Items	15-yr. Items	Total
1	138.45	59.99	198.44	276.90	119.94	396.84
2	"	"	"	207.68	103.93	311.61
3	"	"	"	155.73	90.07	245.80
4	"	"	"	116.85	78.10	194.95
5	"	"	"	87.61	67.66	155.27
6	"	"	"	65.68	58.58	124.26
7	"	"	"	49.29	50.84	100.13
8	"	"	"	36.99	44.09	81.08
9		"	59.99		38.24	38.24
10		"	"		33.11	33.11
11		"	"		28.70	28.70
12		"	"		24.83	24.83
13		"	"		21.60	21.60
14		"	"		18.72	18.72
15		"	"		16.20	16.20

Table 4.20. Depreciation schedules for hog feeding facilities.

Year	Pasture						Partial Confinement					
	Straight-Line			Double-Declining-Balance			Straight-Line			Double-Declining-Balance		
	8-yr. Items	15-yr. Items	Total	8-yr. Items	15-yr. Items	Total	8-yr. Items	15-yr. Items	Total	8-yr. Items	15-yr. Items	Total
1	3.70	1.78	5.48	7.39	3.55	10.94	3.22	1.54	4.76	6.44	3.08	9.52
2	"	"	"	5.55	3.08	8.63	"	"	"	4.83	2.67	7.50
3	"	"	"	4.16	2.67	6.83	"	"	"	3.62	2.31	5.93
4	"	"	"	3.12	2.31	5.43	"	"	"	2.72	2.01	4.73
5	"	"	"	2.34	2.00	4.34	"	"	"	2.04	1.74	3.78
6	"	"	"	1.75	1.73	3.48	"	"	"	1.53	1.50	3.03
7	"	"	"	1.32	1.51	2.83	"	"	"	1.15	1.31	2.46
8	"	"	"	0.99	1.31	2.30	"	"	"	0.86	1.13	1.99
9		"	1.78		1.13	1.13		"	1.54		0.98	0.98
10		"	"		0.98	0.98		"	"		0.85	0.85
11		"	"		0.85	0.85		"	"		0.74	0.74
12		"	"		0.74	0.74		"	"		0.64	0.64
13		"	"		0.64	0.64		"	"		0.55	0.55
14		"	"		0.55	0.55		"	"		0.48	0.48
15		"	"		0.48	0.48		"	"		0.42	0.42

Table 4.20 (continued).

	Total Confinement					
	Straight-Line			Double-Declining-Balance		
Year	8-yr. Items	15-yr. Items	Total	8-yr. Items	15-yr. Items	Total
1	4.53	1.76	6.29	9.07	3.51	12.58
2	"	"	"	6.80	3.04	9.84
3	"	"	"	5.10	2.64	7.74
4	"	"	"	3.83	2.29	6.12
5	"	"	"	2.87	1.98	4.85
6	"	"	"	2.15	1.72	3.87
7	"	"	"	1.61	1.49	3.10
8	"	"	"	1.21	1.29	2.50
9		"	1.76		1.12	1.12
10		"	"		0.97	0.97
11		"	"		0.84	0.84
12		"	"		0.73	0.73
13		"	"		0.63	0.63
14		"	"		0.55	0.55
15		"	"		0.47	0.47

a livestock facility is added to long-term assets in the beginning farmer's balance sheet at the end of period 0. The amount added to long-term assets in the beginning farmer's balance sheet at the end of future years is then determined by subtracting the amount of depreciation which occurs during the year from the value of the asset at the end of the previous year. Finally, the activities which depreciate one unit of a livestock facility add one unit of capacity to the appropriate livestock facility capacity constraints in all future years.

The investment and financing of livestock facilities in year 2 through year 5 is slightly different from that in period 0. The activities which acquire livestock facilities in year t, t = 2,3,4,5, are shown in Table 4.21. These activities occur in the first period of year t and provide livestock facilities in year t and all future years. Livestock facility investment activities are not provided in year 1 because the livestock investment activities in period 0 provide livestock facilities for year 1. Five activities, which correspond to the five repayment plans, are again provided for investment in each livestock facility. The five investment activities for each livestock facility add to long-term principal payment constraints for 9 percent loans in year t and future years by the amount given in the corresponding repayment plans. Two activities, one for each depreciation method, are again provided for each livestock facility. When one unit of a livestock facility is acquired in year t through one of the five investment activities it is transferred to one of the two depreciation activities. Each repayment plan requires a down payment of 20

Table 4.21. Tableau of livestock facility investment and financing activities in year t, t=2,3,4,5.

Row	Row Type	RHS	Buy Livestock Facility*	Depr. Livestock Facility*: Straight-Line	Depr. Livestock Facility*: Double-Declining-Balance
Cash, first period of year t	L	0		b	b
Livestock Facility Transfer Row, year t	E	0	-1	1	1
Principal Repayment on 9% Long-Term Loans, year t	G	0	a_0		
Principal Repayment on 9% Long-Term Loans, year t+1	G	0	a_1		
Principal Repayment on 9% Long-Term Loans, year t+2	G	0	a_2		
Principal Repayment on 9% Long-Term Loans, year t+3	G	0	a_3		
Interest Payment on 9% Long-Term Loans, year t	E	0		-c	-c
⋮	⋮	⋮		⋮	⋮
Interest Payment on 9% Long-Term Loans, year t+3	E	0		-c	-c
Long-Term Assets Accounting Row, year t	E	0		$-d_0$	$-d_0$
⋮	⋮	⋮		⋮	⋮
Long-Term Assets Accounting Row, year t+3	E	0		$-d_3$	$-d_3$
Long-Term Debt Accounting Row, year t	E	0		-c	-c
⋮	⋮	⋮		⋮	⋮
Long-Term Debt Accounting Row, year t+3	E	0		-c	-c
Depreciation Accounting Row, year t	E	0		-e	$-f_0$
⋮	⋮	⋮		⋮	⋮
Depreciation Accounting Row, year t+3	E	0		-e	$-f_3$
Livestock Facility Capacity, year t	E	0		-1	-1
⋮	⋮	⋮		⋮	⋮
Livestock Facility Capacity, year t+3	E	0		-1	-1

* a_i: appropriate principal payment in year t+i, b: down payment (20% of investment price), c: debt (80% of investment price), d_i: long-term asset value in year t+i, e: straight-line depreciation value, f_i: double-declining balance depreciation value in year t+1.

percent, so each depreciation activity uses an amount of cash in the first period of year t equal to 20 percent of the purchase price. This leaves an unpaid balance of 80 percent of the purchase price which is added to the long-term interest payment constraints for 9 percent loans in year t and future years. These activities also add an amount equal to 80 percent of the purchase price to long-term debt in the beginning farmer's balance sheet at the end of year t and all future years. Depreciation values are added to the depreciation accounting rows of year t and future years according to the method of depreciation used. An amount equal to the purchase price of one unit of the livestock facility minus the first year's depreciation is added to long-term assets in the beginning farmer's balance sheet at the end of year t. The amount added to long-term assets at the end of each year after year t is then determined by subtracting the amount of depreciation which occurs during the year from the value of the asset at the end of the previous year. Finally, the activities which depreciate one unit of a livestock facility bought in year t add one unit of capacity to the appropriate livestock facility capacity constraints in year t and all years after year t.

Crop Production and Harvesting

Crop production activities that allow the production of corn, soybeans, oats, and meadow are provided in each year. These activities represent growing crops; other activities are provided in each year to harvest the crops. Five crop rotations which produce these crops are considered. These crop rotations are (1) continuous corn, (2) corn-soybeans, (3) corn-soybeans-oats, (4) corn-soybeans-oats-meadow-meadow, and (5) corn-oats-meadow-meadow. Each crop rotation may be produced using any one of the three crop production machinery systems. Appendix Table A.12 gives the annual production costs, labor requirements, and land requirements of each crop rotation using each crop production system.

Owned land, cash rented land, or crop-share rented land may be used for crop production. The beginning farmer must supply all the labor, all the production costs, and all the machinery required for crop production on owned or cash rented land. The beginning farmer must supply all the labor, all the machinery, all the machinery costs, and half of the seed and chemical costs required for crop production on crop-share rented land (77). Crops grown on owned or cash rented land can also be produced by hiring a custom operator. Appendix Table A.13 gives the custom machinery rates for producing the various rotations.

Table 4.22 shows the crop production activities in year t, t=1, 2,3,4,5. Each rotation grown on owned or cash rented land can be produced using any one of the three crop production machinery systems or by hiring a custom operator. Each rotation grown on crop-share rented land can be produced using any one of the three crop production systems. Continuous corn uses one acre of land, the corn-soybean rotation uses two acres of land, the corn-soybean-oats rotation uses three acres of land, the corn-soybeans-oats-meadow-meadow rotation uses five acres of land, and the corn-oats-meadow-meadow rotation uses four acres of land. Each rotation produced by the beginning farmer uses the amount of

Table 4.22. Tableau of crop production activities in year t, t=1,2,3,4,5.

Row	Row Type	RHS	Land Transfer year t-1 to year t	Cash Rent Land	Crop Production on Owned or Cash Rented Land*	Crop Production on Crop-Share Rented Land*
Owned or Cash Rented Land, year t	L	0	-1	-1	a	
Crop-Share Rented Land, year t	G	0				a
Labor, first quarter of year t	L	600			b_1	b_1
Labor, second quarter of year t	L	700			b_2	b_2
Labor, third quarter of year t	L	700			b_3	b_3
Labor, fourth quarter of year t	L	700			b_4	b_4
Cash, first period of year t	L	0		80	c_o	c_{cs}
Labor Intensive Crop Production System Capacity, year t	L	0			d	d
Intermediate Crop Production System Capacity, year t	L	0			e	e
Capital Intensive Crop Production System Capacity, year t	L	0			f	f
Standing Corn on Owned or Cash Rented Land, year t	L	0			-g	
Standing Soybeans on Owned or Cash Rented Land, year t	L	0			-h	
Standing Oats on Owned or Cash Rented Land, year t	L	0			-i	
Standing Corn on Crop-Share Rented Land, year t	L	0				-g
Standing Soybeans on Crop-Share Rented Land, year t	L	0				-h
Standing Oats on Crop-Share Rented Land, year t	L	0				-i
Meadow Transfer Row, year t	L	0			-j	
Income Accounting Row, year t	E	0		80	c_o	c_{cs}

* a: acres of land used by crop production activity, b_q: hours of labor used by crop production activity in quarter q, q=1,2,3,4, c_o: dollars of cash used by crop production activity on owned or cash rented land, c_{cs}: dollars of cash used by crop production activity on crop-share rented land, d: equal to 'a' if crop production activity uses labor intensive crop production system, equal to 0 otherwise, e: equal to 'a' if crop production activity uses intermediate crop production system, equal to 0 otherwise, f: equal to 'a' if crop production activity uses capital intensive crop production system, equal to 0 otherwise, g: acres of corn grown, h: acres of soybeans grown, i: acres of oats grown, j: acres of meadow grown.

operator labor in each quarter of year t as given in Appendix Table A.12. The production costs of each rotation grown on owned or cash rented land (given in Appendix Table A.12) are deducted from cash in the first period of year t and are also deducted from the income accounting row of year t. The production costs plus the custom machinery rates of each rotation grown by a custom operator are deducted from cash in the first period of year t and are also deducted from the income accounting row of year t. For rotations grown on crop-share rented land, the beginning farmer must pay all of the machinery costs and half of the seed and chemical costs of the annual production costs of each rotation given in Appendix Table A.12. This figure is deducted from cash in the first period of year t and from the income accounting row of year t. Each rotation produced by the beginning farmer uses the same number of acres of capacity of the appropriate crop production machinery system as it uses of land. The continuous corn rotation produces one acre of standing corn. The corn-soybean rotation produces one acre of standing corn and one acre of standing soybeans. The corn-soybean-oats rotation produces one acre of standing corn, one acre of standing soybeans, and one acre of standing oats. The corn-soybeans-oats-meadow-meadow rotation produces one acre of standing corn, one acre of standing soybeans, one acre of standing oats, and two acres of meadow. The corn-oats-meadow-meadow rotation produces one acre of standing corn, one acre of standing oats, and two acres of meadow.

Activities that allow the harvesting of the various crops produced in year t are provided in year t. Crops grown on owned land, cash rented land, or crop-share rented land may be harvested by the beginning farmer using either of the two combines. Appendix Table A.14 gives the annual costs and labor requirements to harvest corn, soybeans, and oats as grain, and to harvest corn as silage. It is assumed the beginning farmer receives yields per acre of 110 bushels of corn, 35 bushels of soybeans, 75 bushels of oats, and 16 tons of silage (78). The beginning farmer receives all of the crops produced on owned or cash rented land, and he receives half of the crops produced on crop-share rented land (77). Crops grown on owned or cash rented land can also be harvested by hiring a custom operator. Appendix Table A.13 gives the custom harvesting rates for the various crops. The assumed yields using a custom operator are 90 percent of those obtained when the beginning farmer uses his own combine to harvest the crops. Hay can only be harvested by a custom operator and the assumed yield is four tons per acre.

Harvesting activities which harvest crops produced in year t are shown in Table 4.23. Corn, soybeans, and oats can be harvested by the beginning farmer using either of the two combines. Each harvesting activity using one of the combines uses the amount of operator labor in each quarter of year t as given in Appendix Table A.14. The corn harvesting activities use one acre of corn harvesting capacity of the appropriate combine type in year t and require one acre of standing corn. The soybean harvesting activities use one acre of soybean harvesting capacity of the appropriate combine type in year t and require one acre of standing soybeans. The oat harvesting activities use one acre of oat harvesting capacity of the appropriate combine type

Table 4.23. Tableau of crop harvesting activities in year t, t=1,2,3,4,5.

Row	Row Type	RHS	Harvest Crops on Owned or Cash Rented Land*	Harvest Crops on Crop-Share Rented Land*
Labor, second quarter of year t	L	700	a_2	a_2
Labor, third quarter of year t	L	700	a_3	a_3
Labor, fourth quarter of year t	L	700	a_4	a_4
Cash, second period of year t	L	0	b	b
Labor Intensive Combine Corn Harvesting Capacity, year t	L	0	c	c
Labor Intensive Combine Soybean Harvesting Capacity, year t	L	0	d	d
Labor Intensive Combine Oat Harvesting Capacity, year t	L	0	e	e
Capital Intensive Combine Corn Harvesting Capacity, year t	L	0	f	f
Capital Intensive Combine Soybean Harvesting Capacity, year t	L	0	g	g
Capital Intensive Combine Oat Harvesting Capacity, year t	L	0	h	h
Silage Harvesting Capacity, year t	L	0	i	i
Standing Corn on Owned or Cash Rented Land, year t	L	0	j	
Standing Soybeans on Owned or Cash Rented Land, year t	L	0	d	
Standing Oats on Owned or Cash Rented Land, year t	L	0	e	

Standing Corn on Crop-Share Rented Land, year t	L	0		j
Standing Soybeans on Crop-Share Rented Land, year t	L	0		d
Standing Oats on Crop-Share Rented Land, year t	L	0		e
Meadow Transfer Row, year t	L	0	k	
Corn Grain Transfer Row, second period of year t	L	0	-m	-m/2
Soybean Grain Transfer Row, second period of year t	L	0	-n	-n/2
Oat Grain Transfer Row, second period of year t	L	0	-p	-p/2
Silage Transfer Row, second period of year t	L	0	-r	-r/2
Hay Transfer Row, second period of year t	L	0	-s	
Income Accounting Row, year t	E	0	b	b

* a_q: hours of labor used by crop harvesting activity in quarter q, q=1,2,3,4; b: dollars of cash used by crop harvesting activity; c: equal to 1 if crop harvesting activity harvests corn for grain using the labor intensive combine, equal to 0 otherwise; d: equal to 1 if crop harvesting activity harvests soybeans using the labor intensive combine, equal to 0 otherwise; e: equal to 1 if crop harvesting activity harvests oats using the labor intensive combine, equal to 0 otherwise; f: equal to 1 if crop harvesting activity harvests corn for grain using the capital intensive combine, equal to 0 otherwise; g: equal to 1 if crop harvesting activity harvests soybeans using the capital intensive combine, equal to 0 otherwise; h: equal to 1 if crop harvesting activity harvests oats using the capital intensive combine, equal to 0 otherwise; i: equal to 1 if crop harvesting activity harvests corn for silage, equal to 0 otherwise; j: equal to 1 if crop harvesting activity harvests corn for grain or for silage, equal to 0 otherwise; k: equal to 1 if crop harvesting activity harvests meadow for hay, equal to 0 otherwise; m: bushels of corn grain harvested per acre; n: bushels of soybeans harvested per acre; p: bushels of oats harvested per acre; r: tons of silage harvested per acre; s: tons of hay harvested per acre.

in year t and require one acre of standing oats. The machinery costs of each grain harvesting activity (given in Appendix Table A.14) are deducted from cash in the second period of year t and are also deducted from the income accounting row of year t. The corn harvesting activities on owned or cash rented land add 110 bushels of corn to the corn grain transfer row in the second period of year t, while corn harvesting activities on crop-share rented land add 55 bushels of corn to the same corn grain transfer row. The soybean harvesting activities on owned or cash rented land add 35 bushels of soybeans to the soybean grain transfer row in the second period of year t, while soybean harvesting activities on crop-share rented land add 17.5 bushels of soybeans to the same soybean grain transfer row. The oat harvesting activities on owned or cash rented land add 75 bushels of oats to the oat grain transfer row in the second period of year t, while oat harvesting activities on crop-share rented land add 37.5 bushels of oats to the same oat grain transfer row.

One activity that allows the beginning farmer to harvest corn as silage using the silage harvester is provided in year t. This silage harvesting activity uses the amount of operator labor in each quarter of year t as given in Appendix Table A.14. The silage harvesting activity uses one acre of silage harvesting capacity of the silage harvester in year t and requires one acre of standing corn in year t. The costs of the silage harvesting activity (given in Appendix Table A.14) are deducted from cash in the second period of year t and are also deducted from the income accounting row of year t. The silage harvesting activity on owned or cash rented land adds 16 tons of silage to the silage transfer row in the second period of year t, while the silage harvesting activity on crop-share rented land adds 8 tons of silage to the silage transfer row.

Crops produced on owned or cash rented land in year t can also be harvested by hiring a custom operator. Custom harvesting corn uses one acre of standing corn, custom harvesting soybeans uses one acre of standing soybeans, custom harvesting oats requires one acre of standing oats, custom harvesting silage requires one acre of standing corn, and custom harvesting hay requires one acre of meadow. The costs of custom harvesting (given in Appendix Table A.13) are deducted from the appropriate cash rows in year t and are also deducted from the income accounting row of year t. Custom harvesting corn adds 99 bushels of corn to the corn grain transfer row in the second period of year t. Custom harvesting soybeans adds 31.5 bushels of soybeans to the soybean grain transfer row in the second period of year t. Custom harvesting oats adds 67.5 bushels of oats to the oat grain transfer row in the second period of year t. Custom harvesting silage adds 14.4 tons of silage to the silage transfer row in the second period of year t. Custom harvesting hay adds 4 tons of hay to the hay transfer row in the second period of year t.

Hog Farrowing

Activities are provided each year which allow the pasture farrowing facilities, the partial confinement farrowing facility, and the total confinement farrowing facility to be used to farrow and produce feeder pigs. These feeder pigs can then be sold or transferred to the hog feeding activities. The swine farrowing schedules considered in this model are shown in Table 4.24. The pasture system farrowing facilities can be used to farrow one or two litters per year, while the partial confinement and total confinement farrowing facilities can be used be used to farrow two, four, or six litters per year. Appendix Table A.15 gives the annual cash costs, feed required, and labor required to farrow and raise pigs to 40 pounds using the various farrowing facilities.

Table 4.25 shows the hog farrowing activities in year t, t = 1,2, 3,4,5, included in this model. Two activities farrow pigs on pasture; one farrows one litter per year and the other farrows two litters per year. Each pasture farrowing activity uses one sow space of the pasture farrowing capacity in year t. Three activities farrow pigs in partial confinement; one farrows two litters per year, the second farrows four litters per year, and the third farrows six litters per year. Each partial confinement farrowing activity uses one sow space of the partial confinement farrowing capacity in year t. Three activities farrow pigs in total confinement; the first farrows two litters per year, the next farrows four litters per year, and the third farrows six litters per year. Each total confinement farrowing activity uses one sow space of the total confinement farrowing capacity in year t.

Farrowing one litter on pasture in year t adds seven feeder pigs to the feeder pig transfer row in the second quarter of year t, because Table 4.24 shows that one litter farrowed on pasture is weaned in June.

Table 4.24. Swine farrowing schedules considered in this model.

	Pasture System		Partial or Total Confinement System	
	Farrow	Wean	Farrow	Wean
1 litter per year	April	June		
2 litters per year	March	May	March	May
	September	November	September	November
4 litters per year			March	May
			June	August
			September	November
			December	February
6 litters per year			January	March
			March	May
			May	July
			July	September
			September	November
			November	January

Table 4.25. Tableau of hog farrowing activities in year t, t=1,2,3,4,5.

Row	Row Type	RHS	Hog Farrowing*
Hog Farrowing Facility Capacity, year t	L	0	1
Feeder Pig Transfer Row, first quarter of year t	L	0	$-a_1$
Feeder Pig Transfer Row, second quarter of year t	L	0	$-a_2$
Feeder Pig Transfer Row, third quarter of year t	L	0	$-a_3$
Feeder Pig Transfer Row, fourth quarter of year t	L	0	$-a_4$
Feeder Pig Transfer Row, first quarter of year t+1	L	0	-b
Corn Grain Transfer Row, first period of year t	L	0	c
Corn Grain Transfer Row, second period of year t	L	0	d
Cash, first period of year t	L	0	e
Cash, second period of year t	L	0	f
Labor, first quarter of year t	L	600	g_1
Labor, second quarter of year t	L	700	g_2
Labor, third quarter of year t	L	700	g_3
Labor, fourth quarter of year t	L	700	g_4
Herd Sow Transfer Row, year t	L	0	h
Herd Sow Transfer Row, year t+1	L	0	-h/2
Slaughter Sow Transfer Row, fourth quarter of year t	L	0	-i
Slaughter Sow Transfer Row, first quarter of year t+1	L	0	-j
Short-Term Assets Accounting Row, year t	E	0	-k
Income Accounting Row, year t	E	0	(e+f)

* a_q: number of feeder pigs weaned in quarter q of year t, q=1,2,3,4; b: number of feeder pigs weaned in first quarter of year t+1; c: bushels of corn fed in first period of year t; d: bushels of corn fed in second period of year t; e: dollars of cash used in first period of year t; f: dollars of cash used in second period of year t; g_q: hours of labor used in quarter q of year t; h: hundredweight of sow required for farrowing activity; i: hundredweight of sow available to be sold in the fourth quarter of year t; j: hundredweight of sow available to be sold in the first quarter of year t+1; k: dollars of short-term assets at the end of year t.

Farrowing two litters on pasture adds seven feeder pigs to the feeder pig transfer row in the second quarter (weaned in May) and adds seven feeder pigs to the feeder pig transfer row in the fourth quarter (weaned in November). Farrowing two litters in partial confinement or total confinement adds eight feeder pigs to the feeder pig transfer row in the second quarter and adds eight feeder pigs to the feeder pig transfer row in the fourth quarter. Likewise, farrowing four litters in partial confinement or total confinement adds eight feeder pigs per litter to the feeder pig transfer row in the quarter when the pigs are weaned. Finally, farrowing six litters in year t in partial or total confinement adds eight feeder pigs to the feeder pig transfer row in the first quarter, second quarter, and fourth quarter of year t, and in the first quarter of year t+1, and adds 16 pigs to the feeder pig transfer row in the third quarter of year t.

Each farrowing activity in year t uses the amount of cash in each period of year t, the amount of corn in each period of year t, and the amount of labor in each quarter of year t as given in Appendix Table A.15. In addition, the amount of cash used during year t by each farrowing activity is deducted from the income accounting row of year t.

A conception rate of 85 percent is assumed (4,6,8). So, to farrow one litter the beginning farmer needs to breed 1.176 sows. Assuming that a sow or gilt weighs 220 pounds, the beginning farmer needs 2.6 hundredweight of sows for each sow that farrows. Farrowing one or two litters per year requires one sow, or 2.6 hundredweight of sows, so each activity that farrows one or two litters in year t uses 2.6

hundredweight of the herd sow transfer row in year t. Farrowing four litters per year requires two sows, or 5.2 hundredweight of sows, so each activity that farrows four litters in year t uses 5.2 hundredweight of the herd sow transfer row in year t. Farrowing six litters per year requires three sows, or 7.8 hundredweight of sows, so each activity that farrows six litters in year t uses 7.8 hundredweight of the herd sow transfer row in year t.

It is assumed that half of the herd sows are replaced each year. Half of the sows used for farrowing in year t are added to the sow transfer row in the quarter when their last litter is weaned, and are then available to be sold. The other half of the sows used for farrowing in year t are added to the herd sow transfer row in year t+1, and are then available to be used in farrowing activities in year t+1. The herd sows that are transferred from year t to year t+1 are listed as short-term assets in the beginning farmer's balance sheet. Each farrowing activity in year t adds an amount to the short-term asset accounting row of year t which is equal to the number of hundredweight of sows added to the herd sow transfer row in year t+1 multiplied by the market price of one hundredweight of sow.

Hog Feeding

Activities are provided each year which allow the pasture facilities, the partial confinement facility, and the total confinement facility to be used to feed hogs from 40 pound feeder pigs to 220 pound slaughter hogs. Pigs can be placed on feed in each of the four quarters of year t, so there are four feeding activities in year t for each type of hog feeding facility. It takes approximately five months to produce a 220 pound slaughter hog from a 40 pound feeder pig, so market hogs are available to be sold two quarters after the pigs are placed on feed. Appendix Table A.16 gives the annual costs, feed required, and labor required to feed one hog from a 40 pound feeder pig to a 220 pound market hog using the three hog feeding facilities.

Table 4.26 shows the hog feeding activities in year t, t = 1,2,3, 4,5, included in this model. Four activities feed hogs using each hog feeding facility; one for each quarter of year t. The four activities that feed hogs use one head of feeding facility capacity in the quarter the pigs are placed on feed and the following quarter. Each activity which feeds hogs uses one feeder pig out of the feeder pig transfer row in the quarter the pig is placed on feed.

Activities that begin feeding pigs in the first quarter of year t use the amount of corn and the amount of cash that is required to feed one pig (given in Appendix Table A.16) in the first period of year t. Half the labor required to feed one hog is used in the first quarter and half is used in the second quarter of year t. Activities that place feeder pigs on feed in the second quarter use half of the corn and half of the cash required to feed one hog in the first period of year t (during the second quarter), and use the other half of each in the second period of year t (during the third quarter). These activities use half the labor required in the second quarter and half in the third quarter. Activities that place pigs on feed in the third quarter of year t use the amount of corn and the amount of cash required to feed

Table 4.26. Tableau of hog feeding activities in year t, t=1,2,3,4,5.

			Place Feeder Pigs on Feed in:*			
Row	Row Type	RHS	First Quarter	Second Quarter	Third Quarter	Fourth Quarter
Hog Feeding Facility, first quarter of year t	L	0	1			
Hog Feeding Facility, second quarter of year t	L	0	1	1		
Hog Feeding Facility, third quarter of year t	L	0		1	1	
Hog Feeding Facility, fourth quarter of year t	L	0			1	1
Hog Feeding Facility, first quarter of year t+1	L	0				1
Feeder Pig Transfer Row, first quarter of year t	L	0	1			
Feeder Pig Transfer Row, second quarter of year t	L	0		1		
Feeder Pig Transfer Row, third quarter of year t	L	0			1	
Feeder Pig Transfer Row, fourth quarter of year t	L	0				1
Corn Grain Transfer Row, first period of year t	L	0	a	a/2		
Corn Grain Transfer Row, second period of year t	L	0		a/2	a	a/2
Corn Grain Transfer Row, first period of year t+1	L	0				a/2
Cash, first period of year t	L	0	c	c/2		
Cash, second period of year t	L	0		c/2	c	c/2
Cash, first period of year t+1	L	0				c/2
Labor, first quarter of year t	L	600	b			
Labor, second quarter of year t	L	700	b	b		
Labor, third quarter of year t	L	700		b	b	
Labor, fourth quarter of year t	L	700			b	b
Labor, first quarter of year t+1	L	600				b
Slaughter Hog Transfer Row,						
third quarter of year t	L	0	-d			
fourth quarter of year t	L	0		-d		
first quarter of year t+1	L	0			-d	
second quarter of year t+1	L	0				-d
Short-Term Assets Accounting Row, year t	E	0			-e	-e

Income Accounting Row, year t	E	0	c	c	c	c/2
Income Accounting Row, year t+1	E	0				c/2

* a: bushels of corn fed to feeder pig, b: hours of labor used in each quarter, c: dollars of cash used to feed feeder pig, d: hundredweight of slaughter hog produced, e: short-term assets at end of year t.

one hog in the second period of year t. Half the labor required is used in the third quarter and half is used in the fourth quarter. Finally, for activities that begin feeding pigs in the fourth quarter of year t, half of the corn and half of the cash required to feed one hog is used in the second period of year t (during the fourth quarter of year t), and half of the corn and half of the cash is used in the first period of year t+1 (during the first quarter of year t+1). Half of the labor required is used in the fourth quarter of year t and half is used in the first quarter of year t+1.

A 3 percent death rate during the feeding period is assumed, so each hog feeding activity produces 2.134 hundredweight of a market hog (2.2 hundredweight multiplied by .97). Each hog feeding activity, therefore, adds 2.134 hundredweight to the market hog transfer row two quarters after the pig is placed on feed. The amount of cash used by each hog feeding activity is deducted from the income accounting row of year t.

The activities that begin feeding pigs in the third quarter of year t produce a market hog for sale in the first quarter of year t+1. These hogs on feed at the end of year t are listed as short-term assets in the beginning farmer's balance sheet at a value of $69.50. The activities that begin feeding pigs in the fourth quarter of year t produce a slaughter hog for sale in the second quarter of year t+1. These hogs on feed at the end of year t are listed as short-term assets in the beginning farmer's balance sheet at a value of $26.10.

Cattle Feeding

Activities are provided in each year that allow the cattle feeding facilities to be used to feed 450 pound calves or 650 pound yearlings to market weight. Calves can be put on feed in the spring or in the fall, and a market weight animal is available one year after the calf is placed on feed. Yearlings can also be placed on feed in the spring or in the fall, and a market weight animal is available six months after the yearling is placed on feed. The calves and yearlings can be fed in any one of the four cattle feeding facilities purchased by the beginning farmer. A roughage ration and a concentrate ration are available to feed the calves and yearlings. Appendix Tables A.17 through A.20 give the cash costs, the resources required, and the weight of market animal produced feeding each ration in each of the four cattle feeding facilities when calves are put on feed in the spring. Appendix Tables A.21 through A.24 give the same information for calves placed on feed in the fall. Appendix Tables A.25 through A.28 give the same information for yearlings placed on feed in the spring and in the fall.

Table 4.27 shows the cattle feeding activities in year t, t = 1,2, 3,4,5. Calves and yearlings can be fed either the roughage or concentrate ration, and can be fed in any one of the four cattle feeding facilities, so there are eight activities represented by each column in Table 4.27. Since it takes approximately a year to feed out a calf, each activity that feeds one calf uses one head space of the available feeding capacity of the appropriate cattle feeding facility in the period the calf is placed on feed and the following period. Each

Table 4.27. Tableau of cattle feeding activities in year t, t=1,2,3,4,5.

Row	Row Type	RHS	Calves Placed on Feed in:* Spring	Fall	Yearlings Placed on Feed in:* Spring	Fall
Cattle Feeding Facility, first period of year t	L	0	1		1	
Cattle Feeding Facility, second period of year t	L	0	1	1		1
Cattle Feeding Facility, first period of year t+1	L	0		1		
Calf Transfer Row, first period of year t	L	0	4.5			
Calf Transfer Row, second period of year t	L	0		4.5		
Yearling Transfer Row, first period of year t	L	0			6.5	
Yearling Transfer Row, second period of year t	L	0				6.5
Cash, first period of year t	L	0	a		j	
Cash, second period of year t	L	0	b	a	k	m
Cash, first period of year t+1	L	0	c	b		n
Cash, second period of year t+1	L	0		c		
Roughage Transfer Row, first period of year t	L	0	d/4		p/2	
Roughage Transfer Row, second period of year t	L	0	d/2	d/4	p/2	q/2
Roughage Transfer Row, first period of year t+1	L	0	d/4	d/2		q/2
Roughage Transfer Row, second period of year t+1	L	0		d/4		
Corn Grain Transfer Row, first period of year t	L	0	e/4		r/2	
Corn Grain Transfer Row, second period of year t	L	0	e/2	e/4	r/2	s/2
Corn Grain Transfer Row, first period of year t+1	L	0	e/4	e/2		s/2
Corn Grain Transfer Row, second period of year t+1	L	0		e/4		
Labor, second quarter of year t	L	700	f		u	
Labor, third quarter of year t	L	700	f		u	
Labor, fourth quarter of year t	L	700	f	f		u
Labor, first quarter of year t+1	L	600	f	f		u
Labor, second quarter of year t+1	L	700		f		
Labor, third quarter of year t+1	L	700		f		

Slaughter Cattle Transfer Row,						
second period of year t	L	0			-v	
first period of year t+1	L	0	-g			-w
second period of year t+1	L	0		-g		
Short-Term Assets Accounting Row, year t	E	0	-h	-i		-x
Income Accounting Row, year t	E	0	(a+b)	a	(j+k)	m
Income Accounting Row, year t+1	E	0	c	(b+c)		n

* a: dollars of cash used during the first period calf is on feed, b: dollars of cash used during the second period calf is on feed, c: dollars of cash used during the third period calf is on feed, d: tons of roughage needed to feed calf, e: bushels of corn needed to feed calf, f: hours of labor used in each quarter to feed calf, g: hundredweight of slaughter cattle produced by calf feeding activity, h: short-term asset value at end of year t of calf placed on feed in spring of year t, i: short-term asset value at end of year t of calf placed on feed in fall of year t, j: dollars of cash used during the first period spring yearling is on feed, k: dollars of cash used during the second period spring yearling is on feed, m: dollars of cash used during the first period fall yearling is on feed, n: dollars of cash used during the second period fall yearling is on feed, p: tons of roughage needed to feed spring yearling, q: tons of roughage needed to feed fall yearling, r: bushels of corn needed to feed spring yearling, s: bushels of corn needed to feed fall yearling, u: hours of labor used in each quarter to feed yearling, v: hundredweight of slaughter cattle produced by spring yearling feeding activity, w: hundredweight of slaughter cattle produced by fall yearling feeding activity, x: short-term asset value at end of year t of yearling placed on feed in fall of year t.

activity that feeds calves uses 4.5 hundredweight of a calf in the period the calf is placed on feed. The activities that feed calves use the amount of cash, roughage, corn, and labor in each period the calf is on feed as given in Appendix Tables A.17 through A.24. Each activity that places calves on feed in the spring of year t adds to the slaughter cattle transfer row in the first period of year t+1 the weight of the market animal produced by that activity (given in Appendix Tables A.17 through A.20). Each activity that places calves on feed in the fall of year t adds to the slaughter cattle transfer row in the second period of year t+1 the weight of the slaughter animal produced by that activity (given in Appendix Tables A.21 through A.24).

Since it takes about six months to feed out a yearling, each activity that feeds one yearling uses one head space of the available feeding capacity of the appropriate cattle feeding facility in the period the yearling is placed on feed. Each activity that feeds yearlings uses 6.5 hundredweight of a yearling in the period the yearling is placed on feed. The activities that feed yearlings use the amount of cash, roughage, corn, and labor in each period the yearling is on feed as given in Appendix Tables A.25 through A.28. Each activity that places yearlings on feed in the spring of year t adds to the slaughter cattle transfer row in the second period of year t the weight of the slaughter animal produced by that activity (given in Appendix Tables A.25 through A.28). Each activity that places yearlings on feed in the fall of year t adds to the slaughter cattle transfer row in the first period of year t+1 the weight of the slaughter animal produced by that activity (given in Appendix Tables A.25 through A.28).

Cattle on feed at the end of year t add to the value of short-term assets in the beginning farmer's balance sheet at the end of year t. It is assumed that calves placed on feed in the spring of year t will weigh approximately 700 pounds at the end of year t and could be sold at the market price of yearlings. This gives each calf placed on feed in the spring of year t a value of $261.45 which is added to the short-term asset accounting row of year t. The value of calves placed on feed in the fall of year t and the value of yearlings placed on feed in the fall of year t are also added to the short-term asset accounting row of year t. Finally, all cash expenses incurred during year t are deducted from the income accounting row of year t and the cash expenses paid during year t+1 are deducted from the income accounting row of year t+1.

Tax and Consumption Withdrawals

Activities are provided for each year that determine the beginning farmer's taxable income in that year, the amount of taxes which must be paid on this taxable income, the disposable income then available to the beginning farmer, and the consumption level of the farm family based on this disposable income. Table 4.28 shows these activities for year t, t=1,2,3,4,5. This linear programming formulation to determine tax and consumption withdrawals was suggested by Vandeputte and Baker (89). The formulation in this model depicts the progressive income tax of the 1975 federal income tax schedule for married taxpayers filing joint

Table 4.28. Tableau of activities that determine tax obligations and consumption withdrawals for year t, t=1,2,3,4,5.

Row	Row Type	RHS	Income, year t	Depreciation, year t	Tax Paying Activities, year t*	Taxes, year t	Disposable Income, year t	Consumption, year t
Income Accounting Row, year t	E	0	1					
Depreciation Accounting Row, year t	E	0		1				
Taxable Income Accounting Row, year t	E	0	-1	1	a			
Tax Accounting Equality Row, year t	E	1			1			
Tax Accounting Row, year t	E	0			-b	1		
Disposable Income Accounting Row, year t	E	0			-a	1	1	
Consumption Accounting Row, year t	E	0			-c			1
Cash, first period of year t	L	0						.5
Cash, second period of year t	L	0						.5
Return Accounting Row	G	λ					$(1.05)^{-t}$	

* a: taxable income on which taxes are paid, b: amount of taxes which must be paid on taxable income, see Table 3.1, c: amount of consumption at this level of taxable income, see Table 3.1.

returns. The consumption function built into this model was discussed in the last chapter. The tax obligations and consumption withdrawals for various income levels were given in Table 3.1.

Each activity that affects income in year t has an entry in the income accounting row of year t. The sign of this entry is positive if the activity decreases income (production expenses, interest payments, etc.), and the sign is negative if the activity adds to income (crop selling, off-farm earnings, etc.). The summation of the activity levels each multiplied by the coefficient in the income accounting row will be negative if income in year t is positive. Since the income accounting row of year t is an equality with a zero constraint level, the level of the income activity will be equal to the income of year t. This amount of income is then added to the taxable income accounting row of year t. The amount of depreciation claimed during year t is deducted from the income of year t to give the amount of taxable income of year t in the taxable income accounting row of year t. Since the taxable income accounting row of year t is an equality with a zero constraint level, the amount of taxable income will be given by the tax paying activities of year t.

The sum of activity levels for tax paying activities is forced to equal 1.0 through a tax accounting equality with 1.0 as the right-hand-side quantity. Each tax paying activity in year t adds the amount of tax which must be paid on that income level to the tax accounting row of year t. The taxable income accounting row, the tax accounting equality, and the tax accounting row insure that the correct amount of tax is paid on taxable income of year t. For example, if taxable income equals $16,000, then an activity level of one unit of the $16,000 tax paying activity would satisfy the taxable income accounting row and the tax accounting equality. This would require a tax payment of $3260 in the tax accounting row. However, an activity level of one-half unit for the $12,000 tax paying activity and an activity level of one-half unit for the $20,000 tax paying activity would also satisfy the taxable income accounting row and the tax accounting equality. But this would result in a tax payment of $3320, or $60 more than is required. There is a built-in tendency for the model to choose the "right" tax paying activity or the right combination of two tax paying activities (89). Since the tax accounting row is an equality constraint with a zero constraint level, the amount of tax which must be paid on income of year t is given by the level of the taxes activity.

The amount of taxable income corresponding to each tax paying activity is added to the disposable income accounting row of year t. The amount of taxes which must be paid on income of year t is then deducted from this row. Since the disposable income accounting row is an equality with a zero constraint level, the amount of disposable income available to the beginning farmer in year t is given by the level of the disposable income activity. The return to the beginning farmer of the first t years of farming was defined in equation 3.3 of Chapter 3 as the summation of the discounted value of disposable income. Therefore, disposable income of year t is multiplied by its discount rate and added to the return accounting row.

The consumption withdrawals for each disposable income level are added to the consumption accounting row of year t. This row is an equality with a zero constraint level, so the amount of consumption required by the farm family in year t is given by the level of the consumption activity. Half of each dollar consumed in year t is consumed in the first period and half is consumed in the second period. So, for every dollar consumed in year t, $0.50 is deducted from cash in the first period and $0.50 is deducted from cash in the second period.

Liabilities, Assets, and Net Worth

Activities are provided which determine the values of the farmer's balance sheet at the end of each year. These activities for year t, t=1,2,3,4,5, are shown in Table 4.29. Each activity which affects debt in year t has an entry in the appropriate debt accounting row of year t. This entry is negative if the activity adds to one of the debt categories (short-term borrowing, intermediate-term borrowing, land financing, etc.) and is positive if the activity decreases one of the debt categories (paying intermediate-term principal, paying long-term principal, etc.). Since each debt accounting row is an equality with a zero constraint level, the level of the corresponding debt column gives the value of the debt category in the beginning farmer's balance sheet at the end of year t. Each of the three debt accounting columns then adds to the total debt accounting row of year t. Since the total debt accounting row is an equality with a zero constraint level, the level of the total debt column in year t gives the value of total liabilities in the beginning farmer's balance sheet at the end of year t.

Table 4.29. Tableau of accounting activities for liabilities, assets, and net worth at the end of year t, t=1,2,3,4,5.

Row	Row Type	RHS	Short-Term Debt, year t	Inter-mediate Debt, year t	Long-Term Debt, year t	Total Debt, year t
Short-Term Debt Accounting Row, year t	E	0	1			
Intermediate-Term Debt Accounting Row, year t	E	0		1		
Long-Term Debt Accounting Row, year t	E	0			1	
Total Debt Accounting Row, year t	E	0	-1	-1	-1	1
Short-Term Assets Accounting Row, year t	E	0				
Intermediate-Term Assets Accounting Row, year t	E	0				
Long-Term Assets Accounting Row, year t	E	0				
Total Assets Accounting Row, year t	E	0				
Net Worth Accounting Row, year t	E	0				1
Current Ratio Constraint, year t	G	0	-1			
Debt-to-Equity Ratio Constraint, year t	L	0				1

Table 4.29 (continued).

Row	Short-Term Assets, year t	Intermediate Assets, year t	Long-Term Assets, year t	Total Assets, year t	Net Worth, year t*
Short-Term Debt Accounting Row, year t					
Intermediate-Term Debt Accounting Row, year t					
Long-Term Debt Accounting Row, year t					
Total Debt Accounting Row, year t					
Short-Term Assets Accounting Row, year t	1				
Intermediate-Term Assets Accounting Row, year t		1			
Long-Term Assets Accounting Row, year t			1		
Total Assets Accounting Row, year t	-1	-1	-1	1	
Net Worth Accounting Row, year t				-1	1
Current Ratio Constraint, year t	1				
Debt-to-Equity Ratio Constraint, year t					$-\gamma$

* γ: required debt-to-equity ratio.

Each activity which affects short-term assets, intermediate-term assets, or long-term assets in year t has an entry in the appropriate asset accounting row of year t. This entry is negative if the activity adds to one of the asset categories (cattle on feed at end of year t, machinery investment, land investment, etc.) and it is positive if the activity decreases one of the asset categories. Since each asset accounting row is an equality with a zero constraint level, the level of the corresponding debt column gives the value of that asset category in the beginning farmer's balance sheet at the end of year t. Each of these asset columns then adds to the total asset accounting row of year t. Since the total asset accounting row of year t is an equality with a zero constraint level, the level of the total asset column in year t gives the value of total assets in the beginning farmer's balance sheet at the end of year t.

Net worth at the end of year t is determined by subtracting total debt at the end of year t from total assets at the end of year t. The total asset column of year t adds to the net worth accounting row of year t and the total debt column of year t substracts from the net worth accounting row of year t. Since the net worth accounting row of year t is an equality with a zero constraint level, the level of the net worth column in year t gives the beginning farmer's net worth at the end of year t.

The current ratio constraint in year t insures that short-term assets are at least as great as short-term debt. This constraint forces the model to maintain liquidity to meet current debts. The debt-to-equity ratio constraint in year t insures that the debt-to-equity ratio is less than or equal to γ_t. This ratio was defined in the discussion of equation 3.11 in Chapter 3.

Selling Agricultural Products and Risk Accounting

Activities are provided in each year which allow agricultural products produced by the beginning farmer to be sold. Corn, soybeans, and oats grown in year t and harvested in the second period of year t can be sold at harvest time. These crops can also be stored in the second period of year t to be used in the first period of the next year. Livestock produced by the beginning farmer can also be sold in each year. Slaughter cattle can be sold in the spring and fall of each year. Market hogs and feeder pigs can be sold in each of the four quarters of each year. Finally, sows can be sold in the first and fourth quarters of each year. The expected return from each selling activity is defined as the average price of the product over the years 1971-1976. Appendix Tables A.29 through A.35 give the price data that were used to calculate the expected return for each agricultural product selling activity.

Table 4.30 shows the crop selling activities of year t, t=1,2,3, 4,5. Each crop selling activity in the first period of year t uses one bushel of the appropriate grain from the transfer row in that period. These activities also add the expected market price for one bushel of grain to cash in the first period of year t and to income of year t. Each crop selling activity in the second period of year t uses one bushel of the appropriate grain from the transfer row in that

Table 4.30. Tableau of crop and livestock selling activities and crop storage activities in year t, t=1,2,3,4,5.

Row	Row Type	RHS	Crop Selling, first period*	Crop Selling, second period*	Crop Storing, second period*	Livestock Selling*
Crop Grain Transfer Row,						
first period of year t	L	0	1			
second period of year t	L	0		1	1	
first period of year t+1	L	0			-1	
Livestock Transfer Row, year t[a]	L	0				1
Deviation of 1971 Price from Estimated Time Trend Price, year t	G	0	y_{j1}	y_{j1}		y_{j1}
Deviation of 1972 Price from Estimated Time Trend Price, year t	G	0	y_{j2}	y_{j2}		y_{j2}
Deviation of 1973 Price from Estimated Time Trend Price, year t	G	0	y_{j3}	y_{j3}		y_{j3}
Deviation of 1974 Price from Estimated Time Trend Price, year t	G	0	y_{j4}	y_{j4}		y_{j4}
Deviation of 1975 Price from Estimated Time Trend Price, year t	G	0	y_{j5}	y_{j5}		y_{j5}
Deviation of 1976 Price from Estimated Time Trend Price, year t	G	0	y_{j6}	y_{j6}		y_{j6}
Cash, first period of year t	L	0	-b			$\left\{-e\right.$
Cash, second period of year t	L	0		-c	d	
Income Accounting Row, year t	E	0	-b	-c	d	-e
Short-Term Assets Accounting Row, year t	E	0			-c	

[a]Slaughter cattle transfer rows in both periods, slaughter hog and feeder pig transfer rows in each quarter, and slaughter sow transfer rows in the first and fourth quarters.

* b: mean price for grain in the first period, see Appendix Tables A.29, A.30 and A.31, c: mean price for grain in the second period, see Appendix Tables A.29, A.30, and A.31, d: cost of storing one bushel of grain, e: mean price for livestock in appropriate quarter or period, see Appendix Tables A.32 through A.35, y_{jh}: deviation of observation year h's price from estimated time trend price for activity j.

period. These activities also add the expected market price for one bushel of grain to cash in the second period of year t and to income of year t.

Table 4.30 also shows the livestock selling activities of year t, t=1,2,3,4,5. Selling spring cattle in year t uses one hundredweight of slaughter cattle from the transfer row in the first period of year t. This activity adds the expected return to cash in the first period of year t and to income of year t. Selling fall cattle in year t uses one hundredweight of slaughter cattle from the transfer row in the second period of year t. This activity adds the expected return to cash in the second period of year t and to income of year t. Market hogs can be sold in any one of the four quarters of year t and each activity uses one hundredweight of slaughter hog from the transfer row of the appropriate quarter. Selling market hogs in the first or second quarter of year t adds the expected return to cash in the first period of year t and to income of year t. Selling market hogs in the third or fourth quarter of year t adds the expected return to cash in the second period of year t and to income of year t. Feeder pigs can be sold in any one of the four quarters of year t and each activity uses one hundredweight of feeder pig from the transfer row of the appropriate quarter. Selling feeder pigs in the first or second quarter of year t adds the expected return to cash in the first period of year t and to income of year t. Selling feeder pigs in the third or fourth quarter of year t adds the expected return to cash in the second period of year t and to income of year t. Sows can be sold in the first quarter of year t and in the fourth quarter of year t. Selling sows in the first quarter uses one hundredweight of sow from the transfer row in the first quarter of year t, adds the expected return to cash in the first period of year t, and adds the expected return to income of year t. Selling sows in the fourth quarter of year t uses one hundredweight of sow from the transfer row in the fourth quarter of year t and adds the expected return to cash in the second period of year t and to income of year t.

The risk associated with the farm business is defined in this model as arising from the uncertain market prices of agricultural products as discussed in Chapter 3. Risk was defined by equation 3.1 as the summation of the discounted values of the absolute values of negative deviations. The absolute value of the negative deviation of observation h in period k of year t was defined by equation 3.2. In this model there are six observations, that is h=1, ..., 6, representing the six years of price data from 1971 through 1976. Therefore, there are six rows in each year which constrain the absolute value of negative deviations. Each activity that sells an agricultural product in year t has an entry in each of the six rows which define the absolute value of negative deviation due to observation h. These entries are shown in Table 4.30 and Table 4.31 in the deviation of price from estimated time trend rows for each agricultural product selling activity. The deviations are taken after the trend effect has been deleted by the use of simple regression leaving only the random deviations from the trend (25). The actual product prices, the

Table 4.31. Tableau of risk accounting activities in year t, t=1,2,3,4,5.

Row	Row Type	RHS	Absolute Value of Negative Deviation in year t Due to Observation Year: 1971	1972	1973	1974	1975	1976	Risk year t
Deviation of 1971 Price from Estimated Time Trend Price	G	0	1						
Deviation of 1972 Price from Estimated Time Trend Price	G	0		1					
Deviation of 1973 Price from Estimated Time Trend Price	G	0			1				
Deviation of 1974 Price from Estimated Time Trend Price	G	0				1			
Deviation of 1975 Price from Estimated Time Trend Price	G	0					1		
Deviation of 1976 Price from Estimated Time Trend Price	G	0						1	
Risk Accounting Row, year t	E	0	-1	-1	-1	-1	-1	-1	1
Objective Function	N	0							$(1.05)^{-2t}$

estimated trend price, and the resulting deviation are given in Appendix Tables A.36 through A.42 for each agricultural product that is sold.

The absolute value of the negative deviation of each observation year h in year t is then determined by the level of that activity in Table 4.31. If the value of the deviation due to observation h is positive, then the deviation of observation year h price from estimated time trend price row is satisfied with the level of the corresponding activity at zero. If the value of the deviation due to observation h is negative, then for the corresponding constraint to be satisfied, the level of activity must equal the absolute value of the negative deviation due to observation h. This transfers the size of the negative deviation into the risk accounting row. The total risk in year t is then measured by the summation of the absolute value of the six negative deviations in the risk accounting row. This total risk in year t is given by the level of activity risk because the risk accounting row must equal zero. This value multiplied by the factor $(1.05)^{-2t}$, as given in equation 3.1, is then transferred into the objective function.

Buying Agricultural Products

Some agricultural products need to be bought to provide inputs for production activities. Activities are provided in each year which buy these agricultural products and add them to the appropriate transfer rows. Corn and hay can be bought in both periods of each year to provide feed for the hog farrowing, hog feeding, and cattle feeding activities. Calves and yearlings can be purchased in the spring and fall of each year to provide the animals necessary for the cattle feeding activities. Gilts can be bought at the beginning of each year to provide the breeding animals necessary for the hog farrowing activities. Finally, feeder pigs can be bought in each quarter of each year to provide the animals necessary for the hog feeding activities.

Each activity that buys one unit of an agricultural product uses the amount of cash necessary to buy the product in the period the product is purchased. This amount of cash in also deducted from the income accounting row of year t.

Off-Farm Investment

Activities are provided in each period of each year which allow unused cash to be invested in a savings account. The savings account returns 5 percent per year. Table 4.32 shows the cash savings activities in year t, t=1,2,3,4,5. Cash saving in the first period of year t uses one dollar of cash in the first period of year t. This activity then adds $1.025 to cash transferred to the second period of year t. Saving cash in the second period of year t uses one dollar of cash in that period and adds $1.025 to cash transferred to the first period of the next year. Both cash saving activities in year t add $0.025 to the income accounting row of year t.

Short-Term Borrowing

Activities are provided that allow cash to be borrowed for six months. An interest rate of 10 percent per year must be paid on these short-term loans. Activities which borrow short-term money in year t,

Table 4.32. Tableau of cash saving activities and short-term borrowing activities in year t, t=1,2,3,4,5.

Row	Row Type	RHS	Save Cash, year t: first period	Save Cash, year t: second period
Cash, first period of year t	L	0	1	
Short-Term Borrowing Repayment Constraint, first period of year t	G	0		
Short-Term Borrowing Limit, first period of year t	L	50000		
Cash Transfer Row, first period of year t to second period of year t	L	0	-1.025	
Cash, second period of year t	L	0		1
Short-Term Borrowing Repayment Constraint, second period of year t	G	0		
Short-Term Borrowing Limit, second period of year t	L	50000		
Income Accounting Row, year t	E	0	-0.025	-0.025
Short-Term Debt Accounting Row, year t	E	0		
Cash Transfer Row, second period of year t to first period of year t+1	L	0		-1.025
Cash, first period of year t+1	L	0		
Income Accounting Row, year t+1	E	0		

Table 4.32 (continued).

Row	Short-Term Borrowing first period of year t	Pay Short-Term Borrowing second period of year t	Short-Term Borrowing second period of year t	Pay Short-Term Borrowing first period of year t+1
Cash, first period of year t	-1			
Short-Term Borrowing Repayment Constraint, first period of year t	-1	1		
Short-Term Borrowing Limit, first period of year t	1			
Cash Transfer Row, first period of year t to second period of year t				
Cash, second period of year t		1.05	-1	
Short-Term Borrowing Repayment Constraint, second period of year t			-1	1
Short-Term Borrowing Limit, second period of year t			1	
Income Accounting Row, year t		0.05		
Short-Term Debt Accounting Row, year t			-1	
Cash Transfer Row, second period of year t to first period of year t+1				
Cash, first period of year t+1				1.05
Income Accounting Row, year t+1				0.05

t=1,2,3,4,5, and activities which pay the principal and interest on these short-term loans are shown in Table 4.32. Borrowing one dollar in the first period of year t adds one dollar to cash in that period, adds one dollar to the short-term borrowing repayment constraint in the first period of year t, and uses one dollar of the short-term borrowing limit in the first period of year t. Cash borrowed in the first period of year t must be repaid in the second period of year t. Repaying short-term borrowing in the second period of year t uses one dollar of the short-term borrowing repayment constraint in the first period of year t, uses $1.05 of cash in the second period of year t, and reduces income in year t by $0.05.

Borrowing one dollar in the second period of year t adds one dollar to cash in that period, adds one dollar to the short-term borrowing repayment constraint in the second period of year t, uses one dollar of the short-term borrowing limit in the second period of year t, and adds one dollar to short-term debt at the end of year t. Cash borrowed in the second period of year t must be repaid in the first period of the next year (year t+1). Repaying short-term borrowing in the first period of year t+1 uses one dollar of the short-term borrowing repayment constraint in the second period of year t, uses $1.05 of cash in the first period of year t+1, and reduces income in year t+1 by $0.05.

Wife's Labor

The labor provided by the farmer's wife could be a critical factor in the success or failure of a new farm. If the wife can find an off-farm job, her steady income could provide the cash flow needed for the new farm to survive. The wife's labor could also be used in the farm business as a supplement to the beginning farmer's labor.

Activities that utilize the wife's labor in year t, t=1,2,3,4,5 are shown in Table 4.33. It is assumed that the beginning farmer's wife can provide 500 hours of labor in each quarter of year t. One activity utilizes the wife's labor in year t in an off-farm job. The off-farm job uses all the wife's available labor in each quarter and pays her $8,000 per year. This activity adds $4,000 to cash in each period of year t and adds $8,000 to income in year t.

Activities are also provided that utilize the wife's labor in the farm business. It is assumed that one hour of the wife's labor used in the farm business is equivalent to one-half hour of the beginning farmer's labor. Thus, activities that utilize the wife's labor in the farm business in each quarter of year t use one hour of the wife's labor in that quarter and add one-half hour to the beginning farmer's labor in that quarter.

Table 4.33. Tableau of activities that utilize wife's labor in year t, t=1,2,3,4,5.

Row	Row Type	RHS	Working Wife, year t	Wife's Labor Transferred to Farm Labor in year t in quarter: first	second	third	fourth
Labor, first quarter of year t	L	600		-.5			
Labor, second quarter of year t	L	700			-.5		
Labor, third quarter of year t	L	700				-.5	
Labor, fourth quarter of year t	L	700					-.5
Wife's Labor, first quarter of year t	L	500	500	1			
Wife's Labor, second quarter of year t	L	500	500		1		
Wife's Labor, third quarter of year t	L	500	500			1	
Wife's Labor, fourth quarter of year t	L	500	500				1
Cash, first period of year t	L	0	-4000				
Cash, second period of year t	L	0	-4000				
Income Accounting Row, year t	E	0	-8000				

CHAPTER 5. RESULTS

Overview

There is a number of parameters in the empirical model which describe the initial conditions facing the beginning farmer. Among the most important are the beginning farmer's equity or cash position, the debt-to-equity ratio constraint, and the family consumption function. The initial conditions facing the beginning farmer are also described by the available activities, such as the loan terms available and off-farm employment opportunities. As these parameters and available activities are altered, the position and shape of the efficient E,A frontier may be changed.

