AN ECONOMIC ANALYSIS AND COMPARISON OF PART-TIME AND FULL-TIME BEEF FARM OPERATIONS IN EASTERN OKLAHOMA

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CHAPTER I

INTRODUCTION

Census data and farm surveys indicate that off-farm employment combined with farming may have become more than a transitory stage for entering or leaving farming. There is evidence that the percentage of all cows and acres controlled by part-time farms may be increasing. If part-time farming has become an important structural component of the agricultural industry, then several questions about resource use and production possibilities are relevant to farmers and others. Are the same enterprises relevant for both part-time farms and their full-time counterpart? Do the two types of farms respond differently to changing conditions? Much of this study will be devoted to a comparison of optimal organizations of full-time and part-time beef cattle farming in Eastern Oklahoma.

The 1969 Census of Agriculture [1] defines a part-time farmer as one under age 65 who works 100 days or more off the farm and has a gross farm income of $50 to $2,499 annually. Farmers may exceed the gross farm income level specified by the Census definition and be classified as full-time regardless of days worked off the farm. Numbers of all categories of farmers who work off farm have undergone several changes since the mid-1960's. Table I summarizes 1964 and 1969 Census data with respect to off-farm work for the state and for selected areas of Oklahoma. Farm numbers declined from 88,726 to 83,037 between 1964

TABLE I

FARM OPERATORS REPORTING DAYS OF WORK OFF FARM IN OKLAHOMA[1]

Item	Total Farms 1969	Total Farms 1964	All Farms Reporting Off-Farm Work 1969	All Farms Reporting Off-Farm Work 1964	Farms With Sales Over $2500 and Reporting Off-Farm Work 1969	Farms With Sales Over $2500 and Reporting Off-Farm Work 1964
	No.	No.	No.	No.	No.	No.
State: Total	83,037	88,726	50,472	47,927	26,570	18,150
1 to 49 days			7,395		5,185	4,799
50 to 99 days			3,806	11,609	2,529	2,564
100 to 199 days			7,643		4,210	2,819
200 days or over			31,628	36,318	14,646	7,968
Area 1:[2] Total	3,053	4,162	1,935	2,248	753	444
1 to 49 days			219		112	85
50 to 99 days			136	458	67	69
100 to 199 days			330		138	83
200 days or over			1,250	1,790	436	207
Area 2:[2] Total	7,138	7,769	4,737	4,563	2,142	1,229
1 to 49 days			483		299	266
50 to 99 days			245	768	154	147
100 to 199 days			534		253	149
200 days or over			3,475	3,795	1,441	667
Area 3:[2] Total	3,949	4,895	2,666	3,074	1,148	627
1 to 49 days			240		138	117
50 to 99 days			217	556	87	82
100 to 199 days			409		181	97
200 days or over			1,800	2,518	742	331
Area 4:[2] Total	3,381	4,702	2,341	2,888	962	437
1 to 49 days			249		110	81
50 to 99 days			167	593	82	63
100 to 199 days			415		182	76
200 days or over			1,510	2,295	588	217
Area 5:[2] Total	10,710	10,286	5,855	4,847	3,972	3,540
1 to 49 days			1,168		907	977
50 to 99 days			546	1,711	422	512
100 to 199 days			1,017		719	612
200 days or over			3,123	3,136	1,924	1,436

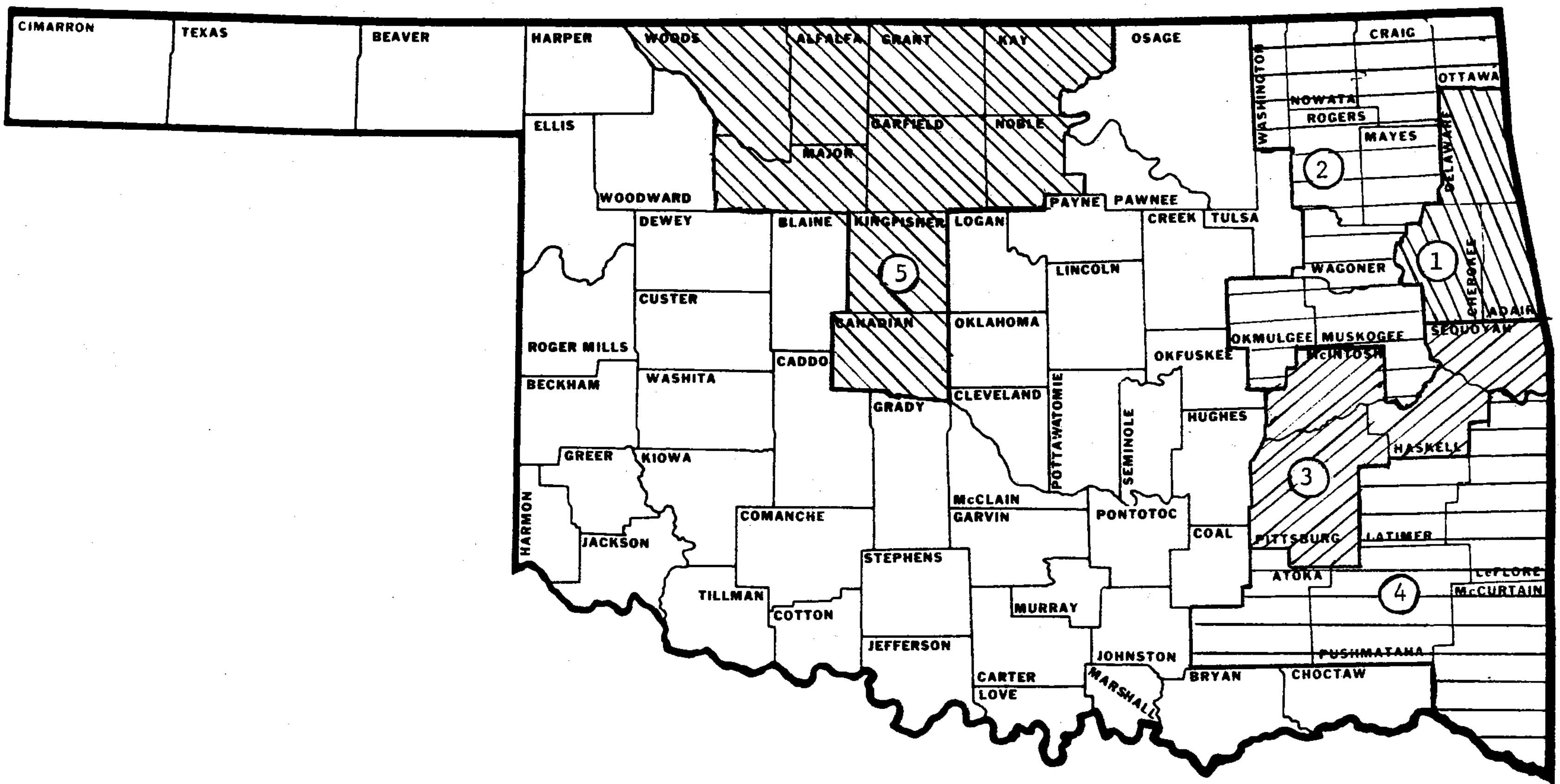
[1]1969 Census of Agriculture, Oklahoma.

[2]For specific parts of the state involved see Figure 1.

and 1969. The number of farm operators reporting days of off-farm work increased from 47,927 to 50,472 in the same period. A large part of this increase was in farms with sales over $2,500 value. By the Census definition the number of part-time farmers in Oklahoma declined from 25,531 (all farms less those with sales over $2,500) in 1964 to 20,415 in 1969 (Table I). But the number of farms which had both sales over $2,500 and an operator who worked more than 200 days off the farm increased by more than 6,500. However, these were not included in the Census part-time category. This was an increase from less than 10 percent of all farms in 1964 to over 17 percent in 1969. Another observation is that over 38 percent of Oklahoma farmers worked off the farm 200 days or more.

Farmers doing off-farm work is not limited to any one part of the state. All five regions indicated in Figure 1 showed marked levels of off-farm work. Topographic differences appear to have little influence on the amount of part-time farming. The Oklahoma Conservation Needs Inventory [2] showed that Area 1 had only about 36 percent of open land available for field crops or pasture, but Table I indicates 1,250 of the 3,053 farm operators in that area worked 200 days or more off farm. Over 80 percent of the land in Area 2 was in crops or pasture, yet 3,475 or over 75 percent of the farmers in this area worked over 200 days off the farm. Area 5 in North Central Oklahoma, considered heavily farmed, had over 3,000 of the 10,710 operators working 200 days or more off the farm.

A 1969 survey of 138 beef cattle farms in Eastern Oklahoma found 68 operators working more than 200 days off the farm [3]. Survey data for the eastern portion of Oklahoma and a segment of central Arkansas



OKLAHOMA

Figure 1. Five Regions in Oklahoma with a High Incidence of Part-Time Farming

are summarized in Table II. The regions for this data are included in Areas 1, 2, 3, and 4 of the previous discussion with some boundary differences. These sample data are expanded to area totals by Jobes [4, p. 10]. In three of the four regions more than half of the beef farm operators worked some days off the farm. In Area 27, over 21 percent of the farms surveyed had operators working 250 or more days off the farm. This percentage ranged upward to over 43 percent in Area 30. In general, off-farm work is widespread in Eastern Oklahoma. If working as much as 200 days off the farm is a measure, part-time farming is of major significance to the area in terms of the number of farms represented.

TABLE II

OFF-FARM WORK CHARACTERISTICS OF BEEF FARMS
FOR SELECTED REGIONS OF OKLAHOMA

Days Worked Off Farm	Number of Farms							
	Region 27[a]		Region 28[a]		Region 29[a]		Region 30[a]	
	Farms							
	Number	Percent	Number	Percent	Number	Percent	Number	Percent
Total[b]	7,511		10,681		3,209		1,868	
None	3,563	47.4	5,092	47.7	1,634	50.9	707	37.9
1 - 99	1,348	18.0	1,274	11.9	69	2.2	202	10.8
100 - 249	963	12.8	1,765	16.5	343	10.7	152	8.1
> 250	1,637	21.8	2,550	23.9	1,163	36.2	807	43.2

[a]Region 27 is Northeast Oklahoma bordering Arkansas. Region 28 is Southeast Oklahoma and central Arkansas. Region 29 is Northeast Oklahoma. Region 30 is East Central Oklahoma.

[b]Expanded from sample.

Several definitions of part-time farming exist. The Census definition considered both off-farm work and farm income. The upper limit on farm income failed to account for large numbers of farmers working off the farm. The empirical analysis in this study will not use an income limit but will assume at least 200 days off-farm work.

This study is based on data developed as part of the regional research project, Evaluation of the Beef Industry in the South. Butler [5] summarizes economic and operation characteristics of beef farms from all states involved. The data for Oklahoma will be used in this study to examine microeconomic effects of resource use for representative beef situations in the study area. The macroeconomic implications of these results will also be discussed.

Statement of the Problem

Inefficient organizations to achieve specific objectives are a major problem in Eastern Oklahoma. Advanced production methods are available to the area, but the appropriate ones to use may vary widely with price and resource situations. Differing types of farm situations may dictate various combinations of practices and production activities. The high incidence of farms with the operator working off the farm in Eastern Oklahoma indicates a need for an evaluation of organizational strategies for part-time farm operators as well as full-time commercial farmers. An evaluation of the differences in organizations is needed to form a basis for macroeconomic implications and to determine kinds and direction of future research needs.

Objectives

Results of this study should provide useful information to beef farm operators to assist in determining livestock and forage programs to fit particular resource situations. Related information should be useful in determining potential income to beef farmers, beef production, and demand for resources used in beef production such as labor, capital, land, and incentives for technological improvements.

An analytical model to evaluate production alternatives of part-time and full-time farming situations should aid in increasing efficiency of resource use in beef farming in Eastern Oklahoma. Comparison of representative farms of each situation should yield insight into the macro implications of part-time farming for beef production in Eastern Oklahoma.

The specific objectives of this study are:

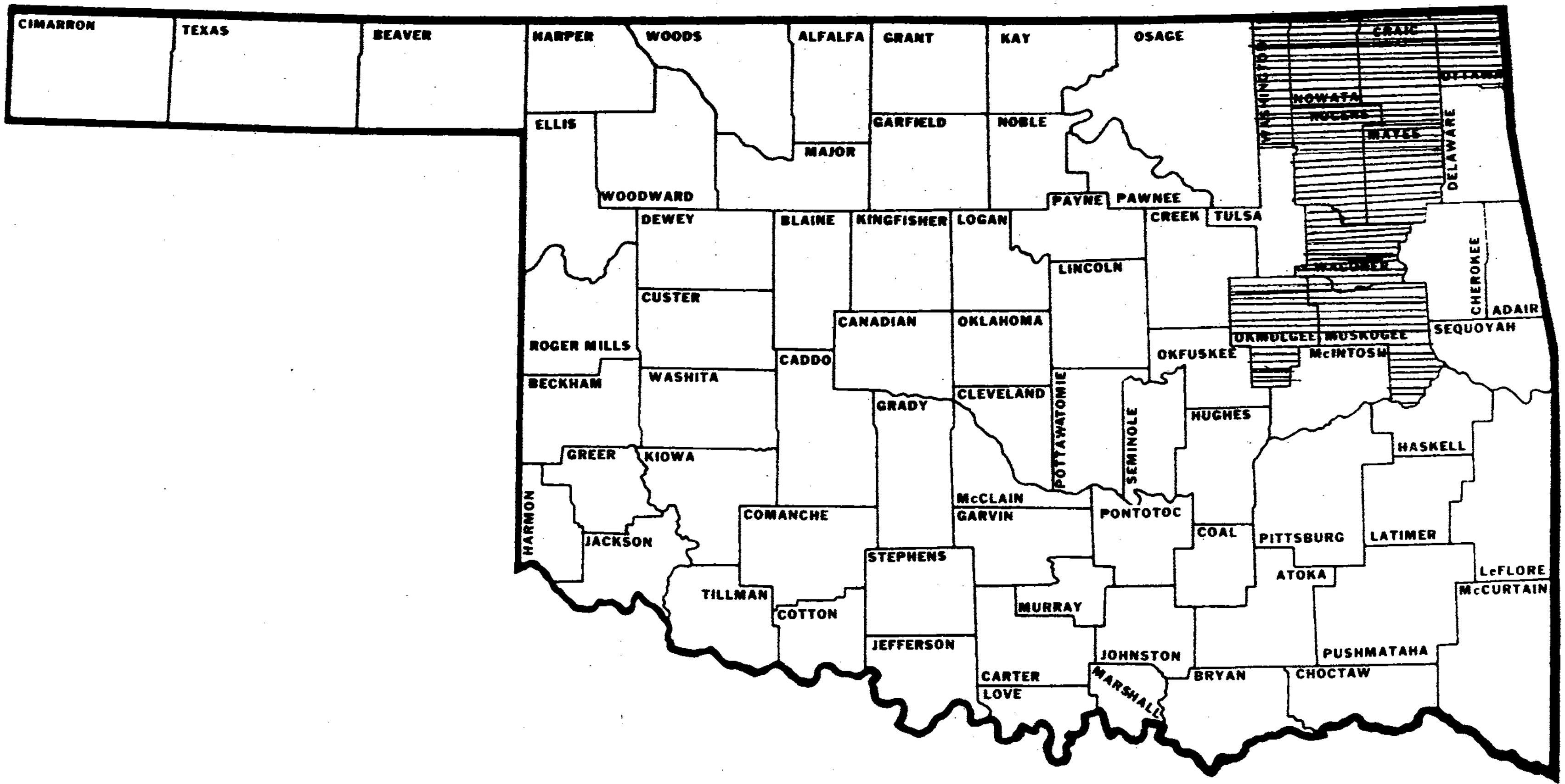
1. To evaluate resource requirements, organizational alternatives, and production estimates for representative part-time and full-time situations in Eastern Oklahoma.

