THE FEASIBILITY OF SWINE PRODUCTION IN OKLAHOMA

By

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INTRODUCTION

Introduction

Farm management is a broad concept that encompasses the managerial functions of production, marketing, and finance. In recent years, the farmer's task of combining these functions with his/her own goals and limitations has become increasingly more difficult due to declining land values, agricultural overcapacity, and low and volatile farm prices. Although enterprise combinations are both endless and diverse, Oklahoma farmers have traditionally relied on winter wheat and stocker cattle as their primary sources of cash receipts, making agricultural income highly dependent on the prices of these two commodities (Oklahoma Agricultural Statistics). Could Oklahoma farmers incorporate swine production into their operations as a means of both increasing farm income and diversifying farm receipts to protect against low wheat and cattle prices?

Importance of Swine Production in the United States

Hog production is an important commodity in United States agriculture. In 1987, hog production ranked fifth in terms of value of production among all agricultural commodities and fourth among all livestock commodities produced in the United States (Table 1). More than 82 million hogs were marketed, generating cash receipts of $9 billion. During that same year, almost 80 million hogs were slaughtered in the United States.

TABLE 1

RANK OF PRINCIPAL AGRICULTURAL COMMODITIES PRODUCED IN THE UNITED STATES BY VALUE OF PRODUCTION, 1987

Rank	Commodity	Value of Production ($1,000 dollars)
1	Beef Cattle	$20,924,859
2	Dairy	18,146,585
3	Corn	12,387,438
4	Poultry/Eggs	12,374,775
5	Hogs/Pigs	9,531,589
6	Soybeans	9,326,186
7	All Hay	8,643,727
8	Fruits	5,618,156
9	Wheat	4,861,364
10	Vegetables	4,120,168

Source: U.S. Department of Commerce, Census of Agriculture 1987.

United States hog production is concentrated in the Corn Belt region (Figure 1). Fifty-four million hogs, or 65 percent of all hogs produced in the U.S., were produced in the Corn Belt in 1987 (Ag Statistics). Three states in this region - Iowa, Illinois, and Indiana - accounted for nearly 44% of the nation's hog production. This information is presented in Table 2.

Traditionally, hog markets and slaughter facilities have been located in or around areas of heavy hog production. Although most hogs are marketed via contractual agreements with large processors (Hayenga), principal hog markets are still located in Kansas City (MO), St. Joseph (MO), Omaha (NB), St. Paul (MN), and Sioux City (IA). In 1987, approximately three million hogs were marketed at these five Midwestern stockyards (Ag Statistics). Processing plants in Iowa, Illinois, Michigan, and Nebraska accounted for almost 50 percent of all hogs commercially slaughtered in the United States.

Importance of Swine Production in Oklahoma

Although hog production is a major commodity in U.S. agriculture, its significance to Oklahoma agriculture is limited. In 1988, cash receipts from Oklahoma's hog industry totaled $39.4 million--only 1.3 percent of the state's total agricultural cash receipts (Figure 2). In terms of value of production, hog production currently ranks ninth among all agricultural activities and fourth among livestock enterprises characteristic to Oklahoma (Table 3). Nationally, Oklahoma ranks 24th in terms of hog numbers.

Hog production occurs in every county and region of Oklahoma, but is primarily concentrated in the northeastern portion of the state (Figure 3). In 1988, this region alone possessed 40 percent of all hogs in the state. In northeastern Oklahoma, Delaware County alone reported 63,000 head of hogs

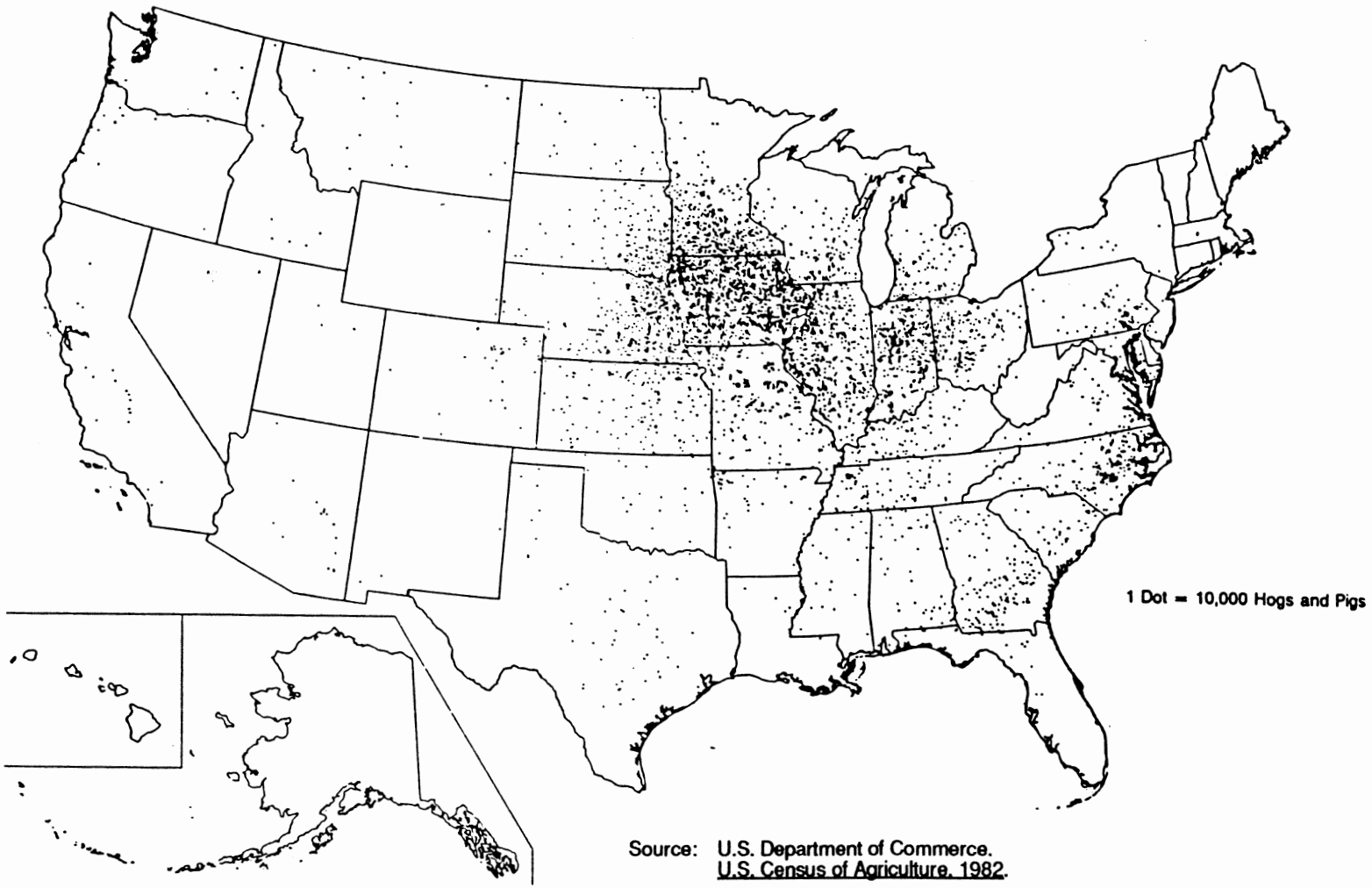


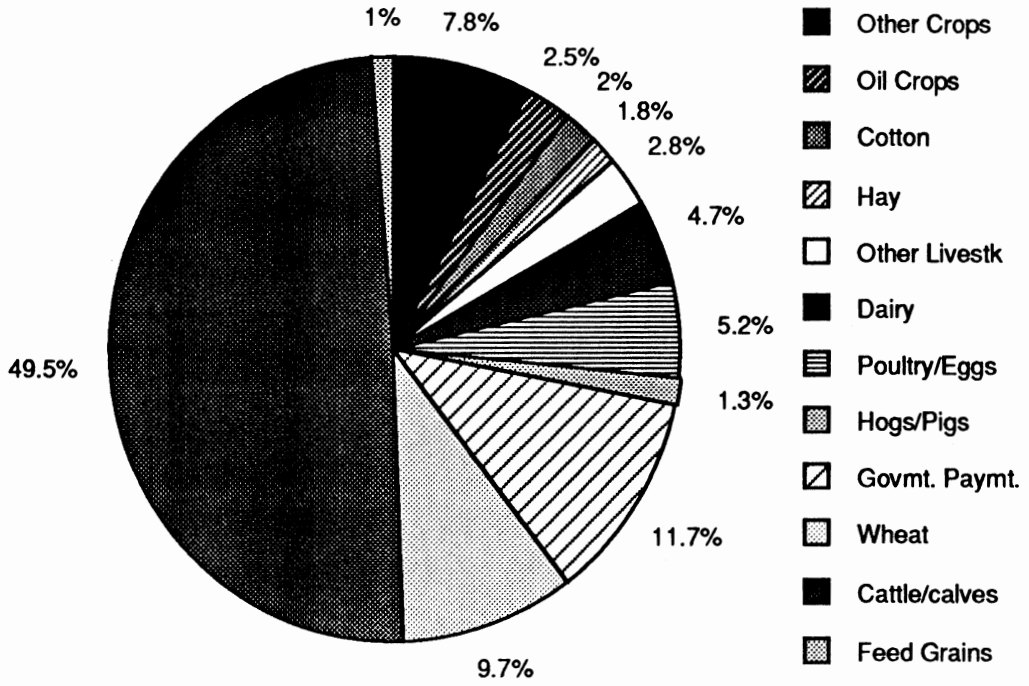
Figure 1. U.S. Hog and Pig Inventory

TABLE 2

HOGS SLAUGHTERED, HOGS PRODUCED, AND CASH RECEIPTS GENERATED BY VALVE AND PROPORTION, CORN BELT STATES -1987

State	Slaughter		Production		Cash Receipts	
	Number -Head-	Proportion -PCT-	Number -Head-	Proportion -PCT-	Number -$1,000-	Proportion -PCT-
Illinois	5,772,800	7.3	8,324,000	10.1	1,007,976	10.4
Indiana	3,427,300	4.3	6,637,000	8.0	778,932	8.0
Iowa	18,711,200	23.5	21,348,000	25.6	2,629,202	27.1
Michigan	4,624,000	5.8	1,755,000	2.1	195,293	2.0
Minnesota	5,862,100	7.4	6,508,000	7.9	750,234	7.7
Missouri	3,632,000	4.5	4,850,000	5.9	552,250	5.7
Ohio	3,659,000	4.6	2,988,400	3.6	354,126	3.7
Wisconsin	2,580,200	3.2	2,062,300	2.5	248,001	2.6
Corn Belt Total	48,268,600	60.6	54,472,700	65.9	6,516,284	67.2
U.S. Total	79,598,200		82,608,000		9,701,947	

Source: U.S. Department of Agriculture, 1988 Ag. Statistics.



Source: Oklahoma Crop and Livestock Reporting Service, Oklahoma Agricultural Statistics, 1989.

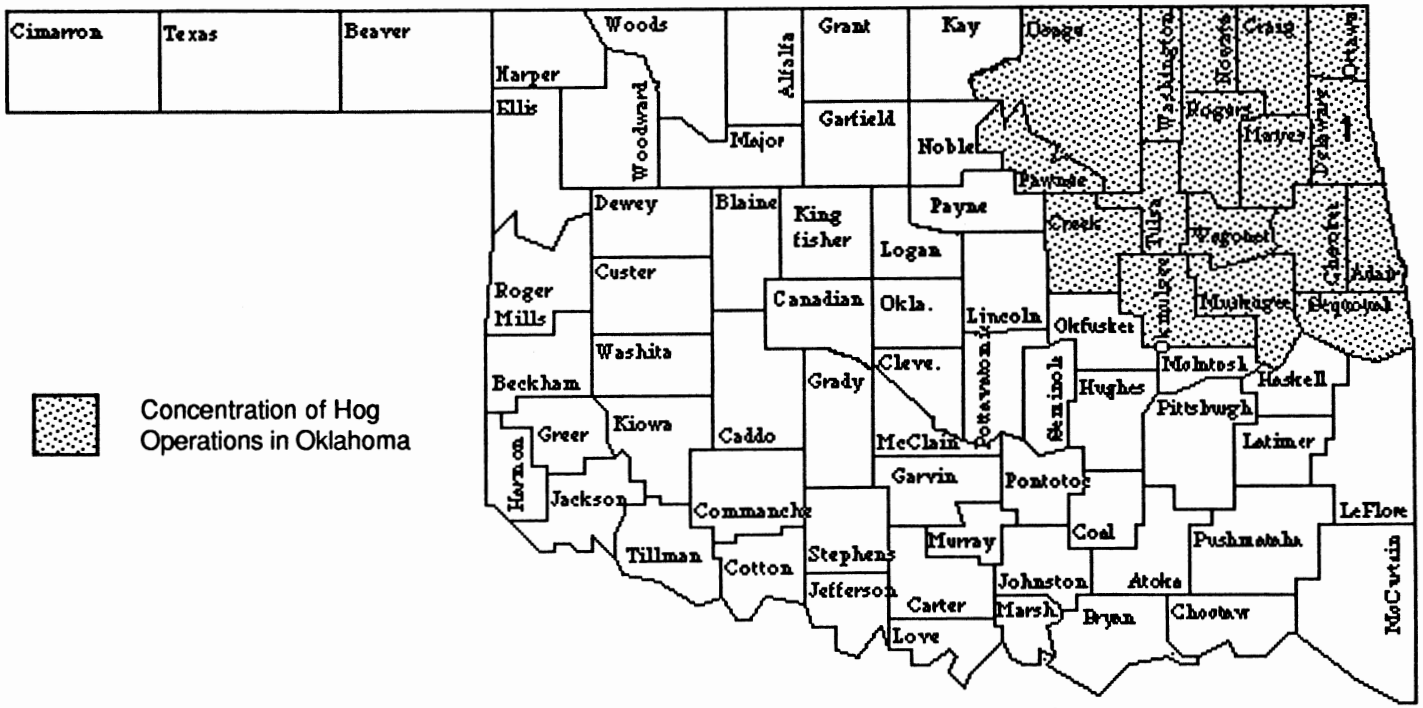
Figure 2. Oklahoma Agricultural Cash Receipts, 1988

TABLE 3

AGRICULTURAL COMMODITIES PRODUCED IN OKLAHOMA
RANKED BY VALUE OF PRODUCTION, 1988

Rank	Commodity	Value of Production --$1,000 dollars--
1	Beef Cattle	$1,333,000
2	Winter wheat	622,000
3	All Hay	311,000
4	Poultry	211,000
5	Dairy	152,000
6	Cotton	79,000
7	Peanuts	62,000
8	Sorghum	40,000
9	HOGS/PIGS	37,000
10	Soybeans	35,000

Source: Oklahoma Crop Livestock Reporting Service, Oklahoma Agricultural Statistics 1989.



Source: Oklahoma Crop and Livestock Reporting Service. Oklahoma Agriculttural Statistics, 1988.

Figure 3. Oklahoma Hog and Pig Numbers, 1988

and pigs--66 percent of the total found in that region and 26 percent of the state's total (Table 4). Production in that county exceeded that of any other county or district in Oklahoma. The East Central and Central districts of Oklahoma together reported an additional 64,000 hogs, almost 27 percent of the state's hog numbers.

Historic Trends

Swine production has historically been a major component of U.S. agriculture. Since the early twentieth century, swine production has continuously ranked among the top three livestock commodities produced in the United States in terms of cash receipts (Table 5). In 1943, hog production contributed more to agricultural income than any other livestock commodity, generating almost three billion dollars in cash receipts (Ag Statistics).

Although hog production's ranking among other commodities as measured by cash receipts has remained relatively constant over the last three decades, other statistics regarding swine production have not. The U.S. hog industry has historically been plagued by large fluctuations in both production and price. Overreactions by producers in good and bad times have resulted in the cyclical nature of hog production and prices that has persisted for many years (Figure 4). Weather has also been a contributing factor to this pattern in two ways. First, the effects of weather on the availability and price of feed grains inevitably affects hog production costs and profitability and could possibly affect decisions regarding herd size. Second, the susceptibility of baby pigs to extreme winter has forced many pasture producers to have more spring and fall farrowings. These cyclical and seasonal price fluctuations, combined with seasonal shifts in

TABLE 4

OKLAHOMA HOG AND PIG NUMBERS BY CROP REPORTING DISTRICT - 1988

District	Number of Head	Proportion
Panhandle	12,000	5.0
West Central	11,000	4.6
Southwest	12,000	5.0
North Central	25,000	10.4
Central	32,000	13.3
South Central	14,000	5.8
Northeast	95,000	39.6
East Central	32,000	13.3
Southeast	7,000	2.9
Oklahoma	240,000	99.9[a]

[a] May not sum to 100 percent due to rounding error

Source: Oklahoma Crop and Livestock Reporting Service, Oklahoma Agricultural Statistics, 1989.

TABLE 5

CASH RECEIPTS GENERATED BY LIVESTOCK COMMODITIES IN SELECTED YEARS, UNITED STATES - 1925 THROUGH 1985

Year	Cattle	Hogs	Dairy	Sheep	Poultry
			- - - - - - - - Thousands of Dollars - - - - - - - -		
1925	1,252,084	1,318,612	1,405,662	206,847	997,296
1930	1,183,573	1,135,500	1,607,441	161,124	938,993
1935	1,062,426	681,804	1,310,204	152,216	707,903
1940	1,375,631	835,618	1,520,346	179,997	654,307
1943	2,562,452	2,929,215	2,785,193	342,397	856,258
1945	3,318,156	2,262,963	3,021,266	319,492	2,194,684
1950	5,679,708	3,214,247	3,718,685	387,344	1,992,016
1955	5,245,324	2,693,958	4,217,133	316,194	2,002,734
1960	7,370,531	2,868,987	4,759,957	325,107	1,843,086
1965	8,941,775	3,693,341	5,037,727	328,609	1,871,227
1970	13,934,696	4,619,946	6,526,575	333,746	2,292,618
1975	17,520,176	7,916,425	9,929,750	385,804	2,901,454
1980	31,827,906	8,942,539	16,568,488	470,782	3,375,383
1985	29,050,683	9,014,059	18,062,961	503,202	N/A

Source: U.S. Department of Agriculture, Ag. Statistics 1987.

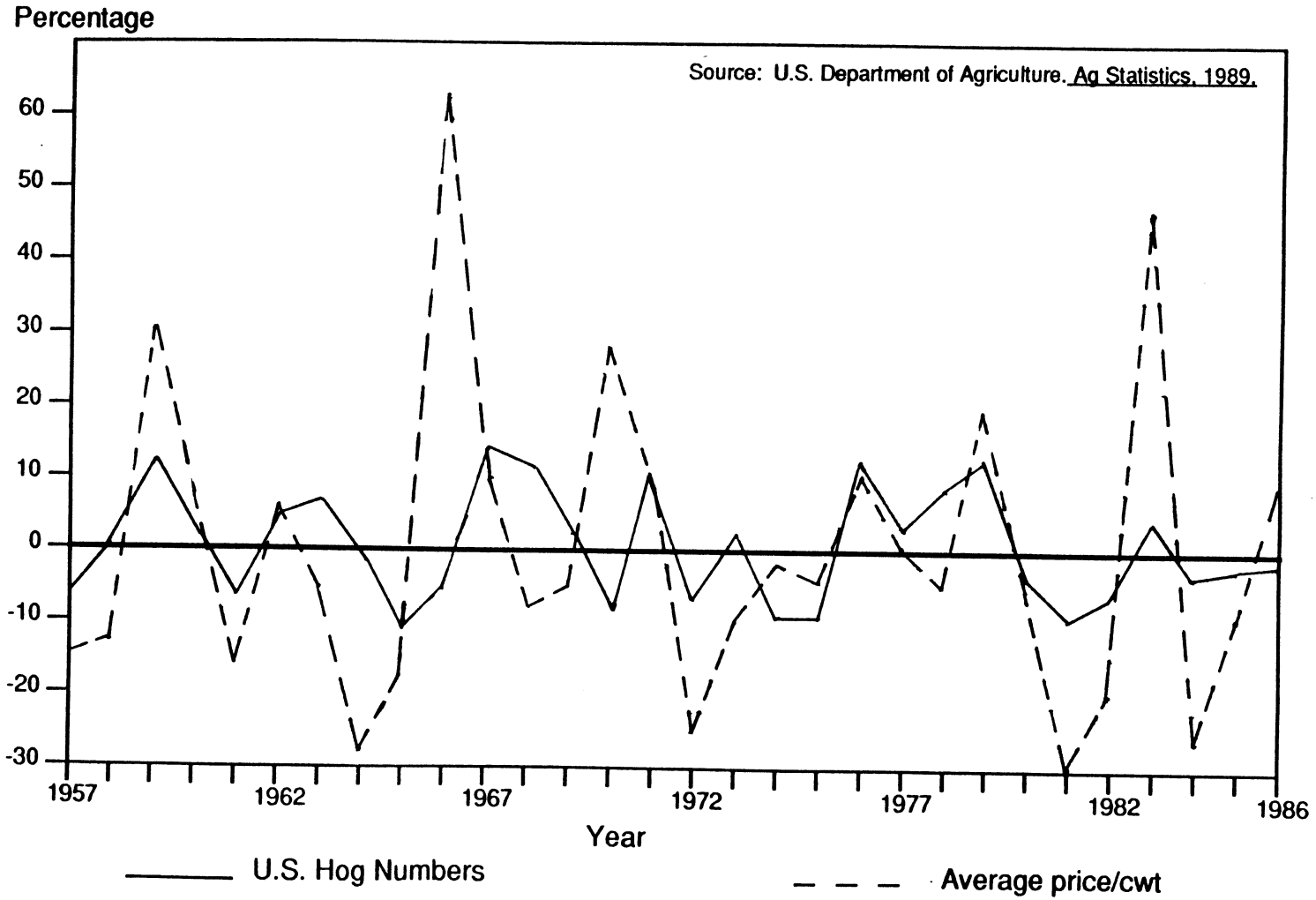


Figure 4. Percent Change in U.S. Hog Numbers and Price ,1957-1986

consumer demand (holidays and climatic conditions) create a volatile pricing environment for hogs and pork products.

Hogs on U.S. farms have typically numbered about 55 million head, but have varied between 47 and 67 million head since the mid-1950's (Table 6). During this thirty year span, hog numbers peaked in 1979 at 67.3 million head. Since this record year, hog numbers have steadily decreased and, by 1986, had fallen to 51 million head - a 24 percent decline in seven years.

Like hog numbers, the average price per hundredweight received by U.S. hog producers has varied greatly over the last three decades (Table 7). Hog producers in 1959 received $14.10 per hundredweight, the lowest average annual price received in any year since 1955. This is contrasted by the record high average price of $52.30 received in 1982. During this thirty-year time frame, hog prices have generally increased; but, as Figure 4 illustrates, this period has been marked by extreme variability in hog prices. Therefore, the road towards this overall price increase has created a relatively volatile pricing situation for hog producers.

Significant changes in the structure of the U.S. swine industry have also occurred in recent years (Table 8). Since the mid-1960's, the number of farms selling hogs and pigs has declined by more than 70 percent. In 1964, 67 percent of the hog operations in the United States sold less than 100 head. Farms selling over 1000 head, however, comprised less than one percent of all hog operations. In 1987, the proportion of farms selling less than 100 head declined by 12.2 percent, while the proportion of larger farms increased by 3.9 percent.

The relationship between farm size and output has also undergone numerous changes. In 1964, 23 percent of all hogs were marketed by farms selling 99 head or less, while 7.3 percent were sold by farms marketing at least

TABLE 6

NUMBER OF HOGS ON U.S. FARMS IN SELECTED YEARS
1956 - 1986

Year	Number of Hogs - - 1,000 head - -
1956	55,534
1961	55,560
1966	47,414
1971	62,412
1976	54,934
1979	67,318
1981	58,698
1986	50,960

Source: U.S. Department of Agriculture, Ag. Statistics 1987.

TABLE 7

AVERAGE ANNUAL PRICE PER HUNDREDWEIGHT RECEIVED FOR SLAUGHTER HOGS BY U. S. HOG PRODUCERS IN SELECTED YEARS, 1956 - 1986

Year	Price/Cwt -dollars-
1956	$14.40
1959	14.10
1961	16.60
1966	22.80
1971	17.50
1976	43.30
1981	43.90
1982	52.30
1986	49.30

Source: U.S. Department of Agriculture, Ag. Statistics, 1987.

TABLE 8

NUMBER OF FARMS AND NUMBER OF HOGS AND PIGS SOLD BY SIZE OF FARM,
UNITED STATES - 1964 AND 1987

		1964		1987	
		Farms	Pigs Sold	Farms	Pigs Sold
TOTAL ALL FARMS		751,000	80,391,000	220,897	94,217,111
1-99 head	number	502,754	18,489,931	120,904	9,465,888
	percent	66.9	23.0	54.7	10.0
100-199 head	number	136,021	13,570,321	32,292	8,525,504
	percent	18.1	23.1	14.6	9.0
200-499 head	number	92,435	26,689,812	40,153	21,848,336
	percent	12.3	33.2	18.1	23.2
500-999 head	number	16,533	10,772,394	17,876	20,042,769
	percent	2.2	13.4	8.1	21.3
> 1,000 head	number	3,758	5,868,543	9,672	34,334,614
	percent	0.5	7.3	4.4	36.4

Source: U.S. Department of Commerce, Census of Agriculture 1964 and 1987.

1000 head. By 1987, however, only 10.0 percent of the hogs were sold by the smaller operations, a proportional decline of 13 percent. Conversely, farms selling at least 1000 head generated 36.4 percent of the hogs sold in 1982, an increase of more than 29.1 percent.

The information in Table 8 suggests that larger operations, though relatively few in number, generated most of the hogs and pigs sold in 1987. Although the most numerous, smaller operations sold the fewest number of hogs and pigs. Despite the substantial decline in the total number of hog operations, farms selling at least 500 head not only increased in proportion (2.7 to 12.5 percent), but also in number. Although the total number of hogs increased by 17 percent, the number of hogs sold by farms with less than 500 head declined by over 18 million head (32 percent). Operations selling more than 500 head increased sales by almost 37 million head, a phenomenal increase of over 200 percent. Representing less than 15 percent of all hog operations, these larger farms generated 57 percent of the hogs and pigs sold in 1987. In the past twenty years, United States hog production has made the transition from being an industry dominated by smaller operations to one dominated by large, 1000-plus head operations.

In terms of livestock inventories, Oklahoma currently ranks 24th among the United States in hog and pig numbers - a ranking that has not changed significantly since 1962. Unlike U.S. agriculture, hog production is not a major component of Oklahoma agriculture, which has traditionally been dominated by beef cattle and winter wheat. Over the past thirty years, hog production has ranked as high as fifth among the principal crops and livestock produced in Oklahoma in terms of value of production; in recent years, however, hog production has consistently ranked eighth or ninth among these commodities.

Like the U.S. swine industry, large variations in both price and production have been characteristic in Oklahoma hog production (Figure 5). Although fluctuations in the average price per hundredweight received by Oklahoma hog producers have closely followed those endured by producers nationwide, Oklahoma hog numbers have exhibited more extremes in variation than U.S. hog numbers (Figure 6). While U.S. hog numbers averaged 6.3 percent change each year, the annual change in average price varied by as much as 12.7 percent. By comparison, Oklahoma hog numbers, on average, vary 15.7 percent each year, but prices have changed by as much as 60 percent in a single twelve-month period.

Since the mid-1950's, an average of 341,000 hogs have been reported on Oklahoma farms each year. Oklahoma hog numbers in the eighties, however, have been consistently less than this 340,000-plus average (Table 9). Over this eight year period, hog numbers have declined a total of 36 percent. From 1956 to 1987, the peak number of hogs was reported in 1960, when an estimated 475,000 head of hogs and pigs could be found on Oklahoma farms. Recent years have brought a considerable decrease in hog numbers, with a record low 200,000 head reported in 1982 and again in both 1985 and 1987.

Oklahoma hog producers, like producers nationwide, have also weathered wide variations in the average price received for their product (Table 10). In 1959, Oklahoma producers received $14.20 per hundredweight live hog -- the lowest average annual price reported since the mid-1950's. This record low price received for slaughter hogs in Oklahoma corresponds to the record low average price of $14.10 per hundredweight received by producers nationally. Similarly, Oklahoma producers received the highest average annual price in 1982 -- $50.80 per hundredweight versus the national record of $52.30 received in that same year. Although producers have experienced an overall

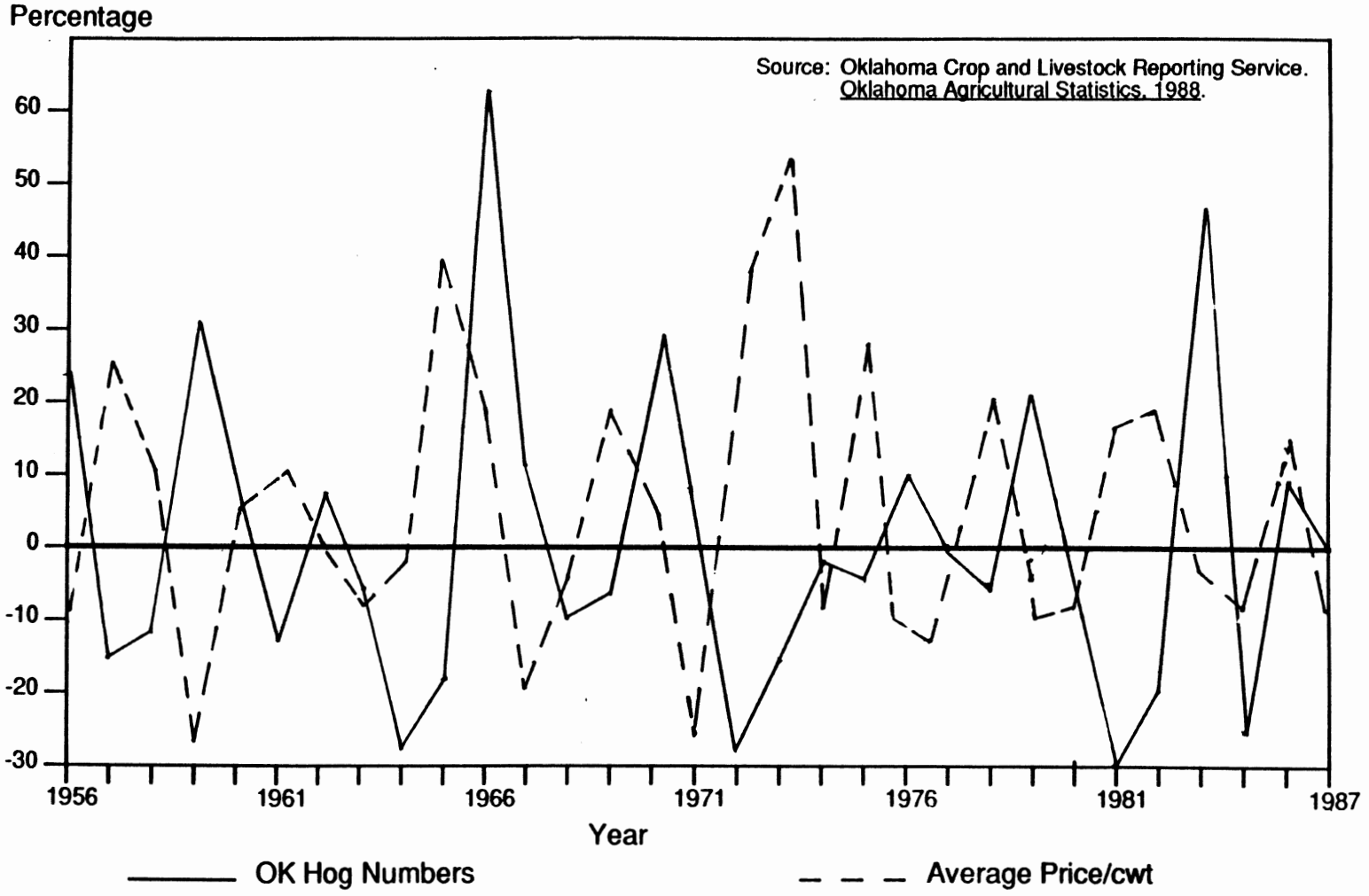


Figure 5. Percent Change in Oklahoma Hog Numbers and Price, 1957-1986

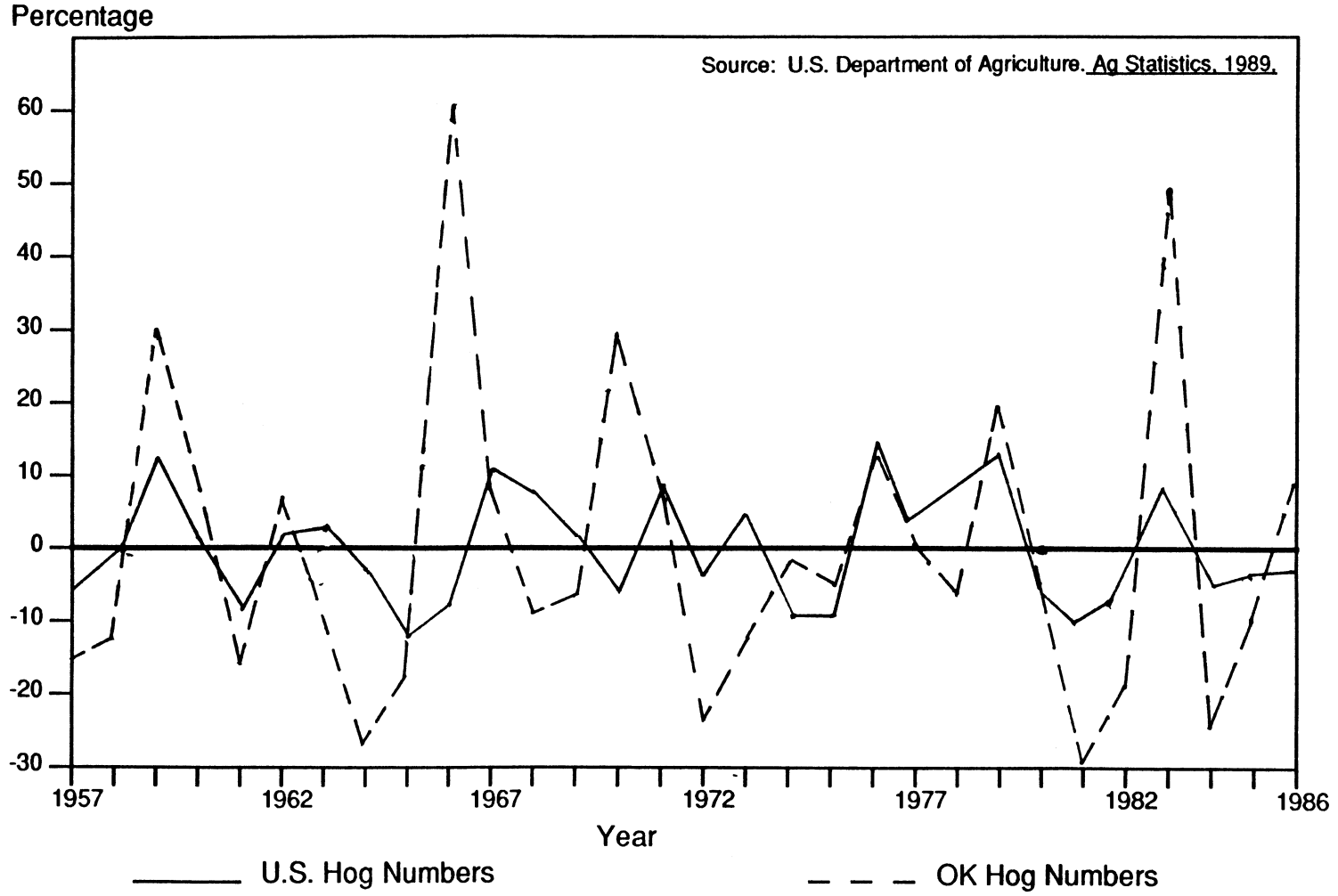


Figure 6. Percent Change in U.S. and Oklahoma Hog Numbers,1957-1986

TABLE 9

NUMBER OF HOGS ON OKLAHOMA FARMS IN SELECTED YEARS 1955-1987

Year	Number of Head
1955	373,000
1960	475,000
1965	240,000
1970	442,000
1975	300,000
1980	350,000
1981	245,000
1982	200,000
1983	290,000
1984	220,000
1985	200,000
1986	220,000
1987	200,000

Source: Oklahoma Crop and Livestock Reporting Service, Oklahoma Agricultural Statistics.

