AN ECONOMIC ANALYSIS OF SEASON-LONG AND INTENSIVE-EARLY GRAZING SYSTEMS ON A NORTHEAST KANSAS REPRESENTATIVE FARM

by

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CHAPTER 1

INTRODUCTION

In Northeast Kansas, farm organizations tend to be diversified with a combination of crop and livestock enterprises. There are many management decisions that effect the economic efficiency of the whole farm organization. Decisions may be unique to specific enterprises, or to a farm business. Specific enterprises are just a part of the total farm and must fit into the total farm plan. Each enterprise has a specific purpose and some enterprises may be more important than other enterprises.

THE PROBLEM

A farm manager of a multiproduct farm must be aware of how the combination of enterprises will use the available resources in the most efficient way. Each enterprise will use a different combination of available land, labor, and capital. On some Northeast Kansas farms, grazing cattle enterprises are a major source of income and use many of the resources available. Rangeland is an important resource in the production of beef. Cattle utilize approximately three-fourths of the range areas (U.S.D.A. Grass 103). In order to utilize rangeland efficiently, the manager must use the grazing system that fits best in the farm operation and that yields the highest net farm return.

Approximately two-fifths of Kansas (about 20 million acres) is native rangeland, reestablished native range, and grazed woodland (Launchbaugh and Owensby Range 3). In Kansas, 64.9 percent of the farms have cattle enterprises, which make up 48.6 percent of the cash receipts in Kansas (Kansas State Board of Agriculture 67th. Annual 227). Thus the efficient use of rangeland is important for the Kansas economy and should be utilized in the most efficient way.

An important decision regarding grazing systems is the stocking rate. Light stocking will produce the most gain per steer, but much of the grass may be wasted except during below average rainfall years. Light stocking will realize the highest return per head, but the lowest return per acre. Heavy stocking will produce lower gains per head and lower returns per head, but will realize the highest returns per acre. Heavy grazing will utilize the grass better, but the pastures will be more vulnerable to drought and jeopardize the future productivity of the rangeland (Snapp 447). In a wholefarm organization, the most profitable grazing system maybe that which provides neither the highest net return per acre or highest return per head. By considering the use of labor and capital as well as pasture, the manager will choose a grazing system that maximizes returns based on that combination of resources and will not necessarily maximize returns on only a per head or per acre.

It takes many years and much capital for over-grazed and abused rangeland to recover. If pasture is over-grazed for too many years the rangeland may not recover. During the years of recovery, much revenue is lost as a result of not being able to graze the rangeland or having to stock the range at a low stocking rate. Thus, it is important for a manager to select a grazing system that will not damage rangeland.

It has been shown that 20 to 25 percent of the annual forage production must be left standing at the close of the season in order to protect the range from vegetative injury (U.S.D.A. Grass 105). Thus, a stocking rate that does not utilize 75 to 80 percent of the annual forage production will not efficiently use labor, capital, cropland, and pasture. Studies on stocking rates in Kansas have indicated that the proper season-long stocking rate is between 3.5 and 4 acres per steer (Thomas 9). At this stocking rate enough forage remains at the end of the season to avoid permanent injury to the pasture. Because of the variability in annual rainfall in Kansas, the forage production fluctuates accordingly. A manager does not know at the time cattle are put on pasture the amount of forage that will become available during the grazing season. Therefore, the stocking rate tends toward that which protects the long run productivity of the pasture.

If heavy grazing occurs, more labor, capital, and cropland will be needed for beef production and the rangeland will be over grazed causing loss of productivity. The inefficient use of those resources will have a negative impact on the total farm operation.

Season-long stocking, the traditional grazing system, consists of placing the cattle on grass about May 1st and removing the cattle about October 1st. The stocking rate of 3.5 to 4 acres per steer used for season-long grazing has been adjusted over many years to fit rainfall variability (U.S.D.A. Grass 214). In most years forage production is adequate for five months of grazing. In some years of high rainfall, forage remains unused. However, in years of low rainfall, forage production may be adequate only for maintenance of cattle leaving little forage for increasing gains.

Season-long grazing complements the labor use pattern with crops.

In late April and early May when the cattle are worked and placed on pasture, crop production does not require much labor. Once the cattle are placed on pasture, little time is spent checking the cattle. In October when the cattle come off pasture, time is needed to round up and load cattle. At this time corn and grain sorghum harvest and wheat planting may be underway. However, the cattle enterprise can be flexible to work around the crop activities. Since the cattle are moved less often, once placed on grass, less stress is imposed on them.

The problem with season-long grazing is that in normal and above normal forage production years the grass is not utilized efficiently during the first-half of the grazing season when the forage is at its nutritional peak. Cattle grazing warm season perennial grasses will gain roughly two-thirds of their total gain during the first half of the grazing season (Launchbaugh and Owensby 16).

The Kansas Experiment Station has conducted extensive experiments on the utilization of pasture to fatten yearling cattle for market and derived the "Kansas Plan". The Kansas Plan consists of wintering calves to gain 1.3 to 1.5 pounds a day, starting May 1st graze the cattle on pasture without grain until August 1st (approximately 90 days) at a stocking rate double that of season-long stocking, and then place cattle on full-feed in drylot until November 15th (approximately 100 days) (Snapp 455-456).

There have been other modifications to the season-long stocking. The deferred grazing system, grazing is deferred until a certain phenologic stage has been reached, allows part of the rangeland to rest in order to regain lost vigor and become more productive. Deferment at the beginning of the grazing season allows seeding to occur. Deferment at mid-season allows regaining of lost vigor so that the grazing can take place towards the end of the grazing season. Deferment at the end of the grazing season allows a higher carrying capacity on pastures (Agricultural Experiment Station Deferred 13).

Another modification is supplementing native pasture with tame cool- and warm-season grasses. Use of cool season grasses may provide grazing before native grasses are available and after the end of the normal grazing period of native pasture. Summer annual grasses can be used to supplement native pasture in mid- to late-summer after the peak in forage production of native grasses.

A study of the monthly gains of cattle on native pasture in Kansas indicated that it is at its best in late spring and summer. To stock a pasture in the spring with only the number of cattle that it will carry through the entire five-month season with average weather conditions does not utilize grass when it is most valuable (Snapp 451). A grazing system of particular interest for stocker cattle in the Flint Hills of Kansas is the Intensive-Early Stocking (IES) system. IES is an adoption of seasonal suitability grazing, in that cattle intensively graze the range during the high-quality-forage period. With IES the rancher puts steers on rangeland May 1st in the Flint Hills and increases the stocking rate to at least two times the season-long stocking rate and takes the steers off approximately July 15th.

IES utilizes more of the forage at its nutritional peak and allows the plants to regain their vigor before frost. IES yields a higher return per acre, but a lower return per head than does the season-long grazing system. The producer sells a lighter steer in July than if the steer is on grass until October and than sold, but may receive a higher price for a lighter steer.

There are problems associated with IES. In Mid-July farmers may be harvesting wheat or tilling cropland which provides for high returns to labor. Gathering cattle and taking them to market at this time competes for valuable labor. The smaller total gain of cattle on IES may not be sufficient to cover the negative buy-sell margin traditionally realized by the producer. Years with low rainfall may not produce enough forage to support IES. As a consequence lower cattle gains will be realized because only the maintenance level of nutrients required by stocker cattle is met. IES requires more capital for purchasing at least twice the number of cattle than with the season-long system.

There are many different grazing systems that involve nonuse of pasture in the last half of the grazing system. For example, late season nonuse, rotational late-season nonuse, and late-season nonuse rotation involve nonuse in the latter portion of the growing season. Some of the rotational grazing systems allows a portion of the pasture to rest while the other portion is grazed. Some other systems include the Savory system, short-duration grazing, and high intensity-low frequency grazing which differ from IES in that they require rotating the cattle from one subunit to another.

Past research in Kansas on IES has compared the season-long stocking and intensive-early stocking stocker cattle. IES has not been considered in a wholefarm situation with crop enterprises or with other livestock enterprises. One question is how the intensive-early stocking stocker cattle enterprise fits into a wholefarm operation and how well the intensive-early stocking stocker cattle enterprise compete with the traditional season-long stocker cattle enterprise and cash crops normally found in the Northeastern Kansas region.

RESEARCH OBJECTIVES

The objective of this research is to analyze the grazing system that maximizes the return to fixed resources on a representative farm in Northeast Kansas. Linear programming is used to analyze the representative farm which includes the alternatives of season-long and intensive-early stocking systems. Alternative livestock enterprises are wintering, wintering and season-long grazing, wintering and IES grazing, season-long grazing, and IES grazing. Crop alternatives are wheat, corn, grain sorghum, soybeans, alfalfa, and sorghum silage. The alternative enterprises are limited by the land, labor, and capital available to the representative farm.

CHAPTER 2

LITERATURE REVIEW

Research has been concentrated primarily on the biological effects of adopting IES by comparing the differences between individual animal gains and rangeland responses under IES and SL grazing. There has been very little research on the economics of IES and different possible marketing alternatives for cattle coming off of IES grazing. Moreover, there has not been a linear programming model developed in which IES was one of the possible activities.

BIOLOGICAL STUDIES

During the years 1943 through 1952 Dr. Graydon Klipple studied the increase in cattle weight per acre that could be expected from IES, and the effect the practice had upon the range vegetation. The study was conducted near Nunn, Colorado, in the Central Great Plains where the vegetation is of the short-grass association and the annual rainfall averages between 9 to 12 inches (Klipple 1).

Graydon Klipple's study concentrated on three different periods of grazing: early-season grazing, late-season grazing, and season-long grazing. The stocking rates used for early-season, late-season, and season-long grazing were 6.1, 6.6, and 13.1 acres per steer, respectively. The length of the grazing period was six months for season-long and three months for early- and late-season grazing. The stocking rate was doubled for early- and late-season grazing, but the grazing period was cut in half. The early-season grazing period is comparable to IES.

The areas of particular concern were the differences in individual animal weights, cattle gains per acre, forage production and utilization, changes in species composition, ground cover of forages, and mechanical impacts of concentrated stocking such as: worn bare spots and paths, and grazing distribution between the three grazing practices.

Drs. Clenton Owensby and Ed Smith studied IES in the Flint Hills region of the True Prairie in Kansas. The range site is located five miles northwest of Manhattan, Kansas, in which the vegetation is that of the tall-grass association and is primarily warm-season perennial grasses. The annual precipitation averages 34 to 46 inches and the growing season lasts approximately 175 days.

Burning the rangeland is a recommended practice in the Flint Hills region as annual late spring prescribed burning increases individual animal gains by approximately 30 pounds. Burning promotes early forage growth and in turn is important to IES grazing. All pastures with IES and one pasture with SL was burned in either the last week of April or first week of May.

There has been two separate studies conducted in Manhattan on IES. One study took place in the years 1972 through 1976 and a second study that began in 1980 is still being conducted.

The first study, conducted by Ed Smith and Clenton Owensby, considered SL and IES-two times the normal stocking rate (2x). The stocking rates used for SL and IES were 3.4 and 1.7 acres per steer, respectively. The purpose of the study was to evaluate the "effects of intensive-early stocking (IES) on steer gain, herbage production, botanical census, and grazing distribution" (Smith and Owensby 14).

The later study, conducted by Clenton Owensby, considers SL and IES-two times (2x), -two and one-half times (2.5x), and -three times (3x) the normal stocking rate. The stocking rates are 3.5, 1.82, 1.5, and 1.2 acres per steer for SL, IES 2x, IES 2.5x, and IES 3x, respectively. The benefits of feeding supplement to the steers at each of the IES stocking rates are being considered as well. The supplement is an average daily ration of 1.73 lb, 1.91 lb, and 1.41 lb of ground sorghum grain and 192 mg, 210 mg, and 156 mg of Rumensin per head for the 2x, 2.5x, and 3x stocking rates, respectively. One pasture under SL is not burned annually and one pasture is burned around the first of May. All pastures under IES are burned at the same time the pasture under SL is burned.

The purpose of the study was to evaluate the level of grazing a pasture was able to support before the animal gains, forage production, grazing distribution, species composition, and ground cover of the forages began to experience detrimental effects. Also, it evaluated whether there were any advantages in supplementing the cattle during the grazing periods.

Drs. John Launchbaugh, John Brethour, and Ken Olson have studied IES at the Fort Hays, Kansas branch experiment station on short-grass range in which the major dominant plant species includes blue grama, buffalograss, and western wheatgrass. Many other species are present, but the most abundant subdominant species are japanese brome and western ragweed. The annual precipitation averages between 20 to 24 inches. The rangeland is not burned at the Fort Hays Experiment Station, because studies have shown that burning the rangeland in that area has detrimental effects on the forage production (Launchbaugh Effect of Fire 135-136).

In 1957 John Launchbaugh studied the effects of light (5.1 acres per acre), moderate (3.4 acres per head), and heavy (2 acres per head) grazing on beef production and forage production. The study also considered the effects of supplementing the cattle during the latter part of the grazing period. The cattle were placed on native pasture at the beginning of May 1st and taken off pasture at the end of October.

The livestock used for the study at Fort Hays were good quality Hereford yearling steers and heifers which had been wintered at various rations prior to summer grazing. Each pasture contained equal numbers of steers and heifers. The steers on the heavily grazed pastures were not removed in mid-July. Therefore, the results of this study will not be typical of the other IES studies.

The purpose of the study at Fort Hays was to consider "(a) the effects of different rates of stocking on beef production; (b) the effects of supplementing short-grass pasture with protein concentrates during the latter part of the grazing season; and (c) the effects of different intensities of grazing on native short-grass vegetation" (Launchbaugh Effects 3).

Launchbaugh extended his study at Fort Hays to 1967 with the same purpose of study. Stocking rates were adjusted whenever forage production was insufficient for grazing and the grazing period lasted only until October 1st instead of November 1st. Also, beginning in 1955, only yearling steers were used in the study. No other changes were made in the experiment procedure.

Currently, at Fort Hays Drs. John Brethour and Ken Olson are studying IES as a continuation of Dr. Launchbaugh's study. The study was started in 1981 and is still being conducted in 1987. During the years 1981 to 1983, the study considered the systems SL, IES 2x, IES 3x, and IES 3x plus Supplement (Roundup 1984, 23). Starting in 1984 the study considered the systems SL, IES 2x, IES 2.5x, and IES 3x. In addition, a group of steers from each stocking rate were supplemented with four pounds of rolled grain sorghum and 200 mg of Rumensin (Roundup 1985, 14).

Starting in 1985, Dr. Brethour studied the influence of different wintering levels and cattle frame scores on performance of IES grazed steers. The different wintering levels were light, medium, and heavy wintered (Roundup 1986, 34). Wintering levels represent the amount of weight that is put on the calves during the winter months, and the calf gains were controlled by the feed ration fed to the calves. The different frame scores are small, medium, and large. The frame score is a subjective measurement based on the height and width of the calf. There has been no publication of the final results of this study as it is ongoing.

Dr. McCollum et al. studied IES in the Cross Timbers rangeland in Pawhuska, Oklahoma. Annual precipitation averages between 30 to 35 inches. "The Pawhuska rangeland is a mosaic of savannah and prairie sites typical of the Cross Timbers resource area" (Bernardo and McCollum 4). Management practice for the Pawhuska area range did not include prescribed burning. The stocking rates used on the Pawhuska range were four and two acres per steer for SL and IES, respectively.

The Pawhuska study was started in 1984 and is still ongoing. No final conclusions have been drawn from this study. The purpose of this study was to evaluate IES grazing in the Cross Timbers region. The points of concern were animal gain responses and rangeland responses to IES.

COMPLEMENTARY FORAGE STUDY

Dr. Posler et al. looked at different alternatives of feeding steers coming off grass in mid-July. The study considered the advantages, if any, of placing steers on a complementary forage before going into the feedlot. The complementary forages were sudan and alfalfa grass. The results were evaluated on the length of time it took each group of steers to reach finishing weight and the feed efficiency rate the steers had in the feedlot.

ECONOMIC STUDY

There has been much research done on the biological aspects of IES, but little work has been done on the economics of IES. Bernardo and McCollum looked at the ways IES influenced the enterprise economics and risk, and the integration of an IES program into a ranching operation.

Bernardo and McCollum identify three areas in which IES will effect the economics of the stocker cattle enterprise. The three areas are: financial, production, and marketing. To evaluate the risk incorporated with IES, enterprise budgets were assembled to represent the alternative production possibilities. The budgets incorporate several assumptions which made it possible to evaluate the IES and SL grazing systems. The budgets contained all the costs and receipts realized by a stocker operation under IES and SL. The budgets were used to evaluate the returns to land, management, and risk. Risk was specifically evaluated by varying the cattle gains and selling prices realized by the cattle in order to conclude which grazing system would be preferable if cattle gains were high or low, if selling prices were high or low, or if any combination thereof existed.

The budgets were also used in a break-even analysis of IES and SL grazing. Four different break-even prices were considered: the break-even price needed to cover total variable costs; the break-even price needed to cover total cash costs; the break-even price needed to cover total cash cost and depreciation on machinery and equipment; the break-even price needed to recover the opportunity costs the producers forgo from their investments in land, equipment, and buildings.

Bernardo and McCollum pointed out that the implementation of IES increased the options available to a manager. The manager had more flexibility in marketing the cattle and in the number of cattle that can be handled; and if a pasture needs to be improved, IES can provide improvements without idling the rangeland.

LINEAR PROGRAMMING MODELS

Dillon Feuz and Gordon Kearl used linear programming (LP) to identify the factors of production, and the underlying production practices, that would have the greatest effect on ranch profitability. Calf crop percentage, death losses, weaning, and sale weights were among the most significant factors affecting net returns. The specific objectives were to: (a) show the effects on ranch profitability of a change in the percent calf crop born, death loss of calves from birth to time of sale, and sale weights; (b) determine the effect on ranch profitability as a result of marketing different age and weight animals; and (c) determine the effect on ranch profitability as a result of different cropping practices (2).

The study was specific to cattle ranches in the mountain valley type area of western Wyoming. Most of the data were obtained from a 1985 survey of mountain valley ranches. The survey data were taken from only full-time commercial cattle operations that had over 375 cows to calve.

The ranch enterprise budgets were constructed to identify production relationships, resource availability, costs, sales, and relevant production practices. Given a certain resource base and average production factors, linear programming was then used to find the optimum resource allocation and appropriate ranch activities that maximized profit (4).

J. W. Wilton et al. used a linear programming model to represent an on-farm integrated beef production enterprise. The model included cropping, feeding, and breeding activities with their requirements for land, labor, animal housing, and crop storage facilities. A method for identifying the distribution of animals across different mature sizes, each under typical Ontario, Canada, farm conditions, were analyzed and interpreted (693). Cropping activities were run solely for the provision of animal feed (703). The objectives of this study were to (a) describe the use of LP in beef production planning on an integrated farm unit and (b) describe a set of animal and crop production values including numbers and weights of animals of various ages, feed and labor requirements, and crop yields (694).

W. C. Miller, J. S. Brinks, and T. M. Sutherland used a linear programming model to "determine management policy for a yearly planning horizon on a typical 1320 acre Southern Colorado mountain ranch" (147). The model structure represented a typical ranch operation in the Southern Colorado mountain area. "The purpose of the modeling effort was to determine the level of each activity that resulted in maximum net return for the ranch subject to resource limitation on land, labour, and capital" (147). After the optimal management plan was determined, a sensitivity and shadow price analysis was conducted on certain coefficients that the researchers concluded to be of importance.

The Miller model consisted of only beef and hay enterprises and no grain crops were integrated into the model for feeding or selling purposes. The grazing systems were predetermined and the model did not include alternative grazing systems.

Steve A. Hildebrand used linear programming to "study the most profitable farm organization on a representative Southeast Kansas farm which produces both beef and crops" (Thesis Abstract). The objective of Hildebrand's research was to "develop a linear programming model that can be used as a decision tool for a representative farm in the southeast region of Kansas which produced both beef and crops" (21). The objective of the model was to "(a) maximize returns to the fixed resources, (b) select type and size of enterprises, (c) allocate resources among enterprises, and (d) determine the forage management and use" (21).

The beef enterprises considered in the Hildebrand analysis were spring calving cow herd and stocker steers and heifers. The cropping enterprises considered were grain sorghum, wheat, soybeans, alfalfa and sudan grass. The study focused on the benefits which arise from using winter wheat pasture and grain sorghum stubble in the production of beef.

The biological studies reviewed have indicated the variables which are important to the practicality of IES from a biological standpoint. The results of the biological research are important because they provide the production coefficients, particularly cattle gains, for the present LP model.

The LP model studies reviewed illustrate the methodology of investigating and identifying certain variables which are important to the success of the enterprise. The prior research is important as it illustrates methods used to evaluate alternative grazing systems and compatibility of livestock and crop enterprises.

The decision model developed for the present research is different from previous studies in that it is based on a Northwest Kansas situation with various cash crop enterprises that are commonly found in that region. In addition, there are different stocking rates available for use on the native pasture that, based on the biological research, can be used to graze more head of cattle for a shorter period of time. Also, certain crops grown can be either sold for cash or fed to the cattle during the wintering period.

CHAPTER 3

THEORY OF MULTIPRODUCT PRODUCTION

One of the most important decisions of managers of Northeast Kansas farms is what combination of enterprises should be produced by using resources in different amounts and times throughout the year. Before that decision is made, the manager needs to establish his objectives. For example, does the farm manager want to minimize the cost of production or is maximizing profit the desired goal of the farm manager?