In this study several different sets of initial conditions are examined by altering the above mentioned items in the empirical model. Beginning equity or cash levels of \$20,000 and \$40,000 are considered. Two family consumption functions are considered: one given by equation 3.7 (referred to as consumption function α) and the second with a marginal propensity to consume equal to 75 percent of the marginal propensity to consume of the first consumption function at each income level (referred to as consumption function β). Debt-to-equity ratio constraints of less than 1.0 and less than 2.0 are considered. Two off-farm employment alternatives are considered: one allows the beginning farmer's wife to work at a job that pays \$8000 per year and the second allows no off-farm employment. Finally, two different sets of loan terms are considered: one set includes nonconventional repayment plans, such as deferred and increasing principal payments, and the second set includes only conventional repayment plans.

Each combination of these five items represents a different set of initial conditions. If every combination were considered there would be 64 efficient E,A frontiers generated. However, there may be instances where two or more combinations generate the same efficient E,A curve. For example, suppose an efficient E,A frontier is found for any of the sets of initial conditions with a debt-to-equity ratio of less than 2.0, but the debt-to-equity ratio at the end of each year for the farm plans associated with every point along the curve is less than 1.0. In this case changing the debt-to-equity ratio constraint to less than 1.0 would not alter the efficient E,A curve. Another example would be generating an efficient frontier for any of the combinations which include nonconventional loan terms. If none of the farm plans associated with the points along the frontier includes investment and financing plans which include nonconventional loan terms, then deleting the nonconventional financing plans would not alter the efficient E,A curve.

Ten different sets of initial conditions are considered in this chapter. The 64 possible sets of initial conditions and the 10 that are evaluated are shown in Table 5.1. Five points are found on the efficient E,A frontier for each set of initial conditions. Each point on the curve represents a five year investment, financing, production, and marketing plan. For each point a balance sheet can be generated for the initial period and for each of the five years. A cash flow

Table 5.1. Initial conditions considered in this model.

	Initial Cash: $20,000				Initial Cash: $40,000			
	Wife Working		Wife Not Working		Wife Working		Wife Not Working	
Consumption Function	α	β	α	β	α	β	α	β
Loan Terms[a]	c	c	c	c	c	c	c	c
Debt-to-Equity Ratio	≤1	≤1	≤1	≤1	≤1	≤1	≤1	≤1
Curve	VII				IX[b]			
Consumption Function	α	β	α	β	α	β	α	β
Loan Terms[a]	nc	nc	nc	nc	nc	nc	nc	nc
Debt-to-Equity Ratio	≤1	≤1	≤1	≤1	≤1	≤1	≤1	≤1
Curve	V		VI		II[b]	I[b]		
Consumption Function	α	β	α	β	α	β	α	β
Loan Terms[a]	c	c	c	c	c	c	c	c
Debt-to-Equity Ratio	≤2	≤2	≤2	≤2	≤2	≤2	≤2	≤2
Curve					IX		X	
Consumption Function	α	β	α	β	α	β	α	β
Loan Terms[a]	nc	nc	nc	nc	nc	nc	nc	nc
Debt-to-Equity Ratio	≤2	≤2	≤2	≤2	≤2	≤2	≤2	≤2
Curve	III	IV	VIII		II	I		

[a]'c' means only conventional terms are available and 'nc' means nonconventional terms are also available.

[b]This situation is represented by this curve because the farm plans associated with each point produced debt-to-equity ratios less than 1.0.

statement can be generated for the initial period and for every six month period of the five years for each point. An income statement can also be generated for each of the five years for each point.

The first point on each curve (Point A) is found by maximizing return subject to risk being equal to zero. Point A on each curve is the intercept with the return axis. The last point on each curve (Point E) is found by maximizing return with no constraint on risk. Point E on each curve is the conventional linear programming solution, or the maximum return possible. The three points on each curve between these two extremes (Points B, C, and D) are found by minimizing risk given a specified return level. The return levels of Points B, C, and D on each curve are found by using the following procedure:

$$\frac{\text{(Return at Point E) - (Return at Point A)}}{4} = d$$

$$\begin{aligned}\text{Return at Point B} &= \text{Return at Point A} + d\\ \text{Return at Point C} &= \text{Return at Point B} + d\\ \text{Return at Point D} &= \text{Return at Point C} + d\end{aligned}$$

In this manner each curve is defined by five points which are equal distance apart on the return axis.

The 10 curves will be discussed in the following sections. The farm plan associated with each point on each curve will be summarized in terms of the investment, financing, production, and marketing plans. A balance sheet for each year of each point will be presented. In each balance sheet current assets are comprised of cash saved in the last period of the year, crops stored, and livestock on hand that will be sold during the next year. Intermediate assets are owned machinery and livestock on hand that will not be sold during the next year. Long-term assets are livestock facilities and land purchased by the farm plans. Current liabilities are the income tax that must be paid on the year's income and any outstanding short-term operating debt. Intermediate liabilities are any outstanding intermediate debt used to finance machinery purchases. Finally, long-term liabilities are any outstanding long-term credit used to finance livestock facility investment or land investment.

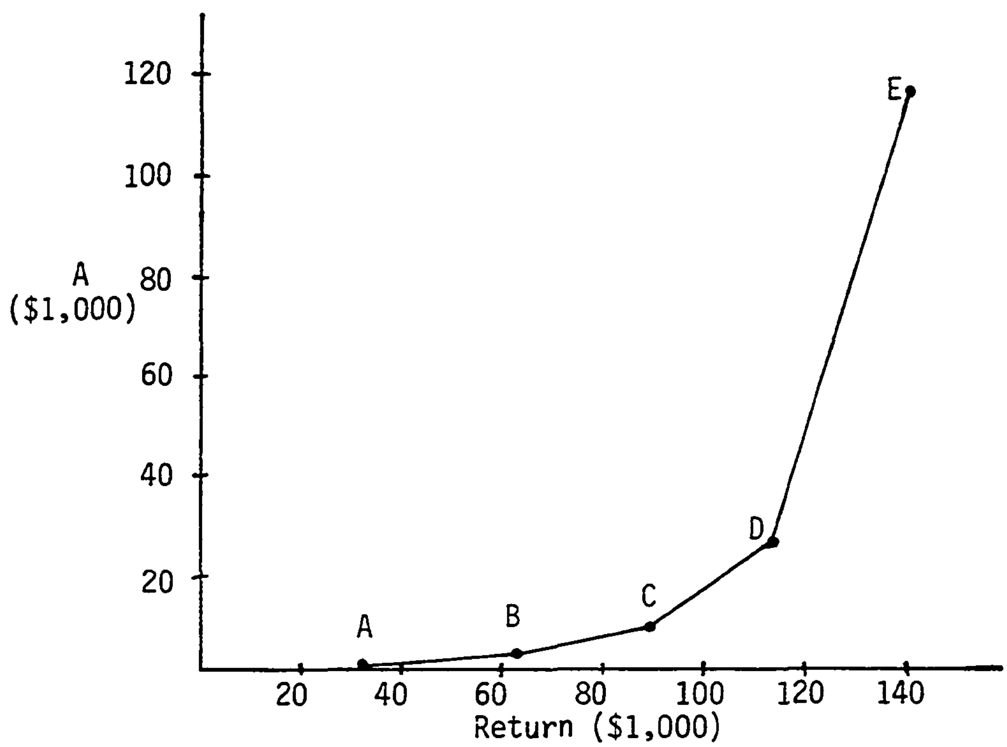
The balance sheets can be used to compute the leverage and liquidity ratios that indicate the financial position of the beginning farmer. Leverage refers to the amount of debt capital relative to equity capital a firm has in its capital structure. Leverage is measured by the debt-to-equity ratio. A debt-to-equity ratio of 1.0 or less indicates the owner's net worth exceeds the amount of borrowed funds invested in the farm business. Lenders generally prefer a debt-to-equity ratio of 1.0 or less. Liquidity refers to the ability of the firm to meet its cash obligations as they come due. Liquidity is measured by the current ratio, which is computed by dividing current assets by current liabilities. The current ratio indicates whether current assets are adequate to meet current financial obligations. A computed ratio of 2.0 indicates that there is $2.00 of current assets to back up each $1.00 of current liabilities. The higher the current ratio, the better the liquidity position of the farm firm.

The farm plans associated with each point on each curve will also be examined in terms of the pattern of yearly disposable income and consumption they generate. The variance of disposable income will also be computed for each year at each point in order to calculate the probability of disposable income falling below certain levels in each year.

Curve I

The first set of initial conditions represents an initial cash position of $40,000, an opportunity for the wife to work off the farm, consumption function β, availability of nonconventional loan terms, and a debt-to-equity ratio constraint of less than 2.0. One would expect this to be the least limiting of all the possible sets of initial conditions. That is, if an efficient E,A frontier was generated for each of the 64 possible sets of initial conditions, one would expect Curve I to be the farthest to the right.

Curve I is shown in Figure 5.1. Consistent with theoretical expectations, the efficient frontier is convex, thus requiring increased risk to reach higher levels of return. For example, a movement from Point A to Point B requires an increase in risk of $0.07 for every $1.00 increase in return, while a movement from Point D to Point E requires an increase in risk of $ 3.46 for every $1.00 increase in return. This means that to move from Point A to Point B, the beginning farmer must be willing to accept an increase in the total absolute deviation of the present value of returns of $0.07 for every $1.00 increase in the present value of returns. To move from Point D to Point E, the beginning farmer must be willing to accept an increase in the total absolute deviation of the present value of returns of $3.46 for every $1.00 increase in the present value of returns.



Point	Return	A
A	$ 36,218	$ 0
B	62,000	1,760
C	89,000	8,343
D	115,000	28,480
E	140,971	118,249

Figure 5.1. Efficient E,A Curve I.

Financing and Investment Plans

The investment and financing plans associated with each point on Curve I are summarized in Table 5.2. The investment plan associated with the conventional linear programming solution (Point E) specifies investment in the capital intensive crop production system and the capital intensive combine. Moving down the efficient frontier results in less machinery purchase and a shift to different machinery systems. At Point D there is investment in the capital intensive crop production system and the labor intensive combine. The investment plan of Point C specifies investment in the intermediate and capital intensive crop production systems and in the capital intensive combine. The investment plan of Point B specifies the lowest level (quantity) of machinery purchase, and the acquisition of the labor intensive crop production system and the capital intensive combine. Since no agricultural production occurs at Point A, no investments are made.

Nineteen percent of the machinery investment in the initial period of Point E is financed with intermediate credit. Also, at Point E all the machinery purchased in years two, three, and five is financed by the use of intermediate credit. Moving down the efficient frontier results in less use of borrowed funds to finance machinery investment. At Point D about 14 percent of the machinery investment in the initial period and all the machinery investment in years four and five is financed with intermediate credit, while all the machinery investment in years two and three is purchased with cash. All the machinery investment at Point C occurs in the intital period and is purchased with cash. All the machinery investment at Point B occurs in the initial period and year two, and it is also all purchased with cash.

Table 5.2. Level of investment and financing activities in farm plans associated with points on Curve I.

	Year 0	1	2	3	4	5
Point A						
Save Cash, first period ($)		40,700	42,327	43,992	45,697	47,441
Save Cash, second period ($)		42,417	44,702	45,766	47,500	49,274
Point B						
Machinery Investment and Financing:						
Labor Intensive Crop Production (unit)	0.39		0.06			
Capital Intensive Combine (unit)	0.11		0.07			
Pay Cash ($)	12,047		4,510			
Hog Facility Investment:						
Pasture Farrowing (litter space)	14		14		1	
Partial Confinement Farrowing (litter space)	3					
Partial Confinement Feeding (hog space)	126		114		2	
Save Cash, first period ($)			13,445	30,421	41,748	60,529
Save Cash, second period ($)		13,254	8,963	24,610	36,294	59,080
Pay Principal, Long-Term 9% Loan ($)		10,360	5,656	939	1,746	1,905
Pay Interest, Long-Term 9% Loan ($)		932	717	210	157	
Point C						
Machinery Investment and Financing:						
Intermediate Crop Production (unit)	0.23					
Capital Intensive Crop Production (unit)	0.20					
Capital Intensive Combine (unit)	0.13					
Pay Cash ($)	20,396					
Hog Facility Investment:						
Partial Confinement Farrowing (litter space)	17					
Partial Confinement Feeding (hog space)	144		25			
Save Cash, first period ($)			15,180	31,453	46,293	61,389
Save Cash, second period ($)		14,104	23,955	40,257	55,623	85,311
Pay Principal, Long-Term 9% Loan ($)		4,571	10,614	1,591	1,822	1,988
Pay Interest, Long-Term 9% Loan ($)		1,580	1,255	301	164	

Point D						
Machinery Investment and Financing:						
Capital Intensive Crop Production (unit)	0.77					0.03
Labor Intensive Combine (unit)	0.47		0.03	0.06	0.09	0.02
Pay Cash ($)	38,664		648	1,089		
Intermediate Credit ($)	6,533				1,660	1,855
Hog Facility Investment:						
Partial Confinement Farrowing (litter space)	2					
Total Confinement Feeding (hog space)	82					
Short-Term Loan, first period ($)		34,169	5,411			
Save Cash, first period ($)				19,941	43,020	60,587
Save Cash, second period ($)		4,480	21,731	42,007	67,043	115,266
Pay Principal, Intermediate 9% Loan ($)		6,533				
Pay Interest, Intermediate 9% Loan ($)		588				149
Pay Principal, Long-Term 9% Loan ($)		4,534		484	527	203
Pay Interest, Long-Term 9% Loan ($)		481	73	73	29	52
Point E						
Machinery Investment and Financing:						
Capital Intensive Crop Production (unit)	0.73		0.29			
Capital Intensive Combine (unit)	0.37		0.41	0.01		0.12
Pay Cash ($)	37,220					
Intermediate Credit ($)	8,981		26,444	394		3,698
Hog Facility Investment:						
Total Confinement Feeding (hog space)	222					
Short-Term Loan, first period ($)		50,000	50,000	50,000	50,000	50,000
Save Cash, second period ($)		29,379	55,760	88,020	107,055	149,530
Pay Principal, Intermediate 9% Loan ($)					8,981	
Pay Interest, Intermediate 9% Loan ($)		808	808	3,188	3,224	2,416
Pay Principal, Long-Term 9% Loan ($)				1,007	1,098	1,198
Pay Interest, Long-Term 9% Loan ($)		1,000	1,000	1,000	910	811

Intermediate debt incurred to finance machinery purchase must be repaid within four years, but principal payments can be delayed until the fourth year. The intermediate debt incurred in the initial period for Point E is repaid in year four, and the intermediate debt incurred in the other years is not repaid in the five year period of this analysis. The intermediate debt incurred in the initial period of Point D is repaid in year one, but the intermediate debt incurred in years four and five is not repaid in the five year period. At both Points D and E an interest charge of 9 percent of the unpaid balance must be paid each year on the intermediate debt as shown in Table 5.2.

The investment plan of each point specifies investment in hog facilities, but the level of investment and type of facility is different for each point. The investment plan of Point E specifies investment in a total confinement feeding facility in the initial period with space for about 222 hogs. At Point D all the hog facility investment occurs in the initial period with investment in a partial confinement farrowing facility with space for about 2 litters and a total confinement feeding facility with space for about 82 hogs. The investment plan of Point C specifies investment in a partial confinement farrowing facility in the initial period with space for about 17 litters. Also at Point C there is investment in a partial confinement feeding facility in the initial period with space for about 144 hogs and in year two with space for about 25 hogs. The investment plan of Point B specifies investment in pasture farrowing facilities in the initial period with space for about 14 litters, in year two with space for another 14 litters, and in year four with space for 1 litter. Point B also has investment in a partial confinement farrowing facility in the initial period with space for about 3 litters. Also at Point B there is investment in a partial confinement feeding facility in the initial period with space for about 126 hogs, in year two with space for about 114 hogs, and in year four with space for about 2 hogs.

Each of these hog facility investments is financed using repayment plan D, which is the Standard plan with deferred principal payments. The pattern of principal and interest payments on this long-term debt in years one through five for each point is shown in Table 5.2. At Point E principal payments are made in years three through five as required by the repayment plan D, and an interest charge of 9 percent of the unpaid balance is paid in each year. Moving down the efficient frontier results in prepayment of long-term debt before the required payments of repayment plan D. At Point D, 85 percent of the long-term debt incurred in the initial period is repaid in year one. Principal payments are also made in years three through five, and interest payments are made in each year. At Point C all of the long-term debt is repaid by year four. At Point B all of the long-term debt incurred in the initial period is repaid in year one and all of the long-term debt incurred in year two is repaid by year four.

The financing plan for Point E specifies the use of a short-term loan of $50,000 (the maximum limit) in the first period of each year to finance agricultural production. Moving down the efficient frontier results in less use of short-term debt to finance agricultural production. The financing plan of Point D specifies the use of short-term loans of $34,169 in the first period of year one and $5,411 in the first period of year two. No short-term operating loans are incurred at Points B or C.

The investment plan for each point specifies cash to be saved. At Point E cash is saved in the second period of each year in increasing amounts as more land is farmed and more crops are sold. The cash is received in the second period of the year when crops are sold and is saved until the first period of the next year when it is used in agricultural production. Moving down the efficient frontier results in less cash being saved in the second period of each year. At lower return levels less cash is generated in the second period of each year to be saved until the first period of the next year. However, at the lower return-risk points, cash is saved in the first period of some years. At Point D, cash is saved in the first period of years three through five, and at Points B and C, cash is saved in the first period of years two through five. This cash is not used for agricultural production because it generates enough income in this risk-free investment, along with the income from agricultural production, to meet the required return level. At Point A, where no risk is accepted and, therefore, no agricultural production occurs, all available cash is saved in both periods of each year.

All machinery and all livestock facilities purchased at each point are depreciated using the striaght-line method rather than the double-declining-balance method. The straight-line method provides the same amount of depreciation during each year of the asset's life. The double-declining-balance method is a method of accelerated capital recovery which provides higher depreciation allowances in the early years of the asset's life. In the first year, the depreciation allowance of the double-declining-balance method is twice the depreciation allowance of the straight-line method. The beginning farmer's taxable income is lowest in the first year and then increases through year five. With the progressive income tax structure, the marginal tax rate increases as taxable income increases. The beginning farmer can reduce taxable income in later years by taking depreciation allowances in these years rather than in the early years. This will allow the minimum amount of taxes to be paid over the five year period. More depreciation allowance is available in later years if the straight-line method is used rather than the double-declining-balance method of accelerated depreciation. With the progressive income tax structure, less taxes are paid in the later years and, therefore, disposable income is higher in these years if the straight-line method is used. This allows the summation of the present values of yearly disposable incomes to be higher when the straight-line method is used rather than the double-declining-balance method.

Production Plans

The production plan associated with each point on Curve I is shown in Table 5.3. The production plan of Point E specifies that the wife work off the farm during year one. In years two through five the wife's labor is used on the farm. The production plans of Points A, B, C, and D specify that the wife work off the farm each year.

The conventional linear programming solution cash rents and crop-share rents land for crop production. The amount of land cash rented varies from about 105 acres in year one to about 656 acres in year five. This cash rented land is used to raise corn and soybeans grown by a custom operator. The amount of crop-share rented land is about 498 acres in year one, about 694 acres in years two through four, and about 684 acres in year five. This crop-share rented land is used to produce corn and soybeans in the acreages given in Table 5.3.

Moving down Curve I to lower return-risk points results in less land being farmed. All of the land farmed in the production plans of Points B, C, and D is crop-share rented. The production plan of Point D specifies crop-share renting about 522 acres in years one through four and about 542 acres in year five. The amount of land crop-share rented at Point C is about 254 acres in years one through four and about 246 acres in year five. At Point B the amount of land crop-share rented is about 172 acres in year one, about 215 acres in years two through four, and only 3 acres in year five. The crop-share rented land at each point is used to produce corn and soybeans

Table 5.3. Levels of production activities in farm plans associated with points on Curve I.

	Year 1	2	3	4	5
Point A					
Wife Work Off-Farm	1.00	1.00	1.00	1.00	1.00
Point B					
Wife Work Off-Farm	1.00	1.00	1.00	1.00	1.00
Crop-Share Rented Land:					
Continuous Corn (acres)	107.94	214.54	214.54	211.12	2.96
Corn-Soybeans-Oats Rotation (acres)	64.20			3.42	
Pasture Farrowing (litters)	28.98	57.00	57.00	59.18	29.59
Partial Confinement Farrowing (litters)	15.42	10.58	10.40	8.98	
Put Feeder Pigs on Feed:					
Partial Confinement, third quarter (pigs)	27.64	20.47	20.99	15.30	
Partial Confinement, fourth quarter (pigs)	98.83	220.02	219.88	227.67	
Point C					
Wife Work Off-Farm	1.00	1.00	1.00	1.00	1.00
Crop-Share Rented Land:					
Continuous Corn (acres)	66.07	78.38	78.38	74.03	
Corn-Soybeans Rotation (acres)	58.76	83.38	83.38	74.70	
Corn-Soybean-Oats Rotation (acres)	129.18	92.22	92.25	105.27	245.55
Partial Confinement Farrowing (litters)	102.96	102.90	102.84	103.38	103.38
Put Feeder Pigs on Feed:					
Partial Confinement, third quarter (pigs)	31.34	31.32	31.64	31.49	
Partial Confinement, fourth quarter (pigs)	112.46	137.28	137.28	137.84	
Point D					
Wife Work Off-Farm	1.00	1.00	1.00	1.00	1.00
Crop-Share Rented Land:					
Continuous Corn (acres)	143.75	116.32	70.23		
Corn-Soybean Rotation (acres)	378.32	405.76	451.84	522.08	541.94
Partial Confinement Farrowing (litters)	10.32	10.32	10.32	10.12	5.06

Put Feeder Pigs on Feed:					
Total Confinement, first quarter (pigs)	81.63	81.63	81.63	81.63	69.35
Total Confinement, third quarter (pigs)	43.01	81.63	81.63	35.66	
Total Confinement, fourth quarter (pigs)				12.28	
<u>Point E</u>					
Wife Work Off-Farm	1.00				
Cash Rented Land:					
Custom Grown Corn (acres)	104.74	155.86	314.74	417.34	472.13
Custom Grown Corn-Soybean Rotation (acres)		50.20	62.20	62.20	184.18
Custom Harvest Corn (acres)			159.32	261.92	323.31
Harvest Corn (acres)	104.74	180.96	186.52	186.52	240.91
Harvest Soybeans (acres)		25.10	31.10	31.10	92.09
Crop-Share Rented Land:					
Continuous Corn (acres)	143.77				
Corn-Soybean Rotation (acres)	353.94	693.80	693.80	693.80	684.26
Put Feeder Pigs on Feed:					
Total Confinement, first quarter (pigs)	221.84	221.84	221.84	221.84	221.84
Total Confinement, third quarter (pigs)	80.29	197.68	180.05	180.05	

primarily, and some oats, with the acreages of the various crop rotations given in Table 5.3.

The production plan of Point E specifies that the total confinement feeding facility be used to capacity in the first and second quarters of each year by putting about 222 feeder pigs on feed in the first quarter of each year. This facility is partially used in the third and fourth quarters of years one through four by putting about 80 feeder pigs on feed in the third quarter of year one, about 198 feeder pigs on feed in the third quarter of year two, and about 180 feeder pigs on feed in the third quarter of years three and four.

The production plan of Point D specifies the partial confinement farrowing facility be used to capacity to farrow about 10 litters in years one through four, and about 5 litters in year five. Also at Point D, the total confinement feeding facility is used to capacity during the first two quarters of year one, all of years two and three, the first two quarters of year four, and the first quarter of year five. This facility is also partially used in the third and fourth quarters of year one to feed 43 hogs, in the third quarter of year four to put about 36 feeder pigs on feed, and in the fourth quarter of year four to put about 12 feeder pigs on feed.

The production plan of Point C specifies the partial confinement farrowing facility be used to capacity in each year to farrow about 103 litters in each year. At Point B the pasture farrowing facilities are utilized to capacity to farrow about 29 litters in year one, about 57 litters in years two through four, and about 30 litters in year five. Also at Point B the partial confinement farrowing facility is used to capacity in various farrowing schedules to farrow about 15 litters in year one, 11 litters in year two, 10 litters in year three, and 9 litters in year four. The production plans of Points B and C specify the partial confinement feeding facility be utilized to capacity in the third and fourth quarters of years one through four. Feeder pigs are put on feed in the third quarter of each year to provide the replacement gilts needed for the next year's farrowing operation. The remaining capacity is then used to put feeder pigs on feed in the fourth quarter of each year. The partial confinement feeding facility is not used in the first or second quarter of each year at Points B and C, except for the first quarter of year one for Point C when 8 feeder pigs are put on feed.

Marketing Plans

The plan associated with each point for marketing and buying agricultural products is shown in Table 5.4. The conventional linear programming solution specifies that all the corn produced each year be sold at harvest. Moving down the efficient frontier results in a greater percentage of corn being stored until the first period of the next year. At Point D the percentage of corn available for sale at harvest that is stored until the first period of the next year is 40 percent in year one, 70 percent in year two, 91 percent in year three, and 100 percent in year four. At Point C the percentage of corn available for sale at harvest that is stored until the first period of the next year is 96 percent in year one and 100 percent in years two

Table 5.4. Marketing and buying plans for agricultural products associated with points on Curve I.

	Year 1	2	3	4	5
Point B					
Sell Corn, first period (bu.)		4,483	7,779	7,767	7,885
Sell Soybeans, second period (bu.)	374			20	
Sell Oats, second period (bu.)	802			43	
Sell Hogs, second quarter (cwt.)		211	470	469	486
Sell Sows, first quarter (cwt.)		3	2	2	1
Sell Sows, fourth quarter (cwt.)	26				
Sell Feeder Pigs, first quarter (pigs)	21	31	18	21	8
Sell Feeder Pigs, second quarter (pigs)	122	220	220	228	207
Sell Feeder Pigs, third quarter (pigs)	13	1			
Sell Feeder Pigs, fourth quarter (pigs)	23				
Store Corn, second period (bu.)	5,814	9,690	9,688	9,569	
Buy Corn, first period (bu.)	560				
Buy Gilts (head)	27				
Replacement Gilts (head)		28	20	21	15
Point C					
Sell Corn, first period (bu.)		3,464	4,135	4,126	3,877
Sell Corn, second period (bu.)	231				3,225
Sell Soybeans, second period (bu.)	1,268	1,268	1,268	1,268	1,432
Sell Oats, second period (bu.)	1,615	1,153	1,153	1,316	3,070
Sell Hogs, second quarter (cwt.)		240	293	293	294
Sell Hogs, third quarter (cwt.)	17				
Sell Sows, first quarter (cwt.)		22	22	22	22
Sell Sows, fourth quarter (cwt.)	45	45	45	45	45
Sell Feeder Pigs, first quarter (pigs)	129	274	274	275	276
Sell Feeder Pigs, second quarter (pigs)	137	137	137	138	138
Sell Feeder Pigs, third quarter (pigs)	243	243	243	244	276
Sell Feeder Pigs, fourth quarter (pigs)	25				138
Store Corn, second period (bu.)	5,275	6,065	6,062	5,815	

Buy Corn, first period (bu.)	1,350				
Buy Gilts, (head)	63				
Replacement Gilts (head)		31	31	32	31
Point D					
Sell Corn, first period (bu.)		6,222	10,838	13,136	13,064
Sell Corn, second period (bu.)	10,660	4,930	1,367		14,854
Sell Soybeans, second period (bu.)	3,310	3,550	3,954	4,568	4,746
Sell Hogs, first quarter (cwt.)		85	167	168	76
Sell Hogs, second quarter (cwt.)		1	3	3	29
Sell Hogs, third quarter (cwt.)	177	176	174	174	148
Sell Sows, first quarter (cwt.)		2	2	2	2
Sell Sows, fourth quarter (cwt.)	4	4	4	4	3
Sell Feeder Pigs, second quarter (pigs)	14	14	14	14	19
Sell Feeder Pigs, fourth quarter (pigs)	13	12	12		19
Store Corn, second period (bu.)	7,120	11,732	14,028	13,836	
Buy Corn, first period (bu.)	901				
Buy Feeder Pigs, first quarter (pigs)	69	55	54	55	56
Buy Feeder Pigs, third quarter (pigs)	16	54	54	9	
Buy Gilts (head)	6				
Replacement Gilts (head)		3	3	3	
Point E					
Sell Corn, second period (bu.)	28,415	37,147	53,695	63,852	77,325
Sell Soybeans, second period (bu.)	3,097	6,949	7,159	7,159	9,211
Sell Hogs, first quarter (cwt.)		171	422	384	384
Sell Hogs, third quarter (cwt.)	473	473	473	473	473
Buy Corn, first period (bu.)	2,063	2,063	2,063	2,063	2,063
Buy Feeder Pigs, first quarter (pigs)	222	222	222	222	222
Buy Feeder Pigs, second quarter (pigs)	80	198	180	180	

through four. At Point B all the corn available for sale at harvest of years one through four is stored until the first period of the next year. At each point there is no corn stored at harvest of year five.

The marketing plan of each point specifies all soybeans and oats produced in any year be sold at harvest. Market hogs are sold two quarters after feeder pigs are put on feed at each point. Sows are sold in the first and fourth quarters of some years at Points B, C, and D as shown in Table 5.4. Feeder pigs not put on feed in the hog feeding enterprises are sold in each quarter of each year at Points B, C, and D.

Some agricultural products must be purchased to support agricultural production at each point. At Point E corn is bought in the first period of each year to be fed in the hog feeding enterprise. At Points B, C, and D corn is bought in the first period of year one to be fed in the hog feeding and farrowing operations in that period. The farm plans of Points D and E specify that feeder pigs be purchased in the first quarter of each year and in the third quarter of years one through four. The plans of Points B, C, and D specify that gilts be purchased in year one to be used in the farrowing operation. Finally, Table 5.4 shows the number of replacement gilts needed by the farrowing operations of Points B, C, and D in each year that are provided by the hog feeding operations.

Resource Control, Debt Use, and Net Worth

The farm plans specified by each point on Curve I generate distinctly different patterns of resource control, asset ownership, debt use, net worth position, and net worth growth. Table 5.5 shows the yearly balance sheets for each point on Curve I. Because each farm plan specifies renting land, the value of resources controlled by the beginning farmer in each year is greater than the value of assets in the balance sheet. Valuing the rented land at $1,000 per acre (the purchase price of land in this model) and adding the value of rented land to the value of owned assets gives the value of assets controlled. This value of assets controlled in each year is also given in Table 5.5 with each point's yearly balance sheets.

The conventional linear programming solution (Point E) specifies the highest debt use, the highest level of asset ownership, and the highest level of resource control. The major portion of debt incurred over the five year period is used to finance the machinery purchases needed to support the high level of crop production specified by the farm plan of Point E. Likewise, the major portion of owned assets in the early years is machinery. In the later years the majority of owned assets is cash, which is saved in increasing amounts in the second period of each year over the five year period. This cash is saved in the second period of the year until the first period of the next year when it is used to finance agricultural production. The major portion of resources controlled, however, is the rented land. For example, in year five the value of resources controlled is over $1.5 million dollars, but the value of owned assets is just over $200,000. As a result of the farm plans of Point E, the net worth of the beginning

Table 5.5 Yearly balance sheets associated with points on Curve I.

	Year 0	1	2	3	4	5
	(dollars)					
Point A						
Assets						
Current	40,000	43,477	45,174	46,910	48,687	50,506
Liabilities						
Current	0	1,837	1,855	1,874	1,893	1,912
Net Worth	40,000	41,640	43,319	45,036	46,794	48,594
Point B						
Assets						
Current	25,363	30,752	37,337	53,401	64,959	61,709
Intermediate	12,047	10,842	13,696	12,041	10,385	8,729
Long-Term	12,954	11,577	19,083	16,639	14,570	14,296
Total	50,364	53,171	70,116	82,081	89,914	84,734
Liabilities						
Current	0	0	1,890	5,973	6,350	12,264
Intermediate	0	0	0	0	0	0
Long-Term	10,364	0	2,314	1,390	0	0
Total	10,364	0	4,204	7,363	6,350	12,264
Net Worth	40,000	53,171	65,912	74,718	83,564	72,470
Assets Controlled	50,364	225,311	284,656	296,621	304,454	87,694
Point C						
Assets						
Current	15,216	32,281	44,628	61,353	76,617	89,456
Intermediate	20,396	18,356	16,317	14,277	12,237	10,599
Long-Term	21,940	19,804	18,762	16,523	14,342	14,418
Total	57,552	70,441	79,707	92,153	103,196	114,473
Liabilities						
Current	0	620	7,080	8,860	9,380	17,861
Intermediate	0	0	0	0	0	445
Long-Term	17,552	12,980	3,335	1,757	0	0
Total	17,552	13,600	10,415	10,617	9,380	18,306
Net Worth	40,000	56,841	69,292	81,536	93,816	96,167
Assets Controlled	57,552	324,441	333,707	346,153	357,196	360,023

Table 5.5 (continued).

	Year 0	1	2	3	4	5
	(dollars)					
Point D						
Assets						
Current	0	22,250	52,001	77,446	99,841	118,246
Intermediate	45,197	40,678	36,741	33,137	29,938	26,748
Long-Term	6,679	6,013	5,347	4,681	4,270	4,265
Total	51,876	68,941	94,089	115,264	134,049	149,259
Liabilities						
Current	0	4,247	7,100	10,340	14,060	30,165
Intermediate	6,533	0	0	0	1,660	3,515
Long-Term	5,343	809	809	324	0	0
Total	11,876	5,056	7,909	10,664	15,720	33,680
Net Worth	40,000	63,885	86,180	104,600	118,329	115,579
Assets Controlled	51,876	590,941	616,089	637,264	656,049	691,259
Point E						
Assets						
Current	0	35,693	70,893	102,734	122,245	153,268
Intermediate	46,201	41,581	60,761	53,851	46,547	42,571
Long-Term	13,894	12,499	11,103	9,708	8,312	6,917
Total	60,095	89,773	142,757	166,293	177,105	202,756
Liabilities						
Current	0	10,340	12,781	18,060	18,529	27,598
Intermediate	8,981	8,981	35,426	35,820	26,839	30,536
Long-Term	11,114	11,114	11,114	10,107	9,009	7,811
Total	20,095	30,435	59,321	63,987	54,377	65,945
Net Worth	40,000	59,338	83,436	102,306	122,728	136,811
Assets Controlled	60,095	692,223	1042,627	1237,033	1350,445	1543,326

farmer increases gradually over the five years, growing from $40,000 to $136,811.

The farm plans of Point D specify less debt use, a lower level of asset ownership, and a lower level of resource control than the farm plans of Point E. Again, though, the majority of debt incurred over the five year period is used to finance machinery purchase, the majority of owned assets in the early years is owned machinery, the majority of owned assets in the latter years is cash saved in the second period of the year, and the majority of resources controlled in each year is rented land. Over the five year period net worth increases from $40,000 to $115,578 at Point D.

The farm plans of Point C specify more debt use in the initial period and in years one and two than Point D. This is because Point C has a higher investment in hog facilities which are financed with long-term debt that is not paid off until year three. Also, because of this investment in hog facilities, Point C has a higher level of asset ownership in the initial period and year one than at Point D. However, the farm plans of Point C specify less crop production than Point D, and the difference in the amount of rented land causes Point D to have a higher level of resource control. As a result of the farm plans of Point C the net worth increases from $40,000 to $96,167 over the five year period.

The farm plans associated with Point B specify the lowest level of debt use, the lowest level of asset ownership, and the lowest level of resource control of the four points which include agricultural production. As a result of the farm plans of Point B the beginning farmer's net worth increases from $40,000 to $72,470 over the five year period.

The balance sheets given in Table 5.5 can be used to compute the leverage and liquidity ratios which indicate the financial position of the beginning farm business. The leverage and liquidity ratios for each year for each point on Curve I are given in Table 5.6. The debt-to-equity ratio in this set of initial conditions was constrained to be less than 2.0, but the highest debt-to-equity ratio was only 0.71. This occurred at the end of year two for the farm plans specified by the conventional linear programming solution. This indicates that in all cases the beginning farmer has more equity capital than debt capital invested in the farm business. The lowest current ratio for any of the points is 3.45 and occurs at the end of year one for Point E. This indicates that with any of the farm plans the beginning farmer has a good liquidity position at the end of each year. These current ratios are high because cash is saved in the second period of each year to be used for agricultural production in the first period of the next year, which causes the value of current assets to be high at the end of each year.

The balance sheets also can be used to compute the yearly growth in net worth for each point on Curve I. Table 5.6 shows these growth in net worth figures. The farm plans associated with Point E result in the greatest growth in net worth with an average growth per year of 28.6 percent. Moving down the efficient frontier to lower return-risk

Table 5.6. Leverage and liquidity ratios, and growth in net worth for points on Curve I.

Year	Point A	Point B	Point C	Point D	Point E
Debt-to-Equity Ratio					
0	0.00	0.26	0.44	0.30	0.50
1	0.04	0.00	0.24	0.08	0.51
2	0.04	0.06	0.15	0.09	0.71
3	0.04	0.10	0.13	0.10	0.62
4	0.04	0.08	0.10	0.13	0.44
5	0.04	0.17	0.19	0.29	0.48
Current Ratio					
0	--	--	--	--	--
1	23.67	--	52.07	5.24	3.45
2	24.35	19.76	6.30	7.32	5.55
3	25.03	8.94	6.92	7.49	5.69
4	25.72	10.23	8.17	7.10	6.60
5	26.42	5.03	5.01	3.92	5.55
Growth in Net Worth During Year					
1	4.1 %	32.9 %	42.1 %	59.7 %	48.3 %
2	4.0	24.0	21.9	34.9	40.6
3	4.0	13.4	17.7	21.4	22.6
4	3.9	12.0	15.1	13.1	20.0
5	3.8	-13.4	2.5	- 2.3	11.5
Average Growth per Year					
	4.0 %	13.8 %	19.9 %	25.4 %	28.6 %
Average Growth per Year During First Four Years					
	4.0 %	20.6 %	24.2 %	32.3 %	32.9 %

points results in less growth in net worth. The farm plans of Point D produce an average growth per year of 25.4 percent, Point C has an average growth per year of 19.9 percent, and Point B has an average growth per year of 13.8 percent. Point A, where no agricultural production occurs, has an average growth in net worth per year of 4 percent.

Income and Consumption

The farm plans associated with each point on Curve I generate different patterns of yearly disposable income and consumption. The overall return for each point was measured by the summation of discounted expected disposable income over the five years. The undiscounted expected disposable income in each year for each point on Curve I is given in Table 5.7. The consumption resulting from each disposable income is also given in Table 5.7. Also shown in this table is the variance of disposable income in each year for each point.

At Point A income is a result of saving cash and the wife working off the farm. This produces a fairly constant disposable income and consumption over the five years. Since no agricultural production occurs at Point A, there is no variance of income. Moving up the efficient frontier to Point B results in a pattern of income and consumption that is higher in each year, except year one, than at Point A. However, disposable income is not as consistent over the five year period, varying from zero in year one to $27,994 in year five. The yearly consumption at Point B varies from $4,000 in year one to $12,482 in year five. At Point C disposable income and consumption are higher

Table 5.7. Expected disposable income, variance, and consumption in each year for each point on Curve I.

Point	Year	Disposable Income	Variance	Standard Deviation	Consumption
A	1	$ 8,241	0	0	$ 6,601
	2	8,305	0	0	6,626
	3	8,370	0	0	6,652
	4	8,437	0	0	6,679
	5	8,506	0	0	6,707
B	1	0	$ 890,642	$ 944	4,000
	2	8,428	312,731	559	6,676
	3	18,896	730,167	854	10,116
	4	19,566	779,968	883	10,302
	5	27,994	734,416	857	12,482
C	1	3,380	12,273,798	3,503	4,363
	2	20,864	10,738,865	3,277	10,663
	3	23,616	11,029,121	3,321	11,386
	4	24,334	11,138,396	3,337	11,568
	5	33,741	35,728,086	5,977	13,800
D	1	15,277	146,556,776	12,106	9,051
	2	20,900	97,098,875	9,854	10,673
	3	25,660	87,050,920	9,330	11,902
	4	29,940	98,199,046	9,910	12,945
	5	44,281	402,333,251	20,058	16,008
E	1	25,660	620,278,648	24,905	11,902
	2	28,550	1,316,356,837	36,282	12,615
	3	33,940	2,369,975,155	48,682	13,845
	4	34,356	3,108,395,923	55,753	13,935
	5	42,180	4,612,268,470	67,914	15,583

in each year than at Point B, and these values are higher at Point D than at Point C. The yearly disposable income and consumption are highest, except for year five, at Point E. The yearly disposable income increases as one moves up the efficient frontier because there is increased agricultural production at each successive point. As a result of this increased agricultural production the variance of income in each year also increases as one moves to higher return-risk points on Curve I.

The expected disposable income and variance of income can be used to calculate the probability of disposable income being less than certain levels. The probability of disposable income in each year for each point being less than zero, $4,000, and $8,000 is given in Table 5.8. At Point A there is no variance of income so there is a probability of one of receiving the disposable income in each year shown in Table 5.7. Since each of these incomes is above $8,000 the probability of disposable income being below $8,000 is zero in each year for Point A.

At Point B there is a probability of 0.5 that disposable income in year one will be negative. However, there is a probability of zero that disposable income will be negative in years two through five. There is a probability of 1.0 that disposable income in year one will be less than $4,000, but there is a probability of zero that disposable income in years two through five will be less than $4,000. In fact, there is a probability of about 0.8 that disposable income in year two will be above $8,000 and there is a probability of 1.0 that disposable

Table 5.8. Probability of disposable income falling below certain levels in each year for each point on Curve I.

Point	Year	$P(\mu_I < 0)$	$P(\mu_I < \$4000)$	$P(\mu_I < \$8000)$
A	1	0.0	0.0	0.0
	2	0.0	0.0	0.0
	3	0.0	0.0	0.0
	4	0.0	0.0	0.0
	5	0.0	0.0	0.0
B	1	0.5	1.0	1.0
	2	0.0	0.0	0.2236
	3	0.0	0.0	0.0
	4	0.0	0.0	0.0
	5	0.0	0.0	0.0
C	1	0.1685	0.5714	0.9066
	2	0.0	0.0	0.0
	3	0.0	0.0	0.0
	4	0.0	0.0	0.0
	5	0.0	0.0	0.0
D	1	0.1038	0.1762	0.2743
	2	0.0170	0.0436	0.0951
	3	0.0030	0.0102	0.0294
	4	0.0	0.0044	0.0136
	5	0.0136	0.0228	0.0352
E	1	0.1515	0.1922	0.2389
	2	0.2148	0.2482	0.2843
	3	0.2420	0.2676	0.2981
	4	0.2676	0.2946	0.3192
	5	0.2676	0.2877	0.3085

income in years three through five will be above \$8,000. Following the farm plans specified by Point B will result in a high probability of low income in year one, but a high probability of disposable income above \$8,000 in years two through five.

Moving up Curve I to Point C results in a different pattern of expected return and consumption. The expected disposable income and consumption in each year is higher than at Point B. However, the variance of income is also higher. But the probability of disposable income being less than zero, \$4,000, and \$8,000 is less than the corresponding probabilities at Point B. Even though the overall return and risk is greater at Point C than at Point B, the probability of yearly disposable income falling below certain levels is less at Point B. At both points the probability of disposable income being less than \$8,000 in years three, four, and five is zero, and the probability of disposable income being less than \$4,000 in year two is zero. Because of the higher disposable income in year one of Point C, the probabilities of disposable income being less than zero, \$4,000, and \$8,000 are lower at Point C than at Point B.

Moving up the efficient frontier to Point D results in a pattern of expected disposable income and consumption that is higher in each year than at Point C. There is also a small probability of disposable income being less than certain levels as shown in Table 5.8. For example, the probability that disposable income will be less than \$4,000 is 0.18 in year one, 0.04 in year two, 0.01 in year three, and

and 0.02 in year five. The probability that disposable income will be less than $8,000 is, of course, higher in each year.

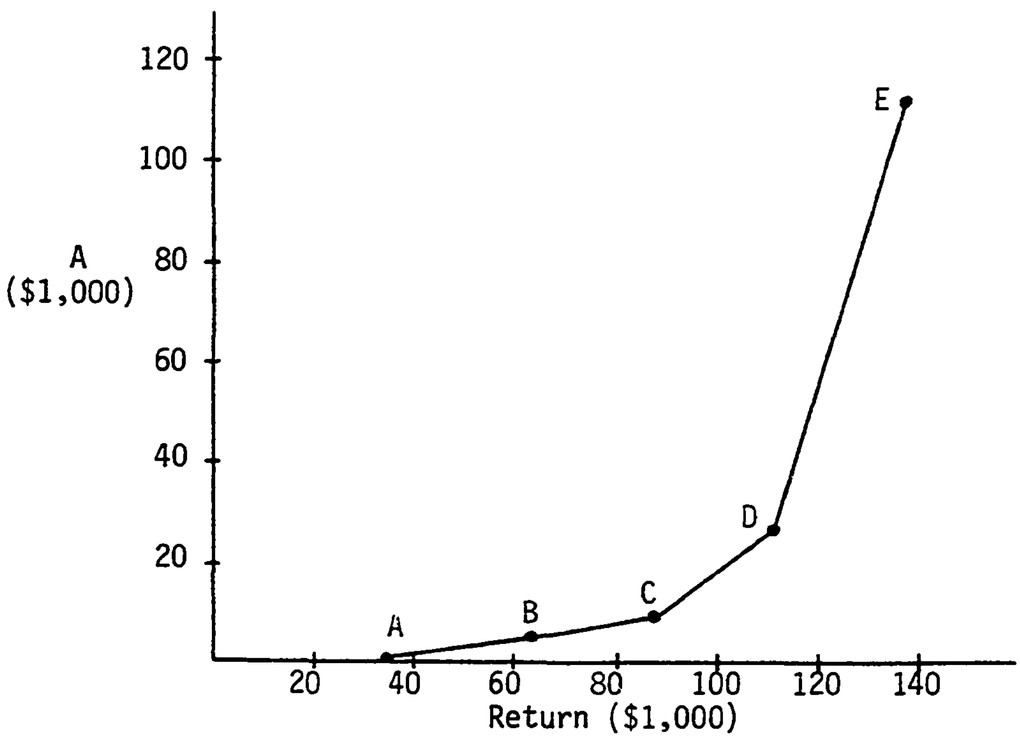
The probabilities that disposable income will fall below certain levels are highest for the conventional linear programming solution, except for year one. At Point E the probability of income being negative is 0.15 in year one, 0.21 in year two, 0.24 in year three, and 0.27 in years four and five. This indicates that the farm plans of Point E not only generate the highest level of overall return and risk, but also have the highest probability of disposable income falling below certain levels in each year after year one.

The probability of the beginning farmer failing might be measured by the probability of disposable income being negative for two or three consecutive years. If this criterion is used, then the farm plans associated with the conventional linear programming solution would result in the highest chance of failure. There is a small probability of failure at Point D, while the farm plans of Points B and C would both result in no chance of failure.

Curve II

The second set of initial conditions represents an initial cash position of $40,000, an opportunity for the wife to work off the farm, consumption function α, availability of nonconventional loan terms, and a debt-to-equity ratio constraint of less than 2.0. This set of initial conditions is identical to Curve I except the consumption function has been changed (see Table 5.2). One would expect Curve II to be to the left of Curve I because of the higher marginal propensity to consume of consumption function α.

Curve II is shown in Figure 5.2. Again, the curve is convex, which is consistent with theoretical expectations. Also, as expected the curve is everywhere slightly to the left of Curve I. In other words, a family with consumption function α will have to accept more risk to reach the same return level as a family with consumption function β.



Point	Return	A
A	$ 35,872	$ 0
B	62,000	1,813
C	87,000	7,739
D	113,000	26,688
E	139,127	113,384

Figure 5.2. Efficient E,A Curve II.

Investment and Financing Plans

The investment and financing plan associated with each point on Curve II is shown in Table 5.9. These plans are very similar to those specified by points on Curve I (see Table 5.2). The investment in machinery systems are practically the same for corresponding points on each curve. Also, the method of financing machinery purchase and the pattern of repayment of intermediate debt are very similar for corresponding points on each curve.

The investment plan of each point on Curve II also specifies investment in hog facilities which is very similar to the investment plan of each point on Curve I. The investment plan of Point E specifies investment in a total confinement feeding facility in the initial period with space for about 208 hogs, which is a slightly smaller facility than that purchased by Point E on Curve I. At Point D there is investment in a partial confinement farrowing facility in the initial period with space for about 3 litters, which is 1 litter space larger than the facility purchased at Point D of Curve I. At Point D there is also investment in a total confinement feeding facility in the initial period with space for about 74 hogs, which is 8 head space smaller than the facility purchased at Point D of Curve I. Also at Point D there is investment in a partial confinement feeding facility in the initial period with space for about 13 hogs and in year three with space for about 1 hog. At Point D of Curve I there is no investment in partial confinement feeding facilities. The investment plan of Point C specifies investment in a partial confinement feeding

Table 5.9. Level of investment and financing activities in farm plans associated with points on Curve II.

	Year 0	1	2	3	4	5
Point A						
Save Cash, first period ($)		40,331	41,204	42,092	42,997	43,918
Save Cash, second period ($)		41,671	42,556	43,458	44,376	45,310
Point B						
Machinery Investment and Financing:						
Labor Intensive Crop Production (unit)	0.41		0.04			
Capital Intensive Combine (unit)	0.12		0.07			
Pay Cash ($)	12,442		4,133			
Hog Facility Investment:						
Pasture Farrowing (litter space)	14		14		1	
Partial Confinement Farrowing (litter space)	3					
Partial Confinement Feeding (hog space)	129		112		2	
Save Cash, first period ($)		8,836	13,261	28,697	38,053	54,369
Save Cash, second period ($)		12,470	8,298	21,892	31,549	51,444
Pay Principal, Long-Term 9% Loan ($)		10,757	5,455	175	1,769	1,931
Pay Interest, Long-Term 9% Loan ($)		952	1,170	212	159	
Point C						
Machinery Investment and Financing:						
Intermediate Crop Production (unit)	0.25					
Capital Intensive Crop Production (unit)	0.19					
Capital Intensive Combine (unit)	0.13					
Pay Cash ($)	20,205					
Hog Facility Investment:						
Partial Confinement Farrowing (litter space)	17					
Partial Confinement Feeding (hog space)	138		30			
Save Cash, first period ($)			14,026	28,282	40,569	54,257
Save Cash, second period ($)		13,531	21,500	35,548	48,118	72,867

Pay Principal, Long-Term 9% Loan ($)		5,390	9,680	1,549	1,807	
Pay Interest, Long-Term 9% Loan ($)		1,538	1,170	300	1,626	
Point D						
Machinery Investment and Financing:						
Capital Intensive Crop Production (unit)	0.74			0.01	0.02	0.04
Labor Intensive Combine (unit)	0.45		0.03	0.10	0.06	0.01
Pay Cash ($)	38,473		599	2,165		
Intermediate Credit ($)	5,049				1,890	2,246
Hog Facility Investment:						
Partial Confinement Farrowing (litter space)	3					
Partial Confinement Feeding (hog space)	13			2		
Total Confinement Feeding (hog space)	74					
Short-Term Loan, first period ($)		33,514	6,069			
Save Cash, first period ($)				15,821	35,039	48,318
Save Cash, second period ($)		2,186	17,968	34,686	56,732	100,246
Pay Principal, Intermediate 9% Loan ($)		5,049				
Pay Interest, Intermediate 9% Loan ($)		454				170
Pay Principal, Long-Term 9% Loan ($)		5,156		554	604	120
Pay Interest, Long-Term 9% Loan ($)		550	86	93	44	60
Point E						
Machinery Investment and Financing:						
Capital Intensive Crop Production (unit)	0.74		0.29			0.13
Capital Intensive Combine (unit)	0.37		0.40			
Pay Cash ($)	36,049					
Intermediate Credit ($)	10,504		26,255			4,165
Hog Facility Investment:						
Total Confinement Feeding (hog space)	208					
Short-Term Loan, first period ($)		50,000	50,000	50,000	50,000	50,000
Save Cash, second period ($)		28,185	50,719	78,805	93,438	132,723
Pay Principal, Intermediate 9% Loan ($)					10,504	
Pay Interest, Intermediate 9% Loan ($)		945	945	3,308	3,308	2,363
Pay Principal, Long-Term 9% Loan ($)				943	1,029	1,122
Pay Interest, Long-Term 9% Loan ($)		937	937	937	852	759

facility and a partial confinement farrowing facility which is practically identical to the investment plan of Point C on Curve I. The investment plan of Point B specifies investment in pasture farrowing facilities, a partial confinement farrowing facility, and a partial confinement feeding facility which is also practically identical to the investment plan of Point B on Curve I.

Each of these hog facility investments is financed using repayment plan D, which is the Standard plan with deferred principal payments, as in Curve I. The pattern of principal and interest payments on this long-term debt at each point is very similar to that for points on Curve I, as shown in Table 5.9.

The use of short-term operating loans is also very similar to points on Curve I. The financing plan of Point E specifies the use of a short-term loan of $50,000 (the maximum limit) in the first period of each year. The financing plan of Point D specifies the use of short-term loans of $33,514 in the first period of year one and $6,069 in the first period of year two. No short-term operating loans are incurred at Points B or C of either curve.

The investment plan of each point on Curve II specifies cash to be saved in the same periods as specified by corresponding points on Curve I. Because of the higher marginal propensity to consume at Curve II there is less cash available to be saved at each point on Curve II than is saved at each corresponding point on Curve I.

Production Plans

The production plan associated with each point on Curve II is shown in Table 5.10. The production plan of each point on Curve II specifies off-farm employment exactly as specified by each corresponding point on Curve I; that is, at Point E the wife works off the farm during year one only and at Points A, B, C, and D the wife works off the farm during each year.

The machinery acquired by the investment plan of each point on Curve II is used in crop production which is very similar to that specified by corresponding points on Curve I. As in Curve I, the conventional linear programming solution specifies cash renting and crop-share renting land. The amount of land cash rented in each year is slightly less, except for year one, than the amount of land cash rented at Point E of Curve I. The amount of land crop-share rented at Point E of Curve II is slightly more in each year than the amount of land crop-share rented at Point E of Curve I. This crop-share rented land is used to produce corn and soybeans in the acreages given in Table 5.10.

Moving down Curve II to lower return-risk points results in less land being farmed. As in Curve I, all of the land farmed in the production plans of Points B, C, and D is crop-share rented. The amount of land crop-share rented in each year at Points C and D of Curve II is a little less than the amount of land crop-share rented in each year at Points C and D, respectively, of Curve I. The amount of land crop-share rented in each year at Point B of Curve II is almost

Table 5.10. Level of production activities in farm plans associated with points on Curve II.

	Year 1	2	3	4	5
Point A					
Wife Work Off-Farm	1.00	1.00	1.00	1.00	1.00
Point B					
Wife Work Off-Farm	1.00	1.00	1.00	1.00	1.00
Crop-Share Rented Land:					
Continuous Corn (acres)	108.36	214.74	214.74	211.01	2.92
Corn-Soybean Rotation (acres)	70.38			3.72	
Pasture Farrowing (litters)	28.76	55.96	55.92	58.34	
Partial Confinement Farrowing (litters)	18.36	11.56	11.38	9.78	
Place Feeder Pigs on Feed:					
Partial Confinement, third quarter (pigs)	26.78	20.45	21.01	14.78	
Partial Confinement, fourth quarter (pigs)	101.77	220.31	220.16	228.66	
Point C					
Wife Work Off-Farm	1.00	1.00	1.00	1.00	1.00
Crop-Share Rented Land:					
Continuous Corn (acres)	72.08	87.90	88.14	87.14	
Corn-Soybean Rotation (acres)	22.44	54.08	53.46	50.52	
Corn-Soybean-Oats Rotation (acres)	163.35	115.89	116.28	120.21	197.04
Partial Confinement Farrowing (litters)	101.10	102.24	102.24	102.42	102.42
Place Feeder Pigs on Feed:					
Partial Confinement, third quarter (pigs)	31.50	31.14	31.25	31.20	
Partial Confinement, fourth quarter (pigs)	106.07	136.33	136.33	136.57	
Point D					
Wife Work Off-Farm	1.00	1.00	1.00	1.00	1.00
Crop-Share Rented Land:					
Continuous Corn (acres)	138.42	113.07	36.50		
Corn-Soybean Rotation (acres)	364.30	389.66	470.04	517.56	496.12
Corn-Soybean-Oats Rotation (acres)					49.74
Partial Confinement Farrowing (litters)	16.08	16.08	16.08	12.64	6.32

Place Feeder Pigs on Feed:					
Partial Confinement, first quarter (pigs)	13.45	12.94	2.19		
Partial Confinement, fourth quarter (pigs)	0.51	13.45	15.64	15.64	
Total Confinement, first quarter (pigs)	74.20	74.20	74.20	74.20	68.39
Total Confinement, third quarter (pigs)	53.62	74.20	74.20	29.10	
Total Confinement, fourth quarter (pigs)				5.81	
Point E					
Wife Work Off-Farm	1.00				
Cash-Rented Land:					
Custom Grown Corn (acres)	108.40	157.98	313.19	387.77	404.71
Custom Grown Corn-Soybean Rotation (acres)		34.10	34.10	37.48	174.88
Custom Harvest Corn (acres)	9.04		155.21	229.98	254.35
Harvest Corn (acres)	99.36	175.03	175.03	176.53	237.80
Harvest Soybeans (acres)		17.05	17.05	18.74	87.44
Crop-Share Rented Land:					
Continuous Corn (acres)	149.05				
Corn-Soybean Rotation (acres)	353.80	700.56	700.56	700.30	689.56
Place Feeder Pigs on Feed:					
Partial Confinement, third quarter (pigs)	31.50	31.14	31.25	31.20	
Partial Confinement, fourth quarter (pigs)	106.07	136.33	136.33	136.57	

identical to the amount of land crop-share rented in each year at Point B of Curve I. The crop-share rented land is used to produce primarily corn and soybeans, and some oats, with the acreages of the various crop rotations given in Table 5.10.