TABLE 10

AVERAGE ANNUAL PRICE PER HUNDREDWEIGHT RECEIVED FOR SLAUGHTER HOGS BY OKLAHOMA PRODUCERS - SELECTED YEARS, 1955 - 1985

Year	Price $/cwt
1955	$16.10
1959	14.20
1960	14.80
1965	20.40
1970	22.60
1975	46.50
1980	37.20
1982	50.80
1985	44.60

Source: Oklahoma Crop and Livestock Reporting Service, Oklahoma Agricultural Statistics.

increase in hog prices, Figure 5 shows that this rise has been characterized by extreme fluctuations in price, making sound decision-making and accurate profitability estimates difficult if not impossible for Oklahoma hog producers.

Like U.S. slaughter numbers, Oklahoma slaughter numbers have varied considerably since 1955 (Table 11). In 1971, over one million hogs were slaughtered in Oklahoma facilities, the largest number ever reported. Between 1971 and 1975, slaughter numbers steadily declined from 1.1 million in 1971 to 618,500 in 1975. Following this period of decline, hog slaughter numbers consistently increased and again topped one million in 1980. In 1981, the Wilson facility in Oklahoma City closed its doors to pork slaughter, but continued to process pork slaughtered at other locations. Consequently, in 1981, Oklahoma slaughter numbers decreased 45 percent to 596,600 head and have continued to decline each year. In 1987, only 125,400 head of hogs were processed in Oklahoma, less than 12 percent of the number slaughtered in 1980, and the fewest number processed in a single year. Prior to the Wilson plant closing, increases or decreases in Oklahoma slaughter numbers corresponded to similar variations in hog numbers.

Since the mid-1960's, the structure of Oklahoma's swine industry has also undergone dramatic changes. In the past twenty years, the number of Oklahoma farms selling hogs and pigs declined by 71 percent (Table 12). According to the 1964 Census of Agriculture, 91 percent of these farms sold less than 100 head, while less than one percent of these farms sold more than 1000 head. By 1987, farms selling less than 100 head were still most numerous, but represented 89 percent of all hog operations. The number of farms selling over 1000 head more than tripled and comprised less than one percent of all farms selling hogs and pigs.

TABLE 11

OKLAHOMA SLAUGHTER STATISTICS
FOR SELECTED YEARS 1955 - 1987

Year	Number of Head
1955	846,000
1960	674,000
1965	567,500
1970	878,500
1971	1,130,500
1975	618,500
1980	1,083,900
1981	596,600
1982	196,300
1983	185,700
1984	158,900
1985	139,500
1986	129,900
1987	125,400

Source: Oklahoma Crop and Livestock Reporting Service, Oklahoma Agricultural Statistics.

TABLE 12

NUMBER OF FARMS AND NUMBER OF HOGS AND PIGS SOLD BY SIZE OF FARM, OKLAHOMA - 1964 AND 1987

		1964		1987	
		Farms	Pigs Sold	Farms	Pigs Sold
TOTAL ALL FARMS		9,905	420,836	2,873	340,784
1-99 head	number	9,020	210,683	2,569	96,520
	percent	91.8	50.1	89.4	28.3
100-199 head	number	573	74,662	145	33,108
	percent	5.8	17.7	5.0	9.7
200-499 head	number	250	69,595	102	41,365
	percent	2.5	16.5	3.6	12.1
500-999 head	number	43	28,839	35	39,430
	percent	0.4	6.9	1.2	11.6
> 1,000 head	number	19	37,057	22	130,361
	percent	0.2	8.8	0.8	38.3

Source: U.S. Department of Commerce, Census of Agriculture - Oklahoma Volume 1964 and 1987.

Moreover, the relationship between farm size and annual sales has changed considerably. Since 1964, the number of hogs and pigs sold in Oklahoma has declined by over 15 percent. In 1964, 50 percent of the hogs were sold by operations selling less than 100 head, while farms selling at least 1000 head sold approximately nine percent of all hogs and pigs marketed. In 1987, however, these large farms generated 38 percent of the hogs sold and the smaller operations sold only 28 percent. These large farms sold proportionally more hogs and pigs than any other size of operation.

The information in Table 12 suggests that large farms currently produce a majority of Oklahoma's hog output, yet are relatively few in number. Conversely, smaller operations are more numerous, but contribute a disproportionately small share of output. Like U.S. swine production, Oklahoma's hog industry is also making the transition to an industry dominated by large swine operations. However, the mid-sized hog operations (200-500 head) are not disappearing as rapidly in Oklahoma as they are on the national level.

Literature Review

The expansion potential of swine production in the Southern Plains of the United States has long been a topic of interest to researchers in this region. By developing good management skills, Goodwin (1965) determined that Oklahoma swine producers could more than double their production and that low-cost feed grains from Oklahoma, Kansas, and Texas were readily available to support substantial increases in hog numbers.

Sprott (1973) and Lee and Perrin (1975) used linear transshipment models for spatial studies of the swine-pork industry. Assuming perfectly

inelastic demand functions, perfectly elastic supply functions and estimates of regional slaughter costs, Sprott determined the least-cost location and quantity of hog production in 27 regions of the United States. Although he predicted continued dominance of the hog-pork industry by producers in the Midwest, Sprott concluded that the deficit pork situation that existed in Oklahoma and other Southern Plains states could be alleviated, given the surplus feed grains produced in the area. Lee and Perrin, assuming a fixed supply and demand for hogs and pigs, determined least-cost shipment patterns for live hogs and pigs simultaneously. The researchers concluded that Oklahoma and other states in the Southwest could feasibly increase hog production, given population growth and the trend towards higher per capita consumption of pork.

Using reactive and linear programming, Williams and Meyer (1982) determined that Oklahoma was one of five regions in the United States where the greatest opportunities existed to expand swine production. Williams and Meyer also concluded that the potential return to resources invested in the swine enterprise was greatest in Oklahoma and Arkansas.

Additional research indicates that expansion of Oklahoma's swine industry is possible as well as profitable to individual producers. Williams and Plain (1978) determined that Oklahoma producers who had adequate animal husbandry skills and a basic understanding of farm management and economic principles could profitably produce hogs. In comparing selected swine enterprises and production systems, Williams and Meyer concluded that confinement systems provided the least-cost method of both producing feeder pigs and finishing purchased hogs. For farrow-to-finish operations, production costs for low investment systems were comparable to those of confinement systems. Weldon (1975) concluded that the type of system employed by a hog producer was a function of capital and labor availability. With adequate capital

and labor supplies, a farrow-to-finish operation was preferred; when labor and capital resources were limited, however, finishing pig operations were favored. Research by Hobbs (1984) indicates that the profitability and net worth of swine producers can be further enhanced by incorporating income tax strategies in production and management decisions.

Although the use of linear programming to determine the expansion potential of swine production has been both widespread and informative, few studies have been conducted using linear programming to determine the feasibility of swine production when considering other crop and livestock enterprises. Martin, et al. (1979) used linear programming to determine the optimal farm plan among eight livestock and eleven crop enterprises characteristic to the Piedmont region in Georgia. Of the eight livestock budgets included, five were developed for swine operations. For each of the three farm sizes examined, a hog enterprise was included in the optimal plan. Further analysis using parametric programming revealed that these plans were fairly stable to changes in hog and corn prices.

Using similar methodology, Doye (1980) used linear programming to examine the feasibility of sheep production in Oklahoma and determined that moderate to large sheep operations could be profitable in Oklahoma. Using parametric programming, the optimal plans proved stable against changes in input and output prices.

Objectives

The purpose of this research is to determine if the economic returns to Oklahoma farmers can be enhanced by incorporating swine enterprises into the production process. Specifically, the objectives are

(1) To review and modify existing O.S.U. crop and livestock enterprise budgets.

(2) To determine the conditions under which the adoption of swine enterprises would provide additional returns to operations in northcentral Oklahoma.

(3) To determine the income sensitivity of optimal farm plans to changes in resource and product prices.

Procedures

For objective 1, information will be gathered from Oklahoma State University animal scientists, Extension personnel, and experienced swine producers about the production costs and returns of feeder pig, finishing pig, and farrow-to-finish production enterprises. Investment and resource requirements, along with production and technical parameters will be identified for three farm sizes in northcentral Oklahoma. This information will be used to modify existing enterprise budgets. Separate budgets will be developed for pasture/dirt-lot and confinement management systems. Small, medium, and large farm operations will be defined by labor, land, and capital availability.

For objective 2, the swine enterprises budgets, along with existing O.S.U. budgets for other crop and livestock enterprises, will be used to develop a linear programming model for three farm sizes in northcentral Oklahoma. Additional solutions will be generated for two equity scenarios and two operator labor scenarios for each farm size. Given a prespecified set of resources and input/output prices for each farm scenario considered, mixed integer programming will be used to identify the swine enterprise that could increase the operation's profitability. The mixed integer programming solution will show

the optimal combination of production activities for each farm, and will indicate the economic conditions for which swine production competes favorably with other farm activities. This routine will be used to limit the number of swine enterprises that may appear in the optimal solution to either zero or one.

For objective 3, the linear programming output for each solution will be used to indicate the sensitivity of these optimal production combinations to changes in input and output prices.

Limitations

This study is limited to agricultural production in northcentral Oklahoma. Every effort has been exercised to make the resource assumptions and enterprise budgets used in the typical farms as representative of actual production as possible. However, it must be noted that the budgets and input constraints used may not accurately reflect the producing environment experienced by any one farm or set of farms in a given area of northcentral Oklahoma.

Overview of Following Chapters

This introductory chapter has not only presented current and historical information about U.S. and Oklahoma hog production, but also a chronological presentation of previous studies that provided the foundation for this research. In addition, the objectives and procedures identified in this chapter have plotted the course for the following chapters.

Chapter two will present a brief overview of the economic concepts underlying farm management studies and will discuss applications of economic theory to farm management through budgeting and linear programming.

Chapter three will specifically enumerate the procedures followed to obtain resource limits, product and input prices, and production enterprises used to define the benchmark farms in this study. A detailed explanation of the linear programming models will be included as will the modifications required to make these models accomplish the prescribed objectives.

Chapter four will be devoted to presenting the optimal solutions obtained for each farm scenario examined and discussing the sensitivity of these solutions to changes in input and output prices.

Chapter five will present a summary of both the procedures and results chapters as well as conclusions about the results. In addition, suggestions for future research in this area will be provided.

CHAPTER II

ECONOMIC THEORY

Economic Models

Although a variety of economic models are used by economists to solve a wide range of problems, practically all models include three common elements: (1) the ceteris paribus assumption, (2) the optimizing behavior of decision-makers, and (3) a distinction between positive and normative questions.

The ceteris paribus condition allows economists to examine the direct relationship among a few forces, while keeping all other forces constant. For example, a model for the market of beef might attempt to explain beef prices with a small number of quantifiable variables, such as the prices of feed grains, consumer incomes, and the prices of other meat products. Although other factors (presence of sickness and disease, changes in the prices of other inputs besides feed, or shifts in consumer attitudes and preferences) may also affect the price of beef, the ceteris paribus assumption allows researchers to keep these forces constant.

Many economic models also assume that decision-makers are rationally pursuing some optimizing objective. Although the objective of many producers is to maximize profits, consumers and other decision-makers may opt to maximize satisfaction or public welfare, minimize costs, etc. The optimization assumption is widely accepted by economists because precise, solvable problems are generated and empirically valid, realistic results can be obtained.

A final feature common to most economic models is the attempt to differentiate between "positive" and "normative" questions. Positive economics seeks to determine how resources are actually allocated in the economy. Normative analysis takes a moral position on how resources should be allocated. Economists who adopt the profit maximization hypothesis because it seems to explain reality are engaged in positive analysis. However, economists who argue that firms should maximize profits are taking a normative position.

Economic Problems

Generally, most theoretical problems in economics are solved assuming a fairly stable, or static, producing environment. A static system is usually accomplished by fixing the production and utility functions, specifying the institutional arrangement, and assuming instantaneous decisions. It is also assumed that all market participants are rational and possess perfect knowledge. In order to solve problems with profit or utility maximization objectives, information about price and technical relationships is needed.

The technical relationship is expressed in terms of a production function. Nicholson (1985) defined the production function as a conceptual mathematical function that records the relationship between a firm's inputs and its outputs. In its general form, a production can be expressed algebraically as:

$$Y = f(x_1 \mid x_2, \ldots, x_n) \qquad (1)$$

where Y is an output, x_1 is a variable input and x_2 through x_n are fixed inputs in the production process. Although, x_2 through x_n are considered to be fixed at some constant level in the short run, all inputs are considered variable in the

long run, since the firm has adequate time to adjust to all market conditions. For any given combination of inputs, the function records the only level of output that can be generated. Hence, all points on the production function are rational and technically efficient: no greater level of output can be attained from the given set of resources and no smaller outlay of inputs can yield the same output. Technically inefficient production occurs when resources are constrained, nondivisible and/or when imperfect knowledge exists.

This technical information, when combined with information about the prices of resources and products, can be used to determine the profitability of the firm. The profit function of a firm pursuing profit maximization can be represented by

$$\pi = PyY-(Px_1 X_1 +Px_2 X_2 +. . .+ Px_n X_n) \quad (2)$$

where π is the firm's profit level, Py is the price of the output (Y), and the input cost of X_n is Px_n. Price of the output times output level yields total revenue, while the sum of the input prices multiplied by the input level represents total costs. A firm's total costs include both the fixed and variable costs of production. Therefore, the profit function can also be written as:

$$\pi = TR-TC \quad (3)$$

where π is profit, TR is total revenue, and TC is total costs. If total revenue generated covers variable costs, the firm will operate in the short run. In the long run, however, both fixed and variable costs must be recovered for the firm to continue operation.

Three general types of problems are solved by economists: factor-factor, factor-product, and product-product. Factor-factor problems deal with the situation in which two inputs are varied in the production of a single output and

are solved by determining cost minimizing combinations for producing a particular level of output. As long as the cost of the added input is less then the cost of the replaced input and output level remains constant, one unit will be substituted for another. The least-cost level of output is expressed as:

$$\frac{\partial x_{ij}}{\partial x_{rj}} = \frac{P_{xr}}{P_{xi}} \qquad (4)$$

where $\frac{\partial x_{ij}}{\partial x_{rj}}$ is the marginal rate of technical substitution (MRTS) of input X_r for input X_i in the production of output level j, Px_r is the price of input X_r and Px_i is the price of input X_i. In order for the equilibrium condition to be satisfied, the MRTS of X_i for X_r must be declining. In addition, the ratios of the MVP of input X_{rj} to the price of X_r and the MVP of input X_{ij} to the price of X_i are equal.

Factor-product models are used in instances where one input is varied in the production of a single output. Resource supply is constrained so that each input is used in producing output yielding the highest return. The most efficient input mix is least cost and each resource is operating under the law of diminishing returns. Resources will continue to be added up to the point where marginal value product (MVP) equals marginal cost or as long as the additional returns exceed the added costs. The equilibrium condition for this type of problem can be represented as:

$$\frac{\partial Y_j}{\partial x_i} = \frac{Px_i}{Py_j} \qquad (5)$$

where $\frac{\partial y_j}{\partial x_i}$ is the partial derivative of output, Y_j, with respect to input X_i, P_{xi} is the price of the input, and Py_j is the price of output Y_j. In addition, marginal productivity of the ith factor in producing the jth product is decreasing.

The product-product model represents the situation in which a single resource is used to produce two different products. As long as costs remain constant and the value of the added output is greater than the value of the output replaced, one product is substituted for another. This equilibrium condition is represented mathematically as:

$$\frac{\partial y_{ij}}{\partial y_{in}} = \frac{Py_n}{Py_j} \qquad (6)$$

where $\frac{\partial y_{ij}}{\partial y_{in}}$ is the marginal rate of product transformation (MRPT) between products j and n using input base i, Py_n and Py_j are the prices of the two outputs, n and j.

Generalized Equilibrium Condition

Unfortunately, the single factor-factor, factor-product, and product-product problems discussed above are not representative of the problems faced by profit-maximizing producers; real-world problems are much more complex and involve satisfying equilibrium conditions in which all factors are variable. Generalized equilibrium conditions for the multiple factor, multiple product case are

1. $\frac{\partial X_{ij}}{\partial X_{rj}} = \frac{Px_r}{Px_j}$ for all i and r (7)

2. $\frac{\partial y_j}{\partial x_i} = \frac{Px_i}{Py_j}$ for all i and j (8)

3. $\frac{\partial Y_{ij}}{\partial Y_{in}} = \frac{Py_n}{Py_j}$ for all j and n (9)

When resources are limited, they are used in producing outputs that will yield the greatest return. In equilibrium, the marginal value product of the variable resources will equal resource price and the marginal value product of the fixed resources equals the opportunity cost of the resource.

Applications to Farm Management

As decision makers, farm managers must allocate resources among a number of production alternatives. There is an abundance of production activities that the operator/manager can consider and the possible input combinations are endless. When more than a few first-order conditions exist for a profit maximization, obtaining a mathematical solution becomes a complicated and burdensome task. Farm managers and agricultural economists use budgeting and linear programming techniques to make this task manageable. Continuous production functions, such as the one presented in equation one, are estimated by the different production processes represented in several enterprise budgets. Linear programming can then be used to select the enterprise combination which achieves the operator's objectives. The linear programming process is applied to the separate processes described in the enterprise budgets.

Budgeting

Budgeting is a technique for forward planning and is often used to select the most profitable plan from a number of alternatives and to test the profitability of a proposed change in a plan. It uses principles of economic theory, farm records, and price expectations to devise a physical and financial plan for a farm operation for some specified period of time in the future (Casey, Jobes, and Walker, 1977). Budgeting can help the manager save time, improve

decision-making, and increase profitability; however, a budget is only as good as the information used to develop or modify it. The validity of a budget depends on how accurately it defines the producer's goals, inventories available resources, and estimates production coefficients. Uncertainty of price and yield information may require frequent budget modification.

Schaffner (1980) identified six steps in the budgeting process. These steps are

(1) Appraisal of farm goals and objectives
(2) Inventory of farm resources
(3) Selection of enterprises to be budgeted
(4) Selection of physical data to be used in the production process
(5) Selection of prices to apply to the physical data
(6) Calculation of anticipated costs and returns.

Several types of budgets are typically used by managers, each of which is designed to analyze a particular size and type of planning problem. Three important budgeting methods are enterprise budgeting, partial budgeting, and whole farm planning and budgeting.

An enterprise budget is a listing of all estimated income and expenses associated with a specific enterprise to provide an estimate of its profitability. Enterprise budgets can be developed for every actual or potential enterprise in a farm plan. Calculations in the enterprise budgets are typically made on a per unit basis, such as one acre for crops or one head for livestock. This single unit basis permits easier comparisons of profit for alternative and competing enterprises.

Partial budgeting is intermediate in scope between enterprise budgeting and whole farm planning and is used to calculate the expected change in profit for a proposed change in the farm business. Partial budgeting is a type of marginal analysis, as it analyzes small changes in the whole farm plan.

Typically, three types of modifications are evaluated using partial budgets: enterprise substitution, input substitution and level, and changes in the size or scale of operation. A partial budget contains only those income and expense items which will change if the proposed modification is implemented; total values are not included. The final result is an estimate of the gain or loss in profit.

A whole farm plan is an outline for the organization of the resources available on a given farm. When anticipated costs and returns are combined with the plan, a whole farm budget is generated. This budget represents a detailed physical and financial plan for the organization and operation of the total farm business. The planning step involves taking an inventory of the available resources and organizing the resources into a plan that best meets the producer's goals and objectives. Then, total costs and returns for the whole farm plan can be estimated and organizing them into a whole farm budget.

Although budgeting is a useful tool in farm planning, it does have several limitations. First, any budget's value depends on the accuracy of the data used. Inaccurate price or production data will generate distorted profitability estimates. Second, inferences drawn from one budget may not be applicable to other farms with different resources. Third, unless a budget is specifically formulated for a farm, it may not represent any one farm. Finally, comparisons are meaningful only when soils, weather conditions, cultural practices, timing, etc. are similar. Budgets can, however, provide basic information which a manager can modify to fit an individual farm.

Linear Programming

Kay (1981) defines linear programming as a procedure for maximizing or minimizing a linear objective function subject to linear constraints. It is a systematic method of selecting the most profitable farm plan from a vast number

of possible solutions (Beneke and Winterboer). The essential characteristics of a linear programming problem are

(1) a function or objective to be maximized or minimized
(2) limited resources to be used in the satisfaction of this objective
(3) numerous means available for using these resources.

In summation notation, the linear programming model can be written as

$$\max Z = \sum_{c=1}^{n} c_j X_j \qquad (10)$$

such that

$$\sum_{j=1}^{n} a_{ij} X_j < b_i \quad \text{for all } i=1,...,m \text{ resources}$$

and

$$X_j > 0 \qquad \text{for all } j=1,....,n \text{ activities}$$

where Z is the objective, c_j is the forecasted gross margin of a unit of the jth activity, x is the level of the jth activity, a_{ij} is the quantity of the ith resource required to produce one unit of the jth activity, b_i represents the amount of the ith resource available, m is the number of resources available, and n is the number of production activities considered in the model. The primal linear programming problem is to find the farm plan that has the largest possible gross margin without violating any resource constraints or involving negative activity levels.

Theoretically, any goal of the operator that can be expressed numerically can be the objective function for a linear programming model; the typical objective function for farm management problems, however, is profit maximization subject to constraints and factor limitations. There are four types of activities in linear programming models: production activities, resource

supply activities, product marketing activities, and transfer activities. Production activities refer to those processes that utilize various resources to generate physical outputs. Examples include the farrowing and feeding of market hogs and corn production on loam land. Resource supply activities are used to acquire additional inputs and make them available for use in the production process, and include such activities as hiring labor, purchasing feed, borrowing capital, or renting additional land. Marketing activities are included to sell the products or commodities produced by the production processes, and include such a transactions selling corn, cattle, or other specific commodities. Transfer activities transfer resources or commodities from one constraint to another. Restrictions may reflect physical constraints, institutional limitations, or operator preferences and may force maximums, minimums, or equalities.

A number of assumptions about the production process, the resources, and the activities are implicit in the linear programming model (Hazell and Norton):

(1) Optimization. An appropriate objective function is either maximized or minimized.

(2) Fixedness. At least one constraint has a nonzero right hand side coefficient.

(3) Finiteness. There are only a finite number of activities and constraints considered so that a solution can be obtained.

(4) Proportionality. The gross margin and resource requirements per unit of activity are constant regardless of the level of the activity used.

(5) Divisibility. Resources can be used and activities produced in quantities that are fractional units.

(6) Homogeneity. All units of the same resource or activity are identical.

(7) Additivity. The total amount of resources used by two or more processes must be the sum of the amount of resources used by each process. Thus, no interaction effects between activities are permitted.

(8) Determinism. All c, a, and b coefficients are known with certainty. This assumption eliminates the important dimension of risk from liner programming analysis.

Modifications of the linear programming model are useful in increasing the model's flexibility without violating these assumptions. The linearity between inputs and outputs can be relaxed in modeling the production of individual crop or livestock products by incorporating several activities which, taken together, provide a piecewise linear approximation to nonlinear relationships. Activities can also be defined to represent mixed enterprises, such as intercropping, to relax the additivity requirement and allow joint production and complementary or supplementary relationships between enterprises. The fixedness assumption can be relaxed through dynamic multiperiod specifications which allow for farm growth and changes in resource constraints over time.

Variations of mathematical programming are also useful in relaxing the basic assumptions of linear programming. Integer and mixed integer programming relax the divisibility assumption and are used in problems requiring that solutions use or produce quantities in whole, not fractional, units. Parametric programming is used in sensitivity analysis and allows any of the model's a, b, or c coefficients to be varied systematically to obtain a sequence of optimal solutions. Nonlinear programming is used in situations in which the objective function or constraints are not linear and the firm faces increasing or decreasing returns to scale.

In agriculture, linear programming is commonly used in selecting the optimal organization of enterprises for a farm. A production possibilities frontier

is formed as the program "bumps into" the various linear resource constraints. The frontier bounds the region of feasible solutions. Points along the production possibility frontier are analyzed to find the optimal solution. The optimal combination of enterprises is where the isorevenue line is tangent to the frontier, which usually occurs at a corner on the production curve. This optimal solution is subject to changes in technical efficiency and/or relative revenues in each enterprise. Therefore, the input constraints that limit production can also change.

Although linear programming is a powerful tool for solving farm management problems, it does have its limitations. First, linear programming cannot help the manager determine what prices to expect in the future or what the physical production relationships will be on his or her farm. Accurate constraint and resource identification may be difficult and can limit the validity of the solution. As previously mentioned, linear programming does not include elements of risk in the farm planning process, nor can it handle relationships that involve decreasing costs. Linear programming also requires considerable time for model construction and interpretation.

CHAPTER III

PROCEDURES

Typical Farm Development

Using data from the 1982 Census of Agriculture, Schones (1989) developed typical farms for eight regions in Oklahoma. Identification of these regions was based on soil survey information and crop production patterns. Within each region, these representative farms were developed for three sizes of operation. For each farm size, three alternative land resource combinations were examined: operations with pasture land only, operations with pasture and nonirrigated cropland, and operations with pasture, dryland, and irrigated cropland. These representative farms identified the average number of acres of each land type (pasture, dryland, or irrigated) per farm as well as the total acreages utilized by all farms of that size in a particular region.

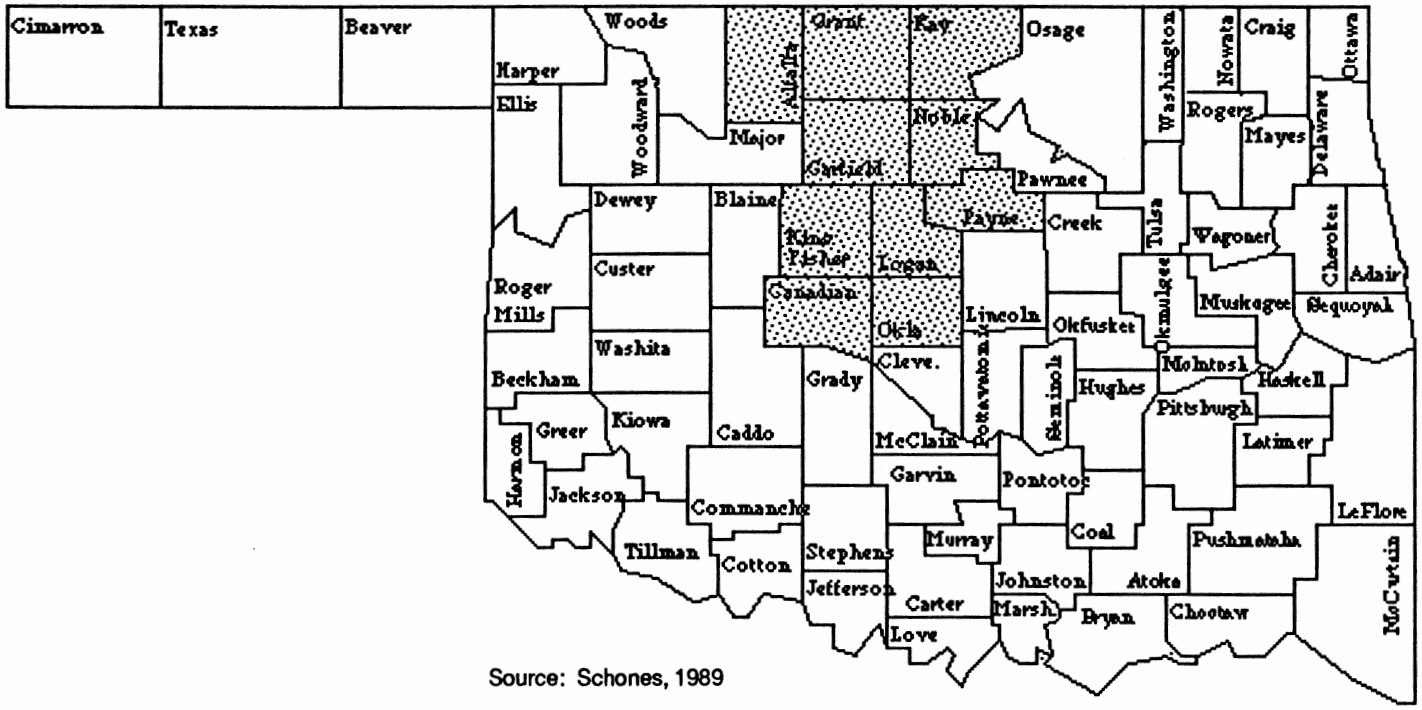
For farms with irrigated and/or nonirrigated cropland, these acreages were further allocated among crop enterprises typically produced in that region. Using Oklahoma Agricultural Statistics from years 1983 through 1986, each crop was characterized by acres planted per farm, acres harvested per farm, and average yield per acre. Although livestock inventories per farm were also included in the typical farm descriptions provided by Schones, these inventories were limited to beef cattle. This is because neither the Census of Agriculture nor Oklahoma Agricultural Statistics report the information needed to derive per farm sheep and swine statistics.

Although Schones (1989) defined typical farms for several regions in Oklahoma, this study incorporated only those farms developed for the northcentral portion of the state. This area is illustrated in Figure 7 and includes the following ten counties: Alfalfa, Canadian, Garfield, Grant, Kay, Kingfisher, Logan, Noble, Oklahoma, and Payne. While Schones identified farms with three alternative land resource combinations, this research only considered operations with pasture and dryland acreages. Generally, these operations were the most numerous of the three alternatives presented by Schones and were therefore regarded as the most representative. The typical farms developed by Schones and used in this study are shown in Table 13.

Resource Restrictions

The representative farms developed by Schones were instrumental in defining the benchmark farms used in this research. While these typical farms provided useful information about land resources and production enterprises characteristic to farms in northcentral Oklahoma, additional assumptions regarding capital and labor availability were required. Extension personnel, area farm management specialists, and others familiar with agriculture in northcentral Oklahoma were especially helpful in defining these additional resource limitations.

Land resources available to the small, medium, and large size farms used in this work were derived directly from the typical farms identified by Schones (1989). The small typical farm in northcentral Oklahoma consisted of 82 acres of nonirrigated cropland and no pasture. The typical medium size operation in this area was comprised of 323 acres of dryland and 152 acres of pasture, while the large farm consisted of 1,111 acres of dryland and 641 acres of pasture.