2. To compare organizations and responses to different price levels, interest rates, and livestock alternatives available by the representative situations.

3. To evaluate effects of the level of part-time farming in an area on resource demand and product supply estimates.

Area of Study

The analytical portion of this study was confined to a nine county area in east central and northeast Oklahoma. The shaded portion of Figure 2 is the study region and is Area 2 of Figure 1. General statistical data were available from approximately the eastern one-third



OKLAHOMA

Figure 2. Region Selected for Empirical Analysis

of the state. The area specifically analyzed is a sub-region in Regional Research Project S-67, Evaluation of the Beef Industry in the South.

The eastern portion of Oklahoma is characterized by small beef farms. Jobes' [4] survey included 138 farms averaging 41 cows per farm with 48 having less than 20 cows. The average land size was about 398 acres. A large part of the land resource in the study area is suitable only for pastureland. In comparison, the nine county study area selected for analysis beef farms averaged about 398 acres per farm, of which, 54 percent was openland suitable for pasture only. Climatically, the area is well suited to beef production having rainfall sufficient for a variety of forages.

Source of Data

Data were developed following guidelines established by the Regional Research Project committee. A survey conducted in 1969 was the source for estimates of available resources and types of farm enterprises. The soil resource delineations and budgeting procedures, both for data inputs and within the programming model, were first used by Jobes [2]. Forage yields and alternatives, livestock production activities, and other relationships were incorporated on the basis of survey data and consultation with soil scientists and animal science specialists.

Chapters that follow first provide a review of some of the basic theory involved in decision-making and a discussion of previous studies. Chapter III will be devoted to discussing data input and procedures used in this study. Chapter IV will develop the representative resource situations. Chapter V will analyze each farm situation. The final chapter will summarize and present conclusions of the study.

CHAPTER II

THEORY AND LITERATURE REVIEW

A review of farm management research and decision theory is essential to define the scope and basis of the study. First a brief look at part-time farming and comments from other studies relating to particular problems associated with it will be presented. A summary of selected aspects of decision theory will then be followed by a review of applicable research conducted in the farm management area. The theory will provide guides for structuring the problem and developing the model. Utility concepts underlying decision theory will be presented, to indicate how the structure of functions relating utility to monetary income influence decisions. Risk, time, and uncertainty will also be discussed to emphasize the role they can play in decision making. This study will not account for either of the latter three factors in a probabilistic or dynamic sense, but alternatives using comparative statics and deterministic or single objective functions will be shown. Results from previous research in the same theoretical areas will afford a basis for assumptions and analysis used in the study.

A Look at Part-Time Farming

Table I in Chapter I indicated that off-farm work is extensive in Oklahoma and appears to be increasing in spite of a decline in farm numbers. Other studies present similar data for other parts of the U. S.

Butler's summary [5, p. 42] of data collected by survey as part of Regional Research Project S-67, reports that 10 of the 34 subregions had over 50 percent of the beef farm operators reporting off-farm work in 1968. A large percent of the operators reported off-farm work of more than 250 days.

A Michigan study [6] examined part-time farming in the southern part of that state. The definition in this case required only that an operator work at a nonfarm job during the year. In this study, two areas were compared. The most productive agricultural area had less part-time farming, but it also had less opportunity for off-farm employment. Total part-time farming increased in the 1959 to 1963 period studied. Though part-time farmers controlled fewer resources than full-time farmers they still made a substantial contribution to Michigan agriculture by producing 38 percent of the value of all farm products sold.

Several factors influence the level of part-time farming. A large volume of farm resources may be necessary to earn an adequate consumption income. When these resources are unavailable off-farm income may be needed to supplement farm earnings. Also, there may be reasons other than current earnings for holding farm real estate such as increases in land price.

A paper by West and Schneeberger [7] points to the importance of studying small or part-time farms. They noted that two-thirds of the farm population lived on farms with gross sales of less than $10,000 in 1964. This proportion varies from one region to another in the U. S.

As pointed out by West and Schneeberger, smaller farms (this could include part-time operators) have special problems in choosing which and how many enterprises to use. The problem is in trying to organize a small farm just like the larger farms with more resources. Land, capital, or other resource limitations are commonly considered reasons for limiting the success of part-time farms. There is a resulting tendency to accept the statement that these farms cannot compete because they cannot achieve economies of size comparable to larger farms. This statement implies that part-time farmers possibly should follow a different organizational strategy than the full-time counterpart.

To adequately study the problems of small or low income farms requires a knowledge of their characteristics. Objectives of these farmers can be influenced by their position in farming, whether it is a transitional phase, a source of retirement income, a permanent way of life mixing off-farm work with living and working on the farm, or a hobby which has income potential in the short or long run. This not only has a great deal to do with potential incomes for rural areas, but also, the potential beef production. If part-time farmers are a permanent and important part of the economic structure, their influence will affect the overall response of beef production to price or cost changes. Because their objectives in farming may be different than those of a full-time commercial farm, a part-time farm may react differently. As a supplemental source of income, overall rural incomes may rise. Different rates of input use could have an important influence on potential beef production. It is necessary to study a wide range of production alternatives to insure that those suited to part-time farms will be included.

Decision Theory

Production economics frequently works with normative estimates for a particular firm. Empirical and theoretical assumptions are made, a resource situation is developed and a result concerning optimal operation of a firm is derived. The results are applicable only so far as the model and assumptions can be accepted. The problem of improving assumptions incorporated into objective functions has led to considerable development in decision theory. Much early work has been devoted to the concept of utility. Blang [8, p. 347] relates the development of utility theory since Marshall.

Recent studies have assumed that satisfaction depends upon the level of income and that the utility function would not necessarily maintain the same shape throughout as the income level changes. One such analysis was made by Friedman and Savage [9]. Figure 3 illustrates their approach. To the left of point A and the right of B the individual would have a decreasing marginal utility for income. Between the two points marginal utility is increasing. The level of income of an individual will determine his willingness to gamble.

The hypothesis of Friedman-Savage is that an individual at lower income levels up to A would not accept even a fair gamble, but would insure against a loss. The reason is that he faces a diminishing marginal utility for increases in income but increasing disutility for losses in income. The same holds if he is past point B. In either of these ranges the decision maker would not gamble and would insure

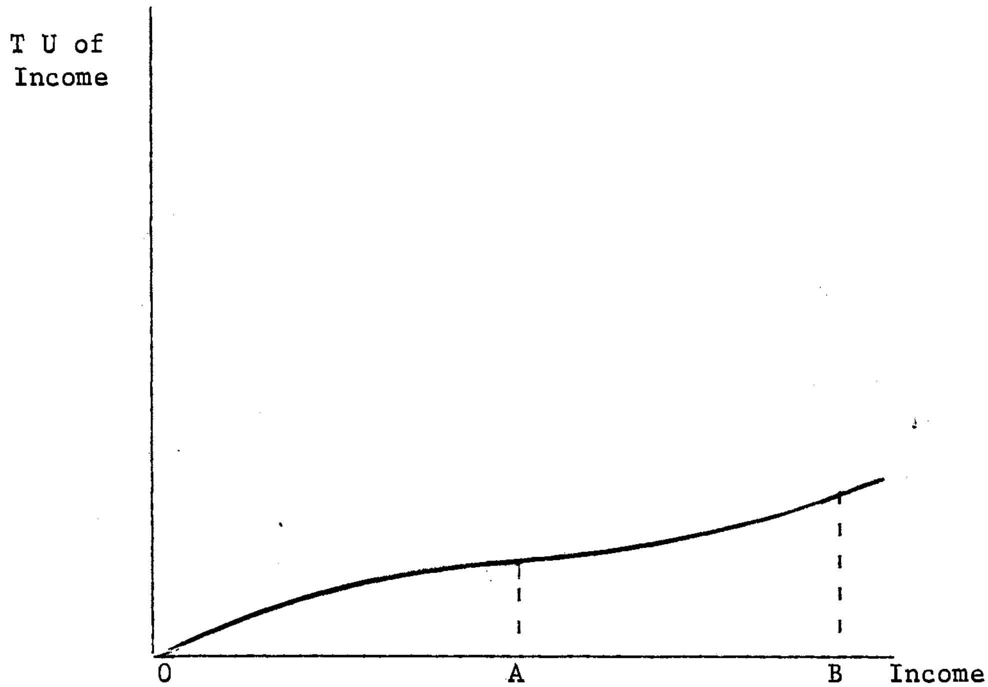


Figure 3. Friedman-Savage Utility Function Relating Total Utility To Income

against loss. Between A and B there is increasing marginal utility of income so that the individual would pay for the chance of a large gain, but the degree of loss is not sufficient to encourage him to buy insurance.

Markowitz [10] extended the income-utility hypothesis by assuming that an individual was concerned with changes in wealth. Figure 4 illustrates his idea. Here, the initial income position is the origin. A disutility is associated with a loss in wealth and utility with a gain. The important factor is the change in total wealth or economic position, not just an income change. It is similar to the Friedman-Savage approach in terms of the effects the shape of the function might have on decisions.

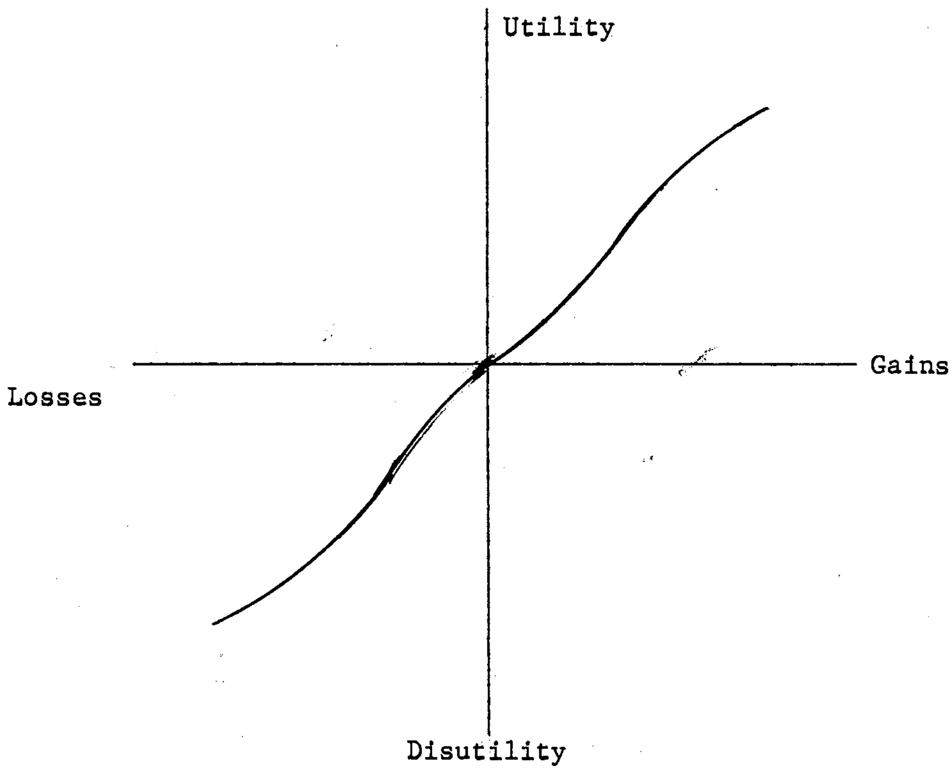


Figure 4. Markowitz Utility Function Relating Utility of an Individual To Gains or Losses of Wealth

The genesis of utility theory can be summarized in three types of utility functions shown in Figure 5 [11]. A utility function for an individual could have any one or a combination of the three. Individual I has a constant marginal utility for each dollar gained. Individual II has a decreasing marginal utility and Individual III values each additional dollar more highly than the previous. For persons having utility functions the shape of I or for parts of functions with that form, maximizing money income would also maximize utility and would justify firm models viewing profits as a single objective criterion.