The hog facilities acquired by the investment plan of each point are utilized in hog farrowing and feeding activities which are very similar to those specified by corresponding points on Curve I. The production plan of Point E specifies that the total confinement feeding facility be used to capacity in the first and second quarters of each year and in the third and fourth quarters of years two and three by putting about 208 feeder pigs on feed in the first quarter of each year and in the third quarter of years two and three. This facility is also partially used in the third and fourth quarters of years one and four by putting about 78 feeder pigs on feed in the third quarter of year one and about 203 feeder pigs on feed in the third quarter of year four.

The production plan of Point D specifies the partial confinement farrowing facility be used to capacity to farrow about 16 litters in years one through three, about 13 litters in year four, and about 6 litters in year five, which is more in each year than at Point D of Curve I. The partial confinement feeding facility is used to capacity in the first quarter of years one through four, the second quarter of years one and two, and the fourth quarter of years two through four. As in Curve I, the total confinement feeding facility is used to capacity during the first two quarters of year one, all of years two and three, the first two quarters of year four, and the first quarter of year five. This facility is also partially used in the third and fourth quarters of year one to feed about 54 hogs, in the third quarter of year four to put about 29 feeder pigs on feed, and in the fourth quarter of year four to put about 6 feeder pigs on feed.

The production plans of Points B and C specify that the farrowing facilities be used exactly as in the production plans of Points B and C, respectively, in Curve I, except the activity levels are slightly lower because fewer facilities are purchased in Curve II. As in Curve I, the production plans of Points B and C specify the partial confinement feeding facility be utilized to capacity in the third and fourth quarters of years one through four. Feeder pigs are put on feed in the third quarter of each year to provide the replacement gilts needed for the next year's farrowing enterprise. The remaining capacity is then used to put feeder pigs on feed in the fourth quarter of each year. The partial confinement facility is not used in the first or second quarter of each year at Points B and C.

Marketing Plans

The plan associated with each point for marketing and buying agricultural products is shown in Table 5.11. The plans are identical to those of corresponding points on Curve I, except the levels of some activities are slightly different because the level of the production activities are somewhat different than those associated with corresponding points on Curve I.

Table 5.11. Marketing and buying plans for agricultural products associated with points on Curve II.

	Year 1	2	3	4	5
Point B					
Sell Corn, first period (bu.)		4,567	7,789	7,777	7,888
Sell Soybeans, second period (bu.)	411			22	
Sell Oats, second period (bu.)	880			47	
Sell Hogs, second quarter (cwt.)		217	470	470	488
Sell Sows, first quarter (cwt.)		4	2	2	1
Sell Sows, fourth quarter (cwt.)	27				
Sell Feeder Pigs, first quarter (pigs)	24	35	18	21	7
Sell Feeder Pigs, second quarter (pigs)	125	220	220	229	204
Sell Feeder Pigs, third quarter (pigs)	22	1			
Sell Feeder Pigs, fourth quarter (pigs)	23				
Store Corn, second period (bu.)	5,911	9,700	9,699	9,596	
Buy Corn, first period (bu.)	593				
Buy Gilts (head)	28				
Replacement Gilts (head)		26	20	20	15
Point C					
Sell Corn, first period (bu.)		3,481	4,314	4,313	4,246
Sell Corn, second period (bu.)	264				2,347
Sell Soybeans, second period (bu.)	1,149	1,149	1,146	1,143	1,149
Sell Oats, second period (bu.)	2,042	1,449	1,454	1,503	2,463
Sell Hogs, second quarter (cwt.)		226	291	291	291
Sell Hogs, third quarter (cwt.)	3				
Sell Sows, first quarter (cwt.)		22	22	22	22
Sell Sows, fourth quarter (cwt.)	44	44	44	44	44
Sell Feeder Pigs, first quarter (pigs)	133	271	273	273	273
Sell Feeder Pigs, second quarter (pigs)	135	136	136	137	137
Sell Feeder Pigs, third quarter (pigs)	238	242	241	242	273
Sell Feeder Pigs, fourth quarter (pigs)	29				137
Store Corn, second period (bu.)	5,253	6,231	6,232	6,166	
Buy Corn, first period (bu.)	1,262				

Buy Gilts (head)	60				
Replacement Gilts (head)		30	30	30	30
<u>Point D</u>					
Sell Corn, first period (bu.)		6,501	11,182	13,048	12,888
Sell Corn, second period (bu.)	9,415	3,825			14,485
Sell Soybeans, second period (bu.)	3,188	3,409	4,113	4,529	4,634
Sell Hogs, first quarter (cwt.)		104	148	152	62
Sell Hogs, second quarter (cwt.)		1	29	33	46
Sell Hogs, third quarter (cwt.)	187	186	163	158	146
Sell Sows, first quarter (cwt.)		3	3	3	2
Sell Sows, fourth quarter (cwt.)	7	7	7	6	4
Sell Feeder Pigs, second quarter (pigs)	21	21	21	21	25
Sell Feeder Pigs, fourth quarter (pigs)	21	8	6		25
Store Corn, second period (bu.)	7,516	12,156	13,969	13,704	
Buy Corn, first period (bu.)	1,018				
Buy Feeder Pigs, first quarter (pigs)	66	44	33	38	54
Buy Feeder Pigs, third quarter (pigs)	11	31	31		
Buy Gilts (head)	10				
Replacement Gilts (head)		5	5	3	
<u>Point E</u>					
Sell Corn, second period (bu.)	29,026	36,587	51,953	59,558	70,301
Sell Soybeans, second period (bu.)	3,096	6,727	6,727	6,783	9,094
Sell Hogs, first quarter (cwt.)		167	443	443	433
Sell Hogs, third quarter (cwt.)	443	443	443	443	443
Buy Corn, first period (bu.)	1,932	1,932	1,932	1,932	1,932
Buy Feeder Pigs, first quarter (pigs)	208	208	208	208	208
Buy Feeder Pigs, third quarter (pigs)	78	208	208	203	

Resource Control, Debt Use, and Net Worth

The yearly balance sheets for each point on Curve II are shown in Table 5.12. Because each farm plan specifies renting land, the value of resources controlled in each year is determined by adding the value of rented land to the value of owned assets. This value of resources controlled in each year is also shown in Table 5.12 with each point's yearly balance sheet.

Because the farm plans of corresponding points on Curve I and Curve II are so similar, the yearly balance sheets of corresponding points on these curves are also very similar. In most cases the yearly value of resources controlled, assets owned, debt used, and net worth are lower for points on Curve II than for points on Curve I. As in Curve I, the conventional linear programming solution specifies the highest debt use, the highest level of asset ownership, and the highest level of resources controlled. As one moves down Curve II to lower return-risk points each successive point specifies less debt use, a lower level of asset ownership, and a lower level of resource control in each year. The exception to this is a movement from Point D to Point C; Point C specifies more debt use in the initial period and in years one through three than Point D. This is because Point C has a higher initial investment in hog facilities which is financed by long-term debt that is not paid off until year three. Also, because of this investment in hog facilities, Point C has a higher level of asset ownership in the initial period and year one than Point D.

Table 5.12. Yearly balance sheets associated with points on Curve II.

	Year 0	1	2	3	4	5
	(dollars)					
Point A						
Assets						
Current	40,000	42,713	43,620	44,544	45,485	46,443
Liabilities						
Current	0	1,831	1,841	1,851	1,861	1,871
Net Worth	40,000	40,882	41,779	42,693	43,624	44,572
Point B						
Assets						
Current	24,869	30,216	36,683	50,644	60,085	53,866
Intermediate	12,441	11,198	13,673	12,016	10,358	8,701
Long-Term	13,450	12,025	19,290	16,825	14,768	14,497
Total	50,761	53,439	69,646	79,485	85,211	77,064
Liabilities						
Current	0	0	1,985	5,936	6,288	12,086
Intermediate	0	0	0	0	0	0
Long-Term	10,761	0	2,340	1,381	0	0
Total	10,761	0	4,325	7,317	6,288	12,086
Net Worth	40,000	53,439	65,321	72,168	78,923	64,978
Assets Controlled	50,761	232,179	284,386	294,225	299,941	79,984
Point C						
Assets						
Current	15,522	31,456	42,398	56,808	69,565	76,682
Intermediate	20,205	18,185	16,164	14,144	12,123	10,103
Long-Term	21,363	19,284	18,676	16,442	14,236	14,312
Total	57,090	68,925	77,238	87,394	95,924	101,097
Liabilities						
Current	0	620	6,777	8,716	9,074	16,593
Intermediate	0	0	0	0	0	0
Long-Term	17,090	11,700	3,324	1,779	0	0
Total	17,090	12,320	10,101	10,495	9,074	16,593
Net Worth	40,000	56,605	67,137	76,899	86,850	84,504
Assets Controlled	57,090	326,795	335,108	345,274	344,314	298,137

Table 5.12 (continued).

	Year 0	1	2	3	4	5
	(dollars)					
Point D						
Assets						
Current	0	21,552	48,915	69,790	89,003	102,875
Intermediate	43,522	39,170	35,357	32,893	29,965	27,169
Long-Term	7,635	6,878	6,120	5,459	4,841	4,847
Total	51,157	67,600	90,392	108,142	123,809	134,891
Liabilities						
Current	0	3,615	7,100	10,340	14,060	29,461
Intermediate	5,049	0	0	0	1,890	4,135
Long-Term	6,108	952	952	484	0	0
Total	11,157	4,567	8,052	10,824	15,950	33,596
Net Worth	40,000	63,033	82,340	97,318	107,859	101,295
Assets Controlled	51,157	570,320	593,122	614,682	641,369	680,751
Point E						
Assets						
Current	1,347	34,312	66,428	95,216	109,870	136,041
Intermediate	46,553	41,898	60,872	53,591	46,402	42,860
Long-Term	13,014	11,706	10,400	9,093	7,786	6,479
Total	60,914	87,916	137,700	157,900	164,058	185,380
Liabilities						
Current	0	10,340	12,140	17,056	18,060	27,591
Intermediate	10,504	10,504	36,759	36,759	26,357	30,522
Long-Term	10,410	10,410	10,410	9,467	8,438	7,316
Total	20,914	31,254	59,309	63,282	52,855	65,429
Net Worth	40,000	56,662	78,391	94,618	111,203	119,951
Assets Controlled	60,914	699,166	1030,350	1205,760	1289,608	1454,520

The leverage and liquidity ratios for each year for each point on Curve II are given in Table 5.13. The debt-to-equity ratio in this set of initial conditions was constrained to be less than 2.0, but the highest debt-to-equity ratio was only 0.76. This occurred at the end of year two for the farm plan specified by the conventional linear programming solution. This indicates that in all cases the beginning farmer has more equity capital than debt capital invested in the farm business. In most cases in Curve II the debt-to-equity ratio is higher than the debt-to-equity ratio for the corresponding case in Curve I. This indicates that a family with consumption function α must use more debt capital than a family with consumption function β to reach similar return levels. The lowest current ratio is 3.32 and occurs at the end of year one for Point E. This indicates that with any of the farm plans the beginning farmer has a good liquidity position. In most cases in Curve II the current ratio is lower than the current ratio for the corresponding case in Curve I; indicating that a family with consumption function α has less liquidity than a family with consumption function β at similar return levels.

The yearly growth in net worth for each point on Curve II is also shown in Table 5.13. The farm plan associated with Point E results in the greatest growth in net worth with an average growth per year of 25.2 percent. As with Curve I, moving down Curve II to lower return-risk points results in less growth in net worth. The farm plan of Point D generates an average growth per year of 22.2 percent, Point C has an average growth per year of 17.0 percent, and Point B has an

Table 5.13. Leverage and liquidity ratios, and growth in net worth for points on Curve II.

Year	A	B	Point C	D	E
Debt-to-Equity Ratio					
0	0.00	0.27	0.43	0.28	0.52
1	0.04	0.00	0.22	0.07	0.55
2	0.04	0.07	0.15	0.10	0.76
3	0.04	0.10	0.14	0.11	0.67
4	0.04	0.08	0.10	0.15	0.48
5	0.04	0.19	0.20	0.33	0.55
Current Ratio					
0	--	--	--	--	--
1	23.33	--	50.74	5.96	3.32
2	23.69	18.48	6.26	6.89	5.47
3	24.06	8.53	6.52	6.75	5.58
4	24.44	9.56	7.67	6.33	6.08
5	24.82	4.46	4.62	3.49	4.93
Growth in Net Worth During Year					
1	2.2%	33.6%	41.5%	57.6%	41.7%
2	2.2	22.2	18.6	30.6	38.3
3	2.2	10.5	14.5	18.2	20.7
4	2.2	9.4	12.9	10.8	17.5
5	2.2	-17.7	- 2.7	- 6.1	7.9
Average Growth Per Year					
	2.2%	11.6%	17.0%	22.2%	25.2%
Average Growth Per Year During First Four Years					
	2.2%	18.9%	21.9%	29.3%	29.6%

average growth per year of 11.6 percent. Point A, where no agricultural production occurs, has an average growth per year in net worth of 2.2 percent. The average growth per year in net worth for points on Curve II are less than the average growth per year in net worth for corresponding points on Curve I.

Income and Consumption

The undiscounted expected disposable income in each year for each point on Curve II and the resulting consumption are shown in Table 5.14. Also shown in this table is the variance of disposable income in each year for each point. As in Curve I, Point A has a fairly constant disposable income and consumption over the five years. The disposable income in each year of Point A on Curve II is slightly lower than the corresponding disposable income of Point A on Curve I. This is because the higher marginal propensity to consume at Curve II leaves less cash to save each period. But because of this higher marginal propensity to consume, the consumption in each year on Point A of Curve II is higher than the corresponding consumption in Curve I. Moving up the efficient frontier to higher return-risk points results in the same general increases in yearly disposable income, consumption, and variance of income that occurred on Curve I.

Point B on both curves produce the same overall return ($62,000), but the pattern of yearly disposable income is slightly different. Point C on Curve I produces an overall return of $89,000 while Point C on Curve II produces an overall return of $87,000, which results in the yearly disposable income for Point C of Curve II being slightly less

Table 5.14. Expected disposable income, variance, and consumption in each year for each point on Curve II.

Point	Year	Disposable Income	Variance	Standard Deviation	Consumption
A	1	$ 8,219	0	0	$ 7,337
	2	8,253	0	0	7,356
	3	8,288	0	0	7,374
	4	8,324	0	0	7,393
	5	8,360	0	0	7,412
B	1	0	$ 2,663,386	$ 1,632	4,000
	2	8,763	323,268	569	7,627
	3	18,830	736,911	858	12,012
	4	19,457	786,836	887	12,245
	5	27,794	733,036	856	15,128
C	1	3,380	11,040,835	3,323	4,363
	2	20,326	10,064,844	3,173	12,567
	3	23,417	10,413,879	3,227	13,666
	4	23,911	10,445,512	3,232	13,832
	5	32,473	28,390,515	5,328	16,570
D	1	13,652	123,074,889	11,094	9,930
	2	20,900	81,292,189	9,016	12,780
	3	25,660	73,486,626	8,572	14,420
	4	29,940	93,763,761	9,683	15,810
	5	43,704	384,074,361	19,598	19,745
E	1	25,660	637,910,647	25,257	14,420
	2	27,860	1,262,904,628	35,537	15,150
	3	32,936	2,198,547,521	46,889	16,709
	4	33,940	2,736,501,827	52,312	17,010
	5	42,175	3,952,759,123	62,871	19,332

than or equal to the corresponding income at Point C of Curve I. Point D on Curve I produces an overall return of $115,000 while Point D on Curve II has an overall return of $113,000, which also results in the yearly disposable income at Point D of Curve II being slightly less than or equal to the corresponding income at Point D of Curve I. Also, the yearly disposable income at the conventional linear programming solution of Curve II is slightly less than or equal to the corresponding income at Point E of Curve I. However, because of the higher marginal propensity to consume for Curve II, the consumption of each year at each point is higher for Curve II than for Curve I.

The probability of disposable income in each year for each point on Curve II being less than zero, $4,000, and $8,000 is given in Table 5.15. These probabilities are very similar to those associated with Curve I. The same general characteristics of the probabilities discussed in the previous section for Curve I apply to the probabilities associated with Curve II. In general, the probabilities of disposable income being less than zero, $4,000, or $8,000 are higher for points on Curve II than for points on Curve I, especially in the first years for each point.

If the probability of the beginning farmer failing is again measured by the probability of disposable income being negative for two or three consecutive years, then the farm plan associated with the conventional linear programming solution would again result in the highest chance of failure. As with Curve I, there is a small

Table 5.15. Probability of disposable income falling below certain levels in each year for each point on Curve II.

Point	Year	$P(\mu_I < 0)$	$P(\mu_I < \$4000)$	$P(\mu_I < \$8000)$
A	1	0.0	0.0	0.0
	2	0.0	0.0	0.0
	3	0.0	0.0	0.0
	4	0.0	0.0	0.0
	5	0.0	0.0	0.0
B	1	0.5	0.9929	1.0
	2	0.0	0.0	0.0901
	3	0.0	0.0	0.0
	4	0.0	0.0	0.0
	5	0.0	0.0	0.0
C	1	0.1539	0.5753	0.9177
	2	0.0	0.0	0.0
	3	0.0	0.0	0.0
	4	0.0	0.0	0.0
	5	0.0	0.0	0.0
D	1	0.1093	0.1922	0.3050
	2	0.0102	0.0307	0.0764
	3	0.0014	0.0057	0.0197
	4	0.0	0.0037	0.0116
	5	0.0129	0.0212	0.0344
E	1	0.1539	0.1949	0.2420
	2	0.2177	0.2514	0.2877
	3	0.2420	0.2676	0.2981
	4	0.2578	0.2843	0.3085
	5	0.2514	0.2709	0.2946

probability of failure at Point D, while the farm plan of Points B and C result in no chance of failure.

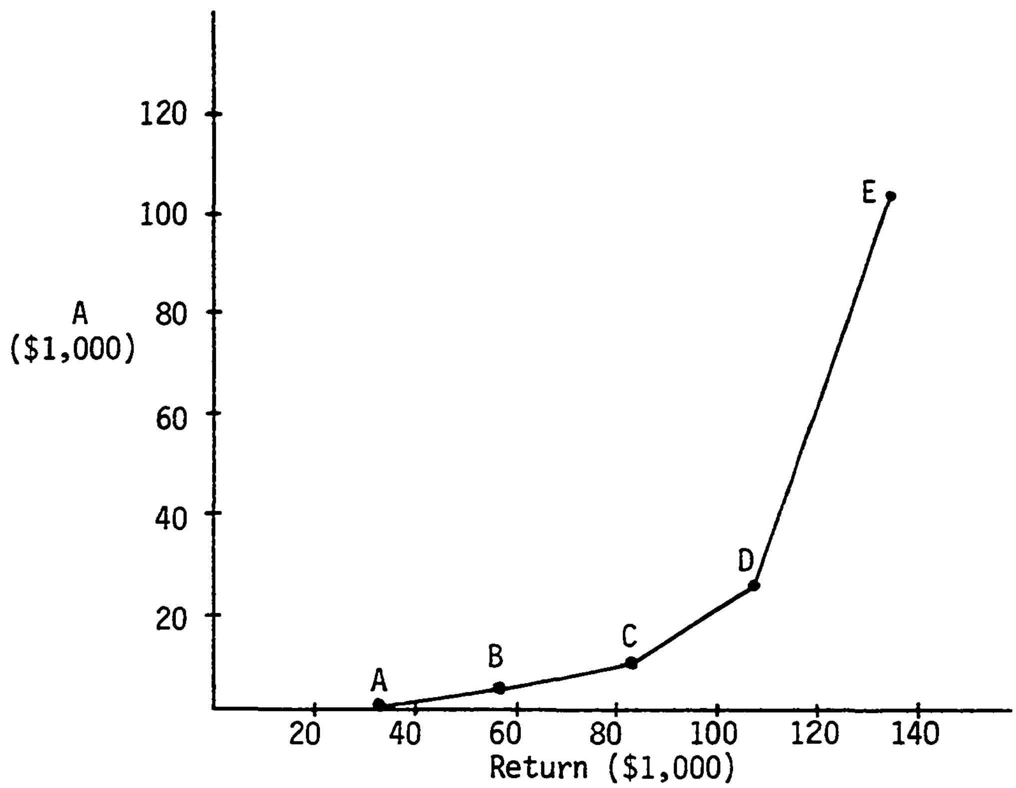
Curve III

The third set of initial conditions represents a beginning cash position of $20,000, an opportunity for the wife to work off the farm, consumption function α, availability of nonconventional loan terms, and a debt-to-equity ratio constraint of less than 2.0. This set of initial conditions is identical to Curve II, except that the beginning cash or equity position is at the lower level (see Table 5.1). One would expect Curve III to be to the left of Curve II because of the lower beginning cash position.

Curve III is shown in Figure 5.3. Consistent with expectations, this efficient frontier is convex and is everywhere to the left of Curve II. A beginning farm family with a cash or equity position of $20,000 will have to accept more risk to reach the same return level as a family with a beginning cash or equity position of $40,000.

Investment and Financing Plans

The investment and financing plan associated with each point on Curve III is shown in Table 5.16. The plans are similar to those specified by corresponding points on Curve II (see Table 5.9). At corresponding points on these two curves the machinery investment is practically the same. However, the method of financing machinery purchase differs between corresponding points on Curve II and Curve III. At each point on Curve III a much larger percentage of machinery



Point	Return	A
A	$ 32,387	$ 0
B	58,000	1,775
C	83,000	7,629
D	108,000	26,469
E	133,185	102,404

Figure 5.3. Efficient E,A Curve III.

purchase is financed with intermediate credit than at corresponding points on Curve II.

The investment plan of each point on Curve III specifies investment in hog facilities which is very similar to the investment plan of corresponding points on Curve II. The investment plan of Point E specifies investment in a total confinement feeding facility in the

Table 5.16. Level of investment and financing activities in farm plans associated with points on Curve III.

	Year 0	1	2	3	4	5
<u>Point A</u>						
Save Cash, first period ($)		20,538	21,051	21,573	22,105	22,646
Save Cash, second period ($)		21,590	22,110	22,640	23,179	23,729
<u>Point B</u>						
Machinery Investment and Financing:						
Labor Intensive Crop Production (unit)	0.37		0.05			
Intermediate Crop Production (unit)			0.05			
Capital Intensive Combine (unit)	0.11		0.08			
Pay Cash ($)	11,328		5,151			
Hog Facility Investment:						
Pasture Farrowing (litter space)	12					
Partial Confinement Farrowing (litter space)	3					
Partial Confinement Feeding (hog space)	113		118		8	
Short-Term Loan, second period ($)			4,243			
Save Cash, first period ($)				6,912	16,268	32,254
Save Cash, second period ($)		2,869		344	9,529	28,912
Pay Principal, Long-Term 9% Loan ($)		1,769	5,621	9,431	1,674	
Pay Interest, Long-Term 9% Loan ($)		837	1,428	923	151	
<u>Point C</u>						
Machinery Investment and Financing:						
Intermediate Crop Production (unit)	0.29					
Capital Intensive Crop Production (unit)	0.14					
Labor Intensive Combine (unit)	0.08					
Capital Intensive Combine (unit)	0.08					
Pay Cash ($)	15,851					
Intermediate Credit ($)	3,198					
Hog Facility Investment:						
Partial Confinement Farrowing (litter space)	17					2

Partial Confinement Feeding (hog space)	129		37		2	
Short-Term Loan, first period ($)		10,038	6,433			
Save Cash, first period ($)				7,802	19,345	31,951
Save Cash, second period ($)		3,474	608	14,730	26,858	49,560
Pay Principal, Intermediate 9% Loan ($)			3,198			
Pay Interest, Intermediate 9% Loan ($)		288	288			
Pay Principal, Long-Term 9% Loan ($)			15,029	1,504	1,769	1,944
Pay Interest, Long-Term 9% Loan ($)		1,493	1,622	285	159	35
Point D						
Machinery Investment and Financing:						
Capital Intensive Crop Production (unit)	0.75			0.01		0.05
Labor Intensive Combine (unit)	0.44		0.03	0.09	0.05	0.04
Pay Cash ($)	18,412					
Intermediate Credit ($)	24,349		576	2,257	993	3,527
Hog Facility Investment:						
Partial Confinement Farrowing (litter space)	3					1
Partial Confinement Feeding (hog space)	19					
Total Confinement Feeding (hog space)	68					
Short-Term Loan, first period ($)		36,171	23,128			
Save Cash, first period ($)					18,055	32,048
Save Cash, second period ($)				19,088	37,995	82,862
Pay Principal, Intermediate 9% Loan ($)		9,195	14,029	1,124		
Pay Interest, Intermediate 9% Loan ($)		2,191	1,364	153	255	344
Pay Principal, Long-Term 9% Loan ($)		2,322		576	628	684
Pay Interest, Long-Term 9% Loan ($)		572	363	363	311	286
Point E						
Machinery Investment and Financing:						
Capital Intensive Crop Production (unit)	0.74		0.29			
Capital Intensive Combine (unit)	0.36		0.35	0.02	0.05	0.09
Pay Cash ($)	17,220					
Intermediate Credit ($)	29,568		24,750	636	1,442	2,834
Hog Facility Investment:						
Total Confinement Feeding (hog space)	208					

Table 5.16 (continued).

	Year 0	1	2	3	4	5
Short-Term Loan, first period ($)		50,000	50,000	50,000	50,000	50,000
Save Cash, second period ($)		23,921	47,974	74,231	71,374	103,873
Pay Principal, Intermediate 9% Loan ($)					29,568	
Pay Interest, Intermediate 9% Loan ($)		2,661	2,661	4,889	4,946	2,415
Pay Principal, Long-Term 9% Loan ($)				945	1,031	1,124
Pay Interest, Long-Term 9% Loan ($)		939	939	939	854	761

initial period with space for about 208 hogs, which is identical to that purchased by Point E on Curve II. At Point D there is investment in a partial confinement farrowing facility in the initial period with space for about 3 litters, which is the same as that purchased at Point D of Curve II. At Point D there is also investment in a partial confinement feeding facility in the initial period with space for about 19 hogs, which is 6 hog spaces larger than the facility purchased at Point D of Curve II. Also at Point D there is investment in a total confinement feeding facility in the initial period with space for about 68 hogs, which is 6 hog spaces smaller than the facility purchased at Point D of Curve II. The investment plan of Point C specifies purchasing a partial confinement farrowing facility with space for about 17 litters, which is identical to the investment plan of Point C of Curve II. Also at Point C, there is investment in a partial confinement feeding facility in the initial period with space for about 129 hogs and in year two with space for about 37 hogs. This investment is 9 hog spaces larger in the initial period and 7 hog spaces smaller in year two than the facility purchased at Point C of Curve II. The investment plan of Point B specifies buying pasture farrowing facilities and a partial confinement farrowing facility which is practically identical to the investment plan of Point B of Curve II. Also at Point B, there is investment in a partial confinement feeding facility in the initial period with space for about 113 hogs, in year two with space for about 118 hogs, and in year four with space for about 8 hogs. This investment is 16 hog spaces smaller in the initial period, 6 hog spaces larger in year two, and 6 hog spaces larger in year four than the facility purchased at Point B of Curve II.

As in Curve II, each of these hog facility investments is financed using repayment plan D, which is the Standard plan with deferred principal payments. However, the pattern of repayment of this long-term debt is quite different between corresponding points, except for Point E, on these two curves. At Point E of both curves principal payments are made in years three through five as required by repayment plan D and an interest charge of 9 percent on the unpaid balance is paid in each year. At Point D of Curve II most of the long-term debt is repaid in year one, but at Point D of Curve III only 37 percent of the long-term debt is repaid in year one and over half is still outstanding at the end of year five. At Points B and C of Curves II and III the long-term debt is repaid by year four, but the pattern of repayment is slower at points on Curve III than at corresponding points on Curve II.

There is more use of short-term operating debt at points on Curve III than at corresponding points on Curve II, except at Point E on both curves. The financing plan of Point E on both curves specifies the use of a short-term loan of $50,000 in the first period of each year. The financing plan of Point D on both curves specifies the use of short-term loans in the first period of years one and two, but the loans are larger at Point D of Curve III. The financing plan of Point C specifies the use of short-term loans of $10,038 in the first period of year one, and $6,433 in the first period of year two, while no short-term debt is used at Point C of Curve II. The financing plan of

Point B specifies the use of a short-term loan of $4,343 in the second period of year two, while no short-term debt is used at Point B of Curve II.

The investment plan of each point specifies cash to be saved, however, more cash is saved at corresponding points on Curve II. At Point E cash is saved in the second period of each year in increasing amounts as more land is farmed and more crops are sold. Moving down the efficient frontier results in less cash being saved in the second period of each year and some cash being saved in the first period of the year. At Point D cash is saved in the first period of years four and five and in the second period of years three through five. The investment plan of Point C specifies cash to be saved in the first period of years three through five and in the second period of each year. At Point B cash is saved in the first period of years three through five and in the second period of each year except year two. At Point A, where no agricultural production occurs, all available cash is saved in both periods of each year.

Production Plans

The production plan associated with each point on Curve III is shown in Table 5.17. The production plan of each point on Curve III specifies off farm employment exactly as specified by each corresponding point on Curve II; that is, at Point E the wife works off the farm during year one and at Points A, B, C, and D the wife works off the farm during each year.

Table 5.17. Level of production activities in farm plans associated with points on Curve III.

	Year 1	2	3	4	5
Point A					
Wife Work Off-Farm	1.00	1.00	1.00	1.00	1.00
Point B					
Wife Work Off-Farm	1.00	1.00	1.00	1.00	1.00
Crop-Share Rented Land:					
Continuous Corn (acres)	102.85	212.87	212.87	210.21	2.92
Corn-Soybean-Oats Rotation (acres)	58.59				
Pasture Farrowing (litters)	24.28	53.98	53.98	58.32	58.32
Partial Confinement Farrowing (litters)	15.78	15.78	15.78	11.74	
Place Feeder Pigs on Feed:					
Partial Confinement, third quarter (pigs)	30.30	21.23	21.43	14.19	
Partial Confinement, fourth quarter (pigs)	83.03	209.99	209.99	225.17	
Point C					
Wife Work Off-Farm	1.00	1.00	1.00	1.00	1.00
Crop-Share Rented Land:					
Continuous Corn (acres)	54.38	80.36	79.62	68.97	
Corn-Soybean Rotation (acres)	34.84	74.44	60.40	66.12	
Corn-Soybean-Oats Rotation (acres)	160.56	94.98	109.74	113.61	185.91
Partial Confinement Farrowing (litters)	99.78	99.78	101.10	101.34	101.34
Place Feeder Pigs on Feed:					
Partial Confinement, first quarter (pigs)	2.51				
Partial Confinement, third quarter (pigs)	30.39	32.41	30.93	32.76	
Partial Confinement, fourth quarter (pigs)	98.39	133.01	134.79	135.10	
Point D					
Wife Work Off-Farm	1.00	1.00	1.00	1.00	1.00
Crop-Share Rented Land:					
Continuous Corn (acres)	136.00	111.64	44.51	9.90	
Corn-Soybean Rotation (acres)	357.94	382.28	456.60	493.10	502.96
Corn-Soybean-Oats Rotation (acres)					35.52

Partial Confinement Farrowing (litters)	19.02	19.02	19.02	17.94	
Place Feeder Pigs on Feed:					
Partial Confinement, first quarter (pigs)	19.25	18.76			
Partial Confinement, fourth quarter (pigs)	0.49	19.25	19.25	19.25	
Total Confinement, first quarter (pigs)	67.78	67.78	67.78	67.78	61.69
Total Confinement, third quarter (pigs)	55.92	67.78	67.78	47.83	
Total Confinement, fourth quarter (pigs)				6.10	
Point E					
Wife Work Off-Farm	1.00				
Crop-Share Rented Land:					
Continuous Corn (acres)	136.01				
Corn-Soybean Rotation (acres)	367.02	701.04	701.04	697.34	690.02
Cash Rented Land:					
Custom Grown Corn (acres)	94.12	175.25	301.32	218.20	260.07
Custom Grown Corn-Soybean Rotation (acres)		0.44	19.78	67.34	160.84
Custom Harvest Corn (acres)			136.67	56.13	103.05
Harvest Corn (acres)	94.12	175.47	175.54	195.75	237.44
Harvest Soybeans (acres)		0.22	9.89	33.67	80.42
Place Feeder Pigs on Feed:					
Total Confinement, first quarter (pigs)	208.22	208.22	208.22	208.22	208.22
Total Confinement, third quarter (pigs)	108.17	208.22	208.22	138.01	

The machinery acquired by the investment plan of each point on Curve III is used in crop production which is very similar to that specified by corresponding points on Curve II. As in Curve II, the conventional linear programming solution specifies cash renting and crop-share renting land. The amount of land cash rented in each year is less than the amount of land cash rented at Point E of Curve II. The amount of land crop-share rented at Point E of Curve III is practically identical to the amount rented each year at Point E of Curve II.

Moving down Curve III to lower return-risk points results in less land being farmed. As in Curve II, all of the land farmed in the production plans of Points B, C, and D is crop-share rented. The amount of land crop-share rented in each year for each point on Curve III is less than the amount of land crop-share rented in each of the corresponding points on Curve II. The production plan of Point D specifies crop-share renting about 494 acres in years one and two, about 501 acres in year three, about 503 acres in year four, and about 538 acres in year five. The amount of land crop-share rented at Point C is about 250 acres in years one through four and about 186 acres in year five. At Point B the amount of land crop-share rented is about 161 acres in year one, about 213 acres in years two and three, about 210 acres in year four, and only about 3 acres in year five. At each point this crop-share rented land is used to produce corn, soybeans, and oats with the acreages of the various rotations shown in Table 5.17.

The hog facilities acquired at each point on Curve III are utilized in hog farrowing and feeding activities which are similar to those specified by corresponding points on Curve II. The production plan of Point E specifies that the total confinement feeding facility be used to capacity in the first and second quarters of each year and in the third and fourth quarters of years two and three by putting about 208 feeder pigs on feed in the first quarter of each year and in the third quarter of years two and three. This facility is also partially used in the third and fourth quarters of years one and four by putting about 108 feeder pigs on feed in the third quarter of year one and about 138 feeder pigs on feed in the third quarter of year four.

The production plan of Point D specifies the partial confinement farrowing facility be used to capacity to farrow about 19 litters in years one through three, about 18 litters in year four, and about 9 litters in year five. The partial confinement feeding facility is used to capacity in the first quarter of each year, the second quarter of year one, and the fourth quarter of years two through four. As in Curve II, the total confinement feeding facility is used to capacity during the first two quarters of year one, all of years two and three, the first two quarters of year four, and the first quarter of year five. This facility is also partially used in the third and fourth quarters of year one to feed about 56 hogs, in the third quarter of year four to put about 48 feeder pigs on feed, and in the fourth quarter of year four to put about 6 feeder pigs on feed.

The production plan of Point C specifies that the partial confinement farrowing facility be used to capacity to farrow about 100 litters in each year. At Point B the pasture farrowing facilities are used to capacity each year to farrow about 24 litters in year one, about 54 litters in years two and three, and about 58 litters in years four and five. Also at Point B, the partial confinement farrowing facility is used to capacity to farrow about 16 litters in years one through three and about 12 litters in year four. At both points there are slightly fewer litters farrowed in each year than at corresponding points on Curve II. As in Curve II, the production plans of Points B and C specify that the partial confinement feeding facility be utilized to capacity in the third and fourth quarters of years one through four. Feeder pigs are put on feed in the third quarter of each year to provide the replacement gilts for the next year's farrowing enterprise. The remaining capacity is then used to put feeder pigs on feed in the fourth quarter of each year.

Marketing Plans

The plan associated with each point for marketing and buying agricultural products in shown in Table 5.18. The plans are very similar to those of corresponding points on Curve II, except the levels of some activities are different because the production activities are different than those associated with corresponding points on Curve II.

Resource Control, Debt Use, and Net Worth

The yearly balance sheets for each point on Curve III are shown in Table 5.19. The value of resources controlled in each year is also

Table 5.18. Marketing and buying plans for agricultural products associated with points on Curve III.

	Year 1	2	3	4	5
Point B					
Sell Corn, first period (bu.)		4,255	7,722	7,715	7,792
Sell Soybeans, second period (bu.)	342				
Sell Oats, second period (bu.)	732				
Sell Hogs, second quarter (cwt.)		177	448	448	481
Sell Sows, first quarter (cwt.)		3	3	3	2
Sell Sows, fourth quarter (cwt.)	23				
Sell Feeder Pigs, first quarter (pigs)	21	42	42	34	13
Sell Feeder Pigs, second quarter (pigs)	106	210	210	225	204
Sell Feeder Pigs, third quarter (pigs)	12	21	21	12	
Sell Feeder Pigs, fourth quarter (pigs)	23				
Store Corn, second period (bu.)	5,537	9,613	9,611	9,456	
Buy Corn, first period (bu.)	505				
Buy Gilts (head)	24				
Replacement Gilts (head)		30	20	21	14
Point C					
Sell Corn, first period (bu.)		3,078	4,139	3,961	3,540
Sell Corn, second period (bu.)	114				2,117
Sell Soybeans, second period (bu.)	1,241	1,205	1,169	1,241	1,084
Sell Oats, second period (bu.)	2,007	1,187	1,372	1,420	2,324
Sell Hogs, first quarter (cwt.)			3		
Sell Hogs, second quarter (cwt.)		210	284	288	288
Sell Hogs, third quarter (cwt.)	5				
Sell Sows, first quarter (cwt.)		22	22	22	22
Sell Sows, fourth quarter (cwt.)	43	43	44	44	46
Sell Feeder Pigs, first quarter (pigs)	131	266	268	270	270
Sell Feeder Pigs, second quarter (pigs)	133	133	135	135	146
Sell Feeder Pigs, third quarter (pigs)	236	234	239	237	270
Sell Feeder Pigs, fourth quarter (pigs)	35				

Store Corn, second period (bu.)	4,782	6,026	5,859	5,480	
Buy Corn, first period (bu.)	1,256				
Buy Gilts (head)	59				
Replacement Gilts (head)		30	30	30	32
Point D					
Sell Corn, first period (bu.)		5,865	11,188	12,380	12,505
Sell Corn, second period (bu.)	9,653	3,550	719		14,369
Sell Soybeans, second period (bu.)	3,132	3,345	3,995	4,315	4,608
Sell Oats, second period (bu.)					444
Sell Hogs, first quarter (cwt.)		107	132	133	103
Sell Hogs, second quarter (cwt.)		1	41	41	54
Sell Hogs, third quarter (cwt.)	186	185	145	145	132
Sell Sows, first quarter (cwt.)		4	4	4	4
Sell Sows, fourth quarter (cwt.)	8	8	8	8	6
Sell Feeder Pigs, second quarter (pigs)	25	25	25	25	35
Sell Feeder Pigs, fourth quarter (pigs)	25	6	6		35
Store Corn, second period (bu.)	6,913	12,145	13,328	13,313	
Buy Corn, first period (bu.)	1,050				
Buy Feeder Pigs, first quarter (pigs)	62	36	17	19	38
Buy Feeder Pigs, third quarter (pigs)	5	17	17		
Buy Gilts (head)	11				
Replacement Gilts (head)		5	5	5	
Point E					
Sell Corn, second period (bu.)	26,921	36,644	50,073	44,982	55,296
Sell Soybeans, second period (bu.)	3,211	6,142	6,480	7,280	8,853
Sell Hogs, first quarter (cwt.)		231	444	444	295
Sell Hogs, third quarter (cwt.)	444	444	444	444	444
Buy Corn, first period (bu.)	1,936	1,936	1,936	1,936	1,936
Buy Feeder Pigs, first quarter (pigs)	208	208	208	208	208
Buy Feeder Pigs, third quarter (pigs)	108	208	208	138	

Table 5.19. Yearly balance sheets associated with points on Curve III.

	Year 0	1	2	3	4	5
	(dollars)					
Point A						
Assets						
Current	20,000	22,130	22,663	23,206	23,759	24,322
Liabilities						
Current	0	1,612	1,617	1,623	1,629	1,635
Net Worth	20,000	20,518	21,046	21,583	22,130	22,687
Point B						
Assets						
Current	6,346	19,233	27,828	28,190	37,189	30,770
Intermediate	11,328	10,195	13,698	12,050	10,402	8,754
Long-Term	11,632	10,402	18,458	16,102	14,684	14,347
Total	29,306	39,830	59,984	56,342	62,275	53,871
Liabilities						
Current	0	0	5,678	5,346	5,823	11,510
Intermediate	0	0	0	0	0	0
Long-Term	9,306	7,534	10,244	820	0	0
Total	9,306	7,534	15,922	6,166	5,823	11,510
Net Worth	20,000	32,296	44,062	50,176	56,452	42,361
Assets Controlled	29,306	200,830	272,984	269,342	272,275	56,871
Point C						
Assets						
Current	0	19,890	20,522	34,628	46,428	52,831
Intermediate	19,049	17,144	15,239	13,334	11,429	9,525
Long-Term	20,743	18,724	18,321	16,315	14,227	14,257
Total	39,792	55,758	54,082	64,277	72,084	76,613
Liabilities						
Current	0	620	5,660	8,263	8,660	15,156
Intermediate	3,198	3,198	0	0	0	0
Long-Term	16,594	16,594	2,997	1,659	0	0
Total	19,792	20,412	8,657	9,922	8,660	15,156
Net Worth	20,000	35,346	45,425	54,355	63,424	61,457
Assets Controlled	39,792	305,758	304,082	314,277	321,084	262,613

Table 5.19 (continued).

	Year 0	1	2	3	4	5
			(dollars)			
Point D						
Assets						
Current	0	18,302	30,238	52,205	70,311	85,112
Intermediate	42,761	38,485	34,727	32,424	28,758	27,031
Long-Term	7,939	7,153	6,368	5,582	4,796	4,397
Total	50,700	63,940	71,333	90,211	103,865	116,540
Liabilities						
Current	0	3,260	5,660	10,340	12,170	29,265
Intermediate	24,349	15,154	1,700	2,832	3,825	7,082
Long-Term	6,351	4,029	4,029	3,453	2,826	2,494
Total	30,700	22,443	11,389	16,625	18,821	38,841
Net Worth	20,000	41,497	59,944	73,586	85,044	77,699
Assets Controlled	50,700	557,940	565,333	591,211	606,865	654,540
Point E						
Assets						
Current	171	32,037	63,644	90,558	82,750	106,469
Intermediate	46,789	42,110	59,706	53,125	47,205	42,394
Long-Term	13,040	11,731	10,421	9,112	7,802	6,492
Total	60,000	85,878	133,771	152,795	137,757	155,355
Liabilities						
Current	0	8,660	12,140	15,991	18,060	23,299
Intermediate	29,568	29,568	54,318	54,955	26,828	29,663
Long-Term	10,432	10,432	10,432	9,486	8,456	7,331
Total	40,000	48,660	76,890	80,432	53,344	60,293
Net Worth	20,000	37,218	56,881	72,363	84,413	95,062
Assets Controlled	60,000	682,878	1010,771	1174,795	1120,757	1266,355

shown in Table 5.19 with each point's yearly balance sheet. As in Curve II, the conventional linear programming solution specifies the highest debt use, the highest level of asset ownership, and the highest level of resource control. Moving down Curve III to lower return-risk points results in less debt use, a lower level of asset ownership, and a lower level of resource control in each year at each successive point.

The lower beginning cash or equity position of Curve III causes some differences in the balance sheets of corresponding points on Curve II and Curve III. At each point on Curve III the value of owned intermediate and long-term assets is about the same as the value of these assets at corresponding points on Curve II. But because of the lower level of beginning cash, a greater percentage of the asset purchases at each point on Curve III is financed with debt than at corresponding points on Curve II. This results in the value of total liabilities in most years for each point on Curve III being larger than the same value at corresponding points on Curve II. Also, because there is less beginning cash available, the value of current assets and total assets at each year for each point on Curve III is less than the corresponding value on Curve II. The combined effect of less assets owned and more debt used in each year for each point on Curve III is that the net worth at the end of each year of each point on Curve III is less than at corresponding points on Curve II. The value of resources controlled at the end of each year of each point on Curve III is also lower than at corresponding points on Curve II.

The leverage and liquidity ratios for each year of each point on Curve III are given in Table 5.20. The debt-to-equity ratio in this set of initial conditions was constrained to be less than 2.0, but this constraint was reached only once. This occurred in the initial period of the conventional linear programming solution. The debt-to-equity ratio was also greater than 1.0 in years one through three of Point E. This means that through year three of the conventional linear programming solution the beginning farmer has more debt capital than equity capital invested in the farm business. The debt-to-equity ratio was also greater than 1.0 in the initial period of Point D. In all other cases the beginning farmer has more equity capital than debt capital invested in the farm business. In all cases, where agricultural production occurs, the debt-to-equity ratio is higher than for corresponding points on Curve II. This indicates that a family with a beginning cash position of $20,000 will have to have a higher percentage of debt capital in the beginning farm's capital structure than a family with a beginning cash position of $40,000 to reach similar return levels.

The lowest current ratio is 2.67 which occurs at the end of year five of Point B. This indicates that with any of the farm plans the beginning farmer has a good liquidity position. In most cases the current ratios associated with points on Curve III are lower than the corresponding current ratios of Curve II. This indicates that a family with a beginning cash position of $20,000 has less liquidity

Table 5.20. Leverage and liquidity ratios, and growth in net worth for points on Curve III.

Year	Point A	Point B	Point C	Point D	Point E
Debt-to-Equity Ratio					
0	0.00	0.46	0.99	1.54	2.00
1	0.08	0.23	0.58	0.54	1.31
2	0.08	0.36	0.19	0.19	1.35
3	0.08	0.12	0.18	0.23	1.11
4	0.07	0.10	0.14	0.22	0.63
5	0.07	0.27	0.39	0.37	0.63
Current Ratio					
0	--	--	--	--	--
1	13.73	--	32.08	5.61	3.70
2	14.02	4.90	3.63	5.34	5.24
3	14.30	5.27	4.19	5.05	5.66
4	14.59	6.39	5.36	5.78	4.58
5	14.86	2.67	3.49	2.91	4.57
Growth in Net Worth During Year					
1	2.6%	61.5%	76.7%	107.5%	86.1%
2	2.6	36.4	28.5	44.4	52.8
3	2.6	13.9	19.6	22.8	27.2
4	2.5	12.5	16.7	15.6	16.6
5	2.5	-25.0	- 3.1	- 8.6	12.6
Average Growth Per Year					
	2.6%	19.9%	27.7%	36.3%	39.1%
Average Growth Per Year During First Four Years					
	2.6%	31.1%	35.4%	47.6%	45.7%

than a family with a beginning cash position of $40,000 at similar return levels.

The yearly growth in net worth for each point on Curve III is also shown in Table 5.20. The conventional linear programming solution results in the greatest growth in net worth with an average growth per year of 39.1 percent. As with Curve II, moving down the curve to lower return-risk points results in less growth in net worth. The farm plan of Point D generates an average growth per year of 36.3 percent, Point C has an average growth per year of 27.7 percent, Point B has an average growth per year of 19.9 percent, and Point A has an average growth per year of 2.6 percent. The average growth rates per year in net worth for points on Curve III are higher than the growth rates in net worth for corresponding points on Curve II. Farm plans associated with points on Curve III start with a lower beginning equity position and specify the use of relatively more debt in order to generate higher average growth rates than those generated by corresponding points on Curve II.

Income and Consumption

The undiscounted expected disposable income in each year of each point on Curve III and the resulting consumption are shown in Table 5.21. Also shown in this table is the variance of disposable income in each year for each point. As in Curve II, Point A has a fairly constant disposable income and consumption over the five years. The disposable income and consumption in each year of Point A of Curve III is lower than at Point A of Curve II. This occurs because the lower

Table 5.21. Expected disposable income, variance, and consumption in each year for each point on Curve III.

Point	Year	Disposable Income	Variance	Standard Deviation	Consumption
A	1	$ 7,442	0	0	$ 6,923
	2	7,462	0	0	6,934
	3	7,482	0	0	6,945
	4	7,503	0	0	6,956
	5	7,524	0	0	6,967
B	1	0	$ 730,168	$ 854	4,000
	2	6,816	373,256	611	6,590
	3	17,672	831,666	912	11,567
	4	18,629	793,926	891	11,937
	5	27,090	719,794	848	14,894
C	1	3,380	11,212,513	3,349	4,363
	2	18,340	9,795,130	3,130	11,830
	3	22,720	10,353,899	3,218	13,421
	4	23,340	10,705,228	3,272	13,640
	5	31,036	28,526,135	5,341	16,139
D	1	12,740	125,114,079	11,185	9,545
	2	18,340	73,643,501	8,582	11,830
	3	25,660	78,369,405	8,853	14,420
	4	27,893	83,811,191	9,155	15,160
	5	43,544	374,128,002	19,342	19,702
E	1	23,340	572,453,791	23,926	13,640
	2	27,860	1,221,361,471	34,948	15,150
	3	31,871	2,047,527,228	45,250	16,389
	4	33,940	1,825,062,064	42,721	17,010
	5	38,586	2,675,714,142	51,727	18,344

beginning cash position of Curve III means there is less cash available to save in each period, which reduces the income earned at Point A where no agricultural production occurs. Moving up the efficient frontier to higher return-risk points results in the same general increases in yearly disposable income, consumption, and variance of income that occurred on Curve II.

Each point on Curve III has an overall return that is lower than the return level of corresponding points on Curve II. This results in the yearly disposable income at each point of Curve III being less than or equal to the yearly disposable income at corresponding points on Curve II. Also, because each curve has the same consumption function, the yearly consumption at each point of Curve III is less than or equal to the yearly consumption at corresponding points on Curve II.

The probability of disposable income in each year for each point on Curve III being less than zero, $4,000, and $8,000 is given in Table 5.22. These probabilities are similar to those associated with Curve II. This does not mean that similar return levels on Curve II and Curve III result in the same probabilities of disposable income being below certain levels; each point on Curve III represents a lower return level than corresponding points on Curve II. In fact, in most cases the probabilities are slightly higher for points on Curve III than for points on Curve II. So each point on Curve III represents a lower return level, but has an equal or higher probability of yearly disposable income falling below certain levels than corresponding points on Curve II.

Table 5.22. Probability of disposable income falling below certain levels in each year for each point on Curve III.

Point	Year	$P(\mu_I < 0)$	$P(\mu_I < \$4000)$	$P(\mu_I < \$8000)$
A	1	0.0	0.0	1.0
	2	0.0	0.0	1.0
	3	0.0	0.0	1.0
	4	0.0	0.0	1.0
	5	0.0	0.0	1.0
B	1	0.5	1.0	1.0
	2	0.0	0.0	0.9738
	3	0.0	0.0	0.0
	4	0.0	0.0	0.0
	5	0.0	0.0	0.0
C	1	0.1587	0.4286	0.9162
	2	0.0	0.0	0.0
	3	0.0	0.0	0.0
	4	0.0	0.0	0.0
	5	0.0	0.0	0.0
D	1	0.1271	0.2177	0.3372
	2	0.0162	0.0475	0.1151
	3	0.0019	0.0071	0.0228
	4	0.0	0.0045	0.0150
	5	0.0122	0.0207	0.0329
E	1	0.1635	0.2090	0.2611
	2	0.2119	0.2483	0.2843
	3	0.2420	0.2676	0.2981
	4	0.2148	0.2420	0.2709
	5	0.2266	0.2514	0.2776

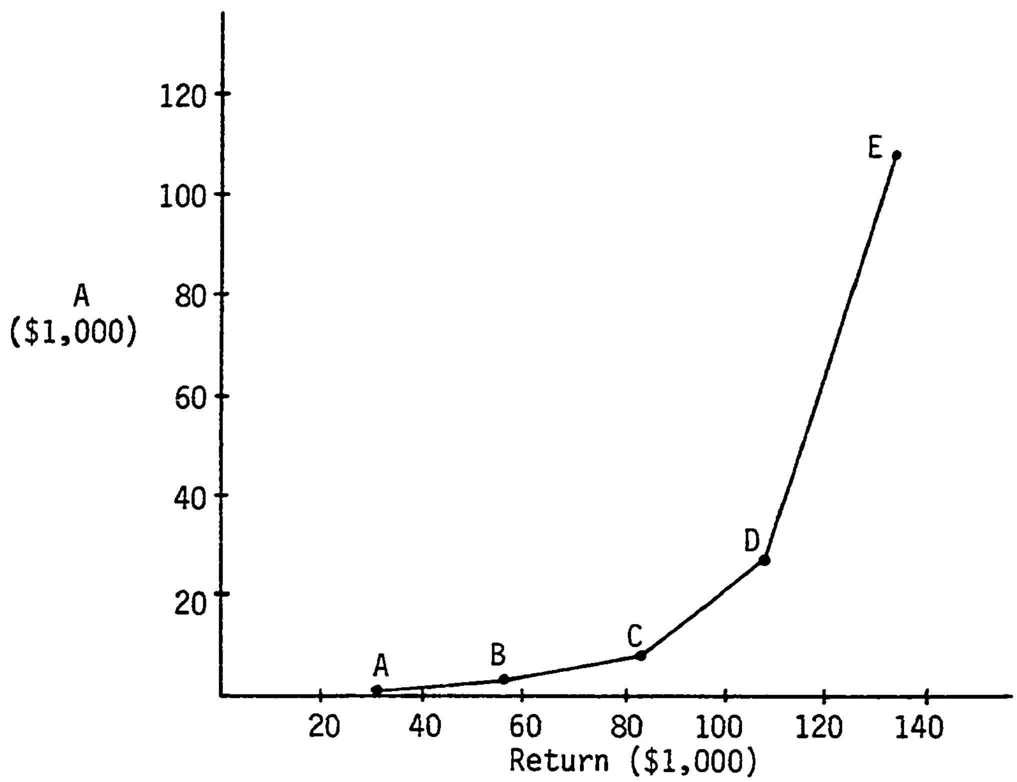
If the probability of the beginning farmer failing is again measured by the probability of disposable income being negative for two or three consecutive years, then the farm plan associated with the conventional linear programming solution would again result in the highest chance of failure. As with Curve II, there is a small probability of failure at Point D, while the farm plans of Points B and C result in virtually no chance of failure.

Curve IV

The fourth set of initial conditions represents a beginning cash or equity position of $20,000, an opportunity for the wife to work off the farm, consumption function β, availability of nonconventional loan terms, and a debt-to-equity ratio constraint of less than 2.0. This set of initial conditions is identical to Curve III, except that the consumption function has been changed (see Table 5.1). Because of the lower marginal propensity to consume, one would expect Curve IV to be to the right of Curve III. This set of initial conditions is also identical to Curve I, except that the beginning cash or equity position is at the lower level. Due to the lower beginning cash position, one would expect Curve IV to be to the left of Curve I.

Curve IV is shown in Figure 5.4. Again, the efficient frontier is convex. As expected, Curve IV is everywhere slightly to the right of Curve III. As was found in comparing Curve I with Curve II, a family with consumption function α will have to accept more risk to reach the same return level as a family with consumption function β. Also as expected, Curve IV is everywhere to the left of Curve I.

As was found in comparing Curve II with Curve III, a beginning farm family with a cash or equity position of $20,000 will have to accept more risk to reach the same level of income as a family with a beginning cash or equity position of $40,000.



Point	Return	A
A	$ 32,684	$ 0
B	58,000	1,723
C	84,000	7,830
D	109,000	26,859
E	135,090	110,057

Figure 5.4. Efficient E,A Curve IV.

Investment and Financing Plans

The investment and financing plan associated with each point of Curve IV is shown in Table 5.23. These plans are practically identical to those specified by corresponding points on Curve III. At each point of Curve IV the investment plan specifies slightly more investment in machinery than that specified by corresponding points on Curve III. The method of financing machinery purchase is the same at corresponding points on these two curves.

The investment plan of each point specifies investment in hog facilities which is similar to the investment plan of corresponding points on Curve III. The investment plan of Point E specifies buying a total confinement feeding facility in the initial period with space for about 163 hogs, which is 45 hog spaces smaller than the facility purchased at Point E of Curve III. At Point D there is investment in a partial confinement farrowing facility which is identical to that specified at Point D of Curve III. At Point D there is also investment in a partial confinement feeding facility in the initial period with space for about 7 hogs, which is 12 hog spaces smaller than the facility purchased at Point D of Curve III. Also at Point D, there is investment in a total confinement feeding facility in the initial period with space for about 74 hogs which is 7 hog spaces larger than the facility purchased at Point D of Curve III. The investment plan of Point C specifies purchasing a partial confinement farrowing facility and a partial confinement feeding facility which is practically identical to the investment plan of Point C of Curve III. Also, the

Table 5.23. Level of investment and financing activities in farm plans associated with points on Curve IV.