Source: Schones, 1989

Figure 7. Study regions used to determine typical farms

TABLE 13

TYPICAL FARMS IN NORTHCENTRAL OKLAHOMA

A. Small Size Farms

	Number	Acres	Total Acres
Farms	2783		
Dryland		82	227872
Pasture		0	334
Total		82	

Type of Livestock	Number
Cows	0
Bulls	0
Strs 500+	2
Hfrs. 500+	2
Calf <500	7

	Acres Planted	Acres Harvested	Yield
Wheat	71	48	34.0
Sorghum	1	1	44.2
Alfalfa	2	2	3.4
Hay	5	5	1.9
Cotton	0	0	0.7
Peanuts	0	0	1255.2
Corn	0	0	86.2
Soybeans	0	0	20.2
Oats	1	0	45.8
Barley	1	1	42.9
Total	82	58	

B. Medium Size Farms

	Number	Acres	Total Acres
Farms	3770		
Dryland		323	1216986
Pasture		152	573764
Total		475	

Type of Livestock	Number
Cows	16
Bulls	2
Strs 500+	12
Hfrs. 500+	11
Calf <500	27

	Acres Planted	Acres Harvested	Yield
Wheat	280	189	34.0
Sorghum	6	4	44.2
Alfalfa	10	10	3.4
Hay	20	20	1.9
Cotton	0	0	0.7
Peanuts	0	0	1255.2
Corn	0	0	86.2
Soybeans	0	0	20.2
Oats	3	2	45.8
Barley	3	2	42.9
Total	323	228	

TABLE 13 (Continued)

B. Large Size Farms

	Number	Acres	Total Acres
Farms	1112		
Dryland		1111	1235012
Pasture		641	713212
Total		1752	

Type of Livestock	Number
Cows	67
Bulls	7
Strs 500+	44
Hfrs. 500+	41
Calf <500	92

	Acres Planted	Acres Harvested	Yield
Wheat	964	651	34.0
Sorghum	20	15	44.2
Alfalfa	33	33	3.4
Hay	69	69	1.9
Cotton	1.2	1.1	0.7
Peanuts	0.1	0.1	1255.2
Corn	1.4	0.8	86.2
Soybeans	1.2	1.0	20.2
Oats	10.5	5.7	45.8
Barley	9.6	7.1	42.9
Total	1111	784	

Source: Schones, 1989

Although irrigation systems are used by many Oklahoma farmers, irrigated cropland was not a resource included in this study. Furthermore, no land purchases or rental arrangements were permitted.

Capital constraints and costs were classified as operating, intermediate, and long-term. Owner-provided operating capital was restricted to $10,000, while intermediate capital furnished by the owner was limited to $25,000. These figures were arbitrarily selected, but are similar to the values used by Doye (1981) in a study analyzing the feasibility of sheep production in this area.

Although operating and intermediate equity capital were constant over the three farm sizes examined, the amount of long-term capital furnished by the operator was dependent upon the acres of cropland and pasture available, the value per acre of both cropland and pasture in northcentral Oklahoma, and the size of operation. Land availability was based on the dryland and pasture constraints identified above. Kletke estimated the value of nonirrigated cropland in the northcentral portion of the state to be $780 per acre, while pasture was valued at $280 per acre. Using these estimates, total land investments of $63,140, $289,750, and $1,028,540 were determined for the small, medium, and large farms, respectively.

Lloyd provided estimates of percent owner equity in land for three sizes of operation in northcentral Oklahoma. Farms with less than 100 total acres of land averaged 90 percent equity in the land they farmed, while owner equity in land for operations with approximately 500 acres was estimated to be 80 percent. Large farms with more than 1,000 acres were expected to have about 50 percent equity in their land. Applying these percentages to the total land investment estimates for each farm size yielded the numerical values used to constrain long-term equity capital. Consequently, long-term capital provided by

the owner was restricted to $59,983 for the small farm, $246,288 for the medium farm, and $514,270 for the large farm.

Borrowed capital was also included in the resource base for these benchmark farms. Operating and intermediate capital could be borrowed at 12.0 percent interest, while additional long-term capital was available at 11.0 percent interest. Unlike owner-provided capital, borrowed capital was not restricted by an actual dollar value; instead, it was limited by a debt-to-asset ratio. Borrowing was permitted up to a prespecified debt-to-asset level. For each farm, separate models incorporating three different leverage ratios were used to analyze the impact of alternative levels of borrowed capital on farm organization and profitability. In the first scenario, borrowing was unconstrained. Although a debt:asset ratio of 1.0 was used in this scenario, this ratio did not limit the amount of capital that could be borrowed. Since equity capital was also included in the resource base for these farms, a leverage ratio of 1.0 was unattainable; therefore, the debt-to-asset ratio of 1.0 was not constraining.

The second scenario allowed borrowing to occur until a debt:asset ratio of 0.8 was reached. This debt-to-asset level permitted the farm to maintain a low equity/high debt status by allowing considerable borrowing against assets. The final scenario incorporated a debt-to-asset ratio of 0.3 into the model. Although this situation did allow borrowing to occur, this activity was limited within a debt to asset ratio of 0.30 in order to maintain a relatively high level of equity in farm assets.

In addition to the three borrowed capital scenarios presented above, two alternative operator labor scenarios were included for each farm size to determine the impact of varying the hours of unpaid labor on farm profitability and organization. Under the part-time operator labor scenario, 104 hours of

labor per month was available at no cost. A full-time owner-operator was assumed to provide 208 hours of unpaid labor per month, or 2,496 hours annually.

Small and medium farms could hire an additional 173 hours of labor, the equivalent of a second full-time worker, for $4.50 per hour. Large farms could hire up to 346 hours of labor per month, or two full-time persons at the same wage rate. For all farm scenarios where labor was a limiting resource, the hired labor constraint was also relaxed and changes in the optimal farm plan were evaluated. The resource bases for the small, medium, and large farms are summarized in Table 14.

Enterprise Selection

Selection of the crop enterprises in these benchmark farms was based largely upon the typical farms developed by Schones (1989). Schones allocated cropland on these typical farms among all crops characteristically produced in northcentral Oklahoma; therefore, Schones results yielded crop acreages that were typical, but not necessarily representative of actual production practices. For example, a farmer with 1,100 acres of dryland is not likely to include 1.2 acres of cotton, 1.4 acres of corn, 0.1 acres of peanuts, and 1.2 acres of soybeans in his production schedule, even though such acreages are considered "typical" for large farms in that area.

Wheat, sorghum, and alfalfa were the three crop enterprises that comprised the most dryland acres planted on the typical farms described by Schones. Together these enterprises accounted for 90 percent of the production on nonirrigated cropland on the small farm, as compared to 92 percent on both the medium and large size farms. These three crop enterprises

TABLE 14

SUMMARY OF RESOURCE RESTRICTIONS FOR SMALL, MEDIUM, AND LARGE BENCHMARK FARMS

	Small	Medium	Large
Land (acres)			
dryland	82	323	1111
pasture	0	152	641
Operator Labor (hrs./mo.)			
part-time	104	104	104
full-time	208	208	208
Hired Labor (hrs./mo.)	173	173	346
Owner-Provided Capital (dollars)			
operating	10,000	10,000	10,000
intermediate	25,000	25,000	25,000
long-term	59,983	246,288	514,270
Borrowed Capital (D/A ratio)			
unconstrained	1.0	1.0	1.0
high equity	0.3	0.3	0.3
low equity	0.8	0.8	0.8

competed directly for the dryland resources available to the small, medium, and large benchmark farms used in this study.

Native hay, native pasture, Bermuda hay, and Bermuda pasture were the production activities selected for consideration on the pasture land available to the medium- and large-size operations. No pasture was available to the small benchmark farm, therefore, these hay and pasture enterprises were allowed to compete directly with wheat, sorghum, and alfalfa for nonirrigated cropland resources. Selection of these hay/pasture activities was based on widespread production across northcentral Oklahoma as determined by O.S.U. extension personnel and was independent of the typical farm definitions provided by Schones.

Like the pasture and hay production activities, the selection of livestock activities used in this study was based on known production habits, rather than the livestock inventories determined by Schones. Although these inventories are useful in estimating the average number of beef cattle on a typical farm in northcentral Oklahoma, they provide little information about the types of livestock enterprises characteristically found on farms in this area. Oklahoma agriculture is known for its cow-calf and stocker cattle operations; therefore, four cattle enterprises were incorporated into the benchmark farms. Cow-calf operations utilizing native pasture were included for both spring and fall calving alternatives. A stocker steer enterprise, as well as a stocker heifer enterprise, was also included for wheat pasture grazing from November through mid-March. No sheep, dairy, poultry, or horse enterprises were considered.

Eleven swine enterprises were also incorporated into the problem framework and allowed to compete directly with other production enterprises for land, labor, and capital resources. These enterprises considered three systems of swine production: farrow-to-finish operations, feeder pig production

operations, and swine feedlot operations. Additionally, these eleven budgets included the opportunity for both confinement and pasture production, as well as on-farm feed processing or purchasing prepared rations.

A farrow-to-finish operation covers all facets of swine production from breeding to the sale of finished hogs for processing. Although farrow-to-finish operations require considerable management skills and capital investment, they typically are more efficient in terms of labor and production than the two other systems considered. Three sizes of farrow-to-finish operations were included in this study: 40-sow, 90-sow, and 140-sow. The 40-sow system was a pasture operation, while both the 90- and 140-sow systems were confinement operations. Pasture operations substitute labor for capital in the production process at the expense of output and productive efficiency. Confinement operations require a substantially higher capital investment, but use less labor and produce output more efficiently than do pasture arrangements. Pasture operations also demand more land than confinement operations: twelve acres for a 40-sow pasture unit as compared to seven acres and five acres for the 90- and 140-sow units, respectively (Table 15). All three sizes of operation were permitted to either purchase prepared rations or process feed on-farm; therefore, six alternative farrow-to-finish enterprises were included.

Feeder pig production includes swine production from breeding to the marketing of forty pound feeder pigs. Although this enterprise does require expertise in marketing and animal husbandry techniques, it does not require the investment in time that is necessary for a farrow-to-finish operator since it does not include the finishing phase of slaughter hog production. Two feeder pig production alternatives were included in this study: a 40-sow pasture operation and a 90-sow confinement operation. The advantages and disadvantages of pasture versus confinement farrow-to-finish operations are also applicable to

TABLE 15

LAND RESOURCE REQUIREMENTS

Enterprise	Acres Required
40-sow farrow-to-finish or feeder pig production (pasture)	12
90-sow farrow-to-finish or feeder pig production (confinement)	7
140-sow farrow-to-finish (confinement)	5
Pasture feedlot	1
Confinement feedlot	2

Source: Huhnke, 1989

feeder pig production. Furthermore, land requirements for the 40- and 90-sow feeder pig production operations are identical to those for the 40- and 90-sow farrow-to-finish enterprises. However, no on-farm feed processing was permitted for either feeder pig production enterprise; all feed was purchased.

Feedlot operations involve the purchase of feeder pigs, finishing these pigs to a slaughter hog weight, and marketing finished hogs to processors. This enterprise demands considerable knowledge in feeding and marketing strategies, but does not require the animal husbandry skills necessary in the farrow-to-finish and feeder pig production enterprises. Finishing pig operations require less labor than either the farrow-to-finish or feeder pig production operations, a characteristic that may be advantageous if labor resources are restricted. Finishing operations with both a 900- and 1500-head annual capacity were included in this study. The 900-head capacity unit was a pasture-dirt lot operation, while the 1500-head unit was a total confinement system. The trade-offs between labor, capital, and efficiency in confinement versus pasture feedlot operations are similar to those in both the farrow-to-finish and feeder-pig production enterprises; however, pasture finishing operations require one acre of land as compared to the two acres necessary for the confinement feedlot (Table 15). Both the pasture and confinement feedlot operations were allowed to either purchase pre-mixed rations or process feed on the farm. Therefore, a total of four swine feedlot budgets were included in this study.

In summary, twenty-two crop and livestock enterprises were incorporated into the small, medium, and large farm models used in this study: three crop enterprises, four hay/pasture enterprises, and fifteen livestock enterprises. A list of these production activities is presented in Table 16.

TABLE 16

SUMMARY OF ENTERPRISES CONSIDERED IN BENCHMARK FARM ANALYSIS

Crop Enterprises
Wheat
Sorghum
Alfalfa
Hay and Pasture Enterprises
Native hay
Bermuda hay
Native pasture
Bermuda pasture
Livestock Enterprises
Cow-calf operation on native pasture - spring calving
Cow-calf operation on native pasture - fall calving
Stocker steers on wheat pasture (November through March)
Stocker heifers on wheat pasture (November through March)
40-sow farrow-to-finish operation - feedmill included
40-sow farrow-to-finish operation - all rations purchased
90-sow farrow-to-finish operation - feedmill included
90-sow farrow-to-finish operation - all rations purchased
140-sow farrow-to-finish operation - feedmill included
40-sow feeder pig production - all rations purchased
90-sow feeder pig production - all rations purchased
Pasture swine feedlot - feedmill included
Pasture swine feedlot - all rations purchased
Confinement swine feedlot - feedmill included
Confinement swine feedlot - all rations purchased

Budget Selection and Modification

Enterprise budgets developed by O.S.U. research and extension personnel were selected for the twenty-two crop, hay, and livestock activities identified above. Crop and hay budgets were selected from those developed specifically for operations in northwestern Oklahoma, and reflect not only the types of machinery and tillage practices used by producers in the area, but also operating input requirements and anticipated yields. These budgets were developed to represent farms in the northwest portion of the state, including the Panhandle. Generally, farms in the western and Panhandle portions of Oklahoma are much larger than those in the central and eastern areas of the state. Therefore, input and production data varies considerably across this region of Oklahoma. Although these budgets developed for northwestern Oklahoma may not be realistic of production for some of the farms in the northcentral portion of the state, Lloyd and other extension staff in the area held them to be satisfactorily representative of the production techniques and yields for the region as a whole. Therefore, these budgets were included without modifications to the data in either the machinery and equipment or the production and yield sections of the budget.

No irrigated cropland was included in the resource base for the benchmark farms in this study; hence, only budgets for dryland production of wheat, sorghum, and alfalfa were selected. Likewise, no irrigated pasture or hay budgets were included. Although many producers in northcentral Oklahoma own and maintain the machinery and equipment necessary to harvest and transport the crops they produce, an equal number of farmers in this area elect to hire custom crews to perform these services for them (Lloyd). The wheat, sorghum, and alfalfa budgets used this study reflected the costs associated with

hiring custom harvest and hauling crews; no budgets incorporating owned harvest equipment were used.

The cow-calf and stocker enterprise budgets selected for this study were developed for use by beef producers statewide and reflect production practices and standards used by Oklahoma producers in their operations. The cow-calf enterprise budgets used in this study identified the necessary operating inputs and anticipated outputs of cow-calf production on warm season pasture and non-legume hay. Two such cow-calf enterprises were considered: one in which calves are born in early spring (February or March) and sold in September and one in which calves born in early fall (September or October) are sold in May. The stocker heifer and stocker steer enterprise budgets involve buying 4-500 pound calves in November, grazing them on wheat pasture through the winter, and selling 6-700 pound animals in March.

Like the beef cattle budgets, the eleven swine budgets used in this research were also developed for use by hog producers across Oklahoma. The production standards implicit in these budgets are presented in Table 17 and are believed to be representative of those standards adopted by many Oklahoma producers. For the farrow-to-finish and feeder pig enterprises, separate budgets were included in the model to permit either on-farm feed processing or feeding purchased rations. Farrow-to-finish and feeder pig production budgets were calculated on a per-sow basis and reflected continuous production and marketing throughout the year. Finishing pig operations completed three production cycles per year for a total annual capacity of 900- or 1500-head, depending upon the system considered.

All budgets were modified to reflect average prices received over a five-year period from 1984 to 1988. Wheat and sorghum prices represented a five-year average of the target prices received by farmers participating in

TABLE 17

SUMMARY OF PRODUCTION ASSUMPTIONS FOR THREE HOG PRODUCTION SYSTEMS[a]

Production Assumption	Unit	Production System: Confinement 140-Sow	Confinement 90-Sow	Pasture 40-Sow
Conception rate				
gilts	pct.	80	80	75
sows	pct.	90	90	80
Pigs weaned	no./1 tr.	7.93	7.93	7.46
Litters/sow	no./yr.	2.42	2.17	2.0
Death loss[b]	pct.	2.0	2.0	2.0
Production				
sales[c]	cwt	44.82	40.27	35.29
net[d]	cwt	44.67	40.12	35.14
mkt. animals	cwt	41.68	37.50	32.27
Feed consumption	cwt	170.05	152.60	140.4
Feed conversion	lb. feed/ lb. gain	3.8	3.8	4.0
Labor requirements	hrs.	22.0	28.0	35.0

a figures are based on a sow unit
b post-weaning
c includes culled breeding stock
d gross sales wt. - wt. of purchased stock

government programs. The price of wheat used in this research was calculated to be $4.35 per bushel, while the price of sorghum used was $2.86 per hundredweight. Hay prices represented a five-year average of the prices used in the O.S.U. enterprise budgets. The average price of alfalfa was determined to be $65.00 per ton, while Bermuda and native hay had an average value of $48.00 and $46.00 per ton respectively.

Generally, cattle prices reflected the five-year average price received by Oklahoma producers as quoted by the Oklahoma Crop and Livestock Reporting Service. For livestock prices not directly quoted by this agency, an average of the prices used in the O.S.U. enterprise budgets was used. Steers weighing 4-500 pounds averaged $81.00 per hundredweight as compared to $69.00 per hundredweight received for 4-500 pound heifers. The prices paid for steer and heifer calves for stockers were $82.00/hundredweight and $70.00 per hundredweight, respectively.

Producers received an average price of $64.00 per hundredweight for 6-700 pound heifers and $69.00 per hundredweight for 6-700 pound steers. Culled cows averaged $40.00 per hundredweight and aged bulls brought an average price of $49.00 per hundredweight.

Slaughter hog and feeder pig prices used in the budgets reflected a five-year average of the prices received by producers as reported in Oklahoma Agricultural Statistics for years 1984 through 1988. These prices were calculated to be $48.00 per hundredweight for slaughter hogs and $75.00 per hundredweight for feeder pigs. $76.00 per hundredweight was paid for feeder pigs purchased for the finishing pig operations. Price for non-breeder gilts, sows, and boars were derived as a proportion of the average slaughter hog price using percentages determined by Plain (1981). Plain concluded that gilt, sow, and boar prices were approximately 95, 80, and 65 percent respectively of

the average slaughter hog price. Therefore, the price per hundredweight received for non-breeder gilts was calculated as $43.00 versus $41.00 per hundredweight for sows and $31.00 per hundredweight for boars.

The feed prices used in the swine enterprise budgets estimate the average price paid by producers from 1984 to 1988 as determined by direct price quotes from feed processors located in the study region. Hog producers purchasing prepared rations paid an average per hundredweight price of $8.60 for both farrowing and finishing rations, $8.65 for sow-boar ration, $9.10 for grower ration, and $11.70 for starter ration. For producers that elected to process feed on-farm, the average price paid for protein supplement was $10.40 per hundredweight. Grain sorghum not produced on the farm and transferred into the swine enterprise could be purchased for $3.00 per hundredweight - slightly more than the price received from milo production.

Machinery, equipment, and livestock labor was priced at $4.50 per hour in all budgets used in this research. This value was included as the default value for all O.S.U. enterprise budgets, but was anticipated to cover the minimum wage require by law plus all employment taxes and workers compensation plans. Operating and intermediate capital was available at 12.0 percent interest, while long-term capital was available at 11.0 percent interest. Although the percentages used in the budgets incorporated into this study were slightly higher than the five-year average of interest rates used in the enterprise budgets they more accurately represented the actual borrowing environment faced by northcentral Oklahoma producers. The prices of other operating inputs in the budgets used in the research were equal to those included as default values in the state price vector.

A summary of all product prices used in the enterprise budgets is shown in Table 18, while input prices are summarized in Table 19. All enterprise budgets used in this study are presented in Appendices A and B.

Development of Linear Programming Models

Two objectives of this study were to determine the conditions under which the adoption of swine enterprises would improve additional returns to farms in northcentral Oklahoma and to determine the sensitivity of optimal farm plans to changes in resource and product prices. Three separate programming routines were designed to systematically accomplish these objectives by:

(1) determining the optimal farm organization for a given set of resources when swine enterprises are not among the crop and livestock activities considered,

(2) determining which swine enterprise, if any, would enter the optimal farm plan given the same set of resources, and

(3) determining the sensitivity of such a plan to changes in input and product prices.

The initial linear programming model was designed to provide information about the crop and livestock enterprises that would be undertaken for a given set of resource restrictions and input/output prices. The solutions generated from this base run also provided information about the assets required for production on typical farms and the implicit ownership costs associated with these assets. This information was used in successive runs to reflect the fixed costs already incurred regardless of what enterprises are produced or if production even occurs.

For each of the three farm sizes examined, two solutions were generated using the part-time and full-time operator labor restrictions described earlier in

TABLE 18

SUMMARY OF PRODUCT PRICES USED
IN ENTERPRISE BUDGETS

Product	Unit	Price ($)
Steer calves (4-500 lbs.)	cwt	81.00
Heifer calves (4-500 lbs.)	cwt	69.00
Culled cows	cwt	40.00
Aged bulls	cwt	49.00
Heifers (6-700 lbs.)	cwt	64.00
Steers (6-700 lbs.)	cwt	69.00
Market hogs	cwt	48.00
Non-breeder gilts	cwt	43.00
Sows	cwt	41.00
Boars	cwt	31.00
Feeder pigs	cwt	75.00
Wheat	bu	4.35
Sorghum	cwt	2.86
Alfalfa	ton	65.00
Native hay	ton	46.00
Bermuda hay	ton	48.00

TABLE 19

SUMMARY OF INPUT PRICES USED IN ENTERPRISE BUDGETS

Input	Unit	Price
Steers (4-500 lbs.)	cwt	82.00
Heifers (4-500 lbs.)	cwt	70.00
Feeder pigs	cwt	76.00
Farrowing ration	cwt	8.60
Sow-boar ration	cwt	8.65
Grower ration	cwt	9.10
Finishing ration	cwt	8.60
Starter ration	cwt	11.70
41-45% protein supplement	cwt	10.40
Grain sorghum	cwt	3.00
Labor	hr	4.50
Interest rate		
operating & intermediate	pct	12.0
long-term	pct	11.0
Gasoline	gal	0.94
L. P. Gas	gal	0.70
Diesel	gal	0.85
Electricity	kwh	0.03
Natural gas	cu. ft.	2.25

his chapter. Therefore, six solutions were produced in this initial round of programming. For all farms sizes and levels of operator labor considered, an unlimited amount of borrowed capital was available.

Three crop, four hay/pasture, and four beef cattle enterprises were included in these base linear programming runs. These thirteen production activities required fourteen marketing activities for buying inputs and selling products. One transfer activity was also incorporated to allow the transfer of native hay from the production activity to the livestock enterprises. Additional activities were included to allow short-, intermediate-, and long-term borrowing, as well as hiring labor in the twelve monthly labor periods specified.

Resource restrictions comprised twenty-nine rows in the initial models: two land resource restrictions, twelve operator labor constraints, twelve hired labor constraints, and three capital restrictions. Transfer rows permitting the transfer of outputs from production activities to corresponding buy, sell, or on-farm usage activities accounted for an additional eleven rows. An equality constraint was used to force in the debt and equity levels associated with land ownership. Four more rows were used to make debt, asset, equity, and objective function information readily visible in the printed solution.

Information specified in the enterprise budgets and resource base assumptions were used to construct six matrices of sixty rows and forty-four columns. These matrices were constructed on a personal computer using a Lotus 1-2-3 spreadsheet and then transferred to the mainframe computer. The Mathematical Programming Solutions Extended (MPSX) algorithm was used to maximize the objective function given the resource constraints described previously. In this study, the objective function to be maximized was returns above all costs except overhead, risk, management and unpaid operator labor. The solutions generated described the optimal production processes on base

farms where swine enterprises were not considered and served as the standard of comparison for the two following linear programming runs.

The second series of runs was designed to determine if swine production was feasible given the set of resources available to the typical farms initially used. To accomplish this, a second set of matrices were constructed that included a "fixed" activity which forced in the asset and fixed cost information provided in the first set of solutions. Eleven swine enterprises and the six supporting buy/sell activities were added to the original matrix, as were five accounting rows required to transfer swine output from the production activities to the appropriate marketing activities. Mixed integer programming was used to determine whether or not swine production was feasible given a specified resource base and, if so, which one of the eleven swine enterprises would appear in the optimal farm plan.

Twelve scenarios permitting two additional levels of borrowed capital were added to the initial six unconstrained borrowed capital scenarios. Six of these significantly limited borrowing in order to maintain a high equity/low debt status. The remaining six permitted considerable borrowing against farm assets by allowing a debt:asset ratio of 0.80. Finally, additional runs were included that relaxed the hired labor constraints for any size farm in which labor was a limiting resource. In all, twenty-four additional matrices were constructed, bringing the total number of scenarios examined to thirty. Table 20 lists these thirty different scenarios representing three farm sizes, two levels of operator labor, three levels of borrowed capital, two levels of hired labor, and two sets of crop and livestock enterprises.

The final series of runs was engineered to determine the sensitivity of optimal farm plans to changes in prices and resource availability. This required changing the cards controlling the linear programming routine and modifying

TABLE 20

FARM RESOURCE AND ENTERPRISE SCENARIOS USED TO EXAMINE THE FEASIBILITY OF SWINE PRODUCTION IN NORTHCENTRAL OKLAHOMA

Scenario	Description
A.	Small Size Operations
1.	No swine enterprises. Full-time operator labor. Unconstrained borrowed capital
2.	No swine enterprises. Part-time operator labor. Unconstrained borrowed capital
3.	Swine enterprises. Full-time operator labor. Unconstrained borrowed capital
4.	Swine enterprises. Full-time operator labor. D/A $\leq$ 0.8 (low equity)
5.	Swine enterprises. Full-time operator labor, D/A $\leq$ 0.3 (high equity)
6.	Swine enterprises. Part-time operator labor. Unconstrained borrowed capital
7.	Swine enterprises. Part-time operator labor. D/A $\leq$ 0.8 (low equity)
8.	Swine enterprises. Part-time operator labor, D/A $\leq$ 0.3 (high equity)
9.	Swine enterprises. Part-time operator labor. Unconstrained borrowed capital. Unconstrained hired labor
B.	Medium Size Operations
10.	No swine enterprises. Full-time operator labor. Unconstrained borrowed capital
11.	Swine enterprises. Full-time operator labor. Unconstrained borrowed capital
12.	Swine enterprises. Full-time operator labor. D/A $\leq$ 0.8 (low equity)
13.	Swine enterprises. Full-time operator labor. D/A $\leq$ 0.3 (low equity)
14.	Swine enterprises, Full-time operator labor. Unconstrained borrowed capital.
15.	No swine enterprises. Part-time operator labor. Unconstrained borrowed capital
16.	Swine enterprises. Part-time operator labor. Unconstrained borrowed capital
17.	Swine enterprises. Part-time operator labor. D/A $\leq$ 0.8 (low equity)
18.	Swine enterprises. Part-time operator labor. D/A $\leq$ 0.3 (high equity)
19.	Swine enterprises. Part-time operator labor. Unconstrained borrowed capital. Unconstrained hired labor.
20.	Swine enterprises. Part-time operator labor. D/A = 0.3 (high equity). Unconstrained hired labor
C.	Large Operations
21.	No swine enterprises. Full-time operator labor. Unconstrained borrowed capital

TABLE 20 (Continued)

22. Swine enterprises. Full-time operator labor. Unconstrained borrowed capital
23. Swine enterprises. Full-time operator labor. D/A $\leq$ 0.8 (low equity)
24. Swine enterprises. Full-time operator labor. D/A $\leq$ 0.3 (high equity)
25. Swine enterprises. Full-time operator labor. Unconstrained borrowed capital. Unconstrained hired labor
26. No swine enterprises. Part-time operator labor. Unconstrained borrowed capital
27. Swine enterprises. Part-time operator labor. Unconstrained borrowed capital
28. Swine enterprises. Part-time operator labor. D/A $\leq$ 0.8 (low equity)
29. Swine enterprises. Part-time operator labor. D/A $\leq$ 0.3 (high equity)
30. Swine enterprises. Part-time operator labor. Unconstrained borrowed capital. Unconstrained hired labor

the twenty-four matrices used in the previous set of runs. First, all swine enterprises except the one included in the optimal solution were eliminated from the matrix. Unnecessary marketing activities and accounting rows were also removed from the problem framework. Second, the control cards commanding the integer programming routine, as well as the cards marking integer activities were deleted. Finally, a range card was included in the control card deck to instruct the routine to generate and print the range of prices and resource levels over which the optimal plan was valid.

CHAPTER IV

RESULTS

Small Size Farms

Unconstrained Borrowed Capital and No Swine Production

The initial models for the small size farm in northcentral Oklahoma consist of two matrices, each with 58 rows and 42 columns. One matrix is used to identify the resource scenario when full-time operator labor (208 hours per month) is available; the other matrix defines the situation where only part-time operator labor (104 hours per month) is available. Both matrices allow unlimited borrowing and restrict hired labor to the equivalent of up to one full-time worker. Returns to overhead, risk, management, and operator labor are maximized using MPSX on these stored matrices.

The optimal farm plans obtained for the small size base farms with full-time and part-time operator labor are identical. Returns to overhead, risk, management, and operator labor are $5,479.43, or $70.11 per acre. Only two rows are constrained at upper limit level in the solution: dryland acres and owner-furnished long-term capital.

Shadow prices are listed in the MPSX output for these constrained resources and are presented in Table 21. The marginal value product (MVP) associated with a one unit change in nonirrigated cropland is $87.63. The range over which this value holds is 0.00 to 325.00 acres of dryland. An

TABLE 21

SUMMARY OF MPSX RANGE OUTPUT FOR ROWS AT UPPER LIMIT LEVEL ON SMALL SIZE BASE FARM FULL-TIME OPERATOR LABOR[a]

Row	Unit	Activity level	Range	Shadow price
Dryland	acre	82.00	0.00 - 325.00	$87.63
Long-term Capital[b]	dollar	59,983.00	(-)9,994.30 - 63,140.00	0.11

[a] Solution values are valid for small size base farm with part-time operator labor.

[b] Owner-furnished capital

additional dollar of long-term capital furnished by the owner is worth $0.11. This value holds for long-term capital levels between (-)$9,994.30 and $63,140.00.

The only activity included in the optimal solution for these small size base farms is 82 acres of wheat (Table 22). A total of 205 hours of operator labor is used, leaving almost 2,300 hours in slack. Consequently, no labor is hired in any period during the production cycle. Operator-provided capital levels are $2,311.58 of operating capital, $7,682.72 of intermediate capital, and $59,983.00 of long-term capital. The only outside borrowing that occurs represents land debt; therefore, $3,157.00 of long-term capital is borrowed at 11 percent interest. In this optimal solution, 2,952 bushels of wheat are sold.

Input costs, unit costs, and lower/upper cost ranges for activities not in the solution are also listed in the range output. The input costs represent the value of the activity in the objective function. Therefore, production and purchase activities have negative input costs, marketing activities have positive values, and transfer activities have no costs. Unit costs indicate the change in the objective function value that results from forcing in a unit of an activity not included in the optimal solution, ceteris paribus. The reduced cost associated with activities in the optimal solution is zero. The upper costs show the highest cost of outputs or the lowest price of inputs that permit that activity to be maintained at its current level and status in the optimal plan.

Range output for selected production and sell activities is summarized in Table 23. Input costs per budget unit for production activities in the solution at limit level are: cow-calf, $215.90; alfalfa, $296.50; native pasture, $2.67; sorghum, $49.25; and Bermuda hay, $175.92. Input costs for hired labor, borrowed capital, and buy/sell activities are the prices associated with the purchase and sale of inputs and outputs. The cow-calf enterprise has a

TABLE 22

SUMMARY OF INPUT AND OUTPUT LEVELS IN MPSX
OPTIMAL SOLUTION FOR SMALL SIZE BASE FARM
FULL-TIME OPERATOR LABOR[a]

Activity	Unit	Level
Objective function	dollar	5,749.43
Wheat	acre	82.00
Operator labor	hour	
February		22.14
June		42.64
July		52.48
August		45.92
September		42.64
Hired labor	hour	0.00
Total borrowing	dollar	3,157.00
Wheat Sold	bushel	2,952.00
Debt:Asset Ratio		0.04

[a] Solution values are valid for small size base farm with part-time operator labor.

TABLE 23

SUMMARY OF MPSX RANGE OUTPUT FOR PRODUCTION ACTIVITIES AT LIMIT LEVEL AND SELECTED SELL ACTIVITIES ON SMALL SIZE BASE FARMS[a]

A. PRODUCTION ACTIVITIES AT LIMIT LEVEL

Activity	Unit	Input cost	Unit cost	Upper cost
Cow-calf[b]	head	$(-)215.90	$ 97.44	$(-)118.46
Alfalfa	acre	(-)296.50	172.88	(-)123.62
Native pasture	acre	(-) 2.67	70.09	67.41
Sorghum	acre	(-) 49.25	51.08	1.83
Bermuda hay	acre	(-)175.92	52.35	(-)123.57

B. SELECTED SELL ACTIVITIES

Activity	Unit	Input cost	Upper cost
Steers (4-500#)	cwt	$ 81.00	$ 81.38
Cows	cwt	40.00	331.78
Alfalfa	ton	65.00	118.19
Native hay	ton	46.00	81.72
Sorghum	cwt	2.86	4.56
Steers (6-700#)	cwt	69.00	69.41

[a] Solution values are valid for small size base farm with part-time operator labor.
[b] Fall-calving; 205-day weaning

reduced cost of $97.44; alfalfa, $172.88; native pasture, $70.09; sorghum, $51.08; and Bermuda hay, $52.35.

Small Typical Farms With the Opportunity for Swine Production

Three matrices were constructed for the small sized farm with full-time operator labor available and the opportunity to hire up to one additional full-time worker. These matrices incorporated three alternative levels of borrowed capital: unconstrained borrowing, borrowing constrained to maintain a high equity status, and borrowing constrained to maintain a low equity status. Mixed integer programming was used to determine which swine enterprise would be present in the optimal solution for each scenario. A second run omitting the integer programming routine and including the cards was required to generate the range analysis portion of the output, which was used to determine the sensitivity of the optimal plan to changes in both prices and resource levels. A discussion combining the results of these runs is presented in this section.