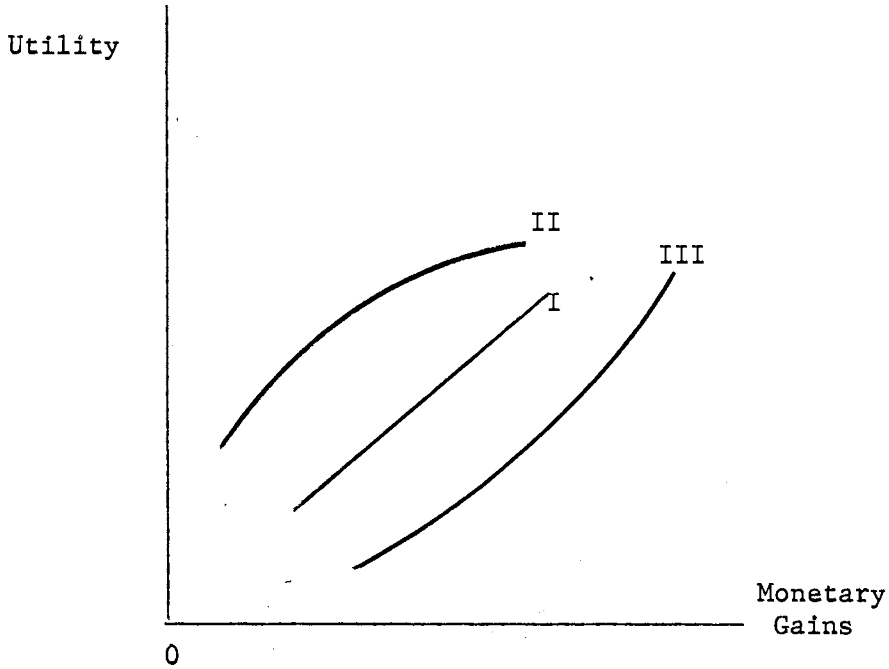


Figure 5. Three Conceptual Forms of Utility Functions Relating Utility to Monetary Gains

Utility functions as described previously indicate that the current level of income can be an important factor in decision making. Income targets may become objective criterion particularly if the Markowitz hypothesis that utility is a function of a change in wealth is true. The level or amount of change related to the utility function would influence a decision. The analytical portion of this study will evaluate resource situations and a specified income target.

The influence of how other factors contribute to utility and firm organization was examined by Hurt [12]. Hurt assumed that utility an individual would receive from a given organization of production would be a function of income, output (some products favored), and inputs (particularly operator labor). He showed that to maximize utility, marginal value product could be less than, equal to, or greater than marginal cost.

Briefly his proof is as follows [12, p. 12-13]:

$$U = U(V, Y_1, Y_2, \ldots, Y_m, X_1, X_2, \ldots, X_n) \quad (1)$$

$$V = \sum_{i=1}^{m} P_{yi}Y_i - \sum_{i=1}^{n} P_{xj}X_j \quad (2)$$

$$F(Y_1, Y_2, \ldots, Y_m, X_1, X_2, \ldots, X_n) = 0 \quad (3)$$

where U is utility, V is net monetary income, Pyi's and Pxi's are prices, Yi's are physical products and Xj's are inputs. Equation (3) is the production function.

To maximize utility, the necessary condition is

$$P_{yi} \cdot \frac{\delta Yi}{\delta Xj} = P_{xj} - \frac{\frac{\delta U}{\delta xj} + \frac{\delta U}{\delta yi} \cdot \frac{\delta yi}{\delta Xj}}{\frac{\delta U}{\delta V}} \quad (4)$$

If the marginal utility of profits, $\frac{\delta U}{\delta V}$, is considered positive then in the case where there is no utility associated with production of any product or use of any input

$$\frac{\delta U}{\delta xj} + \frac{\delta U}{\delta yi} \cdot \frac{\delta Yi}{\delta Xj} = 0$$

for all i and j. Equation (4) becomes

$$Pyi \cdot \frac{\delta Yi}{\delta Xj} = Pxj$$

for all i and j. The latter expression is the necessary condition for profit maximization, i.e. marginal value product equals marginal factor cost. This condition could be approached if the marginal utility of money, $\frac{\delta U}{\delta V}$, becomes very large relative to the utility of the Yi's and

X_j's. However, if there is utility (disutility) associated with producing a particular product or using an input and $\frac{\delta U}{\delta V}$ is not excessive then output may be greater (less) than the profit maximizing condition.

Hurt discussed some specific factors affecting utility other than profit, especially those that could influence decisions in low income areas. Basically, there are four categories; knowledge, time, effort, and capital. It is because of these factors that he concludes farmers are motivated by income goals or targets rather than by optimums, and the goals may fall short of profit maximization equilibrium.

Factors other than profit maximization can be incorporated to a great degree in linear programming. Where income targets are appropriate objectives, models minimizing resources to achieve the specified income can be used. Minimizing inputs such as labor can be done if there is disutility associated with its use. Such models are also capable of accounting for product preferences. The advantage of using linear programming in this fashion is that it determines the most efficient combination of resources that will satisfy the objective function subject to the limitations placed on the model.

Time and knowledge are also factors in firm decision making. Hicks [13] develops the completely static model dealing with certain knowledge and a single production period. His first extension of this model dealt with time (more than one production period). Still operating under a complete knowledge situation, all that was required was dating input and outputs. Because future returns were not worth as much as current returns, they would be discounted. Thus, products and inputs were distinct by time or production periods. Discounting for uncertainty also could be accomplished within the framework of the dynamic model.

Hick's equilibrium conditions were a summary of the marginal principals (equating marginal returns and costs) used almost exclusively in the static sense from 1870 to 1914 [8, p. 347]. In early analyses economic functions were generally assumed continuous and differentiable because of the ease of handling the maximization assumptions. However, the discontinuous functions offered no great difficulties in analysis. The principle involved was that of dividing limited quantities of resources used in production among the alternatives available to the point that the cost of moving a resource from one use to another would just equal the returns from using it in the other. Hicks' work summarizes the necessary and sufficient conditions for the firm to be in equilibrium.

Much recent attention has been given to the effect uncertainty would have on results derived from traditional theory. Under the static (and comparative statics) assumptions, profit maximization or cost minimization was the motive of a firm. The question that has arisen deals with the effect on decision making if the manager does not know what his prices or yields will be or what competitors will do. Knight [14], Hicks [13], Heady [15], and others have contributed to decision making under uncertainty. In the following, contemporary contributions of theory pertaining to this study are given primary attention. Underlying them are the work of many others.

A recent article by Sandmo [16] presents a theoretical approach to a competitive firm under uncertainty. He says that assuming a firm seeks to maximize expected profits in inadequate, because it rules out any risk aversion on the part of the decision maker. He does accept the proposition that very short-run decisions may be made with a profit maximization objective.

Sandmo assumes utility is a continuous function of profits with a positive first derivative and a negative second as for individual II in Figure 5. In this case the firm is risk averse because each additional dollar gain would have less value than would a dollar loss. He also defines the price of the product as a random variable. Using these conditions he shows that output would be smaller than if prices were certain. Heady [15, p. 550] also points out that uncertainty almost always necessitates a sacrifice in production if precautions are taken to avoid risk.

The possibility of motives other than profit maximization or cost minimization has resulted in some different uses of existing research models. Strickland [17] viewed income goals as reasonable objectives. He gave three reasons for this approach: (1) an income level could maintain the "status quo," (2) the income level could represent the opportunity cost of farming, and (3) the income level would give maximum efficiency for that farm and the economy. The latter is held to be true because the author felt that if farmers could not achieve income comparable to an off-farm wage they would adjust out of farming.

Halbrook [18] also worked with models showing farm and resource organizations necessary to achieve specified levels of income. He made estimates for some situations with all income from farming and others with off-farm income. Halbrook used amounts of operator labor to approximate levels of part-time farming situations.

Both Halbrook and Strickland viewed the minimum resource model as an acceptable alternative to assuming profit maximization. Their models do not allow monetary returns to fall below what could be termed a satisfactory income assuming perfect knowledge.

Linear programming models can be used to analyze conditions of risk and uncertainty. Discounted returns can be used to account for risk or by changing appropriate interest rates in the model to increase costs of risky alternatives. A means of handling uncertainty is to program many situations and compare results. Alternatively, expected values can be used in the objective function, for example, seasonally indexed prices. Again in this situation the linear programming model would yield the solution resulting in most efficient resource use given the restrictions imposed.

Empirical Implications of Decision Theory

The foregoing discussion of decision theory leads to an important part of this study. If farmers do have different goals, there could be differences in "optimal" organizations in addition to differences in magnitude of operation between part-time and full-time farmers. For example, achieving a given level of income would result in a different combination of enterprises and resource use than maximizing profits to a set of variable resources. In the latter case the optimal combination will be on the expansion path, i.e. marginal returns and costs for all resources equal. However, minimizing a resource such as land to achieve a desired income means that all other resources are used in optimum combinations for that minimum quantity of land. The solution is the best combination to use if land were fixed at that level.

Halbrook [18] and Strickland [17] point out that under profit maximization assumptions the problems of small farms and low returns to resources should not persist. Their basis for this conclusion is that returns to farm size become constant at relatively small sizes and hold over a wide range so that labor and management returns increase almost linearly with the number of acres. Profit maximizing farmers would expand the size of their farms to the limit of their managerial ability. Resources of those that could not adjust would be acquired by expanding farms so that, theoretically, only large, viable farm units would survive. As will be shown later, this has not necessarily been the case. There are indications that part-time farming is increasingly used as an organizational strategy. Thus, even though results indicate that returns to farm inputs on small farms are low, they are not necessarily consolidated into more "efficient" units.

There are several possibilities to explain why small farms and low total returns to farm resources persist. One is the utility concept. An individual may take a lower return because he likes to farm or chooses enterprises on something other than a returns basis. Another is that some operators earn an off-farm income which may meet or exceed minimal living requirements. Any farm income could be viewed as an investment income or just income to "spare time" labor. Crop Reporting Service estimates [19] indicate that from 1960 through 1970 farm real estate values increased over 7 percent per year in Oklahoma. Thus, if returns to the farm operation are allocated to inputs other than land, the increased land price could be sufficient return on land investment. In this case there is no incentive to expand the farm operation.

A high incidence of off-farm employment and holding of farm real estate to attain the increase in real estate value would reduce potential adjustments in number of farms and consolidation of resources. If risk is of importance, then a sure off-farm income may be more than a dollar for dollar substitute for farm income. Even though a small farm could potentially be expanded by, say, substituting work on the farm for off-farm, there may be no desire to accept the risk. Thus, total returns to farm resources would be constrained.

Decision theory indicates that differing objectives lead to differences in organizational structures of individual farmers. However, in a short or intermediate run situation it seems reasonable to assume that full-time farmers with sufficient resources to achieve at least a minimal income, would actually maximize returns to their available resources, and add to them if feasible and available. Farmers with a source of off-farm income would tend to maximize their returns to farm resources, within the size constraint they choose or their labor dictates. Linear programming models can be used to study these types of situations. Resource restraints can be imposed to reflect representative situations or personal preferences. Minimal or maximum use of any activities desired can be required. Basic production data and a basis for specifying different farm operator characteristics and objectives are needed.

Supply Response

Studies of interregional trade recognize differences in production response between regions and the aggregate impliactions of those differences. Several factors that influence regional differences could also be of importance between firms.

In a discussion of interregional competition, Williams [20] examined factors causing differences in supply functions between regions. He felt that supply function differences were due primarily to costs and gave four factors that determine cost differences between regions:

1. relative scarcity of factors,
2. technical input-output relationships,
3. organizational possibilities, e.g. feasible products,
4. factor prices.

These same factors can determine response differences between firms. The first three appear to be more important for firms within a given region as prices could be expected to be very nearly the same. Scarcity of factors and organizational possibilities would be especially important in comparing firms of different economic classes such as part-time and full-time farms.

Supply Response Studies

A study by Dobson [21] illustrates the effect of separate regions on aggregate elasticity. His was a recursive model of intermarket competition and price structures using estimated milk supply elasticities. These price elasticities for three regions were .17, .14, and .26 for the Upper Midwest, the Northeast, and East North Central United States, respectively. In 1968, the production from these regions was 33,157; 22,528; and 8,072 million pounds of milk, respectively [22]. Based on the individual region's elasticity, a 1 percent increase in price in each market leads to an estimated 10.9 million pounds of increased production. This result could also have been found by summing the individual supply functions to an aggregate.

If supply functions are not available, the weighted sum of elasticities can be used to calculate an aggregate elasticity. Aggregation of elasticities can be shown by:

$$Q = q_1 + q_2 + \dots + q_n = Q\sum_{i=1}^{m} q_i. \qquad (5)$$

Total supply is the sum of supply in markets. Taking the total derivative of Q with respect to market price, p,

$$\frac{dQ}{dp} = \frac{dq_1}{dp} + \frac{dq_2}{dp} + \dots + \frac{dq_n}{dp}. \qquad (6)$$

Price is the same to all producers in all markets. Multiplying by $\frac{P}{Q}$,

$$\frac{dQ}{dp} \cdot \frac{P}{Q} = \frac{dq_1}{dp} \cdot \frac{P}{Q} + \frac{dq_2}{dp} \cdot \frac{P}{Q} + \dots + \frac{dq_m}{dp} \cdot \frac{P}{Q}. \qquad (7)$$

The expression on the left is total market supply elasticity ($E = \frac{dQ}{dp} \cdot \frac{P}{Q}$). Multiplying the right side of (7) by $\frac{qi}{qi}$ (i = 1, 2, ..., m) does not change the equality:

$$E = (\frac{dq_1}{dp} \cdot \frac{P}{q_1}) (\frac{Q-1}{Q}) + \frac{dq_2}{dp} \cdot \frac{P}{q_2}) (\frac{q_2}{Q} + \dots + (\frac{dq_m}{dp} \cdot \frac{P}{q_m}) (\frac{q_m}{Q})$$

$$= W_1E_1 + W_2E_2 + \dots + W_mE_m \qquad (8)$$

where $E_1 = \frac{dq_i}{dp} \cdot \frac{P}{q_i}$ (i = 1, 2, ..., m) is the supply elasticity for market i and $W_i = \frac{q_i}{Q}$ (i = 1, ...m) is the proportion of total supply by the ith market. Total market elasticity is the weighted sum of the individual elasticities. The weights are subject to the restraints:

$$0 \leq W_i \leq 1 \text{ and } \sum_{i=1}^{m} W_i = 1.$$

Returning to the three market examples, the Upper Midwest controlled 52 percent of the production, the East North Central 12.7 percent and the Northeast had 35.4 percent. Multiplying these proportions (W_i's) by the respective supply elasticity and summing gives the total elasticity of 0.17. This indicates a one percent price increase would increase production to 10.9 million pounds, the same as determined from looking at individual markets. A simple average of the elasticities would indicate a 0.19 aggregate, overstating elasticity by 0.02 percent.

The same error in measurement can hold true within a region. A wide range of characteristics between firms could cause several different production responses within the region. Attempting to measure response with an averaged or a single representative situation could yield biased results.