It is assumed that the manager of the representative Northeast farm wants to maximize profit. Achieving this goal is based on selecting a combination of the following enterprises: wheat, grain sorghum, corn, sorghum silage, soybeans, alfalfa hay, wintering, wintering and season-long graze, wintering and IES graze, season-long graze, and IES graze steers. Some of the crops may be sold directly, some may be sold through livestock, and some may be sold both ways. Some resources are available as owned, some as rented, and some resources are purchased using capital.

All of the crop and livestock enterprises on this representative farm compete for capital and land. Cropland and government programs limit the size of some crops. Crop and livestock enterprises compete for labor during some months, but not in others. Therefore, some economically independent relationship exists between crop and livestock enterprises in the use of operator labor.

The job of the farm manager is to efficiently allocate the available resources to the various enterprises to achieve profit maximization. Theory is needed to define the profit maximization criteria given the complexity and number of the possible organizations.

ECONOMIC DECISION CRITERIA

The type of resource to be allocated among enterprises determines the economic decision criteria which will be used in determining how resources are allocated among economically competing and economically independent enterprises. Three categories of resources are considered: (1) the variable resources that can be allocated among the products, (2) the resources that are fixed to the farm but can be allocated among enterprises, and (3) the resources that are fixed to the firm and fixed in use and thus cannot be allocated between enterprises.

Interrelationships between enterprises are classified as economically competing or economically independent (Beattie and Taylor). Economically competing enterprises are also called competitive enterprises and economically independent enterprises are also called supplementary enterprise.

> "The art of farm management centers around a knowledge of the competitive, complementary, and supplementary relationships among farm enterprises. The farm manager tries to combine enterprises to take maximum advantage of supplementary and complementary relationships" (Doll and Orazem 92).

Economically Independent Relationship

Products are economically independent if the amount of one enterprise can increase without taking resources away from the production of another. Crop and livestock enterprises can have an economically independent relationship when an input such as fixed operator labor can be used by one enterprise at a time when it is not used by the other enterprise. For example, Wheat production and winter calves both require operator labor however, wheat production requires most of its labor in June, July, August, September, and October and wintering calves requires labor in only January, February, March, April, November, and December. Thus, increasing the production of wheat by increasing operator labor use may not reduce the availability of operator labor used in wintering calves. This relationship is expressed as

$$\frac{MPPw}{MPPb} = 0$$

which states that the change in wheat production is not affected by using labor to produce beef.
where MPPw is marginal physical product of labor in wheat production, and MPPb is marginal physical product of labor in beef production. Under this combination profits are increased by producing both enterprises.

However, the economically independent relationship between enterprises will not last indefinitely and at some level of resource use, enterprises begin to compete for the resource; then an economically competing relationship will exist. Cost savings occurs when the total cost of an input, operator labor, does not change when output from enterprises as wheat and wintered calves increases. Thus, the farmer spreads the fixed cost over more units of output, wheat and wintered calves.

Economically Competitive Relationship

Products are termed economically competitive when the output of one product can be increased only by shifting resources away from the other thereby reducing its output. Outputs are economically competitive because they require the same resources at the same time. Crop and livestock enterprises in the same farm operation have economically competitive relationships for cropland. This relationship is expressed as

$$\frac{MPPw}{MPPc} < 0$$

which states that wheat production is decreased as the resource is shifted from wheat to beef.

where MPPw is marginal physical product of labor in wheat production, and MPPc is marginal physical product of labor in corn production. If corn is being produced on an acre of land, then wheat cannot be produced on that same acre of land at the same time. Therefore, wheat and corn compete for land. If the livestock enterprises use grain or forage produced on cropland, they compete for the use of cropland. Crop and livestock enterprises, which use operator labor in the same month, compete for operator labor. All enterprises on the representative farm are assumed to compete for capital. When allocating a resource to competing enterprises the manager is concerned about the trade-off between the loss in value of production from the enterprise given up as compared to the gain in value from the production of the enterprise added.

Certain assumptions are made in the multiproduct theory. These assumptions are: (A) The production functions of the enterprises considered are given. (B) Prices of the resource and of the product are known. (C) All products and resources are homogeneous and infinitely divisible. (D) The goal of the manager is to maximize profit. (E) At least one resource is fixed and the law of diminishing returns holds. (F) Resource and output prices do not change as production and resource use changes. The discussion that follows will describes the criteria for solving the problems of efficiently allocating resources to various enterprises.

One Variable Resource And One Product

When producing one product with one variable resource, keeping in mind that there must be at least one fixed resource, the production function is:

$$Y = f\ (x1, \text{fixed resource})$$

where y is the product and x1 is the variable resource.

The profit equation is:

$$\text{(3.1)} \quad \text{Profit} = Py * Y - Px * X - (\text{fixed costs})$$

where Py is the price of the output, Y is the quantity of the output, Px is the price of variable resource, and X is the amount of the variable resource used. To determine maximize profit from the use of resource X, differentiate the profit equation with respect to X:

$$\text{(3.2)} \quad \frac{d\text{Profit}}{dX} = \frac{dY}{dX} * Py - Px \geq 0$$

Fixed costs are not included because the they do not change as X changes.

One Resource And Two Products

When the resource is "unlimited," meaning there is a sufficient amount of input to reach the most profitable production of both enterprises. The production functions are:

$$Y1 = f(X1, \text{ fixed resources})$$
$$Y2 = f(X1, \text{ fixed resources})$$

where Y1 and Y2 are the products and X1 is the resource. Equation 3.3 is used to maximize profit when producing two products with one "unlimited" resource.

$$\frac{dY1*PY1}{dX1*Px1} = \frac{dY2*PY2}{dX1*Px1} = 1 \qquad (3.3)$$

The equal marginal principle is used when allocating "limited" resources to multiple products and when the value added by the last unit of the resource is the same in each of its alternative uses (Boehlje and Eidman 191). A resource is classified as "limited" when there is not a sufficient amount of resource to reach the most profitable production of both enterprises. The production functions for products with limited resources are written:

$$Y1 = f(\overline{X1}, \overline{X2}, \ldots \overline{Xn}) \text{ and } Y2 = f(\overline{X1}, \overline{X2}, \ldots \overline{Xn})$$

where Y1 is product one, Y2 is product two, $\overline{X1}$ is the limited resources, and $\overline{X2} \ldots \overline{Xn}$ are fixed resources. Profit maximization is derived by equating

$$\frac{dY1*PY1}{dX1*PX1} = \frac{dY2*PY2}{dX1*PX1} \qquad (3.4)$$

where P1 and P2 are the prices for Y1 and Y2, respectively, and X1 is the quantity of resource 1.

Multiproduct - Multifactor Production

Almost every farm is a multiproduct, multifactor operation. The multifactors are a combination of (1) variable resources that can be allocated among the products, (2) resources that are fixed to the farm but can be allocated among enterprises, and (3) resources that are fixed to the firm and fixed in use and thus cannot be allocated between enterprises. The multiproducts maybe a combination of primary and secondary products. Primary products are products produced on the farm using land, labor, capital, and other purchased inputs. Secondary products are products produced on the farm using land, labor, capital, other purchased inputs, and products produced on the farm (primary).

Allocating Variable Resources Among Competing Enterprises

For the most profitable enterprise combination the using the variable resources which is limited the criteria is

$$(3.5)\quad \frac{MVPXi(Y1)}{PXi} = \frac{MVPXi(Y2)}{PXi} = \cdots = \frac{MVPXi(Yn)}{PXi}$$

for resources X1, X2,...,Xn, products Y1, Y2,..., Yn, and MVPXi is the Marginal Value Product for resources X1, X2,...,Xn. MVPXi can be written as $\frac{dYi}{dXi}*PYi$ which is the general case of the situation specified in equation 3.4. For the most profitable enterprise combination when resources are unlimited the criteria is

$$(3.6)\quad \frac{MVPXi(Y1)}{PXi} = \frac{MVPXi(Y2)}{PXi} = \cdots = \frac{MVPXi(Yn)}{PXi} = 1.$$

for resources, X1, X2,...n and for products Y1, Y2,...Yn. Equations 3.5 and 3.6 are similar to equations 3.4 and 3.2, respectively but equations 3.5 and 3.6 have been expanded to include many products and resources.

Allocating Resources Fixed To The Farm But Variable Among Enterprises

When a farm firm has resources that are fixed to the farm but can be allocated among competitive and primary enterprises the production functions may be written as follows:

$$Y1 = f(X1, X2,\ldots, Xn \mid Xn+1,\ldots,Xg)$$

$$Y2 = f(X1, X2,\ldots, Xn \mid Xn+1,\ldots,Xg)$$

$$Y3 = f(X1, X2,\ldots, Xn \mid Xn+1,\ldots,Xg)$$

where X1 - Xn are variable resources that are variable to the enterprise and firm and Xn+1 - Xg are resources fixed to the firm but can be allocated among enterprises. An example is operator labor which is fixed to the farm but can be allocated among wheat, corn, wintering calves, stocker cattle, etc.

The method to use to determine the most profitable combination of allocating the resources that are fixed to the firm but variable to the enterprises is referred to as "the opportunity cost principle." The opportunity cost principle equates the MVP of all the products. This can be written:

$$(3.7) \quad MVP\ Xi\ (Y1) = MVP\ Xi\ (Y2) = \ldots = MVP\ Xi\ (Yn)$$

where Xi are resource Xn+1 - Xg and Y1 - Yn are products.
Equation 3.7 is different from 3.6 in that the market price of the input does not exist. The fixed resource is allocated among competing enterprises until the marginal returns are equal. Allocating resources any other way means, based on the law of diminishing returns, that one gives up more income on some enterprise than one gained from the use of the resource in another using the same amount of the resource in total.

Allocating Resources Fixed To The Farm And Enterprise

An input is not fixed unless marginal return is greater than its salvage value or less then returns of an additional unit. Resources fixed to the farm and enterprise are specialized facilities or equipment. Based on the concept above, if the salvage price of specialized facilities is zero, they are used as long as their earnings are greater than zero. That type of situation is also referred to as "Asset Fixity." The production functions may be written as follows:

$$Y1 = f(X1, X2, \ldots, Xd \mid Xg+1, \ldots, Xn)$$

$$Y2 = f(X1, X2, \ldots, Xd \mid Xn+1, \ldots, Xr)$$

$$Y3 = f(X1, X2, \ldots, Xd \mid Xr+1, \ldots, Xv)$$

where X1 - Xd are variable resources that are variable to the enterprise and firm and Xg+1 - Xn,...,Xr+1-Xv are resources fixed to the firm and to the enterprises.

Intermediate Products

Products grown on the farm (primary) and used as inputs for other farm products (secondary) are called intermediate products. For example, grain and forage that is produced on the farm and then fed to steers are intermediate products. There are substitution possibilities between grain and forage to produce beef.

If the primary products grain (Y1) and forage (Y2) are used to produce the secondary product beef (Y3), the production functions are:

$$Y1 = f(X1, X2, \ldots Xn)$$

$$Y2 = f(X1, X2, \ldots Xn)$$

$$Y3 = f(Y1, Y2, X1, X2, \ldots Xn)$$

where X1 - Xn are a specified amount of resources.

The Production Possibilities Curve (PPC), shown in Figure 3.1, indicates the possible combinations of grain and forage production given the resources available to the farm. The Y3 isoquant, shown in Figure 3.1, indicates the different combinations of grain and forage use that will produce Y3 level of beef. The most profitable combination of grain and forage used to produce Y3 level of beef is indicated by point "A" which is where the grain-forage PPC is tangent with the Y3 beef isoquant. If the primary products are not sold, the prices of primary products are of no consequence in allocating resource use to the production of grain and forage. The value of resources used to produce grain and forage is determined by the value of beef

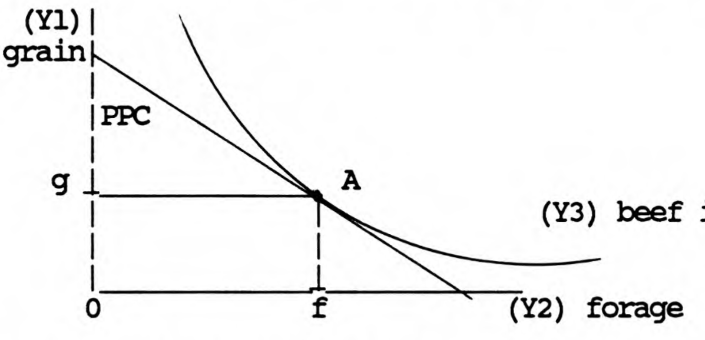

Figure 3.1. Profit maximization with two primary products and one secondary product. The primary products are not sold.

produced from using grain and forage. The amount of grain "0g" and forage "0f" represents the feed ration that maximizes beef production, given the specified amount of input available to produce grain and forage.

At point "A"

$$\text{(3.8)} \quad \frac{\text{MPPX1 (Y2)}}{\text{MPPX1 (Y1)}} = \frac{\text{MPP Y1 (Y3)} * \text{P (Y3)}}{\text{MPP Y2 (Y3)} * \text{P (Y3)}}.$$

Here the amount of the grain and forage fed and produced is determined by their productivity in producing beef.

Another situation is where the primary products can be sold and/or used as resources in the production of beef. Figure 3.2 illustrates this situation. The curve which is indicated by the letter "A" is the PPC for grain and forage same as in figure 3.1. Curve "B" is an isoquant which indicates the given level of secondary product (beef). Line "C" is the isorevenue line for the cropping enterprises with the slope being the negative of the ratio of the price of forage and the price of grain. With market prices for grain and forage, the most profitable combination of grain and forage production is at point "1" where

$$(3.9) \qquad \frac{MPPX1\ (Y2)}{MPPX1\ (Y1)} = \frac{P(Y1)}{P(Y2)}.$$

Because market price for grain and forage determine the least cost production of beef, line "C" is also an isocost line for the beef enterprise.

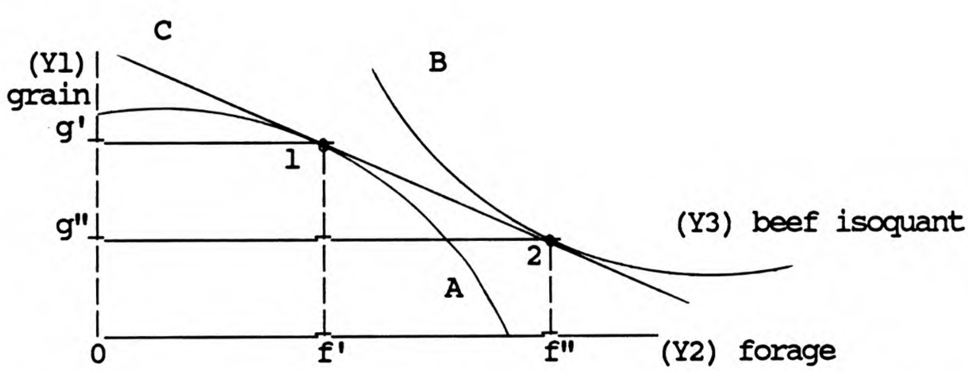

Figure 3.2. Profit maximization with two primary products and one secondary product. The primary products can be sold.

The isocost line represents the combinations of the two resources, forage and grain, which cost the same amount. The slope of the isocost line represents the price ratio of forage to grain. Point "2" represents the least cost ration of grain and forage to produce Y3 level of beef. With the possibility of buying and selling forage and grain, it is possible that higher levels of beef can be produced more profitably than in the case where beef production was limited by farm produced feed, illustrated by figure 3.1. The Y3 beef isoquant in Figure 3.2 is at a higher level of production than is Y3 beef isoquant in Figure 3.1 because the isoquant tangent to the production possibilities curve "A" would be to the right and lower in quantity of beef production. The most profitable amount of grain production is 0g' and 0f' of forage. The least cost combination of grain and forage is 0g" and of 0f", respectively. The quantity of grain from point g' to point g" can be sold and the revenue is adequate to purchase forage represented by the distance from point f' to point f". This transaction makes producing beef at a higher level, point "2", possible where in the previous case a lower quantity of beef was produced. At point "2"

$$(3.10) \quad \frac{MPP\ Y1\ (Y3) * P\ (Y3)}{MPP\ Y2\ (Y3) * P\ (Y3)} = \frac{P(Y1)}{P(Y2)}.$$

At point "2", maximum possible returns from the use of primary products are obtained and the output of the secondary product is produced with the least cost combination (Doll and Orazem 180-183).

The intermediate product criteria used when developing a model is important to the results produced by the model. If a producer buys, sells, and feeds grains and forages to livestock, than the model should be structured to represent equation 3.10. A model that excludes marketing of grains or forages when markets for these commodities exist will estimate production that is less than would be obtained otherwise. In the case where buying and selling of grain and forage is not an option to the producer, the criteria represented in equation 3.9 applies and a model should not include the marketing activities. A model that includes marketing of grains or forages when markets for these commodities do not exist will estimate production that is more than would be obtained otherwise.

Chapter 4

LINEAR PROGRAMMING MODEL

Linear programming (LP) is used to evaluate the most profitable organization of a representative farm located in Northeast Kansas producing crops and livestock. The representative farm is made up of activities: producing and marketing wheat, grain sorghum, corn, alfalfa, sorghum silage, and winter and graze steers on a season-long and intensive-early grazing system.

The theory chapter, chapter 3, demonstrates the complexity of maximizing profit for a multiproduct-multifactor operation. LP is one tool available to farm managers and researchers to aid in the evaluation of a multi-activity operation. LP, defined by Dr. Orlan Buller, is a method that selects alternatives to maximize or minimize some objective, subject to specified constraints or limits (Linear 3). With LP, one can compare several alternative methods, such as grazing systems, to determine the most profitable farm organization.

LINEAR PROGRAMMING MODEL

The mathematical formulation of a LP model can be expressed as the following:

maximize (or minimize) $Z = C_1X_1 + \ldots C_nX_n$

subject to $A11X1 + A12X2 + \ldots A1nXn \leq b1$

$$A21X1 + A22X2 + \ldots A2nXn \leq b2$$

$$\vdots$$

$$Am1X1 + Am2X2t + \ldots AmnXn \leq bm$$

$$X1, X2, \ldots Xn \geq 0$$

All the functions are linear in the n variables X1, X2, . . . Xn (4), where

Xj's are the decision variables including crop and livestock enterprises.

Cj's are the gross margins derived from the marginal cost or marginal revenue from each variable or activity.

bi's (referred to as the right-hand-side) are the resources fixed to the farm.

Aij's are the per unit resource use (if positive) or per unit resource supplied (if negative) by each variable or activity.

Z is the gross margin (total revenue less variable costs) (Stanton 5).

The inequality constraints represent the resources required in production and the amount of resources available for production. The inequalities allow for some of the resources to be unused and excludes the production of negative quantities. Equality constraints may be used to insure the use of a resource.

Relationships among the activities with respect to a resource are expressed by the linear inequality constraints. Categories of resources are represented by different equations. For example, labor for different months allows for supplemental relationships. If one activity requires a resource and another activity does not require that resource, the two activities are supplementary activities with respect to that resource. Two or more activities with positive coefficients in the same inequality constraint require the same resource and are competitive with respect to that resource. Within each activity the X_{ij}'s are complements. (Heady and Candler 213-215).

LINEAR PROGRAMMING ASSUMPTIONS

There are seven assumptions of linear programming (Agrawal and Heady 31-32). These assumptions are:

1) The assumption of linearity of the objective function implies that regardless of the quantity of output sold or the quantity of resource purchased, the price is the same for each unit.

2) Additivity indicates that different activities are independent. The output in combination never exceeds or can be exceeded by the sum of the output of each activity.

3) Divisibility means that it is possible to use resources and to produce commodities in quantities that are fractional units. Divisibility can be a problem in linear programming models if a unit of input that requires a large increase in capacity and capital outlay. The problem arises when a fraction of the discrete input is determined to be the profit maximizing level of input use. The fractional unit might be rounded up or down which may have a significant influence on the production process. Integer programming can be used to determine the most profitable plan with discrete units of inputs. In some cases using a fractional unit may be acceptable and not have a large influence on the production process.

4) Finiteness of activities and resource restrictions means that there is a limited or finite set of activities to evaluate. The number of activities available to an operation is realistically finite. Due to limitations in land, management and equipment, only a finite number of activities needs to be evaluated.

5) The single value expectation assumption is that the input/output coefficients used in the model are known and are

correct.

6) Proportionality of activity levels to resource use is the assumption that there is a linear input/output relationship. That is, if inputs are doubled then output is doubled. Constant returns to scale and constant resource productivity are implied. Nonlinear relationships such as diminishing returns to input use can be modeled by specifying several activities for alternate input levels.

7) Nonnegativity of the decision variables excludes the possibility of producing negative quantities or purchasing negative quantities of resources.

THE MODEL

The model of the representative farm that produces and sells crops and steers has a fixed amount of cropland, pasture, capital, and labor; is enrolled in the government program; and hires labor, rents pasture, purchases steers, corn, grain sorghum, and alfalfa if needed is presented in matrix format in appendix "A". Abbreviations used for the columns and rows are explained in appendix "B".

Objective Function

The objective function is the return to fixed resources. All values in the objective function, or gross margin, are in dollars and includes per unit cost of producing crops and steers, selling price, purchase price, per unit net income, or government deficiency payments. However, fixed cost associated with the fixed resources are not included in the objective function.