Full-time Operator Labor; Unconstrained Borrowed Capital. The optimal solution obtained for the small size farm with full-time operator labor and unconstrained borrowing was identical to the solution for the small size farm in which borrowing was permitted up to a debt:asset ratio of 0.80. Returns to overhead, risk, management, and operator labor are $91,798.56. Several rows are constrained at upper limit level in the optimal solution. These rows represent operator labor in all labor periods, nonirrigated cropland, and owner-furnished intermediate and long-term capital.

Shadow prices for the constrained resources are presented in Table 24. Another acre of nonirrigated cropland is worth $76.33. The range over which

TABLE 24

SUMMARY OF MPSX RANGE OUTPUT FOR ROWS AT LIMIT LEVEL ON SMALL TYPICAL FARM WITH FULL-TIME OPERATOR LABOR AND UNCONSTRAINED BORROWED CAPITAL[a]

Row	Unit	Activity level	Range	Shadow price
Dryland	acre	82.0	7.00 - 200.75	$76.33
Operator labor	hour/mo.			
January, March, April, May, October				
November, December		208.0	84.00 - 257.00	4.50
February		208.0	104.25 - 277.25	4.50
June, September		208.0	123.00 - 296.00	4.50
July		208.0	132.00 - 305.00	4.50
August		208.0	126.00 - 299.00	4.50
Intermediate capital[b]	dollar	25,000.00	(-)16,994.88 - 160,257.00	0.12
Long-term capital[c]	dollar	59,983.00	(-)17,988.13 - 63,140.00	0.11

a Solution values are valid for small typical farm with full-time operator labor and borrowing allowed up to a debt:asset ratio of 0.80.

b,c Owner-furnished capital

this value holds is 7.00 to 200.75 acres of dryland. Additional operator labor is valued at $4.50 per hour, the price paid per hour of hired labor. Although operator labor is constrained in all periods, the maximum amount of hired labor available in any labor period is never required; therefore, another hour of operator labor is valued at the hourly wage of $4.50.

The shadow price of operator labor is constant over all labor periods; however, the ranges over which the shadow price is valid vary with labor period and amount of labor hired. Intermediate capital provided by the operator has a value in use of $0.12, while long-term equity capital is worth $0.11. The ranges over which the shadow prices for capital apply are wide: (-)$16,994.88 to $160,257.50 for intermediate capital and $17,988.13 to $63,140.00 for long-term capital.

In addition to 75 acres of wheat, a 140-sow farrow-to-finish confinement system is included in the optimal solution for this scenario (Table 25). A total of 776.25 hours of labor are hired. The operation is financed with $135,257.72 of intermediate-term borrowed capital and $3,157.00 of long-term borrowed capital. Owner-furnished capital levels are: operating, $2,114.25; intermediate, $25,000.00; and long-term, $59,983.00. In the optimal solution for this scenario, 2,700 bushels of wheat and 5,757 hundredweights of slaughter hogs are the primary commodities sold.

Table 26 presents the range output for selected production and sell activities. Input costs represent the contribution of each activity to the objective function and are the same values as those presented for the small size base farm. Input costs for selected production activities included in the farm plan at lower limit level are: cow-calf, $166.46 to $215.90; stocker steers, $53.22; native hay, $34.95; native pasture, $2.67; Bermuda hay, $175.92; and Bermuda pasture, $61.53. Unit costs for production activities tell how much the value of

TABLE 25

SUMMARY OF INPUT AND OUTPUT LEVELS IN MPSX OPTIMAL SOLUTION FOR SMALL TYPICAL FARM WITH FULL-TIME OPERATOR LABOR AND UNCONSTRAINED BORROWED CAPITAL[a]

Activity	Unit	Level
Objective function	dollar	91,798.56
Wheat	acre	75.00
Farrow-to-finish (140-sow)	enterprise	1.0
Operator labor	hour	2,496.00
Hired labor	hour	776.25
Total borrowing	dollar	138,414.50
Wheat sold	bushel	2,700.00
Slaughter hogs sold	cwt	5,757.00
Debt:Asset ratio		0.61

[a] Solution values are valid for small typical farm with full-time operator labor and borrowing allowed up to a debt:asset ratio of 0.8.

TABLE 26

SUMMARY OF MPSX RANGE OUTPUT FOR PRODUCTION ACTIVITIES AT LIMIT LEVEL AND SELECTED SELL ACTIVITIES ON SMALL TYPICAL FARM WITH FULL-TIME OPERATOR LABOR AND UNCONSTRAINED BORROWED CAPITAL[a]

A. PRODUCTION ACTIVITIES AT LIMIT LEVEL

Activity	Unit	Input cost	Unit cost	Upper cost
Cow-calf[b]	head	$(-)166.46	$253.69	$ 87.23
Cow-calf[c]	head	(-)215.90	334.46	118.56
Stocker steer	head	(-) 53.22	1.10	(-) 52.12
Native pasture	acre	(-) 2.67	47.12	44.45
Native hay	acre	(-) 34.95	50.04	15.10
Bermuda hay	acre	(-)175.92	76.03	(-) 99.89
Bermuda pasture	acre	(-) 61.53	107.66	46.13

B. SELECTED SELL ACTIVITIES

Activity	Unit	Input cost	Upper cost
Steers (4-500#)	cwt	$ 81.00	$ 82.00
Cows	cwt	40.00	331.59
Alfalfa	ton	65.00	114.83
Native hay	ton	46.00	79.36
Sorghum	cwt	2.86	3.00
Steers (6-700#)	cwt	69.00	69.20

[a] Solution values are valid for small typical farm with full-time operator labor and borrowing allowed up to a debt:asset ratio of 0.80.

[b] Spring-calving; 205-day weaning

[c] Fall-calving; 205-day weaning

the objective function would be reduced if one unit of an enterprise not included in the farm plan were forced into the solution, ceteris paribus. For this scenario, these values range from $1.10 if one stocker steer unit is included to $334.46 if one fall-calving cow-calf unit is forced into the farm organization.

Upper costs represent the lowest cost of production required to keep the activity in the solution at its current level. For cow-calf enterprises, this value ranges from $87.23 to $118.56 per budget unit. Upper costs for other production activities included in the solution at limit level are: stocker steers, (-) $52.12; native hay, $44.45; native pasture, $15.10; and Bermuda hay and pasture, (-)$99.89 and (-)$46.13 respectively.

For sell activities, upper costs represent the highest price for outputs that permit the activity to be maintained at its current level and status in the solution. Upper costs for selected sell activities that appear in the solution for the small typical farm with full-time operator labor and unlimited borrowed capital resources are also listed in Table 26. These per unit values are $82.00 for steer calves, $331.59 for cows, $114.83 for alfalfa, $79.36 for native hay, $3.00 for sorghum, and $69.20 for 6-700 pound steers.

Full-time Operator Labor; Borrowing Constrained Within a Debt:Asset Ratio of 0.30. For the small farm with full-time operator labor seeking to maintain a high equity/low debt status, returns to overhead, risk, management, and unpaid operator labor are $28,179.30. Only three resources are included in the optimal solution at upper limit levels: dryland and intermediate- and long-term capital furnished by the owner.

The marginal value products, or shadow prices, of these three limiting resources are presented in Table 27. An additional acre of nonirrigated land is worth $87.63, a value which holds over a range of 12.00 to 138.56 acres. The

TABLE 27

SUMMARY OF MPSX RANGE OUTPUT FOR ROWS AT LIMIT LEVEL ON SMALL SIZE TYPICAL FARM WITH FULL-TIME OPERATOR LABOR AND BORROWING CONSTRAINED TO MAINTAIN A HIGH EQUITY STATUS

Row	Unit	Activity level	Range	Shadow price
Dryland	acre	82.00	12.00 - 138.56	$87.63
Intermediate capital[a]	dollar	25,000.00	12,771.36 - 41,884.72	0.12
Long-term capital[b]	dollar	59,983.00	47,254.36 - 63,140.00	0.11

[a,b] Owner-furnished capital

shadow prices of intermediate and long-term capital provided by the owner are $0.12 and $0.11 respectively. The ranges over which these shadow prices are valid are $12,771.36 to $41,884.72 for intermediate equity capital and $47,254.36 to $63,140.00 for long-term equity capital.

Wheat and swine production are the only enterprises included in the optimal farm plan (Table 28). The 40-sow farrow-to-finish enterprise is included in the solution for this capital scenario, as compared to the 140-sow confinement system included in both the unconstrained and low equity maintenance scenarios. Since the 40-sow pasture system requires more land, only 70 acres of nonirrigated cropland are available for wheat production. Operator labor is in slack for all labor periods; therefore, no additional labor is hired. Owner-provided capital is the primary means of financing this operation, although some borrowing does take place. Total capital borrowing in this scenario is $20,041.72. In addition to the 2,520 bushels of wheat sold, 1,262 hundredweights of slaughter hogs are produced and marketed. The on-farm feed processing alternative is included in the swine production enterprise, requiring the purchase of 4,276.80 hundredweights of sorghum.

Input costs, unit costs, and upper costs for selected production activities included in the optimal solution at limit level are presented in Table 29. Input costs represent the value of that production activity in the objective function and are negative. These values are the same as those presented and discussed previously. Income penalties for forcing in one budget unit of these production activities are $14.68 and $125.90 for the cow-calf enterprises; $173.03 for alfalfa; $58.33 for native hay; and $76.52 and $152.97 for Bermuda hay and pasture respectively.

Input costs for sell activities are equal to their sale price and have also been discussed in previous sections. The upper costs for these activities

TABLE 28

SUMMARY OF INPUT AND OUTPUT LEVELS IN MPSX SOLUTION FOR SMALL TYPICAL FARM WITH FULL-TIME OPERATOR LABOR AND BORROWING CONSTRAINED WITHIN A DEBIT:ASSET OF 0.30

Activity	Unit	Level
Objective function	dollar	28,179.30
Wheat	acre	70.00
Farrow-to-finish (40-sow)	enterprise	1.0
Operator labor hour		
January		127.00
February		145.90
March		127.00
April		127.00
May		127.00
June		163.40
July		171.80
August		166.20
September		163.40
October		127.00
November		127.00
December		127.00
Hired labor	hour	0.00
Total borrowing	dollar	20,041.72
Wheat sold	bushel	2,520.00
Slaughter hogs sold	cwt	1,262.00
Sorghum purchased	cwt	4,276.80
Debt:Asset ratio		0.18

TABLE 29

SUMMARY OF MPSX RANGE OUTPUT FOR PRODUCTION ACTIVITIES AT LIMIT LEVEL AND SELECTED SELL ACTIVITIES ON SMALL TYPICAL FARM WITH FULL-TIME OPERATOR LABOR AND BORROWING CONSTRAINED WITHIN A DEBT:ASSET OF 0.30

A. PRODUCTION ACTIVITIES AT LIMIT LEVEL

Activity	Unit	Input cost	Unit cost	Upper cost
Cow-calf[a]	head	$(-)166.46	$ 14.68	$(-)151.78
Cow-calf[b]	head	(-)215.90	125.90	(-) 90.00
Alfalfa	acre	(-)296.50	173.03	(-)123.57
Native hay	acre	(-) 34.95	58.33	23.38
Native pasture	acre	(-) 2.67	76.52	73.85
Sorghum	acre	(-) 49.25	53.55	4.36
Bermuda hay	acre	(-)175.92	75.67	(-)100.25
Bermuda pasture	acre	(-) 61.53	152.97	91.44

B. SELECTED SELL ACTIVITIES

Activity	Unit	Input cost	Upper cost
Steers (4-500#)	cwt	$ 81.00	$ 81.42
Cows	cwt	40.00	56.87
Alfalfa	ton	65.00	118.24
Native hay	ton	46.00	84.88
Sorghum	cwt	2.86	3.00
Steers (6-700#)	cwt	69.00	69.39

[a] Spring-calving; 205-day weaning

[b] Fall-calving; 205-day weaning

represent the highest price of outputs necessary to keep the marketing activity in the solution at its current level. Per unit upper costs for selected sell activities are as follows: sorghum, $3.00; steer calves, $81.42; 6-700 pound steers, $69.39; alfalfa, $118.24; native hay, $84.88; and cows, $56.87.

Part-time Operator Labor; Unconstrained Borrowed Capital. Three additional matrices were constructed to allow part-time operator labor and the ability to hire one additional full-time worker. Like the full-time operator scenarios discussed above, these matrices incorporated three alternative levels of borrowed capital: borrowing unconstrained, borrowing constrained so that the debt:asset ratio does not exceed 0.80, and borrowing does not exceed a debt:asset ratio of 0.30.

The objective function value obtained for both the unconstrained borrowing and low equity maintenance scenario is $83,290.14. Several resources are limiting in the optimal solution for these scenarios: nonirrigated cropland; operator labor in all periods; hired labor in June, July, and September; and owner-furnished intermediate and long-term capital.

Shadow prices for these limiting resources and the ranges over which they hold are summarized in Table 30. An additional acre of dryland has a value in use of $7.05. The shadow price of operator labor in all periods where hired labor is not also limiting is $4.50. An additional hour of operator labor in June is worth $12.79, while additional operator labor in July and September is valued at $82.69 and $33.22 per hour respectively. The ranges over which these shadow prices hold vary with labor period, but are relatively narrow for periods where hired labor is also constrained.

Four crop enterprises are included in the solution at the levels listed in Table 31: 24.79 acres of wheat; 10.61 acres of native hay; 23.07 acres of native

TABLE 30

SUMMARY OF MPSX RANGE OUTPUT FOR ROWS AT LIMIT LEVEL ON SMALL TYPICAL FARM WITH PART-TIME OPERATOR LABOR AND UNCONSTRAINED BORROWED CAPITAL[a]

Row	Unit	Activity level	Range	Shadow price
Dryland	acre	82.00	58.93 - 38.21	$ 7.05
Hired labor	hour			
June		173.00	169.88 - 178.74	8.29
July		173.00	165.09 - 176.69	78.19
September		173.00	168.84 - 188.46	28.72
Operator labor	hour/mo.			
January, December		104.00	88.04 - 261.04	4.50
February		104.00	94.73 - 267.73	4.50
March		104.00	90.35 - 263.35	4.50
April		104.00	87.92 - 260.92	4.50
May		104.00	84.83 - 257.83	4.50
June		104.00	100.88 - 109.74	12.79
July		104.00	96.09 - 107.69	82.69
August		104.00	97.88 - 270.88	4.50
September		104.00	99.84 - 119.46	33.22
October		104.00	84.00 - 257.00	4.50
November		104.00	84.75 - 257.75	4.50

TABLE 30 (Continued)

Row	Unit	Activity level	Range	Shadow price
Intermediate capital[b]	dollar	25,000.00	(-)61,619.50 - 161,982.81	0.12
Long-term capital[c]	dollar	59,983.00	(-)26,636.50 - 63,140.00	0.11

a Solution values are valid for small typical farms with part-time operator labor and borrowing constrained within a debt:asset ratio of 0.80.

b,c Owner-furnished capital

TABLE 31

SUMMARY OF INPUT AND OUTPUT LEVELS IN MPSX OPTIMAL SOLUTION FOR SMALL TYPICAL FARM WITH PART-TIME OPERATOR LABOR AND UNCONSTRAINED BORROWED CAPITAL[a]

Activity	Unit	Level
Objective function	dollar	83,290.14
Wheat	acre	24.79
Stocker heifers	head	7.48
Native hay	acre	10.61
Native pasture	acre	23.07
Sorghum	acre	16.53
Farrow-to-finish (140-sow)	enterprise	1.0
Operator labor	hour	1,248.00
Hired labor	hour	1,904.54
Total borrowing	dollar	140,139.85
Wheat sold	bushel	892.56
Native hay sold	ton	15.91
Heifers (600-700#) sold	cwt	46.39
Slaughter hogs sold	cwt	5,757.00
Sorghum purchased	cwt	15,749.73
Debt:Asset ratio		0.62

[a] Solution values are valid for small typical farm with part-time operator labor and borrowing constrained within a debt:asset ratio of 0.80.

pasture; and 16.53 acres of sorghum. In addition to the 140-sow farrow-to-finish enterprise, 7.48 head of stocker heifers appear in the optimal farm plan. Over 1,900 hours of labor are hired and $140,139.85 of capital are borrowed in this scenario.

The diversity of crop and livestock enterprises included in the farm organization requires several marketing activities. Over 892 bushels of wheat are sold, as well as 15.91 tons of native hay, 46.39 hundredweights of heifers, and 5,757 hundredweights of slaughter hogs. Since on-farm feed processing is included in the swine enterprise, 1579.73 hundredweights of sorghum are purchased to supplement the sorghum produced.

Unit costs for production activities included in the farm organization at lower limit level are summarized in Table 32. The objective function value would decline between $88.76 and $206.89 if one budget unit of a cow-calf enterprise were forced into the solution; $1.10 for a unit of stocker steers; $92.68 for one acre of alfalfa; and $78.46 and $79.79 for one acre of Bermuda hay and pasture respectively. Upper costs are (-)$77.70 and (-)$9.01 for the cow-calf enterprises, (-)$52.12 for the stocker steer enterprise, (-)$203.82 for the alfalfa enterprise, (-)$97.46 for the Bermuda hay enterprise, and $18.26 for the Bermuda pasture enterprise. Upper costs for selected sell activities are also listed in Table 32. Values per unit for these activities are $82.00 for steer calves; $142.03, cows; $93.52, alfalfa; $65.83, Bermuda hay; and $69.17, feeder steers.

Part-time Operator Labor: Borrowing Constrained Within a Debt:Asset Ratio of 0.30. Returns to overhead, risk, management, and operator labor in the solution for the small size farm with part-time operator labor resources and borrowing restricted within a debt:asset ratio of 0.30 are $26,146.65. Dryland

TABLE 32

SUMMARY OF MPSX RANGE OUTPUT FOR PRODUCTION ACTIVITIES AT LIMIT LEVEL AND SELECTED SELL ACTIVITIES ON SMALL TYPICAL FARM WITH PART-TIME OPERATOR LABOR AND UNCONSTRAINED BORROWED CAPITAL[a]

A. PRODUCTION ACTIVITIES AT LIMIT LEVEL

Activity	Unit	Input cost	Unit cost	Upper cost
Cow-calf[b]	head	$(-)166.46	$ 88.76	$(-) 77.70
Cow-calf[c]	head	(-)215.90	206.89	(-) 9.01
Stocker steers	head	(-) 53.22	1.10	(-) 52.12
Alfalfa	acre	(-)296.50	92.68	(-)203.82
Bermuda hay	acre	(-)175.92	78.46	(-) 97.46
Bermuda pasture	acre	(-) 61.53	79.79	18.26

B. SELECTED SELL ACTIVITIES

Activity	Unit	Input cost	Upper cost
Steers (4-500#)	cwt	$ 81.00	$ 82.00
Cows	cwt	40.00	142.03
Steers (6-700#)	cwt	69.00	69.17
Alfalfa	ton	65.00	93.52
Bermuda hay	ton	48.00	65.83

[a] Solution values are valid for small typical farm with part-time operator labor and borrowing within a debt:asset ratio of 0.80.

[b] Spring-calving; 205-day weaning

[c] Fall-calving; 205-day weaning

acreage, operator labor in all labor periods, and operator-provided intermediate and long-term capital are the inputs included in the optimal solution at upper limit level.

Shadow prices for these resources, as well as the ranges over which these values are valid, are presented in Table 33. In this scenario, an acre of nonirrigated cropland is worth $76.33, a value which applies between 12.00 and 246.37 acres. Although all available operator labor is used, hired labor is in slack for all labor periods. Therefore, the shadow price for operator labor in all months is $4.50 per hour. The ranges over which this shadow price hold, however, depend upon the amount of hired labor utilized in each period. Additional intermediate and long-term equity capital have values in use of $0.12 and $0.11 respectively. The marginal value product of intermediate capital is valid between $12,271.36 and $41,884.72, while that of long-term capital holds between $47,254.36 and $63,140.00.

The solution for this scenario includes 70 acres of wheat and one 40-sow farrow-to-finish pasture enterprise (Table 34). In addition to the 1,248 hours of operator labor used, over 530 hours of labor are hired. Total borrowing is $20,041.72. Since wheat and swine are the only production enterprises included in the optimal plan, grain and slaughter hogs are the primary sell activities. In this scenario, 2,520 bushels of wheat and 1,262 hundredweights of slaughter hogs are sold. No sorghum production is included in solution; therefore, all sorghum used in the feed processing aspect of swine production (4,276.80 hundredweight) is purchased.

Unit costs for production activities included in the optimal farm organization at lower limit level are presented in Table 35. Income penalties for forcing one budget unit of these enterprises, ceteris paribus, are: $44.99 and $159.01 for the cow-calf enterprises; stocker steers, $1.10; alfalfa, $161.96; native pasture,

TABLE 33

SUMMARY OF MPSX RANGE OUTPUT FOR ROWS AT LIMIT LEVEL ON SMALL TYPICAL FARM WITH PART-TIME OPERATOR LABOR AND BORROWING CONSTRAINED WITHIN A DEBT:ASSET RATIO OF 0.30.

Row	Unit	Activity level	Range	Shadow price
Dryland	acre	82.00	12.00 - 246.37	$76.33
Operator labor	hour/mo.			
January, March, April, May, October, November, December		104.00	(-)46.00 - 127.00	4.50
February		104.00	(-)27.10 - 145.90	4.50
June, September		104.00	(-) 9.60 - 163.40	4.50
July		104.00	(-) 1.20 - 171.80	4.50
August		104.00	(-) 6.80 - 166.20	4.50
Intermediate capital[a]	dollar	25,000.00	12,271.36 - 41,884.72	0.12
Long-term capital[b]	dollar	59,983.00	47,254.36 - 63,140.00	0.11

[a,b] Owner-furnished capital

TABLE 34

SUMMARY OF INPUT AND OUTPUT LEVELS IN MPSX OPTIMAL SOLUTION FOR SMALL TYPICAL FARM WITH PART-TIME OPERATOR LABOR AND BORROWING CONSTRAINED WITHIN A DEBT:ASSET RATIO OF 0.30

Activity	Unit	Level
Objective function	dollar	26,146.65
Wheat	acre	70.00
Farrow-to-finish (40-sow)	enterprise	1.0
Operator labor	hour	1,248.00
Hired labor	hour	533.70
Total borrowing	dollar	20,041.72
Wheat sold	bushel	2,520.00
Slaughter hogs sold	cwt	1,262.00
Sorghum purchased	cwt	4,276.80
Debt:Asset ratio		0.18

TABLE 35

SUMMARY OF MPSX RANGE OUTPUT FOR PRODUCTION ACTIVITIES AT LIMIT LEVEL AND SELECTED SELL ACTIVITIES ON SMALL TYPICAL FARM WITH PART-TIME OPERATOR LABOR AND BORROWING CONSTRAINED WITHIN A DEBT:ASSET RATIO OF 0.30

A. PRODUCTION ACTIVITIES AT LIMIT LEVEL

Activity	Unit	Input cost	Unit cost	Upper cost
Cow-calf[a]	head	$(-)166.46	$ 44.99	$(-)121.47
Cow-calf[b]	head	(-)215.90	159.01	(-) 56.89
Stocker steer	head	(-) 53.22	1.10	(-) 52.12
Alfalfa	acre	(-)296.50	161.96	(-)134.54
Native pasture	acre	(-) 2.67	69.29	66.62
Native hay	acre	(-) 34.95	50.04	15.10
Sorghum	acre	(-) 49.25	46.17	(-) 3.08
Bermuda hay	acre	(-)175.92	76.03	(-) 99.89
Bermuda pasture	acre	(-) 61.53	144.60	83.06

B. SELECTED SELL ACTIVITIES

Activity	Unit	Input cost	Upper cost
Steers (4-500#)	cwt	$ 81.00	$ 82.00
Cows	cwt	40.00	91.71
Steers (6-700#)	cwt	69.00	69.17
Alfalfa	ton	65.00	114.83
Native hay	ton	46.00	79.36
Bermuda hay	ton	48.00	65.28

[a] Spring-calving; 205-day weaning

[b] Fall-calving; 205-day weaning

$69.29; native hay, $50.04; sorghum, $46.17; and $76.03 and $144.60 for Bermuda hay and pasture respectively. Upper costs for some of these activities are (-)$121.47 and (-)$56.89 for the cow-calf enterprises, (-)$134.54 for alfalfa, and (-)$3.08 for sorghum. Upper costs for selected sell activities are $82.00 per hundredweight for steer calves, $91.71 per hundredweight for cows, $69.17 per hundredweight for feeder steers, $114.83 per ton alfalfa, $79.36 per ton native hay, and $65.28 per ton Bermuda hay. These values are also presented in Table 35.

Part-time Operator Labor; Unconstrained Borrowed Capital; Unconstrained Hired Labor. As discussed in the previous section, hired labor was constrained in three labor periods for the small size farm with part-time operator labor and unconstrained borrowing. Therefore, an additional solution was generated to determine the impact of unlimited hired labor on the optimal farm organization. The solution for this unconstrained hired labor scenario is summarized in Table 36.

When an unlimited amount of hired is available, returns to overhead, risk, management, and operator labor are $86,182.59. Two production enterprises are included in the optimal solution: a 140-sow farrow-to-finish enterprise and 75 acres of wheat. In addition to the 1,248 hours of operator labor available, 2,024.30 hours of labor are hired. Total borrowing is $138,414.52. Two commodities are marketed in this scenario: 2,700 bushels of wheat and 5,757 hundredweights of slaughter hogs. All sorghum required by the swine enterprise, 16,245.60 hundredweights, is purchased.

A summary of all the solutions obtained for the small size farms is presented in Table 37. When the hired labor constraint is relaxed for the part-time operator labor/unconstrained borrowed capital scenario, returns to

TABLE 36

SUMMARY OF INPUT AND OUTPUT LEVELS IN MPSX OPTIMAL SOLUTION FOR SMALL TYPICAL FARM WITH PART-TIME OPERATOR LABOR, UNCONSTRAINED BORROWED CAPITAL, AND UNCONSTRAINED HIRED LABOR

Activity	Unit	Level
Objective function	dollar	86,182.59
Wheat	acre	75.00
Farrow-to-finish (140-sow)	enterprise	1.0
Operator labor	hour	1,248.00
Hired labor	hour	2,024.30
Total borrowing	dollar	138,414.52
Wheat sold	bushel	2,700.00
Slaughter hogs sold	cwt	5,757.00
Sorghum purchased	cwt	16,245.60
Debt:Asset ratio		0.61

TABLE 37

SUMMARY OF INPUT AND OUTPUT LEVELS IN MPSX SOLUTIONS FOR SMALL SIZE FARMS

	Unit	--- Scenario number --- 1	2	3,4
Swine enterprises		no	yes	yes
Level of operator labor[a]		FT	FT	FT
Capital restriction[b]		U	HE	U,LE
Hired labor restriction[c]		FTE	FTE	FTE
Objective function	dollar	5,749.43	28,179.30	91,798.56
CROP ENTERPRISES				
Wheat	acre	82.00	70.00	75.00
Alfalfa	acre			
Sorghum	acre			
Native pasture	acre			
Native hay	acre			
LIVESTOCK ENTERPRISES				
Stocker heifers	head			
Swine	enterprise		LIF2FF	140F2F
RESOURCES USED				
Operator labor	hour	205.82	1,699.70	2,496.00
Hired labor	hour			776.25
Dryland	acre	82.00	82.00	82.00
Total borrowing	dollar	3,157.00	20,041.72	138,414.52
Sorghum bought	cwt		4,276.80	16,245.60
PRODUCTION				
Slaughter hogs	cwt		1,262.00	5,757.00
Wheat	bushel	2,952.00	2,520.00	2,700.00
Alfalfa	ton			
Sorghum	cwt			
Native hay	ton			
Heifers (6-700#)	cwt			
DEBIT:ASSET RATIO		0.04	0.18	0.61

[a] FT Operator labor = 2,496 hrs/yr: PT = 1,248 hrs/yr

[b] U = Unconstrained borrowing: LE = borrowing permitted up to a D/A Ratio of 0.80: HE = borrowing permitted up to a D/A Ratio of 0.30

[c] FTE = One full-time laborer equivalent

TABLE 37 (Continued)

	Unit	--- Scenario number --- 5	6	7,8
Swine enterprises		no	yes	yes
Level of operator labor[a]		PT	PT	PT
Capital restriction[b]		U	HE	U,LE
Hired labor restriction[c]		FTE	FTE	FTE
Objective function	dollar	5,749.43	28,146.65	83,290.14
CROP ENTERPRISES				
Wheat	acre	82.00	70.00	24.79
Alfalfa	acre			
Sorghum	acre			16.53
Native hay	acre			10.61
Native pasture	acre			23.07
LIVESTOCK ENTERPRISES				
Stocker heifers	head			7.48
Swine	enterprise		LIF2FF	140F2F
RESOURCES USED				
Operator labor	hour	205.82	1,248.00	1,248.00
Hired labor	hour		533.70	1,904.54
Dryland	acre	82.00	82.00	82.00
Total borrowing	dollar	3,157.00	20,041.72	140,139.85
Sorghum bought	cwt		4,276.80	15,749.73
PRODUCTION				
Slaughter hogs	cwt		1,262.00	5,757.00
Wheat	bushel	2,952.00	2,520.00	892.56
Alfalfa	ton			
Sorghum	cwt			
Native hay	ton			15.91
Heifers (6-700#)	cwt			46.39
DEBIT:ASSET RATIO		0.04	0.18	0.62

[a] FT Operator labor = 2,496 hrs/yr: PT = 1,248 hrs/yr

[b] U = Unconstrained borrowing: LE = borrowing permitted up to a D/A Ratio of 0.80: HE = borrowing permitted up to a D/A Ratio of 0.30

[c] FTE = One full-time laborer equivalent

TABLE 37 (Continued)

	Unit	Scenario 9
Swine enterprises		yes
Level of operator labor[a]		PT
Capital restriction[b]		U
Hired labor restriction[c]		FTE
Objective function	dollar	86,182.59
CROP ENTERPRISES		
Wheat	acre	75.00
Alfalfa	acre	
Sorghum	acre	
Native hay	acre	
Native pasture	acre	
LIVESTOCK ENTERPRISES		
Stocker heifers	head	
Swine	enterprise	140F2F
RESOURCES USED		
Operator labor	hour	1,248.00
Hired labor	hour	2,024.30
Dryland	acre	82.00
Total borrowing	dollar	138,414.52
Sorghum bought	cwt	16,245.60
PRODUCTION		
Slaughter hogs	cwt	5,757.00
Wheat	bushel	2,700.00
Alfalfa	ton	
Sorghum	cwt	
Native hay	ton	
Heifers (6-700#)	cwt	
DEBIT:ASSET RATIO		0.62

[a] FT Operator labor = 2,496 hrs/yr: PT = 1,248 hrs/yr

[b] U = Unconstrained borrowing: LE = borrowing permitted up to a D/A Ratio of 0.80: HE = borrowing permitted up to a D/A Ratio of 0.30

[c] FTE = One full-time laborer equivalent

overhead, risk, management, and operator labor increase 3.5%, or $2,892.43 (Scenario 6 versus Scenario 9). Although an additional 119.76 hours of labor are hired, borrowed capital requirements decrease by $1,725.33. Wheat, sorghum, native hay, native pasture, swine, and stocker steers are the production enterprises included in the optimal solution when hired labor is constrained. When hired labor resources are unrestricted, however, only wheat and swine production are included.

Medium Size Farms

Full-time Operator Labor Available, Unconstrained Borrowed Capital, and No Swine Production

Unlike the small size base farms, the solutions for the medium size base farms with full-time and part-time operator labor resources differ considerably. Returns to overhead, risk, management, and operator labor for the medium size base farm with full-time operator labor available are $28,706.27, or $60.43 per acre. Five resources are included in the optimal farm plan at upper limit level: dryland, pasture, operator labor in September, and intermediate- and long-term owner-furnished capital.

Shadow prices listed in the MPSX output for these limiting resources are presented in Table 38. An additional acre of nonirrigated cropland is worth $79.12 per acre, as compared to $26.29 per acre for pasture. The shadow price of dryland resources is valid between 212.32 and 347.08 acres, while the marginal value product for pasture resources holds between 69.40 and 327.61 acres.

TABLE 38

SUMMARY OF MPSX OUTPUT FOR ROWS AT LIMIT LEVEL ON MEDIUM SIZE BASE FARM WITH FULL-TIME OPERATOR LABOR

Row	Unit	Activity level	Range	Shadow price
Dryland	acre	323.00	212.32 - 347.08	$79.12
Pasture	acre	152.00	69.40 - 327.61	26.29
Operator labor	hour			
September		208.00	90.34 - 263.34	4.50
Intermediate capital[a]	dollar	25,000.00	(-)255,594.06 - 43,965.25	0.12
Long-term capital[b]	dollar	246,288.00	(-) 34,306.06 - 289,750.01	0.11

[a,b] Owner-furnished capital

An additional hour of operator labor in September has a value in use of $4.50 per hour. Although operator labor in this period is constraining, hired labor is not. Therefore, the value of another hour of operator labor is limited to the hourly wage rate. This value is valid between 90.34 and 263.34 hours. The shadow prices for intermediate and long-term capital provided by the owner-operator are $0.12 and $0.11 respectively. The ranges over which these values hold are (-)$255,594.06 and $43,965.25 for intermediate capital and (-) $34,306.06 to $289,750.01 for long-term capital.

The optimal solution for the medium size base farm with full-time operator labor includes three production enterprises: 323 acres of wheat, 152 acres of native hay and 23.07 head of stocker heifers (Table 39). Of the 2,496 hours of operator labor available, only 447.49 hours are used. Since all operator labor resources are used in September, an additional 55.34 hours of labor are hired. Total capital borrowing in this scenario is $62,427.25. In addition, 11,628 bushels of wheat, 228 tons of native hay, and 143.04 hundredweight of 6-700 pound heifers are marketed.