Another analysis that illustrates how different supply responses can arise was done by Colyer and Irwin [23]. This study indicates the effects of factors of production on responsiveness. The authors give the elasticity of production for different types of farms in three states and the marginal value product for selected inputs (Table III). A Cobb-Douglas production function was used in their analysis. Inputs were land, labor, expenses, livestock and crop inventory, and machinery.

The elasticity of production estimates indicate decreasing returns to scale for Missouri farms, but somewhat increasing for the others. There would be some incentive to expand production, at least with some of the resources. A weakness of the estimates admitted by the authors is the correlation between some inputs, making specific statements unreliable.

TABLE III

ESTIMATED ELASTICITIES OF PRODUCTION AND MARGINAL VALUE PRODUCTS OF SELECTED INPUTS IN MICHIGAN, MISSOURI, AND INDIANA FARMS[a]

	Elasticity of Production	Land	Labor	Expenses	Livestock & Crop Inventory	Machinery
		MVP				
		$/ac.	$/wk.	$/$	$/$	$/$
Michigan Thumb	1.027	12.54	15.37	2.60	0.50	0.30
Michigan S. Central	1.066	20.26	8.35	1.62	0.45	0.14
Mo., North	.881	21.44	18.23	1.60	0.09	0.27
Indiana, Central	1.088	62.55	45.94	.14	0.19	0.48
		Costs				
Michigan		12-30	40-60	1.05	.15-.20	.15-.20
Missouri		17.50	60	1.05	0.05	0.05
Indiana		30.00	60	1.05	0.15	0.15

[a]Taken from Table 10 [23, p. 40].

By examining marginal factor costs and marginal value products it is possible to determine general input areas where increases are most likely to occur. In Indiana, each acre of land would produce $62.55 at a cost of $30. To the extent possible, these farmers would tend to acquire land for increased production. The comparable figures for Missouri are more nearly equal, while those for Michigan indicate there may be relatively too much land used.

Labor is not returning its cost in any of the regions indicating sufficient labor in relation to other resources. Further profitable use could be made of variable expenses such as fertilizer and fuel except in Indiana. Inputs of additional inventories would seem profitable although the margin is close in two states. Increased investment in machinery and equipment also seem warranted except for South Central Michigan.

Specific inferences for individual commodities would not be realistic from these very general results, but general farm output can be discussed. An increase in prices received by farmers would tend to increase output in those areas where MVP > MC. It would be expected that on those farms where MVP < MC input use would expand less if at all. The opposite could logically hold true for a price decrease. As long as MVP > MC there would be no incentive to decrease output. Those operating past the maximum profit point MVP < MC would have new incentive to reduce production.

Interpretation of responsiveness from the preceding study may be limited. A continuous function production is used which implies a completely reversible supply function. In an aggregate sense and over time, response would tend to approach a smooth path; however, in the short run and on a more local level, fixed asset theory provides another hypothesis, as discussed by Edwards in a 1959 article [24].

Edwards illustrates that the asset structure can have a definite effect on resource adjustments. The acquisition cost, use value, or salvage value of an asset may be the appropriate criterion to use for making decisions. If the use value of an asset is between the acquisition price and salvage price, it is fixed in the sense that product price must rise enough for MVP to be greater than acquisition cost to expand or fall below salvage value to decrease production.

Many studies of farm management problems have used linear programming models as tools for analysis. Earlier works in this area determined representative farm situations in terms of land resources, capital, and labor. Optimal resource combinations would be estimated for each situation and aggregated for regional implications. A bulletin by Helmers and Lagrone [25] is an example of aggregating representative farm results. Recent works have used minimum resource linear programming models to help determine different representative situations for income levels. The work by Halbrook [18], and Hurt [12], and Strickland [17] were of this type. Results from these studies yielded normative estimates of farm organizations from which regional implications were drawn.

The total supply function for a commodity is a horizontal summation of individual firm functions. Generally, supply functions are viewed as continuous, but the normative functions obtained through use of linear programming and their unique characteristics require a closer inspection. Because the LP model is used as the basic tool in this study, the "stepped supply" will be examined in some detail. An analysis by Kottke [26] will be the basis for discussion.

The foremost question concerning a stepped supply function is how it compares conceptually to a smooth function. Could it be converted to a smooth function and retain the general interpretation of supply behavior? Kottke takes the position that the steps modify and accentuate the interpretation.

In Figure 6 the dotted lines are marginal cost. From U1 to U2 marginal cost (MC) is constant. At a price greater than P_1 up to and equal to P_2, U1 would be produced. Profits would not be raised by increasing output at price P_2 because marginal revenue (MR) or price and MC would be equal. The solid vertical segments indicate the range over which price could change without effecting production. These are equivalent to the corner points of an LP solution.

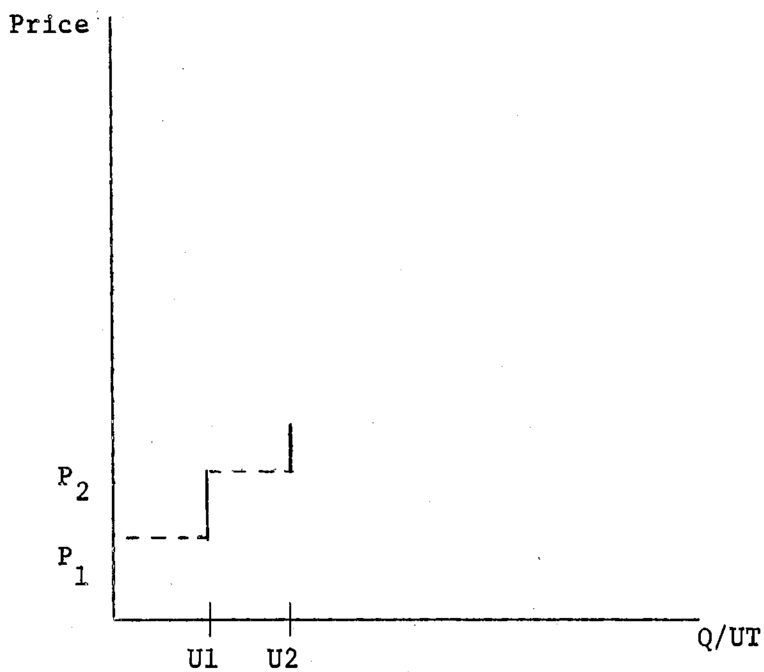


Figure 6. Hypothetical Supply Function Estimated by Linear Programming

The supply functions of individual firms derived by linear programming individual firms can be summed to estimate aggregate supply. To do this firms are assumed to behave independently, in unison, and all face the same length of run. This does not mean that the steps cannot be of different intervals along the horizontal. The steps are economic in nature relating to profitability of that solution and not to a time interval within the production period, i.e. the horizontal axis measures quantities and not time intervals.

The difficulty in discussing a stepped supply function lies in interpreting elasticities. On a continuous function elasticity is defined at a single point. The stepped function is discontinuous with no changes in supply for some price ranges and has drastic changes for other price ranges. Thus, elasticity for a step function is for a range rather than a single point. Supply responsiveness, rather than the formal elasticity concept, is a term that can be used as substitute to reflect the length of the vertical segments (price increase) related to the horizontal (MC).

The key question to be examined in this study concerns part-time farming and the effect it has (or does not have) on aggregate supply. The empirical analysis will determine the steps in the supply functions for the two categories for comparison and discuss the influence of differences on total response.

Summary

This chapter discussed the development of decision theory and how it relates to farm management problems to be considered in this study. The effects of uncertainty, resources, and income situations on profit maximization solutions were illustrated. Minimum income studies by Halbrook and Strickland were cited as alternatives to profit maximization.

Other studies were cited that reviewed factors causing supply response differences and examples were given that showed the effect of different responses by individual regions on aggregate response. The same factors were compared to those that would cause different responses between economic classes of farmers. A discussion of special problems in measuring responsiveness from supply functions estimated by linear programming was also presented. The following chapter will summarize some characteristics of the study area and develop the input data.

CHAPTER III

AN OVERVIEW OF SELECTED CHARACTERISTICS OF BEEF FARMING IN EASTERN OKLAHOMA AND DEVELOPMENT OF INPUT DATA

This chapter summarizes some of the data from the survey taken for S-67 with particular emphasis on Oklahoma data. Survey results provide useful information relating to technological levels being used as well as farming methods. Table I in Chapter I indicated that off-farm work is extensive in Oklahoma, and appears to be increasing in absolute terms in spite of a decline in farm numbers. The survey data should indicate any distinguishable characteristics between part-time and full-time farming. With survey results as a base, the data for this study will be developed.

Survey Data

The entire southern region of the United States is characterized by relatively small farms in terms of beef cow numbers. In 1969, 74.4 percent of all beef farms in the S-67 region had fewer than 50 cows and only 8.5 percent had over 100 brood cows (Table IV). In contrast, those farms with less than 50 cows had 34.8 percent of all brood cows on beef farms. Over 40 percent of all beef cows were on farms with more than 100 cows.

TABLE IV

PERCENTAGE DISTRIBUTION OF BEEF FARMS AND OF BROOD COWS BY SIZE OF BROOD COW HERD, JANUARY 1, 1969[1]

Item	Size of Beef Farms (no. of Beef Cows)				
	<20	20-49	50-99	100-499	500 & Over
			Percent		
Percent of Farms	36.9	37.9	17.1	8.0	0.5
Percent of Cows	9.6	25.2	24.5	30.1	10.7

[1]Charles P. Butler, Economic and Operational Characteristics of The Southern Beef Cattle Industry, Southern Cooperative Services Bulletin 176, October, 1972.

Similar characteristics were found in Oklahoma. The sample [4, p. 10] was expanded based on available census data to provide an estimate of the expected number of beef farms in the area. Based on sample expansion the 21 county area of Eastern Oklahoma had 9,854 beef farms. A beef farm is defined as a farm operating more than 50 acres of openland, holding 10 or more beef cows and yearlings, and having gross receipts greater than $1,000 for 1968. Over 6,300 of these farms had less than 50 cows, but these farms had 31.9 percent of all cows. Over 35 percent of the farms had more than 50 cows and farms that size or greater had 68.1 percent of the brood cows (Table V).

The survey yielded considerable information relating to production practices, farm size, and labor used on beef farms in Eastern Oklahoma. The data provide useful guidelines to analyze beef production potential

TABLE V

ESTIMATED NUMBER OF BEEF FARMS, ACRES, AND BEEF COWS IN EASTERN OKLAHOMA, 1968

		Openland		Beef Cattle		Percent	Percent	Percent
	Number of Farms	Total Acres	Acres Per Farm	Total Number	Number Per Farm	of Total Farms	of Total Acres	of Total Cows
	Farms	Acres	Acres	Head	Head	Percent	Percent	Percent
Beef Farms	9,854	4,268,003	433.1	537,012.4	54.5	100	100	100
< 20 cows	1,891.8	201,473.9	106.5	30,496.5	16.1	19.2	4.7	5.7
20 - 49	4,491.5	954,366.6	212.5	141,067.3	31.4	45.6	22.4	26.2
50 - 99	2,348.8	818,850.8	348.6	155,707.8	66.3	23.8	19.2	29.0
100 - 499	1,078.2	2,151.212.5	1,995.2	184,116.0	170.8	10.9	50.4	34.3
500 and over	44.2	141,599.0	3,203.6	25,664.8	580.7	0.4	3.3	4.8

Source: Expanded from sample survey [3].

and differences that can occur for specific farm structure situations.

The farms surveyed in Eastern Oklahoma had an average of over 231 acres of open land (Table VI). The land was allocated to: 14.3 percent annual crops, 47.9 percent bermuda, 28.2 percent native range, and 1.8 percent fescue. The remaining 7.8 percent was devoted to other improved pastures and hay. The nine county region to be specifically analyzed in this study averaged 20.2 percent annual crops, 43.9 percent bermuda, 25.4 percent native range, and 2.5 percent fescue. It is apparent that resources in the area are judged by farmers to be well suited to use in beef production.

TABLE VI

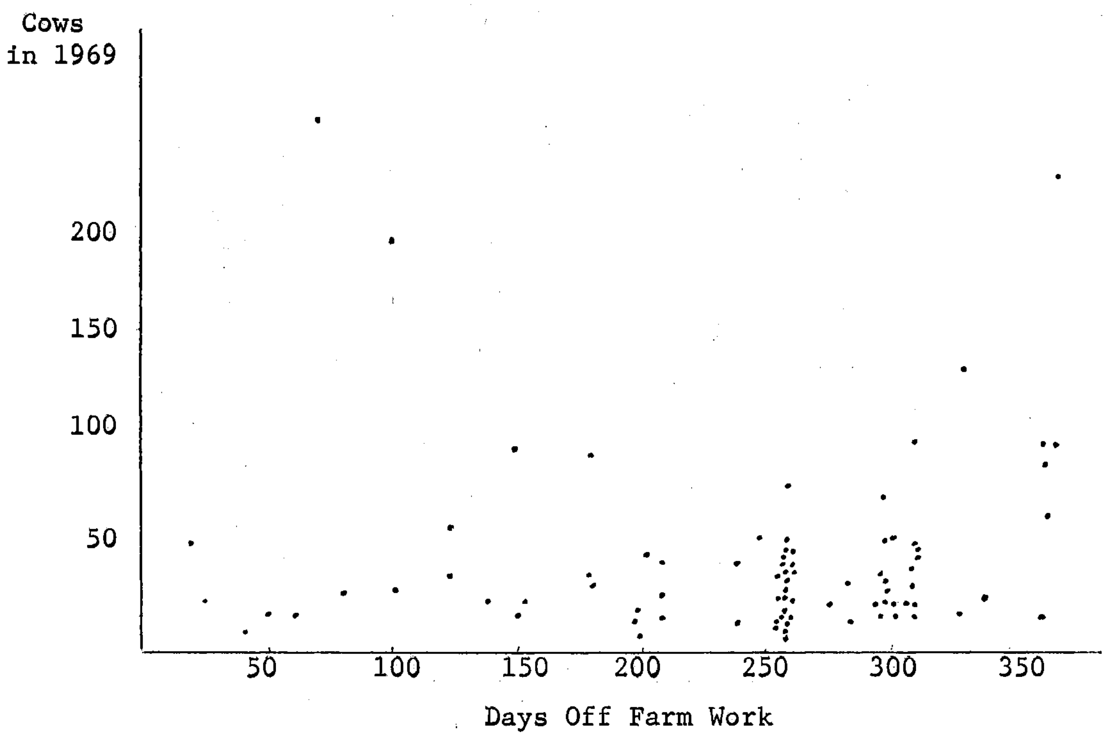
COMPARISON OF LAND USE AND SELECTED PRODUCTION CHARACTERISTICS OF ALL SURVEYED FARMS AND THE STUDY AREA IN EASTERN OKLAHOMA

Item	Survey Average	Study Region
Type of Crop as Percent of Openland:		
Annual Crop	14.3	20.2
Bermuda	47.9	43.9
Fescue	1.8	2.5
Native	28.2	25.4
Other Improved Pastures	4.8	4.4
Hay	3.0	3.8
Acres Openland	321.56	368.5
Beef Cows (hd.)	41.55	39.88
Replacements (hd.)	6.59	6.53
Fed or Grazed (hd.)	5.27	7.92
Hay Feeding		
Days Fed	148.75	156.27
Pounds Fed (per cow)	158.17	178.73
Protein Feeding		
Days Fed	130.20	124.75
Pounds Fed (per cow)	179.61	182.67

Several relationships were plotted from the survey data to examine selected organizational characteristics found in Eastern Oklahoma. Days worked off the farm were related to cow numbers per farm to indicate any differences in size of herd associated with the level of off-farm work. As shown in Figure 7 most farms had less than 50 cows and the majority of operators worked 250 days or more off the farm. It was not possible, however, to establish a conclusive relationship between the number of beef cows and days worked off the farm. No relationship was apparent when comparing acres operated to days worked off the farm (Figure 8). Most farmers operated less than 250 acres regardless of days of off-farm work.