Chapter 3 discusses the theory of profit maximization. Profit is total revenue less variable cost less fixed costs which is expressed in equation 3.1. Linear programming maximizes gross margin. Gross margin is total revenue less variable costs. Thus, by maximizing gross margin the maximization of profit occurs. The profit equation 3.1 is

$$\text{Profit} = Py * Y - Px * X - (\text{fixed costs})$$

To maximize profit, one differentiates the profit equation with respect to X which yields: $\frac{dY}{dX} * Py - Px = 0$

This equation represents the maximization of gross margin as well, which is defined as change in revenue minus change in variable costs. The gross margin equation does not include fixed costs.

The goal of the model is to maximize the gross margin of the Northeast Kansas farm based on the best use of resources available to the farm. The objective function is

$$\text{Max. } Z=\sum_{g} \{P(g)*Y(g)\}+\sum_{y} \{P(y)*Y(y)\}-\sum_{x} \{C(x)*U(x)\}-\{PS*HS\}$$

$$-\{CP*PI\}+\{RP*AO\}-\sum_{i} H(i)*CH(i)+\sum_{f} F(f)*D(f)-B*I$$

$$-CSF*USF-CACR*AG-CSUP*USUP$$

P(g) is the loan rate and deficiency payment received per bushel of crop g= corn, grain sorghum, and wheat.

Y(g) is the number of bushels sold of crops g.

P(y) is the market price received per unit y= bushel soybeans, per ton of alfalfa hay, and per cwt of steers.

Y(y) is the number of units of y sold.

C(x) is the cost of production per acre of crops x= corn, wheat, grain sorghum, sorghum silage, soybeans, alfalfa and per head of steers.

U(x) is the acreage or number of x.

PS is the purchase price per cwt of steers.

HS is number cwt of steers purchased.

CP is the per acre rental rate for renting pasture.

PI is the number of pasture acres rented.

RP is the revenue per acre of pasture rented out.

AO is the number of pasture acres rented out.

H(i) is the number of labor hours hired for the month i= January, February, March, April, May, June, July, August, September, October, November, and December.

CH(i) is the hourly wage rate paid for hired labor in month i.

F(f) is the bushels fed to steers of f= corn and grain sorghum.

D(f) is the deficiency payment less feed preparation cost received per bushel of f.

B is the amount of capital borrowed.

I is the interest rate paid for borrowed capital.

CSF is the unit cost of investment for steer facilities.

USF is the number of units of steer facilities.

CACR is the cost per acre to maintain the acreage reserve acres in the government program.

AG is the number of acres in the acreage reserve government program.

CSUP is the per pound cost of purchased supplement.

USUP is the number of pounds of supplement purchased.

Resource Equations

Resources specified in the model as constraints are those most important in determining the limits to producing crops and livestock on the representative farm.

Labor:

A separate labor equation is used for each month of the year to allow for economically independent relationship of the crop and livestock enterprises. The labor equations are of the following form:

$$\sum_{j}\sum_{k} \{L(j,K)*X(j,k)\}+FLS-\sum_{k} \{H(k)*O(k)\} \leq Labor(k)$$

L(j,k) is the per unit labor requirement of the j-th enterprise in period k. k = each of the twelve months of the year and j= corn, wheat, grain sorghum, soybeans, alfalfa, sorghum silage, and steers.

X(j,k) is the acreage or livestock units of the j-th enterprise in period k.

H(k) is the hours of labor per person provided by hiring part-time laborers during period k.

O(k) is the number of persons hired in period k.

labor(k) is the hours of operator labor available in the k-th period.

FLS is the fixed labor requirement of steers.

Field Work Time:

Nine equations, representing the months April, May, June, July, August, September, October, November, and December, are used to describe the time available and the time spent to do field work. The nine months are the months in which most of the field work is done. Time available to do field work is based on that portion of time when weather, soil conditions, and proper rainfall will allow field work. The field work time equations are of the form:

$$\sum_{j}\sum_{k} \{f(j,k) * X(j,k)\} - \sum_{k} \{K(k) * LAB(k)\} \leq FWD(k)$$

f(j,k) is the field work time requirements for the j= wheat, corn, grain sorghum, alfalfa, soybeans, and sorghum silage and k= each of the nine months.

X(j,k) is the acreage of the j-th enterprise in period k.

K(k) is the field work time in hours per laborer provided by hiring labor during period k.

LAB(k) is the number of laborers hired during period k.

FWD(k) is the total field work time available during k-th period based on the operators time available.

Land:

Cropland is classified as owned or as rented. Cropland acres available in the model are based on the cropland acres reported by the Kansas Farm Management Association for the Northeast Kansas region in 1985. Wheat, Grain Sorghum, and Corn crop enterprises are assumed to have established base acreage. These crop enterprises are limited by their established base acreage.

Native pasture is required by the grazing enterprises. Owned pasture acres available are based on the pasture acres reported by the Kansas Farm Management Association for the Northeast Kansas region in 1985.

The cropland restrictions are:

Cropland : $\sum_{j}\sum_{i} X(i,j) + \sum_{i}\sum_{g} a(i,g) \leq \text{Cropland}(i)$

Cropland Base : $\sum_{i}\sum_{g} \{X(i,g) + a(i,g)\} \leq \text{Cropland Base}(i)$

Alfalfa land : $\sum_{i} EA(i) \leq \text{Established Alfalfa}(i)$

Pasture : $\sum_{j} P(j)*STR - \text{Pasture rented}$

$+ \text{Pasture rented out} \leq \text{Pasture owned}$

X(i,j) is the number of acres of crop j= corn, wheat, grain sorghum, sorghum silage, soybeans, and alfalfa hay classified as i= rented or owned.

a(i,g) the number of required set-a-side acres for crop g= corn, wheat, and grain sorghum classified in the i-th ownership.

X(i,g) is the number of base acres of crop g= corn, wheat and grain sorghum classified in the i-th ownership.

EA(i) is the number of acres established in alfalfa classified in the i-th ownership.

P(j) is the number of acres of pasture required per steer of j= season-long, IES 2x, IES 2.5x, and IES3x grazed steers.

STR is the number of steers in the j-th enterprise.

Cropland is the number of cropland acres available classified in the i-th ownership.

Cropland Base is the number of acres established in g= corn, wheat, and grain sorghum production classified in the i-th ownership.

Established Alfalfa is the number of acres established in alfalfa classified in the i-th ownership.

PASTURE is the number of owned pasture acres available.

Feedlot Capacity Equations:

Facilities to feed wintered steers are assumed to be limited on the representative farm to 275 head. To exceed the limit imposed requires capital investments in pens, buildings, and equipment.

The equation is of the form:

$$LVSTKW - FDLOTCPDEV \leq FDLOTCPW$$

LVSTKW is the feedlot capacity required by the wintering calf enterprise.

FDLOTCPDEV is the units of feedlot capacity developed.

FDLOTCPW is the total feedlot capacity available for wintering calves limited to 275. If the number of wintering steers exceeds 275 head, capacity can be increased by investing in pens and feeding facilities.

Production Transfer Equations:

A number of rows are used to link crop and livestock producing activities with selling, feeding, or grazing activities. These equations are of the form:

$$\{1.09*HS\} + \{6*HG\} - \{6*STR\} \leq 0$$

Feed Grain Production and Use

$$\sum_{y} FGS(y) + C + GS - \sum_{y} YPA(y)*ACRES(y) \leq 0$$

$$R*STR - GS - 1.05*C - PGS - 1.05*PC \leq 0$$

Forage and Supplement Production and Use

$$AS + AF - \{AP*ACRES(y)\} - AB \leq 0$$

$$F*STR - 3*AF - FS - 3*AB \leq 0$$

$$S*STR - 560*AF - SB \leq 0$$

$$2.9*FS - SP*ACRES(y) \leq 0$$

HS is the number of steers sold in May assuming a 2% death loss, 4% shrinkage, and 3% marketing.

HG is the number of 600 pound steers placed on pasture.

STR is the total number of 600 pound steers completing the wintering phase.

FGS is the number of bushels sold of y= corn and grain sorghum.

C is one bushel of corn fed to steers in the wintering phase

PC is one bushel of corn purchased and fed to steers in the wintering phase.

GS is one bushel of grain sorghum fed to steers in the wintering phase.

PGS is one bushel of grain sorghum purchased and fed to steers in the wintering phase.

YPA is the yield per acre of y= corn and grain sorghum in bushels.

AS is the number of tons of alfalfa sold.

AF is the number of tons of alfalfa fed to steers in the wintering phase. A ton of alfalfa supplies an equivalence of 560 pounds of supplement. A ton of alfalfa supplies 3 tons of sorghum silage equivalent forage.

AP is the yield per acre of alfalfa in tons.

AB is the number of tons of alfalfa purchased. A ton of purchased alfalfa supplies 3 tons of sorghum silage equivalent forage.

SB is the number of pounds of supplement purchased and fed to steers in the wintering phase.

FS is one ton of sorghum silage fed to steers in the wintering phase.

SP is the yield per acre of sorghum silage.

R is the grain requirement per steer of 4.64 bushels grain sorghum in the wintering phase.

S is the supplement requirement per steer of 210 pounds in the wintering phase.

F is the forage requirement per steer of 2.9 tons of silage in the wintering phase in terms of sorghum silage.

ACRES(y) is the number of acres producing crops y= grain sorghum, corn, sorghum silage, and alfalfa.

Capital Requirement Equations:

Three capital rows are used to express the capital requirements, amount borrowed, and limit on amount borrowed. One capital row is an accounting row that sums total operating capital used. This row accounts for all operating capital for farm expenses. Another capital row specifies the amount of capital that is borrowed for operating expenses. The model assumes that only one-half of the capital needed for operating expenses is borrowed and the interest on the borrowed capital is figured on a twelve month period. All of the capital needed for purchasing livestock is borrowed and the interest on the borrowed capital is figured on the months the cattle are actually owned. The interest charged for borrowed capital is 10.25 Annual Percentage Rate. The limit row limits the amount of operating capital that can be borrowed.

The equation for total operating capital is of the form:

$$\sum_j \sum_i [C(j,i) * X(j,i)] - TOTCAP \leq 0$$

The equation for using borrowed capital is:

$$\sum_j [.5(CC(j))*A(j)]+\sum_i [.5(COL(i))*STR(i)]+\sum_i [CPL(i)*STR(i)]-BC \leq CL$$

The equation to limit the amount of operating capital borrowed is:

$$BC \leq CL$$

C(j,i) is the operating capital required per unit of j= corn, wheat, soybeans, grain sorghum, alfalfa, sorghum silage, wintering calves, season-long, IES 2x, IES 2.5x, and IES 3x grazing steers for the i= each of the twelve months of the year.

X(j,i) is the number of crop acres and livestock units of the j-th enterprise.

CC(j) is the operating capital required for one-half of a unit of crop j= corn, wheat, soybeans, grain sorghum, alfalfa, and sorghum silage.

COL(i) is the operating capital required for one-half of the operating expense per steer in i= wintering phase, or season-long, or IES grazing.

CPL(i) is the capital requred to purchase one steer in the ith period.

STR is the number of steers in the ith period.

TOTCAP is the total operating capital used on the farm.

CL is the limit on the amount of capital borrowed.

BC is the amount of capital borrowed.

Chapter 5

DATA SOURCES AND COMPUTATIONS

The description of the representative farm, commodity prices, field work hours available, labor requirements, and operator labor hours available are derived from non-experimental sources. Steer weight gains and stocking rate data are derived from experimental sources. Problems can develop when a study combines both experimental and non-experimental data, but in some cases the mixture can not be prevented.

Experimental data is generated under the researcher's control over certain factors of production. The data shows the influences that the controlled factors have on production. The net effect tends to be a reduction in the number of unobserved variable factors. Production functions fitted from experimental data are more reliable as there tends to be a closer statistical fit of the function to the data. Non-experimental data is generated from the end results of production where controlled factors of production do not exist. The production functions fitted from nonexperimental data tend to be scattered and do not provide as good a statistical fit of the function to the data (Heady and Dillon 145). The effect on the results in this study is that the weight gains and stocking rate data used are not representative of on-farm experience. Most likely the experimental results show more favorable results than that which would be observed with on-farm data if available.

The land resources available as specified by the right hand side values (Appendix A) in the model are the averages of records from 118 farms that are reported in the Kansas Farm Management Association (KFMA) Records Summary of the Northeast Kansas region for 1985. These farms have combinations of crops and beef enterprises and are assumed to be representative of farms in the Flint Hills area having these enterprises. This group is used to construct the representative KFMA farm.

Land Constraints

The available land resource base of the representative farm is 956 acres of productive land of which 438 is owned and 518 rented. Of the owned land 267 acres are cropland and 171 acres are native tall grass rangeland used for grazing. The 518 acre limited on rented land is used only for crops. Table 5.1 lists acres of owned and rented land and base acres for the crop enterprises.

Table 5.1 Owned and Rented Land and Base Acres

Land	Acreage
Owned Cropland	267
Rented Cropland	518
Rented Wheat Base	112
Owned Wheat Base	46
Rented Grain Sorghum Base	140
Owned Grain Sorghum Base	67
Rented Corn Base	118
Owned Corn Base	61
Owned Alfalfa	27
Rented Alfalfa	37
Owned Pasture	171

The only hay production in the model is alfalfa. Rental arrangements for cropland is on production shares. The landlord and the operator receive one-third and two-thirds of the production, respectively and they share the fertilizer cost the same way. The model can rent native pasture and there is no limit on the amount of pasture that may be rented.

The right-hand side values for the wheat, corn, and grain sorghum on both owned and rented land are the estimated established base for each crop. Crop enterprises compete for cropland but not for base acres. The model limits wheat, corn, and grain sorghum acres to their base acres as it is assumed that the operator is enrolled in the government program. An upper limit of alfalfa acres for both owned and rented land is specified because it is believed that in the short run the operator will not likely change acreage of alfalfa, because it is not considered to be an annual crop. Alfalfa does not compete for cropland. Soybeans and Sorghum silage compete for cropland, but have no base acre limit.

Labor Constraints

Hours worked per week for each month are an average calculated using quarterly reports from the Kansas Crop and Livestock Reporting Service of the weekly hours worked by producers in years 1975 through 1981. The Kansas Crop and Livestock Reporting Service reported weekly hours worked for January, April, July, and October. Thus, for the remaining eight months the values used for the average number of hours worked per week were estimated by following the up and down trend in the number of hours worked during the four given months. The coefficients used to determine the monthly availability of the operator labor is reported in Table 5.2.

Hours worked per month per farm, Table 5.2, was calculated based on average number of hours per week times weeks per month times number of operators. The number of operators, Table 5.2, was based on Farm Management Association reports. The hours per month per farm is the operator labor available in the model. If additional labor is needed, it can be hired.

Table 5.2 Number of Operators, Hours Worked per Week and per Month by Months.

Month	number of operators Per farm	ave. number of hours worked per week	hours worked per month per farm
Jan.	1.07	37.38*	160
Feb.	1.07	38.32	164
Mar.	1.07	39.25	168
Apr.	1.07	40.42*	173
May	1.07	42.76	183
June	1.07	54.67	234
July	1.07	54.67*	234
Aug.	1.07	54.67	234
Sept.	1.07	53.97	231
Oct.	1.07	52.80*	226
Nov.	1.07	47.66	204
Dec.	1.07	37.38	160

* months for which data was reported by Kansas Crop and Livestock Reporting Service.

The hourly wages for hired labor were derived by averaging the July and October field and livestock farm wage rates for 1984 reported by the Kansas State Board of Agriculture, 67th Annual Report. The July wage rate is used for June, July, and August and the other months use the October wage rates (229).

The wage rate used in this model is less than the wage rate used by the Kansas Farm Management Guides. The Kansas Crop and Livestock Reporting Service reports do not specify the type of labor that is hired at their specified wages. The model does not specify labor by categories, such as management labor, machinery repair labor, or general labor.

The model assumes a fixed labor requirement for each livestock enterprise. Labor spent repairing fence and facilities, driving to the pasture, checking cattle, and setting up work chutes are considered fixed labor and the amount of fixed labor is assumed not to change with changes in the number of steers. It was determined that the amount of fixed labor required for a stocker steer enterprise remains the same for 275 steers or less and for that size of operation the amount of fixed labor used is 12 hours per month (Buller, Langemeier, and Schobert). Table 5.3 reports the fixed labor requirements by enterprise and month. With 275 steers or less in the enterprise, the

Table 5.3 Fixed Labor Requirements For Livestock Enterprises By Month.

Month	Wintering calves Per 275 Steers	IES Grazed Calves Per 275 Steers	Season-long Grazed Calves Per 275 Steers
January	12	--	--
Feb.	12	--	--
March	12	--	--
April	12	--	--
May	--	12	12
June	--	12	12
July	--	12	12
Aug.	--	--	12
Sept.	--	--	12
Oct.	--	--	12
Nov.	12	--	--
Dec.	12	--	--

fixed labor for the wintering phase is 72 hours per year, 36 hours for IES, and 72 hours for season-long. With more then 275 steers fixed labor remains the same.

The amount of variable labor does change with the number of steers. Variable labor is primarily treating and feeding cattle, maintaining records, and manure disposal. Table 5.4 reports the amount of variable labor required per steer by enterprise and month.

Table 5.4 Variable Labor Requirements per Steer For Livestock Enterprises By Month.

Month	Wintering calves	IES Grazed Calves	Season-long Grazed Calves
January	.10	—	—
Feb.	.10	—	—
March	.10	—	—
April	.10	—	—
May	—	.10	.10
June	—	.10	.10
July	—	.38	.10
Aug.	—	—	.10
Sept.	—	—	.10
Oct.	—	—	.38
Nov.	.38	—	—
Dec.	.10	—	—

Figure 5.1 illustrates the total labor per steer for the wintering phase, season-long, and IES grazing phase in the model.

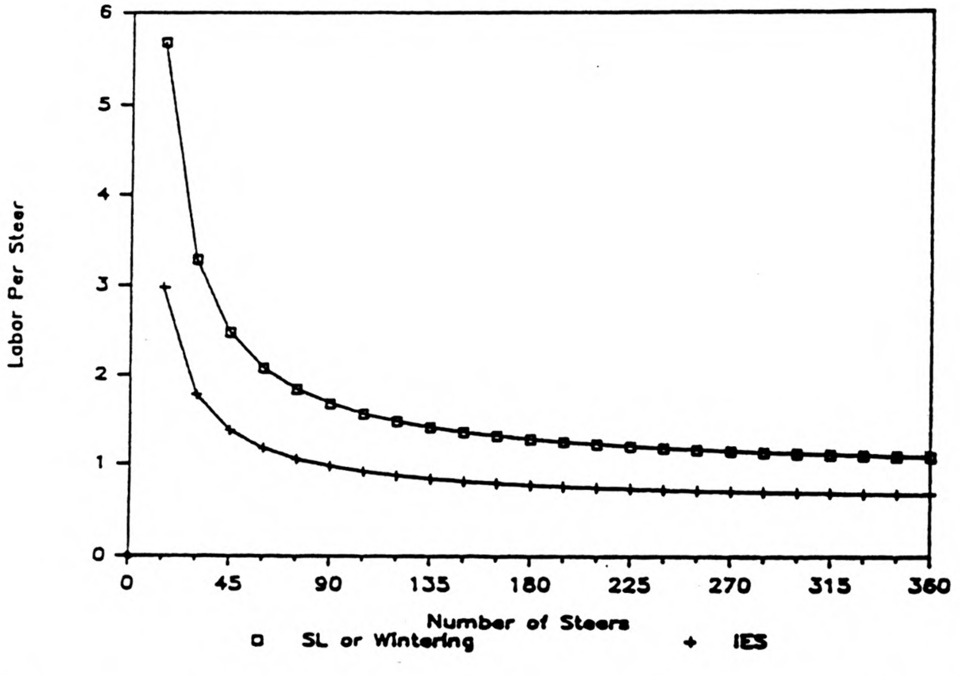

Figure 5.1: Per head total labor requirements for the wintering phase, season-long, and IES grazing phase.

With the fixed labor requirement for the three phases, the total labor function becomes non-linear. As the number of steers increases, the fixed labor is spread over more steers and the per head amount of fixed labor required becomes smaller.

Field Work Time

Time is a critical factor during periods such as planting and harvesting. Time when field work can be accomplished is referred to as field work hours. The number of field work hours available each month is influenced by solar radiation, wind, precipitation, and soil type. The estimation of the number of field work hours available for Northeast Kansas is based on soils which water permeates the subsoil moderately fast (Buller, Langemeier, Kasper, and Stone 9). Table 5.5 presents the field work hours by month. The operator field work hours is limited to the amount indicated in Table 5.5. Hiring additional labor also provides additional field work hours if needed.

Table 5.5: Field Work Days and Hours per Month by Month.

Month	Field Work Days Per Month	Field Work hours Accomplished/Day	Field Work Hours Per Month
Apr.	18	7.22	130
May	14	7.63	107
June	15	9.73	146
July	20	9.75	195
Aug.	21	9.76	205
Sept.	15	9.60	144
Oct.	17	9.41	160
Nov.	16	8.50	136
Dec.	14	7.14	100

Capital Constraints

In the model operating capital is borrowed to meet one-half of the variable costs and all of the cost of purchasing the cattle and is limited to $93,000. The limit on operating capital maintains a ratio of assets to liabilities of 2:1. The representative farm's assets and liabilities are shown in Table 5.6. It is assumed that money borrowed for current assets is equal to added current liabilities, thus the $93,000 operating capital limit is derived as follows:

$$\frac{231{,}000 + X}{69{,}000 + X} = 2 \qquad (5.1)$$

this can be written

$$231{,}000 + X = 2(69{,}000 + X)$$

$$93{,}000 = X$$

where X is current assets and current liabilities.