The range output for production activities included in the optimal farm plan at limit level is summarized in Table 40. Input costs for these activities represent the value of that activity in the objective function and are identical to the values discussed for the small farms in the preceding section. Unit costs identify how much the objective function would decrease if one unit of one of these activities were forced into the farm production plan, ceteris paribus. Forcing in one unit of a cow-calf enterprise would decrease returns to overhead, risk, management, and operator labor by $90.24.

Including one acre of alfalfa would lower returns by $164.51, while one acre of sorghum would reduce the optimal objective function value by $49.24. Unit costs for the remaining activities at lower limit level are $21.84 for native

TABLE 39

SUMMARY OF INPUT AND OUTPUT LEVELS IN MPSX OPTIMAL SOLUTION FOR MEDIUM BASE FARM WITH FULL-TIME OPERATOR LABOR

Activity	Unit	Level
Objective function	dollar	28,706.27
Wheat	acre	323.00
Native hay	acre	152.00
Stocker heifers	head	23.07
Operator labor	hour	
January		38.30
February		57.68
March		12.46
June		51.68
August		64.60
November		2.31
December		12.46
Hired labor	hour	55.34
Total borrowing	dollar	62,427.25
Wheat sold	bushel	11,628.00
Native hay sold	ton	228.00
Heifers (6-700#)		143.04
Debt:Asset ratio		0.18

TABLE 40

SUMMARY OF MPSX RANGE OUTPUT FOR PRODUCTION ACTIVITIES AT LIMIT LEVEL AND SELECTED SELL ACTIVITIES ON MEDIUM SIZE BASE FARM WITH FULL-TIME OPERATOR LABOR AND UNCONSTRAINED BORROWED CAPITAL

A. PRODUCTION ACTIVITIES AT LIMIT LEVEL

Activity	Unit	Input cost	Unit cost	Upper cost
Cow-calf[a]	head	(-)215.90	90.24	(-) 125.65
Alfalfa	acre	(-)296.50	164.51	(-)131.98
Native pasture	acre	(-) 2.67	21.84	19.17
Sorghum	acre	(-) 49.25	49.84	(-) 0.01
Bermuda hay	acre	(-)175.92	16.76	(-)159.16
Bermuda pasture	acre	(-) 61.53	84.16	22.63

B. SELECTED SELL ACTIVITIES

Activity	Unit	Input cost	Upper cost
Cows	cwt	40.00	239.00
Alfalfa	cwt	65.00	115.62
Sorghum	cwt	2.86	4.50
Steers (6-700#)	cwt	69.00	69.39
Heifers (6-700#)	cwt	64.00	64.27
Bermuda hay	ton	48.00	51.81

[a] Fall-calving; 205-day weaning

pasture; Bermuda hay, $16.76; and Bermuda pasture, $84.16. Upper costs identify the value of that enterprise in the objective function that would change its status or level in the optimal solution. The upper costs for the cow-calf enterprises are (-)$125.65; alfalfa, (-)$131.98; native pasture, $19,17; sorghum (-)$0.01; Bermuda hay, (-) $159.16; and Bermuda pasture, $22.63.

Table 40 also summarizes the input and upper costs for selected sell activities included in the solution for the medium-sized base farm with full-time operator labor available. Input costs for these activities represent the actual prices received per unit marketed and are no different than the values presented earlier. Upper costs identify the price at which the level or status of the activity would change in the optimal solution, all other prices held constant. The per unit upper cost for steers is $69.39, as compared to $64.27 for 6-700 pound steers. Per unit upper costs for other sell activities are $239.00 for cows; alfalfa, $115.62; sorghum, $4.50; and Bermuda hay, $51.81.

Full-time Operator Labor Available and the Opportunity for Swine Production

Unconstrained Borrowed Capital. The solutions for the medium farms with unconstrained borrowed capital and borrowed capital constrained so that the debt:asset ratio does not exceed 0.80 are identical. In these scenarios, the value of the objective function is $101,592.91. Nonirrigated cropland, pasture, intermediate- and long-term equity capital, as well as operator labor in all periods are exhausted in the optimal solution. In addition, all available hired labor is used in September.

Shadow prices for the constrained resources are presented in Table 41. Another acre of dryland is worth $29.08, while each additional acre of pasture is

TABLE 41

SUMMARY OF MPSX RANGE OUTPUT FOR ROWS AT LIMIT LEVEL ON MEDIUM TYPICAL FARM WITH FULL-TIME OPERATOR LABOR AND UNCONSTRAINED BORROWED CAPITAL[a]

Row	Unit	Activity level	Range	Shadow price
Dryland	acre	323.00	319.29 - 444.09	$ 29.08
Pasture	acre	152.00	149.82 - 736.41	1.67
Hired labor	hour			
September		173.00	172.16 - 210.50	141.53
Operator labor	hours/mo.			
January		208.00	124.59 - 297.59	4.50
February		208.00	139.47 - 312.47	4.50
March		208.00	115.25 - 288.25	4.50
April		208.00	108.65 - 281.65	4.50
May		208.00	87.75 - 260.75	4.50
June		208.00	155.93 - 328.93	
July		208.00	102.53 - 346.53	4.50
August		208.00	133.60 - 306.60	4.50
September		208.00	207.16 - 245.50	146.03
October		208.00	84.00 - 257.00	4.50
November		208.00	87.84 - 260.84	4.50
December		208.00	104.75 - 277.75	4.50

TABLE 41 (Continued)

Row	Unit	Activity level	Range	Shadow price
Short-term capital	dollar	10,000	(-)271,287.94 - 10,033.35	0.12
Intermediate capital[b]	dollar	25,000.00	(-)256,287.97 - 200,709.94	0.12
Long-term capital[c]	dollar	246,288.00	(-) 34,999.99 - 289,750.00	0.11

a Solution values are valid for medium typical farm with full-time operator labor and borrowing constrained such that a debit:asset ratio of 0.80 is not exceeded.

b,c Owner-furnished capital

valued at $1.67. The ranges over which these values hold are 319.29 to 444.09 acres and 149.82 to 736.41 acres for dryland and pasture respectively. Operator labor in September has a value in use of $146.03, while each additional hour of operator labor in the remaining labor periods is worth $4.50. In September, all available labor resources are exhausted. This increases the value of additional hired labor beyond the $4.50 hourly wage. In the other periods, only operator labor resources are completely used; hired labor resources are in slack. Therefore, another hour of operator labor in these periods is worth only $4.50. The $146.03 per hour shadow price of operator labor in September is valid between 207.16 and 245.50 hours. Although the shadow price of operator labor in the ten remaining labor periods is constant, the ranges over which this value hold vary considerably and depend upon the amount of labor hired in each period. The marginal value product of hired labor in September is $141.53 and is valid between 172.16 and 210.50 hours.

In addition to land and labor resources, owner-provided short-term, intermediate and long-term capital resources are restricting and have shadow prices of $0.12 and $0.11 respectively. The range over which the marginal value product of short-term capital holds is: (-)$271,287.94 to 10,033.35. The range for intermediate and long-term capital are (-)$256,287.97 to $200,709.94 and 34,999.99 to 289,750.00, respectively.

Four crop and hay enterprises, as well as one swine enterprise, are included in the optimal farm plan for this scenario: 248.00 acres of wheat, 75.00 acres of sorghum, 145.00 acres of native pasture, 23.07 head of stocker heifers and one 140-sow farrow-to finish enterprise (Table 42). In addition to the 2,496 hours of operator labor available, 1,032.58 hours of hired labor are required. The operation is financed with $219,205.34 of borrowed capital. Principal sell activities and the level of their inclusion in the optimal farm plan are: 8,928.00

TABLE 42

SUMMARY OF INPUT AND OUTPUT LEVELS IN MPSX OPTIMAL SOLUTION FOR MEDIUM TYPICAL FARM WITH FULL-TIME OPERATOR LABOR AND UNCONSTRAINED BORROWED CAPITAL[a]

Activity	Unit	Level
Objective function	dollar	101,592.91
Wheat	acre	248.00
Sorghum	acre	75.00
Native pasture	acre	145.00
Stocker heifers	head	23.07
Farrow-to-finish (140-sow)	enterprise	1.0
Operator labor	hour	2,496.00
Hired labor	hour	1,032.58
Total borrowing	dollar	219,205.34
Wheat sold	bushel	8,928.00
Heifers (6-700#)	cwt	238.26
Slaughter hogs sold	cwt	5,757.00
Sorghum purchased	cwt	13,995.60
Debt:Asset ratio		0.48

[a] Solution values are valid for medium typical farm with full-time operator labor and borrowing constrained such that a debt:asset ratio of 0.80 is not exceeded.

bushels of wheat, 238.26 hundredweights of 6-700 pound heifers, and 5,757.00 hundredweights of slaughter hogs. On-farm feed processing in the swine enterprise not only consumes all of the sorghum produced, but also requires an additional 13,995.60 hundredweights of purchased sorghum.

Table 43 presents the MPSX range output for both production activities at limit level and selected sell activities in the optimal solution. Including one unit of a cow-calf enterprise would decrease returns to overhead, risk, management, and operator labor by as much as $198.56. Similarly, one stocker steer unit would reduce returns by $14.93, while Bermuda hay and pasture would decrease returns by $78.68 and $70.78 respectively. Upper costs for these activities are (-)$83.90 and (-)$17.34 for the cow-calf enterprises, (-)$38.29 for stocker steers, (-)$97.24 for Bermuda hay, and $9.25 for Bermuda pasture.

Upper costs for selected sell activities identify the price at which the level of the activity would change in the solution. Per hundredweight upper costs for cows and steers are $134.89 and $71.24 respectively. The per unit upper cost of native hay is $92.80, while that of Bermuda hay is $65.88.

Borrowing Constrained Within a Debt:Asset Ratio of 0.30. Returns to overhead, risk, management, and operator labor for the medium typical farm with full-time operator labor and borrowing constrained within a debt:asset ratio of 0.30 are $62,981.34. Dryland and pasture resources, as well as owner-furnished intermediate and long-term capital are included at upper limit level. Operator labor in September is also limiting in this scenario. The marginal value products, or shadow prices, of these resources are listed in Table 44.

An additional acre of nonirrigated cropland is valued at $105.84 per acre when between 179.62 and 347.08 acres of the resource are considered. Pasture land has a per unit value in use of $36.51, a value which holds

TABLE 43

SUMMARY OF MPSX RANGE OUTPUT FOR PRODUCTION ACTIVITIES AT LIMIT LEVEL AND SELECTED SELL ACTIVITIES ON MEDIUM TYPICAL FARM WITH FULL-TIME OPERATOR LABOR AND UNCONSTRAINED BORROWED CAPITAL[a]

A. PRODUCTION ACTIVITIES AT LIMIT LEVEL

Activity	Unit	Input cost	Unit cost	Upper cost
Cow-calf[b]	head	$(-)166.46	$82.56	$(-)83.90
Cow-calf[c]	head	(-)215.90	198.56	(-)17.34
Stocker steer	head	(-) 53.22	14.93	(-)38.29
Bermuda hay	acre	(-)175.92	78.67	(-)97.24
Bermuda pasture	acre	(-) 61.53	70.78	(-) 9.25

B. SELECTED SELL ACTIVITIES

Activity	Unit	Input cost	Upper cost
Cows	cwt	$40.00	$134.89
Steers (6-700#)	cwt	69.00	71.24
Bermuda hay	ton	48.00	65.88
Native hay	ton	46.00	92.80

[a] Solution values are valid for medium typical farm with full-time operator labor and borrowing constrained such that the debt:asset is less than or equal to 0.80.

[b] Spring-calving; 205-day weaning

[c] Fall-calving; 205-day weaning

TABLE 44

SUMMARY OF MPSX RANGE OUTPUT FOR ROWS AT LIMIT LEVEL ON MEDIUM TYPICAL FARM WITH FULL-TIME OPERATOR LABOR AND BORROWING CONSTRAINED WITHIN A DEBT:ASSET RATIO OF 0.30

Row	Unit	Activity level	Range	Shadow price
Dryland	acre	323.00	179.62 - 347.08	$105.84
Pasture	acre	152.00	2.00 - 182.82	36.51
Operator labor	hour			
September		208.00	184.00 - 357.00	4.50
Intermediate capital[a]	dollar	25,000.00	24,056.15 - 100,445.94	0.12
Long-term capital[b]	dollar	246,288.00	245,334.15 - 289,750.01	0.11

[a,b] Owner-furnished capital

between 2.00 and 182.82 acres. Because hired labor is in slack, the shadow price of operator labor in September is $4.50 per hour. The range over which this value holds is 184.00 to 357.00 hours. The shadow prices of owner-provided intermediate and long-term capital are $0.12 and $0.11 respectively. The shadow price of intermediate equity capital is valid when between $24,056.15 and $100,445.94 are considered; the shadow price of long-term equity capital holds between $245,344.15 and $289,750.01.

Wheat, native hay, stocker heifers and a swine enterprise are the production activities that are included in the optimal solution (Table 45). Rather than the 140-sow farrow-to-finish enterprise included in the unconstrained and low equity maintenance scenarios, a confinement swine feedlot appears in the farm organization for the high equity scenario. Although over 900 hours of operator labor are not used during the production cycle, operator labor is constraining in one labor period. Since additional labor is required in this month, 149.00 hours of labor are hired. Total borrowing in this scenario is $118,907.96. Sell activities and the level of their inclusion in the optimal solution are 3,381 hundredweights of market hogs, 11,628 bushels of wheat, and 225 tons of native hay. No sorghum is produced on the farm; therefore, the 7,481 hundredweights required in the swine feedlot enterprise are purchased.

The input, unit, and upper costs for production activities at limit level in the optimal solution are presented in Table 46. Input costs for these production activities represent all cash and noncash costs except labor, overhead, risk, and management. Unit costs identify the decrease in the objective function value when one unit of the enterprise is forced into the optimal solution, ceteris paribus. Unit costs for production activities at lower limit level in the solution are $88.83 and $163.30 for the cow-calf enterprises; sorghum, $71.76; alfalfa, $191.24; and native hay, $23.93. The upper costs for these activities are

TABLE 45

SUMMARY OF INPUT AND OUTPUT LEVELS IN MPSX OPTIMAL SOLUTION FOR MEDIUM TYPICAL FARM WITH FULL-TIME OPERATOR LABOR AND BORROWING CONSTRAINED WITHIN A DEBT:ASSET RATIO OF 0.30

Activity	Unit	Level
Objective function	dollar	62,981.34
Wheat	acre	323.00
Native hay	acre	152.00
Stocker heifers	head	23.07
Confinement feedlot	enterprise	1.00
Operator labor	hour/mo.	
January		133.30
February		152.68
March		107.46
April, May		
June		146.68
July		
August		159.60
October		95.00
November		97.31
December		107.46
Hired labor	hour	149.00
Total borrowing	dollar	118,907.96
Sorghum purchased	cwt	7,841.00
Wheat sold	bushel	11,628.00
Native hay sold	ton	225.00
Slaughter hogs sold	cwt	3,381.00
Heifers (6-700#)	cwt	143.04
Debt:Asset ratio		0.30

TABLE 46

SUMMARY OF MPSX RANGE OUTPUT FOR PRODUCTION ACTIVITIES AT LIMIT LEVEL AND SELECTED SELL ACTIVITIES ON MEDIUM TYPICAL FARM WITH FULL-TIME OPERATOR LABOR AND BORROWING CONSTRAINED WITHIN A DEBT:ASSET RATIO OF 0.30

A. PRODUCTION ACTIVITIES AT LIMIT LEVEL

Activity	Unit	Input cost	Unit cost	Upper cost
Sorghum	acre	$(-) 49.25	$71.76	$ 22.51
Cow-calf[a]	head	(-)166.46	88.83	(-) 77.63
Cow-calf[b]	head	(-)215.90	163.30	(-) 52.60
Alfalfa	acre	(-)296.50	191.24	(-)105.26
Native hay	acre	(-) 2.67	23.93	21.26

B. SELECTED SELL ACTIVITIES

Activity	Unit	Input cost	Upper cost
Heifers (4-500#)		69.00	70.00
Steers (4-500#)	cwt	81.00	81.40
Bermuda hay	ton	48.00	54.01
Sorghum	cwt	2.86	3.00

[a] Spring-calving; 205-day weaning

[b] Fall-calving; 205-day weaning

(-)$77.63 and (-)$52.60 per unit cow-calf production; sorghum, (-)$22.51; alfalfa, (-)$105.26; and native hay, $21.26.

Upper costs for selected sell activities in the solution are also summarized in Table 46. The upper costs for sorghum and Bermuda hay are $3.00 and $54.13 per unit respectively. Per unit upper costs for other sell activities are $81.40 for steer calves, and $70.00 for heifer calves.

Unconstrained Borrowed Capital; Unconstrained Hired Labor. Hired labor was constrained in two labor periods for the medium typical farm with full-time operator labor and unlimited borrowed capital resources. An additional solution was generated to determine the impact of unlimited hired labor on the optimal farm organization for this operator labor/capital scenario. When the hired labor constraint is relaxed, returns to overhead, risk, management, and operator labor are $110,387.38 (Table 47). The optimal solution includes 323 acres of wheat, 145 acres of native hay, 23.07 head of stocker heifers, and one 140-sow farrow-to-finish enterprise. Although 2,496 hours of operator labor are available, an additional 1,085.14 hours of labor are hired. Total borrowing in this scenario is $220,736.14. Marketing activities permit the sale of 11,628 bushels of wheat, 217.50 tons of native hay, and 5,757.00 hundredweights of slaughter hogs. No sorghum is produced on the farm; therefore, the 16,245.60 hundredweights of sorghum required by the swine operation are purchased.

Part-time Operator Labor Available; Unconstrained Borrowed Capital; No Swine Production

The optimal solution for the medium-sized base farm with operator labor available on a part-time basis is considerably different than the solution obtained with full-time operator labor resources. Returns to overhead, risk,

TABLE 47

SUMMARY OF INPUT AND OUTPUT LEVELS IN MPSX OPTIMAL SOLUTION FOR MEDIUM TYPICAL FARM WITH FULL-TIME OPERATOR LABOR, UNCONSTRAINED BORROWED CAPITAL, AND UNCONSTRAINED HIRED LABOR

Activity	Unit	Level
Objective function	dollar	110,387.38
Wheat	acre	323.00
Native hay	acre	145.00
Stocker heifers	head	23.07
Farrow-to-finish (140-sow)	enterprise	1.00
Operator labor	hour	2,496.00
Hired labor	hour	1,085.14
Total borrowing	dollar	220,736.14
Wheat sold	bushel	11,628.00
Slaughter hogs sold	cwt	5,757.00
Sorghum purchased	cwt	16,245.00
Heifers (6-700#)	cwt	143.04
Native hay	ton	217.50
Debt:Asset ratio		0.44

management and operator labor in the part-time labor scenario are $28,238.27. Five resources are included in the solution at upper limit level: dryland, pasture, operator labor in September, and owner-provided intermediate and long-term capital.

The shadow prices for the constrained resources and the ranges over which they are valid are presented in Table 48. Nonirrigated cropland has a value in use of $79.12 per acre, a value which holds between 161.60 and 347.08 acres. The shadow price for pasture is $26.29 and is valid between 0.00 and 172.39 acres. Each additional hour of operator labor in September is worth $4.50, or the wage rate at which additional labor can be hired. This shadow price holds between 90.34 and 263.34 hours. Additional intermediate and long-term capital furnished by the owner is worth $0.12 and $0.11 respectively. The ranges that apply to these shadow prices are fairly narrow: (-) $255,594.06 to $43,965.25 for intermediate equity capital and (-)$34,306.06 to $289,750.00 for long-term equity capital.

Table 49 contains a summary of input and output levels for activities included in the optimal solution for the medium-sized base farm with part-time operator labor resources. Included in the solution are 323 acres of wheat, 152 acres of native hay, and 23.07 head of stocker heifers. These three enterprises require 343.00 hours of operator labor, 159.34 hours of hired labor, and $62,427.25 of borrowed capital. Marketing activities permit the sale of 11,628 bushels of wheat, 228 tons of native hay, and 143.04 hundredweights of 6-700 pound heifers.

Unit costs for production activities at limit are listed in Table 50. Forcing in one unit of a cow-calf enterprise would reduce returns by as much as $90.25. The objective function value would decline by $164.52 per acre alfalfa forced into the farm organization. Returns forfeited when other activities are forced into

TABLE 49
SUMMARY OF INPUT AND OUTPUT LEVELS IN MPSX OPTIMAL SOLUTION FOR MEDIUM BASE FARM WITH PART-TIME OPERATOR LABOR

Activity	Unit	Level
Objective function	dollar	28,238.27
Wheat	acre	323.00
Native hay	acre	152.00
Stocker heifers	head	23.07
Operator labor	hour	
January		38.30
February		57.68
March		12.46
June		51.68
August		64.60
November		2.31
December		12.46
Hired labor	hour	159.34
Total borrowing	dollar	62,427.25
Wheat sold	bushel	11,628.00
Native hay sold	ton	228.00
Heifers (6-700#)	cwt	143.04
Debt:Asset ratio		0.18

TABLE 50

SUMMARY OF MPSX RANGE OUTPUT FOR PRODUCTION ACTIVITIES AT LIMIT LEVEL AND SELECTED SELL ACTIVITIES ON MEDIUM BASE FARM WITH PART-TIME OPERATOR LABOR

A. PRODUCTION ACTIVITIES AT LIMIT LEVEL

Activity	Unit	Input cost	Unit cost	Upper cost
Cow-calf[a]	head	(-)215.90	90.25	(-)125.65
Alfalfa	acre	(-)296.50	164.52	(-)131.98
Native pasture	acre	(-) 2.67	21.84	19.17
Bermuda hay	acre	(-)175.92	16.76	(-)159.16
Bermuda pasture	acre	(-) 61.53	84.16	22.63
Sorghum	acre	(-) 49.25	49.24	(-) 0.01

B. SELECTED SELL ACTIVITIES

Activity	Unit	Input cost	Upper cost
Heifers (4-500#)	cwt	$69.00	$70.00
Steers(4-500#)	cwt	81.00	81.40

[a] Fall-calving; 205-day weaning

the farm plan, ceteris paribus, are $21.84 per acre native pasture, $49.24 per acre sorghum, $16.76 per acre Bermuda hay, and $84.16 per acre Bermuda pasture. Upper costs are (-)$125.65 for the cow-calf enterprises, (-)$131.98 for alfalfa, $19.17 for native hay, (-)0.01 for sorghum, (-)$159.16 for Bermuda hay, and $22.63 for Bermuda pasture. Per unit upper costs for selected sell activities are also summarized in Table 50. These are $81.40 for steer calves and $70.00 for heifer calves.

Part-time Operator Labor Available and the Opportunity for Swine Production

Unconstrained Borrowed Capital. Returns to overhead, risk, management, and operator labor for the medium farm with part-time operator labor resources and unlimited borrowing are $50,674.25. This objective function value and the corresponding solution set are identical to the values obtained for the medium farm with part-time operator labor resources and borrowing constrained within a debt:asset of 0.80. Nonirrigated cropland, pasture, hired labor in periods April, June, and September, and all classifications of owner-furnished capital are included at upper limit level in the optimal solution for this scenario. In addition, operator labor is constrained in all labor periods.

The shadow prices for these resources are summarized in Table 51. An additional acre of dryland is valued at $90.65 per acre, as compared to the $3.98 per acre shadow price of pasture. These values are valid between 253.37 and 440.00 acres of dryland and 124.65 and 254.58 acres of pasture. The shadow prices of operator labor in April, June, and September are $22.75, $282.95 and $294.78 respectively. The ranges over which these values hold are 88.09 to 108.65 hours in April, to 90.40 to 119.21 hours in June, and 84.00

TABLE 51

SUMMARY OF MPSX RANGE OUTPUT FOR ROWS AT LIMIT LEVEL ON MEDIUM TYPICAL FARM WITH PART-TIME OPERATOR LABOR AND UNCONSTRAINED BORROWED CAPITAL[a]

Row	Unit	Activity level	Range	Shadow price
Dryland	acre	323.00	253.37 - 440.00	$ 90.65
Pasture	acre	152.00	124.65 - 254.58	3.98
Hired labor	hour			
April		173.00	157.09 - 177.65	18.25
June		173.00	159.40 - 188.21	278.45
September		173.00	153.00 - 183.59	290.28
Operator labor	hour/mo.			
January		104.00	97.82 - 270.82	4.50
February		104.00	100.22 - 273.22	4.50
March		104.00	99.05 - 272.05	4.50
April		104.00	89.09 - 108.65	22.75
May		104.00	98.15 - 271.15	4.50
June		104.00	90.40 - 119.21	282.95
July		104.00	94.64 - 267.64	4.50
August		104.00	92.00 - 265.00	4.50
September		104.00	84.00 - 114.59	294.78
October		104.00	84.00 - 257.00	4.50
November		104.00	85.97 - 258.97	4.50
December		104.00	94.62 - 267.62	4.50

TABLE 51 (Continued)

Row	Unit	Activity level	Range	Shadow price
Short-term capital[b]	dollar	10,000.00	(-)271,288.00 - 13,744.39	0.12
Intermediate capital[c]	dollar	25,000.00	(-)256,288.00 - 199,830.56	0.12
Long-term capital[d]	dollar	246,288.00	(-) 35,000.00 - 289,750.00	0.11

a Solution values are valid for medium typical farm with part-time operator labor and borrowing constrained within a debt:asset of 0.80.

b,c,d Owner-furnished capital

to 114.59 hours in September. Operator labor in the nine other labor periods is worth a constant $4.50 per hour. The ranges over which this value hold vary with the amount of labor hired and are different for every period.

Hired labor in April has a value in use of $18.25, while an additional hour of hired labor in June and September is worth $278.45 and $290.28, respectively. The shadow price of April hired labor is valid between 157.09 and 177.65 hours, while the value for June holds between 159.40 and 188.21 hours. The marginal valve product of labor hired in September is valid between 153.00 and 183.59 hours. Short- and intermediate-term capital furnished by the owner-operator have a marginal value product of $0.12. This value holds between (-)$271,288.00 and $13,744.39 of short-term equity capital and between (-)$256,288.00 and $199,830.56 of intermediate equity capital. An additional dollar of long-term equity capital is worth $0.11, a value that applies between (-)$35.000.00 and $289,750.00.

A variety of production activities appear in the solution for this scenario, including 19.66 head of stocker heifers and an 140-sow farrow-to-finish enterprise (Table 52). Crop enterprises in the farm plan are 251.37 acres of wheat, 40.00 acres of alfalfa production, 117.65 acres of native pasture, 27.35 acres of idle pasture and 31.63 acres of sorghum production. These production enterprises use 1,248 hours of operator labor, 1,986.47 hours of hired labor, and $222,042.75 of borrowed capital. Marketing activities are used to sell 1,440.00 bushels of wheat, 816.96 tons of alfalfa, 121.96 hundredweights of 6-700 pound heifers, and 5,757.00 hundredweights of slaughter hogs. Although all production in the sorghum enterprise is transferred to the swine enterprise for on-farm feed processing, this activity requires the purchase of an additional 15,296.76 hundredweights of sorghum.

TABLE 52

SUMMARY OF INPUT AND OUTPUT LEVELS IN MPSX OPTIMAL SOLUTION FOR MEDIUM TYPICAL FARM WITH FULL-TIME OPERATOR LABOR AND UNCONSTRAINED BORROWED CAPITAL[a]

Activity	Unit	Level
Objective function	dollar	50,674.25
Wheat	acre	251.37
Alfalfa	acre	40.00
Native pasture	acre	117.65
Idle pasture	acre	27.35
Sorghum	acre	31.63
Stocker heifers	head	19.66
Farrow-to-finish (140-sow)	enterprise	1.00
Operator labor	hour	1,248.00
Hired labor	hour	1,986.47
Total borrowing	dollar	222,042.75
Alfalfa sold	ton	816.96
Slaughter hogs sold	cwt	5,757.00
Sorghum purchased	cwt	15,296.76
Wheat sold	bushel	1,440.00
Heifers (6-700#) sold	cwt	121.96
Debt:Asset ratio		0.44

[a] Solution values are valid for medium farm with part-time operator labor available and borrowing constrained within a debt:asset of 0.80.

Unit costs for production activities included in the optimal solution at lower limit level represent the revenues forfeited by forcing in one unit of the enterprise in to the farm organization, while upper costs for these activities identify the value of that activity in the objective function that would alter the status or level of the activity in the solution. Unit costs for these production activities are presented in Table 53. These per unit costs are $242.62 and $411.66 respectively for the cow-calf enterprises; stocker steers, $3.30; Bermuda hay, $336.35; Bermuda pasture, $217.50. Upper costs for the cow-calf enterprises are (-)$76.16 and $195.76. These costs for other activities are (-)$49.92 for stocker steers; Bermuda hay, $160.43; and Bermuda pasture, $155.97.

Table 53 also lists the input and upper costs for selected sell activities in this scenario. Upper costs for these sell activities are $3.00 per hundredweight of sorghum; $148.67 per ton of native hay; and $70.00 per hundredweight of heifer calves. Input costs identify the actual prices received by the operator for each of these commodities and are the same as the values discussed in previous sections.

Borrowing Constrained Within a Debt:Asset Ratio of 0.30. Returns to overhead, risk, management, and operator labor for the medium typical farm with part-time operator labor available and borrowing restricted within a debt:asset of 0.30 are $57,291.32. Operator labor in eight periods is used at upper limit levels, as are all classes of owner-provided capital. Other constrained resources in this scenario are nonirrigated cropland, pasture, and hired labor in September.

The marginal value products, or shadow prices, for these limiting resources are listed in Table 54. In this scenario, an additional acre of

TABLE 53

SUMMARY OF MPSX RANGE OUTPUT FOR PRODUCTION ACTIVITIES AT LIMIT LEVEL AND SELECTED ACTIVITIES ON MEDIUM TYPICAL FARM WITH PART-TIME OPERATOR LABOR AND UNCONSTRAINED BORROWED CAPITAL[a]

A. PRODUCTION ACTIVITIES AT LIMIT LEVEL

Activity	Unit	Input cost	Unit cost	Upper cost
Cow-calf[b]	head	$(-)166.46	$242.62	$(-) 76.16
Cow-calf[c]	head	(-)215.90	411.66	195.76
Stocker steers	head	(-) 53.22	3.30	(-) 49.92
Bermuda hay	acre	(-)175.92	336.35	160.43
Bermuda pasture	acre	(-) 61.53	217.50	155.97

B. SELECTED SELL ACTIVITIES

Activity	Unit	Input cost	Upper cost
Heifers (4-500#)	cwt	$ 69.00	$ 70.00
Native hay	ton	46.00	148.67
Sorghum	cwt	2.86	3.00

[a] Solution values are valid for medium typical farm with part-time operator labor and borrowing constrained within a debt:asset ratio of 0.80.

[b] Spring-calving; 205-day weaning

[c] Fall-calving; 205-day weaning

TABLE 54

SUMMARY OF MPSX RANGE OUTPUT FOR ROWS AT LIMIT LEVEL ON MEDIUM TYPICAL FARM WITH PART-TIME OPERATOR LABOR AND BORROWING CONSTRAINED WITHIN A DEBT:ASSET RATIO OF 0.30

Row	Unit	Activity level	Range	Shadow price
Dryland	acre	323.00	311.18 - 355.31	$65.68
Pasture	acre	152.00	127.90 - 217.90	3.53
Hired labor	hour			
September		173.00	152.50 - 189.15	59.75
Operator labor	hour			
January		104.00	(-)32.35 - 140.65	4.50
February		104.00	(-)12.97 - 160.03	4.50
March		104.00	(-)58.20 - 114.81	4.50
April		104.00	(-)61.80 - 111.20	4.50
June		104.00	(-)26.32 - 146.68	4.50
August		104.00	(-)13.40 - 159.60	4.50
September		104.00	83.50 - 123.15	64.25
December		104.00	(-)58.19 - 114.81	4.50
Short-term capital[a]	dollar	10,000.00	9,272.03 - 10,414.17	0.12
Intermediate capital[b]	dollar	25,000.00	24,272.03 - 25,414.17	0.12

TABLE 54 (Continued)

Row	Unit	Activity level	Range	Shadow price
Long-term capital[c]	dollar	246,288.00	245,560.03 - 246,702.17	0.11

[a,b,c] Owner-furnished capital

nonirrigated cropland would add $65.68 to returns when 311.18 to 355.31 acres of dryland are available. Pasture land is worth $3.53 per acre, a value that holds between 127.90 and 217.90 acres. The shadow price of operator labor in periods where hired labor is not constrained is $4.50 per hour. In September, all available hired labor is utilized; therefore, an additional hour of operator labor is valued at $64.25. The range over which this value holds is 83.50 and 123.15. Additional hired labor in September is worth $59.75 per hour when between 152.50 and 189.15 hours are considered. Short-term and intermediate equity capital have values in use of $0.12, while additional long-term equity capital is worth $0.11. These shadow prices are valid relatively very narrow ranges: $9,272.03 to $10,414.17 for short-term capital, $24,272.03 to 25,414.17 for intermediate capital, and $245,560.03 to 246,702.17 for long-term capital.

Although the farm organization in this scenario is similar to that when unlimited borrowed capital is available, a confinement swine feedlot appears in the optimal solution instead of the 140-sow farrow-to-finish enterprise (Table 55). Also included in the farm plan are 38.67 head of stocker heifers, 323.00 acres of wheat production, 95.30 acres of native pasture, 30.60 acres of native hay production, and 24.10 acres of idle pasture. These six production enterprises require the following inputs: 1,218.08 hours of operator labor, 392.78 hours of hired labor, and $120,553.72 of borrowed capital. Marketing activities are used to sell 11,628.00 bushels of wheat, 45.90 tons of native hay 227.45 hundredweights of 6-700 pound heifers, and 3,381 hundredweights of slaughter hogs. No sorghum is produced on-farm; therefore, 7,841 hundredweights are purchased for feed processing in the swine enterprise.