	Year 0	1	2	3	4	5
Point A						
Save Cash, first period ($)		20,885	22,017	23,206	24,423	25,669
Save Cash, second period ($)		22,232	23,414	24,623	25,861	27,128
Point B						
Machinery Investment and Financing:						
Labor Intensive Crop Production (unit)	0.36		0.06			
Intermediate Crop Poduction (unit)			0.05			
Capital Intensive Crop Combine (unit)	0.11		0.08			
Pay Cash ($)	11,137		5,321			
Hog Facility Investment:						
Pasture Farrowing (litter space)	12		15		2	
Partial Confinement Farrowing (litter space)	2					
Partial Confinement Feeding (hog space)	113		120	3	8	
Short-Term Loan, second period ($)			4,007			
Save Cash, first period ($)				8,113	19,331	37,736
Save Cash, second period ($)		2,703		2,313	13,305	35,797
Pay Principal, Long-Term 9% Loan ($)		2,131	5,393	9,463	1,677	
Pay Interest, Long-Term 9% Loan ($)		824	1,399	932	151	
Point C						
Machinery Investment and Financing:						
Intermediate Crop Production (unit)	0.29					
Capital Intensive Crop Production (unit)	0.15					
Labor Intensive Combine (unit)	0.09					
Capital Intensive Combine (unit)	0.08					
Pay Cash ($)	15,811					
Intermediate Credit ($)	3,180					
Hog Facility Investment:						
Partial Confinement Farrowing (litter space)	17					3

Parial Confinement Feeding (hog space)	131		33	1	4	
Short-Term Loan, first period ($)		10,131	5,323			
Save Cash, first period ($)				10,820	24,775	39,788
Save Cash, second period ($)		3,324	2,863	19,603	33,389	60,579
Pay Principal, Intermediate 9% Loan ($)			3,180			
Pay Interest, Intermediate 9% Loan ($)		286	286			
Pay Principal, Long-Term 9% Loan ($)			15,033	1,519	1,774	532
Pay Interest, Long-Term 9% Loan ($)		1,508	1,625	280	160	67
Point D						
Machinery Investment and Financing:						
Capital Intensive Crop Production (unit)	0.74					0.05
Labor Intensive Combine (unit)	0.45		0.03	0.09	0.04	0.04
Pay Cash ($)	18,508			1,367		
Intermediate Credit ($)	24,986		595	538	778	3,309
Hog Facility Investment:						
Partial Confinement Farrowing (litter space)	3					1
Partial Confinement Feeding (hog space)	7					
Total Confinement Feeding (hog space)	74					
Short-Term Loan, first period ($)		36,723	24,655			
Save Cash, first period ($)					21,238	39,210
Save Cash, second period ($)				21,043	43,200	92,039
Pay Principal, Intermediate 9% Loan ($)		8,370	16,616			
Pay Interest, Intermediate 9% Loan ($)		2,249	1,495	54	102	172
Pay Principal, Long-Term 9% Loan ($)		4,470		541	589	643
Pay Interest, Long-Term 9% Loan ($)		537	135	135	86	65
Point E						
Machinery Investment and Financing:						
Capital Intensive Crop Production (unit)	0.76		0.28			
Capital Intensive Combine (unit)	0.38		0.41		0.04	0.07
Pay Cash ($)	17,962					
Intermediate Credit ($)	29,829		26,512		1,179	2,169
Hog Facility Investment:						
Total Confinement Hog Feeding (hog space)	163					

Table 5.23 (continued)

	Year 0	1	2	3	4	5
Short-Term Loan, first period ($)		50,000	50,000	50,000	50,000	50,000
Save Cash, second period ($)		29,171	54,209	83,495	83,615	118,924
Pay Principal, Intermediate 9% Loan ($)					29,829	
Pay Interest, Intermediate 9% Loan ($)		2,685	2,685	5,071	5,071	2,492
Pay Principal, Long-Term 9% Loan ($)				739	805	878
Pay Interest, Long-Term 9% Loan ($)		734	734	734	667	595

investment of Point B specifies investment in pasture farrowing facilities, a partial confinement farrowing facility, and a parital confinement feeding facility which is practically identical to the investment plan of Point B on Curve III.

As in the first three curves, each of these hog facility investments is financed using repayment plan D, which is the Standard Plan with deferred principal payments. The pattern of repayment of the long-term debt is also the same for corresponding points on Curve IV and Curve III, except for Point D. At Point D of Curve IV 75 percent of the long-term debt incurred in the initial period is repaid in year one, but at Point D of Curve III only 37 percent of this debt is repaid in year one.

The use of short-term operating loans is almost identical between corresponding points on Curve III and Curve IV. Also, the investment plan of each point specifies cash to be saved in the same periods as specified by corresponding points on Curve III. However, in most cases the amount of cash saved is larger than at the corresponding point on Curve III, because the lower marginal propensity to consume leaves more cash available to be saved in each period.

Production Plans

The production plan associated with each point of Curve IV is shown in Table 5.24. The production plan of each point specifies off-farm employment exactly as specified by corresponding points on Curve III. The crop production plan is also very similar to that specified by corresponding points on Curve III. As in Curve III, Point E specifies cash renting land and crop-share renting land. The amount of land cash

Table 5.24. Level of production activities in farm plans associated with points on Curve IV.

	Year 1	2	3	4	5
Point A					
Wife Work Off-Farm	1.00	1.00	1.00	1.00	1.00
Point B					
Wife Work Off-Farm	1.00	1.00	1.00	1.00	1.00
Crop-Share Rented Land:					
Continuous Corn (acres)	102.25	212.77	212.77	212.72	2.98
Corn-Soybean-Oats Rotation (acres)	56.13				
Pasture Farrowing (litters)	24.44	54.98	55.84	59.56	29.78
Partial Confinement Farrowing (litters)	14.52	14.52	13.36	8.74	
Place Feeder Pigs on Feed:					
Partial Confinement, third quarter (pigs)	30.48	20.98	20.51	15.48	
Partial Confinement, fourth quarter (pigs)	82.09	211.81	214.81	227.85	
Point C					
Wife Work Off-Farm	1.00	1.00	1.00	1.00	1.00
Crop-Share Rented Land:					
Continuous Corn (acres)	56.94	76.95	76.19	71.56	
Corn-Soybean Rotation (acres)	39.46	79.48	74.06	68.72	
Corn-Soybean-Oats Rotation (acres)	101.66	92.46	98.64	108.63	204.33
Partial Confinement Farrowing (litters)	100.26	100.26	100.86	101.10	107.40
Place Feeder Pigs on Feed:					
Partial Confinement, first quarter (pigs)	3.08				
Partial Confinement, third quarter (pigs)	30.54	30.95	30.86	34.41	
Partial Confinement, fourth quarter (pigs)	100.81	133.71	134.45	134.77	
Point D					
Wife Work Off-Farm	1.00	1.00	1.00	1.00	1.00
Crop-Share Rented Land:					
Continuous Corn (acres)	138.33	113.18	40.99	8.06	
Corn-Soybean Rotation (acres)	364.08	389.22	463.77	496.48	508.14
Corn-Soybean-Oats Rotation (acres)					32.67

Partial Confinement Farrowing (litters)	17.16	17.16	17.16	17.16	25.68
Place Feeder Pigs on Feed:					
Partial Confinement, first quarter (pigs)	7.12	6.61			
Partial Confinement, fourth quarter (pigs)	.50	7.12	7.12	7.12	
Total Confinement, first quarter (pigs)	73.89	73.89	73.89	73.07	58.17
Total Confinement, third quarter (pigs)	45.69	73.89	73.89	45.69	
Total Confinement, fourth quarter (pigs)				15.73	
Point E					
Wife Work Off-Farm	1.00				
Crop-Share Rented Land:					
Continuous Corn (acres)	160.13				
Corn-Soybean Rotation (acres)	358.38	714.94	714.94	712.12	706.52
Cash Rented Land:					
Custom Grow Corn (acres)	110.76	163.69	326.26	271.65	359.54
Custom Grow Corn-Soybean Rotation (acres)		34.80	34.80	73.48	145.02
Custom Harvest Corn (acres)	19.27		165.03	112.47	204.24
Harvest Corn (acres)	91.49	181.09	178.63	195.91	227.81
Harvest Soybeans (acres)		17.40	17.40	36.74	72.51
Place Feeder Pigs on Feed:					
Total Confinement, first quarter (pigs)	162.67	162.67	162.67	162.67	162.67
Total Confinement, third quarter (pigs)	57.38	155.57	162.67	105.62	

rented in each year is more than the amount cash rented at Point E of Curve III. The amount of land crop-share rented in each year is slightly more than the amount crop-share rented at Point E of Curve III. Moving down Curve IV results in less land being farmed. As in Curve III, all the land farmed at Points B, C, and D is crop-share rented. The amount of land crop-share rented in each year of Point D is slightly more than the amount of land crop-share rented at Point D of Curve III. The amount of land crop-share rented in each year of Point B and Point C is practically the same as that rented at corresponding points on Curve III. This crop-share rented land at each point is used to produce corn, soybeans, and oats. The acreages of the various crop rotations are shown in Table 5.24.

The hog facilities acquired by the investment plan of each point are utilized in hog farrowing and feeding activities that are very similar to those specified by corresponding points on Curve III. At Point E the total confinement feeding facility is used to capacity in the first and second quarters of each year and in the third and fourth quarters of year three by placing about 163 feeder pigs on feed in the first quarter of each year and in the third quarter of year three. This facility is also partially used in the third and fourth quarters of years one, two, and four by placing about 57 feeder pigs on feed in the third quarter of year one, about 156 feeder pigs on feed in the third quarter of year two, and about 106 feeder pigs on feed in the third quarter of year four. The production plan of Point D specifies the partial confinement farrowing facility be used to capacity in each year to farrow about 17 litters in years one through four and about 26 litters in year five. The partial confinement feeding facility is used to capacity in the first quarter of each year, the second quarter of years one and two, and the fourth quarter of years two through four by feeding about 7 hogs in these quarters. As in Curve III, the total confinement feeding facility is used to capacity during the first two quarters of years one and four, all of years two and three, and the first quarter of year five. This facility is also partially used in the third and fourth quarters of year one to feed about 46 hogs, in the third quarter of year four to put about 46 feeder pigs on feed, and in the fourth quarter of year four to put about 16 feeder pigs on feed.

The production plan of Point C specifies that the partial confinement farrowing facility be used to capacity to farrow about 100 litters in years one and two, about 101 litters in years three and four, and about 107 litters in year five. At Point B the pasture farrowing facilities are used to capacity to farrow about 24 litters in year one, about 58 litters in year two, about 56 litters in year three, about 60 litters in year four, and about 30 litters in year five. Also, at Point B the partial confinement farrowing facility is used to farrow about 15 litters in years one and two, about 13 litters in year three, and about 9 litters in year four. As in Curve III, the production plans of Point B and Point C specify the partial confinement feeding facility to be used to capacity in the third and fourth quarters of years one through four. Feeder pigs are put on feed in the third quarter of each year to provide the replacement gilts needed for the next year's farrowing enterprise. The remaining capacity is then used to put feeder pigs on feed in the fourth quarter of each year.

Marketing Plans

The plan associated with each point for marketing and buying agricultural products is shown in Table 5.25. These plans are practically identical to those of corresponding points on Curve III, except the levels of some activities are slightly different because the level of some production activities are slightly different than those associated with corresponding points on Curve III.

Resource Control, Debt Use, and Net Worth

The yearly balance sheets and the value of resources controlled in each year of each point on Curve IV are shown in Table 5.26. As in Curve III, the conventional linear programming solution specifies the highest debt use, the highest level of asset ownership, and the highest level of resource control. Moving down this efficient frontier to lower return-risk points results in less debt use, a lower level of asset ownership, and a lower level of resource control in each year. Because the farm plans of corresponding points on Curve III and Curve IV are so similar, the yearly balance sheets of corresponding points on these curves are also very similar. In most cases the value of resources controlled, assets owned, and net worth are higher for points on Curve IV than for corresponding points on Curve III.

The leverage and liquidity ratios for each year of each point on Curve IV are given in Table 5.27. The debt-to-equity ratio in this set of initial conditions was constrained to be less than 2.0, but the

Table 5.25. Marketing and buying plans for agricultural products associated with points on Curve IV.

	Year 1	2	3	4	5
Point B					
Sell Corn, first period (bu.)		4,200	7,709	7,699	7,940
Sell Soybeans, second period (bu.)	327				
Sell Oats, second period (bu.)	702				
Sell Hogs, second quarter (cwt.)		175	452	458	486
Sell Sows, first quarter (cwt.)		3	3	3	1
Sell Sows, fourth quarter (cwt.)	22				
Sell Feeder Pigs, first quarter (pigs)	19	39	36	25	8
Sell Feeder Pigs, second quarter (pigs)	105	212	215	228	208
Sell Feeder Pigs, third quarter (pigs)	8	18	14		
Sell Feeder Pigs, fourth quarter (pigs)	23				
Store Corn, second period (bu.)	5,475	9,603	9,597	9,590	
Buy Corn, first period (bu.)	491				
Buy Gilts (head)	23				
Replacement Gilts (head)		30	20	20	15
Point C					
Sell Corn, first period (bu.)		3,119	4,049	3,955	3,621
Sell Corn, second period (bu.)	156				2,422
Sell Soybeans, second period (bu.)	1,235	1,235	1,224	1,235	1,192
Sell Oats, second period (bu.)	1,906	1,156	1,233	1,358	2,554
Sell Hogs, second quarter (cwt.)		215	285	287	288
Sell Hogs, third quarter (cwt.)	7				
Sell Sows, first quarter (cwt.)		22	22	22	22
Sell Sows, fourth quarter (cwt.)	43	43	44	44	48
Sell Feeder Pigs, first quarter (pigs)	131	267	268	269	270
Sell Feeder Pigs, second quarter (pigs)	134	134	134	135	156
Sell Feeder Pigs, third quarter (pigs)	237	236	238	235	270
Sell Feeder Pigs, fourth quarter (pigs)	33				156
Store Corn, second period (bu.)	4,841	5,936	5,849	5,592	
Buy Corn, first period (bu.)	1,268				

Buy Gilts (head)	59				
Replacement Gilts (head)		30	30	30	33
<u>Point D</u>					
Sell Corn, first period (bu.)		6,373	11,020	12,462	12,597
Sell Corn, second period (bu.)	9,644	4,043	682		14,466
Sell Soybeans, second period (bu.)	3,186	3,406	4,056	4,344	4,637
Sell Oats, second period (bu.)					408
Sell Hogs, first quarter (cwt.)		86	147	145	98
Sell Hogs, second quarter (cwt.)		1	15	17	49
Sell Hogs, third quarter (cwt.)	173	172	158	156	125
Sell Sows, first quarter (cwt.)		4	4	4	4
Sell Sows, fourth quarter (cwt.)	7	7	7	7	6
Sell Feeder Pigs, second quarter (pigs)	23	23	23	23	33
Sell Feeder Pigs, fourth quarter (pigs)	22	16	15		33
Store Corn, second period (bu.)	7,337	11,953	13,391	13,353	
Buy Corn, first period (bu.)	967				
Buy Feeder Pigs, first quarter (pigs)	58	35	28	27	35
Buy Feeder Pigs, third quarter (pigs)		28	27		
Buy Gilts (head)	10				
Replacement Gilts (head)		5	5	5	
<u>Point E</u>					
Sell Corn, second period (bu.)	30,156	38,134	54,135	51,286	64,709
Sell Soybeans, second period (bu.)	3,136	6,865	6,865	7,517	8,702
Sell Hogs, first quarter (cwt.)		110	332	347	225
Sell Hogs, third quarter (cwt.)	347	347	347	347	347
Buy Corn, first period (bu.)	1,513	1,513	1,513	1,513	1,513
Buy Feeder Pigs, first quarter (pigs)	163	163	163	163	163
Buy Feeder Pigs, third quarter (pigs)	51	156	163	106	

Table 5.26. Yearly balance sheets associated with points on Curve IV.

	Year 0	1	2	3	4	5
	(dollars)					
Point A						
Assets						
Current	20,000	22,788	23,999	25,239	26,508	27,806
Liabilities						
Current	0	1,617	1,630	1,643	1,657	1,670
Net Worth	20,000	21,171	22,369	23,596	24,851	26,136
Point B						
Assets						
Current	6,575	18,903	27,834	30,231	41,456	37,851
Intermediate	11,137	10,023	13,699	12,053	10,407	8,761
Long-Term	11,441	10,229	18,520	16,376	18,841	14,502
Total	29,153	39,155	60,053	58,660	66,704	61,114
Liabilities						
Current	0	0	5,388	5,335	5,781	11,776
Intermediate	0	0	0	0	0	0
Long-Term	9,153	7,019	10,153	896	0	0
Total	9,153	7,019	15,541	6,231	5,781	11,776
Net Worth	20,000	32,136	44,512	52,429	60,923	49,338
Assets						
Controlled	29,153	197,155	273,053	271,660	279,704	64,114
Point C						
Assets						
Current	0	19,940	22,577	39,030	53,450	64,176
Intermediate	18,991	17,092	15,193	13,294	11,395	9,495
Long-Term	20,944	18,905	18,335	16,240	14,235	14,231
Total	39,935	55,937	56,105	68,564	79,080	87,902
Liabilities						
Current	0	591	5,889	8,309	8,660	16,071
Intermediate	3,180	3,180	0	0	0	0
Long-Term	16,755	16,755	3,023	1,594	0	0
Total	19,935	20,526	8,912	9,903	8,660	16,071
Net Worth	20,000	35,411	47,193	58,661	70,420	71,831
Assets						
Controlled	39,935	304,937	305,105	317,564	328,080	291,902

Table 5.26 (continued)

	Year 0	1	2	3	4	5
			(dollars)			
Point D						
Assets						
Current	0	18,417	29,918	54,371	75,490	94,507
Intermediate	43,494	39,145	35,331	32,636	28,738	27,039
Long-Term	7,458	6,717	5,977	5,237	4,497	4,150
Total	50,952	64,279	71,266	92,244	108,725	125,696
Liabilities						
Current	0	3,260	5,961	10,340	12,509	29,597
Intermediate	24,986	16,616	595	1,133	1,911	5,221
Long-Term	5,966	1,495	1,495	954	365	80
Total	30,952	21,371	8,051	12,427	14,785	34,898
Net Worth	20,000	42,908	63,175	79,817	93,940	90,798
Assets Controlled	50,952	566,279	573,226	597,244	613,725	633,696
Point E						
Assets						
Current	0	33,471	66,376	96,889	93,046	121,897
Intermediate	47,791	43,012	62,093	54,663	48,294	42,698
Long-Term	10,188	9,165	8,142	7,119	6,095	5,072
Total	57,979	85,648	136,611	158,671	147,435	169,667
Liabilities						
Current	0	10,340	12,140	15,969	18,060	22,887
Intermediate	29,829	29,829	56,341	56,341	27,691	29,860
Long-Term	8,150	8,150	8,150	7,411	6,606	5,728
Total	37,979	48,319	76,631	79,722	52,357	58,475
Net Worth	20,000	37,329	59,980	78,949	95,078	111,192
Assets Controlled	57,979	715,648	1050,611	1234,671	1204,435	1381,667

Table 5.27. Leverage and liquidity ratios, and growth in net worth for points on Curve IV.

	Point				
Year	A	B	C	D	E
Debt-to-Equity Ratio					
0	0.00	0.46	1.00	1.55	1.90
1	0.08	0.22	0.58	0.50	1.29
2	0.07	0.35	0.19	0.13	1.28
3	0.07	0.12	0.17	0.16	1.01
4	0.07	0.10	0.12	0.16	0.55
5	0.06	0.24	0.22	0.38	0.53
Current Ratio					
0	--	--	--	--	--
1	14.09	--	33.74	5.65	3.24
2	14.72	5.17	3.83	5.02	5.47
3	15.36	5.67	4.70	5.26	6.07
4	16.00	7.17	6.17	6.03	5.15
5	16.65	3.21	3.99	3.19	5.33
Growth in Net Worth During Year					
1	5.6%	60.7%	77.0%	114.5%	86.6%
2	5.6	38.5	33.3	47.2	60.7
3	5.5	17.8	24.3	26.3	31.6
4	5.3	16.2	20.0	17.7	20.4
5	5.2	-19.0	0.2	-3.3	16.9
Average Growth Per Year					
	5.4%	22.8%	31.0%	40.5%	43.2%
Average Growth Per Year During First Four Years					
	5.5%	33.3%	38.6%	51.4%	49.8%

highest debt-to-equity ratio was 1.9. This occurred in the initial period of the conventional linear programming solution. The debt-to-equity ratio was greater than 1.0 in years one through three of Point E. The debt-to-equity ratio was also greater than 1.0 in the initial period of Point D and it was equal to 1.0 in the initial period of Point C. In all other cases the beginning farmer has more equity capital than debt capital invested in the farm business. In most years for each point on Curve IV the debt-to-equity ratio is lower than the corresponding debt-to-equity ratio for points on Curve III. The lower marginal propensity to consume at each point on Curve IV results in the use of relatively less debt than at corresponding points on Curve III to reach similar return levels.

The lowest current ratio is 3.19 which occurs at the end of year five of Point D. With any of the farm plans the beginning farmer has a good liquidity position. In most cases the current ratios associated with points on Curve IV are higher than the current ratios of corresponding points on Curve III. A beginning farm family with consumption function α has less liquidity than a beginning farm family with consumption function β at similar return levels.

The yearly growth in net worth for each point on Curve IV is also shown in Table 5.27. The farm plan associated with Point E generates the greatest growth in net worth with an average growth per year of 43.2 percent. As in Curve III, moving down Curve IV to lower return-risk points results in less growth in net worth. The farm plan of Point D generates an average growth per year of 40.5 percent, Point C has an average growth per year of 31.0 percent, Point B has an average growth per year of 22.8 percent, and Point A has an average growth per year of 5.4 percent. The average growth per year in net worth for points on Curve IV is higher than the average growth per year in net worth for corresponding points on Curve III. The lower marginal propensity to consume allows farm plans associated with points on Curve IV to invest more and generate higher average growth rates than farm plans of corresponding points on Curve III.

Income and Consumption

The undiscounted expected disposable income, the resulting consumption, and the variance of income in each year for each point on Curve IV are shown in Table 5.28. As in all previous curves, Point A has a fairly constant disposable income and consumption over the five years. The disposable income in each year of Point A of Curve IV is slightly higher than the corresponding disposable incomes in Point A of Curve III because the lower MPC of Curve IV leaves more cash to save each period. But because of this lower MPC, the consumption in each year of Point A of Curve IV is lower than the consumption in the corresponding year of Point A of Curve III. Moving up Curve IV to higher return-risk points results in the same general increases in yearly disposable income, consumption, and variance of income that occurred in all previous curves. Because the overall return at points on Curve IV are very close to the return at corresponding points on Curve III, the patterns of yearly disposable income at corresponding points on these curves are very similar. But because of the lower MPC, the consumption

Table 5.28. Expected disposable income, variance, and consumption in each year for each point on Curve IV.

Point	Year	Disposable Income	Variance	Standard Deviation	Consumption
A	1	$ 7,460	0	0	$ 6,289
	2	7,506	0	0	6,308
	3	7,553	0	0	6,326
	4	7,601	0	0	6,345
	5	7,650	0	0	6,365
B	1	0	$ 663,655	$ 815	4,000
	2	6,624	353,618	595	5,956
	3	17,648	792,391	890	9,757
	4	18,556	727,653	853	10,021
	5	27,415	738,687	859	12,339
C	1	3,224	11,361,633	3,371	4,346
	2	18,747	10,087,985	3,176	10,074
	3	22,792	10,528,314	3,245	11,172
	4	23,340	10,550,107	3,248	11,317
	5	31,951	31,430,696	5,606	13,398
D	1	12,740	125,986,845	11,224	8,249
	2	18,876	82,465,637	9,081	10,110
	3	25,660	80,157,859	8,953	11,902
	4	28,259	87,041,879	9,330	12,545
	5	43,815	379,565,359	19,482	15,914
E	1	25,660	670,054,691	25,885	11,902
	2	27,860	1,335,380,931	36,543	12,450
	3	31,849	2,326,902,004	48,238	13,375
	4	33,940	2,220,406,662	47,121	13,845
	5	38,220	3,353,543,081	57,910	14,766

in each year of points on Curve IV is lower than the consumption in each year of corresponding points on Curve III.

The probability of disposable income in each year of each point on Curve IV being less than zero, \$4,000, and \$8,000 is given in Table 5.29. These probabilities are very similar to those associated with Curve III. As with previous curves, the farm plan associated with the conventional linear programming solution results in the greatest probability of failure, there is a small probability of failure at Point D, and there is virtually no chance of failure at Points B and C.

Curve V

The fifth set of initial conditions represents a beginning cash or equity position of \$20,000, an opportunity for the wife to work off the farm, consumption function α, availability of nonconventional loan terms, and a debt-to-equity ratio constraint of less than 1.0. This set of initial conditions is identical to Curve III except that the debt-to-equity ratio constraint is at the lower level (see Table 5.1).

The debt-to-equity ratio for Points A, B, and C of Curve III was not greater than 1.0 for any of the years at these points. Therefore, Points A, B, and C of Curve III will be points on Curve V. However, Points D and E on Curve III had a debt-to-equity ratio greater than 1.0 in some years, so Points D and E of Curve III cannot be on Curve V. One would then expect Curve V to be identical to Curve III up to about Point C and then be everywhere to the left of Curve III. This set of initial conditions is also identical to Curve II (when the debt-to-equity ratio constraint is less than 1.0) except that the beginning

Table 5.29. Probability of disposable income falling below certain levels in each year for each point on Curve IV.

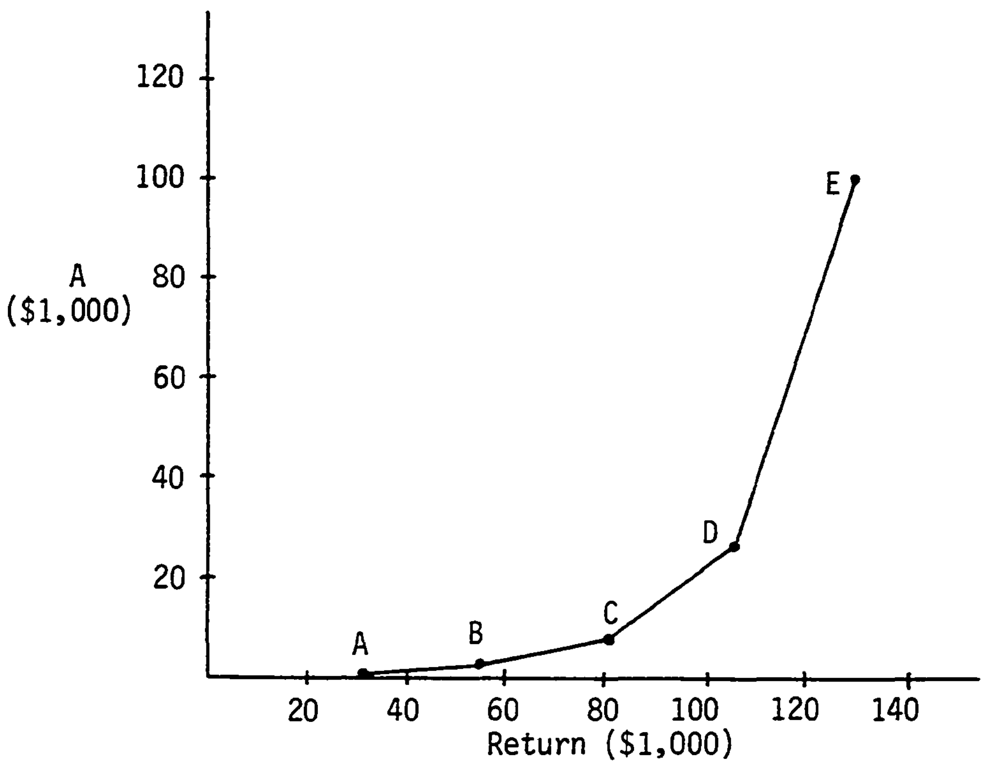
Point	Year	$P(\mu_I < 0)$	$P(\mu_I < \$4000)$	$P(\mu_I < \$8000)$
A	1	0.0	0.0	1.0
	2	0.0	0.0	1.0
	3	0.0	0.0	1.0
	4	0.0	0.0	1.0
	5	0.0	0.0	1.0
B	1	0.5	1.0	1.0
	2	0.0	0.0	0.9896
	3	0.0	0.0	0.0
	4	0.0	0.0	0.0
	5	0.0	0.0	0.0
C	1	0.1685	0.5910	0.9222
	2	0.0	0.0	0.0
	3	0.0	0.0	0.0
	4	0.0	0.0	0.0
	5	0.0	0.0	0.0
D	1	0.1271	0.2177	0.3372
	2	0.0188	0.0505	0.1112
	3	0.0021	0.0078	0.0244
	4	0.0	0.0047	0.0150
	5	0.0122	0.0207	0.0329
E	1	0.1611	0.2005	0.2483
	2	0.2236	0.2578	0.2946
	3	0.2546	0.2810	0.3121
	4	0.2358	0.2611	0.2912
	5	0.2546	0.2776	0.3015

cash position is at the lower level. One would expect Curve V to be to the left of Curve II because of the lower beginning cash or equity position.

Curve V is shown in Figure 5.5. As expected, Curve V is identical to Curve III up to a return level of about $80,000, which is around Point C on both curves. A beginning farm family with a debt-to-equity ratio constraint of less than 1.0 will have to accept more risk to reach return levels above $80,000 than a family with a debt-to-equity ratio constraint of less than 2.0. Also as expected, Curve V is everywhere to the left of Curve II. As was found in comparing Curve III with Curve II and Curve IV with Curve I, a beginning farm family with a cash position of $20,000 will have to accept more risk to reach the same level of return as a family with a beginning cash or equity position of $40,000.

Investment and Financing Plans

The investment and financing plan associated with each point on Curve V is shown in Table 5.30. These plans are similar to those specified by corresponding points on Curve III (see Table 5.16). At Point E there is less investment in machinery in the initial period than at Point E of Curve III, but there is more machinery investment in years two and three at Point E of Curve V. The machinery investment is restricted in the initial period at Point E because of the debt-to-equity ratio constraint. At Point D there is also less machinery investment in the initial period than at Point D of Curve III, but there is more machinery investment in years two, four and five. The



Point	Return	A
A	$ 32,387	$ 0
B	57,000	1,617
C	81,000	6,916
D	106,000	25,935
E	130,208	100,558

Figure 5.5. Efficient E,A Curve V.

machinery investment is about the same at Point C of both curves. At Point B the machinery investment is about the same in the initial period, but there is a little more investment in year two than at Point B of Curve III.

Table 5.30. Level of investment and financing activities in farm plans associated with points on Curve V.

	Year					
	0	1	2	3	4	5
Point A						
Save Cash, first period ($)		20,538	21,051	21,573	22,105	22,646
Save Cash, second period ($)		21,590	22,110	22,640	23,179	23,729
Point B						
Machinery Investment and Financing:						
Labor Intensive Crop Production (unit)	0.34		0.11			
Intermediate Crop Production (unit)			0.03			
Capital Intensive Combine (unit)	0.10		0.09			
Pay Cash ($)	10,496		6,055			
Hog Facility Investment:						
Pasture Farrowing (litter space)	12		17		1	
Partial Confinement Farrowing (litter space)	2					
Partial Confinement Feeding (hog space)	112		129		2	
Short-Term Loan, second period ($)			4,485			
Save Cash, first period ($)				7,079	16,332	32,286
Save Cash, second period ($)		2,230			9,385	28,946
Pay Principal, Long-Term 9% Loan ($)		3,241	3,527	9,639	1,707	235
Pay Interest, Long-Term 9% Loan ($)		790	1,333	1,015	175	21
Point C						
Machinery Investment and Financing:						
Intermediate Crop Production (unit)	0.31					
Capitial Intensive Crop Production (unit)	0.14					
Labor Intensive Combine (unit)	0.04					
Capital Intensive Combine (unit)	0.11					
Pay Cash ($)	15,954					
Intermediate Credit ($)	3,816					
Hog Facility Investment:						
Partial Confinement Farrowing (litter space)	16				1	

Partial Confinement Feeding (hog space)	124		39			
Short-Term Loan, first period ($)		10,085	6,645			
Save Cash, first period ($)				6,994	18,649	33,714
Save Cash, second period ($)		3,217		13,299	25,349	46,483
Pay Principal, Intermediate 9% Loan ($)			3,816			
Pay Interest, Intermediate 9% Loan ($)		343	343			
Pay Principal, Long-Term 9% Loan ($)			14,170	2,222	1,762	
Pay Interest, Long-Term 9% Loan ($)		1,457	1,618	344	159	
<u>Point D</u>						
Machinery Investment and Financing:						
Capital Intensive Crop Production (unit)	0.56		0.04	0.01	0.05	0.09
Labor Intensive Combine (unit)	0.34		0.05	0.05	0.04	0.16
Pay Cash ($)	18,657					
Intermediate Credit ($)	14,627		2,975	1,367	2,951	7,237
Hog Facility Investment:						
Partial Confinement Farrowing (litter space)	7					1
Partial Confinement Feeding (hog space)	13					
Total Confinement Feeding (hog space)			112			
Short-Term Loan, first period ($)		28,844	23,460			
Save Cash, first period ($)					18,121	33,658
Save Cash, second period ($)			5,576	22,487	42,551	84,138
Pay Principal, Intermediate 9% Loan ($)		8,410	6,217			
Pay Interest, Intermediate 9% Loan ($)		1,316	560	268	391	656
Pay Principal, Long-Term 9% Loan ($)		3,415		487	1,040	1,134
Pay Interest, Long-Term 9% Loan ($)		484	682	682	638	562
<u>Point E</u>						
Machinery Investment and Financing:						
Capital Intensive Crop Production (unit)	0.60		0.50	0.01		
Labor Intensive Combine (unit)	0.07					
Capital Intensive Combine (unit)	0.32		0.17	0.24	0.02	0.01
Pay Cash ($)	20,000					
Intermediate Credit ($)	20,000		28,914	7,813	581	282

Table 5.30 (continued)

	Year 0	1	2	3	4	5
Hog Facility Investment:						
Total Confinement Feeding (hog space)			40			
Short-Term Loan, first period ($)		50,000	50,000	50,000	50,000	50,000
Save Cash, second period ($)		24,268	29,731	55,946	76,586	101,753
Pay Principal, Intermediate 9% Loan ($)			15,922		4,078	
Pay Interest, Intermediate 9% Loan ($)		1,800	1,800	2,963	3,672	3,358
Pay Principal, Long-Term 9% Loan ($)					180	197
Pay Interest, Long-Term 9% Loan ($)			179	179	179	163

The lower debt-to-equity ratio constraint forces the financing plans of Points D and E to use less intermediate debt in the initial period than is used at corresponding points on Curve III. The financing plan of the conventional linear programming solution for Curve V specifies that 50 percent of the machinery purchase be financed using intermediate credit, while at Point E of Curve III intermediate credit is used to finance 63 percent of the machinery purchase in the initial period. The financing plan of Point D specifies the use of intermediate debt to finance 44 percent of machinery purchase in the initial period, while Point D of Curve III uses intermediate credit to finance 57 percent of machinery purchases in the initial period. At both points on both curves machinery purchases in years two through five are all financed with intermediate credit. At Point C of Curve V, intermediate debt is used to finance 19 percent of machinery purchase, while at Point C of Curve III intermediate debt is used to finance 17 percent of machinery purchase. At Point B of both curves all machinery purchase is paid for with cash.

The investment plan of each point specifies purchasing the same type of hog facilities that are bought at corresponding points on Curve III. However, the lower debt-to-equity ratio constraint forces the timing of hog facility investment and the amount of investment at Points D and E to be quite different than at corresponding points on Curve III. The investment plan of Point E specifies purchasing a total confinement feeding facility in year two with space for about 40 hogs, which is 168 hog spaces smaller than the facility purchased at Point E of Curve III. The lower debt-to-equity ratio constraint forces this hog facility investment to occur in year two rather than in the initial period as specified by Point E of Curve III, because all available credit in the initial period was used to finance machinery purchases. The investment plan of Point D specifies purchasing a partial confinement farrowing facility in the initial period with space for 7 litters, which is 4 litter spaces larger than the facility purchased at Point D of Curve III. The investment plan of Point D also specifies investment in a partial confinement feeding facility in the initial period with space for about 13 hogs, which is 6 hog spaces smaller than the facility purchased at Point D of Curve III. Also at Point D, there is investment in a total confinement feeding facility in year two with space for about 112 hogs, which is 44 hog spaces larger than the facility purchased at Point D of Curve III. The lower debt-to-equity ratio constraint forces this hog facility purchase to occur in year two rather than in the initial period as specified by Point D of Curve III, because all available credit in the initial period is used to finance machinery and other hog facility purchases. The investment plans of Points B and C specify investment in hog facilities that are practically identical to that specified by corresponding points on Curve III.

As in all previous curves, each of these hog facility investments is financed using repayment plan D, which is the Standard plan with deferred principal payments. At Point E principal payments are made in years four and five as required by repayment plan D and an interest charge of 9 percent of the unpaid balance is paid in years two through five. At Points B, C, and D the pattern of repayment of this long-term debt is about the same as the repayment patterns at corresponding points on Curve III.

The use of short-term operating loans at each point is about the same as specified at corresponding points on Curve III, except for year one of Point D. In this particular case less short-term debt is needed because less agricultural production occurs than in year one of Point D of Curve III. The investment plan of each point specifies cash to be saved in approximately the same pattern as specified by corresponding points on Curve III. At Point A of each curve exactly the same farm plan is specified because the lower debt-to-equity ratio constraint does not affect this point where no agricultural production occurs.

Production Plans

The production plan associated with each point on Curve V is shown in Table 5.31. The production plan of each point specifies off-farm employment exactly as specified by corresponding points on all previous curves.

The crop production plan specified by the conventional linear programming solution is quite different than that specified by Point E of Curve III. Cash renting land and crop-share renting land occurs as in Point E of Curve III, but the amounts are quite different. The amount of land acquired through cash renting is 192 acres in year one, 78 acres in year two, 212 acres in year three, 316 acres in year four, and 448 acres in year five. This cash rented land is used to raise corn and soybeans grown by a custom operator. The amount of land

Table 5.31. Level of production activities in farm plans associated with points on Curve V.

	Year 1	2	3	4	5
Point A					
Wife Work Off-Farm	1.00	1.00	1.00	1.00	1.00
Point B					
Wife Work Off-Farm	1.00	1.00	1.00	1.00	1.00
Crop-Share Rented Land:					
Continuous Corn (acres)	99.88	214.50	214.50	211.48	3.02
Corn-Soybean-Oats Rotation (acres)	48.27			2.49	
Pasture Farrowing (litters)	24.78	58.52	58.49	60.36	30.18
Partial Confinement Farrowing (litters)	11.28	8.92	9.00	7.76	
Place Feeder Pigs on Feed:					
Partial Confinement, third quarter (pigs)	30.11	20.59	20.94	16.02	
Partial Confinement, fourth quarter (pigs)	81.58	219.91	219.56	226.33	
Point C					
Wife Work Off-Farm	1.00	1.00	1.00	1.00	1.00
Crop-Share Rented Land:					
Continuous Corn (acres)	59.64	102.62	102.62	99.82	
Corn-Soybean Rotation (acres)	17.66				
Corn-Soybean-Oats Rotation (acres)	182.10	159.75	159.75	162.57	131.94
Partial Confinement Farrowing (litters)	97.74	99.96	99.96	100.38	91.64
Place Feeder Pigs on Feed:					
Partial Confinement, third quarter (pigs)	31.11	30.44	30.70	25.27	
Partial Confinement, fourth quarter (pigs)	93.14	133.27	133.27	138.69	
Point D					
Wife Work Off-Farm	1.00	1.00	1.00	1.00	1.00
Crop-Share Rented Land:					
Continuous Corn (acres)	105.85	98.47	65.55	66.47	
Corn-Soybean Rotation (acres)	278.60	316.08	355.32	386.34	513.68
Partial Confinement Farrowing (litters)	42.06	42.06	41.62	31.20	15.62

Place Feeder Pigs on Feed:					
Partial Confinement, first quarter (pigs)	12.81	12.81			
Partial Confinement, third quarter (pigs)	12.81				
Partial Confinement, fourth quarter (pigs)		12.81	12.81	12.81	
Total Confinement, first quarter (pigs)		112.12	112.12	110.38	68.86
Total Confinement, third quarter (pigs)		112.12	110.38	68.86	
Total Confinement, fourth quarter (pigs)			1.74	43.25	
<u>Point E</u>					
Wife Work Off-Farm	1.00				
Crop-Share Rented Land:					
Continuous Corn (acres)	45.77	222.43			
Corn-Soybean Rotation (acres)	365.14	527.82	755.14	755.14	754.40
Cash Rented Land:					
Custom Grow Corn (acres)	191.68	77.56	212.37	298.00	420.61
Custom Grow Corn-Soybean Rotation (acres)				17.66	26.96
Custom Harvest Corn (acres)			25.26	111.54	234.65
Harvest Corn (acres)	191.68	77.56	187.10	195.29	199.44
Harvest Soybeans (acres)				8.83	13.48
Place Feeder Pigs on Feed:					
Total Confinement, first quarter (pigs)		39.70	39.70	39.70	39.70
Total Confinement, third quarter (pigs)		39.70	39.70	13.72	

crop-share rented is 411 acres in year one, 750 acres in year two, and 755 acres in years three through five. This crop-share rented land is used to produce corn and soybeans in the acreages shown in Table 5.31.

As in all previous curves, all the land farmed in Points B, C, and D is crop-share rented. The amount of land crop-share rented in each year of Point D is less than the amount crop-share rented at Point D of Curve III. The amount of land crop-share rented at Point C is 259 acres in year one, 263 acres in years two through four, and 132 acres in year five, which is more in each year except year five than is crop-share rented at Point C of Curve III. The amount of land crop-share rented in each year of Point B is about equal to the amount crop-share rented at Point B of Curve III. At each point this crop-share rented land is used to produce corn, soybeans and oats, with the acreages of the various crop rotations shown in Table 5.31.

The hog production plan of Point E specifies that the total confinement feeding facility be used to capacity in the first and second quarters of years two through five and in the third and fourth quarters of years two and three by putting about 40 feeder pigs on feed in the first quarter of years two through five and in the third quarter of years two and three. This facility is also partially used in the third and fourth quarters of year four by putting about 14 feeder pigs on feed in the third quarter of year four.

The production plan of Point D specifies that the partial confinement farrowing facility be used to capacity to farrow about 42 litters in years one through three, about 31 litters in year four, and about

16 litters in year five. The partial confinement feeding facility is used to capacity in the first quarter of each year, the second quarter of years one and two, the third quarter of year one, and the fourth quarter of years one through four. This facility is empty at other times. The total confinement feeding facility is used to capacity in the first quarter of years two through five, the second quarter of years two and three, the third quarter of year two, and the fourth quarter of years two through four. This facility is partially used at other times except the third and fourth quarters of year five.

The production plan of Point C specifies that the partial confinement farrowing facility be used to capacity to farrow about 100 litters in years one through four and about 92 litters in year five. At Point B the pasture farrowing facilities are used to capacity in each year to farrow about 25 litters in year one, about 60 litters in years two through four, and about 30 litters in year five. Also at Point B the partial confinement farrowing facility is used to farrow about 11 litters in year one, about 9 litters in years two and three, and about 8 litters in year four. At both points there is about the same number of litters farrowed in each year as at corresponding points on Curve III. As in all previous curves, the production plans of Points B and C specify that the partial confinement feeding facility be utilized to capacity in the third and fourth quarters of years one through four. Feeder pigs are put on feed in the third quarter of each year to provide the replacement gilts for the next year's farrowing enterprise.

The remaining capacity is then used to put feeder pigs on feed in the fourth quarter of each year.

Marketing Plans

The plan associated with each point for marketing and buying agricultural products is shown in Table 5.32. These plans are similar to those specified by corresponding points on Curve III, but some differences can be noted. At Point B no feeder pigs are sold in quarter three of any year, while at Point B of Curve III feeder pigs are sold in the third quarter of years one through four. At Point C, 16 bushels of oats are stored at harvest of year three and sold in the first period of year four, while at Point C of Curve III no oats are ever stored. At Point D of Curve V the percentage of corn available for sale at harvest that is stored until the first period of the next year is 42 percent in year one, 77 percent in year two, 95 percent in year three, and 100 percent in year four. The corresponding figures for Point D of Curve III were 34 percent in year one, 60 percent in year two, 82 percent in year three, and 77 percent in year five.

Resource Control, Debt Use, and Net Worth

The yearly balance sheets and the value of resources controlled in each year of each point on Curve V are given in Table 5.33. As in all previous curves, the conventional linear programming solution specifies the highest debt use, the highest level of asset ownership, and the highest level of resource control. Moving down Curve V to lower return-risk points results in less debt use, a lower level of asset ownership,

Table 5.32. Marketing and buying plans for agricultural products associated with points on Curve V.

	Year				
	1	2	3	4	5
Point B					
Sell Corn, first peirod (bu.)		3,994	7,775	7,767	7,881
Sell Soybeans, second period (bu.)	282			15	
Sell Oats, second period (bu.)	603			31	
Sell Hogs, second quarter (cwt.)		174	469	469	483
Sell Sows, first quarter (cwt.)		2	2	2	1
Sell Sows, fourth quarter (cwt.)	21				
Sell Feeder Pigs, first quarter (pigs)	14	25	21	18	8
Sell Feeder Pigs, second quarter (pigs)	102	220	220	226	211
Sell Feeder Pigs, fourth quarter (pigs)	20				
Store Corn, second period (bu.)	5,242	9,688	9,686	9,571	
Buy Corn, first period (bu.)	461				
Buy Gilts (head)	21				
Replacement Gilts (head)		29	20	20	15
Point C					
Sell Corn, first period (bu.)		3,434	4,533	4,525	4,527
Sell Corn, second period (bu.)	36				1,299
Sell Soybeans, second period (bu.)	1,217	932	932	948	770
Sell Oats, first period (bu.)				16	
Sell Oats, second period (bu.)	2,276	1,997	1,981	2,032	1,649
Sell Hogs, second quarter (cwt.)		199	284	284	296
Sell Sows, first quarter (cwt.)		21	22	22	21
Sell Sows, fourth quarter (cwt.)	42	43	43	44	41
Sell Feeder Pigs, first quarter (pigs)	130	264	267	265	246
Sell Feeder Pigs, second quarter (pigs)	130	133	133	138	138
Sell Feeder Pigs, third quarter (pigs)	230	236	236	238	238
Sell Feeder Pigs, fourth quarter (pigs)	37				133
Store Corn, second period (bu.)	5,115	6,407	6,404	6,322	
Store Oats, second period (bu.)			16		
Buy Corn, first period (bu.)	1,215				

Buy Gilts (head)	58				
Replacement Gilts (head)		30	30	30	25
Point D					
Sell Corn, first period (bu.)		2,707	5,117	8,120	8,894
Sell Corn, second period (bu.)	8,450	5,749	2,085	3,001	13,933
Sell Soybeans, second period (bu.)	2,438	2,766	3,109	3,380	4,495
Sell Hogs, first quarter (cwt.)			212	222	147
Sell Hogs, second quarter (cwt.)		267	27	31	120
Sell Hogs, third quarter (cwt.)	27		239	236	147
Sell Sows, first quarter (cwt.)		9	9	9	6
Sell Sows, fourth quarter (cwt.)	18	18	18	15	10
Sell Feeder Pigs, first quarter (pigs)	43				
Sell Feeder Pigs, second quarter (pigs)	56	56	56	56	62
Sell Feeder Pigs, third quarter (pigs)	99				
Sell Feeder Pigs, fourth quarter (pigs)	56	43	42		62
Store Corn, second period (bu.)	4,392	6,735	9,682	9,990	
Buy Corn, first period (bu.)	642				
Buy Feeder Pigs, first quarter (pigs)		13	1	21	34
Buy Gilts (head)	25				
Replacement Gilts (head)		12	12	6	
Point E					
Sell Corn, second period (bu.)	33,644	34,542	43,479	53,163	65,915
Sell Soybeans, second period (bu.)	3,195	4,618	6,607	6,917	7,073
Sell Hogs, first quarter (cwt.)			85	85	29
Sell Hogs, third quarter (cwt.)		85	85	85	85
Store Corn, second period (bu.)		369			
Buy Corn, first period (bu.)		369		369	369
Buy Feeder Pigs, first quarter (pigs)		40	40	40	40
Buy Feeder Pigs, third quarter (pigs)		40	40	14	

Table 5.33. Yearly balance sheets associated with points on Curve V.

	Year 0	1	2	3	4	5
	(dollars)					
Point A						
Assets						
Current	20,000	22,130	22,663	23,206	23,759	24,322
Liabilities						
Current	0	1,612	1,617	1,623	1,629	1,635
Net Worth	20,000	20,518	21,046	21,583	22,130	22,687
Point B						
Assets						
Current	7,309	17,852	28,149	28,162	37,396	30,844
Intermediate	10,496	9,446	13,847	12,192	10,536	8,881
Long-Term	10,980	9,811	18,966	16,534	14,436	13,873
Total	28,785	37,109	60,962	56,888	62,368	53,598
Liabilities						
Current	0	0	5,673	5,247	5,824	11,612
Intermediate	0	0	0	0	0	0
Long-Term	8,785	5,540	11,279	1,640	235	0
Total	8,785	5,540	16,952	6,887	6,059	11,612
Net Worth	20,000	31,569	44,010	50,001	56,309	41,986
Assets Controlled	28,785	185,109	274,962	270,888	276,368	56,598
Point C						
Assets						
Current	0	20,177	20,545	34,207	46,146	49,428
Intermediate	19,769	17,793	16,002	14,004	12,007	10,009
Long-Term	20,231	18,262	18,320	16,144	14,133	14,181
Total	40,000	56,232	54,867	64,355	72,286	73,618
Liabilities						
Current	0	571	5,468	8,053	8,479	14,060
Intermediate	3,816	3,816	0	0	0	0
Long-Term	16,184	16,184	3,811	1,599	0	0
Total	20,000	20,571	9,279	9,652	8,479	14,060
Net Worth	20,000	35,661	45,588	54,703	63,807	59,558
Assets Controlled	40,000	315,232	316,867	326,355	334,286	205,618

Table 5.33 (continued)

	Year 0	1	2	3	4	5
	(dollars)					
Point D						
Assets						
Current	0	10,624	28,333	51,564	70,753	86,545
Intermediate	33,283	29,955	29,304	26,909	25,802	28,258
Long-Term	6,717	6,063	11,727	10,368	9,009	7,871
Total	40,000	46,642	69,364	88,841	105,564	122,674
Liabilities						
Current	0	3,818	5,660	8,660	12,140	27,181
Intermediate	14,627	6,216	2,975	4,342	7,293	14,531
Long-Term	5,373	1,959	7,576	7,089	6,048	5,115
Total	20,000	11,993	16,211	20,091	25,481	46,827
Net Worth	20,000	34,649	53,153	68,750	80,083	75,847
Assets Controlled	40,000	430,642	484,364	509,841	558,564	636,674
Point E						
Assets						
Current	0	24,874	33,983	60,104	79,455	104,297
Intermediate	40,000	36,000	58,022	58,163	51,013	43,536
Long-Term	0	0	2,237	1,987	1,737	1,487
Total	40,000	60,874	94,242	120,254	132,205	149,320
Liabilities						
Current	0	9,972	12,140	15,765	17,006	18,060
Intermediate	20,000	20,000	32,992	40,805	37,308	37,590
Long-Term	0	0	1,989	1,989	1,809	1,612
Total	20,000	29,972	47,121	58,559	56,123	57,262
Net Worth	20,000	30,902	47,121	61,695	76,082	92,058
Assets Controlled	40,000	663,874	922,242	1087,254	1203,205	1352,320

and a lower level of resource control in each year at each successive point.

The lower debt-to-equity ratio constraint of Curve V causes some differences in the balance sheets of corresponding points on Curve III and Curve V. Because of the lower debt-to-equity ratio constraint, Point E specifies the use of less intermediate and long-term debt than is specified at Point E of Curve III. Since less debt can be used to acquire assets, the owned intermediate assets through year two and the owend long-term assets in each year of Point E are less than those of Point E of Curve III. Also because less debt can be used to generate growth in net worth, the net worth at the end of each year of Point E is less than at Point E of Curve III. The same observations are true of Point D on both curves. Point D has less intermediate debt outstanding and less long-term debt outstanding through year one than at Point D of Curve III. Since less debt is used to acquire assets in the early years, Point D has less owned intermediate assets through year four and less long-term assets through year one than Point D of Curve III. Again, because less debt can be used to generate growth in net worth, the net worth at the end of each year of Point D is less than at Point D of Curve III. Because the farm plans associated with Points B and C are so similar to those specified by corresponding points on Curve III, the balance sheets of Points B and C are very similar for the two curves. The lower debt-to-equity ratio constraint did not affect the lower return-risk points represented by Points B and C on both curves.

The leverage and liquidity ratios for each year of each point on Curve V are given in Table 5.34. The debt-to-equity ratio constraint of 1.0 was reached four times: in the initial period for Points C, D, and E and at the end of year two of Point E. In all other cases the beginning farmer has more equity capital than debt capital invested in the farm business. The debt-to-equity ratios for Points A, B, and C are practically identical to those associated with corresponding points on Curve III. The lower debt-to-equity ratio constraint did not affect the farm plans of these lower return-risk points, but the lower debt-to-equity ratio did affect the farm plans of the higher return-risk points of Points D and E. The debt-to-equity ratio at the end of the initial period and year one for Point D is lower than for Point D of Curve III, but the debt-to-equity ratio at the end of years two through five for Point D is higher than at Point D of Curve III. The debt-to-equity ratio at the end of each year for Point E is lower than at Point E of Curve III, except for year four.

The lowest current ratio is 2.49 which occurs at the end of year one for Point E. This indicates that with any of the farm plans the beginning farmer has a good liquidity position. The current ratios for Points A, B, and C are practically identical to those of corresponding points on Curve III. The current ratios at the end of years one and two for Point D are lower than corresponding ratios for Point D of Curve III, and the current ratios at the end of years three, four, and five for Point D are higher than corresponding ratios for Point D of Curve III. The current ratio at the end of the first three years for

Table 5.34. Leverage and liquidity ratios, and growth in net worth for points on Curve V.

Year	Point A	Point B	Point C	Point D	Point E
Debt-to-Equity Ratio					
0	0.00	0.44	1.00	1.00	1.00
1	0.08	0.18	0.58	0.35	0.97
2	0.08	0.38	0.20	0.30	1.00
3	0.08	0.14	0.18	0.29	0.95
4	0.07	0.11	0.13	0.32	0.74
5	0.07	0.28	0.24	0.62	0.62
Current Ratio					
0	--	--	--	--	--
1	13.73	--	35.34	2.78	2.49
2	14.02	4.96	3.76	5.01	2.80
3	14.30	5.37	4.25	5.94	3.81
4	14.59	6.42	5.44	5.83	4.67
5	14.88	2.66	3.52	3.18	5.78
Growth in Net Worth During Year					
1	2.6%	57.8%	78.3%	73.2%	54.5%
2	2.6	39.4	27.8	53.4	52.5
3	2.6	13.6	20.0	29.3	30.9
4	2.5	12.6	16.6	16.5	23.3
5	2.5	-25.4	-6.7	-5.3	21.0
Average Growth Per Year					
	2.6%	19.6%	26.6%	33.4%	36.4%
Average Growth Per Year During First Four Years					
	2.6%	30.8%	35.7%	43.1%	40.3%

Point E is lower and the current ratio at the end of years four and five for Point E is higher than corresponding ratios of Point E of Curve III.

The yearly growth rates in net worth for each point on Curve V are also given in Table 5.34. The farm plan associated with Point E results in the greatest growth in net worth with an average growth per year of 36.4 percent. Moving down the efficient frontier to lower return-risk points results in less growth in net worth. The farm plan of Point D generates an average growth per year of 33.4 percent, Point C has an average growth per year of 26.6 percent, and Point B has an average growth of 19.6 percent. Point A, where no agricultural production occurs, has an average growth in net worth per year of 2.6 percent. The average growth per year in net worth for points on Curve V are lower than for corresponding points on Curve III. The lower debt-to-equity ratio constraint forces Points D and E to specify less debt use than at corresponding points on Curve III, and this causes the growth in net worth at Points D and E to be less than at corresponding points on Curve III. The growth in net worth at Points B and C is less than at Points B and C on Curve III because these points represent lower return-risk levels than corresponding points on Curve III.

Income and Consumption

The undiscounted expected disposable income, the resulting consumption, and the variance of income in each year for each point on Curve V are shown in Table 5.35. The disposable income and consumption

Table 5.35. Expected disposable income, variance, and consumption in each year for each point on Curve V.

Point	Year	Disposable Income	Variance	Standard Deviation	Consumption
A	1	$ 7,442	0	0	$ 6,923
	2	7,462	0	0	6,934
	3	7,482	0	0	6,945
	4	7,503	0	0	6,956
	5	7,524	0	0	6,967
B	1	0	$ 497,504	$ 705	4,000
	2	5,803	261,730	512	5,951
	3	17,462	728,625	854	11,485
	4	18,632	765,160	875	11,938
	5	27,215	738,088	859	14,936
C	1	3,115	10,524,669	3,244	4,335
	2	17,932	8,766,636	2,961	11,670
	3	22,390	9,204,467	3,034	13,305
	4	23,056	9,422,273	3,070	13,504
	5	29,940	18,828,251	4,339	15,810
D	1	14,176	82,021,862	9,057	10,151
	2	18,340	76,548,035	8,749	11,830
	3	23,340	54,062,128	7,353	13,640
	4	27,860	81,157,675	9,009	15,150
	5	41,839	311,706,602	17,655	19,241
E	1	25,152	780,271,366	27,933	14,249
	2	27,860	931,723,424	30,524	15,150
	3	31,645	1,570,185,388	39,626	16,321
	4	32,886	2,194,673,336	46,847	16,694
	5	33,940	3,127,972,170	55,928	17,010

in each year for Point A is identical to that at Point A of Curve III because they are the same point. The disposable income, consumption, and variance of income in most years of Points B and C are lower than at corresponding points on Curve III because Points B and C represent lower return-risk levels than corresponding points on Curve III. The lower debt-to-equity ratio constraint causes the pattern of disposable income and consumption in each year for Points D and E of Curve V to be different than for corresponding points on Curve III. At both points disposable income and consumption are higher in year one, equal to in year two, and lower in years three through five than disposable income and consumption in the same years at corresponding points on Curve III.

The probability of disposable income being less than zero, $4,000, and $8,000 in each year for each point on Curve V is given in Table 5.36. The probabilities for Points B and C are very similar to those for Points B and C on Curve III. The probabilities associated with Points D and E are somewhat different than those of corresponding points on Curve III, but they have the same general patterns. As in all previous curves, the farm plan associated with the conventional linear programming solution results in the highest probability of the beginning farm failing; there is a small chance of failure at Point D, and there is virtually no chance of failure at Points B and C.

Table 5.36. Probability of disposable income falling below certain levels in each year for each point on Curve V.