Long term and intermediate assets assumed available and fixed to the farm are land, buildings, and farm machinery.

Table 5.6: Assets and Liabilities of the Representative Farm

Intermediate Assets	$ 25,000	Intermediate Liabilities	$ 12,100
Long-Term Assets	$206,000	Long-Term Liabilities	$ 56,900
Total I & L-T Assets	$231,000	Total I & L-T Liabilities	$ 69,000

Farm machinery is fixed for the planning period and it is assumed that the proper complement of farm machinery is owned and available to accomplish the machine work required for the crop enterprise. It is also assumed that the cattle facilities on the operation is sufficient for 275 steers. If number of steers in the model exceeds 275 steers than an investment in additional facilities is required using operating capital to finance the facilities.

Commodity Prices

With linear programming the relationship between product prices and input prices is important. Having all prices too high or too low will cause the objective function value (gross margin) to be high or low. However, if relative price relationships are correct then the most profitable plan may still be correct.

The prices used for crops were the 1987 loan rates plus the deficiency payments for wheat, grain sorghum, corn, and soybeans. The loan rate used for wheat is the average of the counties loan rates in the northeast region of Kansas. Loan rates used for grain sorghum, corn, and soybeans are the national average loan rate. The deficiency payments do not vary by county, therefore the national deficiency payments are used. If grain sorghum and/or corn is produced and fed, the producer will receive the deficiency payment but will not receive the loan payment.

The prices used for the cattle are a ten-year weight adjusted average price from Kansas City for choice steers. One price is reported for each 100 or 200 pound weight group. However at the market, the price on a 400 pound steer will likely be different than the price on a 498 pound steer, but only one price is reported for the 400 to 500 pound weight group. Thus, a linear function was estimated using the mid-weight of each group and the price associated with that group. With the linear function, a price is estimated for any weight of steer, thus, yielding a weight adjusted steer price. The ten years of price data used were 1977 through 1986. The use of average prices tends to smooth out year to year variability in prices. These prices are presented in Table 5.7.

Table 5.7: Prices Used in the Analysis

Commodity	Purchase Price	Selling Price or Loan Price	Deficiency Payment
Wheat / bushel	*	2.06	2.10
Grain Sorghum / bushel	1.99	1.44	1.14
Soybeans / bushel	*	4.23	*
Corn / bushel	2.07	1.52	1.21
Alfalfa Hay / ton	50.00	45.00	*
400 lb calf / cwt	67.14	*	*
600 lb calf / cwt	67.27	67.27	*
798 lb steer / cwt	*	60.37	*
692 - 698 lb steer / cwt	*	62.04	*
Rent in pasture / acre	15.87	*	*
Rent out pasture / acre	*	14.13	*

* does not apply to the model

The market for alfalfa hay is not as well developed as beef and grain markets. Most hay is sold through private treaty or at auctions. The selling price for alfalfa hay was estimated by Fausett and Schlender and the purchase price was estimated by adding to selling price $5.00 per ton for hauling, handling and weight loss.

The rental value of the native pasture is based on the quoted price from the Kansas Crop and Livestock Reporting Service Bluestem Pasture Report released March 14, 1986. The quoted per acre rental rate is based on a per steer cost assuming that one steer requires 4.2 acres from May to October. The steers in this study require 3.3 acres from May to October. Thus, the per acre rental rate used in the model was estimated by multiplying the quoted rate per acre by 4.2 and then dividing the product by 3.3 to get the adjusted per acre rental rate.

Input costs for variable inputs are reported in the budgets presented in the Budget Appendix. These budgets were developed from the Kansas State University Farm Management Guides for 1986.

Cattle Production Data

The cattle gains used for this model were taken from the Intensive-Early Stocking study started in 1981 and conducted through 1986. The data for 1987 were not available for use. The IES study was conducted in Manhattan, Kansas on the experimental rangeland sites located five miles northwest of Manhattan, Kansas.

Forage Production Results

The dominant species on the rangeland sites are big bluestem, little bluestem, indiangrass, and switchgrass and is burned annually around May 1st (Owensby 12th Annual c-1). To evaluate the long run forage production response to IES, a reading was taken of the forage production October 1st when the season-long cattle were taken off pasture and after IES grazed pastures had time to recover from the intensive grazing. The October forage reading indicated that regrowth had occurred on the IES grazed pastures since the cattle were removed in July and no detrimental effects to the IES grazed pastures occurred. An analysis of variance indicates that there is interaction between years and the amount of forage produced.

When studying rangeland responses to grazing systems, six years is not long enough to verify all of the effects on rate of gain and pasture condition. This study analyzes the data available and evaluates the results. Rainfall is an important factor in the forage production of rangeland. Monthly average rainfall in Manhattan, Kansas for the years 1981 through 1986 in the months of March through September was above the 30 year average, years 1951 through 1980, in 26 of the 42 months. In 9 months the average rainfall was one inch or more below the 30 year average monthly rainfall. These months were: September* of 1981, April and June of 1982, August* and September of 1983, July* and August* of 1984, and May and July of 1985. The * months indicate the months where the average monthly rainfall was two or more inches less than the 30 year average monthly rainfall.

Cattle

The cattle used in the study are yearly steers weighing approximately 550 to 600 pounds on May 1st. The steers were implanted with one of three different growth hormones; Ralgro, Synovex, or Compudose. Production research suggests that the cattle should be fed a winter ration that provides the amount of nutrients that allow between 1 and 1 and one-fourth pounds (light wintering ration) of gain per day. In the model, a light winter ration is used. In the IES study, half of the cattle in each grazing intensity group were supplemented with grain sorghum and Rumensin. However, only steers that were not supplemented were used for the study of the representative farm.

Stocking Rate

The stocking rates used in the experiment are 3.3, 1.65, 1.32, and 1.1 acres per steer for season-long, intensive-early stocking 2x, IES 2.5x, and IES 3x, respectively. Ranchers in Kansas traditionally stock the rangeland at about 4 acres per steer. However, in the experiment the season-long stocking rate used was 3.3 acres per steer. Cattle grazed season-long, went on pasture May 1st and taken off pasture October 1st. Cattle grazed on all three levels of IES were placed on pasture May 1st and taken off pasture and sold July 15th.

All cattle in the experiment were weighed before going on pasture May 1st, weighed again July 15th, and then season-long cattle were weighed coming off pasture October 15th. The season-long cattle were weighed July 15th, so that the individual animal gains realized by the season-long cattle could be compared to those of the IES cattle.

Cattle Gain Results

An analysis of variance was preformed on the cattle gains on grass from May 1st through July 15th for the cattle grazed season-long and IES. Table 5.8 illustrates the total gains and net gains used in the model. Average total gains are average gains realized in the wintering phase plus average gains realized during the grazing phase. The average net gain is average total gain per head less 4 percent shrinkage from shipping and handling and less 3 percent for marketing. The 4 percent shrinkage and 3 percent marketing, Table 5.8, are based on Kansas State Farm Management Guides. Shrinkage is the amount of weight loss expected to occur as a result of moving and handling the cattle and the cattle being off feed. The 3 percent of the ending steer weight is deducted to cover selling cost and the selling cost is expressed in pounds instead of dollars.

During the wintering phase, it is assumed that all steers are fed the same ration and the average winter gain is reported. Thus, The wintering phase has no impact on the gains realized by the steers during the grazing phase and does not influence the average total gain per steer. Average net gains per steer is used in the model.

Table 5.8 Average Total Gain and Average Net Gain Per Steer.

	Season-long	IES 2x	IES 2.5x	IES 3x
Purchased weight	400	400	400	400
Weight gain				
wintering phase	200	200	200	200
grazing phase	255	150	144	143
Ave. Total Weight Per Steer	855	750	744	743
Less 4% Shrinkage	-34	-30	-30	-30
Less 3% Marketing	-24	-22	-21	-21
Ave. Net Weight Per Steer	796	698	693	692

If the model sells the steers in May at the end of the wintering phase, the weight of the steer sold is 600 pounds (400 pounds purchased weight + 200 pounds winter gain). The average daily gain results are shown in Table 5.9. The analysis of variance indicated that there is interaction between stocking rate and the year for both IES and season-long grazing experiments. Table 5.10 shows the total gains realized by season-long and IES grazed steers by year. It is assumed that the year affects are the same for IES and SL.

Table 5.9 Average Daily Gains of Steers From May 1st to July 15th.

Year	Season-long May-July	Season-long May-Oct.	IES 2x	IES 2.5x	IES 3x
1981	1.629	1.959	1.057^{1*}	1.284^{*}	1.345^{1}
1982	1.990^{*}	1.715	1.979^{*}	1.965^{*}	1.806^{*}
1983	2.118^{*}	1.643	2.033^{*}	1.696^{1}	1.926^{1*}
1984	NA	1.671	2.115^{*}	2.261^{*}	2.115*
1985	NA	2.000	3.019	2.687^{*}	2.554^{*}
1986	2.062	1.739	2.511^{*}	2.555^{*}	2.589^{*}
Average	1.952	1.787	2.187^{*}	2.081^{*1}	2.076^{1}

values within a row that are grouped by a * or a 1 have no significant difference in value using a .05 C.I.

Table 5.10 Total Gains Per Steer By Year.

Year	Season-long	IES 2x	IES 2.5x	IES 3x
1981	239.58	79.57	96.84	101.08
1982	242.50	130.97	130.00	119.62
1983	255.33	120.24	100.26	113.95
1984	234.29	150.44	160.79	150.43
1985	292.85	199.56	177.69	168.88
1986	267.08	191.18	194.53	197.17
Average	255.27	150.33	144.35	142.85

Chapter 6

RESULTS AND CONCLUSION

In this chapter the Base model and two alternative model organizations will be evaluated. The Base model is that organization described in the data section as the representative farm. The Alternative SL model is the Base model organization except that IES grazing is not allowed and the Alternative IES model is the Base model organization except that season-long grazing is not allowed. The most profitable farm organization and alternative farm organizations will be compared and discussed and the effect of changes in the selling price of the July feeder cattle, and limitations on the capital and pasture available will also be discussed.

Wholefarm Plans

Table 6.1 through 6.6 specifies the type and number of units of enterprises that maximize the gross margin and the reduced cost of those enterprises not included in the Base model and the two alternatives models. The reduced cost in tables 6.1 and 6.2 are the decrease in the value of the objective function if one unit of the enterprise not included in the solution is forced into the solution (Stanton 20-21). A "*" in the "reduced cost" column appears for enterprises that are in the optimal organization and thus have no reduced cost value. Table 6.2 specifies the type and number of units of buy, sell, feed, and rent activities.

The most profitable allocation of land, labor, and capital and the shadow prices of the resources used are presented in tables 6.3 through

6.6, respectively. A shadow price is an imputed price to a resource derived from the value of the earnings of the resource. The shadow price specifies how much the gross margin would be reduced if one unit less of the limiting resource was available. A "*" in the shadow price column means that more of that resource is available than is used and thus the shadow price is zero.

Optimal Wholefarm Organization For The Base Model

The objective function for the Base model is $59,727.01. This value is the return to the operator for his labor, management, investment, and fixed costs. All of the owned and rented cropland and owned pasture is used and both crop and livestock enterprises are in the wholefarm organization.

For the Base model the crop enterprises are 114.6 acres of wheat, 165.6 acres of grain sorghum, 143.2 acres of corn, 64.0 acres of alfalfa, and 141.0 acres of soybeans. Wheat, corn, and grain sorghum acreage is determined and limited by their base acreage and 120.6 acres of their cropland is put in the acreage reserve program. All alfalfa produced on the farm and 101.0 tons purchased alfalfa is fed to the steers to meet the forage requirement.

Sorghum silage is not produced. Silage competes with other enterprises for cropland, labor, and capital. The only market for silage is through feeding it to cattle. Silage is not the only source of forage available for the cattle, as alfalfa is an available feed. Silage production requires labor in seven months with a concentrated amount of labor in October and November. Alfalfa production requires labor primarily in the summer months, June to September. Silage

Table 6.1 Type and Number of Units of Beef and Crop Enterprises that Maximizes Profit for the Base Farm, Alternative SL, and Alternative IES.

		Base Farm		Alt. SL		Alt. IES	
Enterprise	Unit	Number of Units	Reduced Costs ($)	Number of Units	Reduced Costs ($)	Number of Units	Reduced Costs ($)
Wheat (rented)	Acre	81.20	*	81.20	*	81.20	*
Wheat (owned)	Acre	33.35	*	33.35	*	33.35	*
Grain Sorg.(rented)	Acre	112.00	*	49.22	*	112.00	*
Grain Sorg.(owned)	Acre	53.60	*	53.60	*	53.60	*
Corn (rented)	Acre	94.40	*	94.40	*	94.40	*
Corn (owned)	Acre	48.80	*	48.80	*	48.80	*
Soybeans (rented)	Acre	148.00	*	*	5.15	148.00	*
Soybeans (owned)	Acre	93.00	*	93.00	*	93.00	*
Alfalfa (owned)	Acre	27.00	*	27.00	*	27.00	*
Alfalfa (rented)	Acre	37.00	*	*	12.47	37.00	*
Silage (owned)	Acre	*	17.36	*	25.51	*	16.94
Silage (rented)	Acre	*	22.78	*	36.97	*	22.34
Winter Calves	No.	277.50	*	275.00	*	289.90	*
Graze Nov. Calf SL	No.	78.13	*	275.00	*	*	*
Graze Nov.Calf IES2x	No.	*	5.38	*	59.85	*	5.32
Graze Nov.Calf IES25	No.	*	3.00	*	56.30	*	2.98
Graze Nov.Calf IES3x	No.	199.38	*	*	52.52	289.90	*
Graze May Calf SL	No.	*	*	*	65.38	*	*
Graze May Calf IES2x	No.	*	10.75	*	7.32	*	12.79
Graze May Calf IES25	No.	*	8.74	*	3.78	*	10.45
Graze May Calf IES3x	No.	*	5.37	*	*	*	7.47

Table 6.2 Type and Number of Units of Buy, Sell, feed, and Rent activities in the Base farm, Alternative SL, and Alternative IES.

		Base Farm		Alt. SL		Alt. IES	
Enterprise	Unit	Number of Units	Reduced Costs ($)	Number of Units	Reduced Costs ($)	Number of Units	Reduced Costs ($)
Rent Out Pasture	Acre	*	2.29	*	5.82	*	2.18
Rent In Pasture	Acre	306	*	736.50	*	147.93	*
Buy Supplement	lbs	*	.09	*	.13	*	.09
Steer Facility	No.	2.50	*	*	*	14.94	*
Buy Nov. Calves	cwt.	1110	*	1100	*	1160	*
Buy May Calves	cwt.	*	3.77	*	20.51	*	2.93
Sell Grain Sorghum	bu.	10261	*	6913	*	10261	*
Feed Grain Sorghum	bu.	*	.004	*	.004	*	.004
Sell Corn	bu.	9886	*	9898	*	9828	*
Feed Corn	bu.	1288	*	1276	*	1345	*
Sell Alfalfa	ton	*	5	*	5	*	5
Feed Alfalfa	ton	286.66	*	279.13	*	294.29	*
Buy Alfalfa	ton	100.95	*	184.63	*	113.58	*
Buy Corn	bu.	*	.44	*	1.35	*	.41
Sell May Steers	cwt.	*	4.20	*	*	*	3.02
Sell July Steers	cwt.	1353	*	*	*	1967	*
Sell Oct. Steers	cwt.	610	*	2146	*	*	*

Table 6.3 Acres of Land Used and Shadow Prices by class.

Resource	Base Farm No. of Acres	Base Farm Shadow Price $	Alt. SL No. of Acres	Alt. SL Shadow Price $	Alt. IES No. of Acres	Alt. IES Shadow Price $
Owned Cropland	267	65.70	267	35.03	267	67.05
Rented Cropland	518	22.87	291.52	24.13	518	22.91
Rented Wheat Base	112	18.06	112	22.91	112	17.46
Owned Wheat Base	46	15.75	46	26.47	46	15.11
Rent Grain Sorghum Base	140	6.28	61.52	*	140	6.46
Own Grain Sorghum Base	67	12.46	67	11.16	67	12.65
Rented Corn Base	118	21.68	118	6.71	118	21.06
Owned Corn Base	61	44.48	61	33.77	61	44.88
Owned Alfalfa	27	61.87	27	35.28	27	63.33
Rented Alfalfa	37	10.59	*	*	37	11.93
Pasture	171	16.42	171	19.93	171	16.31

Table 6.4 Hours of Field Work by Month and Shadow Prices.

Resource	Base Farm No. of Hours	Base Farm Shadow Price $	Alt. SL No. of Hours	Alt. SL Shadow Price $	Alt. IES No. of Hours	Alt. IES Shadow Price $
Field Work Hours April	170.08	7.32	113.66	*	170.08	*
Field Work Hours May	208.10	9.41	165.08	9.93	208.10	9.29
Field Work Hours June	473.51	7.02	445.06	9.93	473.48	6.93
Field Work Hours July	323.59	*	194.50	*	322.78	*
Field Work Hours August	245.04	5.00	138.47	*	245.04	4.94
Field Work Hours Sept.	120.22	*	77.06	*	120.22	*
Field Work Hours Oct.	249.95	7.77	147.08	*	249.95	7.67
Field Work Hours Nov.	412.91	8.25	295.58	11.67	412.91	8.15
Field Work Hours Dec.	27.21	*	27.21	*	12.21	*

Table 6.5 Hours of Labor Used by Month and Shadow Prices

	Base Farm		Alt. SL		Alt. IES	
Resource	Number of Hours	Shadow Price ($)	Number of Hours	Shadow Price ($)	Number of Hours	Shadow Price ($)
January Labor	68.15	*	58.25	*	69.40	*
February Labor	72.39	*	61.86	*	73.63	*
March Labor	68.15	*	58.25	*	69.40	*
April Labor	225.35	*	163.83	*	226.60	5.43
May Labor	268.87	*	189.61	*	270.11	*
June Labor	548.47	*	321.52	*	549.67	*
July Labor	441.02	4.38	249.42	6.19	467.63	4.32
August Labor	268.28	*	186.40	*	257.16	*
September Labor	141.89	*	123.15	*	130.78	*
October Labor	312.25	*	283.20	7.78	279.51	*
November Labor	572.24	*	441.72	*	576.97	*
December Labor	68.39	*	68.14	*	69.63	*

Table 6.6 Borrowed and Operating Capital Used and Shadow Prices.

		Base Farm		Alt. SL		Alt. IES	
Resource	Unit	Number of Units	Shadow Price ($)	Number of Units	Shadow Price ($)	Number of Units	Shadow Price ($)
Borrowed Capital	$	93000	.0339	93000	.9183	93000	.0065
Operating Capital	$	146204	.1364	132591	1.0207	148843	.1090

requires more operating capital than does alfalfa. Silage competes with the other crops for the use of cropland, labor, and capital and the returns realized by feeding it to steers is not great enough to take these resources away from other crops, especially with the government payments received by wheat, grain sorghum, corn, and soybean enterprises.

All soybeans, wheat, and grain sorghum produced are sold. Of the corn produced, 9886 bushels are sold and 1287.6 bushels are fed to the steers. No supplement is purchased as the alfalfa supplies all the protein needed in the wintering phase.

The livestock enterprise is to purchase 277 steers in November weighing 400 pounds, winter them, and then 78 are put on pasture season-long, 199 are put on pasture IES 3x. All owned pasture is grazed and an additional 306.1 acres of pasture is rented. The representative farm rents 90 acres of pasture more than the model, which indicates that the resources used by the model are obtainable and comparable to the resource use of actual farm operators.

The model could have selected only a wintering or grazing system but instead it selected a combination. All the livestock alternatives were independent in the model. The model selects a size that is kept through both the wintering and grazing phase. The size is influenced by the feedlot capacity assumed available which is for 275 head. But instead of borrowing capital to expand facilities beyond 277 head it used the capital to keep steers longer which is through the grazing season. Apparently, the returns to the limited capital are higher if steers are kept through a grazing system than if it were used to expand facilities to expand the size of the wintering system.

Furthermore, the model could select either a season-long or intensive-early grazing system, but it selected a combination. The combination of these systems may not be practical but apparently neither system has a clear advantage for this representative farm situation.

The amount of operating capital available for borrowing is limited and the model borrows the maximum. With the combination of season-long and IES, the amount capital committed to season-long grazed steers is not as great as using only season-long grazing. This allows operating capital that would otherwise be committed to season-long cattle to be available for use in other enterprises. Less rented pasture is required for 277 steers with the combination of grazing systems than would be required using only season-long grazing. Thus, less operating capital is required for pasture rental.

Labor is hired in April (53.63 hours), May (172.02 hours), June (524.16 hours), July (205.92 hours), August (46.80 hours), October (126.56 hours), and November (416.16 hours). Labor hired in April, May, June, August, October, and November is for field work time and is used for crop enterprises. Labor hired in July is used for steers with most of it used to market the steers on the IES system. It may be difficult to find available labor for hire during the non-summer months. The large amounts of labor used during the summer months will likely be students not attending school. But the large requirement for November could be a problem for this representative farm. Steers do not directly require field work labor. However, field work labor used to produce corn and alfalfa which are fed to the steers is an indirect field work labor requirement of the steers.