TABLE 55

SUMMARY OF INPUT AND OUTPUT LEVELS IN MPSX SOLUTION FOR MEDIUM TYPICAL FARM WITH PART-TIME OPERATOR LABOR BORROWING CONSTRAINED WITHIN A DEBT:ASSET RATIO OF 0.30

Activity	Unit	Level
Objective function	dollar	57,291.32
Wheat	acre	323.00
Native pasture	acre	95.30
Native hay	acre	30.60
Idle pasture	acre	24.10
Stocker heifers	head	38.67
Confinement swine		
feedlot	enterprise	1.00
Operator labor	hour	
May		95.00
July		97.41
October		95.00
November		98.67
Hired labor	hour	392.78
Total borrowing	dollar	120,553.72
Wheat sold	bushel	11,628.00
Native hay sold	ton	45.90
Slaughter hogs sold	cwt	3,381.00
Sorghum purchased	cwt	7,841.00
Debt:Asset ratio		0.30
Heifers (6-700#) sold	cwt	227.45

TABLE 56

SUMMARY OF MPSX RANGE OUTPUT FOR PRODUCTION ACTIVITIES AT LIMIT LEVEL AND SELECTED SELL ACTIVITIES ON MEDIUM TYPICAL FARM WITH PART-TIME OPERATOR LABOR AND BORROWING CONSTRAINED WITHIN A DEBT:ASSET RATIO OF 0.30

A. PRODUCTION ACTIVITIES AT LIMIT LEVEL

Activity	Unit	Input cost	Unit cost	Upper cost
Cow-calf[a]	head	(-)166.46	92.75	$(-) 73.71
Cow-calf[b]	head	(-)215.90	185.65	(-) 30.25
Stocker steers	head	(-) 53.22	1.92	(-) 51.30
Alfalfa	acre	(-)296.50	160.88	(-)135.62
Bermuda hay	acre	(-)175.92	48.73	(-)127.19
Bermuda pasture	acre	(-) 61.53	69.87	8.34
Sorghum	acre	(-) 49.25	42.40	(-) 6.85

B. SELECTED SELL ACTIVITIES

Activity	Unit	Input cost	Upper cost
Heifers (4-500)	cwt	69.00	70.00
Sorghum	cwt	2.86	3.00

[a] Spring-calving; 205-day weaning

[b] Fall-calving; 205-day weaning

Table 56 summarizes the MPSX range output for both production activities at limit level and selected sell activities on the medium typical farm with part-time operator labor and borrowing constrained to maintain a high equity status. Unit costs for the cow-calf enterprises are $92.75 and $185.65 per budget unit, while unit costs for the other production activities at lower limit level are $1.92 for stocker steers, $160.88 for alfalfa, $48.73 for Bermuda hay, $69.87 for Bermuda pasture, and $42.40 for sorghum. Upper costs for these activities are (-)$73.71 and (-)30.25 for the cow-calf enterprises; stocker steers, (-)$51.30; alfalfa, (-)$135.62; Bermuda hay, (-) $127.19; Bermuda pasture, $8.34; and sorghum, (-)6.85. Per unit upper costs for selected sell activities in the solution for this scenario are $70.00 for heifer calves, and $3.00 for sorghum.

Unconstrained Borrowed Capital; Unconstrained Hired Labor. In scenarios 16 & 17, hired labor is constrained in two labor periods, June and September. Therefore, another solution was obtained to determine the impact of unlimited hired labor on the organization of the farm's resources. Table 57 summarizes the solution obtained when the hired labor constraint is relaxed. Returns to overhead, risk, management, and operator labor are $105,991.08.

Production enterprises and the level of their inclusion in the optimal farm plan are 323 acres of wheat, 145 acres of native hay, 23.07 head of stocker heifers, and one 140-sow farrow-to-finish enterprise. Operator labor resources are exhausted and an additional 2,335.14 hours of labor are hired. Total borrowing in this scenario is $215,952.76. Marketing activities are used to sell 11,628 bushels of wheat, 217.50 tons of native hay, 143.04 hundredweights of 6-700 pound heifers, and 5,757 hundredweights of slaughter hogs. These activities are also used to purchase the 16,245.60 hundredweights of sorghum required for swine rations.

TABLE 57

SUMMARY OF INPUT AND OUTPUT LEVELS IN MPSX OPTIMAL SOLUTION FOR MEDIUM TYPICAL FARM WITH PART-TIME OPERATOR LABOR, UNCONSTRAINED BORROWED CAPITAL AND UNCONSTRAINED HIRED LABOR[a]

Activity	Unit	Level
Objective function	dollar	105,991.08
Wheat	acre	323.00
Native hay	acre	145.00
Stocker heifers	head	23.07
Farrow-to-finish (140-sow)	enterprise	1.0
Operator labor	hour	1,248.00
Hired labor	hour	2,335.14
Total borrowing	dollar	215,952.76
Wheat sold	bushel	11,628.00
Native hay sold	ton	217.50
Slaughter hogs sold	cwt	5,757.00
Sorghum purchased	cwt	16,245.60
Debt:Asset ratio		0.43
Heifers (6-700#) sold	cwt	143.04

[a] Solution values are valid for medium typical farm with part-time operator labor, borrowing constrained within a debt:asset ratio of 0.80, and unconstrained hired labor

Borrowing Constrained Within a Debt:Asset Ratio of 0.30; Unconstrained Hired Labor. When limited hired resources are available to the medium typical farm maintaining a high equity/low debt status, hired labor is constrained in both June and September. Therefore, the hired labor restriction was relaxed to determine the impact of additional labor resources on the optimal solution. The objective function value is $61,689.06 when unlimited amounts of hired labor are available (Table 58). The optimal solution includes 323 acres of wheat, 150 acres of native hay, 23.07 head of stocker heifers, and a confinement finishing hog operation. Operator labor and hired labor levels are 1,205.31 hours and 436.18 hours respectively. Total borrowing when hired labor is unrestricted is $118,907.96. Commodities sold in this scenario include 11,628 bushels of wheat, 225 tons of native hay, and 143.04 hundredweights of 6-700 pound heifers and 3,381 hundredweights of slaughter hogs. More than 7,800 hundredweights of sorghum are purchased for use in the swine feedlot enterprise.

A summary of all the solutions obtained for the medium size farms is presented in Table 59. When the hired labor constraint is relaxed for the scenario incorporating full-time operator labor, and unconstrained borrowed capital (scenario 11), returns increase $8,794.47. Total borrowing increases $1,531.40. An additional 63.44 hours of labor are hired. Relaxing the hired labor constraint decreased the number of production enterprises from five to four: wheat, native hay, stocker heifers, and an 140-sow farrow-to-finish enterprise. Sorghum production also increased 2,250.00 hundredweights when hired labor is not restricted.

Similar changes occur when the hired labor restriction is removed in scenario 16. The objective function value increases 109.2% or $55,371.63. Despite this considerable increase in returns, total borrowing decreases from

TABLE 58

SUMMARY OF INPUT AND OUTPUT LEVELS IN MPSX SOLUTION FOR MEDIUM TYPICAL FARM WITH PART-TIME OPERATOR LABOR, UNCONSTRAINED BORROWED CAPITAL, AND UNCONSTRAINED HIRED LABOR

Activity	Unit	Level
Objective function	dollar	61,689.06
Wheat	acre	323.00
Native hay	acre	150.00
Stocker heifers	head	23.07
Confinement swine feedlot	enterprise	1.00
Operator labor	hour	1,205.31
Hired labor	hour	436.18
Total borrowing	dollar	118,907.96
Wheat sold	bushel	11,628.00
Native hay sold	ton	225.00
Slaughter hogs sold	cwt	3,381.00
Sorghum purchased	cwt	7,841.00
Debt:Asset ratio		0.30
Heifers (6-700#) sold	cwt	143.04

TABLE 59

SUMMARY OF PRODUCTION ENTERPRISES AND RESOURCES USE FOR ALL MEDIUM SIZE FARM SCENARIOS

	Unit	--- Scenario number --- 10	11	12
Swine enterprises		no	yes	yes
Operator labor level[a]		FT	FT	FT
Capital restriction[b]		U	HE	U,LE
Hired labor level[c]		FTE	FTE	FTE
Objective function	dollar	28,706.27	62,981.34	101,592.91
CROP ENTERPRISES				
Wheat	acre	323.00	323.00	248.00
Alfalfa	acre			
Sorghum	acre			75.00
Native hay	acre	152.00	150.00	
Native pasture	acre			145.00
Idle pasture	acre			
LIVESTOCK ENTERPRISES				
Stocker heifers	head	23.07	23.07	38.43
Swine	enterprise		CFFDTF	140F2F
RESOURCES USED				
Operator labor	hour	447.49	1,492.49	2,496.00
Hired labor	hour	55.34	149.00	1,032.58
Dryland	acre	323.00	323.00	323.00
Pasture	acre	152.00	152.00	152.00
Total borrowing	dollar	62,427.25	118,907.96	219,205.34
Sorghum purchased	cwt		7,841.00	13,995.60
PRODUCTION				
Slaughter hogs	cwt		3,381.00	5,757.00
Wheat	bushel	11,628.00	11,628.00	8,928.00
Alfalfa	ton			
Sorghum	cwt			
Native hay	ton	228.00	225.00	
Heifers (6-700#)	cwt	143.04	143.04	238.26
DEBIT:ASSET RATIO		0.18	0.30	0.48

[a] FT Operator labor = 2,496 hrs/yr; PT = 1,248 hrs/yr

[b] U = Unconstrained borrowing; LE = borrowing permitted up to a D/A Ratio of 0.80; HE = borrowing permitted up to a D/A Ratio of 0.30

[c] FTE = One full-time laborer equivalent

TABLE 59 (Continued)

	Unit	--- Scenario number --- 14	15	16
Swine enterprises		yes	no	yes
Operator labor level[a]		FT	PT	PT
Capital restriction[b]		U	U	HE
Hired labor level[c]		U	FTE	FTE
Objective function	dollar	110,387.38	28,238.27	57,291.32
CROP ENTERPRISES				
Wheat	acre	323.00	323.00	323.00
Alfalfa	acre			
Sorghum	acre			
Native hay	acre	145.00	152.00	30.68
Native pasture	acre			95.30
Idle pasture	acre			24.10
LIVESTOCK ENTERPRISES				
Stocker heifers	head	23.07	23.07	38.67
Swine	enterprise	140F2F		CFFDTF
RESOURCES USED				
Operator labor	hour	2,496.00	343.00	1,218.08
Hired labor	hour	1,085.14	159.34	392.78
Dryland	acre	323.00	323.00	323.00
Pasture	acre	152.00	152.00	152.00
Total borrowing	dollar	220,736.74	62,427.25	120,553.72
Sorghum purchased	cwt	16,245.60		7,841.00
PRODUCTION				
Slaughter hogs	cwt	5,757.00		3,381.00
Wheat	bushel	11,628.00	11,628.00	11,628.00
Alfalfa	ton			
Sorghum	cwt			
Native hay	ton	217.50	228.00	45.90
Heifers (6-700#)	cwt	143.04	143.04	227.45
DEBIT:ASSET RATIO		0.44	0.18	0.30

[a] FT Operator labor = 2,496 hrs/yr; PT = 1,248 hrs/yr

[b] U = Unconstrained borrowing; LE = borrowing permitted up to a D/A Ratio of 0.80; HE = borrowing permitted up to a D/A Ratio of 0.30

[c] FTE = One full-time laborer equivalent

TABLE 59 (Continued)

	Unit	--- Scenario number --- 17, 18	19	20
Swine enterprises		yes	yes	yes
Operator labor level[a]		PT	PT	PT
Capital restriction[b]		U,LE	HE	U
Hired labor level[c]		FTE	U	U
Objective function	dollar	50,674.25	61,689.06	105,991.08
CROP ENTERPRISES				
Wheat	acre	40.00	323.00	323.00
Alfalfa	acre	251.37		
Sorghum	acre	31.63		
Native hay	acre		150.00	145.00
Native pasture	acre	117.65		
Idle pasture	acre	27.35		
LIVESTOCK ENTERPRISES				
Stocker heifers	head	19.66	23.07	23.07
Swine	enterprise	140F2F	CFFDTF	140F2F
RESOURCES USED				
Operator labor	hour	1,248.00	1,205.31	1,248.00
Hired labor	hour	1,986.47	436.18	2,335.14
Dryland	acre	323.00	323.00	323.00
Pasture	acre	152.00	152.00	152.00
Total borrowing	dollar	222,042.75	118,907.96	215,952.76
Sorghum purchased	cwt	15,296.76	7,841.00	16,245.60
PRODUCTION				
Slaughter hogs	cwt	5,757.00	3,381.00	5,757.00
Wheat	bushel	1,440.00	11,628.00	11,628.00
Alfalfa	ton	816.96		
Sorghum	cwt			
Native hay	ton		225.00	217.50
Heifers (6-700#)	cwt	121.96	143.04	143.04
DEBIT:ASSET RATIO		0.44	0.30	0.43

[a] FT Operator labor = 2,496 hrs/yr; PT = 1,248 hrs/yr

[b] U = Unconstrained borrowing; LE = borrowing permitted up to a D/A Ratio of 0.80; HE = borrowing permitted up to a D/A Ratio of 0.30

[c] FTE = One full-time laborer equivalent

$222,042.75 to $215,952.76. An additional 1,348.67 hours of labor are employed when the hired labor constraint is relaxed. Moreover, only wheat, native hay, stocker heifers, and swine production are included. Finally, 948.84 additional hundredweights of sorghum are purchased.

Scenario 20 considers the effect of unlimited hired labor on the part-time operator labor/scenario with borrowing permitted up to a Debt:Asset ratio of 0.30. Returns to overhead, risk , management, and operator labor are $61,689.06 or 7.7% greater than returns in the comparable constrained hired labor scenario. Total borrowing, however, decreases by $1,645.76. An additional 43.40 hours of labor are hired. Three production enterprises are included in the optimal solution: wheat, native hay, stocker heifers, and an 140-sow farrow-to-finish enterprise. When hired labor resources are not restricted, no sorghum is produced on the farm; therefore, sorghum purchases increase by 7,455.76 hundredweights.

Large Size Farms

Full-time Operator Labor; Unconstrained Borrowed Capital; No Swine Production

Like the medium size base farms, the solutions for the large size base farms with full-time and part-time operator labor resources differ considerably. Returns to overhead, risk, management, and operator labor in the full-time operator labor scenario are $33,106.42. Thirteen resources are included in the optimal solution at upper limit levels: nonirrigated cropland; pasture; hired labor in September; operator labor in February, August, and September; and short-term, intermediate, and long-term owner-furnished capital.

TABLE 60

SUMMARY OF MPSX RANGE OUTPUT FOR ROWS AT LIMIT LEVEL
ON LARGE BASE FARM WITH FULL-TIME OPERATOR LABOR

Row	Unit	Activity level	Range	Shadow price
Dryland	acre	1,111.00	1,108.00 - 1,179.40	$28.80
Pasture	acre	641.00	131.48 - 993.26	0.99
Hired labor	hour			
September		346.00	312.00 - 347.50	90.32
Operator labor	hour			
February		208.00	(-) 98.69 - 247.31	4.50
August		208.00	(-)124.40 - 221.60	4.50
September		208.00	(-)174.00 - 209.50	94.82
Short-term				
capital[a]	dollar	10,000.00	(-)539,270.00 - 41,733.55	0.12
Intermediate				
capital[b]	dollar	25,000.00	(-)524,270.00 - 136,313.81	0.12
Long-term				
capital[c]	dollar	514,270.00	(-) 35,000.00 -1,028,540.00	0.11

[a,b,c] Owner-furnished capital

The shadow prices for these resources are listed in Table 60. The value per additional acre of dryland is $28.80 when between 1,108.00 and 1,179.40 acres are considered. Pasture has a shadow price of $0.99 per acre, a value which applies between 131.48 and 993.26 acres. Operator labor in February and August, has a value in use of $4.50 per hour. An additional hour of operator labor in September is worth $94.82, considerably more than operator labor in the two other constrained periods. The shadow price of operator labor in September is valid between (-)174.00 and 209.50 hours.

The marginal value product for one more hour of hired labor in September is $90.32 and holds between 312.00 and 347.50 hours for September hired labor. Both short-term and intermediate equity capital have a shadow price of $0.12, while an additional dollar of long term capital furnished by the owner-operator is worth $0.11. These shadow prices apply to fairly wide ranges: (-)$539,270.00 to $41,733.55 for short-term capital; (-)$524,270.00 to $136,313.81 for intermediate capital; and (-)$35,000.00 to $1,028,540.00 for long-term capital.

The optimal solution for the large size base farm with full-time operator labor resources contains three crop/hay enterprises and one livestock enterprise (Table 61). This solution includes 1,108.00 acres of wheat, 641.00 acres of native pasture, 3.00 acres of sorghum, and 170.71 head of stocker heifers. These production activities require 1,295.14 hours of operator labor, 398.91 hours of hired labor, and $657,317.31 of borrowed capital. Marketing activities permit the sale of 1,058.43 hundredweights of stocker heifers, 39,888 bushels of wheat, and 90 hundredweights of sorghum.

Input, unit, and upper costs for production activities included at lower limit level in the solution for this scenario are summarized in Table 62. Unit costs for these activities represent the loss of returns if one unit of this activity were forced

TABLE 61

SUMMARY OF INPUT AND OUTPUT LEVELS IN MPSX OPTIMAL SOLUTION FOR LARGE BASE FARM WITH FULL-TIME OPERATOR LABOR

Activity	Unit	Level
Objective function	dollar	33,106.42
Wheat	acre	1,108.00
Native pasture	acre	641.00
Sorghum	acre	3.00
Stocker heifers	head	170.71
Operator labor	hour	
January		180.83
March		92.61
April		108.97
May		0.15
June		178.57
July		0.75
November		17.10
December		92.19
Hired labor	hour	398.91
Total borrowing	dollar	657,317.37
Wheat sold	bushel	39,888.00
Sorghum sold	cwt	90.00
Debt:Asset ratio		0.54
Heifers (6-700#) sold	cwt	1,058.43

TABLE 62

SUMMARY OF MPSX RANGE OUTPUT FOR PRODUCTION ACTIVITIES AT LIMIT LEVEL AND SELECTED SELL ACTIVITIES ON LARGE BASE FARM WITH FULL-TIME OPERATOR LABOR

A. PRODUCTION ACTIVITIES AT LIMIT LEVEL

Activity	Unit	Input cost	Unit cost	Upper cost
Cow-calf[a]	head	$(-)166.46	$ 22.86	$(-)143.60
Cow-calf[b]	head	(-)215.90	121.71	(-) 94.19
Stocker steers	head	(-) 53.22	4.69	(-) 48.53
Alfalfa	acre	(-)296.50	119.22	(-)177.28
Bermuda pasture	acre	(-) 61.53	67.18	5.65
Native hay	acre	(-) 34.95	35.21	0.26

B. SELECTED SELL ACTIVITIES

Activity	Unit	Input cost	Upper cost
Steers (4-500#)	cwt	$ 81.00	$ 82.00
Heifers (4-500#)	cwt	69.00	70.00
Bermuda hay	ton	48.00	57.50

[a] Spring-calving; 205-day weaning

[b] Fall-calving; 205-day weaning

into the farm plan. Requiring one unit of a cow-calf enterprise would decrease returns by as much as $121.71, while forcing in one unit of the stocker steer enterprise would reduce the optimal objective function value by $4.69.

Unit costs for other activities are $119.22 for alfalfa, $35.21 for native hay, and $67.18 for Bermuda pasture. Upper costs for these activities are (-)$143.60 and (-)$94.19 for cow-calf production; stocker steers, (-)$48.53; alfalfa, (-)$177.28; native hay, $0.26; and Bermuda pasture, $5.65. Input and upper costs for selected sell activities in this solution are also listed in Table 62. The per unit upper costs for these are $70.00 for heifer calves, $82.00 for steer calves, and $57.50 for Bermuda hay.

Full-time Operator Labor Available and the Opportunity for Swine Production

Unconstrained Borrowed Capital. The solutions for the large farms with both unconstrained borrowed capital and borrowing limited so that the debt:asset ratio is less than or equal to 0.80 are identical. In these scenarios, the objective function value is $73,240.21. Several resources are included in the optimal solution at maximum levels: nonirrigated cropland; pasture; hired labor in June and September, and operator labor in all labor periods; and all classes of owner-provided capital.

Table 63 summarizes the shadow prices for these constrained resources and the ranges over which these values apply. An additional acre of dryland is worth $90.65, a value that holds between 1,063.67 and 6,534.00 acres. Land for pasture use has a shadow price of $1.67, which is valid between 7.00 and 1,754.06 acres. Operator labor in all months except June and September has a value in use of $4.50 per hour. The shadow price of March operator labor

TABLE 63

SUMMARY OF MPSX RANGE OUTPUT FOR ROWS AT LIMIT LEVEL ON LARGE TYPICAL FARM WITH FULL-TIME OPERATOR LABOR AND UNCONSTRAINED BORROWED CAPITAL[a]

Row	Unit	Activity level	Range	Shadow price
Dryland	acre	1,111.00	1,063.67 - 6,534.00	$ 90.65
Pasture	acre	641.00	7.00 - 1,754.06	1.67
Hired labor	hour			
June		346.00	144.04 - 366.35	311.36
September		346.00	249.76 - 383.69	281.36
Operator labor	hour			
January	hour	208.00	30.34 - 376.34	4.50
February	hour	208.00	65.98 - 411.98	4.50
March	hour	208.00	48.57 - 394.57	4.50
April	hour	208.00	18.78 - 364.78	4.50
May	hour	208.00	(-) 63.14 - 282.85	4.50
June	hour	208.00	6.04 - 228.35	315.86
July	hour	208.00	28.42 - 374.42	4.50
August	hour	208.00	29.80 - 375.80	4.50
September	hour	208.00	111.46 - 245.69	285.86
October	hour	208.00	89.00 - 257.00	4.50
November	hour	208.00	75.70 - 270.30	4.50
December	hour	208.00	17.18 - 328.82	4.50

TABLE 63 (Continued)

Row	Unit	Activity level	Range	Shadow price
Short-term capital[b]		10,000.00	(-)265,935.50 - 32,997.80	0.12
Intermediate capital[c]		25,000.00	(-)250,935.56 - 305,133.81	0.12
Long-term capital[d]		514,270.00	(-)238,334.41 - 1,028,540.00	0.11

a Solution values are valid for large farm with full-time operator labor and borrowing constrained within a debt:asset ratio of 0.80

b,c,d Owner-furnished capital

applies between (-)48.57 and 394.57 hours, while that for July is valid between 28.42 and 374.42 hours. An additional hour of operator labor in June has a marginal value product of $315.86 as compared to the $285.86 shadow price of September operator labor. The shadow price of June operator labor applies between 6.04 and 228.35 hours, while that of September operator is valid between 111.46 and 245.69 hours.

Hired labor in June and September is also constrained in the solution for this scenario. The shadow price for June hired labor is $311.36 per hour when between 144.04 and 366.35 hours are considered. An additional hour of hired labor in September is worth $281.36, a value which applies between 249.76 and 383.69 hours. Both short-term and intermediate owner-furnished capital have a shadow price of $0.12. Long-term capital provided by the owner-operator has a value in use of $0.11. The ranges that apply to these shadow prices are (-) $265,935.50 to $32,997.80 for short-term equity capital; (-)$250,935.56 to $305,133.81 for intermediate capital; and (-)$238,334.41 to $1,028,540.00 for long-term capital.

The optimal solution for the large farm with full-time operator labor resources and unconstrained borrowed capital is summarized in Table 64. This solution contains six production activities: wheat, alfalfa, sorghum, native pasture, stocker heifers, and a confinement swine feedlot. Of the 1,111 acres of dryland available, 594.00 acres are allocated toward the production of wheat. Other crop enterprises included in this solution are 47.33 acres of alfalfa, 469.67 acres of sorghum, 824.60 hundredweights of 6-700 pound heifers, and 5757 hundredweights of slaughter hogs.

Table 65 presents a summary of the MPSX range output for production activities at limit level and selected sell activities in the solution for this scenario. Unit costs for production activities at lower limit level are $157.69 for the cow-

TABLE 64

SUMMARY OF INPUT AND OUTPUT LEVELS IN MPSX OPTIMAL SOLUTION FOR LARGE TYPICAL FARM WITH FULL-TIME OPERATOR LABOR AND UNCONSTRAINED BORROWED CAPITAL[a]

Activity	Unit	Level
Objective function	dollar	73,240.21
Wheat	acre	594.00
Alfalfa	acre	47.33
Native pasture	acre	634.00
Sorghum	acre	469.67
140F2F feedlot	enterprise	1.00
Operator labor	hrs.	2,496.00
Hired labor		2,048.85
Total borrowing	dollar	817,401.80
Wheat sold	bushel	21,384.00
Alfalfa sold	ton	153.81
Sorghum sold	cwt	2,155.37
Slaughter hogs sold	cwt	5,757.00
Debt:Asset ratio		0.60
Heifers (6-700#) sold	cwt	824.60

[a] Solution values are valid for large farm with full-time operator labor and borrowing constrained within a debt:asset of 0.80.

TABLE 65

SUMMARY OF MPSX RANGE OUTPUT FOR PRODUCTION ACTIVITIES AT LIMIT LEVEL AND SELECTED SELL ACTIVITIES ON LARGE TYPICAL FARM WITH FULL-TIME OPERATOR AND UNCONSTRAINED BORROWED CAPITAL[a]

A. PRODUCTION ACTIVITIES AT LIMIT LEVEL

Activity	Unit	Input cost	Unit cost	Upper cost
Cow-calf[b]	head	(-)215.90	157.69	(-) 58.21
Stocker steers	head	(-) 53.22	14.93	(-) 38.29
Bermuda hay	acre	(-)175.92	356.57	180.65
Bermuda pasture	acre	(-) 61.53	238.91	177.38

B. SELECTED SELL ACTIVITIES

Activity	Unit	Input cost	Upper cost
Heifers (4-500#)	cwt	69.00	70.00
Bulls	cwt	49.00	1,814.36

[a] Solution values are valid for large farm with full-time operator labor and borrowing constrained within a debt:asset of 0.80.

[b] Fall-calving; 205-day weaning

calf enterprise; stocker steers, $14.93; Bermuda hay, $356.57; and $238.91 for Bermuda pasture. Upper costs for these production activities are (-)$58.21 for the cow-calf activity; stocker steers, (-)$38.21; and $180.65 and $177.38 for Bermuda hay and pasture respectively. Upper costs for selected sell activities are $70.00 for heifer calves and $1,814.36 for bulls.

Borrowing Constrained Within a Debt:Asset Ratio of 0.30. Unlike the other labor/capital scenarios, an infeasible solution for the large farm with full-time operator labor resources and borrowing restricted to maintain a low debt/high equity status was obtained. Although borrowing is permitted in this alternative, it is constrained within a debt:asset ratio of 0.30. The solution for the large base farm with full-time operator labor has a debt:asset ratio of 0.53. Given the resource base and set of enterprises considered in this scenario, this is the minimum debt:asset ratio possible. Since this minimum ratio for large farms far exceeds the maximum ratio allowed for high equity maintenance, it is apparent that a feasible solution for this scenario is not possible.

Unconstrained Borrowed Capital; Unconstrained Hired Labor. Hired labor is constrained in two labor periods for the large farm with full-time operator and unlimited borrowed capital resources. Therefore, another problem permitting an unlimited amount of hired labor was constructed to determine the impact of additional labor on the optimal farm plan. Table 66 summarizes the resources included in solution at limit level when the hired labor restriction is removed. Returns to overhead, risk, management, and operator labor are $130,933.56.

All available dryland (1,111 acres) is used in the production of wheat. Pasture resources are allocated to native hay production (634 acres) and a 140-sow confinement system. In this scenario, 79.36 head of stocker heifers

TABLE 66

SUMMARY OF INPUT AND OUTPUT LEVELS IN MPSX OPTIMAL SOLUTION FOR LARGE TYPICAL FARM WITH FULL-TIME OPERATOR LABOR, UNCONSTRAINED BORROWED CAPITAL, AND UNCONSTRAINED HIRED LABOR

Activity	Unit	Level
Objective function	dollar	130,933.56
Wheat	acre	1,111.00
Native hay	acre	634.00
Farrow-to-finish (140-sow)	enterprise	1.00
Stocker heifers	head	79.36
Operator labor	hour	2,496.00
Hired labor	hour	2,391.99
Total borrowing	dollar	816,352.91
Wheat sold	bushel	39,996.00
Native hay sold	ton	951.00
Slaughter hogs sold	cwt	5,757.00
Sorghum purchased	cwt	16,245.60
Debt:Asset ratio		0.58
Heifers (6-700#) sold	cwt	492.01

are also included in the solution. The 140-sow farrow-to-finish enterprise replaces the feedlot enterprise present in the optimal solution when hired labor resources are limited. In addition to the operator labor resources available, 2,391.99 hours of hired labor are required. Total borrowing when hired labor is unrestricted is $816,352.91. Four commodities are sold in the optimal solution: 39,996 bushels of wheat, 951 tons of native hay, 492.01 hundredweights of heifers, and 5,757 hundredweights of slaughter hogs. All sorghum required in the swine enterprise (16,245.60 hundredweights) is purchased.

Part-time Operator Labor; Unconstrained
Borrowing; No Swine Production

Returns to overhead, risk, management and operator labor for the large size base farm with part-time operator resources are (-)$21,420.27. Since all land must either be used in crop or livestock production or assessed a maintenance charge for remaining idle, returns are unexpectedly low. The optimal solution for this base farm includes eighteen resources at maximum levels. These resources are operator labor in January through April, June, August and September; hired labor in September; dryland; pasture; and short-, intermediate-, and long-term equity capital.

The marginal value products, or shadow prices, of these constrained resources are listed in Table 67. The shadow price of nonirrigated cropland is $26.23 per acre and is valid over a relatively narrow range of resource values: 1,041.69 to 1,316.00 acres. Pasture land has a value in use of $0.47 per acre, which applies between 611.76 and 898.15 acres. Although short-term and intermediate equity capital both have a shadow price of $0.12, the ranges over which this value applies are considerably different: (-)$539,269.50 to

TABLE 67

SUMMARY OF MPSX RANGE OUTPUT FOR ROWS AT LIMIT LEVEL ON LARGE BASE FARM WITH PART-TIME OPERATOR LABOR

Row	Unit	Activity level	Range	Shadow price
Dryland	acre	1,111.00	1041.69 - 1,316.00	$26.23
Pasture	acre	641.00	611.76 - 898.15	0.47
Hired labor	hour			
September		346.00	243.50 - 393.83	92.59
Operator labor	hour			
January		104.00	(-) 189.84 - 156.16	4.50
February		104.00	(+)135.84 - 210.16	4.50
March		104.00	(-)232.30 - 113.00	4.50
April		104.00	(-)237.03 - 108.97	4.50
June		104.00	(-)111.27 - 234.73	4.50
August		104.00	(-)166.00 - 179.80	4.50
September		104.00	1.50 - 151.83	97.09
Short-term capital[a]	dollar	10,000.00	(-)539,269.50 - 37,612.78	0.12
Intermediate capital[b]	dollar	25,000.00	(-)524,269.50 - 124,437.84	0.12
Long-term capital[c]	dollar	514,270.00	34,999.88 -1,028,540.00	0.11

a,b,c Owner-furnished capital

$37,612.78 for short-term owner-provided capital as compared to (-)$524,269.50 to $124,437.84 for intermediate equity capital. Long-term capital furnished by the owner has a marginal value product of $0.12, a value which holds between $34,999.88 and $1,028,540.00.

An additional hour of operator labor in September is valued at $97.09. This value applies between 1.50 and 151.83 hours. Operator labor in the other five periods in which it is constrained has a value in use of $4.50 per hour. The ranges that apply to this value vary with the amount of hired labor required. The shadow price of September hired labor is $92.59 and holds between 243.50 and 393.83 hours.

The optimal solution for this resource scenario includes 900.00 acres of wheat, 641.00 acres of native pasture, 211.00 acres of sorghum, and 155.86 head of stocker heifers (Table 68). These four production enterprises require 891.05 hours of operator labor, 725.72 hours of hired labor, and $640,320.65 in borrowed capital. Marketing activities allow the sale of 3,240.00 bushels of wheat, 966.31 hundredweights of 6-700 pound heifers, and 6,330.00 hundredweights of sorghum.