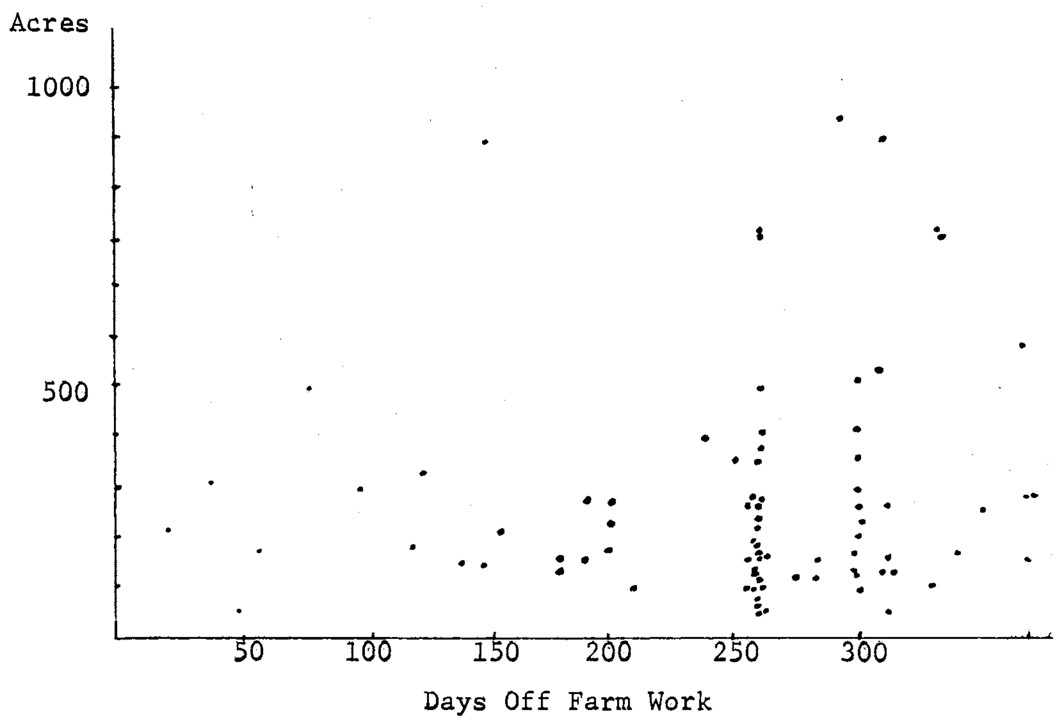
A significant relationship was found in the number of acres per cow. The rays from the origin represent different stocking rates as indicated. From Figure 9, only one farm had less than two acres per cow. Most operators had between four and eight acres per cow, but many required more than eight acres. The average number of acres per cow was 9.6; however, when woodland was not considered, the ratio was 7.7 acres per head. Later parts of the study indicate that current levels of intensity are far less than two acres per cow. Most operators had between four and eight acres per cow, but many required more than eight acres. The average number of acres per cow was 9.6; however, when woodland was not considered, the ratio was 7.7 acres per head. Later parts of the study indicate that current levels of intensity are far less than that possible with existing technology.

Stocking rates are influenced to a great extent by the kind of forage grown. Over 100 of the surveyed farms reported using common bermuda grass for forage. Sixty-nine used native range, 39 produced



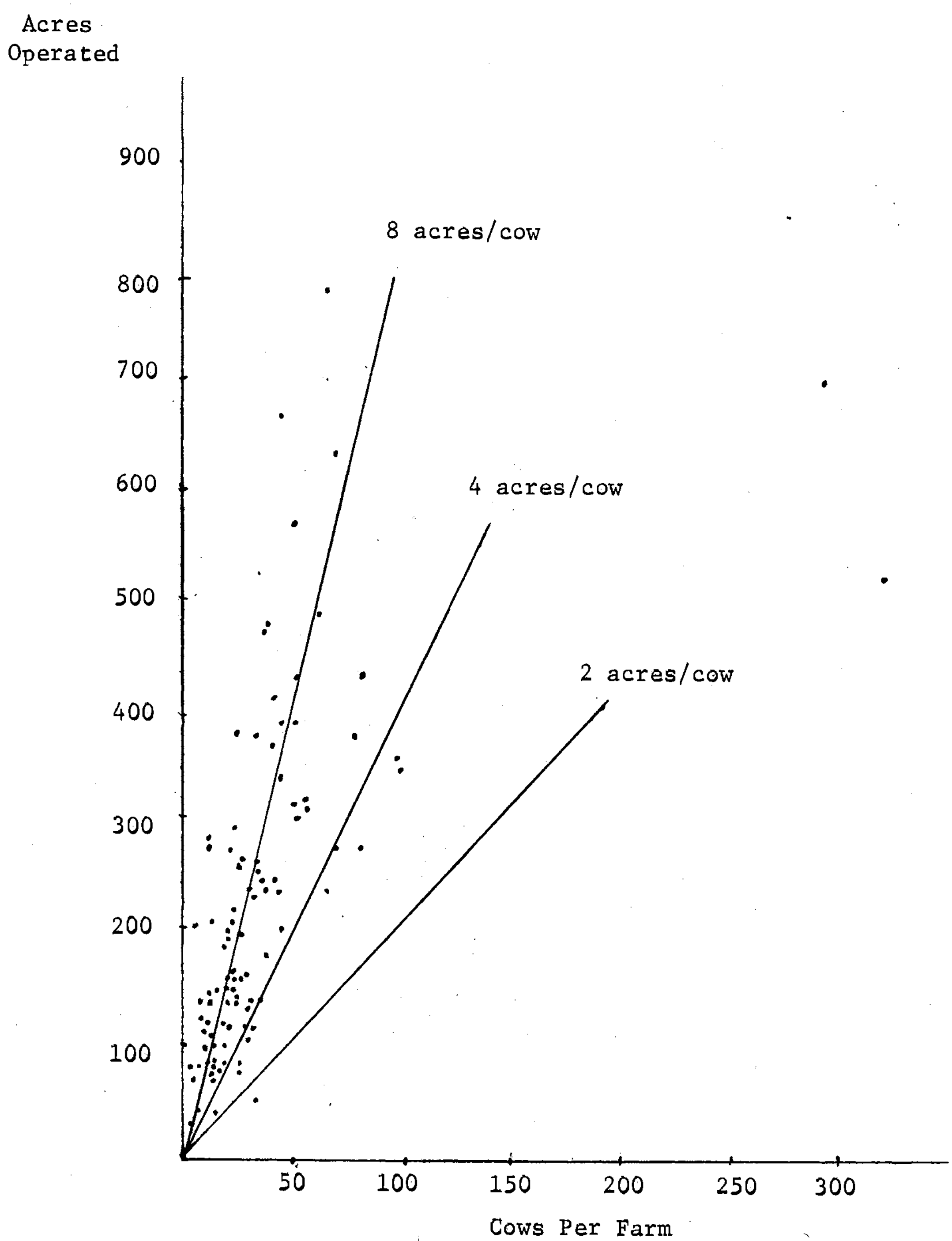
Source: Sample Survey [3].

Figure 7. Beef Cows Compared to Days Work Off-Farm, of Beef Farm Operators in Eastern Oklahoma, 1968



Source: Sample Survey [3].

Figure 8. Acres Operated and Days Worked Off Farm of Beef Farm Operators in Eastern Oklahoma, 1968



Source: Sample Survey [3].

Figure 9. Cows and Acres Operated on Beef Farms in Eastern Oklahoma, 1968

lespedeza, and 19 grew fescue. As was mentioned previously, over 70 percent of the openland in Eastern Oklahoma was in bermuda and native range (Table VI).

Discussions with soil scientists indicated that it would be possible to follow cultural and management practices that allow greater intensity of pastureland use than is currently practiced. Grazing management, proper fertilization, and the combination of forages were considered important variables for the more intensive use levels.

Since a nine county region in Northeast Oklahoma was selected for detailed analysis, Table VI will be used to summarize and compare the production practices described above for all surveyed farms in Eastern Oklahoma and for the specific nine county study area. Land use followed similar patterns although the nine counties selected for analysis showed a higher average of openland acreage. A larger proportion of the openland was used for annual crops.

All farms surveyed averaged 41.55 beef cows per farm and only 5.27 fed or grazed animals. Previous economic analyses for an overlapping area indicated a higher relative profitability of grazing stockers rather than cows [18]. Hay was fed over a 148 day period at 158.17 pounds per cow and protein supplement of 179.61 pounds per cow was fed over a 130 day period.

The study region averaged 39.88 cows and 7.92 fed or grazed stockers per farm. Supplemental feeding was heavier in the subregion. Hay was fed 156 days at 178.73 pounds per cow, and protein supplement of 182.67 pounds per cow was fed over 124 days.

There were 103 responses to the part of the survey dealing with farm assets. Table VII compares the result for all farms responding to those from the study region. Responding farms averaged 399.12 acres per farm. Land and buildings were valued at $137.57 per acre. The average value of livestock per acre was $28.67, while machinery and equipment was $13.04 per acre. Total asset value per acre was 179.27.

Asset value per acre, $180.96, was not significantly different in the study region. Land and buildings averaged $139.61 per acre. Livestock was valued at $26.88 per acre and machinery and equipment was $14.48.

The data in the asset section should prove useful for comparison with study results. Comparing the proportion of nonland to land capital would indicate kinds of capital investment changes needed. The supply of capital and lending policies of financial institutions would influence the degree of potential changes.

TABLE VII

VALUE PER ACRE OF REPORTED FARM ASSETS FOR BEEF FARMS SURVEYED IN EASTERN OKLAHOMA, SURVEY AVERAGE AND STUDY AREA

Item	Unit	Survey Average	Study Region
Acres Per Farm	Acres	399.12	416.64
Average Value Per Acre			
Land and Buildings	Dollars	137.57	139.61
All Livestock	Dollars	28.67	26.88
Machinery and Equipment	Dollars	13.04	14.48
Total	Dollars	179.27	180.96

Development of Input Data

Regional project committee guidelines were followed in estimating data needed. The basic regional objective was to provide data for comparison of the economics of beef production in the South. The survey was conducted to give a uniform base of data for historical and current comparisons of beef production practices. It also served as a common base for determining inputs for economic analysis of beef production potential. Each state was to determine the enterprises to consider and develop budgets for alternatives that use available resources. The three regional restrictions most applicable to this study were:

1. At least one beef enterprise in each of the following two general systems should be included: (1) cow-calf, and (2) growing out, to evalute alternative beef systems.

2. Grain and other concentrates for feed could be purchased; however, hay, pasture, and other forage crops used by livestock must be raised on the farm.

3. Produced forages could not be sold.

Other more specific requirements will be indicated as necessary for explaining the model and analyzing results.

The Soil Resource Base

The soil resource base used for this study was developed by Jobes [4]. The survey results determined some general soil groups--openland, native, and woodland. These definitions were inadequate for soil classification because of uncertainties in meaning. Survey data did not clearly distinguish whether pasture was grown on cropland or if some forest land was mixed with pasture. Jobes [4, p. 44] used the Oklahoma Conservation Needs Inventory [2] to estimate the amounts of land resources by type of land use for four use categories; cropland, native pasture, grazed forest land, and nongrazed forest land. The openland was separated into that suitable for crops and that for pasture only.

Using soil survey maps and consultations with the soil scientists, five soil groups and fourteen productivity levels for forage production were obtained [4 p. 46]. These were further divided into percentages used for native pasture, cropland, and in woodland. Table VIII gives the proportions by soil productivity level for the study area. Just over 50 percent of the land was cropland, 33 percent was native range and the remaining 16.65 percent was woodland. The five soil groups are sandy (S), loamy (L), clay (C), and two bottomland (B) groups. Three groups (sandy, clay, loam) were further divided into four productivity levels. The percentages in Table VIII can be viewed as proportions of a typical acre in the study area.

Budget Development

Livestock production alternatives were limited to cow-calf and "stocker" grazing systems. Several systems were budgeted to represent the current practices and additional potential alternatives. Forage budgets were developed to be used by the livestock alternatives. Forage production was expressed in pounds of nutrients (total digestible nutrients, digestible protein, dry matter) by production period with several species, yield levels, and times of forage output to allow determination of beef and feed systems.