Total operating capital needed for the Base model is $146,203.69. The Base model borrows $93,000 which is the maximum amount allowed in the model and it is assumed that the remainder of the operating capital comes from past and current revenue generated by the farm operation. All enterprises in the model compete for this capital as it is needed to purchase inputs, hire labor, and purchase steers. The interest paid on borrowed capital is 10.25 percent and the shadow price for borrowed capital is .0339 which means for each dollar of operating capital not used, the gross margin will decrease by 3.39 cents. Because 10.25 cents is paid on each dollar borrowed, the borrowed operating capital earns a 13.64 percent return which is the value of the shadow price for operating capital.

The mixture of season-long and IES 3x grazing may not be practical. For this particular mix, the producer would need at least two pastures, one for season-long grazing and one for IES 3x grazing. Producers may not have that arrangement or the management of the two grazing systems may not be easily handled. Therefore, the model was changed to allow only season-long grazing and only intensive-early grazing. The Alternative SL model is the Base model except that IES grazing is not allowed. The Alternative IES model is the Base model except season-long grazing is not allowed.

Optimal Wholefarm Organization For Alternative SL Model

Tables 6.1 through 6.6 provide the results for the Alternative SL model. The objective function for the Alternative SL model is $54,381.83 which is $5,345.18 less than the Base model. All of the owned cropland and pasture are used. However, only 291.5 of the 518 acres of rented cropland available is used. For the Alternative SL model 62.8 fewer acres of grain sorghum, 37 fewer acres of alfalfa, 148 fewer acres of soybeans are produced, wheat and corn acres are the same and 15.7 fewer acres of cropland are placed in the acreage reserve program than on the Base model. Since less alfalfa is produced in the Alternative SL model than the Base model, more purchased alfalfa is required for the cattle. All soybeans, wheat, and grain sorghum produced are sold. Of the corn produced, 9897.7 bushels are sold and 1276 bushels are fed to the steers.

The Alternative SL model does not use all of the grain sorghum base established on rented cropland which will reduce the grain sorghum base and the acreage for the representative farm. Also, not all of the rented land available for alfalfa and soybean production is used.

Season-long grazing steers compete with the crops for operator labor and capital. Capital is the limiting resource and some of the rented land is idle. There is not enough operator labor in May, June, July, October, and November and not enough capital available to hire labor for field work for those months to utilize all of the rented land and the steers. With season-long grazing, capital is committed longer to the cattle enterprise, and more labor is needed in October. Whereas, IES grazing releases capital that is committed to the cattle enterprise sooner and labor is not required in October.

The Alternative SL model uses less total operating capital than the Base model because it hires less labor, rents less cropland, and purchases fewer steers. However, the Alternative SL model borrows the same amount of operating capital as the Base model. The operating capital used to purchase season-long cattle is borrowed for the entire year. In the model all operating capital needed to purchase steers is borrowed whereas only one-half of total operating capital needed to hire labor and farm rented land is borrowed. Therefore, with less labor hired and fewer acres rented the Alternative SL model uses less capital, but borrows the limit to finance the steers for one year.

The livestock enterprise is to purchase 275 steers weighing 400 pounds in November, winter them, and put the steers on native pasture season-long. All owned pasture is grazed and an additional 736.5 acres of pasture are rented which is 430.4 acres of pasture more than the Base model. The acres of pasture rented in the Alternative SL model is much greater than shown for the representative farm.

The Alternative SL model hires 53.63 fewer hours of labor in April, 122.61 hours less in May, 339.30 hours less in June, 189.54 hours less in July, 70.06 hours less in October, and 177.48 hours less in November than the Base farm. July and October required hired labor for steers and May, June, and November required hired field work hours for crops. All other months had unused operator labor and did not need to hire additional labor. The reduction in hired field work hours and labor is due to fewer acres rented. The Alternative SL model has two steers less than does the Base farm as it does not expand feeding facilities above the 275 steer capacity.

The Altlernative SL model borrows $93,000 of operating capital which is the maximum amount of capital and the same as the Base farm, but uses $13,613 less total operating capital. The interest rate paid on borrowed capital is 10.25 cents for each dollar borrowed and the shadow price for borrowed capital is .9183 which means for each dollar of operating capital not used the gross margin decreases by 91.83 cents. Thus, operating capital earns a 102.08 percent return which is 88.44 percentage points higher than the Base farm. Increasing the capital limit for the Alternative SL model will increase the objective value more than for the Base model.

The Alternative SL model's objective function is approximately $5,400 less than the Base model, does not use all of the available rented cropland, and rents more pasture. But, the Alternative SL model does not hire as much labor as the Base model because there is not enough operating capital available to do so. A larger proportion of the borrowed capital is for the steer enterprise than in the Base model. This suggests that the season-long grazing steer enterprise successfully competes for capital and labor with grain sorghum, alfalfa, and soybeans produced on rented land.

Optimal Wholefarm Organization For Alternative IES Model

Tables 6.1 through 6.6 provide results of the Alternative IES model. The objective function for The Alternative IES model is $58,995.52 which is $731.49 less than the Base farm. All the owned and rented cropland and owned pasture is used. For the Alternative IES model the crop enterprises are the same as for the Base farm. All wheat, soybeans, and grain sorghum produced are sold. Of the corn produced, 9828.3 bushels are sold and 1345.3 bushels are fed to the steers. The Alternative IES model winters more steers than does the Alternative SL model and the Base model, thus more corn is fed and less is sold in the Alternative IES model.

The livestock enterprise is to purchase 290 steers weighing 400 pounds in November, winter them, and put on native pasture at a stocking rate three times season-long. All of the owned pasture is grazed and an additional 147.9 acres of pasture are rented which is 158.2 acres less than the Base model. More cattle are purchased and grazed on fewer acres of pasture than the Alternative SL and the Base models. A smaller proportion of capital borrowed is for the steer enterprise than in the Alternative SL model. This suggests that the IES grazing steer enterprise does not compete as well for capital and labor as the Alternative SL model.

Labor was hired in April (53.63 hours), May (172.02 hours), June (524.16 hours), July (234 hours), October (126.56 hours), and November (416.16 hours). All other months had unused operator labor and did not need to hire additional labor. April required hired labor for steers, May required hired labor for steers and field work labor for crops, and June, July, October, and November required hired field work labor for crops. All other months had unused operator labor and did not need to hire additional labor. The Alternative IES model hires more labor in July and less in August than the Base model and hires more labor in all months than the Alternative SL model.

The Alternative IES model borrows $93,000 of operating capital which is the maximum amount of capital and the same amount as the Base and the Alternative SL model and uses $148,843 of total operating capital. Even though the Alternative IES model rents less pasture than the Base and the Alternative SL model, it uses more operating capital because it purchases more steers and hires more labor in July than the Base model and hires more labor in months requiring hired labor than the Alternative SL model. The shadow price on borrowed capital is .0065 which means that for each dollar not used the gross margin will decrease by .65 cents. Thus, operating capital earns a 10.9 percent return, given a 10.25 percent interest cost for borrowed capital. This is less than the Base model's return of 13.641 percent and the Alternative SL model's return of 102.08 percent.

The Alternative IES model's objective function is approximately $4,600 more than the Alternative SL model and is approximately $732 less than the Base model. The Alternative IES model hires more labor than does the Alternative SL model and about the same amount of labor as the Base model. The Alternative IES model utilizes all of the rented and owned cropland, whereas the Alternative SL model does not use all of the rented cropland available.

The Base and the Alternative IES models are similar in organization, resource utilization, and both produce a greater gross margin than does the Alternative SL model. All cropland and owned pasture is used as well as the available capital. The Alternative SL model substitutes rented pasture for rented cropland as it rents more pasture than the Base and the Alternative IES models, but is not able to utilize the available rented cropland.

Effect Of A Change In July Feeder Cattle Price

The Base model used average steer prices based on ten years of data. Because the Base model includes both season-long stocking and intensive-early stocking, a test is conducted on the price sensitivity of these two systems. For the price sensitivity test the selling price of July steers is changed with all other prices and data unchanged. After the model determined the July selling prices at which only season-long or intensive-early stocking are in the solution, the buy-sell price margins were calculated for each system.

The Base model has been modified in that there is no longer a fixed labor or requirement imposed on the steer enterprises. Total labor is now proportionate to the number of steers in the enterprises. With the fixed labor requirement the model is not flexible enough to go from IES to season-long grazing or visa versa. Whereas, without the minimum requirement of fixed labor the model has the flexibility to chose a combination of season-long and IES grazing, only season-long, and only IES grazing and less labor may be required in the steer enterprise. Thus, the evaluation of the effects of price changes in July on grazing systems is possible.

Knowledge of relative price relationships and the buy-sell margins can be useful to producers to help choose the best system for their farm. Average prices may be most important for long run farm planning, but a farmer may be interested in the percent of years in which one system is preferred.

The parametric routine in linear programming is used to determine the price changes in the July selling price needed for either only IES or season-long grazing to occur in the farm organization. The parametric routine starts at a specified selling price and reports changes from incremental price increases. The purchase price of winter steers of $67.14 and the selling price of October steers of $60.37 remain unchanged. A July selling price of $61.80 results in only season-long grazing and a price of $63.40 results in only IES grazing. This compares to a $62.04 July selling price in the Base model. The farm organization with only season-long grazing will be referred to as Alternative SL II and with only IES grazing is referred to as Alternative IES II.

The relationship between the buying and selling price of the steer is important to the profitability of cattle production. The buy-sell margin for season-long grazed cattle selling in October is -$6.77 and remains unchanged throughout the analysis. If buy-sell margin for IES is -5.34 or a greater negative than only season-long stocking is selected by the model. If the buy-sell margin for IES is -3.74 or a smaller negative than only IES stocking is selected by the model. The buy-sell margin for IES in the Base model is -$5.10. Because the gains realized by IES grazed cattle are not as large as if grazed season-long, the IES system needs a smaller negative buy-sell margin to cover the cost of production. Season-long grazed cattle gain more weight than IES grazed cattle and can compensate for a large negative buy-sell margin and cover the costs of production. During the years of 1977 through 1986, the buy-sell margin for IES grazed cattle has been greater than -3.74 in five years and less than -5.34 in the other five years.

The changes in the July selling price for the feeder steers only effect the size and type of livestock enterprises and not that of the crop enterprises. The Base farm purchases 277 steers and rents 306.1 acres of pasture using a July selling price of $62.04 per cwt; Alternative IES II purchases 292 steers and rents 150.6 acres of pasture with a July selling price of $63.40 per cwt; and Alternative SL II purchases 242 steers and rents 626.81 acres of pasture with a July selling price of $61.80 per cwt. The objective function for Alternative SL II is $62,082.34, and for Alternative IES II is $63,517.99 which is $3,700.99 greater and $1,435.65 greater than the Base farm and Alternative SL II, respectively.

The objective function for the Alternative SL II model is $1,436.00 less than for the Alternative IES II model with July steer selling price is $3.03 per cwt higher than the October selling price. The Alternative IES II model purchases and sells 49 more steers at a $3.03 per cwt higher selling price than does Alternative SL II. But the 49 added steers increase weight sold only 97 pounds over that sold by the Alternative SL II model. The selling weight of a season-long grazed steer is 104 pound heavier steer than if the steer is grazed on the IES system.

With the fixed labor requirement on steers, Alternative SL does not use all of the rented cropland. Whereas Alternative SL II, without the fixed labor requirement, does use all of the rented cropland. By not requiring a minimum fixed labor requirement Alternative SL II does not purchase as many steers which allows capital and labor to shift over to crop production. Alternative SL II yields a $7,700.51 higher objective function than Alternative SL yields.

Effect Of Pasture Availability

Sometimes there is no pasture available to rent or rental rates are extremely high and available pasture becomes scarce. The manager must decide what grazing system will bring the highest returns when pasture is limited. The model of the Base farm is changed to allow no renting of pasture.

When the model of the representative farm is limited to use of only owned pasture, the organization of the crop enterprises does not change from the Base farm. However, the livestock enterprises do change. 275 calves are purchased in November for the wintering phase, 109.7 steers are then sold in May, and the remaining 156 steers are grazed IES 3x on the owned pasture and sold in July. The amount of capital borrowed is $78,145.54 as the model does not use all of the borrowed capital available. When pasture becomes the limiting resource with adequate capital, the model selects IES grazing to follow the wintering phase instead of SL grazing. The IES is more pasture intensive than SL.

Effect Of Capital Availability

The amount of operating capital available to a producer may be limited more than specified in the Base model. The manager must decide which grazing system is the most profitable system to use within the constraint of the amount of operating capital available. The Base farm model is changed to reduce parametrically the amount of borrowed operating capital available from $93,000 to $41,500.

As the amount of borrowed capital available decreases from $93,000, the season-long grazing system becomes more dominant. If Capital is limited to $41,500, IES grazing no longer enters the farm organization and only season-long grazing is used. 51 calves are purchased in November for the wintering phase, placed in the pasture on the season-long grazing system, and then sold in October.

Other changes in the farm organization with a $41,500 limit on borrowed capital are that not all of the available rented alfalfa acres are used and no additional pasture is rented. IES requires more capital to purchase the steers to place on pasture and when capital is limiting relative to the availability of pasture the most profitable grazing system is season-long grazing. If the number of steers that can be purchased is limited relative to the amount of grass, the model selects the system with the maximum gain per steer. When capital is the limiting resource with adequate pasture available, the model selects the season-long grazing system. The Season-long grazing system provides higher returns per unit of capital.

CONCLUSION

The most profitable organization of enterprises chosen for the Northeast Kansas representative farm by the linear programing model are similar to the enterprise organization reported by the Kansas Farm Management Association. This research showed that both season-long and intensive-early stocking grazing can profitably fit into farm situations of Northeast Kansas.

IES grazing is more profitable when pasture is limiting relative to the amount of capital or when July feeder steer prices are higher than average in relationship to October feeder steer prices which provides a smaller negative buy-sell margin. However, when capital is limited relative to the pasture available, then season-long grazing is the most profitable grazing system. The crop size and organization for the representative farm does not differ between the farm organization using IES grazing or using season-long grazing.

There is more risk involved with IES grazing. "Due to the strong dependence of pasture growth on climate, grazing tends to be a very risk-prone operation. As the stocking rate rises, the associated risk increases more than proportionately since drought is not only a function of rainfall but also of stocking rate" (Heady and Dillon 253).

Because the grazing season is shorter and the stocking rate is higher for IES than the SL system, adequate rainfall in April and May are likely to be more important for IES to achieve the steer gains specified than for SL. Adequate soil moisture and/or rainfall is needed early in the season to provide the vigorous forage growth necessary to sustain IES. As reported earlier, the rainfall during the six years of the study was average or above for most of the years.

IES grazing will requires careful range management. Season-long grazing has survived unfavorable weather for many years. Yet there is not enough research to determine the effects of unfavorable weather on pastures under IES grazing.

Chapter 7

SUMMARY

Linear Programming was used to study the most profitable farm organization of season-long grazing and intensive-early grazing systems and crop enterprises on a representative Northeast Kansas farm. Beef and crop enterprises are included in a wholefarm planning model to allow for the most profitable organization among the enterprises based on the use of land, labor, and capital to be incorporated into the decision making process.

The objective in this study was to analyze which grazing system fits best with crop enterprises in a wholefarm operation. The effects of limited pasture and capital and July feeder cattle price changes on the wholefarm organization were investigated.

A wholefarm model (Base model) was developed that maximizes returns to the wholefarm resource base. The Base model is flexible in that the steers can be bought in November and/or May, sold in May, July, and/or October, wintered and/or grazed on native pasture. If the cattle are purchased in November, they go through a wintering phase and then they are either sold or placed on native pasture in May. During the wintering phase, the model allows the grain and forage fed to the cattle to be either grown on the farm, purchased, or a combination of grown and purchased feed. If the cattle are purchased in May, they are placed on native pasture. Also, the cattle can be placed on native pasture at different stocking rates. The different stocking rates represent the intensive-early stocking and season-long grazing practices.

The representative farm includes the alternatives of season-long and intensive-early stocking systems. Alternative livestock enterprises are wintering, wintering and season-long grazing, wintering and IES grazing, season-long grazing, and IES grazing. Crop alternatives are wheat, corn, grain sorghum, soybeans, alfalfa, and sorghum silage. The wheat, grain sorghum, and corn acres are enrolled in the government program. 20 percent of the wheat base and 25 percent of the grain sorghum and corn bases are placed in the acreage reserve program. Prices received for wheat, grain sorghum, corn, and soybeans are based on the loan rates and wheat, grain sorghum, and corn has a deficiency payment.

THE BASE MODEL

For the Base model The objective function for the Base model is $59,727.01. This value is the return to fixed inputs of operator labor, owned land, and machinery and equipment. All of the owned and rented cropland and owned pasture is used and both crop and livestock enterprises are in the wholefarm organization. Total operating capital needed for the Base model is $146,203.69. The Base model borrows $93,000 which is the maximum amount allowed in the model and it is assumed that the remainder of the operating capital comes from past and current revenue generated by the farm operation. Labor is hired in April (53.63 hours), May (172.02 hours), June (524.16 hours), July (205.92 hours), August (46.80 hours), October (126.56 hours), and November (416.16 hours).

The crop enterprises are 114.6 acres of wheat, 165.6 acres of grain sorghum, 143.2 acres of corn, 64.0 acres of alfalfa, and 141.0 acres of soybeans. 120.6 acres of cropland is put in the acreage reserve program. All alfalfa produced on the farm and 101.0 tons purchased alfalfa is fed to the steers for the forage requirement. No silage is produced and all soybeans, wheat, and grain sorghum produced are sold. Of the corn produced, 9886 bushels are sold and 1287.6 bushels are fed to the steers.

The livestock enterprise is to purchase 277 steers in November weighing 400 pounds, winter them, and then 78 are put on pasture season-long, 199 are put on pasture IES 3x. All owned pasture is grazed and an additional 306.1 acres of pasture is rented.

Modifications were made on the Base model to evaluate only IES grazing and only season-long grazing on the wholefarm orgainization. The Alternative SL is the Base model except that IES grazing is not allowed. The Alternative IES model is the Base model except that SL grazing is not allowed. Table 7.1 illustrates the farm organizations of the Base, Alternative SL, and Alternative IES models.

ALTERNATIVE SL MODEL

The objective function for the Alternative SL model is $54,381.83 which is $5,345.18 less than the Base model. All of the owned cropland and pasture are used. However, only 291.5 of the 518 acres of rented cropland available is used. For the Alternative SL model 62.8 fewer acres of grain sorghum, 37 fewer acres of alfalfa, 148 fewer acres of soybeans are produced, wheat and corn acres are the same and 15.7 fewer acres of cropland are placed in the acreage reserve program than on the Base model. The Alternative SL model does not use all of the grain sorghum base established on rented cropland. All soybeans, wheat, and grain sorghum produced are sold. Of the corn produced, 9897.7 bushels are sold and 1276 bushels are fed to the steers.

The livestock enterprise is to purchase 275 steers weighing 400 pounds in November, winter them, and put the steers on native pasture season-long. All owned pasture is grazed and an additional 736.5 acres of pasture are rented which is 430.4 acres of pasture more than the Base model.

The Alternative SL model hires 53.63 fewer hours of labor in April, 122.61 hours less in May, 339.30 hours less in June, 189.54 hours less in July, 70.06 hours less in October, and 177.48 hours less in November than the Base farm. The Altlernative SL model borrows $93,000 of operating capital which is the maximum amount of capital and the same as the Base farm, but uses $13,613 less total operating capital.

ALTERNATIVE IES MODEL

The objective function for The Alternative IES model is $58,995.52 which is $731.49 less than the Base farm. All the owned and rented cropland and owned pasture is used. For the Alternative IES model the crop enterprises are the same as for the Base farm. All wheat, soybeans, and grain sorghum produced are sold. Of the corn produced, 9828.3 bushels are sold and 1345.3 bushels are fed to the steers. The livestock enterprise is to purchase 290 steers weighing 400 pounds in November, winter them, and put on native pasture at a stocking rate three times season-long. All of the owned pasture is grazed and an additional 147.9 acres of pasture are rented which is 158.2 acres less than the Base model.

Labor was hired in April (53.63 hours), May (172.02 hours), June (524.16 hours), July (234.00 hours), October (126.56 hours), and November (416.16 hours). The Alternative IES model borrows $93,000 of operating capital which is the maximum amount of capital available and uses $148,843 of total operating capital.

Table 7.1 Farm organizations of the Base, Alternative SL, and Alternative IES models.

	Base Farm	Alt. SL	Alt. IES
Cropland (Acres)			
Rented	518	292	518
Owned	267	267	267
Number of Steers (Head)			
Wintered	277	275	290
Grazed IES 3X	199	000	290
Grazed SL	78	275	000
Pasture Acres Rented	306	737	148
Objective Function	$59,727	$54,382	$58,996
Operating Capital			
Borrowed	$93,000	$93,000	$93,000
Total	$146,204	$132,591	$148,843
Total Hired Labor(Hours)	1,545	646	1,527

To evaluate influences on the wholefarm organization caused by changes in the July selling price, changes in the capital available, and changes in the amount of pasture available the Base model was modified. The parametric routine in linear programming was used to determine the price changes in the July selling price needed for either only IES or season-long grazing to occur in the farm organization. The parametric routine was also used to determine the amount of operating capital needed for either only IES or season-long grazing to occur. The Base model was also modified to no longer allow renting more pasture. The pasture acres were limited to the pasture acres owned.