Table 69 presents the input, unit, and upper costs for production activities included in the solution at limit level. Substituting one cow-calf into the production process on this farm would reduce returns by either $36.90 or $139.13, depending upon the calving alternative selected. Unit costs for other production activities included at lower limit level are $0.18 for stocker steers; $47.19 for Bermuda hay; and $68.64 for Bermuda pasture. Upper costs for these activities are (-)$129.56 and (-)$76.76 per unit cow-calf production; (-)$53.04 for stocker steers; and (-)$128.73 and $7.11 for Bermuda hay and pasture respectively. Upper costs for selected sell activities in the solution for the large size base farm with part-time operator labor are also presented in

TABLE 68

SUMMARY OF INPUT AND OUTPUT LEVELS IN MPSX OPTIMAL SOLUTION FOR LARGE BASE FARM WITH PART-TIME OPERATOR LABOR

Activity	Unit	Level
Objective function	dollar	(-)21,420.27
Wheat	acre	900.00
Stocker heifers	head	155.86
Native pasture	acre	641.00
Sorghum	acre	211.00
Operator labor	hour	
July		52.75
May		10.55
November		15.59
December		84.16
Hired labor	hour	725.72
Total borrowing	dollar	640,320.65
Wheat sold	bushel	3,240.00
Heifers (6-700#)	cwt	966.31
Sorghum sold	cwt	6,330.00
Debt:Asset ratio		0.54

TABLE 69

SUMMARY OF MPSX RANGE OUTPUT FOR PRODUCTION ACTIVITIES AT LIMIT LEVEL AND SELECTED SELL ACTIVITIES ON LARGE BASE FARM WITH PART-TIME OPERATOR LABOR AND UNCONSTRAINED BORROWED CAPITAL

A. PRODUCTION ACTIVITIES AT LIMIT LEVEL

Activity	Unit	Input cost	Unit cost	Upper cost
Cow-calf[a]	head	$(-)166.46	$ 36.90	$(-)129.56
Cow-calf[b]	head	(-)215.90	139.13	(-) 76.76
Stocker steers	head	(-) 53.22	0.18	(-) 53.04
Bermuda hay	acre	(-)175.92	47.19	(-)128.73
Bermuda pasture	acre	(-) 61.53	68.64	7.11

B. SELECTED SELL ACTIVITIES

Activity	Unit	Input cost	Upper cost
Heifers (4-500#)	cwt	69.00	70.00
Native hay	ton	48.00	69.52

[a] Spring-calving; 205-day weaning

[b] Fall-calving; 205-day weaning

Table 69. These unit values are 4-500 pound heifers, $70.00, and native hay, $69.52.

Part-time Operator Labor Available

Unconstrained Borrowed Capital. The solutions for both the unconstrained borrowed capital and the low equity maintenance scenarios on the large farm with part-time operator labor resources are identical. Returns to overhead, risk, management, and operator labor are $35,355.04. Nonirrigated cropland, pasture, hired labor in June and September, operator labor in eight periods, and all classes of equity capital are included at upper limit levels.

The shadow prices for these limiting resources and the ranges over which they apply are summarized in Table 70. Operator labor resources in six periods are exhausted. The shadow price of operator labor in all periods except September is $4.50 per hour. The ranges over which this value holds depends upon the amount of labor hired and, therefore, are different for each period. Operator labor in September has a marginal value product of $126.13 when between (-)23.72 and 173.82 hours of labor are available. September hired labor has a shadow prices of $121.63. The shadow price of hired labor in September is valid between 218.28 and 415.82 hours.

Another acre of dryland would increase returns by $39.04 when no less than 971.37 acres and no more than 1,271.40 acres are considered. An additional acre of pasture would increase the objective function value by $1.26 when between 277.00 and 2,090.33 acres are considered. Short-, intermediate-, and long-term capital furnished by the operator have shadow prices of $0.12, $0.12, and $0.11 respectively. These values apply over the following ranges: (-) $539,269.50 and $13,145.80 for short-term capital;

TABLE 70

SUMMARY OF MPSX RANGE OUTPUT FOR ROWS AT LIMIT LEVEL ON LARGE BASE FARM WITH PART-TIME OPERATOR LABOR AND UNCONSTRAINED BORROWED CAPITAL[a]

Row	Unit	Activity level	Range	Shadow price
Dryland	acre	1,111.00	971.37 - 1,271.40	$ 39.04
Pasture	acre	641.00	227.00 - 2,090.33	1.26
Hired labor	hour			
September		346.00	218.28 - 415.82	121.63
Operator labor	hour			
January		104.00	(-)117.52 - 228.48	4.50
February		104.00	(-) 74.92 - 271.08	4.50
March		104.00	(-)118.18 - 227.82	4.50
April		104.00	(-)142.37 - 203.63	4.50
May		104.00	(-)230.95 - 115.05	4.50
June		104.00	(-) 35.03 - 381.03	4.50
July		104.00	(-)150.75 - 195.25	4.50
August		104.00	(-)109.00 - 237.00	4.50
September		104.00	(-) 23.72 - 173.82	126.13
October		104.00	(-) 23.72 - 173.82	4.50
November		104.00	(-)236.80 - 109.20	4.50
December		104.00	(-)174.32 - 171.68	4.50

TABLE 70 (Continued)

Row	Unit	Activity level	Range	Shadow price
Short-term capital[b]	dollar	10,000.00	(-)539,269.50 - 13,145.80	0.12
Intermediate capital[c]	dollar	25,000.00	(-)524,269.50 - 84,675.09	0.12
Long-term capital[d]	dollar	514,270.00	(-) 34,999.88 -1,028,540.00	0.11

a Solution values are valid for large typical farm with part-time operator labor and borrowing constrained within a debt:asset of 0.80.

b,c,d Owner-furnished capital

(-)$524,269.50 to $84,675.09 for intermediate capital; and (-)$34,999.88 to $1,028,540.00 for long-term capital.

The optimal solution for the large size farm with part-time operator labor resources and unlimited borrowing is summarized in Table 71. This solution includes 710.00 acres of wheat, 142.00 head of stocker heifers, 639.00 acres of native pasture, 401.00 acres of sorghum, and a confinement swine feedlot. This diversity of production activities requires 1,248.00 hours of operator labor, 1,446.22 hours of hired labor, and $723,289.29 of borrowed capital. In this solution, 25,560 bushels of wheat, 4,189.00 hundredweights of sorghum, 880.40 hundredweights of 6-700 pound heifers, and 3,381 hundredweights of slaughter hogs are marketed.

A summary of the MPSX range output for production activities at limit level and selected sell activities in the solution for scenario is presented in Table 72. Unit costs for the cow-calf enterprises are $68.89 and $180.46, depending upon the calving season selected. Forcing a unit of stocker steers into the farm plan would reduce returns to unpaid resources by $19.30. Unit costs for other production activities in the solution are $46.24 for native hay, $67.52 for Bermuda hay, $70.37 for Bermuda pasture, and 129.36 for alfalfa. Upper costs for these activities are (-)$97.57 and (-)35.44 for the cow-calf enterprises; stocker steers, (-)$33.92; native hay, (-)$16.76; Bermuda hay, (-)$108.40; Bermuda pasture $8.84; and alfalfa, (-)$166.97. Upper costs for selected sell activities are $82.00 for 4-500# steers; and $72.00 for 4-500 pound heifers.

Borrowing Constrained Within a Debt:Asset Ratio of 0.30. Like the large farm with full-time operator labor resources maintaining a high equity status, a feasible solution for the part-time operator labor alternative was not obtained. Since a debt:asset ratio below 0.53 was not attained in the base farm scenario

TABLE 71

SUMMARY OF INPUT AND OUTPUT LEVELS IN MPSX OPTIMAL SOLUTION FOR LARGE TYPICAL FARM WITH PART-TIME OPERATOR LABOR AND UNCONSTRAINED BORROWED CAPITAL[a]

Activity	Unit	Level
Objective function	dollar	35,355.04
Wheat	acre	710.00
Stocker heifers	head	142.00
Native pasture	acre	639.00
Sorghum	acre	401.00
Confinement swine feedlot	enterprise	1.00
Operator labor	hour/mo.	
January, February, December		103.40
August, October		95.00
November		96.60
Hired labor	hour	1,446.22
Total borrowing	dollar	723,289.29
Wheat	ton	25,560.00
Heifers (6-700#)	cwt	880.40
Slaughter hogs sold	cwt	3,381.00
Debt:Asset ratio		0.57

[a] Solution values are valid for large farm with part-time operator labor and borrowing constrained within a debt:asset ratio of 0.80.

TABLE 72

SUMMARY OF MPSX RANGE OUTPUT FOR PRODUCTION ACTIVITIES AND SELECTED SELL ACTIVITIES ON LARGE TYPICAL FARM WITH PART-TIME OPERATOR LABOR AND UNCONSTRAINED BORROWED CAPITAL

A. PRODUCTION ACTIVITIES AT LIMIT LEVEL

Activity	Unit	Input cost	Unit cost	Upper cost
Native hay	acre	$(-) 29.48	$ 46.24	$ 16.76
Cow-calf[a]	head	(-)166.46	68.89	(-) 97.57
Cow-calf[b]	head	(-)215.90	180.46	(-) 35.44
Stocker steers	head	(-) 53.22	19.30	(-) 33.92
Bermuda hay	acre	(-)175.92	67.52	(-)108.40
Bermuda pasture	acre	(-) 61.53	70.37	8.84
Alfalfa	acre	(-)296.33	129.36	(-)166.97

B. SELECTED SELL ACTIVITIES

Activity	Unit	Input cost	Upper cost
Steers (4-500#)	cwt	$81.00	$82.00
Heifers (4-500#)	cwt	69.00	70.00

[a] Spring-calving; 205-day weaning

[b] Fall-calving; 205-day weaning

when capital-intensive swine enterprises were not considered, it stands to reason that the addition of these enterprises cannot be accomplished while maintaining a debt:asset ratio of 0.30 or lower.

Unconstrained Borrowed Capital; Unconstrained Hired Labor. When the hired labor constraint is relaxed for the large farm with part-time operator labor and unconstrained borrowed capital resources, the value of the objective function is $125,317.56 (Table 73). Wheat production exhausts the 1,111 acres of nonirrigated cropland available; pasture acreage is used in native hay production (634 acres) and swine production (140-sow farrow-to-finish operation). In addition, 79.36 head of stocker heifers are included in the optimal plan. All available operator labor is used, as well as 2,391.99 hours of hired labor. For this scenario, borrowed capital requirements are $817,401.80. Commodities marketed included 39,996 bushels of wheat, 951 tons of native hay, 824.60 hundredweights of 6-700 pound heifers, and 5,757 hundredweights of slaughter hogs. All sorghum used in the swine operation is purchased (16,245.60 hundredweights).

The solutions for all large farm scenarios are summarized in Table 74. Relaxing the hired labor constraint when full-time operator labor and unconstrained borrowed capital are available increases returns by $89,962.52 to $125,317.56. Total borrowing in the unrestricted hired labor scenario is $816,352.91, an increase of $93,063.67. An additional 2,193.77 hours of hired labor are required. The 140-sow farrow-to-finish enterprise was included in this solution, rather than the confinement feedlot operation that enters the solution when hired labor is restricted. Consequently, more slaughter hogs are marketed in the unlimited hired labor scenario. Likewise, additional acreages in both wheat and native hay production give rise to greater quantities of these commodities being sold in the unconstrained hired labor scenario.

TABLE 73

SUMMARY OF INPUT AND OUTPUT LEVELS IN MPSX OPTIMAL SOLUTION FOR LARGE TYPICAL FARM WITH PART-TIME OPERATOR LABOR, UNCONSTRAINED BORROWED CAPITAL, AND UNCONSTRAINED HIRED LABOR

Activity	Unit	Level
Objective function	dollar	125,317.56
Wheat	acre	1,111.00
Native hay	acre	634.00
Stocker heifers	head	79.36
Farrow-to-finish (140-sow)	enterprise	1.00
Operator labor	hour	1,248.00
Hired labor	hour	2,391.99
Total borrowing	dollar	817,401.80
Wheat sold	bushel	39,996.00
Native hay sold	ton	951.00
Slaughter hogs sold	cwt	5,757.00
Sorghum purchased	cwt	16,245.60
Debt:Asset ratio		0.60
Heifers (6-700 pound)	cwt	824.60

TABLE 74

SUMMARY OF INPUT AND OUTPUT LEVELS IN MPSX SOLUTIONS FOR LARGE SIZE FARMS

	Unit	--- Scenario number --- 21	23, 24	25
Swine enterprises		no	yes	yes
Operator labor level[a]		FT	FT	FT
Capital restriction[b]		U	U,LE	U
Hired labor level[c]		2FTE	2FTE	U
Objective function	dollar	33,106.42	73,240.21	130,933.56
CROP ENTERPRISES				
Wheat	acre	1,108.00	594.00	1,111.00
Alfalfa	acre		47.33	
Sorghum	acre	3.00	469.67	
Native hay	acre			634.00
Native pasture	acre	641.00	634.00	
Idle pasture	acre			
LIVESTOCK ENTERPRISES				
Stocker heifers	head	170.71	133.00	79.36
Swine	enterprise		140F2F	140F2F
RESOURCES USED				
Operator labor	hour	1,295.14	2,496.00	2,496.00
Hired labor	hour	398.91	2,048.85	2,391.99
Dryland	acre	1,111.00	1,111.00	1,111.00
Pasture	acre	641.00	641.00	641.00
Total borrowing	dollar	657,317.37	817,401.80	816,352.91
Sorghum purchased	cwt		2,155.37	16,245.60
PRODUCTION				
Slaughter hogs	cwt		5,757.00	5,757.00
Wheat	bushel	39,888.00	21,384.00	39,996.00
Alfalfa	ton		153.81	
Sorghum	cwt	90.00		
Native hay	ton			951.00
Heifers (6-700#)	cwt	1,058.43	824.60	492.01
DEBIT:ASSET RATIO		0.54	0.60	0.60

[a] FT Operator labor = 2,496 hrs/yr; PT = 1,248 hrs/yr

[b] U = Unconstrained borrowing; LE = borrowing permitted up to a D/A Ratio of 0.80; HE = borrowing permitted up to a D/A Ratio of 0.30

[c] 2FTE = Two full-time laborer equivalents

TABLE 74 (Continued)

	Unit	--- Scenario number --- 26	28, 29	30
Swine enterprises		no	yes	yes
Operator labor level[a]		PT	PT	PT
Capital restriction[b]		U	U,LE	U
Hired labor level[c]		2FTE	2FTE	U
Objective function	dollar	(-)21,420.27	35,355.04	125,317.56
CROP ENTERPRISES				
Wheat	acre	900.00	710.00	1,111.00
Alfalfa	acre			
Sorghum	acre	211.00	401.00	
Native hay	acre			634.00
Native pasture	acre	641.00	639.00	
Idle pasture	acre			
LIVESTOCK ENTERPRISES				
Stocker heifers	head	155.86	142.00	79.36
Swine	enterprise		CFFDTF	140F2F
RESOURCES USED				
Operator labor	hour	891.05	1,248.00	1,248.00
Hired labor	hour	725.72	1,446.22	2,391.99
Dryland	acre	1,111.00	1,111.00	1,111.00
Pasture	acre	641.00	641.00	641.00
Total borrowing	dollar	640,320.65	723,289.29	817,401.80
Sorghum purchased	cwt			16,245.60
PRODUCTION				
Slaughter hogs	cwt		3,381.00	5,757.00
Wheat	bushel	32,400.00	25,560.00	39,996.00
Alfalfa	ton			
Sorghum	cwt	6,330.00	4,189.00	
Native hay	ton			951.00
Heifers (6-700#)	cwt	966.31	880.40	824.60
DEBIT:ASSET RATIO		0.54	0.57	0.60

[a] FT Operator labor = 2,496 hrs/yr; PT = 1,248 hrs/yr

[b] U = Unconstrained borrowing; LE = borrowing permitted up to a D/A Ratio of 0.80; HE = borrowing permitted up to a D/A Ratio of 0.30

[c] 2FTE = Two full-time laborer equivalents

When an unlimited amount of hired labor is available in the part-time operator labor/unlimited capital scenario, the value of the objective function becomes $125,317.56, an increase of more than $89,000.00. Borrowed capital requirements also increase from $723,289.29 to $817,401.80. Although operator labor usage increases only slightly, hired labor requirements are almost three times greater than in the constrained hired labor scenario. Once again, wheat, native hay, and slaughter hog sales increase, as does sorghum purchases.

CHAPTER V

SUMMARY AND CONCLUSIONS

Summary

Introduction

The primary objective of this study was to analyze the feasibility of swine production in Oklahoma. Historic trends in production, prices, and slaughter numbers for both the United States and Oklahoma were discussed. Economic theory as related to production problems was summarized along with the principles and applications of budgeting and linear programming. Literature regarding the use of linear programming in farm management studies was briefly reviewed, and recent studies on swine production and marketing were cited. Eleven swine budgets developed by the O.S.U. Cooperative Extension Service were selected and modified to reflect a five-year average of production and prices. These swine budgets represented various combinations of management systems, (confinement or pasture/dirt lot), production operations (farrow-to-finish, feeder pig or finishing pig), and feed sources (on-farm processing or purchased rations). The swine budgets were first incorporated into an integer programming routine to determine which swine enterprise, if any, would be included in the optimal solution for a given farm size and set of resources. The budget for the swine enterprise that appeared in this solution was then incorporated into a linear programming problem so that the sensitivity of the optimal solution could be analyzed. Using linear programming, optimal

solutions for 24 scenarios reflecting various farm sizes, operator and hired labor levels, and borrowed capital restrictions were obtained. Solutions were also obtained for six additional problems in which the hired labor constraint was relaxed.

For all farm sizes considered, inclusion of a swine production activity in the enterprise set increased returns to overhead, risk, management, and operator labor in most labor/capital alternatives. Moreover, swine enterprises not only required additional borrowed capital from off-farm sources, but also increased both hired and operator labor usage. Finally, solutions for the unconstrained and low equity maintenance borrowing scenarios were identical for each farm size/operator labor alternative.

Small Farms. All optimal solutions for small farms included wheat and swine production. In addition to these two enterprises, activities permitting the production of sorghum, stocker heifers, native hay, and native pasture were included in the optimal farm plan for the small size farm with part-time operator labor and unrestricted capital resources. When outside borrowing was not constrained, a 140-sow farrow-to-finish enterprise entered the optimal farm plan. Restricting off-farm borrowing within debt:asset ratio of 0.30, however, permitted the 40-sow farrow-to-finish unit to enter the farm organization.

Increases in returns to overhead, risk, management, and operator labor ranged between 390% and 1500% when swine production enterprises were considered. Larger increases in returns were observed when unlimited capital resources were available, allowing the 140-sow unit to enter the optimal solution. Inclusion of the swine enterprises in the optimal solution increased borrowed capital requirements for all labor/capital scenarios. As expected, more off-farm capital was utilized in the unlimited borrowing scenarios.

Generally, operator labor resources were exhausted when a swine enterprise was present in the optimal farm plan. The full-time operator labor scenario with borrowing constrained within a debt:asset ratio of 0.30 was the only alternative that included operator labor as a slack activity in all periods and, therefore, did not use any hired labor. For the small farms, labor hire ranged from 0 to 173 hours per month with more labor being hired in the part-time operator labor situations. Although hired labor was a limiting resource for the unconstrained capital/part-time operator labor scenario, the additional labor afforded by relaxing the hired labor constraint did not change the optimal swine enterprise; rather, labor resources used in the production of sorghum, stocker heifers, native hay, and native pasture were transferred to the production of wheat.

Medium Farms. Although wheat and swine are the primary production activities on the mid-sized farms, several other enterprises also appeared in the optimal solutions for these farms. The set of enterprises present in the part-time operator labor/unconstrained borrowed capital solution included a 140-sow farrow-to-finish enterprise, as well as alfalfa, sorghum, stocker heifers, native hay, and native pasture enterprises. Wheat production was not included in the solution for this scenario, but replaced the alfalfa enterprise in the set of production activities for the medium-sized farm with part-time operator labor resources and borrowing constrained within a debt:asset ratio of 0.30. In addition, the confinement feedlot enterprise replaced the 140-sow farrow-to-finish enterprise in the optimal solution for this alternative.

A confinement finishing pig enterprise was also included in the optimal farm organization for the medium-sized farm with full-time operator labor available and borrowing permitted up to a debt:asset ratio of 0.30. Unlike its

part-time labor counterpart, however, the only other production activity included in the solution for this resource combination was wheat production. The solution for the mid-sized farm with full-time operator labor and unrestricted capital resources included a 140-sow farrow-to-finish enterprise in addition to wheat, alfalfa, sorghum, and native hay activities.

Inclusion of the swine activities when part-time operator labor was available resulted in increases in returns to overhead, risk, management and operator labor of 122% and 131% for the unconstrained and high equity maintenance scenarios, respectively. When full-time operator labor resources were available, however, returns increased 279% and 147%. While larger increases in returns were observed when unlimited capital resources were available these increases were not as dramatic as those experienced in the small farm scenarios. Borrowed capital requirements also increased when swine enterprises entered in the optimal farm plan, especially when the 140-sow unit was included.

In all mid-sized farm scenarios, operator labor was constrained in at least one labor period. Moreover, the farm scenario incorporating full-time operator labor and limiting borrowed capital within a debt:asset of 0.30 was the only medium-sized farm in which hired labor was not also a limiting resource. When the hired labor constraint was relaxed for the remaining scenarios, returns to overhead, risk, management, and operator labor increased an average of 35%. However, all land, labor, and capital resources were used in the production of wheat, native hay, and swine when hired labor resources were not restricted. The swine enterprise present in the optimal farm organization did not change when the hired labor constraint was relaxed.

Large Farms. Like the solutions for the small- and medium-sized farms, wheat and swine production is the only enterprise common to all labor/capital scenarios. The solution for the large-size farm with full-time operator labor and unlimited borrowed capital resources included a confinement hog feedlot as well as wheat, alfalfa, sorghum, and native hay enterprises. When only part-time operator labor was available, however, the enterprises in the solution set were alfalfa, sorghum, native hay, native pasture, and a finishing pig operation.

Given the set of resource restrictions and production assumptions described in Chapter Two, the base run for the large farms determined that the lowest debt:asset ratio possible was 0.53. The high equity maintenance scenario restricted borrowing within a debt:asset of 0.30; therefore, no feasible solutions were obtained for the large farm scenarios with this capital constraint.

When the confinement feedlot is included in the optimal solutions, returns increased 10% in the part-time operator labor scenario and doubled in the full-time operator labor scenario. Borrowed capital requirements increased with the inclusion of the swine enterprise; however, this increase was proportionally smaller than the increase observed when swine production was added to the small- and medium-sized farms. Both hired and operator labor are exhausted in at least two labor periods in both operator labor alternatives.

Relaxing the hired labor constraint not only increased the amount of off-farm labor utilized, but also significantly altered the enterprises present in the optimal solutions. Hired labor requirements ranged between 49 and 1,155.50 hours. The 140-sow farrow-to-finish operation replaced the confinement finishing pig operation. Moreover, all inputs were utilized in the production of wheat and native hay rather than the variety of enterprises included in the solution when labor resources were limited. The availability of additional labor resulted in a five-fold increase in returns for farms with full-time operator labor

resources and a ten-fold increase in returns for farms with part-time operator labor available. These increases in returns corresponded to full- and part-time operator labor scenarios, respectively.

Conclusions

Swine production enterprises require considerable labor and capital resources. Confinement systems, especially the 140-sow farrow-to-finish system, demand more capital than the livestock activities considered in this model, yet use less labor per production unit. Pasture systems substitute manpower for money in the production process and are therefore considered labor intensive. Management skills are also a prerequisite for swine production. Successful managers of farrow-to-finish operations must be knowledgeable not only in marketing, but also in animal husbandry and nutrition.

Generally, swine enterprises are included in the farming operations as supplementary activities. Swine operations take a small amount of land out of crop production and afford considerably higher returns per acre than the enterprises they replace. Swine production in Oklahoma is most profitable when farrowed pigs are retained until they reach market weight; however, operations focusing on the finishing phase of production also yield positive returns if slaughter hog prices are near the level used in this research. Increasing capital costs, however, favor labor-intensive swine enterprises or other agricultural enterprises which require a lower investment in facilities and equipment.

Given the resource and pricing environment used in this research, swine enterprises enhanced returns for most farm sizes and resource scenarios. This study, however, did not consider the importance of individual owner

preferences when analyzing the feasibility and profitability of swine production as part of the whole farm organization. While resource limitations and economic conditions are important considerations in whole farm analysis, owner preferences are often the underlying force in enterprise selection and farm planning. Returns to overhead, risk, management, and operator labor in the eleven swine budgets show that swine can be a profitable addition to Oklahoma farms if proper herd size, management system, and production enterprise are selected. Cost and return analysis permits the operator to determine the most efficient allocation of farm inputs and to decide if per unit returns justify the input requirements. Input requirements in swine enterprise budgets can be compared to those in other crop and livestock budgets to determine optimal usage of resources to production activities.

When summarizing the optimal solutions determined by MPSX, the limitations of the model must also be addressed. In this study, a five-year average annual price was used to represent the prices paid and received by farmers. Therefore, the optimal farm plans are valid when relative input and output prices remain the same. The five-year average price was used to avoid selecting an abnormally high or low price. Seasonal price variations that occur within a production cycle, however, were not considered. In addition, the risks and income variability associated with different enterprises are also ignored.

The linear programming model maximizes returns to overhead, risk, management, and operator labor without considering a number of qualitative variables such as personal preferences and traditions. These variables could significantly increase or decrease the value of the enterprise, depending upon the owner-operator's perspective. Finally, using budgets to evaluate production alternatives is accurate only when the underlying assumptions are similar in all budgets. Despite its limitations, the model still indicates practical solutions to

realistic farm management problems. Moreover, the MPSX solution provides invaluable information about the sensitivity of the optimal solution to changes in these assumptions.

Recommendations For Further Study

Oklahoma farmers should consider the swine enterprises when selecting production activities for their operations. Swine budgets can be modified by the manager to reflect production or price assumptions unique to his/her operation.

Although swine enterprises appear profitable, production will occur only if adequate markets are available. This model assumed that hog markets existed and were readily accessible to Oklahoma producers. However, the closing of several key slaughter facilities in both Oklahoma City and Arkansas City, Kansas may reduce the demand hence price for slaughter animals in the state. The Arkansas City facility closed while this research was in progress; therefore, the impact of this plant closing was not analyzed in this study. Further research designed to examine the effects of this plant closure on Oklahoma hog production and marketing should be conducted. Another priority of future study should be to determine the conditions necessary for obtaining a new pork slaughter and processing facility in Oklahoma.

This research used budget analysis and linear programming to determine the feasibility of swine production in Oklahoma. However, cash flow analysis is also important in analyzing the feasibility of swine production on a month-to-month basis. Therefore, additional work should be done to determine the impact of swine enterprises on a farm organization's cash flow statement.

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APPENDIXES

APPENDIX A

SWINE ENTERPRISE BUDGETS

LOW INVESTMENT FARROW TO FINISH
ALL RATIONS PURCHASED

41001233

OPERATING INPUTS:	UNITS	PRICE	QTY.	VALUE /SOW	VALUE /ENTERPRISE
FARROWING RATION	CWT.	8.50	10.08	85.68	3,427.20
SOW-BOAR RATION	CWT.	8.60	20.44	175.78	7,031.20
STARTER RATION	CWT.	11.55	7.40	85.46	3,418.80
GROWER RATION	CWT.	9.00	39.84	358.56	14,342.40
FINISHING RATION	CWT.	8.50	62.66	532.61	21,304.40
STRAW	BL.	1.25	6.00	7.50	300.00
MACHINE HIRE	HD.	87.00	0.05	4.35	174.00
VET MEDICINE	HD.	1.50	14.69	22.03	881.20
HAULING & MKTG. CHARGE	HD.	1.75	14.69	25.71	1,028.30
UTILITIES	LBS.	18.00	1.00	18.00	720.00
YOUNG BOAR	HD.	400.00	0.07	22.03	881.20
ANNUAL OPERATING CAPITAL	DOL.	0.12	80.44	9.65	386.00
LABOR CHARGES	HR.	4.50	35.06	116.91	4,676.40
M&E FUEL, LUBE, & REP.	DOL.			39.08	1,563.20
TOTAL OPERATING COST				1,550.18	62,007.20

FIXED COSTS	UNITS	VALUE	
MACHINERY & EQUIPMENT			
INTEREST AT 12.0%	DOL.	39.57	1,582.80
DEPR., TAXES, INSUR.	DOL.	58.08	2,323.20
LIVESTOCK			
INTEREST AT 12.0%	DOL.	23.59	943.60
TOTAL FIXED COSTS		121.24	4,849.60

LOW INVESTMENT FARROW TO FINISH
ALL RATIONS PURCHASED (CONTINUED)

PRODUCTION	UNITS	PRICE	QTY.	VALUE	
SLAUGHTER HOGS	CWT.	48.00	31.56	1,514.69	60,587.60
NON-BREEDER GILTS	CWT.	43.00	0.72	30.74	1,220.60
SOWS	CWT.	41.00	2.72	111.52	4,460.80
BOARS	CWT.	31.00	0.30	9.22	368.80
TOTAL RECEIPTS				1,666.17	66,646.80
RETURNS ABOVE TOTAL OPERATING COSTS				130.45	5,218.00
RETURNS ABOVE ALL COSTS EXCEPT OVERHEAD, RISK, & MGMT.				68.40	2,736.00

LOW INVESTMENT FARROW TO FINISH
COMPLETE FEEDMILL

SPECIAL

OPERATING INPUTS:	UNITS	PRICE	QTY.	VALUE /SOW	VALUE /ENTERPRISE
GRAIN SORGHUM	CWT.	2.86	106.92	305.79	12,231.60
41-45% PROTEIN SUPP.	CWT.	10.50	22.32	234.36	9,374.40
SALT	CWT.	4.20	0.324	1.36	54.40
BASE MIX	CWT.	28.00	3.24	90.72	3,628.80
MACHINE HIRE	HD.	87.00	0.05	4.35	174.00
HAULING & MARKETING	HD.	1.00	14.69	14.69	587.60
VET MEDICINE	HD.	1.50	14.69	22.03	881.20
ANTIBIOTICS	LBS.	2.60	7.20	18.72	748.80
STRAW	BL.	1.25	6.00	7.50	300.00
UTILITIES	LBS.	38.00	1.00	38.00	1,520.00
YOUNG BOAR	HD.	300.00	0.07	21.00	840.00
ANNUAL OPERATING CAPITAL	DOL.	0.12	55.89	6.15	246.00
LABOR CHARGES	HR.	4.50	38.06	171.27	6,850.80
M&E FUEL, LUBE, & REP.	DOL.			48.90	1,956.00
TOTAL OPERATING COST				1,083.61	43,344.40

FIXED COSTS	UNITS	VALUE		
MACHINERY & EQUIPMENT				
INTEREST AT 12.0%	DOL.	71.92	2,876.80	
DEPR., TAXES, INSUR.	DOL.	107.73	4,309.20	
LIVESTOCK				
INTEREST AT 12.0%	DOL.	22.14	885.60	
TOTAL FIXED COSTS		201.79	8,070.60	

LOW INVESTMENT FARROW TO FINISH
COMPLETE FEEDMILL (CONTINUED)

PRODUCTION	UNITS	PRICE	QTY.	VALUE	
SLAUGHTER HOGS	CWT.	48.00	31.56	1,514.69	60,587.60
NON-BREEDER GILTS	CWT.	43.00	0.72	30.74	1,220.60
SOWS	CWT.	41.00	2.72	111.52	4,460.80
BOARS	CWT.	31.00	0.30	9.22	368.80
TOTAL RECEIPTS				1,666.17	66,646.80
RETURNS ABOVE TOTAL OPERATING COSTS				582.56	23,302.40
RETURNS ABOVE ALL COSTS EXCEPT OVERHEAD, RISK, & MGMT.				380.78	15,281.20

90-SOW CONFINEMENT FARROW TO FINISH
COMPLETE FEEDMILL

41001433

OPERATING INPUTS:	UNITS	PRICE	QTY.	VALUE /SOW	VALUE /ENTERPRISE
GRAIN SORGHUM	CWT.	2.86	114.24	326.73	29,405.70
41-45% PROTEIN SUPP.	CWT.	10.50	24.00	252.00	22,680.00
SALT	CWT.	4.20	0.36	1.51	135.90
BASE MIX	CWT.	28.00	3.56	106.92	9,622.80
STARTER RATION	CWT.	11.55	10.33	119.31	10,737.90
HAULING & MARKETING	HD.	1.75	16.93	29.63	2,666.70
VET MEDICINE	HD.	1.00	16.93	16.93	1,523.70
ANTIBIOTICS	LBS.	2.60	7.20	18.72	1,684.80
UTILITIES	LBS.	38.00	1.00	30.00	2,700.00
YOUNG BOAR	HD.	400.00	0.05	20.00	1,800.00
ANNUAL OPERATING CAPITAL	DOL.	0.12	0.00	0.00	0.00
LABOR CHARGES	HR.	4.50	23.62	106.29	9,566.10
M&E FUEL, LUBE, & REP.	DOL.			68.59	6,173.10
TOTAL OPERATING COST				1,096.61	98,694.90

FIXED COSTS	UNITS	VALUE	
MACHINERY & EQUIPMENT			
INTEREST AT 12.0%	DOL.	168.60	15,174.00
DEPR., TAXES, INSUR.	DOL.	202.80	18,252.00
LIVESTOCK			
INTEREST AT 12.0%	DOL.	22.03	1,982.70
TOTAL FIXED COSTS		393.44	35,409.60

90-SOW CONFINEMENT FARROW TO FINISH
COMPLETE FEEDMILL (CONTINUED)

PRODUCTION	UNITS	PRICE	QTY.	VALUE	
SLAUGHTER HOGS	CWT.	48.00	36.98	1,783.00	160,470.00
NON-BREEDER GILTS	CWT.	43.00	0.52	22.56	2,030.40
SOWS	CWT.	41.00	2.56	104.91	9,441.90
BOARS	CWT.	31.00	0.21	6.66	599.40
TOTAL RECEIPTS				1,917.13	172,541.70
RETURNS ABOVE TOTAL OPERATING COSTS				822.02	73,981.80
RETURNS ABOVE ALL COSTS EXCEPT OVERHEAD, RISK, & MGMT.				428.58	38,572.20