Point	Year	$P(\mu_I < 0)$	$P(\mu_I < \$4000)$	$P(\mu_I < \$8000)$
A	1	0.0	0.0	1.0
	2	0.0	0.0	1.0
	3	0.0	0.0	1.0
	4	0.0	0.0	1.0
	5	0.0	0.0	1.0
B	1	0.5	1.0	1.0
	2	0.0	0.0	1.0
	3	0.0	0.0	0.0
	4	0.0	0.0	0.0
	5	0.0	0.0	0.0
C	1	0.1685	0.6064	0.9345
	2	0.0	0.0	0.0
	3	0.0	0.0	0.0
	4	0.0	0.0	0.0
	5	0.0	0.0	0.0
D	1	0.0594	0.1314	0.2483
	2	0.0174	0.0505	0.1190
	3	0.0	0.0043	0.0183
	4	0.0	0.0040	0.0228
	5	0.0089	0.0162	0.0274
E	1	0.1841	0.2236	0.2709
	2	0.1814	0.2177	0.2578
	3	0.2119	0.2420	0.2743
	4	0.2420	0.2676	0.2981
	5	0.2709	0.2946	0.3228

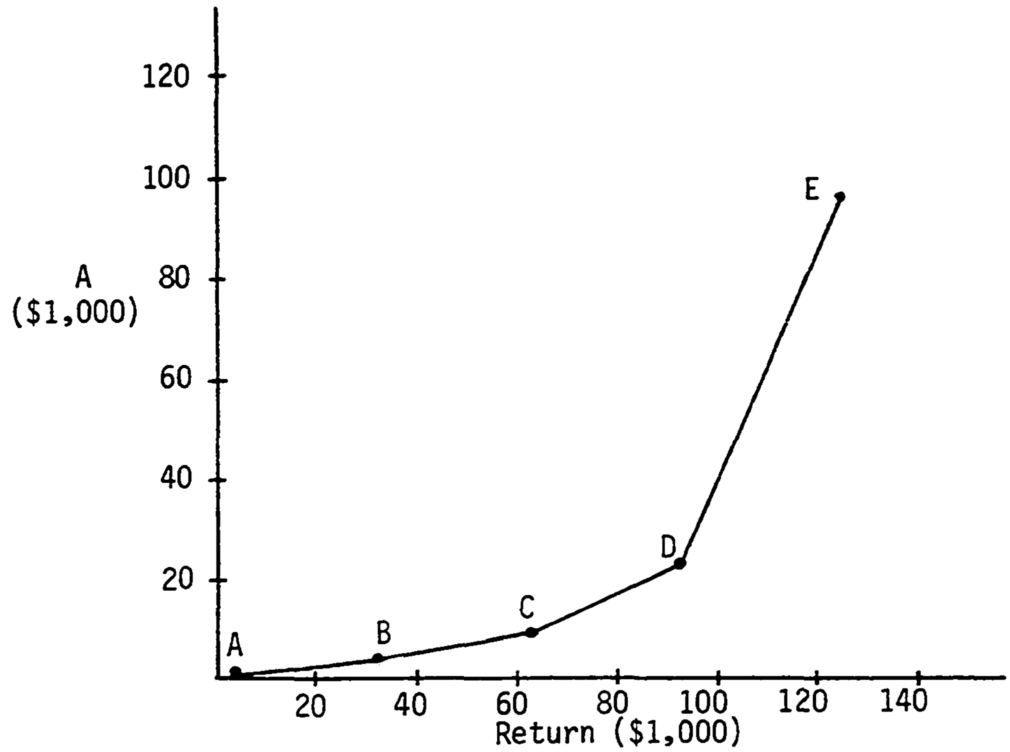
Curve VI

The sixth set of initial conditions is represented by a beginning cash or equity position of $20,000, no opportunity for the wife to work off the farm, consumption function α, availability of nonconventional loan terms, and a debt-to-equity ratio constraint of less than 1.0. This set of initial conditions is identical to Curve V except that there is no opportunity for the wife to work off the farm (see Table 5.1). One would expect Curve VI to be to the left of Curve V because there is no opportunity to earn any off-farm income.

Curve VI is shown in Figure 5.6. Consistent with expectations, this efficient frontier is convex and is to the left of Curve V. A beginning farm family with no opportunity to earn any off-farm income will have to accept more risk to reach the same return level as a farm family that has an opportunity for the wife to earn an off-farm income of $8,000 per year. Because the farm plan associated with Point E of Curve V specifies the wife to work off the farm only during year one, the farm plans specified by Point E on Curve V and Curve VI are very similar. However, the farm plans associated with Points A, B, C, and D are quite different than those specified by corresponding points on Curve V, because each point represents a much lower return level than those of corresponding points on Curve V.

Investment and Financing Plans

The investment and financing plan of each point on Curve VI is shown in Table 5.37. The investment plan of Point E specifies investment in machinery that is practically identical to the machinery



Point	Return	A
A	$ 1,918	$ 0
B	32,000	2,563
C	63,000	7,795
D	93,000	24,438
E	124,027	96,792

Figure 5.6. Efficient E,A Curve VI.

purchase at Point E of Curve V. The investment plan of Point D specifies purchasing the capital intensive crop production system and the labor intensive combine. At Point C the investment plan specifies investment in the intermediate crop production system and the labor intensive combine. At Point B there is investment in the labor

Table 5.37. Level of investment and financing activities in farm plans associated with points on Curve VI.

	Year 0	1	2	3	4	5
Point A						
Save Cash, first period ($)		17,961	14,616	11,144	7,540	3,798
Save Cash, second period ($)		16,371	12,950	9,399	5,713	1,886
Point B						
Machinery Investment and Financing:						
Labor Intensive Crop Production (unit)	0.37			0.17		
Labor Intensive Combine (unit)	0.12		0.10	0.12		
Pay Cash ($)	10,259		1,950	3,989		
Intermediate Credit ($)				1,975		
Hog Facility Investment:						
Pasture Farrowing (litter space)			1	23	5	
Partial Confinement Farrowing (litter space)	8					
Partial Confinement Feeding (hog space)	42		75	133	27	
Short-Term Loan, first period ($)		425				
Short-Term Loan, second period ($)			2,640	5,750		
Save Cash, first period ($)					13,285	26,560
Save Cash, second period ($)		5,690			2,614	20,025
Pay Principal, Intermediate 9% Loan ($)					1,098	
Pay Interest, Intermediate 9% Loan ($)					178	79
Pay Principal, Long-Term 9% Loan ($)			4,218	661	1,019	2,097
Pay Interest, Long-Term 9% Loan ($)		656	952	1,552	1,694	1,602
Point C						
Machinery Investment and Financing:						
Intermediate Crop Production (unit)	0.56					
Capital Intensive Crop Production (unit)			0.05			
Labor Intensive Combine (unit)	0.24					
Capital Intensive Combine (unit)			0.04			
Pay Cash ($)	16,091					
Intermediate Credit ($)	4,364		3,647			

Hog Facility Investment:						
Partial Confinement Farrowing (litter space)	18		3			
Partial Confinement Feeding (hog space)	81		131			
Short-Term Loan, first period ($)		14,609	548			
Short-Term Loan, second period ($)		53				
Save Cash, first period ($)					11,714	32,878
Save Cash, second period ($)			5,762	3,834	15,570	34,935
Pay Principal, Intermediate 9% Loan ($)				4,364		
Pay Interest, Intermediate 9% Loan ($)		393	393	721	328	328
Pay Principal, Long-Term 9% Loan ($)				14,659	2,233	2,434
Pay Interest, Long-Term 9% Loan ($)		1,407	2,090	2,090	771	570
<u>Point D</u>						
Machinery Investment and Financing:						
Capital Intensive Crop Production (unit)	0.46		0.27	0.04	0.02	0.16
Labor Intensive Combine (unit)	0.28		0.31		0.02	0.12
Capital Intensive Combine (unit)					0.04	
Pay Cash ($)	17,454		9,019			
Intermediate Credit ($)	9,818		9,526	1,848	2,630	9,977
Hog Facility Investment:						
Partial Confinement Farrowing (litter space)	13					7
Partial Confinement Feeding (hog space)	24		47			50
Total Confinement Feeding (hog space)			84			
Short-Term Loan, first period ($)		21,343	27,819	4,077		
Save Cash, first period ($)					16,391	23,347
Save Cash, second period ($)				16,211	37,466	85,041
Pay Principal, Intermediate 9% Loan ($)		3,602	2,348	3,867		
Pay Interest, Intermediate 9% Loan ($)		884	559	1,205	1,024	1,206
Pay Principal, Long-Term 9% Loan ($)				923	1,556	1,696
Pay Interest, Long-Term 9% Loan ($)		916	1,462	1,462	1,371	1,563
<u>Point E</u>						
Machinery Investment and Financing:						
Capital Intensive Crop Production (unit)	0.60		0.52			
Labor Intensive Combine (unit)	0.08					

Table 5.37 (continued)

	Year 0	1	2	3	4	5
Capital Intensive Combine (unit)	0.31		0.14	0.28		0.01
Pay Cash ($)	20,000					
Intermediate Credit ($)	20,000		29,061	8,672		434
Hog Facility Investment:						
Total Confinement Feeding (hog space)			25			
Short-Term Loan, first period ($)		50,000	50,000	50,000	50,000	50,000
Save Cash, second period ($)		17,670	23,551	50,927	71,787	97,727
Pay Principal, Intermediate 9% Loan ($)			17,031	1,011	1,958	
Pay Interest, Intermediate 9% Loan ($)		1,800	1,800	2,883	3,572	3,404
Pay Principal, Long-Term 9% Loan ($)					115	125
Pay Interest, Long-Term 9% Loan ($)			114	114	114	103

intensive crop production system and the labor intensive combine. At Points B, C, and D there is less machinery investment and this investment is in more labor intensive systems than at corresponding points on Curve V. However, the method of financing machinery investment is practically identical for corresponding points on both curves.

The investment plan for each point specifies investment in the same type of hog facilities that are purchased at corresponding points on Curve V, but the amount of investment and the timing of the investment are quite different. The investment plan of Point E specifies the purchase of a total confinement feeding facility in year two with space for about 25 hogs, which is 15 hog spaces smaller than the facility purchased at Point E of Curve V. As in Curve V, this facility is purchased in year two because all available debt in the initial period is used to finance machinery purchase. The investment plan of Point D specifies buying a partial confinement farrowing facility in the initial period with space for about 13 litters, which is 6 litter spaces larger than the facility purchased at Point D of Curve V. There is also investment in this facility in year five with space for about 17 litters. Point D also specifies investment in a partial confinement feeding facility in the initial period with space for about 24 hogs, which is 11 hog spaces larger than the facility purchased at Point D of Curve V. There is also investment in this facility in year two with space for about 47 hogs, and in year five with space for about 50 hogs. Also at Point D, there is investment in a total confinement feeding facility in year two with space for about 84 hogs, which is about

28 hog spaces smaller than the facility purchased at Point D of Curve V. The investment plan of Point C specifies purchasing a partial confinement farrowing facility in the initial period with space for about 18 litters, which is about 2 litters larger than the facility purchased at Point C of Curve V. There is also investment in this facility in year two with space for about 3 litters. At Point C there is also investment in a partial confinement feeding facility in the initial period with space for about 81 hogs, and in year two with space for about 131 hogs; this is 43 hog spaces smaller in the initial period and 92 hog spaces larger in year two than the facility purchased at Point C of Curve V. The investment plan of Point B specifies the purchase of pasture farrowing facilities in year two with space for 1 litter, in year three with space for 23 litters, and in year four with space for 5 litters, while at Point B of Curve V these facilities were purchased in the initial period with space for about 12 litters and in year two with space for about 17 litters. The investment plan of Point B also specifies buying a partial confinement farrowing facility in the initial period with space for about 8 litters, which is 6 litter spaces larger than the facility purchased at Point B of Curve V. Also at Point B, there is investment in a partial confinement feeding facility in the initial period with space for about 42 hogs, in year two with space for about 75 hogs, in year three with space for about 133 hogs, and in year four with space for about 27 hogs; these purchases are 70 hog spaces smaller in the initial period, 54 hogs spaces smaller in year two, 133 hog spaces larger in year three, and 25 hog

spaces larger in year four than the facilities purchased at Point B of Curve V.

As in all previous curves, each of these hog facility investments is financed using repayment plan D, which is the Standard plan with deferred principal payments. However, there is much less prepayment of this long-term debt at each point than at corresponding points on Curve V.

Also as in all previous curves, the financing plan of the conventional linear programming solution specifies the use of a short-term operating loan of $50,000 in the first period of each year. At lower return-risk points there is more use of short-term operating loans than at corresponding points on Curve V. Also, at each point on Curve VI there is less cash saved in most periods than at corresponding points on Curve V.

Production Plans

The production plan associated with each point on Curve VI is shown in Table 5.38. As in all previous curves, the production plan associated with the conventional linear programming solution specifies cash renting land and crop-share renting land. The amount of land cash rented in each year is less than the amount cash rented at Point E of Curve V. This cash rented land is used to raise corn and soybeans grown by a custom operator. The amount of land crop-share rented in each year of Point E is about the same as the amount crop-share rented at Point E of Curve V. As in all previous curves, all the land farmed in each year at Points B C, and D is crop-share rented. The amount of

Table 5.38. Level of production activities in farm plans associated with points on Curve VI.

	Year 1	2	3	4	5
Point B					
Crop-Share Rented Land:					
Continuous Corn (acres)	22.74	150.74	238.20	238.20	2.88
Corn-Soybean-Oats Rotation (acres)	140.71	12.12			
Pasture Farrowing (litters)		2.80	48.20	57.54	28.77
Partial Confinement Farrowing (litters)	48.54	48.54	48.54	19.10	
Place Feeder Pigs on Feed:					
Partial Confinement, third quarter (pigs)	16.49	43.29	17.22	11.71	
Partial Confinement, fourth quarter (pigs)	26.01	74.53	233.41	266.09	
Point C					
Crop-Share Rented Land:					
Continuous Corn (acres)	20.62	153.33	153.33	153.33	
Corn-Soybean Rotation (acres)	24.50				
Corn-Soybean-Oats Rotation (acres)	249.54	176.46	176.46	176.46	55.59
Partial Confinement Farrowing (litters)	107.58	128.04	128.04	128.04	63.68
Place Feeder Pigs On Feed:					
Partial Confinement, third quarter (pigs)	45.65	39.21	39.21	39.21	
Partial Confinement, fourth quarter (pigs)	35.40	173.11	173.11	173.11	
Point D					
Crop-Share Rented Land:					
Continuous Corn (acres)	86.74	14.37	40.98		
Corn-Soybean Rotation (acres)	228.28	481.50	481.50	536.78	595.70
Corn-Soybean-Oats Rotation (acres)					52.71
Partial Confinement Farrowing (litters)	79.68	79.68	79.68	79.68	39.84

Place Feeder Pigs on Feed:					
Partial Confinement, first quarter (pigs)	24.27	71.44	7.59		49.57
Partial Confinement, third quarter (pigs)	24.27	7.59			
Partial Confinement, fourth quarter (pigs)		63.85	71.44	71.44	
Total Confinement, first quarter (pigs)		84.23	84.23	49.44	49.44
Total Confinement, third quarter (pigs)		84.23	49.44		
Total Confinement, fourth quarter (pigs)			34.79	34.79	
Point E					
Crop-Share Rented Land:					
Continuous Corn (acres)	59.05	276.02	2.77		
Corn-Soybean Rotation (acres)	358.04	494.78	758.52	761.10	759.98
Cash Rented Land:					
Custom Grow Corn (acres)	171.84	50.88	187.10	295.08	415.11
Custom Grow Corn-Soybean Rotation (acres)					14.32
Custom Harvest Corn (acres)				105.33	226.13
Harvest Corn (acres)	171.84	50.88	187.10	189.75	196.14
Harvest Soybeans (acres)					7.16
Place Feeder Pigs on Feed:					
Total Confinement, first quarter (pigs)		25.22	25.22	25.22	25.22
Total Confinement, third quarter (pigs)		25.22	25.22	21.14	

land crop-share rented during each year at Points B, C, and D is more than the amount crop-share rented at corresponding points on Curve V. At each point this crop-share rented land is used to produce corn, soybeans, and oats, with the acreages of the various crop rotations given in Table 5.38.

The hog facilities acquired by the investment plan of each point are utilized in hog farrowing and feeding activities which are similar to those specified by corresponding points on Curve V. The production plan of Point E specifies that the total confinement feeding facility be used to capacity all of years two and three, and in the first and second quarters of years four and five by putting 25 feeder pigs on feed in the first quarter of years two through five and in the third quarter of years two and three. This facility is also partially used in the third and fourth quarters of year four to feed 21 hogs. At Point D the partial confinement farrowing facility is used to capacity to farrow about 80 litters in years one through four and about 40 litters in year five. As at Point D of Curve V, the partial confinement feeding facility is used to capacity in the first quarter of each year, the second quarter of years one and two, the third quarter of year one, and the fourth quarter of years one through four. Also at Point D the total confinement feeding facility is used to capacity in the first quarter of years two through five, the second quarter of years two and three, the third quarter of year two, and the fourth quarter of years two through four.

The production plan of Point C specifies that the partial confinement feeding facility be used to capacity to farrow about 108 litters in year one, about 128 litters in years two through four, and about 64 litters in year five. At Point B the pasture farrowing facilities are used to farrow about 3 litters in year two, about 48 litters in year three, about 58 litters in year four, and about 29 litters in year five. Also at Point B, the partial confinement feeding facility is used to farrow about 49 litters in years one through three and about 19 litters in year four. As in all previous curves, the production plans of Points B and C specify that the partial confinement feeding facility be used to capacity in the third and fourth quarters of years one through four. Feeder pigs are put on feed in the third quarter of each year to provide the replacement gilts for the next year's farrowing operation. The remaining capacity is then used to put feeder pigs on feed in the fourth quarter of each year.

Marketing Plans

The plan associated with each point on Curve VI for marketing and buying agricultural products is shown in Table 5.39. These plans are very similar to those associated with corresponding points on Curve V, given the differences in the levels of production activities. One major difference is that at Point D a greater percentage of the corn available for sale at harvest of years one through four is stored until the first period of the next year than at Point D of Curve V.

Table 5.39. Marketing and buying plans for agricultural products associated with points on Curve VI.

	Year 1	2	3	4	5
Point B					
Sell Corn, first period (bu.)		2,177	5,533	8,511	8,889
Sell Soybeans, second period (bu.)	817	71			
Sell Oats, second period (bu.)	1,752	151			
Sell Hogs, second quarter (cwt.)		56	159	498	568
Sell Sows, first quarter (cwt.)		11	11	11	1
Sell Sows, fourth quarter (cwt.)	21	15			
Sell Feeder Pigs, first quarter (pigs)	65	129	129	71	6
Sell Feeder Pigs, second quarter (pigs)	65	75	233	267	201
Sell Feeder Pigs, third quarter (pigs)	113	86	112		
Sell Feeder Pigs, fourth quarter (pigs)	39				
Store Corn, second period (bu.)	2,937	7,104	10,601	10,742	
Buy Corn, first period (bu.)	599				
Buy Gilts (head)	29				
Replacement Gilts (head)		16	42	17	11
Point C					
Sell Corn, first period (bu.)		2,686	6,450	6,450	7,246
Sell Corn, second period (bu.)					231
Sell Soybeans, second period (bu.)	1,670	1,029	1,029	1,029	324
Sell Oats, second period (bu.)	3,119	2,206	2,206	2,206	695
Sell Hogs, first quarter (cwt.)					84
Sell Hogs, second quarter (cwt.)		76	369	369	369
Sell Sows, first quarter (cwt.)		23	28	28	28
Sell Sows, fourth quarter (cwt.)	47	56	56	56	35
Sell Feeder Pigs, first quarter (pigs)	143	314	341	341	213
Sell Feeder Pigs, second quarter (pigs)	143	173	173	173	173
Sell Feeder Pigs, third quarter (pigs)	241	302	302	302	84
Sell Feeder Pigs, fourth quarter (pigs)	108				171
Store Corn, second period (bu.)	4,446	8,871	8,871	8,871	
Buy Corn, first period (bu.)	1,329				

Buy Gilts (head)	64				
Replacement Gilts (head)		44	38	38	
<u>Point D</u>					
Sell Corn, first period (bu.)		3,311	8,946	11,598	11,335
Sell Corn, second period (bu.)	4,067	793			16,851
Sell Soybeans, second period (bu.)	1,997	4,213	4,213	4,697	5,520
Sell Oats, second period (bu.)					659
Sell Hogs, first quarter (cwt.)			144	54	
Sell Hogs, second quarter (cwt.)			136	227	227
Sell Hogs, third quarter (cwt.)		332	196	106	211
Sell Sows, first quarter (cwt.)		17	17	17	17
Sell Sows, fourth quarter (cwt.)	35	35	35	35	26
Sell Feeder Pigs, first quarter (pigs)	82	57	121	163	7
Sell Feeder Pigs, second quarter (pigs)	106	106	106	106	153
Sell Feeder Pigs, third quarter (pigs)	188	121	163	212	
Sell Feeder Pigs, fourth quarter (pigs)	106	42			153
Store Corn, second period (bu.)	5,765	11,092	13,546	13,273	
Buy Corn, first period (bu.)	1,217				
Buy Gilts (head)	47				
Replacement Gilts (head)		24	24	24	
<u>Point E</u>					
Sell Corn, first period (bu.)			1,360		
Sell Corn, second period (bu.)	31,995	32,555	41,123	52,034	64,862
Sell Soybeans, second period (bu.)	3,133	4,329	6,637	6,660	6,901
Sell Hogs, first quarter (cwt.)			54	54	45
Sell Hogs, third quarter (cwt.)		54	54	54	54
Store Corn, second period (bu.)		1,595	235		
Buy Corn, first period (bu.)		235			235
Buy Feeder Pigs, first quarter (pigs)		25	25	25	25
Buy Feeder Pigs, third quarter (pigs)		25	25	21	

Resource Control, Debt Use, and Net Worth

The yearly balance sheets and the value of resources controlled in each year for each point on Curve VI are given in Table 5.40. As in all previous curves, the conventional linear programming solution specifies the highest debt use, the highest level of asset ownership, and the highest level of resources controlled. Moving down this efficient frontier to lower return-risk points results in less debt use, less asset ownership, and less resource control in each year at each successive point.

The absence of the off-farm income earned by the wife at each point on Curve VI causes some differences in the balance sheets when compared to corresponding points on Curve V. The farm plans specified by the conventional linear programming solution of both curves are similar, and this is reflected in similar balance sheets. Both points specify approximately the same level of intermediate and long-term asset ownership and the same amount of intermediate and long-term debt use. But Point E on Curve VI has less total asset ownership in each year primarily because there is less cash available to save. This also causes the net worth at the end of each year of Point E to be less than net worth of each year of Point E of Curve V.

Point D specifies more debt use, a higher level of asset ownership, and a higher level of resource control in each year than at Point D of Curve V. However, the net worth at the end of each year of Point D is less than at Point D of Curve V. At Point C there is more debt use after year one, a higher level of asset ownership after year one, and

Table 5.40. Yearly balance sheets associated with points on Curve VI.

	Year					
	0	1	2	3	4	5
			(dollars)			
Point A						
Assets						
Current	20,000	16,780	13,274	9,634	5,856	1,934
Liabilities						
Current	0	133	107	80	51	22
Net Worth	20,000	16,647	13,167	9,554	5,805	1,912
Point B						
Assets						
Current	7,920	14,563	20,375	30,692	33,735	21,645
Intermediate	10,259	9,233	9,962	14,109	12,292	10,475
Long-Term	9,107	8,221	11,042	21,845	21,521	18,406
Total	27,286	32,017	41,379	66,646	67,548	50,526
Liabilities						
Current	0	0	2,640	6,370	3,395	8,684
Intermediate	0	0	0	1,975	877	877
Long-Term	7,286	7,286	6,364	16,585	17,799	15,702
Total	7,286	7,286	9,004	24,930	22,071	25,263
Net Worth	20,000	24,731	32,375	41,716	45,477	25,263
Assets Controlled	27,286	195,017	204,379	304,646	305,548	53,526
Point C						
Assets						
Current	0	15,215	33,662	31,685	43,714	37,060
Intermediate	20,455	18,410	19,647	17,237	14,826	12,416
Long-Term	19,545	17,643	24,298	21,470	18,642	15,814
Total	40,000	51,268	77,607	70,392	77,182	65,290
Liabilities						
Current	0	53	1,795	6,337	7,170	11,790
Intermediate	4,364	4,364	8,012	3,647	3,647	3,647
Long-Term	15,636	15,636	23,222	8,563	6,330	3,896
Total	20,000	20,053	33,029	18,547	17,147	19,333
Net Worth	20,000	31,215	44,578	51,845	60,035	45,957
Assets Controlled	40,000	346,268	407,607	400,392	407,182	121,290

Table 5.40 (continued)

	Year 0	1	2	3	4	5
	(dollars)					
Point D						
Assets						
Current	0	14,939	32,116	51,875	69,669	87,943
Intermediate	27,272	24,545	38,508	35,589	35,189	37,139
Long-Term	12,928	11,490	17,077	15,084	13,092	15,112
Total	40,000	50,974	87,701	102,548	115,950	140,194
Liabilities						
Current	0	620	3,451	8,530	12,140	30,444
Intermediate	9,818	6,215	13,392	11,373	14,003	23,980
Long-Term	10,182	10,182	16,246	15,323	13,767	15,673
Total	20,000	17,017	33,089	35,226	39,910	70,097
Net Worth	20,000	33,957	54,612	67,322	76,040	70,097
Assets Controlled	40,000	365,974	583,701	624,548	652,950	788,194
Point E						
Assets						
Current	0	18,112	29,130	54,430	75,051	100,170
Intermediate	40,000	36,000	58,155	59,054	51,357	43,966
Long-Term	0	0	1,421	1,262	1,104	945
Total	40,000	54,112	88,706	114,746	127,512	145,081
Liabilities						
Current	0	6,577	11,060	16,418	16,261	18,060
Intermediate	20,000	20,000	32,029	39,691	37,818	38,253
Long-Term	0	0	1,264	1,264	1,149	1,024
Total	20,000	26,577	44,353	57,373	55,228	57,337
Net Worth	20,000	27,535	44,353	57,373	72,284	87,744
Assets Controlled	40,000	633,112	910,706	1062,746	1183,512	1334,081

more resource control except year five, than at Point C of Curve V. However, there is also less net worth at the end of each year than at Point C of Curve V. Point B also specifies more debt use after year two and a higher level of asset ownership after year two than at Point B of Curve V. However, Point B also has less net worth at the end of each year than at Point B of Curve V.

The leverage and liquidity ratios for each year for each point on Curve VI are given in Table 5.41. The debt-to-equity ratio in this set of initial conditions was constrained to be less than 1.0 and this constraint was reached several times. In most cases, except for Point A, the debt-to-equity ratio is higher than the corresponding ratio associated with Curve V. Even though each point on Curve VI represents a lower return level, each point uses relatively more debt than corresponding points on Curve V. This occurs because points on Curve VI do not have any cash income earned from off-farm employment.

The lowest current ratio is 2.49 which occurs at the end of year five of Point B. In all cases the beginning farmer has a good liquidity position. In most cases, except for Point E, the current ratios are higher than corresponding ratios of Curve V.

The yearly growth rates in net worth for each point on Curve VI are also given in Table 5.41. The farm plan associated with Point E results in the greatest growth in net worth with an average growth per year of 35.1 percent. Moving down the efficient frontier to lower return-risk points results in less growth in net worth. The farm plan of Point D generates an average growth in net worth per year of 31.8

Table 5.41. Leverage and liquidity ratios, and growth in net worth for points on Curve VI.

Year	Point A	Point B	Point C	Point D	Point E
Debt-to-Equity Ratio					
0	0.00	0.36	1.00	1.00	1.00
1	0.01	0.30	0.64	0.50	0.97
2	0.01	0.28	0.74	0.61	1.00
3	0.01	0.60	0.36	0.52	1.00
4	0.01	0.49	0.29	0.52	0.76
5	0.01	1.00	0.42	1.00	0.65
Current Ratio					
0	--	--	--	--	--
1	126.17	--	287.08	24.10	2.75
2	124.06	7.72	18.75	9.31	2.63
3	120.42	4.82	5.00	6.08	3.32
4	114.82	9.94	6.10	5.74	4.62
5	87.91	2.49	3.14	2.89	5.55
Growth in Net Worth During Year					
1	-16.8%	23.7%	56.1%	69.8%	37.7%
2	-20.9	30.9	42.8	60.8	61.1
3	-27.4	28.8	16.3	23.3	29.4
4	-39.3	9.0	15.6	12.9	26.0
5	-67.1	-44.4	-23.4	-7.8	21.4
Average Growth Per Year					
	-34.3%	9.6%	21.5%	31.8%	35.1%
Average Growth Per Year During First Four Years					
	-26.1%	23.1%	32.7%	41.7%	38.6%

percent, Point C has an average growth per year of 21.5 percent, and Point B has an average growth per year of 9.6 percent. Point A, where no agricultural production occurs, has an average growth in net worth per year of -34.3 percent. At Point A the only income is earned from saving cash and this produces very little return. In order to meet the minimum consumption of $4,000 per year it is necessary to use up the beginning cash of $20,000 over the five year period. The average growth per year in net worth for points on Curve VI are lower than the average growth per year in net worth for corresponding points on Curve V.

Income and Consumption

The undiscounted expected disposable income, the resulting consumption, and the variance of income in each year for each point of Curve VI are shown in Table 5.42. The disposable income and consumption each year for each point is lower than the disposable income and consumption in each year of corresponding points on Curve V. The probability of disposable income being less than zero, $4,000, and $8,000 in each year for each point on Curve VI is given in Table 5.43. These probabilities are higher in most years for each point than at corresponding points on Curve V. As in all previous curves, the farm plan associated with the conventional linear programming solution results in the highest probability of the beginning farm failing. However, with this set of initial conditions there is also a small probability of failure at Points B, C, and D. A beginning farm family with no opportunity to earn any off-farm income will have a much greater chance of

Table 5.42. Expected disposable income, variance, and consumption in each year for each point on Curve VI.

Point	Year	Disposable Income	Variance	Standard Deviation	Consumption
A	1	$ 725	0	0	$ 4,078
	2	582	0	0	4,063
	3	434	0	0	4,047
	4	280	0	0	4,030
	5	120	0	0	4,013
B	1	0	$ 3,374,352	$ 1,837	4,000
	2	0	735,261	857	4,000
	3	3,380	1,313,653	1,146	4,363
	4	13,088	930,022	964	9,691
	5	23,373	903,883	951	13,651
C	1	0	16,796,503	4,098	4,000
	2	8,092	12,179,854	3,490	7,269
	3	19,543	14,030,326	3,746	12,278
	4	21,009	14,030,326	3,746	12,818
	5	27,433	9,221,936	3,037	15,008
D	1	3,380	36,650,738	6,054	4,363
	2	13,231	58,631,848	7,657	9,752
	3	23,137	55,136,105	7,425	13,568
	4	27,860	62,318,652	7,894	15,150
	5	44,508	447,165,734	21,146	19,926
E	1	19,970	643,803,822	25,373	12,435
	2	26,540	824,535,183	28,715	14,712
	3	32,300	1,438,495,751	37,928	16,518
	4	32,141	2,081,819,165	45,627	16,470
	5	33,940	3,020,781,354	54,962	17,010

Table 5.43. Probability of disposable income falling below certain levels in each year for each point on Curve VI.

Point	Year	$P(\mu_I < 0)$	$P(\mu_I < \$4000)$	$P(\mu_I < \$8000)$
A	1	0.0	1.0	1.0
	2	0.0	1.0	1.0
	3	0.0	1.0	1.0
	4	0.0	1.0	1.0
	5	0.0	1.0	1.0
B	1	0.5	0.9854	1.0
	2	0.5	1.0	1.0
	3	0.0016	0.7054	1.0
	4	0.0	0.0	0.0
	5	0.0	0.0	0.0
C	1	0.5	0.8365	0.9744
	2	0.0179	0.1210	0.4880
	3	0.0	0.0	0.0
	4	0.0	0.0	0.0
	5	0.0	0.0	0.0
D	1	0.2877	0.5398	0.7764
	2	0.0418	0.1131	0.2483
	3	0.0	0.0049	0.0207
	4	0.0	0.0	0.0059
	5	0.0174	0.0274	0.0418
E	1	0.2148	0.2643	0.3192
	2	0.1788	0.2177	0.2578
	3	0.1977	0.2266	0.2611
	4	0.2420	0.2676	0.2981
	5	0.2676	0.2946	0.3192

failure, at lower return-risk points, than a farm family with an opportunity to earn off-farm income.

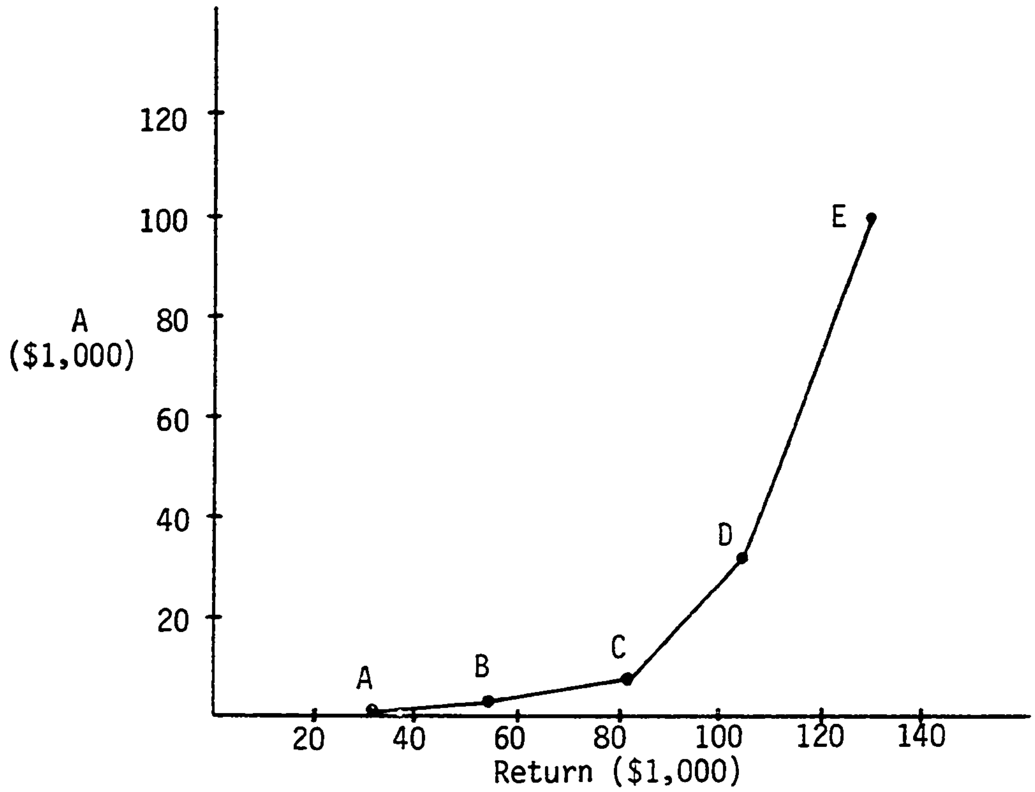
Curve VII

The seventh set of initial conditions represents a beginning cash or equity position of $20,000, an opportunity for the wife to work off the farm, consumption function α, availability of only conventional loan terms, and a debt-to-equity ratio constraint of less than 1.0. This set of initial conditions is identical to Curve V except that only conventional loan terms are available (see Table 5.1). Since nonconventional loan terms are specified by the farm plan of each point on Curve V, except Point A, one would expect Curve VII to be to the left of Curve V for return levels above $32,387.

Curve VII is shown in Figure 5.7. As all previous curves, this efficient frontier is convex. Also as expected, Curve VII is slightly to the left of Curve V at return levels about $32,387. A beginning farmer with no opportunity to use nonconventional loan terms will have to accept slightly more risk than a beginning farmer who has an opportunity to use nonconventional loan terms to reach the same return level.

Investment and Financing Plans

The investment and financing plan associated with each point on Curve VII is shown in Table 5.44. Each of these investment and financing plans is practically identical to that specified by corresponding points on Curve V. The only difference is that hog facilities purchased by Points B, C, D, and E of Curve VII are financed using repayment plan C, which is the Standard plan, while the hog facilities



Point	Return	A
A	$ 32,387	$ 0
B	57,000	1,619
C	81,000	6,924
D	106,000	25,946
E	130,181	100,373

Figure 5.7. Efficient E,A Curve VII.

purchased by corresponding points on Curve V are financed using repayment plan D, which is the Standard plan with deferred principal payments. Since repayment plan D is a nonconventional loan it is not available to farm plans associated with points on Curve VII.

Table 5.44. Level of investment and financing activities in farm plans associated with points on Curve VII.

	Year 0	1	2	3	4	5
Point A						
Save Cash, first period ($)		20,538	21,051	21,573	22,105	22,646
Save Cash, second period ($)		21,590	22,110	22,640	23,179	23,729
Point B						
Machinery Investment and Financing:						
Labor Intensive Crop Production (unit)	0.34		0.11			
Intermediate Crop Production (unit)			0.03			
Capital Intensive Combine (unit)	0.10		0.09			
Pay Cash ($)	10,506		6,038			
Hog Facility Investment:						
Pasture Farrowing (litter space)	12		17		1	
Partial Confinement Farrowing (litter space)	2					
Partial Confinement Feeding (hog space)	112		129		2	
Short-Term Loan, second period ($)			4,481			
Save Cash, first period ($)				7,202	16,096	31,697
Save Cash, second period ($)		2,235		126	9,161	28,235
Pay Principal, Long-Term 9% Loan ($)		3,227	3,555	9,508	2,057	
Pay Interest, Long-Term 9% Loan ($)		791	1,333	1,014	185	
Point C						
Machinery Investment and Financing:						
Intermediate Crop Production (unit)	0.31					
Capital Intensive Crop Production (unit)	0.14					
Labor Intensive Combine (unit)	0.04					
Capital Intensive Combine (unit)	0.11					
Pay Cash ($)	15,950					
Intermediate Credit ($)	3,799					
Hog Facility Investment:						
Partial Confinement Farrowing (litter space)	16					
Partial Confinement Feeding (hog space)	124		39			

Short-Term Loan, first period ($)		11,563	6,484			
Save Cash, first period ($)				7,376	18,662	33,336
Save Cash, second period ($)		1,680	140	13,684	25,380	46,087
Pay Principal, Intermediate 9% Loan ($)			3,799			
Pay Interest, Intermediate 9% Loan ($)		342	342			
Pay Principal, Long-Term 9% Loan ($)		1,469	12,603	1,922	2,105	
Pay Interest, Long-Term 9% Loan ($)		1,458	1,486	352	189	
<u>Point D</u>						
Machinery Investment and Financing:						
Capital Intensive Crop Production (unit)	0.56		0.04	0.01	0.05	0.09
Labor Intensive Combine (unit)	0.34		0.05	0.05	0.04	0.16
Pay Cash ($)	18,656					
Intermediate Credit ($)	14,623		2,969	1,381	2,923	7,258
Hog Facility Investment:						
Partial Confinement Farrowing (litter space)	7					1
Partial Confinement Feeding (hog space)	13					
Total Confinement Feeding (hog space)			112			
Short-Term Loan, first period ($)		28,862	22,799			
Save Cash, first period ($)					17,924	33,245
Save Cash, second period ($)			6,241	22,522	42,393	83,717
Pay Principal, Intermediate 9% Loan ($)		10,137	4,486			
Pay Interest, Intermediate 9% Loan ($)		1,316	404	267	391	655
Pay Principal, Long-Term 9% Loan ($)		1,703	1,041	1,135	1,237	1,366
Pay Interest, Long-Term 9% Loan ($)		484	837	743	641	547
<u>Point E</u>						
Machinery Investment and Financing:						
Capital Intensive Crop Production (unit)	0.60		0.50	0.01		0.01
Labor Intensive Combine (unit)	0.07					
Capital Intensive Combine (unit)	0.32		0.17	0.24	0.02	
Pay Cash ($)	20,000					
Intermediate Credit ($)	20,000		28,914	7,814	577	286
Hog Facility Investment:						
Total Confinement Feeding (hog space)			40			

Table 5.44 (continued)

	Year					
	0	1	2	3	4	5
Short-Term Loan, first period ($)		50,000	50,000	50,000	50,000	50,000
Save Cash, second period ($)		24,268	29,731	55,736	76,142	101,294
Pay Principal, Intermediate 9% Loan ($)			15,742		4,258	
Pay Interest, Intermediate 9% Loan ($)		1,800	1,800	2,985	3,689	3,357
Pay Principal, Long-Term 9% Loan ($)			180	197	214	233
Pay Interest, Long-Term 9% Loan ($)			179	163	145	126

Production Plans

The production plan associated with each point on Curve VII is shown in Table 5.45. These plans are almost identical to the plans associated with corresponding points on Curve V.

Marketing Plans

The plan associated with each point on Curve VII for marketing and buying agricultural products is shown in Table 5.46. These plans are also almost identical to the plan associated with corresponding points on Curve V.

Resource Control, Debt Use, and Net Worth

The yearly balance sheets and the value of resources controlled in each year for each point on Curve VII are given in Table 5.47. Since the farm plan associated with each point is so similar to that specified by corresponding points on Curve V, the yearly balance sheets and resources controlled at each point on Curve VII are also practically identical to those of corresponding points on Curve V.

Likewise, the leverage and liquidity ratios for each year for each point on Curve VII, shown in Table 5.48, are practically identical to those of corresponding points on Curve V. Also, the average growth in net worth per year for each point is practically the same as that of corresponding points on Curve V.

Income and Consumption

The undiscounted expected disposable income, the resulting consumption, and the variance of income in each year for each point on Curve VII are shown in Table 5.49. The pattern of disposable income,

Table 5.45. Level of production activities in farm plans associated with points on Curve VII.

	Year 1	2	3	4	5
Point A					
Wife Work Off-Farm	1.00	1.00	1.00	1.00	1.00
Point B					
Wife Work Off-Farm	1.00	1.00	1.00	1.00	1.00
Crop-Share Rented Land:					
Continuous Corn (acres)	99.91	214.43	214.43	211.33	3.02
Corn-Soybean-Oats Rotation (acres)				2.85	
Pasture Farrowing (litters)	24.80	58.50	58.48	60.36	30.18
Partial Confinement Farrowing (litters)	11.28	9.00	9.00	7.76	
Place Feeder Pigs on Feed:					
Partial Confinement, third quarter (pigs)	30.12	20.56	20.94	16.02	
Partial Confinement, fourth quarter (pigs)	81.58	219.82	219.65	226.29	
Point C					
Wife Work Off-Farm	1.00	1.00	1.00	1.00	1.00
Crop-Share Rented Land:					
Continuous Corn (acres)	59.69	102.63	102.63	99.44	
Corn-Soybean Rotation (acres)	19.06				
Corn-Soybean-Oats Rotation (acres)	180.45	159.69	159.66	162.87	132.45
Partial Confinement Farrowing (litters)	97.86	99.90	99.90	99.36	90.74
Place Feeder Pigs on Feed:					
Partial Confinement, third quarter (pigs)	31.07	30.43	30.69	25.28	
Partial Confinement, fourth quarter (pigs)	93.35	133.29	133.18	138.58	
Point D					
Wife Work Off-Farm	1.00	1.00	1.00	1.00	1.00
Crop-Share Rented Land:					
Continuous Corn (acres)	105.84	98.45	65.37	67.38	
Corn-Soybean Rotation (acres)	278.56	315.98	355.48	385.38	513.64

Partial Confinement Farrowing (litters)	42.06	42.06	41.64	31.28	15.62
Place Feeder Pigs on Feed:					
Partial Confinement, first quarter (pigs)	12.82	12.82			
Partial Confinement, third quarter (pigs)	12.82				
Partial Confinement, fourth quarter (pigs)		12.82	12.82	12.82	
Total Confinement, first quarter (pigs)		112.20	112.20	110.33	68.91
Total Confinement, third quarter (pigs)		112.20	110.33	68.91	
Total Confinement, fourth quarter (pigs)			1.86	43.28	
<u>Point E</u>					
Wife Work Off-Farm	1.00				
Crop Share Rented Land:					
Continuous Corn (acres)	45.77	222.42			
Corn-Soybean Rotation (acres)	365.14	527.82	755.14	755.14	754.40
Cash Rented Land:					
Custom Grow Corn (acres)	191.68	77.56	211.22	295.78	418.14
Custom Grow Corn-Soybean Rotation (acres)				17.54	26.96
Custom Harvest Corn (acres)			24.11	109.31	232.18
Harvest Corn (acres)	191.68	77.56	187.11	195.24	199.44
Harvest Soybeans (acres)				8.77	13.48
Place Feeder Pigs on Feed:					
Total Confinement, first quarter (pigs)		39.70	39.70	39.70	39.70
Total Confinement, third quarter (pigs)		39.70	39.70	13.91	

Table 5.46. Marketing and buying plans for agricultural products associated with points on Curve VII.

	Year 1	2	3	4	5
Point B					
Sell Corn, first period (bu.)		3,997	7,772	7,762	7,880
Sell Soybeans, second period (bu.)	282			17	
Sell Oats, second period (bu.)	605			36	
Sell Hogs, second quarter (cwt.)		174	469	469	483
Sell Sows, first quarter (cwt.)		2	2	2	1
Sell Sows, fourth quarter (cwt.)	21				
Sell Feeder Pigs, first quarter (pigs)	15	26	21	18	8
Sell Feeder Pigs, second quarter (pigs)	102	220	220	226	211
Sell Feeder Pigs, fourth quarter (pigs)	20				
Store Corn, second period (bu.)	5,246	9,684	9,681	9,570	
Buy Corn, first period (bu.)	461				
Buy Gilts (head)	21				
Replacement Gilts (head)		29	20	20	15
Point C					
Sell Corn, first period (bu.)		3,439	4,533	4,526	4,513
Sell Corn, second period (bu.)	39				1,302
Sell Soybeans, second period (bu.)	1,219	931	932	950	773
Sell Oats, first period (bu.)				16	
Sell Oats, second period (bu.)	2,255	1,996	1,980	2,036	1,656
Sell Hogs, second quarter (cwt.)		199	284	284	296
Sell Sows, first quarter (cwt.)		21	22	22	21
Sell Sows, fourth quarter (cwt.)	42	43	43	44	41
Sell Feeder Pigs, first quarter (pigs)	130	264	266	265	247
Sell Feeder Pigs, second quarter (pigs)	130	133	133	136	136
Sell Feeder Pigs, third quarter (pigs)	230	236	236	239	230
Sell Feeder Pigs, fourth quarter (pigs)	37			2	133
Store Corn, second period (bu.)	5,121	6,406	6,405	6,308	
Store Oats, second period (bu.)			16		

Buy Corn, first period (bu.)	1,217				
Buy Gilts (head)	58				
Replacement Gilts (head)		30	30	30	25
<u>Point D</u>					
Sell Corn, first period (bu.)		2,694	5,127	8,182	8,871
Sell Corn, second period (bu.)	8,459	5,734	2,096	3,046	13,931
Sell Soybeans, second period (bu.)	2,437	2,765	3,111	3,372	4,494
Sell Hogs, first quarter (cwt.)			213	222	147
Sell Hogs, second quarter (cwt.)			27	31	120
Sell Hogs, third quarter (cwt.)	27	227	239	235	147
Sell Sows, first quarter (cwt.)		9	9	9	6
Sell Sows, fourth quarter (cwt.)	18	18	18	15	10
Sell Feeder Pigs, first quarter (pigs)	43				
Sell Feeder Pigs, second quarter (pigs)	56	56	56	56	62
Sell Feeder Pigs, third quarter (pigs)	99				
Sell Feeder Pigs, fourth quarter (pigs)	56	43	41		62
Store Corn, second period (bu.)	4,380	6,746	9,665	9,968	
Buy Corn, first period (bu.)	643				
Buy Feeder Pigs, first quarter (pigs)		13	1	21	34
Buy Gilts (head)	25				
Replacement Gilts (head)		12	12	6	
<u>Point E</u>					
Sell Corn, second period (bu.)	33,644	34,542	43,366	52,935	65,670
Sell Soybeans, second period (bu.)	3,195	4,619	6,607	6,914	7,073
Sell Hogs, first quarter (cwt.)			85	85	30
Sell Hogs, third quarter (cwt.)		85	85	85	85
Store Corn, second period (bu.)		369			
Buy Corn, first period (bu.)		369		369	369
Buy Feeder Pigs, first quarter (pigs)		40	40	40	40
Buy Feeder Pigs, third quarter (pigs)		40	40	14	

Table 5.47. Yearly balance sheets associated with points on Curve VII.

	Year					
	0	1	2	3	4	5
	(dollars)					
Point A						
Assets						
Current	20,000	22,130	22,663	23,206	23,759	24,322
Liabilities						
Current	0	1,612	1,617	1,623	1,629	1,635
Net Worth	20,000	20,518	21,046	21,583	22,130	22,687
Point B						
Assets						
Current	7,298	17,865	28,138	28,284	37,162	30,116
Intermediate	10,506	9,455	13,838	12,184	10,530	8,875
Long-Term	10,985	9,816	18,957	16,535	14,433	14,594
Total	28,789	37,136	60,933	57,003	62,125	53,585
Liabilities						
Current	0	0	5,672	5,247	5,820	11,605
Intermediate	0	0	0	0	0	0
Long-Term	8,789	5,558	11,257	1,757	0	0
Total	8,789	5,558	16,929	7,004	5,820	11,605
Net Worth	20,000	31,578	44,004	49,999	56,305	41,980
Assets						
Controlled	28,789	185,136	274,933	271,003	276,125	56,585
Point C						
Assets						
Current	0	18,618	20,687	34,600	46,147	49,023
Intermediate	19,749	17,774	15,994	13,998	12,001	10,005
Long-Term	20,251	18,280	18,314	16,133	14,070	14,563
Total	40,000	54,672	54,995	64,731	72,218	73,591
Liabilities						
Current	0	553	5,522	8,055	8,469	14,060
Intermediate	3,799	3,799	0	0	0	0
Long-Term	16,201	14,732	3,907	1,991	0	0
Total	20,000	19,084	9,429	10,046	8,469	14,060
Net Worth	20,000	35,588	45,566	54,685	63,749	59,531
Assets						
Controlled	40,000	313,672	316,795	326,731	334,218	205,591

Table 4.47 (continued)

	Year 0	1	2	3	4	5
	(dollars)					
Point D						
Assets						
Current	0	10,600	29,042	51,565	70,550	86,114
Intermediate	33,279	29,951	29,295	26,913	25,781	28,258
Long-Term	6,721	6,067	11,735	10,375	9,015	7,876
Total	40,000	46,618	70,072	88,853	105,346	122,248
Liabilities						
Current	0	3,824	5,660	8,660	12,140	27,158
Intermediate	14,623	4,486	2,969	4,350	7,273	14,531
Long-Term	5,377	3,674	8,254	7,119	5,882	4,717
Total	20,000	11,984	16,883	20,129	25,295	46,406
Net Worth	20,000	34,634	53,189	68,724	80,051	75,842
Assets Controlled	40,000	430,618	484,072	509,853	558,346	636,248
Point E						
Assets						
Current	0	24,874	33,983	59,888	79,012	103,826
Intermediate	40,000	36,000	58,022	58,164	51,010	43,537
Long-Term	0	0	2,237	1,987	1,737	1,488
Total	40,000	60,874	94,242	120,039	131,759	148,851
Liabilities						
Current	0	9,972	12,140	15,753	16,985	18,060
Intermediate	20,000	20,000	33,172	40,987	37,305	37,591
Long-Term	0	0	1,809	1,612	1,398	1,164
Total	20,000	29,972	47,121	58,352	55,688	56,815
Net Worth	20,000	30,902	47,121	61,687	76,071	92,036
Assets Controlled	40,000	663,874	922,242	1086,039	1199,759	1348,851

Table 5.48. Leverage and liquidity ratios, and growth in net worth for points on Curve VII.

Year	Point A	Point B	Point C	Point D	Point E
Debt-to-Equity Ratio					
0	0.00	0.44	1.00	1.00	1.00
1	0.08	0.18	0.54	0.35	0.97
2	0.08	0.37	0.21	0.32	1.00
3	0.08	0.14	0.18	0.29	0.95
4	0.07	0.10	0.13	0.32	0.73
5	0.07	0.28	0.24	0.61	0.62
Current Ratio					
0	--	--	--	--	--
1	13.73	--	33.67	2.77	2.49
2	14.02	4.96	3.75	5.13	2.80
3	14.30	5.39	4.30	5.95	3.80
4	14.58	6.39	5.45	5.81	4.65
5	14.88	2.60	3.49	3.17	5.75
Growth in Net Worth During Year					
1	2.6%	57.9%	77.9%	73.2%	54.5%
2	2.6	39.4	28.0	53.6	52.5
3	2.6	13.6	20.0	29.2	30.9
4	2.5	12.6	16.6	16.5	23.3
5	2.5	-25.4	-6.6	-5.3	21.0
Average Growth Per Year					
	2.6%	19.6%	27.2%	33.4%	36.4%
Average Growth Per Year During First Four Years					
	2.6%	30.9%	35.6%	43.1%	40.3%

Table 5.49. Expected disposable income, variance, and consumption in each year for each point on Curve VII.

Point	Year	Disposable Income	Variance	Standard Deviation	Consumption
A	1	$ 7,442	0	0	$ 6,923
	2	7,462	0	0	6,934
	3	7,482	0	0	6,945
	4	7,503	0	0	6,956
	5	7,524	0	0	6,967
B	1	0	$ 499,320	$ 707	4,000
	2	5,817	263,197	513	5,960
	3	17,463	728,653	854	11,485
	4	18,625	769,075	877	11,936
	5	27,206	737,557	859	27,206
C	1	3,016	10,560,521	3,250	4,324
	2	18,046	8,758,510	2,959	11,714
	3	22,394	9,194,852	3,032	13,307
	4	23,041	9,481,750	3,079	13,534
	5	29,940	18,932,034	4,351	15,810
D	1	14,191	82,133,023	9,063	10,157
	2	18,340	76,317,859	8,736	11,830
	3	23,340	54,240,284	7,365	13,640
	4	27,860	81,162,558	9,009	15,150
	5	41,820	311,445,952	17,648	19,236
E	1	25,152	780,271,366	27,933	14,249
	2	27,860	931,723,424	30,524	15,150
	3	31,633	1,563,893,382	39,546	16,318
	4	32,865	2,179,368,589	46,684	16,687
	5	33,940	3,108,807,623	55,757	17,010

consumption, and variance is slightly different in some cases, but is generally identical to the pattern of these values associated with corresponding points on Curve V. The probability of disposable income being less than zero, \$4,000, and \$8,000 in each year for each point on Curve VII is given in Table 5.50. As one would expect, these are also practically identical to the probabilities associated with corresponding points on Curve V.

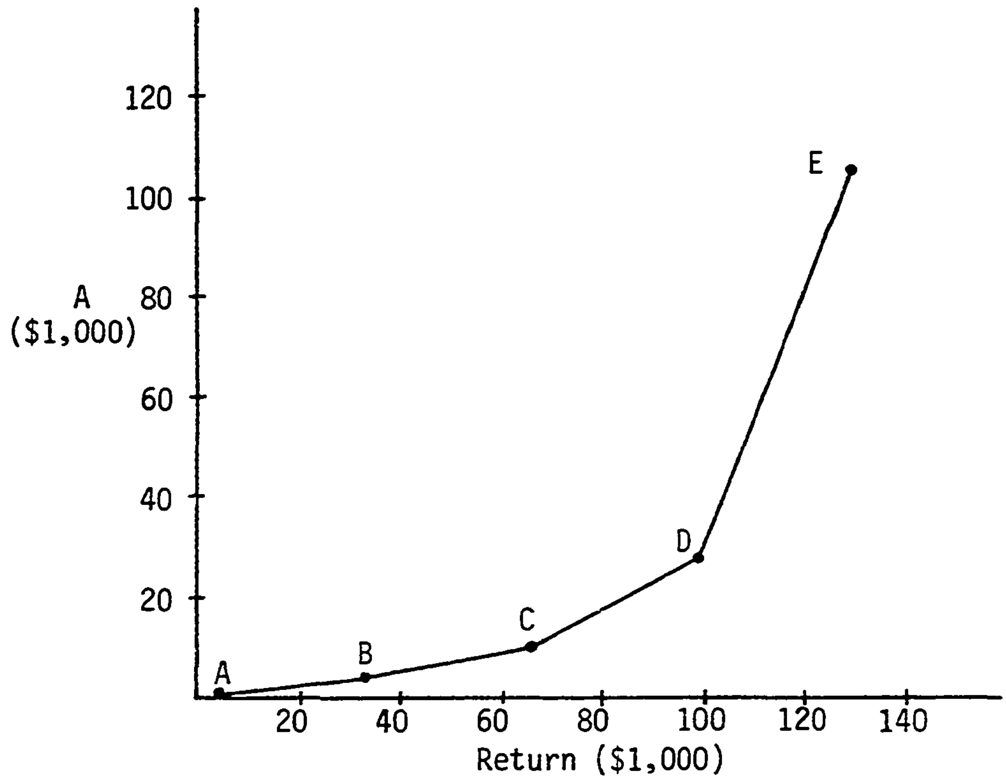
Curve VIII

The eighth set of initial conditions is represented by a beginning cash or equity position of \$20,000, no opportunity for the wife to work off the farm, consumption function α, availability of nonconventional loan terms, and a debt-to-equity ratio constraint of less than 2.0. This set of initial conditions is identical to Curve VI except that the debt-to-equity ratio constraint is at the higher level (see Table 5.1). Because the debt-to-equity ratio was 1.0 in some years for each point on Curve VI, except Point A, one would expect Curve VIII to be to the right of Curve VI for return levels above \$1,918. This set of initial conditions is also identical to Curve III except that there is no opportunity for the wife to work off the farm. Because the farm plan of each point on Curve III specified that the wife should work off the farm, one would expect Curve VIII to be to the left of Curve III.

Curve VIII is shown in Figure 5.8. As all previous curves, this efficient frontier is convex. As expected, Curve VIII is slightly to the right of Curve VI at return levels above Point A. As was found in

Table 5.50. Probability of disposable income falling below certain levels in each year for each point on Curve VII.