TABLE VIII

PERCENT OF THE LAND BASE BY SOIL PRODUCTIVITY LEVELS AND LAND USE FOR THE STUDY REGION, 1969[a]

Soil Productivity Level	Cropland	Pasture
S_1	0.03	0.02
S_2	0.13	0.17
S_3	3.56	0.78
S_4	11.30	6.44
L_1	0.95	0.77
L_2	2.85	1.43
L_3	0.58	0.43
L_4	2.37	5.35
C_1	8.33	6.60
C_2	10.33	5.32
C_3	3.25	2.35
C_4	0.60	1.49
B_1	5.45	0.60
B_2	0.46	1.41
Total	50.19	33.16
	(Percent of Land Area by Land Use)	
Cropland	50.19	
Pasture	33.16	
Openland	83.35	
Forest Land		
Grazed	12.50	
Nongrazed	4.15	
Total	100.00	

[a]From Jobes [4] Table XVIII, p. 50.

Forage Systems and Budgets

Range management poses a great number of decision problems. Many kinds of forages can be grown which may be close substitutes in feed value. The problems of how much and when to fertilize pasture must be solved. There are also different ways to utilize forage: as hay, deferred grazing, seasonally, or combinations of these uses.

Both annual and perennial forages were considered. The annual crops were small grain pasture, forage sorghums, and rye-vetch. The latter could only be produced on the best three sandy soils. Small grain was assumed grazed out. The forage sorghums were used for grazing or a combination of hay and grazing.

The perennial or "permanent" pastures were bermuda, fescue, weeping love grass, and native range. Bermuda budgets were developed for three levels of fertilization; no fertilizer, 100 pounds and 200 pounds of nitrogen per acre. For each of the fertilization levels bermuda could be grazed seasonally, deferred for grazing when needed, or cut for hay with late growth grazed as well. The nonfertilized bermuda could be grazed seasonally or deferred, but not cut for hay. This alternative was included because of the large amount of bermuda established in the area. Very little maintenance cost was assumed and yields were only moderately better than native. There was one fescue grazing activity and another combining fescue and bermuda. Weeping love was budgeted for sandy soil with seasonal and deferred grazing. Native pasture could be used either as grazing or hay and grazing.

The yields of different forages were determined from agronomic studies, mainly from the Muskogee Agricultural Experiment Station, and discussion with soil and pasture scientists. Yields were in terms of pounds of nutrients; dry matter, digestible protein, and total digestible nutrients and digestible protein. The procedure for doing this is described by Jobes [4, p. 62]. Table XXXIV in Appendix B gives the percentages of TDN and DP for the forages produced. In addition to nutrients from cultivated forages and native range, the woodland was assumed to produce some grazing but furnishing relatively small amounts of nutrients.

To determine the timing of forage production (and needs), the year was divided into six, two-month periods with January-February as period 1. The forage production was then estimated by periods for each activity. This enabled the model to select the type of grazing and feed combination needed more accurately. Table IX lists the forage activities and periods by which grazing was produced as well as capital, costs, and labor requirements for L_1 soil. Other soil categories produce the same forages, but yields and inputs vary between soils. Annual crops or hay could not be produced on S_4, C_4, or L_4 soils because these categories are too heavily sloped to accommodate necessary equipment.

Carefully selected management practices were assumed in budgeting the forages. The assumption for this study was that the technology level should be that available in 1969 and expected to be commonly used in 1975. Technology was incorporated into the model in two ways. Appropriate timing of fertilization was built into the budgets--for example, the nitrogen was spread in four applications for the bermuda with 200 lbs. per acre, and grazing systems to accommodate different forage systems were included.

TABLE IX

FORAGES, YIELDS, ANNUAL COSTS, CAPITAL, AND LABOR REQUIREMENTS INCLUDED IN THE MODEL AS ALTERNATIVE USES OF L_1 LAND FOR THE STUDY AREA OF EASTERN OKLAHOMA

Forage Crop	Grazing System	Lbs. of DM by Period						Total Annual Lbs.			Hay Harvested	Total Specified Costs[a]	An. Cap.	Labor Req.
		1	2	3	4	5	6	TDN	DP	DM	(cwt.)	(dol.)	(dol.)	(hrs.)
Bermuda:														
	Seasonal			816.2	340.1	204.0		901.9	45.4	1360.3		1.24	0.23	0.6
Nonfertilized	Deferred	248.8		796.3	155.3	77.7	291.1	954.1	47.5	1569.2		1.24	.53	.6
100 lbs. N	Seasonal		2000.0	1600.0	1900.0			3164.0	545.7	5500.0		15.96	9.04	.71
	Deferred & Hay	379.4	379.4			379.4	379.4	713.0	73.7	1517.6	53.32	37.15	9.04	.71
	Deferred	919.0	910.0	919.0	919.0	919.0	919.0	2803.0	374.1	5514.0		15.96	9.04	.71
200 lbs. N.	Seasonal			2991.7	2398.9	2864.6		4728.1	818.5	8255.2		25.28	12.51	.95
	Deferred & Hay	564.9	564.9			564.9	564.9	1061.4	136.0	2259.6	75.74	54.67	12.51	.95
	Deferred	1376.0	1376.0	1376.0	1376.0	1376.0	1376.0	4196.7	692.1	8256.0		25.28	12.51	.95
Bermuda Fescue	Seasonal		1000.0	4267.5	1616.3	1616.3		4565.7	571.3	8500.1		26.81	11.41	.76
		756.0	1000.0	1000.0	400.0		1944.0	1292.0	160.4	5100.0		18.57	4.80	.29
Forage Sorghum	Grazeout			1673.0	3019.0	2000.0		2580.65	520.8	4692.0		22.66	3.50	1.64
	Graze & Hay					5026.7		2764.7	558.0	5026.7	23.93	32.81	3.50	1.64
Small Grain	Grazeout	437.0	2532.5	134.3		202.5	1113.8	3341.7	636.5	4420.1		17.29	5.75	1.50
Native Pasture	Deferred	216.3		692.2	115.4	57.7	216.3	791.5	40.3	1297.9		1.24	.23	.47
	Deferred & Hay	137.7					137.7	170.2	6.2	347.	30.88	13.97	.27	.45

[a]Costs are cash expenditures for production except for interest charges and labor expense which are determined internally in the programming model.

[b]Annual capital includes annual costs of production and machinery operating costs.

[c]Labor requirements are only the amounts needed for care and maintenance of the pasture annually.

Two grazing systems were specified for management of grazing and built into the model. A certain amount of rotation of livestock is required as pasture is grazed, especially under heavy stocking rates. Rotation varies with the kind of forage, but more importantly, the yield. "Regular grazing" can be used for low producing forages, e.g. bermuda with low fertilization, that would not be subject to heavy stocking rates. It would have one fencing system and labor requirement. "Rotational grazing" would be for faster growing, heavily stocked forages such as small grain pasture or heavily fertilized bermuda. Smaller land segments would be fenced and a closer scrutiny of cattle and vegetative condition would be necessary. Fertilizer is applied more often, usually after cows are removed to promote lush growth for the next grazing period. The additional fencing and labor involved made the "rotation" system the most expensive per acre. The native pasture, nonfertilized bermuda, and bermuda with 100 pounds nitrogen used the "regular grazing" system as did the combination hay and graze bermuda. The other forages required "rotation."

Other Feeds

Production of grain was not allowed in the model. Oats, barley, and grain sorghum could be purchased for feeding purposes. Protein supplement could also be purchased as 20 and 40 percent protein cubes or, cottonseed meal, soybean meal, or cake. Table XXV in Appendix B gives the prices and seasonal indexes for these items.

The program model was designed to derive the least cost ration. To allow a detailed approach, a feeding labor requirement was associated with each type of feed. Equipment costs were also associated with each feeding activity. Thus the model could match feeding systems to livestock systems.

Beef Systems and Budgets

The survey data indicated that relatively minor numbers of beef animals were fed or grazed as stockers. Primarily, beef farms were cow-calf operations. The beef enterprises considered were cow-calf systems with several stocker activities included to determine potential grazing systems. A variety of systems was considered so that the model could determine the beef feed system that would most profitably match the operator's resources.

Three basic calving times were used in this study from which six cow-calf systems were organized. The alternatives are listed in Table X. The COW 1 is a late winter-early spring; calf drop is around February 1. The spring calving system is COW 2 with calving around April 1. Fall calving was assumed to be October 1. COW 1, COW 2, and COW 3 assumed weaning ages for calves at 205 days. The calves were either sold or transferred to stocker activities at that time. The steer calves weighted 460 pounds and heifers 440.

COW 4, as indicated in Table X, calved at the same time as COW 3, but the selling date was two months later. This activity was added because survey data indicated many farmers kept at least some of their calves to heavier weights before weaning. The fall calving system was selected to represent this to utilize lush forage growth in the spring. This activity would be similar to having a very short term spring stocker program added to a cow calf system, except that the calves acquire some nutrients from the mother's milk. Steer calves gained two pounds a day during this period and were sold at 580 pounds. Heifers were assumed to have a slower rate of gain than steers, and were sold at 554 pounds.

TABLE X

CALVING AND SELLING DATE FOR COW-CALF ALTERNATIVES

Cow Budget	Calving Date	Selling Date
COW 1	Feb. 1	Aug. 25
COW 2	Apr. 1	Oct. 23
COW 3	Oct. 1	Apr. 24
COW 4	Oct. 1	June 23
COW 5	Oct. 1, Apr. 1	June 23, Oct. 23
COW 6	Oct. 1, Apr. 1	Apr. 24, Oct. 23

COW 5 and COW 6 are combinations of the other cow systems and are not distinctly different systems. It is possible to utilize a herd bull more efficiently if more than one calving system is followed. That is, the same bull can be used for the fall calving system and can also be used for the spring calving. If it is otherwise feasible to have more than one calving time, this will allow some saving in investment and feed. COW 5 combines COW 4 and COW 2; fall and spring calving carrying fall calves to heavier weights. COW 6 is a combination of COW 2 and COW 3, a fall-spring calving system with the standard weaning weights.

Cow-calf budgets assumed 25 cows per bull, and cows were replaced every eight years. It was assumed that 88 percent of the cows would wean calves. Four heifers were kept as replacements and the remaining calves were sold along with one replacement heifer and the cull cows. The replacement heifer was culled at 18 months old weighing 900 pounds and the cows weighed 980.. Death loss was two percent of the herd investment. The average value of the herd bull was $519, assuming an initial value of $660 and a salvage value of $377. Brood cows were valued at $220 and replacement heifers at $150.

Nutrient requirements were determined for all livestock activities for each of the six calendar periods. The TDN requirements are given in Table XI for the cow activities. The requirements were based on the stage of pregnancy or lactation and age of calf. The COW 3 and COW 4 systems were alike except that the COW 3 calf was sold in period 2 while for COW 4 the calf was kept into period 3 and required more TDN.

Several stocker calf systems were developed as alternatives to cow-calf operations or to use in conjunction with cows. Stocker activities can be used to grow calves to heavier weights after weaning or calves can be purchased for grazing to heavier weights. A stocker budget was developed to transfer calves from each of the cow activities except COW 4. Purchasing calves was allowed at the same time calves were weaned to offer an alternative to growing the calves.

In all, ten stocker alternatives were budgeted. Table XII lists the stocker activities, the time period, and beginning and ending weights. These could be generalized into fall, spring, and August beginning periods. Stocker heifer calves were transferred from cows but not purchased. Steers could be transferred or bought. Table XXXVI in Appendix B gives the TDN and DP requirements as a percent of dry matter for each activity.

TABLE XI

DM REQUIREMENTS BY PERIOD FOR SIX COW-CALF SYSTEMS

Cow-Calf System	Pounds DM by Period 1	2	3	4	5	6
COW 1	1295.4	1557.9	1557.6	1582.9	1081.5	1081.5
COW 2	1046.0	1346.5	1557.9	1583.1	1557.3	1081.5
COW 3	1506.6	1557.3	1081.5	1099.3	1353.3	1557.9
COW 4	1056.6	1654.3	2151.1	1099.3	1353.3	1557.9
COW 5[a]	2488.6	2936.8	3845.0	2618.4	2846.6	2575.4
COW 6[b]	2488.6	2939.8	2575.4	2618.4	2846.6	2575.4

[a]The sum of COW 2 and COW 4 requirements with requirements for one bull subtracted. The nutrients will take care of two cows per period.

[b]The sum of COW 2 and COW 3 requirements with requirements for one bull subtracted.

Two different average rates of gain were assumed for the fall and spring stocker activities. The fall steer activities gained an average of 1.6 pounds per day (FLST) and 1.3 pounds per day (FLSNSGR), the spring steers gained 1.4 (SPST) and 1.28 (SPSNSGR) pounds per day, respectively. The steers started in August and had an average gain of 1.33 pounds per day. Heifer gains were varied in much the same way and were assumed to be slower rates of gain than steers under comparable circumstances. Across the production period, the rate of gain varies with forage production and the weight of the animal. Table XXXVII in Appendix B gives the rate of gain for each stocker by production period.

TABLE XII

STOCKER CALF SYSTEMS USED FOR ANALYSIS; BEGINNING DATES ENDING DATES, BEGINNING AND SELLING WEIGHT AND AVERAGE GAIN PER DAY

Stocker System[d]	Time Started	Time Ended	Beginning Weight (lbs.)	Ending Weight (lbs.)	Gain/Day (lbs.)
FLST[a]	Nov. 1	Apr. 20	460	750	1.65
SPST[a]	Apr. 24	Oct. 12	460	720	1.4
FLSNSGR[a]	Nov. 1	Apr. 20	460	691	1.3
SPSNSGR[a]	Apr. 24	Oct. 12	460	678	1.28
StHF1[b]	Apr. 24	Oct. 12	440	675	1.33
StHF2[b]	Nov. 1	Apr. 20	440	704	1.4
SPHSNSGR[b]	Apr. 24	Oct. 12	440	656	1.2
FLHNSGR[b]	Nov. 1	Apr. 20	440	655	1.2
AUGStKRS[c]	Aug. 25	Feb. 20	460	699	1.3
AUGStKRH[b]	Aug. 25	Feb. 20	440	663	1.19

[a]Stocker steers that can be transferred from cow-calf activities or purchased.

[b]Stocker heifer activities.

[c]Stocker steers transferred from cow-calf activities only.

[d]FLST, FLSNSGR, SPST, SPSNSGR, and AUGSTRRS are stocker steers. STHF1, STHF2, SPHNSGR, FLHNSGR, and AUGSTKRH are stocker heifers.