90-SOW CONFINEMENT FARROW TO FINISH
ALL RATIONS PURCHASED

41001333

OPERATING INPUTS:	UNITS	PRICE	QTY.	VALUE /SOW	VALUE /ENTERPRISE
FARROWING RATION	CWT.	8.50	9.12	77.52	6,976.80
SOW-BOAR RATION	CWT.	8.60	19.85	170.71	15,363.90
STARTER RATION	CWT.	11.55	10.33	119.31	10,737.90
GROWER RATION	CWT.	9.00	44.07	396.63	35,696.70
FINISHING RATION	CWT.	8.50	69.21	588.28	52,945.20
VET MEDICINE	HD.	1.00	16.93	16.93	1,523.70
HAULING & MKTG. CHARGE	HD.	1.75	16.93	29.63	2,666.70
UTILITIES	LBS.	30.00	1.00	30.00	2,700.00
YOUNG BOAR	HD.	400.00	0.05	20.00	1,800.00
ANNUAL OPERATING CAPITAL	DOL.	0.12	0.00	0.00	0.00
LABOR CHARGES	HR.	4.50	20.00	90.00	8,100.00
M&E FUEL, LUBE, & REP.	DOL.			61.44	5,529.60
TOTAL OPERATING COST				1,600.46	144,041.40

FIXED COSTS	UNITS	VALUE	
MACHINERY & EQUIPMENT			
INTEREST AT 12.0%	DOL.	142.55	12,829.50
DEPR., TAXES, INSUR.	DOL.	172.39	15,515.10
LIVESTOCK			
INTEREST AT 12.0%	DOL.	6.48	583.20
TOTAL FIXED COSTS		321.42	28,927.80

90 SOW CONFINEMENT FARROW TO FINISH
ALL RATIONS PURCHASED (CONTINUED)

PRODUCTION	UNITS	PRICE	QTY.	VALUE	
SLAUGHTER HOGS	CWT.	48.00	36.98	1,783.00	160,470.00
NON-BREEDER GILTS	CWT.	43.00	0.52	22.56	2,030.40
SOWS	CWT.	41.00	2.56	104.91	9,441.90
BOARS	CWT.	31.00	0.21	6.66	599.40
TOTAL RECEIPTS				1,666.17	66,646.80
RETURNS ABOVE TOTAL OPERATING COSTS				130.45	5,218.00
RETURNS ABOVE ALL COSTS EXCEPT OVERHEAD, RISK, & MGMT.				68.40	2,736.00

140-SOW CONFINEMENT FARROW TO FINISH
COMPLETE FEEDMILL

SPECIAL

OPERATING INPUTS:	UNITS	PRICE	QTY.	VALUE /SOW	VALUE /ENTERPRISE
GRAIN SORGHUM	CWT.	2.86	116.04	331.87	46,461.80
41-45% PROTEIN SUPP.	CWT.	10.50	20.88	219.24	30,693.60
BASE MIX	CWT.	28.00	7.20	201.60	28,224.00
STARTER RATION	CWT.	11.55	26.04	300.76	42,106.40
HAULING & MARKETING	HD.	1.75	18.84	32.97	4,615.80
VET MEDICINE	HD.	1.00	18.84	18.84	2,637.60
UTILITIES	LBS.	36.00	1.00	36.00	5,040.00
YOUNG BOAR	HD.	300.00	0.06	18.00	2,520.00
ANNUAL OPERATING CAPITAL	DOL.	0.12	0.00	0.00	0.00
LABOR CHARGES	HR.	4.50	22.04	99.18	13,885.20
M&E FUEL, LUBE, & REP.	DOL.			37.69	5,276.60
TOTAL OPERATING COST				1,296.16	181,462.40

FIXED COSTS	UNITS	VALUE	
MACHINERY & EQUIPMENT			
INTEREST AT 12.0%	DOL.	115.07	16,109.80
DEPR., TAXES, INSUR.	DOL.	151.54	21,214.20
LIVESTOCK			
INTEREST AT 12.0%	DOL.	4.80	672.00
TOTAL FIXED COSTS		271.42	37,998.80

140-SOW CONFINEMENT FARROW TO FINISH
COMPLETE FEEDMILL (CONTINUED)

PRODUCTION	UNITS	PRICE	QTY.	VALUE	
SLAUGHTER HOGS	CWT.	48.00	41.12	1,973.95	276,353.00
NON-BREEDER GILTS	CWT.	43.00	0.55	23.76	3,326.40
SOWS	CWT.	41.00	2.84	116.44	16,301.60
BOARS	CWT.	31.00	0.34	10.54	1,475.60
TOTAL RECEIPTS				2,124.69	297,456.60
RETURNS ABOVE TOTAL OPERATING COSTS				828.53	115,994.20
RETURNS ABOVE ALL COSTS EXCEPT OVERHEAD, RISK & MGMT.				557.11	77,995.40

LOW INVESTMENT FEEDER PIG PRODUCTION
ALL RATIONS PURCHASED

42001133

OPERATING INPUTS:	UNITS	PRICE	QTY.	VALUE /SOW	VALUE /ENTERPRISE
FARROWING RATION	CWT.	8.50	10.08	85.68	3,427.20
SOW-BOAR RATION	CWT.	8.60	20.44	175.78	7,031.20
STARTER RATION	CWT.	11.55	11.19	129.24	5,169.60
STRAW	BL.	1.25	3.00	3.75	150.00
VET MEDICINE	HD.	1.25	15.89	19.86	794.50
HAULING & MKTG. CHARGE	HD.	1.75	15.89	27.81	1,112.30
UTILITIES	LBS.	15.00	1.00	15.00	600.00
YOUNG SOWS	HD.	140.00	0.90	126.00	5,040.00
YOUNG BOAR	HD.	400.00	0.07	28.00	1,120.00
ANNUAL OPERATING CAPITAL	DOL.	0.12	35.76	4.29	171.60
LABOR CHARGES	HR.	4.50	20.10	90.45	3,618.00
M&E FUEL, LUBE, & REP.	DOL.			27.33	1,093.20
TOTAL OPERATING COST				737.58	29,503.20

FIXED COSTS	UNITS	VALUE	
MACHINERY & EQUIPMENT			
INTEREST AT 12.0%	DOL.	24.29	971.60
DEPR., TAXES, INSUR.	DOL.	36.04	1,441.60
LIVESTOCK			
INTEREST AT 12.0%	DOL.	7.39	295.60
TOTAL FIXED COSTS		67.72	2,708.80

LOW INVESTMENT FEEDER PIG PRODUCTION
ALL RATIONS PURCHASED (CONTINUED)

PRODUCTION	UNITS	PRICE	QTY.	VALUE	
FEEDER PIGS	CWT.	75.00	7.46	559.50	22,380.00
NON-BREEDER GILTS	CWT.	43.00	0.72	30.96	1,238.40
SOWS	CWT.	41.00	2.72	111.52	4,460.80
BOARS	CWT.	31.00	0.30	9.30	372.00
TOTAL RECEIPTS				711.28	28,451.20
RETURNS ABOVE TOTAL OPERATING COSTS				26.30	1,052.00
RETURNS ABOVE ALL COSTS EXCEPT OVERHEAD, RISK, & MGMT.				-41.42	-1,656.80

90-SOW CONFINEMENT FEEDER PIG PRODUCTION
ALL RATIONS PURCHASED 42001233

OPERATING INPUTS:	UNITS	PRICE	QTY.	VALUE /SOW	VALUE /ENTERPRISE
FARROWING RATION	CWT.	8.50	9.12	77.52	6,976.80
SOW-BOAR RATION	CWT.	8.60	19.85	170.71	15,363.90
STARTER RATION	CWT.	11.55	14.64	169.09	15,218.10
VET MEDICINE	HD.	0.75	18.07	13.55	1,219.50
HAULING & MKTG. CHARGE	HD.	1.75	18.07	31.62	2,845.80
UTILITIES	LBS.	16.00	1.00	16.00	1,440.00
YOUNG SOWS	HD.	140.00	0.80	112.00	10,080.00
YOUNG BOAR	HD.	400.00	0.05	20.00	1,800.00
ANNUAL OPERATING CAPITAL	DOL.	0.12	0.94	0.11	9.90
LABOR CHARGES	HR.	4.50	11.00	49.50	4,455.00
M&E FUEL, LUBE, & REP.	DOL.			43.81	3,942.90
TOTAL OPERATING COST				703.93	63,353.70

FIXED COSTS	UNITS	VALUE	
MACHINERY & EQUIPMENT			
INTEREST AT 12.0%	DOL.	99.32	8,938.80
DEPR., TAXES, INSUR.	DOL.	123.90	11,151.00
LIVESTOCK			
INTEREST AT 12.0%	DOL.	6.48	583.20
TOTAL FIXED COSTS		229.70	20,673.00

90-SOW CONFINEMENT FEEDER PIG PRODUCTION
ALL RATIONS PURCHASED (CONTINUED)

PRODUCTION	UNITS	PRICE	QTY.	VALUE	
FEEDER PIGS	CWT.	75.00	8.61	645.75	58,117.50
NON-BREEDER GILTS	CWT.	43.00	0.52	22.36	2,012.40
SOWS	CWT.	41.00	2.56	104.96	9,446.40
BOARS	CWT.	31.00	0.21	6.51	585.90
TOTAL RECEIPTS				779.58	70,162.20
RETURNS ABOVE TOTAL OPERATING COSTS				75.65	6,808.50
RETURNS ABOVE ALL COSTS EXCEPT OVERHEAD, RISK, & MGMT.				-154.05	-13,864.50

FEEDING PURCHASED PIGS ON DIRT
100 HEAD UNITS - 300 HEAD CAPACITY LOT
ALL RATIONS PURCHASED

44001233

OPERATING INPUTS:	UNITS	PRICE	QTY.	VALUE /UNIT	VALUE /ENTERPRISE
GROWER RATION	CWT.	9.00	267.00	2,403.00	21,627.00
FINISHING RATION	CWT.	8.50	420.00	3,570.00	32,130.00
STRAW	BL.	1.25	25.00	31.25	281.25
FEEDER PIGS	CWT.	76.00	50.00	3,800.00	34,200.00
VET MEDICINE	HD.	0.50	98.00	49.00	441.00
HAULING & MKTG. CHARGE	HD.	2.75	98.00	269.50	2,425.50
UTILITIES	HD.	0.75	98.00	73.50	661.50
ANNUAL OPERATING CAPITAL	DOL.	0.12	1,987.62	238.51	2,146.59
LABOR CHARGES	HR.	4.50	97.79	440.06	3,960.51
M&E FUEL, LUBE, & REP.	DOL.			120.50	1,084.50
TOTAL OPERATING COST				10,995.32	98,957.88
FIXED COSTS	UNITS	VALUE			
MACHINERY & EQUIPMENT					
INTEREST AT 12.0%	DOL.	107.22		964.98	
DEPR., TAXES, INSUR.	DOL.	146.36		1,317.24	
TOTAL FIXED COSTS		253.58		2,282.22	
PRODUCTION	UNITS	PRICE	QTY.	VALUE	
SLAUGHTER HOGS	CWT.	48.00	225.40	10,819.20	162,288.00
TOTAL RECEIPTS				10,819.20	162,288.00
RETURNS ABOVE TOTAL OPERATING COSTS				-176.12	-1,585.08
RETURNS ABOVE ALL COSTS EXCEPT OVERHEAD, RISK, & MGMT.				-429.70	-3,867.30

LOW INVESTMENT SWINE FEEDLOT, PER ANNUAL PIG CAPACITY
100 HEAD UNITS - 300 HEAD CAPACITY LOT
COMPLETE FEEDMILL

44001433

OPERATING INPUTS:	UNITS	PRICE	QTY.	VALUE /UNIT	VALUE /ENTERPRISE
GRAIN SORGHUM	CWT.	3.00	16.44	47.02	14,106.00
41-45% PROTEIN SUPP.	CWT.	10.50	3.60	37.80	11,340.00
SALT	LBS.	0.04	4.73	0.19	57.00
BASE MIX	CWT.	30.00	0.48	14.40	4,320.00
ANTIBIOTICS	LBS.	2.60	1.08	2.81	843.00
FEEDER PIGS	CWT.	76.00	1.50	114.00	34,200.00
VET MEDICINE	HD.	1.50	2.94	4.41	1,323.00
UTILITIES	HD.	0.50	4.94	2.47	741.00
TRUCKING	HD.	1.75	2.94	5.15	1,543.50
ANNUAL OPERATING CAPITAL	DOL.	0.12	67.46	8.09	2,427.00
LABOR CHARGES	HR.	4.50	3.38	15.21	4,563.00
M&E FUEL, LUBE, & REP.	DOL.			5.13	1,539.00
TOTAL OPERATING COST				256.68	77,004.00
FIXED COSTS	UNITS	VALUE			
MACHINERY & EQUIPMENT					
INTEREST AT 12.0%	DOL.	11.43		3,429.00	
DEPR., TAXES, INSUR.	DOL.	14.70		4,410.00	
TOTAL FIXED COSTS		26.13		7,839.00	
PRODUCTION	UNITS	PRICE	QTY.	VALUE	
SLAUGHTER HOGS	CWT.	48.00	6.76	324.48	97,344.00
TOTAL RECEIPTS				324.48	97,344.00
RETURNS ABOVE TOTAL OPERATING COSTS				67.80	20,340.00
RETURNS ABOVE ALL COSTS EXCEPT OVERHEAD, RISK, & MGMT.				41.67	12,501.00

SWINE FEEDLOT - FULLY ENCLOSED, FULLY SLATTED
100 HEAD UNITS - 500 HEAD CAPACITY LOT
ALL RATIONS PURCHASED

44001133

OPERATING INPUTS:	UNITS	PRICE	QTY.	VALUE /UNIT	VALUE /ENTERPRISE
GROWER RATION	CWT.	9.00	256.00	2,304.00	34,560.00
FINISHING RATION	CWT.	8.50	402.00	3,417.00	51,255.00
FEEDER PIGS	CWT.	76.00	50.00	3,800.00	57,000.00
VET MEDICINE	HD.	0.50	98.00	49.00	735.00
HAULING & MKTG. CHARGE	HD.	2.75	98.00	269.50	4,042.50
UTILITIES	HD.	0.75	98.00	73.50	1,102.50
ANNUAL OPERATING CAPITAL	DOL.	0.12	1,146.40	137.47	2,063.55
LABOR CHARGES	HR.	4.50	60.00	270.00	4,050.00
M&E FUEL, LUBE, & REP.	DOL.			152.45	2,286.75
TOTAL OPERATING COST				10,472.92	157,093.80
FIXED COSTS	UNITS	VALUE			
MACHINERY & EQUIPMENT					
INTEREST AT 12.0%	DOL.	266.98		4,004.70	
DEPR., TAXES, INSUR.	DOL.	299.00		4,485.00	
TOTAL FIXED COSTS		565.98		8,489.70	
PRODUCTION	UNITS	PRICE	QTY.	VALUE	
SLAUGHTER HOGS	CWT.	48.00	225.40	10,819.20	162,288.00
TOTAL RECEIPTS				10,819.20	162,288.00
RETURNS ABOVE TOTAL OPERATING COSTS				346.28	3,116.52
RETURNS ABOVE ALL COSTS EXCEPT OVERHEAD, RISK, & MGMT.				-219.70	-1,977.30

SWINE FEEDLOT - FULLY ENCLOSED, FULLY SLATTED
100 HEAD UNITS - 500 HEAD CAPACITY LOT
COMPLETE FEEDMILL

44001333

OPERATING INPUTS:	UNITS	PRICE	QTY.	VALUE /UNIT	VALUE /ENTERPRISE
GRAIN SORGHUM	CWT.	3.00	15.68	47.04	23,520.00
41-45% PROTEIN SUPP.	CWT.	10.50	3.56	37.42	18,710.00
SALT	LBS.	0.04	4.63	0.19	95.00
BASE MIX	CWT.	30.00	0.36	10.69	5,345.00
ANTIBIOTICS	LBS.	2.60	1.07	2.78	1,390.00
FEEDER PIGS	CWT.	76.00	1.50	114.00	57,000.00
VET MEDICINE	HD.	0.50	3.00	1.50	750.00
UTILITIES	HD.	0.74	2.97	2.20	1,100.00
TRUCKING	HD.	1.75	2.97	5.20	2,600.00
ANNUAL OPERATING CAPITAL	DOL.	0.12	0.00	0.00	0.00
LABOR CHARGES	HR.	4.50	2.33	10.49	5,242.50
M&E FUEL, LUBE, & REP.	DOL.			5.85	2,925.00
TOTAL OPERATING COST				237.36	118,680.00
FIXED COSTS	UNITS	VALUE			
MACHINERY & EQUIPMENT					
INTEREST AT 12.0%	DOL.	13.33		6,665.00	
DEPR., TAXES, INSUR.	DOL.	15.21		7,605.00	
TOTAL FIXED COSTS		28.54		14,270.00	
PRODUCTION	UNITS	PRICE	QTY.	VALUE	
SLAUGHTER HOGS	CWT.	48.00	6.79	325.92	162,960.00
TOTAL RECEIPTS				325.92	162,960.00
RETURNS ABOVE TOTAL OPERATING COSTS				88.56	44,280.00
RETURNS ABOVE ALL COSTS EXCEPT OVERHEAD, RISK, & MGMT.				60.02	30,010.00

APPENDIX B

CROP AND LIVESTOCK

ENTERPRISE BUDGETS

WHEAT FOR GRAIN - SANDY CLAY AND CLAY LOAM SOIL 76120101

OPERATING INPUTS:	UNITS	PRICE	QTY.	VALUE /ACRE
WHEAT SEED	BU.	4.18	1.00	4.18
NITROGEN (N)	LBS.	0.22	40.00	8.80
18-46-0 FERT.	CWT	9.80	1.00	9.80
INSECTICIDE	ACRE	4.50	1.00	4.50
CUSTOM HARVEST	ACRE	16.00	1.00	16.00
CUSTOM HAULING	BU.	0.14	36.00	5.04
RENT FERT. SPREADER	ACRE	2.00	2.00	4.00
ANNUAL OPERATING CAP.	DOL.	0.12	28.19	3.28
LABOR CHARGES	HOUR	4.50	2.50	11.25
MACH. FUEL,LUBE,REPAIR	ACRE			17.11
TOTAL OPERATING COST				83.96

FIXED COSTS	UNITS	VALUE
MACHINERY		
INTEREST AT 12.0%	DOL.	11.24
DEPR., TAXES, INSUR.	DOL.	13.28
TOTAL FIXED COSTS		24.52

PRODUCTION	UNITS	PRICE	QTY.	VALUE
WHEAT	BU.	4.35	36.00	156.60
PASTURE	AUMS	0.00	0.75	0.00
TOTAL RECEIPTS				156.60

RETURNS ABOVE TOTAL OPERATING COSTS	72.64
RETURNS ABOVE ALL COSTS EXCEPT OVERHEAD, RISK, & MGMT.	48.12

GRAIN SORGHUM - DRYLAND, SANDY SOIL; CUSTOM HARVEST 73110108 (NW)

OPERATING INPUTS:	UNITS	PRICE	QTY.	VALUE /ACRE
GRAIN SORGHUM SEED	LBS.	0.45	3.00	1.35
NITROGEN (N)	LBS.	0.22	35.00	7.70
INSECTICIDE	ACRE	6.50	1.00	6.50
CUSTOM HARVEST	ACRE	12.00	1.00	12.00
CUSTOM HAULING	BU.	0.20	21.00	4.20
RENT FERT. SPREADER	ACRE	2.00	1.00	2.00
ANNUAL OPERATING CAP.	DOL.	0.12	9.00	1.08
LABOR CHARGES	HOUR	4.50	0.86	3.86
MACH. FUEL,LUBE,REPAIR	ACRE			8.02
TOTAL OPERATING COST				46.71

FIXED COSTS	UNITS	VALUE
MACHINERY		
INTEREST AT 12.0%	DOL.	6.67
DEPR., TAXES, INSUR.	DOL.	7.48
TOTAL FIXED COSTS		14.15

PRODUCTION	UNITS	PRICE	QTY.	VALUE
GRAIN SORGHUM	CWT.	2.86	30.00	85.80
PASTURE	AUMS	0.00	0.75	0.00
TOTAL RECEIPTS				85.80
RETURNS ABOVE TOTAL OPERATING COSTS				39.09
RETURNS ABOVE ALL COSTS EXCEPT OVERHEAD, RISK, & MGMT.				24.94

ALFALFA - DRYLAND; CUSTOM HARVEST, CONVENTIONAL BALE 81120101

OPERATING INPUTS:	UNITS	PRICE	QTY.	VALUE /ACRE
1/5 EST COST	ACRE	90.22	0.20	18.04
INSECTICIDE/HERBICIDE	ACRE	9.50	1.20	11.40
PHOSPHATE (P205)	LBS.	0.19	100.00	19.00
CUTTING & BALING	BL.	0.85	195.00	165.75
CUSTOM HAULING	BL.	0.42	195.00	81.90
ANNUAL OPERATING CAP.	DOL.	0.12	41.84	5.02
LABOR CHARGES	HOUR	4.50	0.05	0.21
MACH. FUEL,LUBE,REPAIR	ACRE			0.24
TOTAL OPERATING COST				301.56

FIXED COSTS	UNITS	VALUE
MACHINERY		
INTEREST AT 12.0%	DOL.	0.15
DEPR., TAXES, INSUR.	DOL.	0.17
TOTAL FIXED COSTS		0.32

PRODUCTION	UNITS	PRICE	QTY.	VALUE
ALFALFA	TONS	65.00	3.25	211.25
TOTAL RECEIPTS				211.25

RETURNS ABOVE TOTAL OPERATING COSTS	-90.31
RETURNS ABOVE ALL COSTS EXCEPT OVERHEAD, RISK, & MGMT.	-90.63

NATIVE HAY - JULY HARVEST; CUSTOM HAUL 85230301

OPERATING INPUTS:	UNITS	PRICE	QTY.	VALUE /ACRE
CUSTOM HAULING	TONS	12.00	1.50	18.00
BALING WIRE	BL.	0.12	45.00	5.40
ANNUAL OPERATING CAP.	DOL.	0.12	0.00	0.00
LABOR CHARGES	HOUR	4.50	0.67	3.02
MACH. FUEL,LUBE,REPAIR	ACRE			6.09
TOTAL OPERATING COST				32.50

FIXED COSTS	UNITS	VALUE
MACHINERY		
INTEREST AT 12.0%	DOL.	4.75
DEPR., TAXES, INSUR.	DOL.	5.47
TOTAL FIXED COSTS		10.22

PRODUCTION	UNITS	PRICE	QTY.	VALUE
NATIVE HAY	TONS	46.00	1.50	70.00
TOTAL RECEIPTS				70.00

RETURNS ABOVE TOTAL OPERATING COSTS	37.50
RETURNS ABOVE ALL COSTS EXCEPT OVERHEAD, RISK & MGMT.	27.28

BERMUDA BALED HAY 83370504

OPERATING INPUTS:	UNITS	PRICE	QTY.	VALUE /ACRE
1/10 EST COST	ACRE	80.00	0.10	8.00
NITROGEN	LBS.	0.22	180.00	39.60
PHOSPHATE (P205)	LBS.	0.19	40.00	7.60
POTASH (K2O)	LBS.	0.11	20.00	2.20
RENT SPRAYER	ACRE	2.60	1.00	2.60
CUSTOM HAULING	BL.	0.35	136.00	47.60
MISC. EXPENSE	BL.	0.12	136.00	16.32
ANNUAL OPERATING CAP.	DOL.	0.12	7.40	11.65
LABOR CHARGES	HOUR	4.50	2.59	11.65
MACH. FUEL,LUBE,REPAIR	ACRE			24.29
TOTAL OPERATING COST				162.75

FIXED COSTS	UNITS	VALUE
MACHINERY		
INTEREST AT 12.0%	DOL.	23.33
DEPR., TAXES, INSUR.	DOL.	25.71
TOTAL FIXED COSTS		49.04

PRODUCTION	UNITS	PRICE	QTY.	VALUE
BERMUDA HAY	TONS	48.00	4.40	211.20
TOTAL RECEIPTS				211.20

RETURNS ABOVE TOTAL OPERATING COSTS	48.45
RETURNS ABOVE ALL COSTS EXCEPT OVERHEAD, RISK & MGMT.	-0.59

NATIVE GRASS PASTURE - YEAR-ROUND GRAZING 85230101

OPERATING INPUTS:	UNITS	PRICE	QTY.	VALUE /ACRE
2-4-D	LBS.	4.50	0.25	1.13
ANNUAL OPERATING CAP.	DOL.	0.12	0.36	0.04
LABOR CHARGES	HOUR	4.50	0.17	0.78
MACH. FUEL,LUBE,REPAIR	ACRE			1.02
TOTAL OPERATING COST				2.97

FIXED COSTS	UNITS	VALUE
MACHINERY		
INTEREST AT 12.0%	DOL.	0.41
DEPR., TAXES, INSUR.	DOL.	0.52
TOTAL FIXED COSTS		0.93

PRODUCTION	UNITS	PRICE	QTY.	VALUE
PASTURE	AUMS	0.00	1.38	0.00
TOTAL RECEIPTS				0.00

RETURNS ABOVE TOTAL OPERATING COSTS	-2.97
RETURNS ABOVE ALL COSTS EXCEPT OVERHEAD, RISK & MGMT.	-3.90

BERMUDA PASTURE - SANDY SOIL 83370102

OPERATING INPUTS:	UNITS	PRICE	QTY.	VALUE /ACRE
NITROGEN (N)	LBS.	0.22	100.00	22.00
PHOSPHATE (P205)	LBS.	0.19	40.00	7.60
POTASH (K2O)	LBS.	0.11	20.00	2.20
RENT FERT. SPREADER	ACRE	2.00	1.00	2.00
1/10 EST. COST	ACRE	80.00	0.10	8.00
ANNUAL OPERATING CAP.	DOL.	0.12	7.04	0.84
LABOR CHARGES	HOUR	4.50	0.65	2.94
MACH. FUEL,LUBE,REPAIR	ACRE			6.12
TOTAL OPERATING COST				58.96

FIXED COSTS	UNITS	VALUE
MACHINERY		
INTEREST AT 12.0%	DOL.	3.81
DEPR., TAXES, INSUR.	DOL.	4.35
TOTAL FIXED COSTS		8.16

PRODUCTION	UNITS	PRICE	QTY.	VALUE
PASTURE	AUMS	0.00	5.00	0.00
TOTAL RECEIPTS				0.00

RETURNS ABOVE TOTAL OPERATING COSTS	-58.96
RETURNS ABOVE ALL COSTS EXCEPT OVERHEAD, RISK, & MGMT.	-67.12

COW-CALF, SPRING CALVING, WARM SEASON PASTURE,
WINTER DM IS 25% NON-LEGUME HAY 11000000

OPERATING INPUTS:	UNITS	PRICE	QTY.	VALUE /HEAD
NON-LEGUME HAY	LBS.	0.03	964.00	28.92
41-45% PROTEIN SUPP.	LBS.	0.09	299.00	26.91
20% CUBE - REP. HFRS.	LBS.	0.05	367.00	18.35
SALT & MINERALS	LBS.	0.09	30.00	2.70
VET SERVICE & SUPPLIES	HD.	17.43	1.00	17.43
MARKETING CHARGE	CWT	1.72	4.32	7.43
PERSONAL TAXES	HD.	5.28	1.00	5.28
HERD BULLS	CWT	110.00	0.12	13.20
HAULING	CWT	0.35	4.32	1.51
ANNUAL OPERATING CAPITAL	DOL.	0.12	76.39	9.17
LABOR CHARGES	HR.	4.50	10.02	45.11
M&E FUEL, LUBE, & REP.	DOL.			29.51
TOTAL OPERATING COST				205.53

FIXED COSTS	UNITS	VALUE
MACHINERY & EQUIPMENT		
INTEREST AT 12.0%	DOL.	10.59
DEPR., TAXES, INSUR.	DOL.	15.09
LIVESTOCK		
INTEREST AT 12.0%	DOL.	64.78
DEPR., TAXES, INSUR.	DOL.	0.12
TOTAL FIXED COSTS		90.58

COW-CALF, SPRING CALVING, WARM SEASON PASTURE,
WINTER DM IS 25% NON-LEGUME HAY (CONTINUED)

PRODUCTION	UNITS	PRICE	QTY.	VALUE
STR. CALVES (4-5)	CWT	81.00	1.92	155.52
HFR. CALVES (4-5)	CWT	69.00	1.27	87.63
COMMERCIAL COWS	CWT	40.00	0.87	34.80
AGED BULLS	CWT	48.00	0.14	6.72
HEIFERS (6-7)	CWT	65.00	0.12	7.80
TOTAL RECEIPTS				292.47
RETURNS ABOVE TOTAL OPERATING COSTS				86.94
RETURNS ABOVE ALL COSTS EXCEPT OVERHEAD, RISK, & MGMT.				-3.64

COW-CALF, FALL CALVING, WARM SEASON PASTURE,
WINTER DM IS 25% NON-LEGUME HAY

11000003

OPERATING INPUTS:	UNITS	PRICE	QTY.	VALUE /HEAD
NON-LEGUME HAY	LBS.	0.03	1,279.00	38.37
41-45% PROTEIN SUPP.	LBS.	0.09	526.00	47.34
20% CUBE - REP. HFRS.	LBS.	0.05	541.00	27.05
SALT & MINERALS	LBS.	0.09	30.00	2.70
VET SERVICE & SUPPLIES	HD.	17.43	1.00	17.43
MARKETING CHARGE	CWT	1.72	3.94	1.38
PERSONAL TAXES	HD.	5.28	1.00	5.28
HERD BULLS	CWT	110.00	0.12	13.20
HAULING	CWT	0.35	3.94	1.38
ANNUAL OPERATING CAPITAL	DOL.	0.12	63.09	7.57
LABOR CHARGES	HR.	4.50	12.35	54.60
M&E FUEL, LUBE, & REP.	DOL.			38.15
TOTAL OPERATING COST				261.13

FIXED COSTS	UNITS	VALUE
MACHINERY & EQUIPMENT		
INTEREST AT 12.0%	DOL.	12.15
DEPR., TAXES, INSUR.	DOL.	17.82
LIVESTOCK		
INTEREST AT 12.0%	DOL.	64.78
DEPR., TAXES, INSUR.	DOL.	0.12
TOTAL FIXED COSTS		94.86

COW-CALF, FALL CALVING, WARM SEASON PASTURE,
WINTER DM IS 25% NON-LEGUME HAY (CONTINUED)

PRODUCTION	UNITS	PRICE	QTY.	VALUE
STR. CALVES (4-5)	CWT	81.00	1.71	138.51
HFR. CALVES (4-5)	CWT	69.00	1.11	76.59
COMMERCIAL COWS	CWT	40.00	0.87	34.80
AGED BULLS	CWT	48.00	0.14	6.72
HEIFERS (6-7)	CWT	65.00	0.12	7.80
TOTAL RECEIPTS				264.51
RETURNS ABOVE TOTAL OPERATING COSTS				3.38
RETURNS ABOVE ALL COSTS EXCEPT OVERHEAD, RISK, & MGMT.				-91.48

STOCKER STEERS ON WINTER WHEAT PASTURE
SPRING CALVES HELD 135 DAYS

13120001

OPERATING INPUTS:	UNITS	PRICE	QTY.	VALUE /HEAD
STEER CALVES (6-700#)	CWT.	81.00	4.37	353.97
NON-LEGUME HAY	LBS.	0.03	386.00	11.58
SALT & MINERALS	LBS.	0.09	7.46	0.67
VET SERVICE & SUPPLIES	HD.	11.08	1.00	11.08
MARKETING CHARGE	CWT	1.72	6.79	11.68
HAULING	CWT.	0.35	11.16	3.91
ANNUAL OPERATING CAPITAL	DOL.	0.12	125.17	15.02
LABOR CHARGES	HR.	4.50	2.95	13.28
M&E FUEL, LUBE, & REP.	DOL.			7.79
TOTAL OPERATING COST				428.99

FIXED COSTS	UNITS	VALUE
MACHINERY & EQUIPMENT		
INTEREST AT 12.0%	DOL.	4.91
DEPR., TAXES, INSUR.	DOL.	6.50
TOTAL FIXED COSTS		11.41

PRODUCTION	UNITS	PRICE	QTY.	VALUE
STEERS (6-700#)	CWT	69.00	6.65	458.85
TOTAL RECEIPTS				458.85

RETURNS ABOVE TOTAL OPERATING COSTS	27.81
RETURNS ABOVE ALL COSTS EXCEPT OVERHEAD, RISK, & MGMT.	16.40

STOCKER HEIFERS ON WINTER WHEAT PASTURE
SPRING CALVES HELD 135 DAYS 13120002

OPERATING INPUTS:	UNITS	PRICE	QTY.	VALUE /HEAD
HEIFER CALVES	CWT.	69.00	4.22	290.18
NON-LEGUME HAY	LBS.	0.03	377.00	11.01
SALT & MINERALS	LBS.	0.09	7.25	0.65
VET SERVICE & SUPPLIES	HD.	11.08	1.00	11.08
MARKETING CHARGE	CWT	1.72	6.39	10.99
HAULING	CWT.	0.35	10.41	3.71
ANNUAL OPERATING CAPITAL	DOL.	0.12	104.32	12.52
LABOR CHARGES	HR.	4.50	2.95	13.28
M&E FUEL, LUBE, & REP.	DOL.			8.88
TOTAL OPERATING COST				362.32

FIXED COSTS	UNITS	VALUE
MACHINERY & EQUIPMENT		
INTEREST AT 12.0%	DOL.	4.95
DEPR., TAXES, INSUR.	DOL.	6.36
TOTAL FIXED COSTS		11.31

PRODUCTION	UNITS	PRICE	QTY.	VALUE
HEIFERS	CWT.	65.00	6.26	406.90
TOTAL RECEIPTS				406.90
RETURNS ABOVE TOTAL OPERATING COSTS				44.58
RETURNS ABOVE ALL COSTS EXCEPT OVERHEAD, RISK, & MGMT.				33.27

VITA

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