Point	Year	$P(\mu_I < 0)$	$p(\mu_I < \$4000)$	$P(\mu_I < \$8000)$
A	1	0.0	0.0	1.0
	2	0.0	0.0	1.0
	3	0.0	0.0	1.0
	4	0.0	0.0	1.0
	5	0.0	0.0	1.0
B	1	0.5	1.0	1.0
	2	0.0	0.0	1.0
	3	0.0	0.0	0.0
	4	0.0	0.0	0.0
	5	0.0	0.0	0.0
C	1	0.1728	0.6179	0.9370
	2	0.0	0.0	0.0
	3	0.0	0.0	0.0
	4	0.0	0.0	0.0
	5	0.0	0.0	0.0
D	1	0.0582	0.1314	0.2483
	2	0.0179	0.0505	0.1190
	3	0.0	0.0043	0.0188
	4	0.0	0.0040	0.0139
	5	0.0089	0.0162	0.0274
E	1	0.1841	0.2236	0.2709
	2	0.1814	0.2177	0.2578
	3	0.2119	0.2420	0.2743
	4	0.2420	0.2676	0.2981
	5	0.2709	0.2946	0.3228



Point	Return	A
A	$ 1,918	$ 0
B	34,000	2,779
C	66,000	8,503
D	98,000	25,913
E	130,064	104,507

Figure 5.8. Efficient E,A Curve VIII.

comparing Curve V with Curve III, a beginning farm family with a debt-to-equity ratio constraint of less than 1.0 will have to accept more risk to reach the same return level as a family with a debt-to-equity ratio constraint of less than 2.0. Also as expected, Curve VIII is to the left of Curve III. As was found in comparing Curve VI to Curve V, a beginning farm family with no opportunity to earn any off-farm income will have to accept more risk to reach the same level of return as a beginning farm family with an opportunity for the wife to earn an off-farm income of $8,000 per year.

Investment and Financing Plans

The investment and financing plan for each point on Curve VIII is shown in Table 5.51. Because of the higher debt-to-equity ratio constraint, there is $40,000 of credit available in the initial period. The investment and financing plan of Point E uses all of this debt to purchase machinery in the initial period. The investment plan of Point E specifies much more machinery investment in the initial period than is specified by Point E of Curve VI. However, by year two both points have the same crop production system and by year three both points have the same combine. Point D also has much more machinery investment in the initial period than Point D of Curve VI, because of the availability of more credit to finance this machinery purchase. However, by year two the machinery purchased at both points is identical. The machinery investment in the initial period specified by Point C is about the same as that specified by Point C of Curve VI, but more of the investment is financed with intermediate credit. The machinery purchase in the initial period of Point B is practically identical to that purchased at Point B of Curve VI.

The investment plan for each point of Curve VIII specifies purchasing the same type of hog facilities that are purchased at corresponding points on Curve VI. The investment plan of Point E specifies

Table 5.51. Level of investment and financing activities in farm plans associated with points on Curve VIII.

	Year 0	1	2	3	4	5
Point A						
Save Cash, first period ($)		17,961	14,616	11,144	7,540	3,798
Save Cash, second period ($)		16,371	12,950	9,399	5,713	1,886
Point B						
Machinery Investment and Financing:						
Labor Intensive Crop Production (unit)	0.38					
Labor Intensive Combine (unit)	0.12		0.11			
Capital Intensive Combine (unit)			0.01	0.08		
Pay Cash ($)	10,563		2,892			
Intermediate Credit ($)				6,383		
Hog Facility Investment:						
Pasture Farrowing (litter space)			2	25	5	
Partial Confinement Farrowing (litter space)	8					
Partial Confinement Feeding (hog space)	47		81	146	29	
Short-Term Loan, first period ($)		1,082				
Short-Term Loan, second period ($)			981			
Save Cash, first period ($)			1,117	6,002	21,834	36,379
Save Cash, second period ($)		5,358			10,605	29,811
Pay Interest, Intermediate 9% Loan ($)					575	575
Pay Principal, Long-Term 9% Loan ($)			1,403	707	1,095	2,276
Pay Interest, Long-Term 9% Loan ($)		702	1,024	1,969	2,120	2,021
Point C						
Machinery Investment and Financing:						
Intermediate Crop Production (unit)	0.58					
Capital Intensive Crop Production (unit)	0.02		0.02			
Labor Intensive Combine (unit)	0.29					
Pay Cash ($)	15,413		717			
Intermediate Credit ($)	7,538					

Hog Facility Investment:						
Partial Confinement Farrowing (litter space)	21			1		
Partial Confinement Feeding (hog space)	95		114			
Short-Term Loan, first period ($)		16,527	5,846			
Save Cash, first period ($)					11,430	30,291
Save Cash, second period ($)		514		4,077	16,299	35,845
Pay Principal, Intermediate 9% Loan ($)				7,538		
Pay Interest, Intermediate 9% Loan ($)		678	678	678		
Pay Principal, Long-Term 9% Loan ($)			7,948	5,162	2,235	2,440
Pay Interest, Long-Term 9% Loan ($)		1,651	2,071	1,359	911	710
<u>Point D</u>						
Machinery Investment and Financing:						
Capital Intensive Crop Production (unit)	0.72		0.01	0.06	0.02	0.18
Labor Intensive Combine (unit)	0.44		0.14			
Capital Intensive Combine (unit)			0.01		0.07	0.09
Pay Cash ($)	16,447					
Intermediate Credit ($)	25,790		2,997	2,742	3,332	10,965
Hog Facility Investment:						
Partial Confinement Farrowing (litter space)	15					5
Partial Confinement Feeding (hog space)	103			4	6	53
Total Confinement Feeding (hog space)			35			
Short-Term Loan, first period ($)		35,340	22,155	2,631		
Save Cash, first period ($)					16,877	24,263
Save Cash, second period ($)				15,051	36,197	84,867
Pay Principal, Intermediate 9% Loan ($)		5,590	17,333	2,867		
Pay Interest, Intermediate 9% Loan ($)		2,321	1,818	528	516	816
Pay Principal, Long-Term 9% Loan ($)				1,288	1,565	1,722
Pay Interest, Long-Term 9% Loan ($)		1,279	1,438	1,454	1,358	1,518

Table 5.51 (continued)

	Year 0	1	2	3	4	5
Point E						
Machinery Investment and Financing:						
Capital Intensive Crop Production (unit)	0.96		0.16			
Labor Intensive Combine (unit)	0.07					
Capital Intensive Combine (unit)	0.42		0.32			0.01
Pay Cash ($)	20,000					
Intermediate Credit ($)	40,000		17,646			297
Hog Facility Investment:						
Total Confinement Feeding (hog space)			14			
Short-Term Loan, first period ($)		50,000	50,000	50,000	50,000	50,000
Save Cash, second period ($)		26,868	52,147	75,410	56,918	84,772
Pay Principal, Intermediate 9% Loan ($)					40,000	
Pay Interest, Intermediate 9% Loan ($)		3,600	3,600	5,188	5,193	1,593
Pay Principal, Long-Term 9% Loan ($)					66	72
Pay Interest, Long-Term 9% Loan ($)			65	65	65	59

the purchase of a total confinement feeding facility in year two with space for about 14 hogs, which is 11 hog spaces smaller than the facility purchased at Point E of Curve VI. As in Curve VI, this facility is purchased in year two because all available debt in the initial period is used to finance machinery purchase. The investment plan of Point D specifies purchasing a partial confinement farrowing facility in the initial period with space for about 15 litters, and in year five with space for about 5 litters, which is 2 litter spaces larger in the initial period and 2 litter spaces smaller in year five than the facility purchased at Point D of Curve VI. Point D also specifies investment in a partial confinement feeding facility in the initial period with space for 103 hogs, in year three with space for about 4 hogs, in year four with space for about 6 hogs, and in year five with space for about 53 hogs. This investment is entirely different from that of Point D on Curve VI where this facility is purchased in the initial period, year two, and year five with space for 24 hogs, 47 hogs, and 50 hogs, respectively. Also at Point D there is investment in a total confinement feeding facility in year two with space for about 35 hogs, which is 49 hog spaces smaller than the facility purchased at Point D of Curve VI. The investment plan of Point C specifies purchasing a partial confinement farrowing facility in the initial period with space for about 21 litters, which is 3 litter spaces smaller than the facility purchased at Point C of Curve VI. Also at Point C there is investment in a partial confinement feeding facility in the initial period with space for about 95 hogs and in year two with space for about

114 hogs, which is 14 hog spaces larger in the initial period and 17 hog spaces smaller in year two than the facility purchased at Point C of Curve VI. The investment plan of Point B specifies the purchase of pasture farrowing facilities, a partial confinement farrowing facility, and a partial confinement feeding facility in exactly the same periods as at Point B of Curve VI, but in each case there is more investment at Point B of Curve VIII.

As in all previous curves which have availability of nonconventional loan terms, each of these hog facility investments is financed using repayment plan D, which is the Standard plan with deferred principal payments. At Points D and E, principal payments are made on this long-term debt as required by repayment plan D. At Points B and C there is some repayment of principal in years two and three, but not as much as specified by corresponding points of Curve VI.

As in all previous curves, the conventional linear programming solution specifies the use of a short-term operating loan of $50,000 in the first period of each year. At Point D there is more short-term borrowing in the first period of year one, but less in the first period of years two and three than at Point D of Curve VI. At Point C there is more short-term borrowing in the first period of years one and two than at Point C of Curve VI. At Point B there is more short-term borrowing in the first period of year one, but less in the second period of years two and three than at Point B of Curve VI.

The investment plan of the conventional linear programming solution specifies more cash to be saved in the second period of years one through three, but less in the second period of years four and five than is specified at Point E of Curve VI. At Point D more cash is saved in the first period of years four and five, but less is saved in the second period of years three through five than at Point D of Curve VI. At Point C less cash is saved in the first period of years four and five, but more is saved in the second period of years three through five than at Point D of Curve VI. At Point B more cash is saved in the first period of years two through five and in the second period of years four and five than at Point B of Curve VI.

Production Plans

The production plan associated with each point on Curve VIII is shown in Table 5.52. Because of the difference in investment and financing plans between corresponding points on Curve VIII and Curve VI, the production plans specified by corresponding points on these curves are also quite different. As in all previous curves, the conventional linear programming solution specifies cash renting land and crop-share renting land. The amount of cash rented land varies from 108 acres in year one to about 363 acres in year five. This cash rented land is used to grow corn and soybeans produced by a custom operator. The amount of land crop-share rented in each year for Point E is about 654 acres in year one and about 765 acres in years two through five. This is about 247 acres more in year one and about 4 acres more in years two through five than is crop-share rented for Point E of Curve VI. As in all previous curves, all the land farmed in each year of Points B, C, and D is crop-share rented. The amount of

Table 5.52. Level of production activiities in farm plans associated with points on Curve VIII.

	Year 1	Year 2	Year 3	Year 4	Year 5
Point B					
Crop-Share Rented Land:					
Continuous Corn (acres)	21.40	159.39	259.40	259.40	3.15
Corn-Soybean-Oats Rotation (acres)	145.80	22.14			
Pasture Farrowing (litters)		3.38	53.08	63.04	31.52
Partial Confinement Farrowing (litters)	51.54	51.54	51.54	20.42	
Place Feeder Pigs on Feed:					
Partial Confinement, third quarter (pigs)	17.75	47.00	18.98	12.98	
Partial Confinement, fourth quarter (pigs)	29.04	80.53	254.46	289.33	
Point C					
Crop-Share Rented Land:					
Continuous Corn (acres)	12.43	146.12	145.29	132.53	
Corn-Soybean Rotation (acres)	93.99		.94		
Corn-Soybean-Oats Rotation (acres)	211.71	182.34	182.22	195.90	93.90
Partial Confinement Farrowing (litters)	126.30	127.92	127.92	127.92	74.84
Place Feeder Pigs on Feed:					
Partial Confinement, third quarter (pigs)	39.45	38.96	39.88	28.18	
Partial Confinement, fourth quarter (pigs)	55.53	170.52	170.52	182.22	
Point D					
Crop-Share Rented Land:					
Continuous Corn (acres)	134.33	19.61	59.10	4.95	
Corn-Soybean Rotation (acres)	353.54	471.00	471.00	540.30	534.88
Corn-Soybean-Oats Rotation (acres)					129.87
Partial Confinement Farrowing (litters)	87.84	87.84	80.74	78.94	39.48
Place Feeder Pigs on Feed:					
Partial Confinement, first quarter (pigs)	103.20	66.05	22.83	5.76	52.85
Partial Confinement, third quarter (pigs)	51.95	18.35			
Partial Confinement, fourth quarter (pigs)	37.14	84.85	107.67	113.44	
Total Confinement, first quarter (pigs)		35.30	35.30	25.88	31.65

Total Confinement, third quarter (pigs)		35.30	25.88		
Total Confinement, fourth quarter (pigs)			9.42	3.64	
<u>Point E</u>					
Crop-Share Rented Land:					
Continuous Corn (acres)	195.09	1.73			
Corn-Soybean Rotation (acres)	459.34	763.00	764.68	764.68	763.92
Cash Rented Land:					
Custom Grow Corn (acres)	108.26	188.66	315.57	214.31	352.84
Custom Grow Corn-Soybean Rotation (acres)					9.80
Custom Harvest Corn (acres)			125.10	92.84	163.90
Harvest Corn (acres)	108.26	188.66	189.47	189.47	193.84
Harvest Soybeans (acres)					4.90
Place Feeder Pigs on Feed:					
Total Confinement, first quarter (pigs)		14.48	14.48	14.48	14.48
Total Confinement, third quarter (pigs)		14.48	14.48	14.48	

land crop-share rented during each year at these points is a little more than the amount crop-share rented at corresponding points on Curve VI. This crop-share rented land at each point is used to produce corn, soybeans and oats, with the acreages of the various crop rotations given in Table 5.52.

The hog facilities of each point on Curve VIII are utilized in hog production activities which are similar to those specified by corresponding points on Curve VI. The production plan of Point E specifies that the total confinement feeding facility be used to capacity in years two, three, and four, and in the first and second quarters of year five by putting about 14 feeder pigs on feed in the first quarter of years two through five and in the third quarter of years two through four. At Point D the partial confinement farrowing facility is used to farrow about 88 litters in years one and two, about 81 litters in year three, about 79 litters in year four, and about 39 litters in year five. Also at Point D, the partial confinement feeding facility is used to capacity in the first quarter of each year and the second quarter of year one, and is partially used in the second quarter of years two through five, the third quarter of years one and two, and the fourth quarter of years one through four. The only times this facility is not used is during the third quarter of years three through five and the fourth quarter of year five. Also at Point D, the total confinement feeding facility is used to capacity in the first quarter of years two through five, the second quarter of years two and three, the third quarter of year two, and the fourth quarter of years two and three. This facility is partially used in the second quarter of years four and five, the third quarter of year three, and the fourth quarter of year four.

The production plan of Point C specifies that the partial confinement farrowing facility be used to farrow about 126 litters in year one, about 128 litters in years two through four, and about 75 litters in year five. At Point B the pasture farrowing facilities are used to farrow about 3 litters in year two, about 53 litters in year three, about 63 litters in year four, and about 32 litters in year five. Also at Point B, the partial confinement farrowing facility is used to farrow about 52 litters in years one through three and about 20 litters in year four. As in all previous curves, the production plans of Points B and C specify that the partial confinement feeding facility be used to capacity in the third and fourth quarters of years one through four. Feeder pigs are put on feed in the third quarter of each year to provide the replacement gilts for the next year's farrowing enterprise. The remaining capacity is then used to put feeder pigs on feed in the fourth quarter of each year.

Marketing Plans

The plan associated with each point on Curve VIII for marketing and buying agricultural products is shown in Table 5.53. These plans are very similar to those specified by corresponding points on Curve VI, given the differences in the levels of production activities. One major difference is that at Point E no corn is stored at harvest of any

Table 5.53. Marketing and buying plans for agricultural products associated with points on Curve VIII.

	Year 1	2	3	4	5
Point B					
Sell Corn, first period (bu.)		2,085	5,956	9,273	9,679
Sell Soybeans, second period (bu.)	851	129			
Sell Oats, second period (bu.)	1,823	277			
Sell Hogs, second quarter (cwt.)		62	172	543	617
Sell Sows, first quarter (cwt.)		11	11	11	1
Sell Sows, fourth quarter (cwt.)	22	25			
Sell Feeder Pigs, first quarter (pigs)	69	137	137	75	6
Sell Feeder Pigs, second quarter (pigs)	69	81	254	289	221
Sell Feeder Pigs, third quarter (pigs)	120	90	118		
Sell Feeder Pigs, fourth quarter (pigs)	40				
Store Corn, second period (bu.)	2,904	7,655	11,550	11,698	
Buy Corn, first period (bu.)	636				
Buy Gilts (head)	30				
Replacement Gilts (head)		17	45	18	13
Point C					
Sell Corn, first period (bu.)		3,099	6,209	6,159	6,322
Sell Corn, second period (bu.)					793
Sell Soybeans, second period (bu.)	2,057	1,064	1,071	1,143	548
Sell Oats, second period (bu.)	2,646	2,279	2,278	2,449	1,174
Sell Hogs, first quarter (cwt.)					45
Sell Hogs, second quarter (cwt.)		119	364	364	389
Sell Sows, first quarter (cwt.)		27	28	28	28
Sell Sows, fourth quarter (cwt.)	55	54	55	56	39
Sell Feeder Pigs, first quarter (pigs)	168	339	341	341	235
Sell Feeder Pigs, second quarter (pigs)	168	171	171	176	176
Sell Feeder Pigs, third quarter (pigs)	297	302	301	313	129
Sell Feeder Pigs, fourth quarter (pigs)	113				171
Store Corn, second period (bu.)	4,945	8,607	8,576	8,137	

Buy Corn, first period (bu.)	1,559				
Buy Feeder Pigs, fourth quarter (pigs)				6	
Buy Gilts (head)	75				
Replacement Gilts (head)		38	38	39	7
<u>Point D</u>					
Sell Corn, first period (bu.)		6,357	10,083	12,572	11,739
Sell Corn, second period (bu.)	6,766				16,598
Sell Soybeans, second period (bu.)	3,094	4,121	4,121	4,728	5,438
Sell Oats, second period (bu.)					1,623
Sell Hogs, first quarter (cwt.)		54	67	5	
Sell Hogs, second quarter (cwt.)		79	181	250	250
Sell Hogs, third quarter (cwt.)	220	216	124	68	180
Sell Sows, first quarter (cwt.)		19	19	17	16
Sell Sows, fourth quarter (cwt.)	38	38	36	35	26
Sell Feeder Pigs, first quarter (pigs)	14	133	162	171	15
Sell Feeder Pigs, second quarter (pigs)	117	117	117	117	153
Sell Feeder Pigs, third quarter (pigs)	182	181	180	199	
Sell Feeder Pigs, fourth quarter (pigs)	80	32			153
Store Corn, second period (bu.)	8,583	12,035	14,404	13,594	
Buy Corn, first period (bu.)	2,075				
Buy Gilts (head)	52				
Replacement Gilts (head)		26	22	23	
<u>Point E</u>					
Sell Corn, second period (bu.)	35,270	41,676	54,121	44,197	58,557
Sell Soybeans, second period (bu.)	4,019	6,676	6,691	6,691	6,856
Sell Hogs, first quarter (cwt.)			31	31	31
Sell Hogs, third quarter (cwt.)		31	31	31	31
Buy Corn, first period (bu.)		135	135	135	135
Buy Feeder Pigs, first quarter (pigs)		14	14	14	14
Buy Feeder Pigs, third quarter (pigs)		14	14	14	

year, while at Point E of Curve VI a small amount of corn is stored at harvest of years two and three.

Resource Control, Debt Use, and Net Worth

The yearly balance sheets and the value of resources controlled in each year of each point on Curve VIII are given in Table 5.54. As in all previous curves, the conventional linear programming solution specifies the highest debt use, the highest level of asset ownership, and the highest level of resource control in each year. Moving down Curve VIII to lower return-risk points results in less debt use, less asset ownership, and less resource control in each year of each successive point.

The difference in the debt-to-equity ratio constraint causes some differences in the balance sheets of corresponding points on Curve VIII and Curve VI, because points on Curve VIII have more debt available in the initial period. The farm plan of the conventional linear programming solution has more outstanding debt, more asset ownership, and a higher level of resource control through year three than Point E of Curve VI. Also, Point E of Curve VIII generates a higher value of net worth in each year than Point E of Curve VI. Point D specifies more outstanding debt and more asset ownership through year one than Point D of Curve VI. Point D also has more resource control in each year, except year two, than Point D of Curve VI. Also, Point D generates a higher value of net worth in each year than at Point D of Curve VI. Point C specifies more outstanding debt, more asset ownership, and a higher level of resource control through year one than Point C of

Table 5.54. Yearly balance sheets associated with points on Curve VIII.

	Year					
	0	1	2	3	4	5
	(dollars)					
Point A						
Assets						
Current	20,000	16,780	13,274	9,634	5,856	1,934
Liabilities						
Current	0	133	107	80	51	22
Net Worth	20,000	16,647	13,167	9,554	5,805	1,912
Point B						
Assets						
Current	7,487	14,382	21,977	33,443	44,694	31,783
Intermediate	10,563	9,507	11,054	15,453	13,469	11,485
Long-Term	9,751	8,802	11,877	23,751	23,344	19,963
Total	27,801	32,691	44,908	72,647	81,507	63,231
Liabilities						
Current	0	0	981	620	3,807	9,727
Intermediate	0	0	0	6,383	6,383	6,383
Long-Term	7,801	7,801	9,949	21,176	22,458	20,182
Total	7,801	7,801	10,930	28,179	32,648	36,292
Net Worth	20,000	24,890	33,978	44,468	48,859	26,939
Assets Controlled	27,801	199,691	226,908	331,647	340,507	56,231
Point C						
Assets						
Current	0	17,213	27,119	31,300	42,457	38,226
Intermediate	22,952	20,656	19,006	16,640	14,273	11,906
Long-Term	22,932	20,701	23,730	20,971	18,376	15,543
Total	45,884	58,570	69,855	68,911	75,106	65,675
Liabilities						
Current	0	0	2,369	6,565	7,575	12,140
Intermediate	7,538	7,538	7,538	0	0	0
Long-Term	18,346	18,346	15,060	9,934	7,888	5,448
Total	25,884	25,884	24,967	16,499	15,463	17,588
Net Worth	20,000	32,686	44,888	52,412	59,643	48,087
Assets Controlled	45,884	376,570	397,855	396,911	403,106	159,675

Table 5.54 (continued)

	Year 0	1	2	3	4	5
	(dollars)					
Point D						
Assets						
Current	0	23,712	32,083	51,094	69,290	87,757
Intermediate	42,237	38,013	36,486	34,431	32,632	37,370
Long-Term	17,763	16,034	16,294	14,541	12,823	14,559
Total	60,000	77,759	84,863	100,066	114,745	139,686
Liabilities						
Current	0	620	5,551	8,685	12,140	31,020
Intermediate	25,790	20,200	5,864	5,739	9,071	20,036
Long-Term	14,210	14,210	15,979	14,866	13,527	15,150
Total	40,000	35,030	27,394	29,290	34,738	66,206
Net Worth	20,000	42,729	57,469	70,776	80,007	73,480
Assets Controlled	60,000	565,759	575,863	630,066	655,745	804,686
Point E						
Assets						
Current	0	27,539	54,456	78,302	59,347	86,892
Intermediate	60,000	54,000	63,881	56,166	48,396	40,893
Long-Term	0	0	816	724	633	542
Total	60,000	81,539	119,153	135,192	108,376	128,327
Liabilities						
Current	0	10,319	14,275	15,277	14,258	18,060
Intermediate	40,000	40,000	57,646	57,701	17,701	17,998
Long-Term	0	0	725	725	659	588
Total	40,000	50,319	72,646	73,703	32,618	36,646
Net Worth	20,000	31,220	46,507	61,489	75,758	91,681
Assets Controlled	60,000	844,539	1072,153	1215,192	1087,376	1255,327

Curve VI. Point C also generates a higher value of net worth, except year four, than Point C of Curve VI. The farm plan of Point B specifies more outstanding debt, more asset ownership, more resource control and a higher value of net worth in each year than Point B of Curve VI.

The leverage and liquidity ratios for each year for each point on Curve VIII are given in Table 5.55. The debt-to-equity ratio constraint of less than 2.0 was reached in the initial period for Points D and E. The debt-to-equity ratio was also above 1.0 in years one through three for Point E, the initial period for Point C, and year five for Point B. In all other cases the beginning farmer has more equity capital than debt capital invested in the farm business. The debt-to-equity ratios through year three for Point E are higher than for Point E of Curve VI. The debt-to-equity ratios in the initial period and year one for Points C and D are higher than at corresponding points on Curve VI. The debt-to-equity ratio in each year for Point B is higher than Point B of Curve VI. In general, points on Curve VIII use relatively more debt in early years, but less in later years than at corresponding points on Curve VI. The lowest current ratio is 2.67 which occurs at the end of year one for Point E. In all cases the beginning farmer has a good liquidity position.

The yearly growth rates in net worth for each point on Curve VIII are also given in Table 5.55. The conventional linear programming solution results in the largest growth in net worth with an average growth per year of 36.5 percent. As in all previous curves, moving down the efficient frontier to lower return-risk points results in less

Table 5.55. Leverage and liquidity ratios, and growth in net worth for points on Curve VIII.

Year	Point A	B	C	D	E
Debt-to-Equity Ratio					
0	0.00	0.39	1.29	2.00	2.00
1	0.01	0.31	0.79	0.82	1.61
2	0.01	0.32	0.56	0.48	1.56
3	0.01	0.63	0.32	0.41	1.20
4	0.01	0.67	0.26	0.43	0.43
5	0.01	1.35	0.37	0.90	0.40
Current Ratio					
0	--	--	--	--	--
1	126.17	--	--	38.25	2.67
2	124.06	22.40	11.45	5.78	3.81
3	120.42	53.94	4.77	5.88	5.13
4	114.82	11.81	5.60	5.71	4.16
5	87.91	3.27	3.15	2.83	4.81
Growth in Net Worth During Year					
1	-16.8%	24.4%	63.4%	113.6%	56.1%
2	-20.9	36.5	37.3	34.5	50.0
3	-27.4	30.9	16.8	23.2	32.2
4	-39.3	9.9	13.8	13.0	23.2
5	-67.1	-44.9	-19.4	-8.2	21.0
Average Growth Per Year					
	-34.3%	11.4%	22.4%	35.2%	36.5%
Average Growth Per Year During First Four Years					
	-26.1%	25.4%	32.8%	46.1%	40.4%

growth in net worth. The farm plan of Point D generates an average growth in net worth per year of 35.2 percent, Point C has an average growth per year of 22.4 percent, and Point B has an average growth per year of 11.4 percent. As in Curve VI, Point A has an average growth in net worth per year of -34.3 percent. The average growth per year in net worth for points on Curve VIII are higher than the average growth in net worth for corresponding points on Curve VI.

Income and Consumption

The undiscounted expected disposable income, the resulting consumption, and the variance of income in each year for each point on Curve VIII are shown in Table 5.56. The pattern of disposable income and consumption at Point A is identical to that of Point A of Curve VI, because they are the same point. The yearly disposable income and consumption for Points B, C, and D are slightly higher than or equal to the values of corresponding points on Curve VI because each point represents a slightly higher return level than the corresponding points on Curve VI. At Point E the disposable income and consumption in years one and two is higher, in years three and four is lower, and in year five is equal to the disposable income and consumption for Point E on Curve VI.

The probabilities of disposable income being less than zero, \$4,000, and \$8,000 in each year for each point on Curve VIII are given in Table 5.57. The probabilities associated with Point A are, of course, identical to those of Point A on Curve VI. The probabilities associated with Point B are practically identical to those of Point B

Table 5.56. Expected disposable income, variance, and consumption in each year for each point on Curve VIII.

Point	Year	Disposable Income	Variance	Standard Deviation	Consumption
A	1	$ 725	0	0	$ 4,078
	2	582	0	0	4,063
	3	434	0	0	4,047
	4	280	0	0	4,030
	5	120	0	0	4,013
B	1	0	$ 3,726,058	$ 1,930	4,000
	2	0	1,058,994	1,029	4,000
	3	3,380	1,502,063	1,226	4,363
	4	14,147	1,060,996	1,030	10,139
	5	24,813	1,072,776	1,036	14,135
C	1	0	23,462,294	4,844	4,000
	2	10,068	12,640,071	3,555	8,300
	3	19,950	14,178,727	3,765	12,427
	4	21,642	15,328,372	3,915	13,042
	5	27,860	14,313,463	3,783	15,150
D	1	3,380	92,198,080	9,602	4,363
	2	18,109	48,814,487	6,987	11,739
	3	23,375	50,207,320	7,086	13,652
	4	27,860	63,459,647	7,966	15,150
	5	44,980	439,409,951	20,962	20,090
E	1	25,631	910,334,848	30,172	14,410
	2	30,155	1,464,153,304	38,264	15,874
	3	31,157	2,216,101,479	47,075	16,175
	4	30,138	1,607,940,859	40,099	15,869
	5	33,940	2,541,845,665	50,417	17,010

Table 5.57. Probability of disposable income falling below certain levels in each year for each point on Curve VIII.

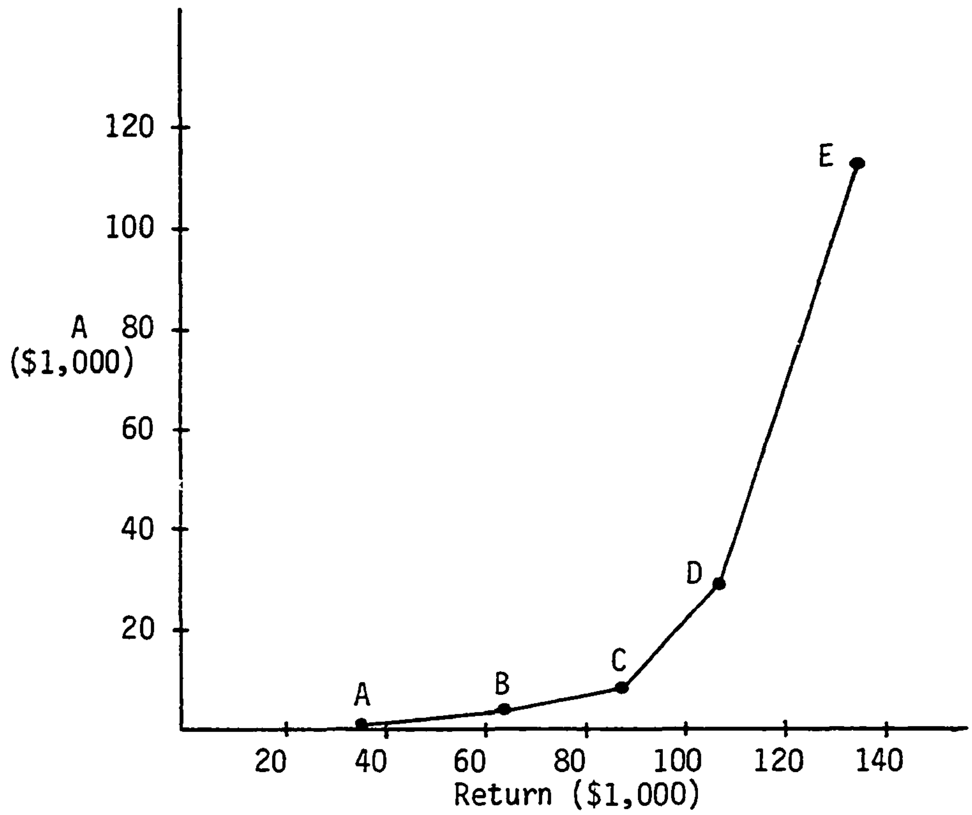
Point	Year	$P(\mu_I < 0)$	$P(\mu_I < \$4000)$	$P(\mu_I < \$8000)$
A	1	0.0	1.0	1.0
	2	0.0	1.0	1.0
	3	0.0	1.0	1.0
	4	0.0	1.0	1.0
	5	0.0	1.0	1.0
B	1	0.5	0.9808	1.0
	2	0.5	1.0	1.0
	3	0.0029	0.6950	1.0
	4	0.0	0.0	0.0
	5	0.0	0.0	0.0
C	1	0.5	0.7967	0.9505
	2	0.0023	0.0436	0.2810
	3	0.0	0.0	0.0
	4	0.0	0.0	0.0
	5	0.0	0.0	0.0
D	1	0.3632	0.5239	0.6844
	2	0.0048	0.0217	0.0735
	3	0.0	0.0032	0.0150
	4	0.0	0.0	0.0064
	5	0.0158	0.0250	0.0392
E	1	0.1977	0.2358	0.3156
	2	0.2148	0.2483	0.2810
	3	0.2546	0.2810	0.3121
	4	0.2266	0.2578	0.2912
	5	0.2514	0.2776	0.3015

on Curve VI. In most years, the probabilities associated with Points C, D, and E are lower than the probabilities of corresponding points on Curve VI. As in all previous curves, the farm plan associated with the conventional linear programming solution results in the highest probability of the beginning farm failing. However, as in Curve VI, with this set of initial conditions there is also a small probability of failure at Points B, C, and D.

Curve IX

The ninth set of initial conditions represents a beginning cash or equity position of $40,000, an opportunity for the wife to work off the farm, consumption function α, availability of only conventional loan terms, and a debt-to-equity ratio constraint of less than 2.0. This set of initial conditions is identical to Curve II except that only conventional loan terms are available (see Table 5.1). Since nonconventional loan terms are specified by the farm plan for each point on Curve II, except Point A, one would expect Curve IX to be to the left of Curve II for return levels above $35,872.

Curve XI is shown in Figure 5.9. As all previous curves, this efficient frontier is convex. Also as expected, Curve IX is slightly to the left of Curve II at return levels above $32,872. As was found in comparing Curve VII with Curve V, a beginning farmer with no opportunity to use nonconventional loan terms will have to accept slightly more risk than a beginning farmer who has an opportunity to use nonconventional loan terms to reach the same level of return.



Point	Return	A
A	$ 35,872	$ 0
B	62,000	1,819
C	87,000	7,750
D	113,000	26,698
E	138,943	113,088

Figure 5.9. Efficient E,A Curve IX.

Investment and Financing Plans

The investment and financing plan associated with each point on Curve IX is shown in Table 5.58. Each of these investment and financing plans is practically identical to the one specified by the

Table 5.58. Level of investment and financing activities in farm plans associated with points on Curve IX.

	Year 0	1	2	3	4	5
Point A						
Save Cash, first period ($)		40,331	41,204	42,092	42,997	43,918
Save Cash, second period ($)		41,671	42,556	43,458	44,376	45,310
Point B						
Machinery Investment and Financing:						
Labor Intensive Crop Production (unit)	0.41		0.04			
Intermediate Crop Production (unit)			0.04			
Capital Intensive Combine (unit)	0.12		0.07			
Pay Cash ($)	12,489		4,089			
Hog Facility Investment:						
Pasture Farrowing (litter space)	14		14		1	
Partial Confinement Farrowing (litter space)	3					
Partial Confinement Feeding (hog space)	129		112		2	
Save Cash, first period ($)			14,597	28,986	38,008	53,934
Save Cash, second period ($)			9,642	22,201	31,508	50,930
Pay Principal, Long-Term 9% Loan ($)		10,804	4,105	1,934	2,144	
Pay Interest, Long-Term 9% Loan ($)		972	369	332	193	
Point C						
Machinery Investment and Financing:						
Intermediate Crop Production (unit)	0.25					
Capital Intensive Crop Production (unit)	0.19					
Capital Intensive Combine (unit)	0.13					
Pay Cash ($)	20,204					
Hog Facility Investment:						
Partial Confinement Farrowing (litter space)	17					
Partial Confinement Feeding (hog space)	138		30			
Save Cash, first period ($)			14,796	28,579	40,538	53,853
Save Cash, second period ($)		13,544	22,290	35,872	48,109	72,427
Pay Principal, Long-Term 9% Loan ($)		5,376	8,933	1,971	2,151	

Pay Interest, Long-Term 9% Loan ($)		1,539	1,172	369	194	
Point D						
Machinery Investment and Financing:						
Capital Intensive Crop Production (unit)	0.74			0.01	0.02	0.04
Labor Intensive Combine (unit)	0.45		0.03	0.10	0.06	0.01
Pay Cash ($)	38,478		601	2,156		
Intermediate Credit ($)	5,092				1,873	2,235
Hog Facility Investment:						
Partial Confinement Farrowing (litter space)	3					
Partial Confinement Feeding (hog space)	13			2		
Total Confinement Feeding (hog space)	74					
Short-Term Loan, first period ($)		32,708	5,880			
Save Cash, first period ($)				15,897	35,001	48,162
Save Cash, second period ($)		2,984	18,177	34,799	56,928	100,076
Pay Principal, Intermediate 9% Loan ($)		5,092				
Pay Interest, Intermediate 9% Loan ($)		458				
Pay Principal, Long-Term 9% Loan ($)		4,303	601	664	604	
Pay Interest, Long-Term 9% Loan ($)		545	160	114	54	
Point E						
Machinery Investment and Financing:						
Capital Intensive Crop Production (unit)	0.77		0.29			
Capital Intensive Combine (unit)	0.37		0.39		0.01	0.09
Pay Cash ($)	38,222					
Intermediate Credit ($)	10,328		25,909		256	2,657
Hog Facility Investment:						
Total Confinement Feeding (hog space)	142					
Short-Term Loan, first period ($)		50,000	50,000	50,000	50,000	50,000
Save Cash, second period ($)		26,303	51,019	76,747	91,757	125,933
Pay Principal, Intermediate 9% Loan ($)					10,328	
Pay Interest, Intermediate 9% Loan ($)		930	930	3,261	3,261	2,355
Pay Principal, Long-Term 9% Loan ($)		644	702	766	834	909
Pay Interest, Long-Term 9% Loan ($)		640	582	519	450	375

corresponding point on Curve II. The main difference is that hog facilities purchased at Points B, C, D, and E of Curve IX are financed using repayment plan C, which is the Standard plan, while the hog facilities purchased at corresponding points on Curve II are financed using repayment plan D, which is the Standard plan with deferred principal payments. Since repayment plan D is a nonconventional loan, it is not available to farm plans associated with points on Curve IX.

The availability of only conventional loan terms also causes some differences between the farm plan specified by the conventional linear programming solution of each curve. Slightly more machinery is purchased at Point E than is purchased at Point E of Curve II. Point E of Curve IX also specifies investment in a total confinement hog feeding facility in the initial period with space for about 142 hogs, which is 66 hog spaces smaller than the facility purchased at Point E of Curve II.

Production Plans

The production plan associated with each point on Curve IX is shown in Table 5.59. The plans for Points A, B, C, and D are practically identical to the plan associated with corresponding points on Curve II. The production plan for Point E is a little different than the plan for Point E on Curve II because of the difference in investment plans. Point E of Curve IX specifies more land to be cash rented and crop-share rented, and fewer hogs to be fed than specified at Point E of Curve II.

Table 5.59. Level of production activities in farm plans associated with points on Curve IX.

	Year 1	2	3	4	5
Point A					
Wife Work Off-Farm	1.00	1.00	1.00	1.00	1.00
Point B					
Wife Work Off-Farm	1.00	1.00	1.00	1.00	1.00
Crop-Share Rented Land:					
Continuous Corn (acres)	108.41	214.76	214.76	211.00	2.91
Corn-Soybean-Oats Rotation (acres)	71.13			3.75	
Pasture Farrowing (litters)	28.74	55.84	55.80	58.24	29.12
Partial Confinement Farrowing (litters)	18.72	11.68	11.50	9.92	
Place Feeder Pigs on Feed:					
Partial Confinement, third quarter (pigs)	26.68	20.45	21.01	14.72	
Partial Confinement, fourth quarter (pigs)	102.12	220.35	220.19	228.78	
Point C					
Wife Work Off-Farm	1.00	1.00	1.00	1.00	1.00
Crop-Share Rented Land:					
Continuous Corn (acres)	71.97	87.63	87.70	86.60	
Corn-Soybean Rotation (acres)	23.58	54.90	54.62	51.80	
Corn-Soybean-Oats Rotation (acres)	162.12	115.17	115.38	119.31	203.52
Partial Confinement Farrowing (litters)	101.16	102.30	102.30	102.48	102.48
Place Feeder Pigs on Feed:					
Partial Confinement, third quarter (pigs)	31.49	31.15	31.26	31.21	
Partial Confinement, fourth quarter (pigs)	106.20	136.37	136.37	136.60	
Point D					
Wife Work Off-Farm	1.00	1.00	1.00	1.00	1.00
Crop-Share Rented Land:					
Continuous Corn (acres)	138.57	113.16	36.26		
Corn-Soybean Rotation (acres)	374.70	390.12	470.66	517.82	496.06
Corn-Soybean-Oats Rotation (acres)					49.98

Partial Confinement Farrowing (litters)	15.90	15.90	15.90	12.50	6.26
Place Feeder Pigs on Feed:					
Partial Confinement, first quarter (pigs)	13.05	12.54	2.22		
Partial Confinement, fourth quarter (pigs)	.51	13.05	15.27	15.27	
Total Confinement, first quarter (pigs)	74.42	74.42	74.42	74.42	68.46
Total Confinement, third quarter (pigs)	53.26	74.42	74.42	28.85	
Total Confinement, fourth quarter (pigs)				5.97	
<u>Point E</u>					
Wife Work Off-Farm	1.00				
Crop-Share Rented Land:					
Continuous Corn (acres)	155.41				
Corn-Soybean Rotation (acres)	370.88	722.44	722.44	721.78	714.92
Cash Rented Land:					
Custom Grow Corn (acres)	116.10	168.88	309.45	378.82	439.00
Custom Grow Corn-Soybean Rotation (acres)		22.12	22.12	30.58	118.24
Harvest Corn (acres)	116.10	179.94	320.51	394.11	498.12
Harvest Soybeans (acres)		11.06	11.06	15.29	59.12
Place Feeder Pigs on Feed:					
Total Confinement, first quarter (pigs)	141.88	141.88	141.88	141.88	141.88
Total Confinement, third quarter (pigs)	72.70	141.88	141.88	129.40	

Marketing Plans

The plan associated with each point on Curve IX for marketing and buying agricultural products is shown in Table 5.60. The plans associated with Points B, C, and D are practically identical to those specified for corresponding points on Curve II. The plan associated with Point E is also very similar to that specified for Point E of Curve II, given the differences in production plans.

Resource Control, Debt Use, and Net Worth

The yearly balance sheets and the value of resources controlled in each year for each point on Curve IX are given in Table 5.61. Since the farm plans for Points B, C, and D are so similar to those for corresponding points on Curve II, the yearly balance sheets and resources controlled at these points on Curve IX are also practically identical to those of corresponding points on Curve II. Since the farm plan for Point E is a little different than that for Point E of Curve II, there are also some differences in the yearly balance sheets for these two points. Point E has less outstanding debt, less ownership of long-term assets, more ownership of intermediate assets, and less net worth in each year than Point E of Curve II.

Likewise, the leverage and liquidity ratios for each year for Points B, C, and D on Curve IX, shown in Table 5.62, are practically identical to those for corresponding points on Curve II. The leverage and liquidity ratios associated with Point E are lower in each year than those associated with Point E on Curve II, with the exception of the current ratio in year five. The average growth in net worth per

Table 5.60. Marketing and buying plans for agricultural products associated with points on Curve IX.

	Year 1	2	3	4	5
Point B					
Sell Corn, first period (bu.)		4,577	7,790	7,778	7,889
Sell Soybeans, second period (bu.)	415			22	
Sell Oats, second period (bu.)	889			47	
Sell Hogs, second quarter (cwt.)		218	470	470	488
Sell Sows, first quarter (cwt.)		4	2	2	1
Sell Sows, fourth quarter (cwt.)	27				
Sell Feeder Pigs, first quarter (pigs)	25	36	18	21	7
Sell Feeder Pigs, second quarter (pigs)	126	220	220	229	204
Sell Feeder Pigs, third quarter (pigs)	23	1			
Sell Feeder Pigs, fourth quarter (pigs)	23				
Store Corn, second period (bu.)	5,923	9,702	9,700	9,569	
Buy Corn, first period (bu.)	597				
Buy Gilts (head)	28				
Replacement Gilts (head)		26	20	20	14
Point C					
Sell Corn, first period (bu.)		3,481	4,306	4,303	4,233
Sell Corn, second period (bu.)	265				2,356
Sell Soybeans, second period (bu.)	1,152	1,152	1,151	1,149	1,152
Sell Oats, second period (bu.)	2,027	1,440	1,442	1,491	2,469
Sell Hogs, second quarter (cwt.)		227	291	291	292
Sell Sows, first quarter (cwt.)		22	22	22	22
Sell Sows, fourth quarter (cwt.)	44	44	44	44	44
Sell Feeder Pigs, first quarter (pigs)	133	271	273	273	273
Sell Feeder Pigs, second quarter (pigs)	135	136	136	137	137
Sell Feeder Pigs, third quarter (pigs)	238	242	241	242	273
Sell Feeder Pigs, fourth quarter (pigs)	29				137
Store Corn, second period (bu.)	5,254	6,224	6,223	6,154	
Buy Corn, first period (bu.)	1,264				

Buy Gilts (head)	60				
Replacement Gilts (head)		30	30	30	30
Point D					
Sell Corn, first period (bu.)		6,552	11,193	13,055	12,901
Sell Corn, second period (bu.)	9,393	3,835			14,488
Sell Soybeans, second period (bu.)	3,191	3,414	4,118	4,531	4,635
Sell Oats, second period (bu.)					625
Sell Hogs, first quarter (cwt.)		103	148	153	62
Sell Hogs, second quarter (cwt.)		1	28	33	45
Sell Hogs, third quarter (cwt.)	187	186	164	159	146
Sell Sows, first quarter (cwt.)		3	3	3	2
Sell Sows, fourth quarter (cwt.)	7	7	7	6	4
Sell Feeder Pigs, second quarter (pigs)	21	21	21	21	25
Sell Feeder Pigs, fourth quarter (pigs)	21	8	6		25
Store Corn, second period (bu.)	7,563	12,166	13,975	13,716	
Buy Corn, first period (bu.)	1,014				
Buy Feeder Pigs, first quarter (pigs)	66	44	34	39	54
Buy Feeder Pigs, third quarter (pigs)	11	32	32		
Buy Gilts (head)	10				
Replacement Gilts (head)		5	5	3	
Point E					
Sell Corn, second period (bu.)	30,444	38,341	52,257	59,683	71,425
Sell Soybeans, second period (bu.)	3,245	6,708	6,708	6,851	8,325
Sell Hogs, first quarter (cwt.)		155	303	303	276
Sell Hogs, third quarter (cwt.)	303	303	303	303	303
Buy Corn, first period (bu.)	1,320	1,320	1,320	1,320	1,320
Buy Feeder Pigs, first quarter (pigs)	142	142	142	142	142
Buy Feeder Pigs, third quarter (pigs)	73	142	142	129	

Table 5.61. Yearly balance sheets associated with points on Curve IX.

	Year					
	0	1	2	3	4	5
	(dollars)					
Point A						
Assets						
Current	40,000	42,713	43,620	44,544	45,485	46,443
Liabilities						
Current	0	1,831	1,841	1,851	1,861	1,871
Net Worth	40,000	40,882	41,779	42,693	43,624	44,572
Point B						
Assets						
Current	24,810	30,152	38,063	50,964	60,043	53,337
Intermediate	12,489	11,240	13,671	12,013	10,355	8,697
Long-Term	13,509	12,079	19,315	16,847	14,792	14,995
Total	50,808	53,471	71,049	79,824	85,190	77,029
Liabilities						
Current	0	0	2,011	5,899	6,277	12,074
Intermediate	0	0	0	0	0	0
Long-Term	10,808	0	3,669	1,752	0	0
Total	10,808	0	5,680	7,651	6,277	12,074
Net Worth	40,000	53,471	65,369	72,173	78,913	64,955
Assets Controlled	50,808	233,471	286,049	294,824	300,190	80,029
Point C						
Assets						
Current	15,520	31,477	43,197	57,124	69,533	76,231
Intermediate	20,204	18,183	16,163	14,143	12,122	10,102
Long-Term	21,381	19,300	18,680	16,446	14,238	14,754
Total	57,105	68,960	78,040	87,713	95,893	101,087
Liabilities						
Current	0	620	6,799	8,698	9,065	16,587
Intermediate	0	0	0	0	0	0
Long-Term	17,105	11,729	4,091	2,124	0	0
Total	17,105	12,349	10,890	10,822	9,065	16,587
Net Worth	40,000	56,611	67,150	76,891	86,828	84,500
Assets Controlled	57,105	326,960	336,040	345,713	353,893	305,087

Table 5.61 (continued)

	Year 0	1	2	3	4	5
	(dollars)					
Point D						
Assets						
Current	0	22,437	49,152	69,919	88,998	102,700
Intermediate	43,570	39,213	35,397	32,920	29,973	27,164
Long-Term	7,607	6,852	6,097	5,440	4,824	4,989
Total	51,177	68,502	90,646	108,279	123,795	134,853
Liabilities						
Current	0	3,616	7,100	10,340	14,060	29,453
Intermediate	5,092	0	0	0	1,873	4,108
Long-Term	6,085	1,782	1,180	604	0	0
Total	11,177	5,398	8,280	10,944	15,933	33,561
Net Worth	40,000	63,104	82,366	97,335	107,862	101,292
Assets Controlled	51,177	581,502	593,646	615,279	641,795	680,853
Point E						
Assets						
Current	0	32,013	62,155	88,526	103,044	129,081
Intermediate	48,550	43,695	62,158	54,713	47,497	42,417
Long-Term	8,886	7,994	7,101	6,209	5,316	4,424
Total	57,436	83,702	131,414	149,448	155,857	175,922
Liabilities						
Current	0	10,493	14,060	16,807	18,060	24,420
Intermediate	10,328	10,328	36,237	36,237	26,166	28,823
Long-Term	7,108	6,464	5,762	4,996	4,161	3,252
Total	17,436	27,285	56,059	58,040	48,387	56,495
Net Worth	40,000	56,417	75,355	91,408	107,470	119,427
Assets Controlled	57,436	725,702	1044,414	1203,448	1286,857	1447,922

Table 5.62. Leverage and liquidity ratios, and growth in net worth for points on Curve IX.

Year	Point A	Point B	Point C	Point D	Point E
Debt-to-Equity Ratio					
0	0.00	0.27	0.43	0.28	0.44
1	0.04	0.00	0.22	0.08	0.48
2	0.04	0.09	0.16	0.10	0.74
3	0.04	0.11	0.14	0.11	0.64
4	0.04	0.08	0.10	0.15	0.45
5	0.04	0.19	0.20	0.33	0.47
Current Ratio					
0	--	--	--	--	--
1	23.33	--	50.77	6.20	3.05
2	23.69	18.93	6.35	6.92	4.42
3	24.06	8.64	6.57	6.76	5.27
4	24.44	9.57	7.67	6.33	5.71
5	24.87	4.42	4.60	3.49	5.29
Growth in Net Worth During Year					
1	2.2%	33.7%	41.5%	57.8%	41.0%
2	2.2	18.2	18.6	30.5	33.6
3	2.2	10.4	14.5	18.2	21.3
4	2.2	9.3	12.9	10.8	17.6
5	2.2	-17.7	-2.7	-6.1	11.1
Average Growth Per Year					
	2.2%	10.8%	17.0%	22.5%	24.9%
Average Growth Per Year During First Four Years					
	2.2%	17.9%	21.9%	29.3%	28.4%

year for each point on Curve IX is practically identical to that of corresponding points on Curve II.

Income and Consumption

The undiscounted expected disposable income, the resulting consumption, and the variance of income in each year for each point on Curve IX are shown in Table 5.63. The pattern of disposable income, consumption, and variance of income is slightly different in some cases, but is generally the same as the pattern of these values associated with corresponding points on Curve II. The probabilities of disposable income being less than zero, \$4,000, and \$8,000 in each year for each point on Curve IX are given in Table 5.64. As one would expect, these are also practically identical to the probabilities associated with corresponding points on Curve II.

Curve X

The last set of initial conditions represents a beginning cash or equity position of \$40,000, no opportunity for the wife to work off the farm, consumption function α, availability of only conventional loan terms, and a debt-to-equity ratio of less than 2.0. This set of initial conditions is identical to Curve IX, except that there is no opportunity for the wife to work off the farm (see Table 5.1). Since the farm plan specified by each point on Curve IX specified that the wife work off the farm, one would expect Curve X to be to the left of Curve IX.

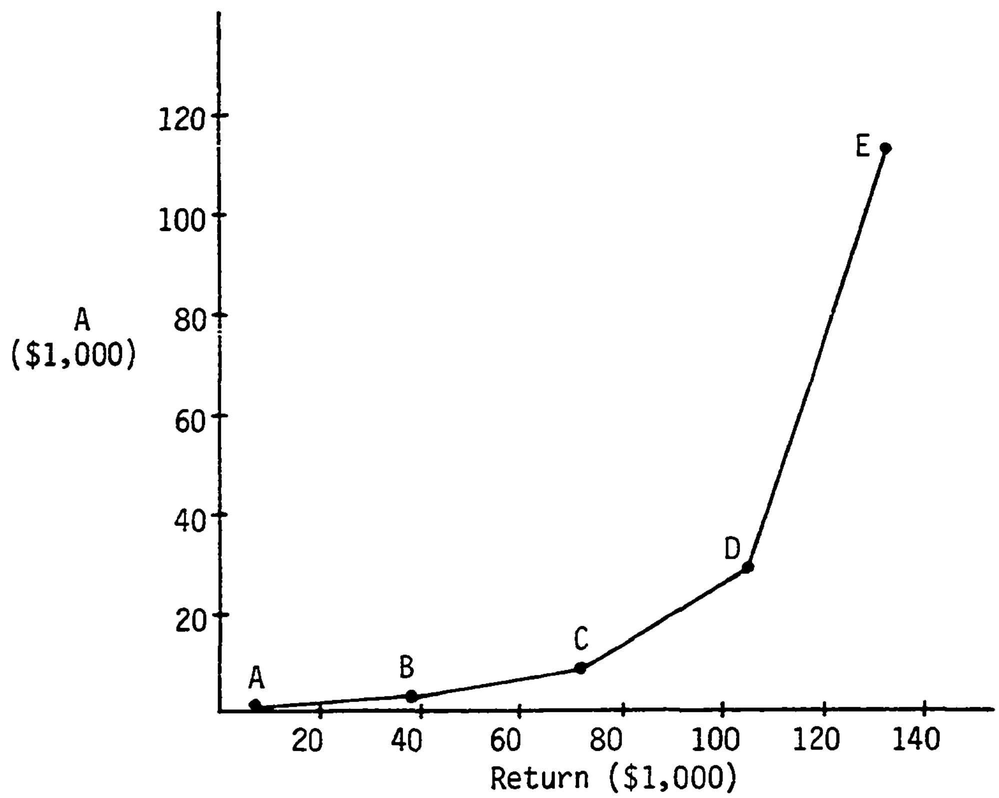
Curve X is shown in Figure 5.10. As expected, Curve X is everywhere to the left of Curve IX. As was found in comparing Curve VI with

Table 5.63. Expected disposable income, variance, and consumption in each year for each point on Curve IX.

Point	Year	Disposable Income	Variance	Standard Deviation	Consumption
A	1	$ 8,219	0	0	$ 7,337
	2	8,253	0	0	7,356
	3	8,288	0	0	7,374
	4	8,324	0	0	7,393
	5	8,360	0	0	8,360
B	1	0	$ 1,116,848	$ 1,057	4,000
	2	8,857	324,211	569	7,677
	3	18,764	732,228	856	11,987
	4	19,437	787,672	888	12,237
	5	27,779	732,437	856	15,123
C	1	3,380	11,083,503	3,329	4,000
	2	20,365	9,683,309	3,112	12,582
	3	23,393	10,190,079	3,192	13,658
	4	23,900	10,476,896	3,237	13,828
	5	32,467	28,468,978	5,336	16,568
D	1	13,657	122,819,719	11,082	9,932
	2	20,900	81,721,043	9,040	12,780
	3	25,660	73,729,235	8,587	14,420
	4	29,940	93,943,111	9,692	15,810
	5	43,698	384,436,138	19,607	19,743
E	1	25,847	683,320,348	26,140	14,482
	2	29,940	1,333,244,164	36,514	15,810
	3	32,687	2,170,921,664	46,593	16,634
	4	33,940	2,704,888,503	52,009	17,010
	5	39,580	3,864,326,419	62,164	18,630

Table 5.64. Probability of disposable income falling below certain levels in each year for each point on Curve IX.

Point	Year	$P(\mu_I < 0)$	$P(\mu_I < \$4000)$	$P(\mu_I < \$8000)$
A	1	0.0	0.0	0.0
	2	0.0	0.0	0.0
	3	0.0	0.0	0.0
	4	0.0	0.0	0.0
	5	0.0	0.0	0.0
B	1	0.5	1.0	1.0
	2	0.0	0.0	0.0655
	3	0.0	0.0	0.0
	4	0.0	0.0	0.0
	5	0.0	0.0	0.0
C	1	0.1539	0.5753	0.9177
	2	0.0	0.0	0.0
	3	0.0	0.0	0.0
	4	0.0	0.0	0.0
	5	0.0	0.0	0.0
D	1	0.1093	0.1922	0.3050
	2	0.0104	0.0307	0.0764
	3	0.0014	0.0059	0.0197
	4	0.0	0.0037	0.0119
	5	0.0129	0.0217	0.0344
E	1	0.1611	0.2005	0.2483
	2	0.2061	0.2389	0.2743
	3	0.2420	0.2676	0.2981
	4	0.2578	0.2810	0.3085
	5	0.2611	0.2843	0.3050



Point	Return	A
A	$ 5,887	$ 0
B	39,000	2,770
C	72,000	8,791
D	105,000	27,705
E	137,907	113,740

Figure 5.10. Efficient E,A Curve X.

Curve V and Curve VIII with Curve III, a beginning farm family with no opportunity to earn any off-farm income will have to accept more risk to reach the same return level as a farm family that has an opportunity for the wife to earn an off-farm income of $8,000 per year. Because the farm plan associated with Point E of Curve IX specifies that the wife work off the farm only during year one, the farm plans specified by Point E on Curve IX and Curve X are very similar. However, the farm plans associated with Points A, B, C, and D of Curve X are quite different than those specified by corresponding points on Curve IX, because each point represents a much lower return level than those of corresponding points on Curve IX.

Investment and Financing Plans

The investment and financing plan of each point on Curve X is shown in Table 5.65. The investment plan of Point E specifies the purchase of the same type of machinery system as Point E of Curve IX, but there is much more machinery investment in the initial period for Curve X than at Point E of Curve IX. The investment plan of Point D specifies the purchase of the same type of machinery system as Point D on Curve IX, but there is more machinery investment over the five year period than at Point D of Curve IX. At Points B and C there is more machinery investment than at corresponding points on Curve IX, and this investment is in more labor intensive systems than at corresponding points on Curve IX. Except for Point C, more intermediate debt is used to finance machinery investment at each point than at corresponding points on Curve IX.