By including different rates of gain as well as time periods in the model several management alternatives can be studied. The higher rates of gain could be attained from higher quality forage; the lower gain from low quality forage where quality refers to TDN/DM and DP/DM ratios. Rate of gain could also be used to represent stocking rates, a lower gain would allow a larger number of animals on a given quantity of forage. The two fall steer activities' TDN and DM requirements are given in Table XIII to illustrate the differences in nutrients required.

TABLE XIII

DRY MATTER AND TDN REQUIREMENTS FOR THE HIGH AND LOW RATES OF GAIN FALL STOCKER STEERS BY PERIOD

Production Period	Low Gain[a] TDN (lbs.)	Low Gain[a] DM (lbs.)	High Gain[b] TDN (lbs.)	High Gain[b] DM (lbs.)
1	498.6	824.2	580.2	894.0
2	535.2	841.8	717.0	964.2
3				
4				
5				
6	463.5	735.7	369.0	641.4

[a]FLSNSGR.

[b]FLST.

Prices and Costs

The base livestock prices used are given in Table XIV. For the calves under 500 pounds these are selling prices from cow-calf operations or purchase costs for the stocker grazing activities. The price for calves from COW 4 was between the 500# or less and 500-800# price. The prices were determined by using the suggested price for good and choice steers under 500 pounds made by the Regional Project Committee. The relationship of the prices of other livestock classes to this category was estimated using 1966-71 annual prices from Oklahoma. These base prices were then seasonally indexed. Index numbers used for livestock activities are given in Table XL, Appendix B. Capital, labor, and costs are given in Table XV.

TABLE XIV

BASE PRICES USED FOR LIVESTOCK ACTIVITIES

Livestock Category	Base Price per Cwt.
Commercial Cows	$19.57
Commercial Bulls	25.12
Good & Choice Steers: 500# or less	32.50
Choice Steers: 500-800#	30.70
Good Steers: 500-800#	27.82
Good & Choice Steers: 580#	30.88
Good & Choice Heifers: 500# or less	28.28
Good & Choice Heifers: 554#	27.31
Choice Heifers: 550-750#	27.72
Good Heifers: 500-750#	24.93
Cull Heifers	25.19

Summary

This chapter summarized some of the survey data regarding production characteristics, land use, and off-farm work, and presented the basic input data for the study. Almost 80 percent of the open land per

TABLE XV

OPERATING CAPITAL, LABOR REQUIREMENTS AND CASH COSTS FOR LIVESTOCK ACTIVITIES

Livestock Activity	Input Item		
	Operating Capital[c]	Cash Cost[d]	Total Labor[e]
	dol.	dol.	hrs.
COW 1	4.25	28.17	6.46
COW 2	4.25	28.17	6.43
COW 3	4.25	28.17	6.53
COW 4	30.67	28.62	6.91
COW 5[a]	34.92	54.09	13.94
COW 6[b]	8.50	53.64	12.96
FLST	64.36	21.29	1.92
SPST	67.59	19.98	2.00
FLSNSGR	63.00	17.70	1.68
SPSNSGR	67.43	17.50	1.60
STHF1	63.25	16.23	2.08
STHF2	64.37	17.66	1.92
SPHNSGR	64.37	16.00	2.00
FLHNSGR	63.25	17.30	1.68
AUGSTKRS	82.10	17.70	1.89
AUGSTKRH	72.78	17.51	1.85

[a]Sum of COW 2 and COW 4 less that for bull.

[b]Sum of COW 2 and COW 3 less that for bull.

[c]Cash expenditures used in the production of particular enterprises and adjusted to an annual basis.

[d]Cash expenses exclusive of interest charges.

[e]Only that labor directly involved in handling and care of livestock. Feed labor or that required in pasture rotation is determined within the model.

farm was in pasture in the study areas. Cow-calf systems were the predominant beef production alternatives, but the study area averaged only about 40 beef cows per farm. Most of the surveyed operators worked 250 days or more off the farm.

Land classifications and forage inputs were developed for the study model. There were fourteen soil productivity levels in four broad groups; sandy, clay, loam and bottomland. The forages considered were bermuda, native pasture, fescue, weeping love, rye-vetch, forage sorghums, and small grain pasture.

A variety of beef alternatives was developed to encompass a wide range of potential management decisions. Six cow-calf systems and ten stocker calf alternatives were developed. The production year was assumed to include six, two-month periods. Nutrient production from forage and nutrient use by the livestock were allocated by period.

Survey data failed to indicate explicit relationships between size of beef farms or numbers of cows and part-time and full-time farmers in the area. However, technical and survey data provide sufficient information to accomplish the first two objectives of the study relating to technical inputs and comparison of optimal organizations and responses. Resulting analysis will allow evaluation of overall effects for the region.

CHAPTER IV

DEVELOPMENT OF THE REPRESENTATIVE FARM SITUATIONS

Guidelines recommended by the regional committee for determination of the representative resource situations were to be used in conjunction with data presented in the previous chapter. Two stages were to be used in the analytical procedure [27, p. 9]. Stage I estimated the minimum relevant size for a large farm that would achieve a specified level of income to operator labor and management. A second size was determined to represent a small or part-time farming operation. Stage II involved models to maximize returns to the operator's labor and management.

Stage I analysis identified representative resource situations and technical input-output ratios. The technical coefficients were used to estimate resource combinations necessary to achieve a minimum income at different levels of equity. Equity (percent of capital owned) was approximated in the linear programming model by changing interest rates charged on total land capital. Six percent was assumed to be the market rate on land capital. Table XVI gives the interest rates on land capital and corresponding equity levels used in this study. These solutions were used to determine the representative full-time farm situation.

Minimization results illustrate the kinds of beef-feeding system complements necessary to achieve designated returns to resources for a given equity level. They also estimate the associated land and capital needs. In addition to reflecting different equity levels, different interest rates can illustrate impacts of changes in land values or rent on returns to resources. For example, a 3 percent interest rate reflects a 50 percent equity on a $200 per acre land price, or 100 percent equity on a $100 land price.

TABLE XVI

ASSUMED LAND CAPITAL INTEREST CHARGES AND CORRESPONDING EQUITY LEVEL[a]

	Percent				
Interest Rate	6.0	5.625	5.25	4.5	3.0
Land Equity	0.0	6.25	12.5	25.0	50.0

[a]At lower interest rates the full opportunity cost is not charged on land capital.

Several types of minimization models could be used for analysis. Minimizing labor to achieve a specified income could be an appropriate objective function. This would be of importance if leisure time were especially valued. Minimizing costs, capital, or land are other possible alternatives to consider. Minimum cost models assure adequate returns with the least possible expenditures for operations. Interest charges on land capital and investment capital would be paid, but no direct limitation would be imposed on investment. Minimization of capital or land models determine the resource combinations necessary to achieve the specified income with the least investment or land capital. Minimum cost models imply that equity levels may not be of importance, the resource base is available but cash available for operational expenses is critical. On the other hand, minimizing capital or land would be appropriate if equity positions were important. Ability to borrow funds may depend on equity. All rent operations paying land costs would be equivalent to 0 equity. Minimizing capital would determine the least amount of investment capital needed to achieve the desired income. Minimum land models determine the acreage that would achieve the specified income. Because the regional project objectives called for the full-time farm to be of sufficient size to be economically feasible in 1975, the minimization of land capital was assumed appropriate for this study.

Jobe's analysis [4, p. 107] indicated little difference in land required to achieve an income of $8,215 when minimizing capital or land. This is partly because land investment comprises a large part of total capital and would be reflected in capital minimization solutions. Because of this similarity and the high land investment, the land minimization approach was used in this study.

Model Restrictions and Input Assumptions

In addition to limitations and assumptions discussed in the previous chapter, restrictions were also made on interest rates, land price, and operator labor. Limitations of land use based on survey data were also imposed.

Labor

Two operator labor supply situations were assumed for this study area. A full-time operator was assumed to work 2500 hours per year on the farm. This was distributed by calendar period throughout the year. The part-time operator worked full-time off the farm leaving evenings, weekends, and holidays for farm work. The part-time operator had a total of 939 hours available for farm work. The distribution of operator labor by periods for each situation is given in Table XVII. Any other labor needed could be hired at a cost of $1.75 per hour; however, an additional restriction was imposed on hiring labor to account for management needed. The method used for this study was to increase the cost of labor by allowing only 0.95 hours for each $1.75. The effect would be a labor cost of $1.84 an hour for hired labor.

TABLE XVII

OPERATOR LABOR AVAILABLE BY PERIOD FOR FULL-TIME AND PART-TIME FARM OPERATORS

Period	Full-Time	Part-Time
1	421.5	126
2	434.5	153
3	434.5	180
4	341.0	184
5	434.5	159
6	434.5	137
Total	2500.0	939

<u>Other Limitations and Costs</u>

The land price used is 200 dollars per acre.[1] The full interest charge on land capital was 6 percent. Nonland capital was charged at a rate of 7 percent.

Survey results in Table VI, Chapter III indicated that 20.2 percent of the openland or 19 percent of the total land, including forest land, in Northeast Oklahoma was used for annual forages. Bermuda was produced on 41 percent of the total land. Because the bermuda and native range were already established, it was not expected that these uses would be changed to a great extent by 1975. In the model, bermuda was required on at least 41 percent of the land and no more than 19 percent of the land could be in annual forages. Native range was required on 23.6 percent of the land.

Survey data and some preliminary programming results indicated a restriction in addition to those discussed in Chapter III would be needed. The COW 4 activity, fall calving with late weaned calves, was limited so that the number of animals would not exceed COW 2. COW 4 was the dominant activity in the development runs, but there were no indications from survey data that it was used exclusively on any operation, and it was not expected to become a dominant system in the area.

The income target was $8,215. Of this, $7,000 was considered consumption income which was required by time periods, $1,000 per period

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[1]Oklahoma Crop and Livestock Reporting Service estimates of land prices were used to determine the value used in this analysis. The average annual dollar increase in land price was $11.14 for Eastern Oklahoma from 1960-71. To obtain the expected land price for 1975, $11.14 was multiplied by 4 and added to the 1971 price. A price of $232.56 per acre was obtained. This price included buildings and improvements. The net value of the land was assumed to be 88.9 [4, p. 96] percent of this total value or $206.25. For ease of calculation, $200 was used.

in the first five and $2,000 in period 6. The other $1,215 was considered farm overhead.[2]

Minimum Income Solutions

The land interest rates in Table XVI were used in the model to estimate the minimum land required to achieve an $8,215 income for the corresponding five equity levels. The results are shown in Table XVIII.

Only the 50 percent equity solution will be explained in detail since the remaining results would be interpreted similarly. Total land required was 537.32 acres. Costs (including interest) were $31,257.10. Total capital required was $199,230.97 of which $80,295.08 was nonland. Operating capital was $11,472.13.

Bermuda was produced at the minimum acreage allowed, 41 percent of total land. The heavily fertilized bermuda (200# nitrogen per acre) was the predominate enterprise with none of the moderate fertilization level produced. However, there were over 62 acres of unfertilized bermuda. Annual forages (forage sorghum, small grain, rye-vetch) were produced at the maximum acreage allowed.

Fescue was produced on 49.43 acres. By imposing the requirements on bermuda and annual forages an indirect limit was placed on fescue. If bermuda was produced at the minimum level required and annual forages were at the upper limit, 9.2 percent of the non-native openland could be used for fescue or bermuda-fescue. In this instance fescue was limited to 49.43 acres.

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[2] Table XXXVIII in Appendix B lists overhead items.

TABLE XVIII

ESTIMATED RESOURCE REQUIREMENTS TO ACHIEVE AN INCOME OF $8,215 TO OPERATOR OVERHEAD, LABOR, AND EQUITY AT FIVE LEVELS OF LAND EQUITY IN NORTHEAST OKLAHOMA

Item	Units	Equity in Land				
		50%	25%	12 1/2%	6 1/4%	0%
Total Land	acres	537.32	814.83	1,262.28	1,740.23	2,800.51
Cost (dol.)	dol.	31,257.10	50,774.52	83,173.66	117,771.90	194,526.51
Capital						
Total	dol.	199,230.97	301,579.26	468,482.28	646,713.89	1,042,112.49
Nonland	dol.	80,295.08	120,626.96	186,879.58	257,629.12	414,583.71
Operating	dol.	11,472.13	17,985.13	29,128.49	41,027.97	67,426.42
Forages:						
Bermuda Graze:						
No Nitrogen	acres	62.03	92.98	144.04	198.58	319.55
200 #N	acres	115.34	117.95	275.69	380.06	611.60
Fescue	acres	49.43	74.97	116.14	160.11	257.65
Native	acres	46.13	39.60	61.35	84.58	136.11
Forage Sorghum	acres	13.87	19.54	30.27	41.73	67.15
Small Grain	acres	63.72	98.11	152.11	209.57	337.25
Rye-Vetch	acres	24.50	37.16	57.56	79.36	127.70
Hay & Graze						
Bermuda, 200 #N	acres	42.93	63.26	97.84	134.88	217.06
Native	acres	75.95	116.18	178.48	246.00	395.98
Livestock[a]						
Cow 2	hd.	105.93	159.55	247.18	340.76	548.37
Cow 4	hd.	105.93	159.55	247.18	340.76	548.37
FLST	hd.	70.57	104.22	161.47	222.59	358.21
Hay Fed	cwt.	4,135.74	5,893.27	9,130.07	12,586.56	20,254.64

[a]See Table 10, p. 52, and Table 12, p. 55 for definitions of terms.

The livestock activities were COW 4 and COW 2 in the COW 3 combination. Fall stocker steers were transferred from the COW 2 herd.

Few changes occurred in organization as equity levels were decreased. Some proportions were changed with the forage group. For example, native became more heavily used for hay, and small grain was a larger proportion of annual forages. However, no species differences were noted. Livestock activities did not change in any instance. Cost per acre was $58.17 at the 50 percent equity and $69.46 at 0 level. Nonland capital per acre did vary slightly with different equity levels.

A look at some more detailed ratios yields additional insight into adjustments as equity declines. Table XIX illustrates other characteristics of the minimization solutions. The total acres are again given for each solution. The acreage increase is the change in total land from one equity level to the next.