For the July price, capital and pasture limitation analysis, a fixed labor requirement was not imposed on the steer enterprises. Total labor is now proportionate to the number of steers in the enterprises. Without the minimum requirement of fixed labor, the model has the freedom to chose a combination of season-long and IES grazing, only season-long, and only IES grazing. Thus, the evaluation of the effects of selling price changes in July, amount of operating capital available, and limited amount of pasture on grazing systems was possible. Table 7.2 illustrates the effects of limited pasture, Capital, and July feeder cattle price changes on the farm organization.

JULY PRICE CHANGES

A July selling price of $61.80 results in only season-long grazing and a price of $63.40 results in only IES grazing. This compares to a $62.04 July selling price in the Base model. The buy-sell margin for season-long grazed cattle selling in October is -$6.77 and remains unchanged throughout the analysis. If buy-sell margin for IES is -5.34 than only season-long stocking is selected by the model. If the buy-sell margin for IES is -3.74 than only IES stocking is selected by the model. The buy-sell margin for IES in the Base model is -$5.10.

The farm organization with only season-long grazing will be referred to as Alternative SL II and with only IES grazing is referred to as Alternative IES II. The changes in the July selling price for the feeder steers only effect the size and type of livestock enterprises and not that of the crop enterprises. Alternative IES II purchases 292 steers and rents 150.6 acres of pasture with a July selling price of $63.40 per cwt; and Alternative SL II purchases 242 steers and rents 626.81 acres of pasture with a July selling price of $61.80 per cwt. The objective function for Alternative SL II is $62,082.34, and for Alternative IES II is $63,517.99.

PASTURE LIMITATION

When the model of the representative farm is limited to use of only owned pasture, the organization of the crop enterprises does not change from the Base farm. However, the livestock enterprises do change. 275 calves are purchased in November for the wintering phase, 109.7 steers are then sold in May, and the remaining 156 steers are grazed IES 3x on the owned pasture and sold in July. The amount of capital borrowed is $78,145.54 as the model does not use all of the borrowed capital available.

CAPITAL LIMITATION

As the amount of borrowed capital available decreases from $93,000, the season-long grazing system becomes more dominant. If Capital is limited to $41,500, IES grazing no longer enters the farm organization and only season-long grazing is used. 51 calves are purchased in November for the wintering phase, placed in the pasture on the season-long grazing system, and then sold in October.

Other changes in the farm organization with a $41,500 limit on borrowed capital are that not all of the available rented alfalfa acres are used and no additional pasture is rented.

Table 7.2 Effects of limited pasture, capital, and July feeder cattle Price changes on the farm organization.

	Limited Pasture	Limited Capital	Alt. SL II	Alt. IES II
Cropland (Acres)				
Rented	518	504	518	518
Owned	267	267	267	267
Number of Steers (Head)				
Wintered	275	51	242	292
Grazed IES 3X	156	00	000	292
Grazed SL	000	51	242	000
Pasture Acres Rented	000	000	627	151
Objective Function	$58,729	$53,672	$62,082	$63,518
Operating Capital				
Borrowed	$78,146	$41,500	$93,000	$93,000
Total	$137,559	$71,951	$138,802	$148,140

This research showed that both season-long and intensive-early stocking grazing can profitably fit into farm situations of Northeast Kansas. IES grazing was more profitable when pasture was limiting relative to the amount of capital or when July feeder steer prices were higher than average in relationship to October feeder steer prices. However, when capital was limited relative to the pasture available, then season-long grazing was the most profitable grazing system to use.

The crop size and organization for the representative farm did not differ between the farm organization using IES grazing and the farm organization using season-long grazing.

There is more risk involved with IES grazing. "Due to the strong dependence of pasture growth on climate, grazing tends to be a very risk-prone operation. As the stocking rate is increased, the associated risk increases more than proportionately since drought is not only a function of rainfall but also of stocking rate" (Heady and Dillon 253).

Because the grazing season is shorter and the stocking rate is higher for IES than the SL system, adequate rainfall in April and May are likely to be more important for IES to achieve the steer gains specified than for SL. Adequate soil moisture and/or rainfall is needed early in the season to provide the vigorous forage growth necessary to sustain IES. As reported earlier, the rainfall during the six years of the study was average or above for most of the years.

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APPENDIX A

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ROWS
N  OBJFUN     L  CPLDOWN    L  CPLDRENT   L  RWHTBASE   L  WHTBASE
L  RGSBASE    L  GSBASE     L  RCORNBAS   L  CORNBASE   L  PASTURE
E  ACROWN     E  ACRRENT    L  ALFOWN     L  ALFRENT    L  FORAGE
L  SUP        L  MILO       L  CORNYLD    L  GSYIELD    L  ALFYIELD
L  SOYBYLD    L  TOTALCAP   L  CAPITAL    G  FIXLABW    G  FIXLABS
G  FIXLABI    G  FIMAYIES   G  FIMAYSL    L  LABJAN     L  LABFEB
L  LABMAR     L  LABAPR     L  LABMAY     L  LABJUN     L  LABJUL
L  LABAUG     L  LABSEP     L  LABOCT     L  LABNOV     L  LABDEC
L  FWHAPR     L  FWHMAY     L  FWHJUN     L  FWHJUL     L  FWHAUG
L  FWHSEP     L  FWHOCT     L  FWHNOV     L  FWHDEC     G  CAPACITY
G  SUMCAP     G  SCAPIES    G  MACAPSL    G  MACAPIES   L  NOVCAL
L  CALF       L  GRASSCAL   L  STEER      L  MAYCAL     L  WINTER
L  BORLIMIT

COLUMNS
GRSOR       OBJFUN     -81.8100   CPLDOWN     1.0000   GSBASE       1.2500
GRSOR       ACROWN     -  .2500   TOTALCAP   82.0000   CAPITAL     41.0000
GRSOR       LABJAN        .0300   LABFEB       .0400   LABMAR        .0300
GRSOR       LABAPR        .4100   LABMAY       .4100   LABJUN        .3400
GRSOR       LABJUN        .2200   LABSEP       .1200   LABOCT        .5000
GRSOR       LABNOV        .3900   FWHAPR       .3800   FWHMAY        .3700
GRSOR       FWHJUN        .3100   FWHJUL       .2000   FWHSEP        .1100
GRSOR       FWHOCT        .4600   FWHNOV       .3600   GSYIELD     80.0000
RENTSOR     OBJFUN     -74.8200   CPLDRENT    1.0000   RGSBASE      1.2500
RENTSOR     ACRRENT    -  .2500   TOTALCAP   75.0000   CAPITAL     37.0000
RENTSOR     LABJAN        .0300   LABFEB       .0400   LABMAR        .0300
RENTSOR     LABAPR        .4100   LABMAY       .4100   LABJUN        .3400
RENTSOR     LABJUL        .2200   LABSEP       .1200   LABOCT        .5000
RENTSOR     LABNOV        .3900   FWHAPR       .3800   FWHMAY        .3700
RENTSOR     FWHJUN        .3100   FWHJUL       .2000   FWHSEP        .1100
RENTSOR     FWHOCT        .4600   FWHNOV       .3600   GSYIELD    -53.3300
WHEATOWN    OBJFUN     133.8800   CPLDOWN     1.0000   WHTBASE      1.3793
WHEATOWN    ACROWN     -  .3793   TOTALCAP   53.0000   CAPITAL     27.0000
WHEATOWN    LABJAN        .0300   LABFEB       .0400   LABMAR        .0300
WHEATOWN    LABAPR        .0100   LABJUN       .5100   LABJUL        .6200
WHEATOWN    LABAUG        .5800   LABSEP       .3900   LABOCT        .2100
WHEATOWN    FWHAPR        .0100   FWHJUN       .4600   FWHJUL        .5600
WHEATOWN    FWHAUG        .5300   FWHSEP       .3600   FWHOCT        .1400
RENTWHT     OBJFUN      77.5900   CPLDRENT    1.0000   RWHTBASE     1.3793
RENTWHT     ACRRENT    -  .3793   TOTALCAP   47.0000   CAPITAL     24.0000
RENTWHT     LABJAN        .0300   LABFEB       .0400   LABMAR        .0300
RENTWHT     LABAPR        .0100   LABJUN       .5100   LABJUL        .6200
RENTWHT     LABAUG        .5800   LABSEP       .3900   LABOCT        .2100
RENTWHT     FWHAPR        .0100   FWHJUN       .4600   FWHJUL        .5600
RENTWHT     FWHAUG        .5300   FWHSEP       .3600   FWHOCT        .1400
ALF         OBJFUN     -61.7000   ALFYIELD - 3.5000    TOTALCAP    62.0000
ALF         CAPITAL     31.0000   LABJAN       .0500   LABFEB        .0500
ALF         LABMAR        .0500   LABJUN      2.9100   LABJUL       2.9700
ALF         LABAUG       2.9800   LABSEP       .4700   FWHJUN       2.8200
ALF         FWHJUL       2.8700   FWHAUG      2.8800   FWHSEP        .4600
ALF         ALFOWN       1.0000
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RENTALF	OBJFUN	-55.0300	TOTALCAP	55.0000	CAPITAL	27.0000
RENTALF	LABJAN	.0500	LABFEB	.0500	LABMAR	.0500
RENTALF	LABJUN	2.9100	LABJUL	2.9700	LABAUG	2.9800
RENTALF	LABSEP	.4700	FWHJUN	2.8200	FWHJUL	2.8700
RENTALF	FWHAUG	2.8800	FWHSEP	.4600	ALFYIELD	- 2.3300
RENTALF	ALFRENT	1.0000				
CORNOWN	OBJFUN	-99.4400	CPLDOWN	1.0000	CORNBASE	1.2500
CORNOWN	ACROWN	- .2500	TOTALCAP	99.0000	CAPTIAL	50.0000
CORNOWN	LABJAN	.0500	LABFEB	.0600	LABMAR	.0500
CORNOWN	LABAPR	.4100	LABMAY	.5200	LABJUN	.3400
CORNOWN	LABJUL	.2000	LABOCT	.2800	LABNOV	1.5300
CORNOWN	LABDEC	.2000	FWHAPR	.3700	FWHMAY	.4700
CORNOWN	FWHJUN	.3100	FWHJUL	.1800	FWHOCT	.2600
CORNOWN	FWHNOV	1.3900	FWHDEC	.1900	CORNYLD	-100.0000
CORNRENT	OBJFUN	-91.1700	CPLDRENT	1.0000	RCORNBAS	1.2500
CORNRENT	ACRRENT	- .2500	TOTALCAP	91.0000	CAPITAL	45.0000
CORNRENT	LABJAN	.0500	LABFEB	.0600	LABMAR	.0500
CORNRENT	LABAPR	.4100	LABMAY	.5200	LABJUN	.3400
CORNRENT	LABJUL	.2000	LABOCT	.2800	LABNOV	1.5300
CORNRENT	LABDEC	.2000	FWHAPR	.3700	FWHMAY	.4700
CORNRENT	FWHJUN	.3100	FWHJUL	.1800	FWHOCT	.2600
CORNRENT	FWHNOV	1.3900	FWHDEC	.1900	CORNYLD	-66.6700
SILOWN	OBJFUN	- 70.5300	CPLDOWN	1.0000	FORAGE	- 9.6000
SILOWN	TOTALCAP	70.0000	CAPITAL	35.0000	LABJAN	.0800
SILOWN	LABFEB	.0900	LABMAR	.0800	LABAPR	.3100
SILOWN	LABMAY	.4200	LABJUN	.3400	LABJUL	.2200
SILOWN	LABSEP	.5700	LABOCT	3.0100	LABNOV	1.0700
SILOWN	FWHAPR	.2800	FWHMAY	.3800	FWHJUN	.3100
SILOWN	FWHJUL	.2000	FWHSEP	.5200	FWHOCT	2.5200
SILOWN	FWHNOV	.9700				
RENTSIL	OBJFUN	- 65.7300	CPLDRENT	1.0000	FORAGE	- 6.4000
RENTSIL	TOTALCAP	65.0000	CAPITAL	33.0000	LABJAN	.0800
RENTSIL	LABFEB	.0900	LABMAR	.0800	LABAPR	.3100
RENTSIL	LABMAY	.4200	LABJUN	.3400	LABJUL	.2200
RENTSIL	LABSEP	.5700	LABOCT	3.0100	LABNOV	1.0700
RENTSIL	FWHAPR	.2800	FWHMAY	.3800	FWHJUN	.3100
RENTSIL	FWHJUL	.2000	FWHSEP	.5200	FWHOCT	2.5200
RENTSIL	FWHNOV	.9700				
SBOWN	OBJFUN	- 59.8100	CPLDOWN	1.0000	TOTALCAP	60.0000
SBOWN	CAPITAL	30.0000	LABJAN	.0400	LABFEB	.0400
SBOWN	LABMAR	.0400	LABAPR	.2400	LABMAY	.3600
SBOWN	LABJUN	.6600	LABJUL	.0800	LABSEP	.1500
SBOWN	LABOCT	.5500	LABNOV	.7100	FWHAPR	.2200
SBOWN	FWHMAY	.3300	FWHJUN	.6000	FWHJUL	.0700
SBOWN	FWHSEP	.1300	FWHOCT	.5000	FWHNOV	.6400
SBOWN	SOYBYLD	- 35.0000				
SBRENT	OBJFUN	- 53.6900	CPLDRENT	1.0000	TOTALCAP	54.0000
SBRENT	CAPTIAL	27.0000	LABJAN	.0400	LABFEB	.0400
SBOWN	LABMAR	.0400	LABAPR	.2400	LABMAY	.3600
SBOWN	LABJUN	.6600	LABJUL	.0800	LABSEP	.1500
SBOWN	LABOCT	.5500	LABNOV	.7100	FWHAPR	.2200
SBOWN	FWHMAY	.3300	FWHJUN	.6000	FWHJUL	.0700

SBOWN	FWHSEP	.1300	FWHOCT	.5000	FWHNOV	.6400
SBOWN	SOYBYLD	- 23.3300				
SELLSOYB	OBJFUN	4.2300	SOYBYLD	1.0000		
PASTOUT	OBJFUN	14.1300	PASTURE	1.0000		
PASTIN	OBJFUN	- 15.8700	PASTURE	1.0000	TOTALCAP	16.0000
PASTIN	CAPITAL	4.0000				
OWNACR	OBJFUN	- 20.0000	CPLDOWN	1.0000	ACROWN	1.0000
OWNACR	TOTALCAP	20.0000	CAPTIAL	10.0000		
RENTACR	OBJFUN	- 20.0000	CPLDRENT	1.0000	ACRRENT	1.0000
RENTACR	TOTALCAP	20.0000	CAPTIAL	10.0000		
BUYSUP	OBJFUN	- .0850	SUP	- 1.0000	TOTALCAP	.0850
BUYSUP	CAPITAL	.0430				
FIXLABI	OBJFUN	-173.2500	LABMAY	12.0000	LABJUN	12.0000
FIXLABI	LABJUL	12.0000	SCAPIES	-275.0000	FIXLABI	1.0000
FIXLABI	TOTALCAP	173.0000	CAPITAL	21.6300		
FIXLABS	OBJFUN	-343.7500	LABMAY	12.0000	LABJUN	12.0000
FIXLABS	LABJUL	12.0000	LABAUG	12.0000	LABSEP	12.0000
FIXLABS	LABOCT	12.0000	SUMCAP	-275.0000	FIXLABS	1.0000
FIXLABS	TOTALCAP	344.0000	CAPITAL	71.6700		
FIXLABW	OBJFUN	-1512.5000	FIXLABW	1.0000	LABJAN	12.0000
FIXLABW	LABFEB	12.0000	LABMAR	12.0000	LABAPR	12.0000
FIXLABW	LABNOV	12.0000	LABDEC	12.0000	CAPACITY	- 275.0000
FIXLABW	TOTALCAP	1512.0000	CAPITAL	756.0000		
FIMAYIES	OBJFUN	-173.2500	LABMAY	12.0000	LABJUN	12.0000
FIMAYIES	LABJUL	12.0000	MACAPIES	-275.0000	FIMAYIES	1.0000
FIMAYIES	TOTALCAP	173.0000	CAPITAL	21.6300		
FIMAYSL	OBJFUN	-343.7500	LABJAN	12.0000	LABJUN	12.0000
FIMAYSL	LABJUL	12.0000	LABAUG	12.0000	LABSEP	12.0000
FIMAYSL	LABOCT	12.0000	MACAPSL	-275.0000	FIMAYSL	1.0000
FIMAYSL	TOTALCAP	344.0000	CAPITAL	71.6700		
STRFACIL	OBJFUN	- 15.6000	TOTALCAP	120.0000	CAPITAL	120.0000
STRFACIL	WINTER	- 1.0000				
BUYNOV	OBJFUN	- 67.1400	TOTALCAP	67.1400	CAPITAL	33.5700
BUYNOV	NOVCAL	- 1.0000				
WINTER	OBJFUN	- 15.1000	FORAGE	3.0450	SUP	220.5000
WINTER	MILO	4.8720	TOTALCAP	15.0000	CAPITAL	3.7500
WINTER	LABJAN	.1000	LABFEB	.1000	LABMAR	.1000
WINTER	LABAPR	.1000	LABNOV	.3800	LABDEC	.1000
WINTER	CAPACITY	1.0000	NOVCAL	4.0000	CALF	- 6.0000
WINTER	WINTER	1.0000				
SELLGS	OBJFUN	2.5800	GSYIELD	1.0000		
FEEDGS	OBJFUN	.8900	MILO	- 1.0000	GSYIELD	1.0000
BUYGS	OBJFUN	- 1.9900	MILO	- 1.0000	TOTALCAP	2.0000
BUYGS	CAPITAL	1.0000				
SELLCORN	OBJFUN	2.7300	CORNYLD	1.0000		
FEEDCORN	OBJFUN	.9600	MILO	- 1.0500	CORNYLD	1.0000
BUYCORN	OBJFUN	- 2.0700	MILO	- 1.0500	TOTALCAP	2.0000
BUYCORN	CAPITAL	1.0300				
SELLMAY	OBJFUN	67.2700	CALF	1.0900		
GRASSSL	OBJFUN	- 7.3500	PASTURE	3.3000	TOTALCAP	7.0000
GRASSSL	CAPITAL	115.4000	LABMAY	.1000	LABJUN	.1000
GRASSSL	LABJJL	.1000	LABAUG	.1000	LABSEP	.1000

GRASSSL	LABOCT	.3800	SUMCAP	1.0000	CALF	6.0000
GRASSSL	GRASSCAL	- 7.9600				
GRASS2X	OBJFUN	- 6.7200	PASTURE	1.6500	TOTALCAP	7.0000
GRASS2X	CAPITAL	70.6400	LABMAY	.1000	LABJUN	.1000
GRASS2X	LABJUL	.3800	SCAPIES	1.0000	CALF	6.0000
GRASS2X	STEER	- 6.9800				
GRASS25	OBJFUN	- 6.7200	PASTURE	1.3200	TOTALCAP	7.0000
GRASS25	CAPITAL	70.6400	LABMAY	.1000	LABJUN	.1000
GRASS25	LABJUL	.3800	SCAPIES	1.0000	CALF	6.0000
GRASS25	STEER	- 6.9300				
GRASS3X	OBJFUN	- 6.7200	PASTURE	1.1000	TOTALCAP	7.0000
GRASS25	CAPITAL	70.6400	LABMAY	.1000	LABJUN	.1000
GRASS25	LABJUL	.3800	SCAPIES	1.0000	CALF	6.0000
GRASS25	STEER	- 6.9200				
SELLJULY	OBJFUN	62.0400	STEER	1.0200		
SELLOCT	OBJFUN	60.3700	GRASSCAL	1.0200		
BUYMAY	OBJFUN	-67.2700	MAYCAL	- 1.0000		
GRAZESL	OBJFUN	-12.2500	PASTURE	3.3000	TOTALCAP	418.8100
GRAZESL	CAPITAL	170.7300	LABMAY	.3800	LABJUN	.1000
GRAZESL	LABJUL	.1000	LABAUG	.1000	LABSEP	.1000
GRAZESL	LABOCT	.3800	MACAPSL	1.0000	MAYCAL	6.0000
GRAZESL	GRASSCAL	- 7.9600				
GRAZE2X	OBJFUN	-11.6200	PASTURE	1.6500	TOTALCAP	412.3700
GRAZE2X	CAPITAL	102.3000	LABMAY	.3800	LABJUN	.1000
GRAZE2X	LABJUL	.3800	MACAPIES	1.0000	MAYCAL	6.0000
GRASS2X	STEER	- 6.9800				
GRAZE25	OBJFUN	-11.6200	PASTURE	1.3200	TOTALCAP	412.3700
GRAZE25	CAPITAL	102.3000	LABMAY	.3800	LABJUN	.1000
GRAZE25	LABJUL	.3800	MACAPIES	1.0000	MAYCAL	6.0000
GRASS25	STEER	- 6.9300				
GRAZE3X	OBJFUN	-11.6200	PASTURE	1.1000	TOTALCAP	412.3700
GRAZE3X	CAPITAL	102.3000	LABMAY	.3800	LABJUN	.1000
GRAZE3X	LABJUL	.3800	MACAPIES	1.0000	MAYCAL	6.0000
GRASS3X	STEER	- 6.9200				
BORCAP	OBJFUN	- .1025	CAPITAL	- 1.0000	BORLIMIT	1.0000
HLABJAN	OBJFUN	-824.0000	TOTALCAP	824.0000	CAPITAL	412.0000
HLABJAN	LABJAN	-160.0000				
HLABFEB	OBJFUN	-844.6000	TOTALCAP	845.0000	CAPITAL	422.5000
HLABFEB	LABFEB	-164.0000				
HLABMAR	OBJFUN	-865.2000	TOTALCAP	865.0000	CAPITAL	432.5000
HLABMAR	LABMAR	-168.0000				
HLABAPR	OBJFUN	-891.0000	TOTALCAP	891.0000	CAPITAL	445.5000
HLABAPR	LABAPR	-173.0000	FWHAPR	-130.0000		
HLABMAY	BJFUN	-942.5000	TOTALCAP	942.5000	CAPITAL	471.2500
HLABMAY	LABMAY	-183.0000	FWHMAY	-107.0000		
HLABJUN	OBJFUN	-959.4000	TOTALCAP	959.4000	CAPITAL	479.7000
HLABJUN	LABJUN	-234.0000	FWHJUN	-146.0000		
HLABJUL	OBJFUN	-959.4000	TOTALCAP	959.4000	CAPITAL	479.7000
HLABJUL	LABAPR	-234.0000	FWHJUL	-195.0000		
HLABAUG	OBJFUN	-959.4000	TOTALCAP	959.4000	CAPITAL	479.7000
HLABAUG	LABAUG	-234.0000	FWHAUG	-205.0000		
HLABSEP	OBJFUN	-1189.7000	TOTALCAP	1189.7000	CAPITAL	594.8500

APPENDIX B

COLUMNS

The columns represent the enterprise, the buying and selling of products and inputs, the borrowing of capital, and hiring of labor. The budgets for the enterprises are in the Budget Appendix.