The investment plan of each point specifies purchasing the same type of hog facilities that are purchased at corresponding points on Curve IX, but the amount of investment and the timing of the investment are quite different. The investment plan of Point E specifies the

Table 5.65. Level of investment and financing activities in farm plans associated with points on Curve X.

	Year 0	1	2	3	4	5
Point A						
Save Cash, first period ($)		37,915	35,330	32,646	29,859	26,967
Save Cash, second period ($)		36,778	34,134	31,389	28,540	25,582
Point B						
Machinery Investment and Financing:						
Labor Intensive Crop Production (unit)	0.45			0.17		
Labor Intensive Combine (unit)	0.13		0.13	0.12		
Pay Cash ($)	12,259		2,432	5,188		
Intermediate Credit ($)				876		
Hog Facility Investment:						
Pasture Farrowing (litter space)			10	19	4	
Partial Confinement Farrowing (litter space)	9					
Partial Confinement Feeding (hog space)	46		128	124	19	
Save Cash, first period ($)		15,671	6,877	8,954	21,965	38,080
Save Cash, second period ($)			3,545		10,101	31,177
Pay Interest, Intermediate 9% Loan ($)					79	79
Pay Principal, Long-Term 9% Loan ($)		7,892	7,541	2,460	2,849	3,106
Pay Interest, Long-Term 9% Loan ($)		710	679	859	803	547
Point C						
Machinery Investment and Financing:						
Intermediate Crop Production (unit)	0.50					
Capital Intensive Crop Production (unit)	0.10		0.02			
Labor Intensive Combine (unit)	0.21					
Capital Intensive Combine (unit)	0.05					
Pay Cash ($)	24,758		719			
Hog Facility Investment:						
Partial Confinement Farrowing (litter space)	21				4	
Partial Confinement Feeding (hog space)	114		101	1		

Short-Term Loan, first period ($)		7,697				
Save Cash, first period ($)				12,309	24,254	43,206
Save Cash, second period ($)		9,246	6,729	17,163	30,288	49,843
Pay Principal, Long-Term 9% Loan ($)		1,755	12,679	7,322	2,819	
Pay Interest, Long-Term 9% Loan ($)		1,742	1,965	827	254	
Point D						
Machinery Investment and Financing:						
Capital Intensive Crop Production (unit)	0.75			0.05	0.02	0.16
Labor Intensive Combine (unit)	0.46		0.14		0.05	
Capital Intensive Combine (unit)				0.02	0.02	0.08
Pay Cash ($)	36,197		2,730	2,773	2,624	
Intermediate Credit ($)	7,999					10,087
Hog Facility Investment:						
Partial Confinement Farrowing (litter space)	13					5
Partial Confinement Feeding (hog space)	49		20			43
Total Confinement Feeding (hog space)	84					
Short-Term Loan, first period ($)		32,666	22,193			
Save Cash, first period ($)					20,269	28,567
Save Cash, second period ($)		6,085	1,758	19,672	41,449	90,335
Pay Principal, Intermediate 9% Loan ($)			7,999			
Pay Interest, Intermediate 9% Loan ($)			718			
Pay Principal, Long-Term 9% Loan ($)		1,379	11,030	1,717	1,817	2,154
Pay Interest, Long-Term 9% Loan ($)		1,369	1,316	232	164	265
Point E						
Machinery Investment and Financing:						
Capital Intensive Crop Production (unit)	1.07					
Capital Intensive Combine (unit)	0.50		0.30		0.03	0.05
Pay Cash ($)	32,406					
Intermediate Credit ($)	33,826		9,417		1,015	1,516
Hog Facility Investment:						
Total Confinement Feeding (hog space)	123					
Short-Term Loan, first period ($)		50,000	50,000	50,000	50,000	50,000

Table 5.65 (continued)

	Year 0	1	2	3	4	5
Save Cash, second period ($)		33,628	59,896	85,111	77,286	107,742
Pay Principal, Intermediate 9% Loan ($)					33,826	
Pay Interest, Intermediate 9% Loan ($)		3,044	3,044	3,892	3,892	939
Pay Principal, Long-Term 9% Loan ($)		560	610	666	725	790
Pay Interest, Long-Term 9% Loan ($)		556	505	450	391	325

purchase of a total confinement feeding facility in the initial period with space for about 123 hogs, which is 19 hog spaces smaller than the facility purchased at Point E of Curve IX.

The investment plan of Point D specifies investment in a partial confinement farrowing facility in the initial period with space for about 13 litters and in year five with space for about 5 litters, which is 10 litter spaces larger in the initial period and 4 litter spaces larger in year five than the facility purchased at Point D of Curve IX. Point D also specifies investment in a partial confinement feeding facility in the initial period with space for about 49 hogs, in year two with space for about 20 hogs, and in year five with space for about 43 hogs. This is entirely different from the investment in a partial confinement feeding facility at Point D of Curve IX, where space for about 13 hogs is purchased in the initial period and space for about 2 hogs is purchased in year three. Also at Point D there is investment in a total confinement feeding facility in the initial period with space for about 84 hogs, which is 10 hog spaces larger than the facility purchased at Point D of Curve IX.

The investment plan of Point C specifies investment in a partial confinement farrowing facility in the initial period with space for about 21 litters and in year five with space for about 4 litters, which is 4 litter spaces larger in the initial period and 4 litter spaces larger in year five than the facility purchased at Point C of Curve IX. Also at Point C there is investment in a partial confinement feeding facility in the initial period with space for about 114 hogs and in year two with space for about 101 hogs, which is 24 hog spaces smaller in the initial period and 71 hog spaces larger in year two than the facility purchased at Point C of Curve IX.

The investment plan of Point B specifies investment in pasture farrowing facilities in year two with space for about 10 litters, in year three with space for about 19 litters, and in year four with space for about 4 litters. This is different from the purchase of pasture farrowing facilities at Point B of Curve IX, where about 14 litter spaces are purchased in the initial period, about 14 litter spaces are purchased in year two, and about 1 litter space is purchased in year four. Point B also specifies investment in a partial confinement farrowing facility in the initial period with space for about 9 litters, which is 6 litter spaces larger than the facility purchased at Point B of Curve IX. Also at Point B there is investment in a partial confinement feeding facility in the initial period with space for about 46 hogs, in year two with space for about 128 hogs, in year three with space for about 124 hogs, and in year four with space for about 19 hogs. This facility is 83 hog spaces smaller in the initial period, 16 hog spaces larger in year two, 124 hog spaces larger in year three, and 17 hog spaces larger in year four than the facility purchased at Point B of Curve IX.

As in Curve IX, each of these hog facility investments is financed using repayment plan C which is the Standard plan. The pattern of repayment of this long-term debt is about the same as at corresponding points on Curve IX. As in all previous curves, the financing plan of

Point E specifies the use of a short-term operating loan of $50,000 in the first period of each year. At Point D the same amount of short-term borrowing is used in the first period of year one as at Point D of Curve IX, but more short-term debt is used in the first period of year two on Curve X. At Point C a short-term loan of $7,697 is incurred in the first period of year one, while at Point C of Curve IX no short-term debt is used. No short-term debt is used at Point B of either curve.

The investment plan for Point E of Curve X specifies more cash to be saved in the second period of years one through three, but less in the second period of years four and five than at Point E of Curve IX. At Point D less cash is saved in each period, except the second period of year one, than at Point D of Curve IX. At Point C less cash is saved in each period than at Point C of Curve IX. At Point B less cash is saved in each period, except the first period of year one, than is saved at Point B of Curve IX.

Production Plans

The production plan associated with each point of Curve X is shown in Table 5.66. As in all previous curves, the conventional linear programming solution specifies cash renting land and crop-share renting land. The amount of land cash rented is less in each year, except years two and three, than the amount cash rented at Point E of Curve IX. This cash rented land is used to produce corn and soybeans grown by a custom operator. The amount of land crop-share rented at Point E is 202 acres more in year one and 6 acres more in years two through five

Table 5.66. Level of production activities in farm plans associated with points on Curve X.

	Year 1	Year 2	Year 3	Year 4	Year 5
Point B					
Crop-Share Rented Land:					
Continuous Corn (acres)	34.09	180.38	272.03	272.03	3.32
Corn-Soybean-Oats Rotation (acres)	162.18	15.90			
Pasture Farrowing (litters)		20.28	57.64	66.50	
Partial Confinement Farrowing (litters)	52.62	52.62	32.12	21.04	
Place Feeder Pigs on Feed:					
Partial Confinement, third quarter (pigs)	28.40	32.46	25.98	13.85	
Partial Confinement, fourth quarter (pigs)	17.41	141.21	271.96	302.94	
Point C					
Crop-Share Rented Land:					
Continuous Corn (acres)	30.38	136.38	136.38	126.71	
Corn-Soybean Rotation (acres)	38.40				
Corn-Soybean-Oats Rotation (acres)	266.46	209.22	209.22	215.34	111.60
Partial Confinement Farrowing (litters)	128.70	130.68	130.68	134.44	84.04
Place Feeder Pigs on Feed:					
Partial Confinement, third quarter (pigs)	34.83	39.88	42.00	14.56	
Partial Confinement, fourth quarter (pigs)	78.87	175.21	174.21	201.65	
Point D					
Crop-Share Rented Land:					
Continuous Corn (acres)	140.56	21.37	43.12		
Corn-Soybean Rotation (acres)	369.94	478.06	500.28	558.70	558.14
Corn-Soybean-Oats Rotation (acres)		11.07			111.03
Partial Confinement Farrowing (litters)	78.12	78.12	73.72	72.32	36.16
Place Feeder Pigs on Feed:					
Partial Confinement, first quarter (pigs)	49.35	50.73			
Partial Confinement, fourth quarter (pigs)	18.70	69.43	69.43	69.43	
Total Confinement, first quarter (pigs)	84.42	84.42	84.42	49.68	49.68

Total Confinement, third quarter (pigs)	84.42	84.42	49.68		
Total Confinement, fourth quarter (pigs)			34.74	34.74	
Point E					
Crop-Share Rented Land:					
Continuous Corn (acres)	250.93				
Corn-Soybean Rotation (acres)	476.96	727.88	727.88	725.26	721.36
Cash Rented Land:					
Custom Grow Corn (acres)	83.95	203.57	340.81	250.78	344.29
Custom Grow Corn-Soybean Rotation (acres)		35.44	35.44	68.94	118.94
Harvest Corn (acres)	83.95	221.29	358.53	285.25	403.76
Harvest Soybeans (acres)		17.72	17.72	34.47	59.47
Place Feeder Pigs on Feed:					
Total Confinement, first quarter (pigs)	123.24	123.24	123.24	123.24	124.24
Total Confinement, third quarter (pigs)	93.49	123.24	124.24	73.80	

than the amount crop-share rented at Point E of Curve IX. This crop-share rented land is used to produce corn and soybeans with the acreages of each crop rotation shown in Table 5.66.

As in all previous curves, all the land farmed at Points B, C, and D is crop-share rented. The amount of land crop-share rented at Point D is less in year one, but more in years two through five than the amount crop-share rented at Point D of Curve IX. The amount of land crop-share rented at Point C is more in each year, except year five, than the amount crop-share rented at Point C of Curve IX. The amount of land crop-share rented at Point B is more in each year, except year two, than the amount of land crop-share rented at Point B of Curve IX. At each point this crop-share rented land is used to produce corn, soybeans, and oats, with the acreages of the various crop rotations shown in Table 5.66.

The hog farrowing and feeding activities specified by each point are very similar to those specified by corresponding points on Curve IX, given the differences in the size of the hog facilities. The production plan of Point E specifies that the total confinement feeding facility be used in exactly the same manner as specified by Point E of Curve IX, but because the facility is smaller fewer hogs are fed in each quarter than are fed at Point E of Curve IX. The production plan of Point D specified that the partial confinement farrowing facility be used to farrow about 78 litters in years one and two, about 74 litters in year three, about 72 litters in year four, and about 36 litters in year five. At Point D the partial confinement feeding facility is used to capacity in the first quarter of each year, the second quarter of year one, and the fourth quarter of years two through four. This facility is also partially used in the second quarter of years two through five and the fourth quarter of year one. Also at Point D the total confinement feeding facility is used to capacity in the first quarter of each year, the second quarter of years one through three, the third quarter of years one and two, and the fourth quarter of years one through three. This facility is also partially used in the second quarter of years four and five, the third quarter of year three, and the fourth quarter of year four.

The production plan of Point C specifies that the partial confinement farrowing facility be used to farrow about 129 litters in year one, about 131 litters in years two and three, about 134 litters in year four, and about 84 litters in year five. The production plan of Point B specifies that the pasture farrowing facilities be used to farrow about 20 litters in year two, about 58 litters in year three, and about 66 litters in year four. Also at Point B the partial confinement farrowing facility is used to farrow about 53 litters in years one and two, about 32 litters in year three, and about 21 litters in year four. As in all previous curves, the production plans of Points B and C specify that the partial confinement feeding facility be used to capacity in the third and fourth quarters of years one through four. Feeder pigs are put on feed in the third quarter of each year to provide the replacement gilts for the next year's farrowing operation.

The remaining capacity is then used to put feeder pigs on feed in the fourth quarter of each year.

Marketing Plans

The plan associated with each point on Curve X for marketing and buying agricultural products is shown in Table 5.67. These plans are very similar to those plans associated with corresponding points on Curve IX, given the differences in the levels of production activities. One major difference is that at Point D the percentage of corn available for sale at harvest that is stored until the first period of the next year is 50 percent in year one and 100 percent in years two through four, while at Point D of Curve IX the percentages are 45 percent in year one, 76 percent in year two, and 100 percent in years three and four.

Resource Control, Debt Use, and Net Worth

The yearly balance sheets and the value of resources controlled in each year for each point on Curve X are shown in Table 5.68. As in all previous curves, the conventional linear programming solution specifies the highest debt use, the highest level of asset ownership, and the highest level of resource control. Moving down Curve X to lower return-risk points results in less debt use, less asset ownership, and less resource control in each year of each successive point.

The absence of any opportunity for the wife to work off the farm at each point on Curve X causes some differences in the balance sheets of corresponding points on Curves IX and X. Point E specifies the ownership of less current assets after year two, less intermediate assets after year one, and less long-term assets each year than Point E

Table 5.67. Marketing and buying plans for agricultural products associated with points on Curve X.

	Year 1	2	3	4	5
Point B					
Sell Corn, first period (bu.)		2,850	6,505	9,863	10,148
Sell Soybeans, second period (bu.)	946	93			
Sell Oats, second period (bu.)	2,027	199			
Sell Hogs, second quarter (cwt.)		37	301	580	646
Sell Sows, first quarter (cwt.)		11	11	5	1
Sell Sows, fourth quarter (cwt.)	23				
Sell Feeder Pigs, first quarter (pigs)	70	140	99	36	7
Sell Feeder Pigs, second quarter (pigs)	70	141	272	303	233
Sell Feeder Pigs, third quarter (pigs)	112	108	32		
Sell Feeder Pigs, fourth quarter (pigs)	53				
Store Corn, second period (bu.)	3,842	8,314	12,275	12,267	
Buy Corn, first period (bu.)	650				
Buy Gilts (head)	31				
Replacement Gilts (head)		28	31	25	14
Point C					
Sell Corn, first period (bu.)		3,314	6,038	5,988	6,159
Sell Corn, second period (bu.)					1,084
Sell Soybeans, second period (bu.)	1,890	1,221	1,220	1,256	651
Sell Oats, first period (bu.)				344	
Sell Oats, second period (bu.)	3,331	2,615	2,270	2,692	1,395
Sell Hogs, first quarter (cwt.)					9
Sell Hogs, second quarter (cwt.)		168	374	372	430
Sell Sows, first quarter (cwt.)		28	28	28	27
Sell Sows, fourth quarter (cwt.)	56	57	57	60	44
Sell Feeder Pigs, first quarter (pigs)	172	346	348	340	231
Sell Feeder Pigs, second quarter (pigs)	172	175	175	202	202
Sell Feeder Pigs, third quarter (pigs)	308	309	306	318	131
Sell Feeder Pigs, fourth quarter (pigs)	93				174
Store Corn, second period (bu.)	5,310	8,495	8,488	8,146	
Store Oats, second period (bu.)			344		

Buy Corn, first period (bu.)	1,590				
Buy Gilts (head)	76	5			
Replacement Gilts (head)		34	39	41	10
Point D					
Sell Corn, first period (bu.)		5,655	10,413	12,412	12,157
Sell Corn, second period (bu.)	8,083				16,934
Sell Soybeans, second period (bu.)	3,237	4,248	4,377	4,889	5,531
Sell Oats, second period (bu.)		138			1,388
Sell Hogs, first quarter (cwt.)		129	135	60	
Sell Hogs, second quarter (cwt.)		40	148	222	222
Sell Hogs, third quarter (cwt.)	285	288	180	106	198
Sell Sows, first quarter (cwt.)		17	17	15	15
Sell Sows, fourth quarter (cwt.)	34	34	32	32	24
Sell Feeder Pigs, first quarter (pigs)		73	115	138	
Sell Feeder Pigs, second quarter (pigs)	104	104	104	104	140
Sell Feeder Pigs, third quarter (pigs)	124	124	141	185	
Sell Feeder Pigs, fourth quarter (pigs)	85	35			140
Store Corn, second period (bu.)	7,982	12,442	14,262	13,976	
Buy Corn, first period (bu.)	2,224				
Buy Feeder Pigs, first quarter (pigs)	30				
Buy Gilts (head)	46				
Replacement Gilts (head)		23	20	21	
Point E					
Sell Corn, second period (bu.)	35,282	42,779	56,366	49,662	62,219
Sell Soybeans, second period (bu.)	4,173	6,989	6,989	7,552	8,393
Sell Hogs, first quarter (cwt.)		200	263	263	158
Sell Hogs, third quarter (cwt.)	263	263	263	263	263
Buy Corn, first period (bu.)	1,146	1,146	1,146	1,146	1,146
Buy Feeder Pigs, first quarter (pigs)	123	123	123	123	123
Buy Feeder Pigs, third quarter (pigs)	93	123	123	74	

Table 5.68. Yearly balance sheets associated with points on Curve X.

	Year					
	0	1	2	3	4	5
	(dollars)					
Point A						
Assets						
Current	40,000	37,698	34,987	32,174	29,253	26,221
Liabilities						
Current	0	289	269	248	226	204
Net Worth	40,000	37,409	34,718	31,926	29,027	26,017
Point B						
Assets						
Current	25,768	27,314	27,872	35,568	45,828	33,250
Intermediate	12,259	11,033	11,996	75,984	13,908	11,833
Long-Term	9,865	8,905	16,374	25,034	23,812	20,280
Total	47,892	47,252	56,242	76,586	83,548	65,363
Liabilities						
Current	0	0	0	1,193	4,384	11,389
Intermediate	0	0	0	876	876	876
Long-Term	7,892	0	0	7,080	6,078	2,972
Total	7,892	0	0	9,149	11,338	15,237
Net Worth	40,000	47,252	56,242	67,437	72,210	50,126
Assets Controlled	47,892	243,252	252,242	348,586	355,548	68,363
Point C						
Assets						
Current	10,402	27,240	34,035	45,217	56,472	52,724
Intermediate	24,758	22,282	20,454	17,906	15,358	12,810
Long-Term	24,201	21,846	24,255	21,433	19,597	20,190
Total	59,361	71,368	78,744	84,556	91,427	85,724
Liabilities						
Current	0	0	3,260	7,420	8,660	13,232
Intermediate	0	0	0	0	0	0
Long-Term	19,361	17,605	9,150	1,872	0	0
Total	19,361	17,605	12,410	9,292	8,660	13,232
Net Worth	40,000	53,763	66,334	75,264	82,767	72,492
Assets Controlled	59,361	406,368	424,744	430,556	433,427	197,724

Table 5.68 (continued)

	Year 0	1	2	3	4	5
	(dollars)					
Point D						
Assets						
Current	0	30,316	36,257	56,722	74,983	93,297
Intermediate	44,195	39,776	37,813	35,617	33,008	36,854
Long-Term	19,016	17,149	16,167	14,205	12,243	13,565
Total	63,211	87,241	90,237	106,544	120,234	143,716
Liabilities						
Current	0	1,305	5,660	10,340	13,570	32,357
Intermediate	7,999	7,999	0	0	2,624	12,711
Long-Term	15,212	13,833	3,587	1,871	0	792
Total	23,211	23,137	9,247	12,211	16,194	45,860
Net Worth	40,000	64,104	80,990	94,333	104,040	97,856
Assets Controlled	63,211	597,241	600,237	649,544	679,234	812,716
Point E						
Assets						
Current	6,050	40,966	69,959	95,804	84,347	110,436
Intermediate	66,231	59,608	61,460	53,895	47,244	40,942
Long-Term	7,719	6,944	6,168	5,393	4,618	3,843
Total	80,000	107,518	137,587	155,092	136,209	155,221
Liabilities						
Current	0	10,340	14,851	16,902	18,060	22,033
Intermediate	33,826	33,826	43,242	43,242	10,432	11,948
Long-Term	6,174	5,615	5,005	4,339	3,615	2,825
Total	40,000	49,781	63,098	64,483	32,107	36,806
Net Worth	40,000	57,737	74,489	90,609	104,102	118,415
Assets Controlled	80,000	919,518	1104,587	1259,092	1181,209	1340,221

of Curve IX. Point E also specifies the use of more intermediate debt through year three, but less long-term debt in each year than Point E of Curve IX. However, Point E for Curve X has less net worth at the end of each year after year one.

Point D specifies more debt use, a higher level of intermediate and long-term asset ownership, and a higher level of resource control in each year than Point D of Curve IX. However, the net worth at the end of each year after year one for Point D is less than for Point D of Curve IX. At Point C there is more debt use through year two, more asset ownership through year two, more resource control in each year except year five, but less net worth at the end of each year than at Point C of Curve IX. Point B generates less asset ownership in each year, less outstanding debt through year two, and less net worth at the end of each year than Point B of Curve IX.

The leverage and liquidity ratios for each year of each point on Curve X are given in Table 5.69. The debt-to-equity ratio in this set of initial conditions was constrained to be less than 2.0, but this constraint was never reached. In fact, none of the debt-to-equity ratios is above 1.0. In general, the debt-to-equity ratios are higher in the early years but lower in later years than for corresponding points on Curve IX. Even though each point on Curve X represents a lower return level, each point uses relatively more debt in the early years than corresponding points on Curve IX. The lowest current ratio is 2.88, which occurs at the end of year five of Point D. In general,

Table 5.69. Leverage and liquidity ratios, and growth in net worth for points on Curve X.

Year	A	B	Point C	D	E
Debt-to-Equity Ratio					
0	0.00	0.20	0.48	0.58	1.00
1	0.01	0.00	0.33	0.36	0.86
2	0.01	0.00	0.19	0.11	0.85
3	0.01	0.14	0.12	0.13	0.71
4	0.01	0.16	0.10	0.16	0.31
5	0.01	0.30	0.18	0.47	0.31
Current Ratio					
0	--	--	--	--	--
1	130.44	--	--	24.00	3.96
2	130.06	--	10.44	6.41	4.71
3	129.73	29.81	6.09	5.49	5.67
4	129.44	10.45	6.52	5.53	4.67
5	128.53	2.92	3.98	2.88	5.01
Growth in Net Worth During Year					
1	-6.5%	18.1%	34.4%	60.3%	44.3%
2	-7.2	19.0	23.4	26.3	29.0
3	-8.0	19.9	13.5	16.5	21.6
4	-9.0	7.1	10.0	10.3	14.9
5	-10.4	-30.6	-12.4	-5.9	13.7
Average Growth Per Year					
	-8.2%	6.7%	13.8%	21.5%	24.7%
Average Growth Per Year During First Four Years					
	-7.7%	16.0%	20.3%	28.4%	27.4%

the current ratios of each point are higher in early years, but lower in later years than at corresponding points on Curve IX.

The yearly growth in net worth for each point on Curve X is also given in Table 5.69. The farm plan associated with Point E results in the greatest growth in net worth with an average growth per year of 24.7 percent. The farm plan for Point D generates an average growth in net worth per year of 21.5 percent, Point C has an average growth per year of 13.8 percent, Point B has an average growth per year of 6.7 percent, and Point A has an average growth per year of -8.2 percent. The average growth per year in net worth for points on Curve X are lower than the average growth per year in net worth for corresponding points on Curve IX.

Income and Consumption

The undiscounted expected disposable income, the resulting consumption, and the variance of income in each year of each point on Curve X are given in Table 5.70. The disposable income and consumption during most years for each point is lower than the disposable income and consumption in each year for corresponding points on Curve IX. The probability of disposable income being less than zero, \$4,000, and \$8,000 in each year of each point on Curve X are given in Table 5.71. These probabilities are higher in most years for each point than at corresponding points on Curve IX. For example, at point A of Curve IX the probability of disposable income being less than \$8,000 is zero in each of the five years, but at Point A of Curve X the same probability is 1.0 in each of the five years. At Point B of Curve IX the

Table 5.70. Expected disposable income, variance, and consumption in each year for each point on Curve X.

Point	Year	Disposable Income	Variance	Standard Deviation	Consumption
A	1	$ 1,578	0	0	$ 4,169
	2	1,467	0	0	4,158
	3	1,353	0	0	4,145
	4	1,234	0	0	4,132
	5	1,110	0	0	4,119
B	1	0	$ 4,105,919	$ 2,026	4,000
	2	0	933,766	966	4,000
	3	5,824	822,928	907	5,965
	4	15,630	1,211,447	1,101	10,764
	5	26,943	1,180,717	1,087	14,846
C	1	0	22,373,988	4,730	4,000
	2	12,740	14,417 825	3,797	9,545
	3	21,401	15,546,650	3,943	12,956
	4	23,340	17,059,476	4,130	13,640
	5	29,043	16,933,913	4,115	15,525
D	1	6,302	116,293,561	10,784	6,278
	2	18,340	55,866,972	7,474	11,830
	3	25,660	61,726,520	7,857	14,420
	4	29,409	70,317,359	8,386	15,642
	5	45,948	462,608,180	21,508	20,340
E	1	25,660	941,091,699	30,677	14,420
	2	30,731	1,601,450,848	40,018	16,047
	3	32,782	2,472,711,157	49,726	16,663
	4	33,940	2,093,518,883	45,755	17,010
	5	37,464	3,068,450,793	55,394	18,022

Table 5.71. Probability of disposable income falling below certain levels in each year for each point on Curve X.

Point	Year	$P(\mu_I < 0)$	$P(\mu_I <$ \$4000$)$	$P(\mu_I <$ \$8000$)$
A	1	0.0	1.0	1.0
	2	0.0	1.0	1.0
	3	0.0	1.0	1.0
	4	0.0	1.0	1.0
	5	0.0	1.0	1.0
B	1	0.5	0.8340	1.0
	2	0.5	1.0	1.0
	3	0.0	0.0222	0.9918
	4	0.0	0.0	0.0
	5	0.0	0.0	0.0
C	1	0.5	0.8023	0.9545
	2	0.0	0.0107	0.1056
	3	0.0	0.0	0.0
	4	0.0	0.0	0.0
	5	0.0	0.0	0.0
D	1	0.2810	0.4163	0.4364
	2	0.0071	0.0274	0.0838
	3	0.0	0.0029	0.0122
	4	0.0	0.0	0.0054
	5	0.0162	0.0256	0.0392
E	1	0.2005	0.2389	0.2810
	2	0.2206	0.2514	0.2843
	3	0.2546	0.2810	0.3085
	4	0.2297	0.2578	0.2843
	5	0.2483	0.2743	0.2981

probability of disposable income being less than \$8,000 is 1.0 in year one, 0.07 in year two, and zero in the last three years, while at Point B of Curve X the same probability is 1.0 in years one and two, 0.99 in year three, and zero in the last two years. The probability of disposable income being less than \$8,000 at Point C of Curve IX is 0.92 in year one and zero in the last four years, but at Point C of Curve X the same probability is 0.95 in year one, 0.11 in year two, and zero in the last three years. At Point D of Curve IX the probability of disposable income being less than \$8,000 is 0.30 in year one, 0.08 in year two, and just slightly greater than zero in years three, four, and five, while at Point D of Curve X the same probability is 0.44 in year one and then it is about equal to the probability of Curve IX in years two through five. At Point E of Curve X the probability of disposable income being less than zero, \$4,000, and \$8,000 is slightly higher in years one through three, but slightly lower in years four and five than the corresponding probabilities for Point E of Curve IX. As in all previous curves, the farm plan for the conventional linear programming solution results in the highest probability of the beginning farm failing. With this set of initial conditions there is virtually no chance of failure at Points B, C, and D.

CHAPTER 6. SUMMARY, CONCLUSIONS, AND SUGGESTIONS FOR FURTHER RESEARCH

Summary

As the capital requirements to be a successful farmer increase, it becomes more and more difficult for a new entrant to acquire adequate capital and credit to get started in farming. The problems faced by the beginning farmer and the need for evaluating the financial strategies available to beginning farmers for entry into agriculture were discussed in Chapter 1. A review of some of the previous research which has considered the problems of the beginning farmer was presented in Chapter 2.

A conceptualization of the entry process of the beginning farmer was presented in Chapter 3 in order to visualize the relationships between the decisions made by the beginning farmer and the results of these decisions in terms of the values of financial variables. This conceptualization of the entry process specified the interrelationships among the financial variables, which assisted in defining the equations needed in the mathematical model of the entry process of the beginning farmer. The beginning farmer must choose which production enterprises to undertake, and which financial strategies to use to acquire the resources necessary for the production enterprises, under conditions of risk or uncertainty. The theory of decision-making under uncertainty and selected programming models which consider uncertainty in farm planning were then discussed in Chapter 3. Finally, a multiperiod MOTAD model of the entry process of the beginning farmer was developed in Chapter 3. The purpose of this model was to show the specific relationships between the decisions made by the beginning farmer and the outcomes in terms of disposable income, cash position, net worth position, and risk position.

From this mathematical model an empirical multiperiod MOTAD model was constructed to depict the first five years of a farm's existence. This empirical model was presented in Chapter 4. In addition to the first five years of a farm's existence, there was also an initial period which allowed investment in machinery, land, and livestock facilities before the first year of operation. The objective function minimized the summation of the discounted values of negative deviations resulting from agricultural product selling activities. Investment and financing activities were provided for acquiring machinery, land, cattle feeding facilities, hog farrowing facilities, and hog feeding facilities. Crop and livestock production activities were included. There were also activities included for investment in off-farm assets, off-farm employment, crop storage, short-term borrowing, renting land, tax paying, and family consumption withdrawals. Restraints which specified the amount of resources available, imposed restrictions on the level of certain activities, provided accounting of several financial variables, and required the payment of financial obligations, taxes, and consumption were included.

There was a number of parameters in the empirical model which described the initial conditions facing the beginning farmer. Among the most important were the beginning farmer's equity or cash position, the debt-to-equity ratio constraint, and the family consumption function. The initial conditions facing the beginning farmer were also described by available activities, such as loan terms and off-farm employment opportunities. As these parameters and available activities were altered, it was hypothesized that the position and shape of the efficient E,A frontier would change.

Ten different sets of initial conditions were considered in Chapter 5, and the resulting efficient E,A curve for each set of initial conditions was described. Five points were found on each efficient E,A frontier; each point represented a five year investment, financing, production, and marketing plan. Also, a balance sheet for each year for each point was presented and the resulting leverage ratios, liquidity ratios, and growth rates were discussed. The farm plans for each point on each curve were also examined in terms of the pattern of yearly disposable income and consumption. Finally, the variance of disposable income was also computed for each year for each point in order to calculate the probability of disposable income falling below certain levels in each year.

Conclusions

General

There are several specific conclusions that can be drawn concerning the effect of alternative initial conditions on the beginning farmer's efficient E,A frontier. In addition, the results from all ten efficient E,A curves described in the last chapter provide the base for generalization to other situations.

The conventional linear programming solution for each frontier specified the acquisition of the capital intensive crop production system and the capital intensive combine. Moving down each efficient frontier to solutions that include less income variability results in less machinery investment and a shift away from capital intensive machinery systems to more labor intensive machinery systems. The amount of intermediate debt used to finance machinery purchases depends upon the set of initial conditions, but in general less intermediate debt is used as one moves down the efficient frontier.

The farm plan for each point, except Point A, on each frontier specifies investment in hog facilities. The amount of hog facility investment and the timing of this investment depends upon the set of initial conditions, but some general patterns are evident. The conventional linear programming solution for each frontier specifies the purchase of a total confinement feeding facility. The investment plan of Point D (which includes less risk) for each frontier specifies the purchase of a partial confinement farrowing facility, a partial confinement feeding facility, and a total confinement feeding facility. Point C on each frontier specifies investment in a partial confinement farrowing facility and a partial confinement feeding facility. At Point B on each frontier there is investment in pasture farrowing facilities, a partial confinement farrowing facility, and a partial confinement feeding facility.

At each point on frontiers where nonconventional loan terms are available, the hog facility investment is financed using the Standard plan with deferred principal payments. At each point on frontiers where only conventional loan terms are available, the hog facility investment is financed using the Standard plan without principal deferral. Moving down each efficient frontier results in more prepayment of long-term debt.

No cattle feeding facilities are purchased at any point on any efficient E,A frontier. This suggests that cattle feeding should not be part of the farm plan for a beginning farmer who wishes to minimize risk at a specified level of return, given the relative prices and production efficiency assumed in this model.

The conventional linear programming solution for each frontier specifies the use of a short-term operating loan of $50,000 (the maximum limit) in the first period of each year to finance agricultural production. Moving down each efficient frontier results in less use of short-term operating loans.

The investment plan for each point on each frontier specifies cash to be saved for future use in the business. The conventional linear programming solution for each frontier specifies that cash be saved in the second period of each year to be used for agricultural production in the first period of the next year. Moving down each efficient frontier results in less cash being saved, but cash being saved in both periods of some years.

At each point all machinery and livestock facilities are depreciated using the straight-line method rather than the double-declining-balance method. The straight-line method provides the same amount of depreciation during each year of the asset's life. The double-declining-balance method is a method of accelerated capital recovery which provides higher depreciation allowances in the early years of the asset's life. In the first year, the depreciation allowance of the double-declining-balance method is twice the depreciation allowance of the straight-line method. The beginning farmer's taxable income is lowest in the first year and then increases through year five. With the progressive income tax structure, the marginal tax rate increases as taxable income increases. The beginning farmer can reduce taxable income in later years by taking depreciation allowances in these years rather than in the early years. This will allow the minimum amount of taxes to be paid over the five year period. More depreciation allowance is available in later years if the straight-line method is used rather than the double-declining-balance method. With the progressive income tax structure, less taxes are paid in the later years and, therefore, disposable income is higher in these years if the straight-line method is used. This allows the summation of the present values of yearly disposable incomes to be higher when the straight-line method is used rather than the double-declining-balance method.

The conventional linear programming solution for each frontier specifies cash renting and crop-share renting land used in crop production. The cash rented land is used to produce corn and soybeans by a custom operator. The crop-share rented land is used to produce corn and soybeans, but the acreages of continuous corn and corn-soybean rotation grown depend on the set of initial conditions. Moving down each efficient frontier results in less land being farmed. Furthermore, all of the land farmed at Points B, C, and D on each frontier is crop-share rented. The crop-share rented land is used to produce corn, soybeans, and oats, with the acreages of the various crop rotations grown depending on the set of initial conditions.

No land is purchased for crop production at any point on any frontier. This suggests that a beginning farmer who wishes to minimize risk given a return level should rent all of the land he farms. Renting land may create some tenure uncertainty, but this type of risk is beyond the scope of the model used in this study.

The conventional linear programming solution for each frontier specifies all the corn and soybeans produced in each year to be sold at harvest. Moving down each efficient frontier results in a larger percentage of the corn available for sale at harvest of years one through four being stored until the first period of the next year. All corn is sold at harvest in year five. At most points on each frontier, all the soybeans and oats produced are sold at harvest.

At Points B and C for all frontiers the partial confinement hog feeding facility is partially used in the third quarter of years one through four, it is used to capacity in the fourth quarter of these years, and it is partially filled in the first quarter of years two through five. Feeder pigs are placed on feed in the third quarter of years one through four to provide the replacement gilts needed for the next year's farrowing operation. The remaining capacity is then used to place feeder pigs on feed in the fourth quarter of years one through four. The partial confinement feeding facility is not used in the second quarter of any year at Points B and C for each frontier.

Effect of Initial Cash or Equity Position

The effect of the initial cash or equity position on the beginning farmer's efficient E,A frontier, when other initial conditions are held constant, can be seen by comparing Curve I with Curve IV, Curve II with Curve III, Curve II with Curve V, and Curve IX with Curve VII (see Table 5.1). The specific changes in farm plans, debt use, resource control, net worth, net worth growth, disposable income, consumption, and probability of survival resulting from a change in the initial cash or equity position were described in detail in the last chapter. The effect of the initial cash or equity position depends, in part, on the values of the other initial conditions. However, some general observations can be made by considering the four comparisons listed above.

Table 6.1 shows the return and risk associated with each point on frontiers with an initial cash position of $40,000 as a percentage of the return and risk associated with corresponding points on curves with an initial cash position of $20,000 with the other initial conditions held constant. Point A on each frontier is the point where no risk is incurred and, therefore, no agricultural production occurs. In each case, increasing the initial cash position allowed the maximum return possible with no risk to increase about 11 percent.

Table 6.1. Effect of initial cash position on return and risk.

	Point A	Point B	Point C	Point D	Point E
Curve I as a percent of Curve IV					
Return	111.9%	108.8%	109.9%	108.5%	108.3%
Risk	-	102.1	106.5	106.0	107.4
Curve II as a percent of Curve III					
Return	110.7	107.0	104.8	104.6	104.5
Risk	-	102.1	101.4	100.8	110.7
Curve II as a percent of Curve V					
Return	110.7	108.8	107.4	106.6	107.0
Risk	-	112.1	111.9	102.9	112.7
Curve IX as a percent of Curve VII					
Return	110.7	108.8	107.4	106.6	106.7
Risk	-	112.4	112.0	102.9	112.6

Point E on each frontier is the conventional linear programming solution. In the first case (Curve I as a percent of Curve IV), increasing the initial cash position allowed the return to increase 8 percent, while the risk increased 7 percent. In the second case (Curve II as a percent of Curve III), the return increased over 4 percent, while the risk increased 11 percent. In the last two cases, the return increased about 7 percent, while the risk increased about 13 percent. The differences in the increases in return and risk between these four cases were caused by the differences in the values of the other initial conditions. Consumption function β was used in the first case, while consumption function α was used in the second case. Since consumption function β has a lower marginal propensity to consume than consumption function α, more cash is available for reinvestment in the farm business. Increasing the initial cash position from \$20,000 to

$40,000, then, caused the return levels to increase more for situations which specify consumption function β. Both curves in the second case (Curve II and Curve III) had a debt-to-equity ratio constraint of less than 2.0, while in the third case (Curve II and Curve V) and in the fourth case (Curve IX and Curve VII) this constraint was less than 1.0. The debt-to-equity ratio constraint had no effect on situations which had an initial cash position of $40,000; all farm plans generated a debt-to-equity ratio less than 1.0. However, when the initial cash position was $20,000, the conventional linear programming solution specified the use of all available debt. This resulted in those frontiers with a debt-to-equity ratio constraint of less than 2.0 having a greater return than those with a debt-to-equity ratio constraint of less than 1.0. Increasing the initial cash position from $20,000 to $40,000, then, caused return levels to increase more for situations which had a debt-to-equity ratio constraint of less than 1.0. Nonconventional loan terms were available in the third case (Curve II and Curve V), but only conventional loan terms were avialable in the fourth case (Curve IX and Curve VII). Because loan terms available had very little effect on the efficient E,A frontier, there was virtually no difference in increases in return and risk between the last two cases.

Points B, C, and D on each curve are defined by return levels which divide the curve evenly between Point A and Point E. In the first case (Curve I as a percent of Curve IV), the return at these three points increased 8 to 10 percent, while the risk increased only 2 to 6 percent. In the second case (Curve II as a percent of Curve III), the return at

Points B, C, and D increased 5 to 7 percent, while the risk only increased 1 to 2 percent. In the last two cases, the return increased 9 percent at Point B, 7 percent at Point C, and 7 percent at Point D, while the risk increased 12 percent, 12 percent, and 3 percent, respectively. Again, the differences in the increases in return and risk between these four cases were caused by the differences in the values of the other initial conditions.

The farm plans for curves with an initial cash position of $20,000 specify less machinery purchase but the use of more intermediate debt to finance this purchase than corresponding points on frontiers with an initial cash position of $40,000. With $20,000 of cash, about the same hog facility investment and financing plans are utilized, but less prepayment of long-term debt occurs compared to corresponding points on curves with an initial cash position of $40,000. On curves with an initial cash position of $20,000 there is more use of short-term operating loans and less cash is saved for future use compared to curves with an initial cash position of $40,000. Points on frontiers with an initial cash position of $20,000 also specify less land to be farmed, less resource control, and less net worth in each year than corresponding points on curves with an initial cash position of $40,000.

Points on curves with an initial cash position of $20,000 have a higher leverage in each year and higher average growth per year in net worth than corresponding points on curves with an initial cash position of $40,000. Farm plans on frontiers with a $20,000 initial cash position start with a lower beginning equity and include the use of relatively more debt, resulting in higher average growth rates than points with an initial cash position of $40,000. Finally, with an initial cash position of $20,000 less disposable income and less consumption occurs in each year, but these farm plans have equal or higher probabilities of disposable income being less than zero, $4,000, and $8,000 in each year compared to corresponding points on curves with an initial cash position of $40,000. That is, points on frontiers with an initial cash position of $20,000 have less yearly disposable income, and an equal or lower chance of survival than corresponding points on frontiers with an initial cash position of $40,000.

In summary, increasing the initial cash position from $20,000 to $40,000 caused the E,A frontier to make a nonparallel shift to the right. If the farm family has an initial cash position of $40,000, similar farm plans will lead to higher resource control, more net worth, lower leverage, more disposable income, and more consumption than with a $20,000 initial cash position. The farm family with the higher initial cash position will also have a better chance of surviving with all other initial conditions the same.

Effect of Consumption Function

Two family consumption functions were considered: one given by equation 3.7 (referred to as consumption function α) and the second with a marginal propensity to consume (MPC) equal to 75 percent of the MPC of the first consumption function at each income level (referred to as consumption function β). The effect of the family consumption function on the beginning farmer's efficient E,A frontier, when other initial conditions are held constant, can be seen by comparing Curve I with Curve II and Curve IV with Curve III (see Table 5.1).

Table 6.2 shows the return and risk associated with each point on curves with consumption function β (the lower MPC) as a percent of the return and risk associated with corresponding points on curves with consumption function α, assuming the other initial conditions held constant. In both cases, the family consumption function β allowed the maximum return possible with no risk (Point A) to increase by about 1 percent over the maximum return possible with no risk and consumption function α. In both cases the return at Point B was the same, but the risk decreased about 3 percent for curves with the lower MPC. The return at Point C for frontiers with consumption function β was about 1 to 2 percent higher than curves with consumption function α, while the risk increased about 3 to 8 percent. The return at Point D for curves with the lower MPC was also about 1 to 2 percent higher than for curves with the higher MPC, while the risk increased about 2 to 7 percent. The return for the conventional linear programming solution (Point E) for curves with consumption funciton β was over 1 percent greater than the return for the same solution for curves with consumption function α. In the first case (Curve I as a percent of Curve II), the risk increased over 4 percent, while in the second case (Curve IV as a percent of Curve III), the risk increased over 7 percent.

The farm plans on frontiers with consumption function β specify slightly larger machinery purchases, about the same use of intermediate debt to finance the machinery purchase, and about the same pattern of

Table 6.2. Effect of consumption function on return and risk.

	Point				
	A	B	C	D	E
Curve I as a percent of Curve II					
Return	101.0%	100.0%	102.3%	101.8%	101.3%
Risk	-	97.1	107.8	106.7	104.3
Curve IV as a percent of Curve III					
Return	100.9	100.0	101.2	100.9	101.4
Risk	-	97.1	102.6	101.5	107.5

repayment of intermediate debt as corresponding points on curves with the higher MPC. These points also specify about the same level of hog facility investment and the same pattern of repayment of long-term debt as points with consumption function α. Points with consumption function β specify about the same use of short-term operating debt as corresponding points on curves with consumption function α. However, these points with the lower MPC specify more cash to be saved for future use than corresponding points with consumption function α.

The conventional linear programming solution for curves with consumption function β specifies more cash rented land (up to 20 percent more) and about the same amount of crop-share rented land, resulting in up to 9 percent more total land farmed in each year than the conventional linear programming solution for curves with consumption function α. At Points B, C, and D on curves with consumption function β, about the same amount of land is farmed (about 2 percent less to about 4 percent more) in each year as at corresponding points on curves with consumption function α.

Points with the lower marginal propensity to consume also have slightly higher resource control in each year than corresponding points with consumption function α. Resource control of the conventional linear programming solution with consumption function β is up to 9 percent higher in each year than resource control for the conventional linear programming solution with the higher MPC. Point D with consumption function β has up to 4 percent higher resource control in each year than Point D with consumption function α. Point C has resource control up to 21 percent higher in each year when the beginning farm family has the lower MPC compared to consumption function α. In both cases, the resource control of Point B is up to 13 percent higher in each year with consumption function β compared to consumption function function α.

The farm plans for points on curves with the lower MPC generate more net worth at the end of each year and have a lower leverage than corresponding points on curves with consumption function α. When the initial equity position is \$40,000 (Curve I as a percent of Curve II), the net worth at the end of each year for each point with consumption function β is up to 14 percent higher than net worth at the end of each year for corresponding points with consumption function α. With an initial equity position of \$20,000 (Curve IV compared to Curve III), the net worth at the end of each year is up to 17 percent higher in each year for points with the lower MPC compared to corresponding points with consumption function α. Farm plans with consumption function β also have a higher average growth per year (10 to 13 percent higher for Point E, 12 to 14 percent higher for Point D, 12 to 17 percent higher for Point C, and 15 to 19 percent higher for Point B) than corresponding points with consumption function α.

Finally, points on curves with the lower MPC generate about the same disposable income in each year (4 percent less to 1 percent more for Point B, 5 percent less to 4 percent more for Point C, the same to 12 percent more for Point D, and 1 percent less to 10 percent more for Point E) than corresponding points on frontiers with consumption function α. However, because of the lower marginal propensity to consume, curves with consumption function β have a lower level of consumption in each year (the same to 17 percent less for Points B and C, 9 to 19 percent less for Point D, and 13 to 20 percent less for Point E) than corresponding points on curves with consumption function α. Points with the lower MPC have equal or lower probabilities of disposable income being less than zero, \$4,000, or \$8,000 in each year than corresponding points with consumption function α.

In summary, curves with consumption function β lie to the right of curves with consumption function α. If the farm family is willing to accept the lower marginal propensity to consume, similar farm plans will lead to slightly higher resource control, more net worth, lower leverage, about the same disposable income, but lower consumption in each year and a higher average growth in net worth. The family with the lower MPC will also have a better chance of surviving with all other initial conditions the same.

Effect of Loan Terms

Two sets of loan terms were considered: one set included nonconventional repayment plans such as deferred principal payments and increasing principal payments, and the second set included only conventional repayments plans. The effect of available loan terms on the beginning farmer's efficient E,A frontier, when other initial conditions are held constant, can be seen by comparing Curve VII with Curve V and Curve IX with Curve II (see Table 5.1).

Table 6.3 shows the return and risk associated with each point on frontiers with conventional loan terms as a percent of the return and risk for corresponding points on frontiers with nonconventional loan terms. The availability of nonconventional loan terms has very little effect on the risk and return at each point. In each case the return is about the same, and the risk increases only slightly for Points B and C when only conventional loan terms are available.

Table 6.3. Effect of loan terms on return and risk.

	Point				
	A	B	C	D	E
Curve VII as a percent of Curve V					
Return	100.0%	100.0%	100.0%	100.0%	99.9%
Risk	-	101.1	100.1	100.0	99.8
Curve IX as a percent of Curve II					
Return	100.0	100.0	100.0	100.0	99.9
Risk	-	100.3	100.1	100.0	99.7

As described in the last chapter, the farm plans for points on frontiers where only conventional loan terms are available are practically identical to the farm plans for corresponding points on frontiers where nonconventional loan terms are available. The only difference is that hog facility investments on frontiers with only conventional loan terms are financed using the Standard plan, while hog facility investments on frontiers with nonconventional loan terms are financed using the Standard plan with deferred principal payments. The availability of nonconventional loan terms has virtually no effect on the beginning farmer's efficient E,A frontier.

Effect of Off-Farm Employment

Two off-farm employment alternatives were considered: one allows the beginning farmer's wife to work at a job that pays $8,000 per year and the second allows no off-farm employment. The effect of off-farm employment on the beginning farmer's efficient E,A frontier, when other initial conditions are held constant, can be seen by comparing Curve V with Curve VI, Curve III with Curve VIII, and Curve IX with Curve X (see Table 5.1).

Table 6.4 shows the return and risk for each point on frontiers with an opportunity for off-farm employment as a percentage of the return and risk for corresponding points on frontiers with no opportunity for off-farm employment, given the other initial conditions held constant. The first two cases in Table 6.4 represent frontiers with an initial cash position of $20,000. At Point A, with no opportunity for off-farm employment, income can only be earned by saving cash. In both

Table 6.4. Effect of off-farm employment on return and risk.

	Point				
	A	B	C	D	E
Curve V as a percent of Curve VI					
Return	1688.6%	178.1%	128.6%	114.0%	104.8%
Risk	-	63.1	88.7	106.2	103.8
Curve III as a percent of Curve VIII					
Return	1688.6	170.6	125.8	110.2	102.4
Risk	-	63.9	89.7	102.1	97.9
Curve IX as a percent of Curve X					
Return	609.3	159.0	120.8	107.6	100.8
Risk	-	65.7	88.2	96.3	99.4

of these cases, the opportunity for the wife to work off the farm allowed the maximum return possible with no risk to increase about 1,600 percent. The third case in Table 6.4 (Curve IX as a percent of Curve X) represents frontiers with an initial cash position of $40,000, and the opportunity for off-farm employment increases the maximum return possible with no risk to increase about 500 percent.

When there is an opportunity for off-farm employment, the farm plans of Points B, C, and D in each case specify that the wife work off the farm each year. In each case, this allowed the return at Point B to increase about 60 to 80 percent, while the risk decreased about 35 percent. In each case, at Point C the return increased about 20 to 29 percent, while the risk decreased about 11 to 12 percent. In the first case, the return for Point D increased 14 percent, while the risk increased only about 6 percent. In the second case, the return for Point D increased about 10 percent, while the risk increased only about

2 percent. In the last case, the return for Point D increased about 8 percent, while the risk decreased about 4 percent.

Point E on each frontier is the conventional linear programming solution. When there is an opportunity for off-farm employment, the conventional linear programming solution specifies that the wife work off the farm during the first year only. In the first case (Curve V as a percent of Curve VI) the return increased about 5 percent, while the risk increased about 4 percent. In the second case (Curve III as a percent of Curve VIII) the return increased about 2 percent, while the risk decreased about 2 percent. In the third case, which has an initial cash position of $40,000, the return and risk changed very little; return increased about 1 percent and risk decreased about 1 percent. There is an increase in risk in the first case, but a decrease in risk in the second and third cases, because the first case had a debt-to-equity ratio constraint of less than 1.0, while this constraint in the second and third cases was less than 2.0.

When the debt-to-equity ratio constraint was less than 1.0, the farm plans for points on curves with no opportunity for off-farm employment included less machinery investment and investment in more labor intensive machinery systems than corresponding points on curves where the wife has an opportunity to work off the farm. There is less machinery investment because there is no off-farm income to pay for the machinery, and the machinery investment is in more labor intensive systems because more labor is available. However, when the debt-to-equity ratio constraint is less than 2.0, the farm plans with no opportunity for off-farm employment include more machinery investment, and investment in more labor intensive machinery systems than corresponding points with an opportunity for the wife to work off the farm. There is more machinery investment because the higher debt constraint permits more debt to be used for machinery purchase, but the machinery investment is still in more labor intensive systems because the wife's labor is used on the farm. With no opportunity for off-farm employment, more intermediate debt is used to finance machinery purchases compared to plans with an opportunity for the wife to work off the farm.

The conventional linear programming solution for curves with no opportunity for off-farm employment specifies less investment in a total confinement hog feeding facility than corresponding points on frontiers with an opportunity for the wife to work off the farm. Point D on frontiers with no opportunity for off-farm employment specifies more investment in farrowing and hog feeding facilities, the purchase of more labor intensive hog feeding facilities, three to six times the investment in partial confinement farrowing facilities, eight to nine times the investment in partial confinement feeding facilities, but only one-half to the same investment in total confinement feeding facilities compared to plans with an opportunity for off-farm employment. The farm plans specified by Points B and C on curves with no opportunity for off-farm employment specify the purchase of larger farrowing and hog feeding facilities than corresponding points when the wife can work off the farm. Point C on curves with no opportunity for off-farm employment specify about 1.2 to 1.5 times the investment in partial confinement farrowing facilities and about 1.3 times the investment in partial confinement feeding facilities specified by Point C on curves with an opportunity for off-farm employment. Point B on frontiers with no opportunity for off-farm employment specifies about the same investment in pasture farrowing facilities, about 3.0 to 4.0 times the investment in partial confinement farrowing facilities, and about 1.1 to 1.3 times the investment in partial confinement hog feeding facilities than specified by Point B on frontiers with an opportunity for off-farm employment. At each point on curves with no opportunity for off-farm employment there is less prepayment of long-term debt compared to situations that include an opportunity for the wife to work off the farm.

The conventional linear programming solution for curves with an opportunity for off-farm employment specifies more cash rented land (about 25 percent more), but less crop-share rented land (up to 10 percent less) and less total land farmed (up to 22 percent less) in most cases than the corresponding point on curves with no opportunity for the wife to work off the farm. At Points B, C, and D on curves with an opportunity for off-farm employment, less land is farmed in most cases than at corresponding points on curves with no opportunity for the wife to work off the farm (Point D is up to 20 percent less, Point C is 20 to 25 percent less, and Point B is up to 20 percent less).

The conventional linear programming solution for curves with an opportunity for the wife to work off the farm includes more resource control (1 to 5 percent more) in each year than the same solution for curves with no opportunity for off-farm employment when the debt-to-equity ratio constraint is less than 1.0. However, when the debt-to-equity ratio constraint is less than 2.0, the conventional linear programming solution for curves with an opportunity for the wife to work off the farm specifies less resource control in the first three years (3 to 21 percent less) than the same solution for curves with no opportunity for off-farm employment. At Points B, C, and D on curves with an opportunity for the wife to work off the farm, there is less resource control in each year (up to 19 percent less for Point D, up to 24 percent less for Point C, and up to 20 percent less for Point B) than for corresponding points on curves with no opportunity for off-farm employment.

With an opportunity for off-farm employment, less use is made of short-term operating debt and more cash is saved for future use compared to plans with no opportunity for the wife to work off the farm. The farm plans for frontiers with an opportunity for the wife to work off the farm generate more net worth at the end of each year and have a lower leverage in most years than on frontiers with no opportunity for off-farm employment. These plans also have a higher average growth per year (61 to 104 percent higher for Point B, 23 to 34 percent higher for Point C, 3 to 5 percent higher for Point D, and up to 7 percent higher for Point E) than plans on frontiers with no opportunity for off-farm employment.

Finally, points on frontiers with an opportunity for the wife to work off the farm generate more disposable income (up to 400 percent more for Point B, up to 122 percent more for Point C, up to 300 percent more for Point D, and up to 26 percent more for Point E) and more consumption (up to 165 percent more for Point B, up to 60 percent more for Point C, up to 139 percent more for Point D, and up to 15 percent more for Point E) in each year than corresponding points on frontiers with no opportunity for off-farm employment. These points also have equal or lower probabilities of disposable income being less than zero, \$4,000, and \$8,000 in each year than points on frontiers with no opportunity for off-farm employment. That is, points on frontiers with an opportunity for the wife to work off the farm have higher disposable income and an equal or higher chance of survival than corresponding points on frontiers with no opportunity for off-farm employment.

In summary, frontiers with an opportunity for the wife to work off the farm lie to the right of frontiers with no opportunity for off-farm employment. If the wife works off the farm, similar farm plans will lead to less resource control (except for the conventional linear programming solution when the debt-to-equity ratio constraint is less than 1.0), more net worth, lower leverage, more disposable income, and more consumption than if there is no off-farm employment. The wife working off the farm will also give the farm a better chance of surviving with all other initial conditions the same.

Effect of Debt-to-Equity Ratio Constraint

Debt-to-equity ratio constraints of less than 1.0 and less than 2.0 were considered. The debt-to-equity ratio constraint had no effect on the beginning farmer's efficient E,A frontier when the initial cash position was $40,000 and there was an opportunity for the wife to work off the farm. At the end of each year for points on Curves I, II, and IX the debt-to-equity ratio was less than 1.0. The effect of the debt-to-equity ratio constraint on the beginning farmer's efficient E,A frontier when the initial cash position was $20,000 and other initial conditions were held constant can be seen by comparing Curve III with Curve V and Curve VIII with Curve VI (see Table 5.1).

Table 6.5 shows the return and risk for each point on frontiers with a debt-to-equity ratio constraint of less than 2.0 as a percent of the return and risk for corresponding points on frontiers with a debt-to-equity ratio constraint of less than 1.0, with the other initial conditions held constant. The debt-to-equity ratio constraint had no

Table 6.5. Effect of debt-to-equity ratio constraint on return and risk.

	Point				
	A	B	C	D	E
Curve III as a percent of Curve V					
Return	100.0%	101.7%	102.5%	101.9%	102.5%
Risk	-	109.8	110.3	102.0	101.8
Curve VIII as a percent of Curve VI					
Return	100.0	106.3	104.7	105.4	104.8
Risk	-	108.5	109.1	106.0	108.8

effect on the maximum return possible with no risk (Point A). The first case in Table 6.5 (Curve III as a percent of Curve V) represents the situation when there is an opportunity for off-farm employemnt. In this case, the return for Points B, C, D, and E for frontiers with a debt-to-equity ratio constraint of less than 2.0 was about 2 percent higher than the return for curves with a debt-to-equity ratio constraint of less than 1.0, while the risk increased about 2 to 10 percent. The second case in Table 6.5 represents the situation when there is no opportunity for off-farm employment. In this case, the return for Points B, C, D, and E for frontiers with a debt-to-equity ratio constraint of less than 2.0 was about 5 to 6 percent higher than the return for frontiers with a debt-to-equity ratio constraint of less than 1.0, while the risk increased about 6 to 9 percent.