GRSOR: one unit of this activity represents one acre of grain sorghum grown on operator owned land. The cost of producing one acre of grain sorghum is represented in the objective function. Production is limited by owned cropland available and the feedgrain base on owned land.

RENTSOR: one unit of this activity represents one acre of grain sorghum grown on land rented by the operator. The landlord receives one-third of the crop's yield and pays one-third of the cost of fertilizer. The cost of producing one acre of grain sorghum is represented in the objective function. Production is limited by rented cropland available and the feedgrain base on rented land.

WHEATOWN: one unit of this activity represents one acre of wheat grown on operator owned land. The gross margin for this activity is represented in the objective function. The price for wheat used in the budget is the average loan rate and deficiency payment for the counties in the Northeast Kansas region defined by the Kansas Farm Management Association. Production is limited by owned cropland available and the wheat base on owned land.

RENTWHT: one unit of this activity represents one acre of wheat grown on land rented by the operator. The landlord receives one-third of the crop's yield and pays one-third of the cost of fertilizer. The gross margin for this activity is represented in the objective function. The price for wheat used in the budget is the average loan rate and deficiency payment for the counties in the Northeast Kansas region defined by the Kansas Farm Management Association. Production is limited by rented cropland available and the wheat base on rented land.

ALF: one unit of this activity represents one acre of alfalfa grown on land owned by the operator. The cost of producing one acre of alfalfa is represented in the objective function. Production is limited by owned cropland established in alfalfa.

RENTALF: one unit of this activity represents one acre of alfalfa grown on land rented by the operator. The landlord receives one-third of the crop's yield and pays one-third of the cost of fertilizer. The cost of producing one acre of alfalfa is represented in the objective function. Production is limited by rented cropland established in alfalfa.

CORNOWN: one unit of this activity represents one acre of corn grown on land owned by the operator. The cost of producing one acre of corn is represented in the objective function. Production is limited by owned cropland available and the feedgrain base on owned land.

CORNRENT: one unit of this activity represents one acre of corn grown on land rented by the operator. The landlord receives one-third of the crop's yield and pays one-third of the cost of fertilizer. The cost of producing one acre of corn is represented in the objective function. Production is limited by rented cropland available and the feedgrain base on rented land.

SILOWN: one unit of this activity represents one acre of silage grown on land owned by the operator. The cost of producing one acre of silage is represented in the objective function. Production is limited by owned cropland available.

RENTSIL: one unit of this activity represents one acre of silage grown on land rented by the operator. The landlord receives one-third of the crop's yield and pays one-third of the cost of fertilizer. The cost of producing one acre of silage is represented in the objective function. Production is limited by rented cropland available.

SBOWN: one unit of this activity represents one acre of soybeans grown on land owned by the operator. The cost of producing one acre of soybeans is represented in the objective function. Production is limited by owned cropland available.

SBRENT: one unit of this activity represents one acre of soybeans grown on land rented by the operator. The landlord receives one-third of the crop's yield and pays one-third of the cost of fertilizer. The cost of producing one acre of soybeans is represented in the objective function. Production is limited by rented cropland available.

PASTOUT: one unit of this activity represents one acre of pasture owned by the operator and is rented to someone else. The rental rate per acre is represented in the objective function (Kansas Crop). This activity is limited by owned pasture acres.

PASTIN: one unit of this activity represents one acre of pasture that the operator rents from someone else. The rental cost per acre is represented in the objective function (Kansas Crop).

OWNACR: one unit of this activity represents one acre of land owned by the operator that has been put in the Acreage Conservation Reserve program. The cost of maintaining the land in the condition required by the program is represented in the objective function. 20 percent of the grain sorghum and corn base acres must be placed in the ACR and 27 percent of the wheat base acres must be placed in the ACR for the operator to receive the loan rate and deficiency payment on those crops.

RENTACR: one unit of this activity represents one acre of land rented by the operator that has been put in the Acreage Conservation Reserve program. The cost of maintaining the land in the condition required by the program is represented in the objective function. 20 percent of the grain sorghum and corn base acres must be placed in the ACR and 27 percent of the wheat base acres must be placed in the ACR for the operator to receive the loan rate and deficiency payment on those crops.

BUYSUP: one unit of this activity represents one pound of supplement purchased to feed the cattle during the wintering process. The cost of one pound of supplement is represented in the objective function.

SELLGS: one unit of this activity represents one bushel of grain sorghum sold on the market. The price used for one bushel of grain sorghum is the national average of the loan rate plus the deficiency payment less thirty cents storage charge. This activity is limited by grain sorghum production and fed grain sorghum.

SELLCORN: one unit of this activity represents one bushel of corn sold on the market. The price used for one bushel of corn is the national average of the loan rate plus the deficiency payment less thirty cents storage charge. This activity is limited by corn production and fed corn.

SELLALF: one unit of this activity represents one ton of alfalfa sold on the market. The price received for one ton of alfalfa is represented in the objective function. This activity is limited by grain alfalfa production and fed alfalfa.

SELLSOYB: one unit of this activity represents one bushel of soybeans sold on the market. The price used for one bushel of soybeans is the national average of the loan rate plus the deficiency payment less thirty cents storage charge. This activity is limited by soy bean production.

BORCAP: one unit of this activity represents one dollar borrowed for operating expenses. The annual percentage rate of interest charged for one dollar of borrowed capital is represented in the objective function. This activity is limited to $93,000.00.

FEEDGS: one unit of this activity represents one bushel of grain sorghum fed to the cattle. The value in the objective function represents the deficiency payment received by the operator for the crop acres enrolled in the ACR program less a twenty-five cent feed processing charge.

FEEDCORN: one unit of this activity represents one bushel of corn fed to the cattle. The value in the objective function represents the deficiency payment received by the operator for the crop acres enrolled in the ACR program less a twenty-five cent feed processing charge.

FEEDALF: one unit of this activity represents one ton of alfalfa fed to the cattle.

BUYGS: one unit of this activity represents one bushel of grain sorghum purchased to feed to the cattle. The purchase price represented in the objective function is based on the national average loan rate for grain sorghum less a twenty-five cent feed processing charge.

BUYCORN: one unit of this activity represents one bushel of corn purchased to feed to the cattle. The purchase price represented in the objective function is based on the national average loan rate for corn less a twenty-five cent feed processing charge.

BUYALF: one unit of this activity represents one ton of alfalfa purchased to feed to the cattle. The purchase price is based on the price used by the KSU Farm Management Guide.

BUYNOV: one unit of this activity represents one hundred pounds of steer purchased in November. The purchase price for the steers were derived by taking the November monthly average Kansas City cash price of 300 - 400 pound choice steers and averaging those prices with the November monthly average Kansas City cash price of 400 - 500 pound choice steers, then calculate the ten year average price. The ten years averaged were 1976 to 1985. Given that the November calves are purchased a year prior to the year they are sold, the ten year average price is lagged by one year. The cattle purchased in November are placed in a wintering program until May.

BUYMAY: one unit of this activity represents one hundred pounds of steer purchased in May. The purchase price for the steers was derived by taking the May monthly average Kansas City cash price of 500 - 600 pound choice steers and averaging those prices with the May monthly average Kansas City cash price of 600 - 700 pound choice steers, then calculate the ten year average price. The ten years averaged were 1977 to 1986. The cattle purchased in May are placed on grass, then sold either mid-July or the beginning of October.

WINTER: one unit of this activity represents one 400 pound steer placed in the wintering program. The steers require a specified amount of forage, supplement, and milo. There are various ways in which those feed requirements can be supplied to the steer. The cattle are in the wintering program from November through April. After completing the wintering phase, the cattle are either sold in May or placed on native pasture in May.

FIXLABI: one unit of this activity represents one hour of labor that is fixed to the steers purchased in November and placed in the GRASS2X or GRASS25 or GRASS3X activities. This amount of labor does not vary with the number of steers in these activities.

The value represented in the objective function is one-half of the cost of repairs, oil, fuel, and gas times 275. This portion of the cost of production is the same regardless of the number of steers in these activities. The 275 represents the number of steers required for the activity to carry before economies of size is realized.

FIXLABS: one unit of this activity represents one hour of labor that is fixed to the steers purchased in November and placed in the GRASSSL activity. This amount of labor does not vary with the number of steers in the activity. The value represented in the objective function is one-half of the cost of repairs, oil, fuel, and gas times 275. This portion of the cost of production is assumed to be the same regardless of the number of steers in the activity. The 275 represents the number of steers required for the activity to carry before economies of size is realized.

FIXLABW: one unit of this activity represents one hour of labor that is fixed to the steers purchased in November and placed in the WINTER activity. This amount of labor does not vary with the number of steers in the activity. The value represented in the objective function is one-half of the cost of repairs, oil, fuel, and gas times 275. This portion of the cost of production is assumed to be the same regardless of the number of steers in the activity. The 275 represents the number of steers required for the activity to carry before economies of size is realized.

FIMAYIES: one unit of this activity represents one hour of labor that is fixed to the steers purchased in May and placed in the GRAZE2X or GRAZE25 or GRAZE3X activities. This amount of labor does not vary with the number of steers in these activities. The value represented in the objective function is one-half of the cost of repairs, oil, fuel, and gas times 275. This portion of the cost of production is assumed to be the same regardless of the number of steers in these activities. The 275 represents the number of steers required for these activities to carry before economies of size is realized.

FIMAYSL: one unit of this activity represents one hour of labor that is fixed to the steers purchased in May and placed in the GRAZESL activity. This amount of labor does not vary with the number of steers in the activity. The value represented in the objective function is one-half of the cost of repairs, oil, fuel, and gas times 275. This portion of the cost of production is assumed to be the same regardless of the number of steers in the activity. The 275 represents the number of steers required for the activity to carry before economies of size is realized.

GRASSSL: one unit of this activity represents one 600 pound steer placed on native pasture at a stocking rate of 3.3 acres from May 1st through October 15th. The steer was purchased in the BUYNOV activity, has completed the wintering program, and will be sold in the SELLOCT activity. The value in the objective function represents the variable production costs per steer.

GRASS2X: one unit of this activity represents one 600 pound steer placed on native pasture at a stocking rate of 1.65 acres from May 1st through July 15th. The steer was purchased in the BUYNOV activity, has completed the wintering program, and will be sold in the SELLJULY activity. The value in the objective function represents the variable production costs per steer. The costs are itemized in Table 15 in the Budget Appendix.

GRASS25: one unit of this activity represents one 600 pound steer placed on native pasture at a stocking rate of 1.32 acres from May 1st through July 15th. The steer was purchased in the BUYNOV activity, has completed the wintering program, and will be sold in the SELLJULY activity. The value in the objective function represents the variable production costs per steer.

GRASS3X: one unit of this activity represents one 600 pound steer placed on native pasture at a stocking rate of 1.1 acres from May 1st through July 15th. The steer was purchased in the BUYNOV activity, has completed the wintering program, and will be sold in the SELLJULY activity. The value in the objective function represents the variable production costs per steer.

GRAZESL: one unit of this activity represents one 600 pound steer placed on native pasture at a stocking rate of 3.3 acres from May 1st through October 15th. The steer was purchased in the BUYMAY activity and will be sold in the SELLOCT activity. The value in the objective function represents the variable production costs per steer.

GRAZE2X: one unit of this activity represents one 600 pound steer placed on native pasture at a stocking rate of 1.65 acres from May 1st through July 15th. The steer was purchased in the BUYMAY activity and will be sold in the SELLJULY activity. The value in the objective function represents the variable production costs per steer.

GRAZE25: one unit of this activity represents one 600 pound steer placed on native pasture at a stocking rate of 1.32 acres from May 1st through July 15th. The steer was purchased in the BUYMAY activity and will be sold in the SELLJULY activity. The value in the objective function represents the variable production costs per steer.

GRAZE3X: one unit of this activity represents one 600 pound steer placed on native pasture at a stocking rate of 1.1 acres from May 1st through July 15th. The steer was purchased in the BUYMAY activity and will be sold in the SELLJULY activity. The value in the objective function represents the variable production costs per steer.

STRFACIL: The unit of this activity is 275 and represents the number of head that can be handled in the facilities the operation currently has. The value in the objective function represents the cost associated with purchasing the facilities.

SELLMAY: one unit of this activity represents one hundred pounds of steer sold in May. The selling price for the steers were derived by taking the May monthly average Kansas City cash price of 500 - 600 pound choice steers and averaging those prices with the May monthly average Kansas City cash price of

600 - 700 pound choice steers, then calculate the ten year average price. The ten years average were 1977 to 1986. The cattle sold in May came out of the wintering program and did not go to grass. Therefore, the cattle are sold as stocker cattle and not sold to the feedlot.

SELLJULY: one unit of this activity represents one hundred pounds of steer sold in July. The selling price for the steers were derived by estimating a linear function equation using a ten-year average of the Kansas City 700 - 800 pound choice steer cash prices. This equation adjusts the price based on the weight of the steer. The ten years averaged were 1977 to 1986.

SELLOCT: one unit of this activity represents one hundred pounds of steer sold in October. The selling price for the steers were derived by estimating a linear function equation using a ten-year average of the Kansas City 800 - 1000 pound choice steer cash prices. This equation adjusts the price based on the weight of the steer. The ten years averaged were 1977 to 1986.

HLABJAN - HLABDEC: one unit of an activity for each month provides one hour of hired labor to meet monthly labor requirements. The hourly wage for June, July, and August is $4.10 and the remaining month's hourly wage is $5.15. There is no limit set on the amount of labor that can be hired at these wages. The values in the objective function for the hired labor activities represent the number of hours one additional worker can supply per month times the wage rate.

ROWS

The rows of the matrix in appendix "A" are of two types, resource rows and transfer rows.

Resource Rows

Resource rows represent the resource constraints on the optimal farm plan.

CPLDOWN: this equation specifies the land coefficients for the crop enterprises grown on cropland owned by the operator. This equation also puts an upper limit the number of owned cropland available for use.

CPLDRENT: this equation specifies the land coefficients for the crop enterprises grown on cropland rented by the operator. This equation also puts an upper limit on the number of rented cropland available for use.

RWHTBASE: this equation specifies the number of rented wheat base acres required to produce one acre of wheat. Twenty-seven percent of the wheat base must be put in the ACR. Therefore, it takes 1.3793 base acres to produce one acre of wheat. This equation also limits the number of rented cropland the operator may plant to wheat. The limited amount of cropland represents the number of acres the operator has in his wheat base.

WHTBASE: this equation specifies the number of owned wheat base acres required to produce one acre of wheat. Twenty-seven percent of the wheat base must be put in the ACR. Therefore, it takes 1.3793 base acres to produce one acre of wheat. This equation also limits the number of owned cropland the operator may plant to wheat. The limited amount of cropland represents the number of acres the operator has in his wheat base.

RGSBASE: this equation specifies the number of rented grain sorghum base acres required to produce one acre of grain sorghum. Twenty percent of the grain sorghum base must be put in the ACR. Therefore, it takes 1.3793 base acres to produce one acre of grain sorghum. This equation also limits the number of rented cropland the operator may plant to grain sorghum. The limited amount of cropland represents the number of acres the operator has in his grain sorghum base.

GSBASE: this equation specifies the number of owned grain sorghum base acres required to produce one acre of grain sorghum. Twenty percent of the grain sorghum base must be put in the ACR. Therefore, it takes 1.3793 base acres to produce one acre of grain sorghum. This equation also limits the number of owned cropland the operator may plant to grain sorghum. The limited amount of cropland represents the number of acres the operator has in his grain sorghum base.

RCORNBAS: this equation specifies the number of rented corn base acres required to produce one acre of corn. Twenty percent of the corn base must be put in the ACR. Therefore, it takes 1.3793 base acres to produce one acre of corn. This equation also limits the number of rented cropland the operator may plant to corn. The limited amount of cropland represents the number of acres the operator has in his corn base.

CORNBASE: this equation specifies the number of owned corn base acres required to produce one acre of corn. Twenty percent of the corn base must be put in the ACR. Therefore, it takes 1.3793 base acres to produce one acre of corn. This equation also limits the number of owned cropland the operator may plant to corn. The limited amount of cropland represents the number of acres the operator has in his corn base.

PASTURE: this equation specifies the amount of summer pasture required by the livestock enterprises. The amount of pasture owned by the operator is limited by this equation, however the PASTIN activity allows the operator to rent additional pasture.

ACROWN: this equation requires that the percentage of owned cropland, that is required to be placed in the ACR, from all the crop activities using owned land into the OWNACR activity. The -.25 and -.3793 supplies twenty percent and twenty-seven percent of the cropland to the OWNACR activity, respectively.

ACRRENT: this equation requires that the percentage of rented cropland, that is required to be placed in the ACR, from all the crop activities using rented land into the RENTACR activity. The -.25 and -.3793 supplies twenty percent and twenty-seven percent of the cropland to the RENTACR activity, respectively.

ALFOWN: this equation limits the number of acres owned by the operator that may be planted to alfalfa.

ALFRENT: this equation limits the number of acres rented by the operator that may be planted to alfalfa.

LABJAN - LABDEC: one equation for each month specificize the monthly labor coefficients for the beef and crop enterprises. The labor requirements for the crop enterprises are from a study by Langemeier, Buller, and Kasper. The labor requirements for livestock are from a study by Buller, Langemeier, and Schobert. There is no distinction between owner labor and hired labor with regard to productivity.

FWHAPR - FWHDEC: one equation for each month specifies the field work hour requirement to complete various field operations required for alternative crops (Langemeier, Buller, and Kasper).

BORLIMIT: this equation places a limit on the operating capital that may be borrowed. The annual percentage rate of the borrowed capital is 10.25 percent.

TOTALCAP: this equation specifies the amount of operating capital needed to cover variable costs for those activities in the operation.

CAPITAL: this equation specifies the amount of operating capital that must be borrowed to cover variable costs for those activities in the operation.

FIXLABS: this equation places a minimum limit on the fixed labor required for the cattle purchased in November and placed on season-long grazing (Buller, Langemeier, and Schobert).

FIXLABI: this equation places a minimum limit on the fixed labor required for the cattle placed on intensive-early stocking grazing that were purchased in November (Buller, Langemeier, and Schobert).

FIXLABW: this equation places a minimum limit on the fixed labor required for the cattle placed in the wintering program (Buller, Langemeier, and Schobert).

FLMAYIES: this equation places a minimum limit on the fixed labor required for the cattle placed on intensive-early stocking grazing that were purchased in May (Buller, Langemeier, and Schobert).

FLMAYSL: this equation places a minimum limit on the fixed labor required for the cattle purchased in May and placed on season-long grazing (Buller, Langemeier, and Schobert).

CAPACITY: One unit represents 275 calves. The farm operation has the facilities to handle 275 calves in the wintering phase. Facilities will have to be built for additional cattles beyond 275. 275 calves is the number of calves that must be carried before economies of size come into effect.

SUMCAP: One unit represents 275 calves. The farm operation has the facilities to handle 275 calves purchased in November and places in the season-long grazing system. Facilities will have to be built for additional cattles beyond 275 calves.

SCAPIES: One unit represents 275 calves. The farm operation has the facilities to handle 275 calves purchased in November and placed in the intensive-early stocking grazing system. Facilities will have to be built for additional cattles beyond 275 calves.

MACAPSL: One unit represents 275 calves. The farm operation has the facilities to handle 275 calves purchased in May and placed in the season-long grazing system. Facilities will have to be built for additional cattles beyond 275 calves.

MACAPIES: One unit represents 275 calves. The farm operation has the facilities to handle 275 calves purchased in May and placed in the intensive-early stocking system. Facilities will have to be built for additional cattles beyond 275 calves.

TRANSFER ROWS

Transfer rows provide a connecting link between activities. They used to link activities that provide primary products and/or purchased inputs to other activities using these products as inputs or selling these products.

FORAGE: this equation transfers alfalfa and sorghum silage to the WINTER activity. Forage is supplied by three sources. The first source is alfalfa grown in the operation. Alfalfa produced by the operator on owned and rented land supplies 10.5 and 6.99 tons of forage per acre, respectively. The second source of forage is sorghum silage grown in the operation. Silage produced by the operator on owned and rented land supplies 9.6 and 6.4 tons of forage per acre, respectively. The third forage source is alfalfa purchased from an outside source. One ton of purchased alfalfa supplies three tons of forage. The amount of forage required is based on the amount of forage that is supplied by sorghum silage (Ritter and McReynolds). The amount of forage supplied by one ton of alfalfa is three times greater then the amount of forage supplied by sorghum silage. Therefore, to derive the amount of forage supplied by operator produced alfalfa the yield is multiplied by three to put it in a silage equivalent basis.

SUP: this equation transfers one pound of supplement to the WINTER activity to meet the supplement requirement of one steer in the wintering phase (Ritter and McReynolds). The supplement may be supplied by purchasing the supplement at eight cents per pound and/or by the alfalfa fed as forage. Alfalfa can be used for both forage and supplement.

MILO: this equation transfers one bushel of grain sorghum or 1.05 bushels of grain sorghum equivalent corn to the WINTER activity to meet the milo requirement of one steer in the wintering phase. The milo requirement is based on the amount of milo needed to meet a certain portion of the nutritional requirements of a steer (Ritter and McReynolds). MILO may be supplied by grain sorghum and/or corn. The corn supplies five percent more nutrients then does grain sorghum. Therefore, the amount of corn supplied has been adjusted to a grain sorghum basis.

CORNYLD: this equation transfers the corn yield per acre received by the operator on owned and rented land to SELLCORN and/or FEEDCORN activities. The yields realized by the farmer are 100 and 66.67 bushels per acre on owned and rented land, respectively.

GSYIELD: this equation transfers the grain sorghum yield per acre received by the operator on owned and rented land to SELLGS and/or FEEDGS activities. The yields realized by the farmer are 80 and 53.33 bushels per acre on owned and rented land, respectively.

ALFYIELD: this equation transfers the alfalfa yield per acre received by the operator on owned and rented land to SELLALF and/or FEEDALF activities. The yields realized by the farmer are 3.5 and 2.33 tons per acre on owned and rented land, respectively.

SOYBYLD: this equation transfers the soybean yield per acre received by the operator on owned and rented land to the SELLSOYB activity. The yields realized by the farmer are 35 and 23.33 bushels per acre on owned and rented land, respectively.

NOVCAL: this equation transfers 100 pounds of a calf from the BUYNOV activity to the WINTER activity. The WINTER activity requires a 400 pound calf.

CALF: this equation transfers a 600 pound calf from the WINTER activity to either SELLMAY, GRASSSL, GRASS2X, GRASS25, OR GRASS3X activities.

GRASSCAL: this activity transfers a 796 pound steer from either the GRASSSL or GRAZESL activities to the SELLOCT activity. The 796 pounds represents the steer's ending weight coming off native pasture in October less four percent of the ending weight for shrinkage and three percent of the ending weight less shrinkage for the marketing cost.

STEER: this activity transfers a 698, 693, or 692 pound steer from either the GRASS2X or GRAZE2X, the GRASS25 or GRAZE25, or the GRASS3X or GRAZE3X activities, respectively to the SELLJULY activity. The 698, 693, and 692 pounds represents the steer's ending weight coming off native pasture in October less four percent of the ending weight for shrinkage and three percent of the ending weight less shrinkage for the marketing cost.

MAYCAL: this equation transfers 100 pounds of a steer from the BUYMAY activity to either the GRAZESL, GRAZE2X, GRAZE25, or GRAZE3X activities. The GRAZESL, etc activities require a 600 pound steer.

WINTER: this equation transfers one unit from the STRFACIL activity to the WINTER activity.

BUDGET APPENDIX

TABLE 1

GRAIN SORGHUM BUDGET

OWNED LAND

Revenue	
Yield/Acre	80.00 Bushels
Price/Bushel	$2.58
Revenue/Acre	$206.40
Variable Cost/Acre	
Seed	$ 3.85
Herbicide	17.00
Insecticide	10.00
Fertilizer	20.96
Drying	8.00
Fuel and oil	8.70
Repairs	9.50
Miscellaneous	3.80
Total Variable Costs	$ 81.81
GROSS MARGIN	$124.59

Source: Figurski, Leo and John R. Schlender. Dryland Grain in Eastern Kansas. KSU Farm Management Guide MF-573. Manhattan, Kansas: Cooperative Extension Serivce, Kansas State University. September 1986.

Grain Sorghum price is based on 1987 national loan rate plus the deficiency payment minus 30 cent storage cost.

TABLE 2

GRAIN SORGHUM BUDGET

RENTED LAND OPERATOR'S SHARE

Revenue	
Yield/Acre	80.00 Bushels
Renter's share	53.33 Bushels
Price/Bushel	$2.58

Renter's Revenue/Acre	$137.59
Variable Cost/Acre	
Seed	$ 3.85
Herbicide	17.00
Insecticide	10.00
Fertilizer	13.97
Drying	8.00
Fuel and oil	8.70
Repairs	9.50
Miscellaneous	3.80

Total Variable Cost	$74.82
GROSS MARGIN	$62.77

Land owner receives 1/3 of the crop and pays for 1/3 of the cost of fertilizer.

Source: Figurski, Leo and John R. Schlender. Dryland Grain in Eastern Kansas. KSU Farm Management Guide MF-573. Manhattan, Kansas: Cooperative Extension Serivce, Kansas State University. September 1986.

Grain Sorghum price is based on 1987 national loan rate plus the deficiency payment minus 30 cent storage cost.

TABLE 3

WHEAT BUDGET

OWNED LAND

Revenue	
Yield/Acre	45.00 Bushels
Price/Bushel	$4.16

Revenue/Acre	$187.20
Variable Cost/Acre	
Seed	$ 7.20
Herbicide	8.30
Fertilizer	18.32
Fuel and oil	8.00
Repairs	8.80
Miscellaneous	2.70

Total Variable Costs	$ 53.32
GROSS MARGIN	$133.88

Source: Figursiki, Leo and John R. Schlender. Continuous Cropped Winter Wheat in Eastern Kansas. KSU Farm Management Guide MF-572. Manhattan, Kansas: Cooperative Extension Service, Kansas State University, September 1986.

Wheat price is based on the average of the Northeast Kansas Counties 1987 loan rates plus the deficiency payment minus 30 cents for storage cost.

TABLE 4

WHEAT BUDGET

RENTED LAND OPERATOR'S SHARE

Revenue	
Yield/Acre	45.00 Bushels
Renter's share	30.00 Bushels
Price/Bushel	$4.16

Renter's Revenue/Acre	$124.80
Variable Cost/Acre	
Seed	$ 7.20
Herbicide	8.30
Fertilizer	12.21
Fuel and oil	8.00
Repairs	8.80
Miscellaneous	2.70

Total Variable Costs	$47.21
GROSS MARGIN	$77.59

Land owner receives 1/3 of the crop and pays for 1/3 of the cost of fertilizer.

Source: Figursiki, Leo and John R. Schlender. Continuous Cropped Winter Wheat in Eastern Kansas. KSU Farm Management Guide MF-572. Manhattan, Kansas: Cooperative Extension Service, Kansas State University, September 1986.

Wheat price is based on the average of the Northeast Kansas Counties 1987 loan rates plus the deficiency payment minus 30 cents for storage cost.

TABLE 5

CORN BUDGET

OWNED LAND

<u>Revenue</u>	
Yield/Acre	100.00 Bushels
Price/Bushel	$2.73
Revenue/Acre	$273.00
<u>Variable Cost/Acre</u>	
Seed	$17.40
Herbicide/Insecticide	21.85
Fertilizer and Lime	24.80
Drying	10.00
Fuel and oil	10.42
Machinery & Equipment Repair	11.32
Miscellaneous	3.65
Total Variable Costs	$99.44
<u>GROSS MARGIN</u>	$173.56

Source: Figurski, Leo and John R. Schlender. <u>Dryland Corn Production in Eastern Kansas</u>. KSU Farm Management Guide MF-571. Manhattan, Kansas: Cooperative Extension Service, Kansas State University, September 1986.

Corn price is based on 1987 national loan rate plus the deficiency payment minus 30 cent storage cost.

TABLE 6

CORN BUDGET

RENTED LAND OPERATOR'S SHARE

Revenue	
Yield/Acre	100.00 Bushels
Renter's share	66.67 Bushels
Price/Bushel	$2.73

Renter's Revenue/Acre	$182.00
Variable Cost/Acre	
Seed	$17.40
Herbicide/Insecticide	21.85
Fertilizer and Lime (24.80x2/3)	16.53
Drying	10.00
Fuel and oil	10.42
Machinery & Equipment Repairs	11.32
Miscellaneous	3.65

Total Variable Costs	$91.17
GROSS MARGIN	$90.83

Land owner receives 1/3 of the crop and pays for 1/3 of the cost of fertilizer.

Source: Figurski, Leo and John R. Schlender. Dryland Corn Production in Eastern Kansas. KSU Farm Management Guide MF-571. Manhattan, Kansas: Cooperative Extension Service, Kansas State University, September 1986.

Corn price is based on 1987 national loan rate plus the deficiency payment minus 30 cent storage cost.

TABLE 7

ALFALFA BUDGET

OWNED LAND

Revenue	
Yield/Acre	3.50 Tons
Price/Ton	$45.00
Total Revenue/Acre	$157.50
Variable Cost/Acre	
Seed	$ 4.00
Herbicide	6.70
Insecticide	3.50
Fertilizer	20.00
Fuel and oil	9.50
Repairs	11.00
Miscellaneous	7.00
Total Variable Costs	$61.70
GROSS MARGIN	$95.80

Source: Fausett, Marvin R. and John R. Schlender. Alfalfa Costs and Returns. KSU Farm Management Guide MF-363. Manhattan, Kansas: Cooperative Extension Service, Kansas State University, September 1986.

TABLE 8

ALFALFA BUDGET

RENTED LAND OPERATOR'S SHARE

Revenue/Acre	
Yield/Acre	3.50 Tons
Renter's share	2.33 Tons
Price/Ton	$45.00
Renter's Revenue/Acre	$104.85
Variable Cost/Acre	
Seed	$ 4.00
Herbicide	6.70
Insecticide	3.50
Fertilizer	13.33
Fuel and oil	9.50
Repairs	11.00
Miscellaneous	7.00
Total Variable Cost	$55.03
GROSS MARGIN	$49.82

Land owner receives 1/3 of the crop and pays for 1/3 of the cost of fertilizer.

Source: Fausett, Marvin R. and John R. Schlender. Alfalfa Costs and Returns. KSU Farm Management Guide MF-363. Manhattan, Kansas: Cooperative Extension Service, Kansas State University, September 1986.

TABLE 9

SORGHUM SILAGE BUDGET

OWNED LAND

Yield/Acre	9.60 Tons
<u>Variable Cost/Acre</u>	
Seed	$ 3.33
Herbicide	10.30
Fertilizer	14.40
Fuel and Oil	19.50
Repairs	17.00
Miscellaneous	6.00

Total Variable Cost	$70.53

Source: McReynolds, Kenneth L. <u>Dryland Sorghum Silage in Central Kansas</u>. KSU Farm Management Guide MF-648. Manhattan, Kansas: Cooperative Extension Service, Kansas State University, September 1986.

TABLE 10

SORGHUM SILAGE BUDGET

RENTED LAND OPERATOR'S SHARE

Yield/Acre	6.40 Tons
Varialbe Cost/Acre	
Seed	$ 3.33
Herbicide	10.30
Fertilizer (14.40 x 2/3)	9.60
Fuel and Oil	19.50
Repairs	17.00
Miscellaneous	6.00

Total Variable Costs	$65.73

Land owner receives 1/3 of the crop and pays for 1/3 of the cost of fertilizer.

Source: McReynolds, Kenneth L. Dryland Sorghum Silage in Central Kansas. KSU Farm Management Guide MF-648. Manhattan, Kansas: Cooperative Extension Service, Kansas State University, September 1986.

TABLE 11

SOYBEAN BUDGET

OWNED LAND

Revenue/Acre	
Yield/Acre	35.00 Bushels
Price/Bushel	$4.40

Total Revenue/Acre	$154.00
Variable Cost/Acre	
Seed	$ 8.40
Herbicide	18.35
Fertilizer and Lime	11.60
Fuel and Oil	9.35
Machinery and Equipment Repairs	10.00
Miscellaneous	2.11

Total Variable Cost	$ 59.81
GROSS MARGIN	$94.19
	=======

Source: Figurski, Leo and John R. Schlender. Soybean Production in Eastern Kansas. KSU Farm Management Guide MF-570. Manhattan, Kansas: Cooperative Extension Service, Kansas State University, September 1986.

Soybean price is based on 1987 national loan rate plus the deficiency payment minus 30 cent storage cost.

TABLE 12

SOYBEAN BUDGET

RENTED LAND OPERATOR'S SHARE

Revenue/Acre	
Yield/Acre	35.00 Bushels
Renter's share Yield/Acre	23.33 Bushels
Price/Bushel	$4.40
Total Revenue/Acre	$102.65
Variable Cost/Acre	
Seed	$ 8.40
Herbicide 18.35 x 2/3	12.23
Fertilizer and Lime	11.60
Fuel and Oil	9.35
Machinery and Equipment Repairs	10.00
Miscellaneous	2.11
Total Variable Cost	$53.69
GROSS MARGIN	$48.96

Land owner receives 1/3 of the crop and pays for 1/3 of the cost of fertilizer.

Source: Figurski, Leo and John R. Schlender. Soybean Production in Eastern Kansas. KSU Farm Management Guide MF-570. Manhattan, Kansas: Cooperative Extension Service, Kansas State University, September 1986.

Soybean price is based on 1987 national loan rate plus the deficiency payment minus 30 cent storage cost.

TABLE 13

WINTERING PHASE BUDGET

Calves purchased in November

WINTER

Per head Variable Costs	
Miscellaneous	2.75
Veterinarian	4.25
Salt	.60
1/2 Repairs	3.00
1/2 Gas, Fuel, and Oil	2.50
Cattle Buyer (.50/cwt)	2.00
Total Variable Cost	15.10

Source: McReynolds, Kenneth L. and G. A. (Art) Barnaby, Jr. Winter and Graze Beef. KSU Farm Management Guide MF-594. Manhattan, Kansas: Cooperative Extension Service, Kansas State University, October 1985.

TABLE 14

SEASON-LONG GRAZING BUDGET

Calves purchased in November

GRASSSL

Per head Variable Costs	
Miscellaneous	2.25
Veterinarian	3.25
Salt	.60
1/2 Repairs	.50
1/2 Gas, Fuel, and Oil	.75
Total Variable Cost	7.35

Source: McReynolds, Kenneth L. and G. A. (Art) Barnaby, Jr. Grazing Yearling Beef. KSU Farm Management Guide MF-591. Manhattan, Kansas: Cooperative Extension Service, Kansas State University, September 1986.

TABLE 15

IES 2X GRAZING BUDGET

Calves purchased in November

GRASS2X

Per head Variable Costs	
Miscellaneous	2.25
Veterinarian	3.25
Salt	.60
1/2 Repairs	.25
1/2 Gas, Fuel, and Oil	.37
Total Variable Cost	6.72

Source: McReynolds, Kenneth L. and G. A. (Art) Barnaby, Jr. Grazing Yearling Beef. KSU Farm Management Guide MF-591. Manhattan, Kansas: Cooperative Extension Service, Kansas State University, September 1986.

TABLE 16

IES 2.5 GRAZING BUDGET

Calves purchased in November

GRASS25

Per head Variable Costs	
Miscellaneous	2.25
Veterinarian	3.25
Salt	.60
1/2 Repairs	.25
1/2 Gas, Fuel, and Oil	.37
Total Variable Cost	6.72

Source: McReynolds, Kenneth L. and G. A. (Art) Barnaby, Jr. Grazing Yearling Beef. KSU Farm Management Guide MF-591. Manhattan, Kansas: Cooperative Extension Service, Kansas State University, September 1986.

TABLE 17

SEASON-LONG GRAZING BUDGET

Calves purchased in November

GRASS3X

Per head Variable Costs	
Miscellaneous	2.25
Veterinarian	3.25
Salt	.60
1/2 Repairs	.25
1/2 Gas, Fuel, and Oil	.37
Total Variable Cost	6.72

Source: McReynolds, Kenneth L. and G. A. (Art) Barnaby, Jr. Grazing Yearling Beef. KSU Farm Management Guide MF-591. Manhattan, Kansas: Cooperative Extension Service, Kansas State University, September 1986.

TABLE 18

SEASON-LONG GRAZING BUDGET

Calves purchased in May

GRAZESL

Per head Variable Costs	
Miscellaneous	2.25
Veterinarian	3.25
Salt	.60
1/2 Repairs	.50
1/2 Gas, Fuel, and Oil	.75
Cattle Buyer (.50/cwt)	3.00
Total Variable Cost	12.25

Source: McReynolds, Kenneth L. and G. A. (Art) Barnaby, Jr. Grazing Yearling Beef. KSU Farm Management Guide MF-591. Manhattan, Kansas: Cooperative Extension Service, Kansas State University, September 1986.

TABLE 19

IES 2X GRAZE BUDGET

calves purchased in MAY

Per head Variable Costs	
Miscellaneous	2.25
Veterinarian	3.25
Feed	1.90
Salt	.60
1/2 Repairs	.25
1/2 Gas, Fuel, and Oil	.37
Cattle Buyer	3.00
Total Variable Cost	11.62

Source: McReynolds, Kenneth L. and G. A. (Art) Barnaby, Jr. Grazing Yearling Beef. KSU Farm Management Guide MF-591. Manhattan, Kansas: Cooperative Extension Service, Kansas State University, September 1986.

TABLE 20

IES 2.5X GRAZE BUDGET

calves purchased in MAY

Per head Variable Costs	
Miscellaneous	2.25
Veterinarian	3.25
Feed	1.90
Salt	.60
1/2 Repairs	.25
1/2 Gas, Fuel, and Oil	.37
Cattle Buyer	3.00
Total Variable Cost	11.62

Source: McReynolds, Kenneth L. and G. A. (Art) Barnaby, Jr. Grazing Yearling Beef. KSU Farm Management Guide MF-591. Manhattan, Kansas: Cooperative Extension Service, Kansas State University, September 1986.

TABLE 21

3X GRAZE BUDGET

calves purchased in MAY

Per head Variable Costs	
Miscellaneous	2.25
Veterinarian	3.25
Feed	1.90
Salt	.60
1/2 Repairs	.25
1/2 Gas, Fuel, and Oil	.37
Cattle Buyer	3.00
Total Variable Cost	11.62

Source: McReynolds, Kenneth L. and G. A. (Art) Barnaby, Jr. Grazing Yearling Beef. KSU Farm Management Guide MF-591. Manhattan, Kansas: Cooperative Extension Service, Kansas State University, September 1986.

AN ECONOMIC ANALYSIS OF SEASON-LONG AND INTENSIVE-EARLY GRAZING SYSTEMS ON A NORTHEAST KANSAS REPRESENTATIVE FARM

by

Jeane' K. Webb

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ABSTRACT

Linear Programming is used to study the most profitable farm organization of season-long grazing and intensive-early grazing systems and crop enterprises on a representative Northeast Kansas farm. Beef and crop enterprises are included in a wholefarm planning model to allow for the most profitable organization among the enterprises based on the use of land, labor, and capital to be incorporated into the decision making process.

A wholefarm plan was developed that maximizes returns to the wholefarm resource base. Key variables reported are enterprise selection, determination of stocking density, resource allocation, and gross margin.

The objective in this study is to analyze which grazing system fits best with crop enterprises in a wholefarm operation. The effects of limited pasture and capital and July feeder cattle price changes on the wholefarm organization are investigated.

The model is flexible in that the steers can be bought in November and/or May, sold in May, July, and/or October, wintered and/or grazed on native pasture. If the cattle are purchased in November, they go through a wintering phase and then they are either sold or placed on native pasture in May. During the wintering phase, the model allows the grain and forage fed to the cattle to be either grown on the farm, purchased, or a combination of grown and purchased feed. If the cattle are purchased in May, they are placed on native pasture. Also, the cattle can be placed on native pasture at different stocking rates. The different stocking rates represent the intensive-early stocking and season-long grazing practices.

This research showed that both season-long and intensive-early stocking grazing can profitably fit into farm situations of Northeast Kansas. IES grazing is more profitable when pasture is limiting relative to the amount of capital or when July feeder steer prices are higher than average in relationship to October feeder steer prices. However, when capital is limited relative to the pasture available, then season-long grazing is the most profitable grazing system to use. The crop size and organization for the representative farm does not differ between the farm organization using IES grazing and the farm organization using season-long grazing.