The conventional linear programming solution (Point E) for curves with a debt-to-equity ratio constraint of less than 1.0 specifies less machinery purchase in the initial period, but more machinery purchase in years two and three than the same solution for curves with a debt-to-equity ratio constraint of less than 2.0. This occurs because more intermediate debt can be used in the initial period for machinery purchase when the debt-to-equity ratio constraint is less than 2.0. In fact, when there is an opportunity for off-farm employment, about 48 percent more intermediate credit is used in the initial period when the debt-to-equity ratio constraint is less than 2.0, and the maximum possible debt ($20,000) is used when the debt-to-equity ratio constraint is less than 1.0. When there is no opportunity for off-farm employment the maximum possible intermediate debt is used in the initial period when the debt-to-equity ratio constraint is 1.0 ($20,000) and when it is 2.0 ($40,000).

The farm plans for Point D on frontiers with a debt-to-equity ratio constraint of less than 1.0 also specify less machinery purchase in the initial period, but more machinery purchase in later years than corresponding points on frontiers with a debt-to-equity ratio constraint of less than 2.0. When there is an opportunity for off-farm employment, Point D uses about 70 percent more intermediate credit in the initial period if the debt-to-equity ratio constraint is 2.0 rather than 1.0. If there is no opportunity for off-farm employment, Point D uses over 2.6 times as much intermediate credit in the initial period when the debt-to-equity ratio constraint is 2.0 rather than 1.0.

With a debt-to-equity ratio constraint of less than 1.0, Points B and C specify about the same machinery purchase as corresponding points with a debt-to-equity ratio constraint of less than 2.0. Point C uses about the same amount of intermediate credit under both debt-to-equity ratio constraints when there is an opportunity for off-farm employment. However, when there is no opportunity for off-farm employment, Point C uses about 73 percent more intermediate credit in the initial period if the debt-to-equity ratio constraint is less than 2.0 rather than 1.0. Point B uses no intermediate credit under both debt-to-equity ratio constraints when there is an opportunity for off-farm employment. However, when there is no opportunity for off-farm employment, Point B uses over 3.0 times as much intermediate credit in the initial period when the debt-to-equity ratio constraint is less than 2.0 rather than 1.0.

The difference in hog facility investment between points with a debt-to-equity ratio constraint of less than 1.0 and corresponding points with a debt-to-equity ratio constraint of less than 2.0 depends on the other initial conditions. When there is an opportunity for off-farm employment, the conventional linear programming solution with a debt-to-equity ratio constraint of less than 2.0 invests in over 5.0 times the total confinement hog feeding facilities than when the debt-to-equity ratio constraint is less than 1.0. But when there is no opportunity for off-farm employment, the conventional linear programming solution with a debt-to-equity ratio constraint of less than 2.0 invests in only about 60 percent of the total confinement hog feeding facilities that are purchased when the debt-to-equity ratio constraint is less than 1.0. When there is an opportunity for off-farm employment, Point D with a debt-to-equity ratio constraint of less than 2.0 invests in about 40 percent less partial confinement farrowing facilities, about 50 percent more partial confinement hog feeding facilities, and about 40 percent less total confinement hog feeding facilities than Point D with a debt-to-equity ratio constraint of less than 1.0. With no opportunity for off-farm employment, Point D with a debt-to-equity ratio constraint of less than 2.0 invests in about the same level of partial confinement farrowing facilities, 40 percent more partial confinement hog feeding facilities, and 60 percent less total confinement hog feeding facilities than Point D with a debt-to-equity ratio constraint of less than 1.0. Points B and C with a debt-to-equity ratio constraint of less than 2.0 specify about the same level of hog facility investment as corresponding points with a debt-to-equity ratio constraint of less than 1.0. Points on frontiers with a debt-to-equity ratio constraint of less than 2.0 have about the same pattern of long-term debt repayment as corresponding points on frontiers with a debt-to-equity ratio constraint of less than 1.0.

The conventional linear programming solution for frontiers with a debt-to-equity ratio constraint of less than 2.0 specifies about the same amount of cash rented land in each year as corresponding points on frontiers with a debt-to-equity ratio constraint of less than 1.0, except in year two when 2.0 to 3.0 times as much land is cash rented and year three when about 1.5 to 1.7 times more land is cash rented with a 2.0 debt-to-equity ratio constraint. These points also specify about the same amount of crop-share rented land as corresponding points with a debt-to-equity ratio constraint of less than 1.0, except in year one when about 25 to 50 percent more land is crop-share rented. This gives about the same amount of total land farmed in each year for the conventional linear programming solution for curves with a debt-to-equity ratio constraint of less than 2.0 as for corresponding points when the debt-to-equity ratio constraint is less than 1.0. At Points B, C, and D on frontiers with a debt-to-equity ratio constraint of less than 2.0, about the same amount of land is farmed in each year as corresponding points with a debt-to-equity ratio constraint of less than 1.0 (up to

12 percent more for Point B, about 5 percent less to 8 percent more for Point C, and up to 25 percent more for Point D).

Points with a debt-to-equity ratio constraint of less than 2.0 have higher resource control in most years than corresponding points with a debt-to-equity ratio constraint of less than 1.0. On curves with a debt-to-equity ratio constraint of less than 2.0, Point E has up to 50 percent more, Point D has up to 50 percent more, Point C has up to 30 percent more, and Point B has up to 24 percent more resource control in each year than corresponding points with a debt-to-equity ratio constraint of less than 1.0. Points with a debt-to-equity ratio constraint of less than 2.0 also have a higher net worth at the end of each year than corresponding points with a debt-to-equity ratio constraint of less than 1.0. Net worth at the end of each year for Point E is up to 20 percent higher, for Point D it is up to 20 percent higher, for Point C it is up to 5 percent higher, and for Point B it is up to 7 percent higher when the debt-to-equity ratio constraint is less than 2.0 than when it is less than 1.0. When the debt-to-equity ratio constraint is less than 2.0, the average growth rate in net worth for Point E is 4 to 7 percent higher, for Point D it is 9 to 11 percent higher, for Point C it is 4 percent higher, and for Point B it is 2 to 19 percent higher than when the debt-to-equity ratio constraint is less than 1.0.

Finally, points on curves with a debt-to-equity ratio constraint of less than 2.0 have slightly higher disposable income and consumption levels in each year than corresponding points with a debt-to-equity ratio constraint of less than 1.0. With a debt-to-equity ratio constraint of less than 2.0, Point E has yearly disposable income of up to 28 percent higher, Point D is up to 37 percent higher, Point C is up to 24 percent higher, and Point B is up to 17 percent higher than corresponding points with a debt-to-equity ratio constraint of less than 1.0. However, these points have about the same probabilities of disposable income being less than zero, \$4,000, and \$8,000 in each year as corresponding points on curves with a debt-to-equity ratio constraint of less than 1.0. Points with a debt-to-equity ratio constraint of less than 2.0 have a higher yearly disposable income and consumption, and about the same chance of survival as corresponding points with a debt-to-equity ratio constraint of less than 1.0.

In summary, increasing the debt-to-equity ratio constraint from less than 1.0 to less than 2.0 caused the efficient E,A frontier to rotate to the right. If the farm family has a debt-to-equity ratio constraint of less than 2.0, similar farm plans will lead to higher resource control, higher net worth, and a higher average growth rate in net worth than if the debt-to-equity ratio constraint is less than 1.0. A debt-to-equity ratio constraint of less than 2.0 will also lead to slightly higher disposable income and consumption, and about the same chance of survival as a debt-to-equity ratio constraint of less than 1.0 with all other initial conditions the same.

Suggestions for Future Research

This study has illustrated the potential applicability of the multiperiod MOTAD model to analyze farm planning decisions under risk and uncertainty. The results and conclusions demonstrate the type of information generated by this type of model. The results may also provide some valuable information to beginning farmers, agricultural lenders, and others interested in the problems of entry into farming. However, this study also suggests areas where future research is needed.

The model developed for this study could be used to consider several other factors which influence the beginning farmer's decisions. One factor not considered in this study is inflation, both general price inflation and land price inflation. These types of inflation could be built into the model to see how inflation would affect the efficient E,A frontiers. Another factor which may affect the efficient E,A frontier is the price series used for calculation of expected prices and price deviations. This model could be used to analyze the impact of the price series used on the efficient E,A frontiers. A third factor which could be analyzed using this model is the effect of the availability of hedging or forward pricing strategies on the efficient E,A frontier. These types of activities could be built into the present model to analyze their impact. Finally, other types of investment, financing, and production activities could be developed and included in the model. These might include other types of off-farm investments, more off-farm employment opportunities, alternative crop and livestock production activities, and alternative financing plans.

This study has assumed that the beginning farmer's decisions are based only on expected return and the risk associated with that return. The values of other possible decision variables, such as consumption, net worth growth, leverage, liquidity, and activity level, were presented so that a beginning farmer might choose that farm plan which maximizes his utility. However, these other possible decision variables were not explicitly considered in the model and did not influence the efficient E,A frontier. This suggests that future research is needed to develop models which can explicitly take into account other possible decision variables.

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APPENDIX TABLES

Appendix Table A.1. Machinery investment costs.[a]

	Crop Production System					
	Labor Intensive		Intermediate		Capital Intensive	
Equipment	Type	Cost	Type	Cost	Type	Cost
Disk	12 ft.	$ 1,320	14 ft.	$ 1,620	20 ft.	$ 3,060
					14 ft.	1,620
Plow	4 bot.	1,440	5 bot.	1,740	7 bot.	2,520
Harrow	20 ft.	350	30 ft.	400	30 ft.	400
Planter	4 row	2,160	6 row	3,240	8 row	4,560
Cultivator	4 row	1,320	6 row	1,680	8 row	1,920
Grain Drill	12 ft.	1,920	12 ft.	1,920	12 ft.	1,920
Rotary Hoe	4 row	840	6 row	1,200	8 row	1,440
Sprayer	8 row	900	8 row	900	8 row	900
Tractor	3-4 plow	6,300	5-6 plow	10,560	6-8 plow	15,560
					4-5 plow	8,460
Pickup Truck	3/4 ton	4,000	3/4 ton	4,000	3/4 ton	4,000
Wagon	200 bu.	1,200	200 bu.	1,200	200 bu.	1,200
Combine						
Corn Head						
Forage Harvester						
Forage Blower						
Total		$21,750		$28,460		$47,360
Capacity (acres):						
Growing		440		526		682
Harvesting Oats						
Harvesting Soybeans						
Harvesting Corn						
Harvesting Silage						

[a]James (48), pp. 121-122 and Putman (68), pp. 167-168.

Appendix Table A.1. (continued)

	Combine					
	Labor Intensive		Capital Intensive		Silage Harvester	
Equipment	Type	Cost	Type	Cost	Type	Cost
Disk						
Plow						
Harrow						
Planter						
Cultivator						
Grain Drill						
Rotary Hoe						
Sprayer						
Tractor						
Pickup Truck						
Wagon						
Combine	12 ft.	$14,000	16 ft.	$24,240	2 row	$4,560
Corn Head	3-4 row	5,000	6-8 row	7,000		1,320
Forage Harvester						
Forage Blower						
Total		$19,000		$31,240		$5,880
Capacity (acres):						
Growing						
Harvesting Oats		404		475		
Harvesting Soybeans		404		475		
Harvesting Corn		711		1,142		
Harvesting Silage						450

Appendix Table A.2. Investment costs for a 500 head open-lot cattle feeding facility with fence-line bunk feeding.[a]

Item	Investment Costs
Physical Facilities in Feedlot	
Land in feedlot, corrals, and feed storage	$ 1,400
Concrete in lot	5,408
Wind-break fence	1,600
Cable fence	560
Fence-line bunk	6,000
Gravel drive along bunk	1,020
Loading chute and corral	450
Sick pen	100
Gates	400
Scales and scale house	2,500
Well and water system	1,500
Feedlot Equipment	
Waterers	800
Oilers	600
Feed Handling Equipment	
Silo unloaders	10,500
Feed conveyors	2,625
Roller mill	1,800
Feed meters	800
Supplement meters	150
Feed wagon	2,500
Manure Handling Equipment	
Loader	1,000
Spreader	2,600
Feed Storage Facilities	
Concrete silos	46,400
Supplement bin	750
Feed room	3,938
Electrical Installation	600
Total Costs for Facilities	$96,001
Costs per Head of Capacity	$192.00

[a] Petritz (67).

Appendix Table A.3. Investment costs for a 500 head shed and paved lot cattle feeding facility with an auger feeding system.[a]

Item	Investment Costs
Physical Facilities in Feedlot	
Land in feedlot and storage facilities	$ 415
Open-front buildings	18,000
Concrete floors in shed and lot	10,560
Concrete feed bunks	1,320
Roof over feed bunk	1,440
Cable feedlot fence	2,250
Loading chute and corral	450
Sick pen	100
Gates	400
Well and water system	1,500
Scales and scale house	2,500
Feedlot Equipment	
Waterers	1,200
Oilers	600
Feed Handling Equipment	
Silo unloader	10,500
Feed conveyors	2,625
Roller mill	1,800
Feed meters	800
Supplement meter	150
Carrier auger	3,375
Auger feeders	3,600
Manure Handling Equipment	
Loader	1,000
Spreader	2,600
Feed Storage Facilities	
Concrete silos	46,400
Supplement bin	750
Feed room	3,938
Electrical Service Installation	800
Total Costs for Facilities	$119,073
Costs per Head of Capacity	$238.15

[a] Petritz (67).

Appendix Table A.4. Investment costs for a 500 head cold confinement slotted floor cattle barn with an auger feeding system.[a]

Item	Investment Costs
Physical Facilities in Feedlot	
Land in buildings, corrals, and feed storage	$ 200
Cold confinement barn	17,000
Slotted floor barn	16,111
Concrete strip in middle of barn	540
Manure pit	27,097
Concrete feed bunks	1,826
Steel fencing in barn	1,150
Loading chute and corral	650
Sick pen	100
Well and water system	1,500
Scales and scale house	2,500
Gates	500
Feedlot Equipment	
Waterers	800
Oilers	600
Feed Handling Equipment	
Silo unloaders	10,500
Feed conveyors	2,625
Roller mill	1,800
Feed meters	800
Supplement meter	150
Carrier auger	300
Auger feeders	4,980
Manure Handling Equipment	
Tank wagons	6,000
Chopper	1,500
Feed Storage Facilities	
Concrete silos	46,400
Supplement bin	750
Feed room	3,938
Electrical Service Installation	800
Total Costs for Facilities	$151,117
Costs per Head of Capacity	$302.23

[a] Petritz (67).

Appendix Table A.5. Investment costs for a 500 head warm confinement slotted floor cattle barn with an auger feeding system.[a]

Item	Investment Costs
Physical Facilities in Feedlot	
Land in buildings, corrals, and feed storage	$ 200
Warm confinement building	34,528
Ventilation equipment	5,000
Slotted floor	16,111
Manure pits	27,097
Concrete strip in middle of barn	540
Concrete feed bunk	1,826
Steel fence in barn	320
Loading chute and corral	650
Sick pen	100
Well and water system	1,500
Scales and scale house	2,500
Gates	500
Feedlot Equipment	
Waterers	800
Oilers	600
Feed Handling Equipment	
Silo unloaders	10,500
Feed conveyors	2,625
Roller mill	1,800
Feed meters	800
Supplement meter	150
Carrier auger	300
Auger feeder	4,980
Manure Handling Equipment	
Tank wagons	6,000
Chopper	1,500
Feed Storage Facilities	
Concrete silos	46,400
Supplement bin	750
Feed room	3,938
Electrical Service Installation	1,200
Total Costs for Facilities	$173,215
Costs per Head of Capacity	$346.43

[a] Petritz (67).

Appendix Table A.6. Investment costs for a 25 sow pasture farrowing system. [a]

Item	Investment Costs
Breeding Herd Facilities [b]	
Sow shelters	$ 1,080
Feeding fence	150
Waterers	87
Fencing	160
Concrete feeding slab	270
Farrowing - Nursery Facilities [c]	
Individual houses	3,750
Feed pans	100
Wooden panels	1,000
Creep feeders	240
Supporting Facilities	
Feed handling, manure handling, and miscellaneous equipment	1,000
Total Costs for Facilities	$ 7,837
Cost per Sow Capacity	$313.48

[a] Bache and Foster (3,4,9,10).

[b] Portable buildings for 30 females.

[c] Individual houses with outside pens for 25 sows and litters.

Appendix Table A.7. Investment costs for a 25 sow partial confinement farrowing system.[a]

Item	Investment Costs
Farrowing Facilities	
Building	$ 5,450
Farrowing crates	1,700
Waterers	160
Feeders	320
Heating devices	300
Feeding floor for sows	360
Outside fencing	180
Nursery Facilities	
Building	3,330
Exposed concrete slab	770
Heat lamps and attachments	150
Waterers	360
Feeders	1,200
Sow troughs	160
Fencing, gates, and creep feeders	800
Breeding Herd Facilities	
Sow shelters	2,160
Feeding fence	300
Waterers	270
Concrete feeding slab	420
Fencing	900
Supporting Equipment	
Feed handling, manure handling, and miscellaneous equipment	2,440
Total Costs for Facilities	$21,730
Costs per Sow Capacity	$869.20

[a] Bache and Foster (8,9,10).

Appendix Table A.8. Investment costs for a 50 sow total confinement farrowing system. [a]

Item	Investment Costs
Farrowing Facilities	
Building	$ 46,700
Farrowing crates	7,750
Bulk feed holding bin	550
Weaning Facilities	
Building	12,460
Bulk feed holding bin	550
Feeders and feed distribution equipment	940
Waterers	140
Pen partitions	910
Breeding Facilities	
Sow shelters	1,800
Feeding fence	270
Waterers	270
Concrete feeding slab	420
Fencing	900
Gestation Facilities	
Building	16,090
Bulk feed holding bin	550
Feeding system	600
Waterers	150
Pen partitions	1,170
Heating	580
Supporting Equipment	
Self-contained feed center	2,800
Feed delivery system	1,200
Sprayer - cleaner	300
Dead pig incinerator	950
Stand-by generator	800
Liquid manure spreader	1,520
Total Costs for Facilities	$100,370
Cost per Sow Capacity	$2,007.40

[a] Bache and Foster (6,9,10).

Appendix Table A.9. Investment costs for a 200 head pasture hog feeding system.[a]

Item	Investment Costs
Growing - Finishing Facilities	
Pull-together houses	$ 3,000
Concrete slab	1,730
Shade frames	160
Feeders	580
Waterers	435
Lot fencing	240
Field fencing	3,600
Supporing Facilities	
Feed handling, manure handling, and miscellaneous equipment	1,500
Total Costs for Facilities	$11,245
Cost per Head Capacity	$56.23

[a] Bache and Foster (5,9,10).

Appendix Table A.10. Investment costs for a 200 head partial confinement hog feeding system.[a]

Item	Investment Costs
Finishing Facilities	
Building	$ 3,750
Exposed concrete slab	870
Waterers	320
Feeders	700
Partitions and gates	470
Supporting Equipment	
Feed handling, manure handling, and miscellaneous equipment	3,660
Total Costs for Facilities	$ 9,770
Cost per Head Capacity	$ 48.85

[a] Bache and Foster (5,8,9,10).

Appendix Table A.11. Investment costs for a 1,000 head total confinement hog feeding system.[a]

Item	Investment Costs
Finishing Facilities	
Building	$46,750
Bulk feed holding bins	1,220
Feeders and feed distribution equipment	2,130
Waterers	280
Pen partitions	2,320
Supporting Equipment	
Self-contained feed center	4,200
Feed delivery system	1,800
Sprayer - cleaner	450
Stand-by generator	1,200
Liquid manure spreader	2,280
Total Costs for Facilities	$62,630
Cost per Head Capacity	$62.63

[a] Bache and Foster (5,6,9,10).

Appendix Table A.12. Annual costs, labor requirements, and land requirements of each crop rotation for each crop production system. [a]

Crop Rotation:	Continuous Corn			Corn - Soybeans		
Machinery System: [b]	L	I	C	L	I	C
Annual Costs ($)						
Machinery	7.28	7.24	7.08	12.82	12.69	12.36
Seed and chemicals	60.30	60.30	60.30	92.80	62.80	92.80
Total	67.58	67.54	67.38	105.62	105.49	105.16
Labor Requirements (hours)						
Jan.-March	.37	.28	.22	.68	.55	.46
April-June	2.17	1.66	1.10	4.19	3.23	2.22
July-Sept.	.63	.52	.35	1.32	1.08	.67
Oct.-Dec.	.39	.30	.22	.56	.50	.38
Land (acres)	1.	1.	1.	2.	2.	2.

[a] James (48), Stoneberg (76), and Stoneberg, Edwards, and Thompson (78).

[b] L refers to the labor intensive crop production system, I refers to the intermediate crop production system, and C refers to the capital intensive crop production system.

Corn - Soybeans - Oats			Corn - Soybeans - Oats - Meadow - Meadow			Corn - Oats - Meadow - Meadow		
L	I	C	L	I	C	L	I	C
14.88	14.73	14.23	21.42	21.27	20.77	15.88	15.82	15.47
113.85	113.85	113.85	173.35	173.35	173.35	140.85	140.85	140.85
128.73	128.58	128.08	194.77	194.62	194.12	156.73	156.67	156.34
1.34	1.15	.97	1.34	1.15	.97	1.03	.88	.73
4.90	3.89	2.82	6.16	5.15	4.08	4.14	3.58	2.96
1.53	1.44	1.27	1.53	1.44	1.27	.84	.71	.62
.85	.77	.65	.85	.77	.65	.66	.57	.49
3.	3.	3.	5.	5.	5.	4.	4.	4.

Appendix Table A.13. Custom machinery rates per acre for various field operations. [a]

	Crop Production			Crop Harvesting			
Operation	Continuous Corn	Corn - Soybean Rotation	Other Rotation	Corn	Soybeans	Oats	Hay
Growing	$30.00	$29.00	$25.00				
Combining				$15.00	$7.00	$6.00	
Mowing, conditioning and raking							$ 3.50
Baling							10.00
Storing							4.00
Total	$30.00	$29.00	$25.00	$15.00	$7.00	$6.00	$17.50

[a] James (48), pp. 147 - 148.

Appendix Table A.14. Annual costs and labor requirements per acre to harvest each crop as grain for each combine type and to harvest corn as silage using the silage harvester. [a]

	Harvest Crop as Grain						
	Corn		Soybeans		Oats		
Combine Type:	Labor Intensive	Capital Intensive	Labor Intensive	Capital Intensive	Labor Intensive	Capital Intensive	Harvest Corn as Silage
Annual Costs ($)							
Machinery	$11.19	$11.19	$2.25	$2.25	$2.63	$2.63	$7.85
Labor Requirements (hours)							
Apr.-June	.10	.10	.10	.10	.10	.10	.34
July-Sept.	.63	.70	1.44	.72	1.11	.86	8.88
Oct.-Dec.	1.44	1.25	.34	.21			.85

[a] James (48), Stoneberg (76), and Stoneberg, Edwards, and Thompson (78).

Appendix Table A.15. Cash costs, feed required, and labor required to farrow pigs and raise pigs to 40 pounds using the three farrowing systems.[a]

	Pasture System		Partial Confinement			Total Confinement		
Litters per Year:	1	2	2	4	6	2	4	6
Cash Costs								
Supplement	$37.00	$ 74.00	$79.10	$158.20	$237.30	$ 86.90	$173.80	$260.70
Veterinary and medical	5.00	10.00	8.00	16.00	24.00	5.00	10.00	15.00
Power and fuel	3.10	6.20	6.20	12.40	18.60	19.34	38.68	58.02
Miscellaneous	5.10	10.20	5.64	11.28	16.92	.40	.80	1.20
Total cash costs	$50.20	$100.40	$98.94	$197.88	$296.82	$111.64	$223.28	$334.92
Jan.-June	38.00	50.20	49.47	98.94	148.41	55.82	111.64	167.46
July-Dec.	12.20	50.20	49.47	98.94	148.41	55.82	111.64	167.46
Corn Required (bu.)								
Jan.-June	20.0	25.5	24.7	49.4	74.1	24.25	48.5	72.75
July-Dec.	5.5	25.5	24.7	49.4	74.1	24.25	48.5	72.75
Labor Required (hours)								
Jan.-Mar.	2.39	8.61	8.03	14.38	22.53	4.21	7.54	11.81
Apr.-June	6.17	6.51	6.52	14.73	21.14	3.42	7.72	11.08
July-Sep.	4.37	8.07	8.18	14.74	22.79	4.29	7.72	11.95
Oct.-Dec.	2.07	6.81	6.27	14.15	20.54	3.28	7.42	10.76
Total	15.00	30.00	29.00	58.00	87.00	15.20	30.40	45.60
Pigs Produced	7	14	16	32	48	16	32	48

[a] Bache and Foster (3,4,6,8,9,10).

Appendix Table A.16. Cash costs, feed required, and labor required to feed one hog from 40 pounds to 220 pounds using the three hog feeding systems. [a]

	Pasture	Partial Confinement	Total Confinement
Cash Costs			
Supplement	$11.40	$10.65	$10.40
Veterinary and medical	2.00	1.75	1.50
Power and fuel	.63	.55	.71
Miscellaneous	2.00	.96	.60
Total cash costs	$16.03	$13.91	$13.21
Corn Required (bu.)	10.10	9.60	9.30
Labor Required (hours)			
First quarter on feed	.65	.50	.40
Second quarter on feed	.65	.50	.40
Total	1.30	1.00	.80

[a] Bache and Foster (5,6,7,8,9,10).

Appendix Table A.17. Cash costs, corn required, roughage required, and labor required for one calf placed on feed in the spring in an open-lot with a windbreak fence using a roughage ration and a concentrate ration. [a]

	Roughage Ration				Concentrate Ration			
	Apr.-June	July-Dec.	Jan.-Mar., next year	Total	Apr.-June	July-Dec.	Jan.-Mar., next year	Total
Cash Costs								
Supplement	$3.75	$ 7.50	$ 3.75	$15.00	$3.28	$6.54	$ 3.28	$13.10
Veterinery and medical	1.50	1.00	.50	3.00	1.50	1.00	.50	3.00
Feed processing and handling	.09	.17	.09	.35	.07	.14	.07	.28
Tractor for feed handling	.15	.28	.15	.58	.11	.21	.11	.43
Insurance on feed and cattle	2.20			2.20	2.20			2.20
Tractor for manure handling	.95	1.90	.95	3.80	.95	1.90	.95	3.80
Marketing cost			7.00	7.00			7.00	7.00
Total cash costs	$8.64	$10.84	$12.44	$31.93	$8.11	$9.79	$11.91	$29.81
Roughage Required (tons)	1.00	2.00	1.00	4.00	.18	.34	.18	.70
Corn Required (bu.)	11.00	21.50	11.00	43.50	16.00	33.00	16.00	65.00
Labor Required (hours)								
Apr.-June				3.27				3.27
July-Sep.				3.27				3.27
Oct.-Dec.				3.27				3.27
Jan.-Mar., next year				3.27				3.27
Weight of Slaughter Steer Produced (lbs.)				1,217				1,150

[a] Petritz (67).

Appendix Table A.18. Cash costs, corn required, roughage required, and labor required for one calf placed on feed in the spring in an open-lot with a shed using a roughage ration and a concentrate ration.[a]

	Roughage Ration				Concentrate Ration			
	Apr.-June	July-Dec.	Jan.-Mar., next year	Total	Apr.-June	July-Dec.	Jan.-Mar., next year	Total
Cash Costs								
Supplement	$3.38	$ 6.74	$ 3.38	$13.50	$2.95	$ 5.90	$ 2.95	$11.80
Veterinary and medical	1.50	1.00	.50	3.00	1.50	1.00	.50	3.00
Bedding		1.73	1.73	3.46		1.73	1.73	3.46
Feed processing and handling	.12	.25	.12	.49	.10	.18	.10	.38
Tractor for manure handling	.95	1.90	.95	3.80	.95	1.90	.95	3.80
Insurance on feed and cattle	2.20			2.20	2.20			2.20
Marketing costs			7.00	7.00			7.00	7.00
Total cash costs	$8.15	$11.62	$13.68	$33.45	$7.70	$10.71	$13.23	$31.64
Roughage Required (tons)	.90	1.80	.90	3.60	.16	.33	.16	.65
Corn Required (bu.)	10.00	19.00	10.00	39.00	14.00	30.00	14.00	58.00
Labor Required (hours)								
Apr.-June				1.80				1.80
July-Sep.				1.80				1.80
Oct.-Dec.				1.80				1.80
Jan.-Mar., next year				1.80				1.80
Weight of Slaughter Steer Produced (lbs.)				1,140				1,082

[a] Petritz (67).

Appendix Table A.19. Cash costs, corn required, roughage required, and labor required for one calf placed on feed in the spring in a cold confinement barn using a roughage ration and a concentrate ration.[a]

	Roughage Ration				Concentrate Ration			
	Apr.-June	July-Dec.	Jan.-Mar., next year	Total	Apr.-June	July-Dec.	Jan.-Mar., next year	Total
Cash Costs								
Supplement	$3.38	$6.74	$ 3.38	$13.50	$2.95	$5.90	$ 2.95	$11.80
Veterinary and medical	1.50	1.00	.50	3.00	1.50	1.00	.50	3.00
Feed processing and handling	.12	.23	.12	.47	.09	.18	.09	.36
Tractor for manure handling	.86	1.70	.86	3.42	.86	1.70	.86	3.42
Insurance on feed and cattle	2.20			2.20	2.20			2.20
Marketing costs			7.00	7.00			7.00	7.00
Total cash costs	$8.06	$9.67	$11.86	$29.59	$7.60	$8.78	$11.40	$27.78
Roughage Required (tons)	.90	1.80	.90	3.60	.16	.33	.16	.65
Corn Required (bu.)	10.00	19.00	10.00	39.00	14.00	30.00	14.00	58.00
Labor Required (hours)								
Apr.-June				1.50				1.50
July-Sep.				1.50				1.50
Oct.-Dec.				1.50				1.50
Jan.-Mar., next year				1.50				1.50
Weight of Slaughter Steer Produced (lbs.)				1,140				1,082

[a] Petritz (67).

Appendix Table A.20. Cash costs, corn required, roughage required, and labor required for one calf placed on feed in the spring in a warm confinement barn using a roughage ration and a concentrate ration.[a]

	Roughage Ration				Concentrate Ration			
	Apr.-June	July-Dec.	Jan.-Mar., next year	Total	Apr.-June	July-Dec.	Jan.-Mar., next year	Total
Cash Costs								
Supplement	$3.38	$ 6.74	$ 3.38	$13.50	$2.95	$ 5.90	$ 2.95	$11.80
Veterinary and medical	1.50	1.00	.50	3.00	1.50	1.00	.50	3.00
Feed processing and handling	.11	.23	.11	.45	.09	.17	.09	.35
Tractor for manure handling	.86	1.70	.86	3.42	.86	1.70	.86	3.42
Insurance on feed and cattle	2.20			2.20	2.20			2.20
Ventilation costs	1.75	3.50	1.75	7.00	1.75	3.50	1.75	7.00
Marketing costs			7.00	7.00			7.00	7.00
Total cash costs	$9.80	$13.17	$13.60	$36.57	$9.35	$12.27	$13.15	$34.77
Roughage Required (tons)	.90	1.80	.90	3.60	.16	.33	.16	.65
Corn Required (bu.)	10.00	19.00	10.00	39.00	14.00	30.00	14.00	58.00
Labor Required (hours)								
Apr.-June				1.50				1.50
July-Sep.				1.50				1.50
Oct.-Dec.				1.50				1.50
Jan.-Mar., next year				1.50				1.50
Weight of Slaughter Steer Produced (lbs.)				1,140				1,082

[a] Petritz (67).

Appendix Table A.21. Cash costs, corn required, roughage required, and labor required for one calf placed on feed in the fall in an open-lot with a windbreak fence using a roughage ration and a concentrate ration.[a]

	Roughage Ration				Concentrate Ration			
	Oct.-Dec.	Jan.-June, next year	July-Sep., next year	Total	Oct.-Dec.	Jan.-June, next year	July-Sep., next year	Total
Cash Costs								
Supplement	$3.75	$ 7.50	$ 3.75	$15.00	$3.28	$6.54	$ 3.28	$13.10
Veterinary and medical	1.50	1.00	.50	3.00	1.50	1.00	.50	3.00
Feed processing and handling	.09	.17	.09	.35	.07	.14	.07	.28
Tractor for feed handling	.15	.28	.15	.58	.11	.21	.11	.43
Insurance on feed and cattle	2.20			2.20	2.20			2.20
Tractor for manure handling	.95	1.90	.95	3.80	.95	1.90	.95	3.80
Marketing costs			7.00	7.00			7.00	7.00
Total cash costs	$8.64	$10.85	$12.44	$31.93	$8.11	$9.79	$11.91	$29.81
Roughage Required (tons)	1.00	2.00	1.00	4.00	.18	.34	.18	.70
Corn Required (bu.)	11.00	21.50	11.00	43.50	16.00	33.00	16.00	65.00
Labor Required (hours)								
Oct.-Dec.				3.27				3.27
Jan.-Mar., next year				3.27				3.27
Apr.-June, next year				3.27				3.27
July-Sep., next year				3.27				3.27
Weight of Slaughter Steer Produced (lbs.)				1,217				1,150

[a] Petritz (67).

Appendix Table A.22. Cash costs, corn required, roughage required, and labor required for one calf placed on feed in the fall in an open-lot with a shed using a roughage ration and a concentrate ration.[a]

	Roughage Ration				Concentrate Ration			
	Oct.-Dec.	Jan.-June, next year	July-Sep., next year	Total	Oct.-Dec.	Jan.-June, next year	July-Sep., next year	Total
Cash Costs								
Supplement	$3.38	$ 6.74	$ 3.38	$13.50	$2.95	$ 5.90	$ 2.95	$11.80
Veterinary and medical	1.50	1.00	.50	3.00	1.50	1.00	.50	3.00
Bedding	1.73	1.73		3.46	1.73	1.73		3.46
Feed processing and handling	.12	.25	.12	.49	.10	.18	.10	.38
Tractor for manure handling	.95	1.90	.95	3.80	.95	1.90	.95	3.80
Insurance on feed and cattle	2.20			2.20	2.20			2.20
Marketing costs			7.00	7.00			7.00	7.00
Total cash costs	$9.88	$11.62	$11.95	$33.45	$9.43	$10.71	$11.50	$31.64
Roughage Required (tons)	.90	1.80	.90	3.60	.16	.33	.16	.65
Corn Required (bu.)	10.00	19.00	10.00	39.00	14.00	30.00	14.00	58.00
Labor Required (hours)								
Oct.-Dec.				1.80				1.80
Jan.-Mar., next year				1.80				1.80
Apr.-June, next year				1.80				1.80
July-Sep., next year				1.80				1.80
Weight of Slaughter Steer Produced (lbs.)				1,140				1,082

[a] Petritz (67).

Appendix Table A.23. Cash costs, corn required, roughage required, and labor required for on calf placed on feed in the fall in a cold confinement barn using a roughage ration and a concentrate ration.[a]

	Roughage Ration				Concentrate Ration			
	Oct.-Dec.	Jan.-June, next year	July-Sep., next year	Total	Oct.-Dec.	Jan.-June, next year	July-Sep., next year	Total
Cash Costs								
Supplement	$3.38	$6.74	$ 3.38	$13.50	$2.95	$5.90	$ 2.95	$11.80
Veterinary and medical	1.50	1.00	.50	3.00	1.50	1.00	.50	3.00
Feed processing and handling	.12	.23	.12	.47	.09	.18	.09	.36
Tractor for manure handling	.86	1.70	.86	3.42	.86	1.70	.86	3.42
Insurance on feed and cattle	2.20			2.20	2.20			2.20
Marketing costs			7.00	7.00			7.00	7.00
Total cash costs	$8.06	$9.67	$11.86	$29.59	$7.60	$8.78	$11.40	$27.78
Roughage Required (tons)	.90	1.80	.90	3.60	.16	.33	.16	.65
Corn Required (bu.)	10.00	19.00	10.00	39.00	14.00	30.00	14.00	58.00
Labor Required (hours)								
Oct.-Dec.				1.50				1.50
Jan.-Mar., next year				1.50				1.50
Apr.-June, next year				1.50				1.50
July-Sep., next year				1.50				1.50
Weight of Slaughter Steer Produced (lbs.)				1,140				1,082

[a] Petritz (67)

Appendix Table A.24. Cash costs, corn required, roughage required, and labor required for one calf placed on feed in the fall in a warm confinement barn using a roughage ration and a concentrate ration. [a]

	Roughage Ration				Concentrate Ration			
	Oct.-Dec.	Jan.-June, next year	July-Sep., next year	Total	Oct.-Dec.	Jan.-June, next year	July-Sep., next year	Total
Cash Costs								
Supplement	$3.38	$ 6.74	$ 3.38	$13.50	$2.95	$ 5.90	$ 2.95	$11.80
Veterinary and medical	1.50	1.00	.50	3.00	1.50	1.00	.50	3.00
Feed processing and handling	.11	.23	.11	.45	.09	.17	.09	.35
Tractor for manure handling	.86	1.70	.86	3.42	.86	1.70	.86	3.42
Insurance on feed and cattle	2.20			2.20	2.20			2.20
Ventilation costs	1.75	3.50	1.75	7.00	1.75	3.50	1.75	7.00
Marketing costs			7.00	7.00			7.00	7.00
Total cash costs	$9.80	$13.17	$13.60	$36.57	$9.35	$12.27	$13.15	$34.77
Roughage Required (tons)	.90	1.80	.90	3.60	.16	.33	.16	.65
Corn Required (bu.)	10.00	19.00	10.00	39.00	14.00	30.00	14.00	58.00
Labor Required (hours)								
Oct.-Dec.				1.50				1.50
Jan.-Mar., next year				1.50				1.50
Apr.-June, next year				1.50				1.50
July-Sep., next year				1.50				1.50
Weight of Slaughter Steer Produced (lbs.)				1,140				1,082

[a] Petritz (67).

Appendix Table A.25. Cash costs, corn required, roughage required, and labor required for one yearling placed on feed in the spring and in the fall in an open-lot with a windbreak fence using a roughage ration and a concentrate ration.[a]

	Roughage Ration						Concentrate Ration					
	Spring			Fall			Spring			Fall		
	Apr.-June	July-Sep.	Total	Oct.-Dec.	Jan.-Mar., next year	Total	Apr.-June	July-Sep.	Total	Oct.-Dec.	Jan.-Mar., next year	Total
Cash Costs ($)												
Supplement	4.64	4.63	9.27	4.09	4.08	8.17	6.58	6.58	13.16	6.21	6.21	12.42
Veterinary and medical	.75	.25	1.00	.75	.25	1.00	.75	.25	1.00	.75	.25	1.00
Feed processing and handling	.09	.09	.18	.09	.08	.17	.08	.07	.15	.07	.06	.13
Tractor for feed handling	.16	.15	.31	.14	.13	.27	.11	.11	.22	.11	.10	.21
Insurance on feed and cattle	1.09		1.09	1.11		1.11	1.09		1.09	1.11		1.11
Tractor for manure handling	.80	.80	1.60	.80	.80	1.60	.80	.80	1.60	.80	.80	1.60
Purchasing costs	5.50		5.50	5.50		5.50	5.50		5.50	5.50		5.50
Marketing costs		6.45	6.45		7.00	7.00		7.32	7.32		7.00	7.00
Total cash costs	13.03	12.37	25.40	12.48	12.34	24.82	14.91	15.13	30.04	14.55	14.42	28.97
Roughage Required (tons)	.70	.70	1.40	.62	.62	1.24	.20	.20	.40	.20	.20	.40
Corn Required (bu.)	23.00	23.00	46.00	20.00	20.00	40.00	25.50	25.50	51.00	24.00	24.00	48.00

Labor Required (hours)				
Apr.-June	3.27		3.27	
July-Sep.	3.27		3.27	
Oct.-Dec.		3.27		3.27
Jan.-Mar., next year		3.27		3.27
Weight of Slaughter Steer Produced (lbs)	1,010	1,025	1,104	1,025

[a] Petritz (67).

Appendix Table A.26. Cash costs, corn required, roughage required, and labor required for one yearling placed on feed in the spring and in the fall in an open-lot with a shed using a roughage ration and a concentrate ration. [a]

	Roughage Ration						Concentrate Ration					
	Spring			Fall			Spring			Fall		
	Apr.-June	July-Sep.	Total	Oct.-Dec.	Jan.-Mar., next year	Total	Apr.-June	July-Sep.	Total	Oct.-Dec.	Jan.-Mar., next year	Total
Cash Costs ($)												
Supplement	4.93	4.92	9.85	4.03	4.03	8.06	6.91	6.91	13.92	6.13	6.13	12.26
Veterinary and medical	.75	.25	1.00	.75	.25	1.00	.75	.25	1.00	.75	.25	1.00
Bedding				1.73	1.73	3.46				1.73	1.73	3.46
Feed processing and handling	.14	.13	.27	.11	.11	.22	.10	.10	.20	.09	.09	.18
Tractor for manure handling	.80	.80	1.60	.80	.80	1.60	.80	.80	1.60	.80	.80	1.60
Insurance on feed and cattle	1.09		1.09	1.09		1.09	1.09		1.09	1.09		1.09
Purchasing costs	5.50		5.50	5.50		5.50	5.50		5.50	5.50		5.50
Marketing costs		7.03	7.03		7.19	7.19		7.42	7.42		7.19	7.19
Total cash costs	13.21	13.13	26.34	14.04	14.11	28.15	15.15	15.48	30.63	16.11	16.19	32.30
Roughage Required (tons)	.75	.75	1.50	.62	.62	1.24	.20	.20	.40	.20	.20	.40
Corn Required (bu.)	24.50	24.50	49.00	20.00	20.00	40.00	21.50	21.50	43.00	23.50	23.50	47.00

<u>Labor Required (hours)</u>				
Apr.-June	1.80		1.80	
July-Sep.	1.80		1.80	
Oct.-Dec.		1.80		1.80
Jan.-Mar., next year		1.80		1.80
Weight of Slaughter Steer Produced (lbs)	1,033	1,071	1,127	1,071

[a] Petritz (67).

Appendix Table A.27. Cash costs, corn required, roughage required, and labor required for one yearling placed on feed in the spring and in the fall in a cold confinement barn using a roughage ration and a concentrate ration. [a]

	Roughage Ration						Concentrate Ration					
	Spring			Fall			Spring			Fall		
	Apr.-June	July-Sep.	Total	Oct.-Dec.	Jan.-Mar., next year	Total	Apr.-June	July-Sep.	Total	Oct.-Dec.	Jan.-Mar., next year	Total
Cash Costs ($)												
Supplement	4.93	4.92	9.85	3.60	3.60	7.20	6.91	6.91	13.82	5.48	5.47	10.95
Veterinary and medical	.75	.25	1.00	.75	.25	1.00	.75	.25	1.00	.75	.25	1.00
Feed processing and handling	.14	.13	.27	.10	.10	.20	.10	.10	.20	.08	.08	.16
Tractor for manure handling	.86	.85	1.71	.86	.85	1.71	.86	.85	1.71	.86	.85	1.71
Insurance on feed and cattle	1.09		1.09	1.09		1.09	1.09		1.09	1.09		1.09
Purchasing costs	5.50		5.50	5.50		5.50	5.50		5.50	5.50		5.50
Marketing costs		7.03	7.03		7.33	7.33		7.42	7.42		7.33	7.33
Total cash costs	13.27	13.18	26.45	11.93	12.13	24.06	15.20	15.53	30.73	13.78	13.98	27.76
Roughage Required (tons)	.75	.75	1.50	.55	.55	1.10	.20	.20	.40	.15	.15	.30
Corn Required (bu.)	24.50	24.50	49.00	18.00	18.00	36.00	21.50	21.50	43.00	21.00	21.00	42.00

<u>Labor Required (hours)</u>				
Apr.-June	1.50		1.50	
July-Sep.	1.50		1.50	
Oct.-Dec.		1.50		1.50
Jan.-Mar., next year		1.50		1.50
Weight of Slaughter Steer Produced (lbs.)	1,033	1,106	1,127	1,106

[a] Petritz (67).

Appendix Table A.28. Cash costs, corn required, roughage required, and labor required for one yearling placed on feed in the spring and in the fall in a warm confinement barn using a roughage ration and a concentrate ration.[a]

	Roughage Ration						Concentrate Ration					
	Spring			Fall			Spring			Fall		
	Apr.-June	July-Sep.	Total	Oct.-Dec.	Jan.-Mar., next year	Total	Apr.-June	July-Sep.	Total	Oct.-Dec.	Jan.-Mar., next year	Total
Cash Costs ($)												
Supplement	4.93	4.92	9.85	3.41	3.41	6.82	6.91	6.91	13.82	5.19	5.19	10.38
Veterinary and medical	.75	.25	1.00	.75	.25	1.00	.75	.25	1.00	.75	.25	1.00
Feed processing and handling	.14	.13	.27	.09	.09	.18	.10	.10	.20	.08	.07	.15
Tractor for manure handling	.86	.85	1.71	.86	.85	1.71	.86	.85	1.71	.86	.85	1.71
Insurance on feed and cattle	1.08		1.08	1.12		1.12	1.08		1.08	1.11		1.11
Ventilation costs	1.75	1.75	3.50	1.75	1.75	3.50	1.75	1.75	3.50	1.75	1.75	3.50
Purchasing costs	5.50		5.50	5.50		5.50	5.50		5.50	5.50		5.50
Marketing costs		7.03	7.03		7.36	7.36		7.42	7.42		7.36	7.36
Total cash costs	15.01	14.93	29.94	13.48	13.71	27.19	16.95	17.28	34.23	15.24	15.47	30.71
Roughage Required (tons)	.75	.75	1.50	.50	.50	1.00	.20	.20	.40	.15	.15	.30
Corn Required (bu.)	24.50	24.50	49.00	17.00	17.00	34.00	21.50	21.50	43.00	20.00	20.00	40.00

Labor Required (hours)				
Apr.-June	1.50		1.50	
July-Sep.	1.50		1.50	
Oct.-Dec.		1.50		1.50
Jan.-Mar., next year		1.50		1.50
Weight of Slaughter Steer Produced	1,033	1,114	1,127	1,114

[a] Petritz (67).

Appendix Table A.29. Iowa corn prices, average price per bushel received by farmers.[a]

	First Period Corn				Second Period Corn			
Year	Jan.	Feb.	Mar.	Avg.	Oct.	Nov.	Dec.	Avg.
1971	$1.36	$1.38	$1.36	$1.367	$ .94	$ .94	$1.05	$ .977
1972	1.04	1.04	1.05	1.043	1.10	1.14	1.35	1.197
1973	1.30	1.26	1.28	1.280	2.06	2.14	2.31	2.170
1974	2.51	2.67	2.59	2.590	3.44	3.27	3.24	3.317
1975	3.01	2.82	2.63	2.820	2.54	2.30	2.30	2.380
1976	2.37	2.43	2.44	2.413	2.27	2.01	2.22	2.167
Average				$1.919				$2.034

[a] U.S. Department of Agriculture (88b).

Appendix Table A.30. Soybean prices, average price per bushel received by farmers.[a]

Year	First Period Soybeans				Second Period Soybeans			
	Jan.	Feb.	Mar.	Avg.	Oct.	Nov.	Dec.	Avg.
1971	$2.80	$2.86	$2.85	$2.837	$2.94	$2.84	$2.94	$2.907
1972	2.90	2.97	3.24	3.003	3.06	3.40	3.99	3.483
1973	4.12	5.44	6.02	5.193	5.49	5.10	5.60	5.397
1974	5.08	6.00	5.85	5.883	8.19	7.45	7.13	7.590
1975	6.25	5.73	5.30	5.760	4.88	4.48	4.20	4.520
1976	4.41	4.43	4.37	4.403	5.80	6.06	6.54	6.133
Average				$4.513				$5.005

[a] U.S. Department of Agriculture (88b).

Appendix Table A.31. Iowa oat prices, average price per bushel received by farmers.[a]

	First Period Oats				Second Period Oats			
Year	Jan.	Feb.	Mar.	Avg.	July	Aug.	Sep.	Avg.
1971	$ .71	$ .73	$ .72	$ .720	$ .65	$ .63	$ .63	$ .637
1972	.67	.68	.69	.680	.67	.65	.68	.667
1973	.85	.85	.85	.850	.87	1.10	.99	.987
1974	1.28	1.40	1.41	1.363	1.30	1.50	1.51	1.437
1975	1.61	1.59	1.51	1.570	1.43	1.44	1.43	1.433
1976	1.44	1.45	1.45	1.447	1.62	1.48	1.48	1.527
Average				$1.105				$1.114

[a] U.S. Department of Agriculture (88b).

Appendix Table A.32. Iowa hog prices, average price per hundredweight received by farmers. [a]

	First Quarter Hogs				Second Quarter Hogs			
Year	Jan.	Feb.	Mar.	Avg.	Apr.	May	June	Avg.
1971	$15.10	$19.60	$17.00	$17.233	$16.00	$17.00	$17.40	$16.800
1972	22.50	26.10	23.00	23.867	22.40	24.90	25.30	24.200
1973	31.10	35.20	38.70	35.000	35.50	34.50	37.40	35.800
1974	39.70	39.20	35.00	37.967	30.30	26.00	22.40	26.233
1975	38.20	39.00	38.90	38.700	39.20	45.90	46.90	44.000
1976	47.30	48.20	45.60	47.023	47.60	47.60	49.40	48.200
Average				$33.300				$32.539

	Third Quarter Hogs				Fourth Quarter Hogs			
Year	July	Aug.	Sep.	Avg.	Oct.	Nov.	Dec.	Avg.
1971	$19.10	$18.50	$18.10	$18.567	$19.80	$18.70	$19.80	$19.433
1972	27.60	28.50	28.40	28.167	27.30	26.80	29.70	27.933
1973	41.00	56.80	44.10	47.300	40.80	40.20	37.50	39.500
1974	34.90	36.60	34.00	35.167	37.30	36.80	38.60	37.567
1975	53.90	56.80	58.60	56.433	57.20	48.50	46.50	50.733
1976	48.10	42.60	38.90	43.200	32.80	30.50	36.70	33.333
Average				$38.139				$34.750

[a] U.S. Department of Agriculture (88b).

Appendix Table A.33. Iowa cattle prices, average price per hundredweight received by farmers. [a]

	Spring Cattle				Fall Cattle			
Year	Mar.	Apr.	May	Avg.	Sep.	Oct.	Nov.	Avg.
1971	$30.80	$31.30	$32.40	$31.500	$31.80	$31.50	$32.80	$32.033
1972	34.70	33.60	35.20	34.500	35.40	35.20	33.20	34.600
1973	45.80	44.30	45.50	45.200	48.50	42.50	40.50	43.833
1974	43.20	40.80	39.10	41.033	39.60	37.20	34.50	37.100
1975	32.80	38.20	44.50	38.500	43.70	41.70	40.50	41.967
1976	34.70	41.60	38.60	38.300	35.70	36.40	36.30	36.133
Average				$38.172				$37.611

[a] U.S. Department of Agriculture (88b).

Appendix Table A.34. Sow prices, average price per hundredweight received by farmers. [a]

Year	First Quarter Sows Jan.	Feb.	Mar.	Avg.	Fourth Quarter Sows Oct.	Nov.	Dec.	Avg.
1971	$12.74	$16.68	$15.28	$14.900	$16.95	$16.32	$16.76	$16.510
1972	20.41	22.90	21.43	21.580	25.05	23.04	24.26	24.117
1973	26.32	31.22	34.47	30.670	36.14	36.14	32.53	34.937
1974	33.93	34.21	31.42	33.187	33.42	33.57	33.78	33.590
1975	35.01	36.52	36.58	36.037	51.94	42.25	38.50	44.230
1976	40.48	44.03	42.24	42.250	26.87	23.64	28.30	26.270
Average				$29.771				$29.942

[a] U.S. Department of Agriculture (88b).

Appendix Table A.35. Iowa feeder pig prices, average price paid per head by farmers.[a]

Year	First Quarter	Second Quarter	Third Quarter	Fourth Quarter
1971	$ 9.80	$13.04	$12.44	$14.00
1972	20.00	23.30	23.30	24.40
1973	23.60	32.20	37.20	32.20
1974	29.40	26.80	15.32	19.20
1975	22.00	37.20	38.80	45.20
1976	38.80	43.20	29.60	21.60
Average	$23.933	$29.273	$26.093	$26.100

[a] U.S. Department of Agriculture (88b).

Appendix Table A.36. Actual corn prices, estimated time trend prices, and deviations from the trend.

	First Period Corn			Second Period Corn		
Year	Actual	Estimated	Deviation	Actual	Estimated	Deviation
1971	$1.367	$1.071	$.296	$ .977	$1.274	-$.297
1972	1.043	1.410	- .367	1.197	1.578	- .381
1973	1.280	1.749	- .469	2.170	1.882	.288
1974	2.590	2.089	.501	3.317	2.187	1.130
1975	2.820	2.428	.392	2.380	2.491	-.111
1976	2.413	2.767	-.354	2.167	2.795	-.628

Appendix Table A.37. Actual soybean prices, estimated time trend prices, and deviations from the trend.

	First Period Soybeans			Second Period Soybeans		
Year	Actual	Estimated	Deviation	Actual	Estimated	Deviation
1971	$2.837	$3.314	-$ .477	$2.907	$3.474	-$ .567
1972	3.003	3.794	- .790	3.483	4.086	- .603
1973	5.193	4.273	.920	5.397	4.699	.698
1974	5.883	4.753	1.130	7.590	5.311	2.279
1975	5.760	5.233	.527	4.520	5.924	- 1.404
1976	4.403	5.713	- 1.310	6.133	6.536	- .403

Appendix Table A.38. Actual oat prices, estimated time trend prices, and deviations from the trend.

	First Period Oats			Second Period Oats		
Year	Actual	Estimated	Deviation	Actual	Estimated	Deviation
1971	$ .720	$ .618	$.102	$ .637	$ .600	$.037
1972	.680	.813	- .133	.667	.806	- .139
1973	.850	1.008	- .158	.987	1.012	- .025
1974	1.363	1.202	.161	1.437	1.217	.219
1975	1.570	1.397	.173	1.433	1.423	.010
1976	1.447	1.592	- .145	1.527	1.629	- .102

Appendix Table A.39. Actual market hog prices, estimated time trend prices, and deviations from trend.

	First Period Hogs			Second Quarter Hogs		
Year	Actual	Estimated	Deviation	Actual	Estimated	Deviation
1971	$17.233	$19.267	-$2.033	$16.800	$17.765	-$ .965
1972	23.867	24.880	- 1.013	24.200	23.675	.525
1973	35.000	30.493	4.507	35.800	29.584	6.216
1974	37.967	36.107	1.860	26.233	35.494	- 9.260
1975	38.700	41.720	- 3.020	44.000	41.403	2.597
1976	47.033	47.333	- .300	48.200	47.313	.887

	Third Quarter Hogs			Fourth Quarter Hogs		
Year	Actual	Estimated	Deviation	Actual	Estimated	Deviation
1971	$18.567	$24.151	-$ 5.584	$19.433	$25.038	-$ 5.605
1972	28.167	29.746	- 1.579	27.933	28.923	- .990
1973	47.300	35.341	11.959	39.500	32.808	6.692
1974	35.167	40.936	- 5.770	37.567	36.692	.874
1975	56.433	46.532	9.902	50.733	40.577	10.156
1976	43.200	52.127	- 8.927	33.333	44.462	- 11.129

Appendix Table A.40. Actual market cattle prices, estimated time trend prices, and deviations from the trend.

	Spring Cattle			Fall Cattle		
Year	Actual	Estimated	Deviation	Actual	Estimated	Deviation
1971	$31.500	$35.184	-$3.684	$32.033	$35.049	-$3.016
1972	34.500	36.379	- 1.879	34.600	36.074	- 1.474
1973	45.200	37.575	7.625	43.833	37.099	6.735
1974	41.033	38.770	2.264	37.100	38.123	- 1.023
1975	38.500	39.965	- 1.465	41.967	39.148	2.818
1976	38.300	41.160	- 2.860	36.133	40.173	- 4.040

Appendix Table A.41. Actual sow prices, estimated time trend prices, and deviations from the trend.

	First Quarter Sows			Fourth Quarter Sows		
Year	Actual	Estimated	Deviation	Actual	Estimated	Deviation
1971	$14.900	$16.725	-$1.825	$16.510	$22.243	-$ 5.733
1972	21.580	21.943	- .363	24.117	25.323	- 1.206
1973	30.670	27.161	3.509	34.937	28.402	6.534
1974	33.187	32.380	.807	33.590	31.482	2.108
1975	36.037	37.598	- 1.561	44.230	34.562	9.668
1976	42.250	42.816	- .566	26.270	37.642	- 11.372

Appendix Table A.42. Actual feeder pig prices, estimated time trend prices, and deviations from the trend.

	First Quarter Feeder Pigs			Second Quarter Feeder Pigs		
Year	Actual	Estimated	Deviation	Actual	Estimated	Deviation
1971	$ 9.800	$12.733	-$2.933	$13.040	$15.888	-$2.848
1972	20.000	17.213	2.787	23.200	21.242	1.958
1973	23.600	21.693	1.907	32.200	26.596	5.604
1974	29.400	26.173	3.227	26.800	31.950	- 5.150
1975	22.000	30.653	- 8.653	37.200	37.305	- .105
1976	38.800	35.133	3.667	43.200	43.200	.541

	Third Quarter Feeder Pigs			Fourth Quarter Feeder Pigs		
Year	Actual	Estimated	Deviation	Actual	Estimated	Deviation
1971	$12.440	$18.185	-$ 5.745	$14.000	$19.857	-$ 5.857
1972	23.200	21.348	1.852	24.400	22.354	2.046
1973	37.200	24.512	12.688	32.300	24.851	7.349
1974	15.320	27.675	- 12.355	19.200	27.349	- 8.149
1975	38.800	30.838	7.962	45.200	29.846	15.354
1976	29.600	34.002	- 4.402	21.600	21.343	- 10.743