On a per acre basis returns ranged from $15.30 per acre at 50 percent equity in land down to $2.93 at no equity. To arrive at a more comparable figure of returns to operator risk and management, the additional interest charge per acre to reach an equivalent of 6 percent was subtracted from net returns per acre. Thus, at the 50 percent equity and a land price of $200 the land charge would be $6.00, at 25 percent $3.00. Subtracting these values gives net returns per acre to operator labor, management and risk.

Net returns per acre to operator labor and management declined as equity was decreased. Thus, farms had to be much larger to reach the target income. A farmer renting all land for beef farming would require a larger farm than operators with high equities, assuming a landlord received the full land charge.

TABLE XIX

ESTIMATED ACREAGE, RETURNS, RETURNS PER ACRE, LABOR REQUIREMENTS, AND SELECTED LABOR RELATIONSHIPS USING MINIMUM LAND AT FIVE EQUITY LEVELS

Item	Units	50	25	12.5	6.25	0
Total Acres	acres	537	814	1,262	1,740	2,800
Acreage Increase	acres		277	448	478	1,060
Returns to owned Equity, Risk, Labor, and Management	dol.	8,215	8,215	8,215	8,215	8,215
Return per acre	dol.	15.30	10.09	6.51	4.72	2.93
Additional land charge per acre	dol.	6.00	3.00	1.50	.75	0
Net ret. per acre	dol.	9.30	7.09	5.01	3.97	2.93
Hired labor	hrs.	273.4	1,340.1	3,521.8	5,851.5	11,020
Total labor	hrs.	2,557	3,804.2	6,021.9	8,351.5	13,521
Total lab. per ac.	hrs.	4.76	4.72	4.77	4.8	4.83
Total cost labor	dol.	503.68	2,468.46	6,487.14	10,778.54	20,298.84
Labor cost per hr.[a]	dol.	.20	.643	1.08	1.29	1.50
Change in Labor Cost	dol.		1,964.78	4,018.68	4,231.40	9,520.30
Marginal Labor Cost per Acre[b]	dol.		7.09	8.97	8.85	8.98

[a] $\frac{\text{Total Cost Labor}}{\text{Total Hours Labor}}$ = Labor cost per hr.

[b] $\frac{\Delta \text{ Total Cost Labor}}{\Delta \text{ Acres}}$ = Marginal labor cost per acre.

Two effects contributed to the large increase in acreage as equity was reduced. First, it was clear that the requirement that all land costs be paid meant more volume was needed to achieve the target income. Second, and less clear, was that as acres increased additional hired labor was needed.

All available operator labor was used in every situation except the 50 percent equity solution. An indication that timing of operator labor inputs may be critical was seen from the 40 percent land equity result. The operator had available 2500 hours and a total 2557 were used; however, 273.4 hours were hired. If the unused labor could have been made available at other times land needed might have been less.

The total cost of labor is the total paid for hired labor. Labor cost per hour is total cost divided by all labor used. As farms become larger the hired labor dominates labor cost causing the computed average cost per hour to increase. Labor cost increased more than $4,000 between the 25 and 12 1/2 percent equities. This was $8.95 per acre for each additional acre needed.

Implications could also be made concerning charges for land investment. Land prices have historically increased so that the land may be a capital investment and any income produced is added benefit. In this situation the higher equities would be appropriate solutions. For example, if land prices were increasing at 7 percent per year and an individual expected a 10 percent return on his investment, the 50 percent equity solution would achieve the minimal income requirement and an investment return to land.

This section of the analysis served to point out some implications for renting or expanding farm size. Assuming that the renter desired a

6 percent return on his land investment, then the rentee would need a large acreage to achieve an adequate income. Viewed in another light, expanding farm size through land purchase could be restricted because sufficient size would be difficult to attain. An example of this latter case can be illustrated. If an operator has 50 percent equity in 537 acres and he could borrow or finance all of a new land purchase, he could increase his acreage to 1262 and still have 21 percent equity. On the other hand, with 25 percent equity and 814 acres, financing the additional 448 acres would mean an equity of just over 16 percent. To increase from a 12.5 percent equity and 1262 acres to 1740 with 100 percent financing would reduce equity to less than 9 percent. At some point, equity position would become important in financing additional purchases. If the additional purchase reduced equity significantly, it may become difficult to achieve the minimal income. It would appear that operations just achieving consumption incomes and paying interest on land loans would require a significant time period for expansion.

Development of Representative Resource Situations

To fulfill regional project objectives a minimum of two resource situations are to be analyzed: (1) a large farm, and (2) a part-time (or small) farm. The large farm is to be representative of what could be expected as an economically viable unit in 1975.

Regional objectives called for the large farm size to be determined through the minimization models. The large farm would be that size with the lowest equity resulting in the target income, the zero equity if a feasible solution were possible. Equity levels were to be approximated by varying interest rates on land capital as described earlier.

Adhering strictly to regional requirements, results of Table XIX indicate the 2800 acre size would be the appropriate large farm. However, the following requirements appear to justify a modification. First, the target date for the study is 1975. Second, technology assumed is that available in 1969 and expected to be in use in 1975. Thus, 1969 is the benchmark year. Third, only seven of the surveyed farms had more than 1000 acres. In view of the large increases in size associated with lower equities in land, it was felt that even if farm size of full-time operators increased it would take considerable time to achieve sizes of two to three thousand acres. The 12.5 percent equity size of 1,262 acres was considered a more reasonable size for this study. From the net returns per acre of $5.01 in Table XIX this would achieve an income of $6,322.62, or $1,892 less than the target income achieved with zero equity. For this study the acreage was rounded to 1,280.

Guidelines for the regional project suggested a small farm size to be the average acres of open land for all farms surveyed smaller than the large farm. There were 132 farms with less than 1280 acres with an average of 267 acres per farm or 280 acres as used in the following analysis. The income potential of this farm, particularly its potential in part-time farming, will be examined in Chapter V.

Minimum Land For Part-Time Farm

One additional solution was obtained in the minimization analysis to represent a possibility for part-time farming. For this solution, two basic assumptions were modified. The operator was assumed to work off the farm full time. Thus, less labor was available for farming. The specified income was reduced to $885, equal to overhead for a part-time farm. It was assumed that off-farm income would provide for family consumption spending. The assumed land equity was 12 1/2 percent.

Just over 75 acres of land was necessary to achieve the income. The same livestock activities were utilized in this situation as the other minimization models; however, some grain sorghum was fed which had not occurred before. All operator labor was not used, an average of 4.8 hours per acre was needed. This compared closely to the total per acre needed of 4.77 hours for the large farm. This latter solution was not used for further analysis because other procedures were used in determining small farm size. It does illustrate however that there is considerable potential for smaller farms to achieve specified incomes using operator labor that is available after a full-time off-farm job. The solution for this situation is presented in Table XX.

Summary

This chapter developed the basic representative situations to be analyzed in this study. The specific assumptions made by the regional committee were incorporated in a linear programming model to examine several minimum resource models to be used in determining a representative large beef farming situation.

Because the land investment was a large part of the capital requirements, the objective used was to minimize land to achieve an $8,215 income. Several land equities were assumed ranging from 50 to 0 percent and programmed by varying land interest. The result indicated that rather large increases in land size were necessary to maintain the specified income as equity becomes lower.

TABLE XX

ESTIMATED MINIMUM LAND AND RESOURCE COMBINATIONS REQUIRED TO ACHIEVE $885 INCOME FOR A PART-TIME OPERATION AT 12.5 PERCENT LAND EQUITY IN NORTHEAST OKLAHOMA

	Units	Quantity
Total Land	acres	75.23
Cost	dol.	$4,743.19
Operator Labor Used		
Period 1	hrs.	65.17
2	hrs.	84.16
3	hrs.	46.78
4	hrs.	58.20
5	hrs.	54.69
6	hrs.	51.37
Forages		
Unfertilized Bermuda	acres	8.39
Bermuda: 200# N	acres	22.45
Fescue	acres	6.92
Native	acres	17.74
Forage Sorghum	acres	2.18
Small Grain	acres	8.68
Rye Vetch	acres	3.44
Total Cows (COW 2 and COW 4)	hd.	29.86
Fall Stocker Steers	hd.	10.23
Hay Fed	cwt.	609.86
Concentrate Fed	cwt.	2.44
Nonland Capital	dol.	$11,338.64
Operating Capital	dol.	$ 1,606.62

A farm size of 1,280 acres, approximately the 12.5 percent equity solution, was chosen as the appropriate large farm size for further analysis. This would be the size expected to exist on a commercial or full-time basis by 1975. A representative part-time farm of 280 acres was determined to be the appropriate size to represent part-time situations.

CHAPTER V

AN ECONOMIC ANALYSIS OF REPRESENTATIVE PART-TIME AND FULL-TIME BEEF FARMING SITUATIONS

Chapter IV used survey data and a land minimization model to estimate the resource combinations necessary to achieve a specified income level given different equities in land. These results were used to determine the representative full-time farm. A representative part-time farm was determined from survey data.

This chapter will examine optimal solutions to profit maximization models for each of the representative situations. Comparisons of effects on optimum conditions of limiting livestock alternatives, changing interest rates, and ranging prices will be made.

Effect of Successive Deletion of Most Profitable Livestock Activities

One approach to estimating the potential production of beef and the effect on income to the beef farm situation given enterprise preferences is to examine the maximum profit solutions with all activities and then successively eliminate the most profitable alternatives for each succeeding solution. Analysis of this nature indicates alternatives that are likely substitutes for the deleted activity. This procedure will be followed here for each farm size. A comparison of resource use and enterprise choice will be made for these results.

Analysis of the Full-Time Operator Situation

Table XXI gives a summary of three basic solutions for the full-time farm operator. Base prices given in Table XIV and interest rates of 7 percent on nonland and 6 percent on land capital were used in all cases. The first solution estimated the maximum profit resource combination from all beef enterprises used for this study. The second did not have the COW 4 alternative available and the third had both COW 4 and COW 1 deleted.

The initial solution returned $6,343.15 to the operator's labor, risk, and management. A nonland capital input of $189,489.34 was required or $148.04 per acre. This organization also required $29,567.43 operating capital. Costs, including all interest charges, were $86,321.74 or $67.44 per acre.

Forage production was concentrated in the relatively high yielding forages. The heavily fertilized bermuda (200 lbs. N. per acre) acreage was predominate with 378.76 acres of the total 524.8 acres of all bermuda in this category. The upper limit on annual forages was produced with more than half the acreage in small grain pasture. Fescue was produced on 117.76 acres, the maximum level allowed given the limits on bermuda and annual forages. However, shadow prices indicate for other fescue or bermuda fescue to have been utilized would have cost from $3 to $25 per acre. The native range utilized was primarily in hay production, but 58.62 acres were left idle.

TABLE XXI

ESTIMATED RESOURCE COMBINATIONS FOR MAXIMUM PROFIT FOR THE 1280 ACRE FARM WITH CHANGING ENTERPRISE ALTERNATIVES[a]

Item	Units	Enterprise Alternatives Allowed		
		All	All Except COW 4	All Except COW 4 and COW 1
Income to Operator Labor and Management	dol.	6,343.15	55.78	(1731.70)
Idle Native Range	acres	58.62	120.82	120.83
Forages				
Unfertilized Bermuda	acres	146.05	285.44	91.65
Bermuda, 200 lbs. N				
Seasonal Graze	acres	279.55	85.21	--
Deferred Graze	acres	--	26.14	--
Hay and Graze	acres	99.21	117.52	.91
Bermuda, 100 lbs. N				
Seasonal Graze	acres	--	--	203.7
Deferred Graze	acres	--	10.5	26.58
Hay and Graze	acres	--	--	201.96
Fescue	acres	117.76	117.76	117.76
Native				
Graze	acres	62.21	--	--
Hay and Graze	acres	181.0	181.0	181.0
Annual Forages				
Forage Sorghum	acres	30.69	85.07	80.77
Small Grain	acres	154.15	99.76	104.06
Rye-Vetch	acres	58.37	58.37	58.37
Total Cows	hd.	501.28	497.87	496.87
COW 1	hd.		497.87	
COW 2	hd.	250.64		
COW 3	hd.			229.7
COW 4	hd.	250.64		
Stockers				
FLSTS	hd.	163.72	8.72	117.32
FLSTS (bought)	hd.	(53.66)	(8.72)	--
AUGSTKRH[b]	hd.		139.18	--
Hay fed (periods)		1,2,6	1,2,5,6	1,2,5,6
Hay volume	cwt.	9,257.57	10,363.96	11,580.2
Concentrate fed	cwt.	--	1,786.39	832.88
Labor Hired				
Period 1	hrs.	696.77	1,691.77	575.15
2	hrs.	965.32	539.42	1,084.09
3	hrs.	374.01	192.63	160.1
4	hrs.	652.55	827.8	622.99
5	hrs.	504.91	62.5	585.36
6	hrs.	413.16	195.97	337.0
Total	hrs.	3,597.72	3,510.9	3,368.69
Nonland Capital	dol.	189,489.34	183,311.52	187,897.54
Operating Capital	dol.	29,567.43	22,268.47	19,979.06
Cost	dol.	86,321.74	80,390.09	76,687.39

[a]Tables XLI and XLIII in the Appendix give the specific soils on which the forages were produced for the solution with all activities and with COW 4 deleted.

[b]Stocker heifers beginning in August.

Some hay feeding was required in periods 1, 2, and 6, but no other supplemental feed was necessary. A total of 9,275.57 cwt. of hay was required. The feeding period lasted from November through April or about 180 days. Hay feeding volume amounted to an average of 51.4 cwt. per day. Converting livestock to an animal unit basis (each stocker equals 0.5 A.U.), this is 8.8 pounds of hay per animal unit per day during the fall and winter periods.

Some labor was hired in all periods. Total hired labor amounted to 3,579.72 hours. Period 2 required 965.32 hours and period 3 needed 374.01 hours for the highest and lowest demand periods respectively.

Livestock activities were the COW 5 combination of COW 2 and COW 4 and fall stocker steers (FLSTS). There were 501.28 brood cows and 163.72 steers with 53.66 of the steers purchased.

The second solution resulted in a drop in returns to the operator from $6,343 to $55.78. Without COW 4 available, the COW 1 activity was the only cow-calf activity in the solution. The heifers from this activity were grazed as stockers from August to January.

Although the same forages were grown, some shifts in proportions were noted. More native pasture was allowed to remain idle. Unfertilized bermuda increased, and 10.5 acres of bermuda with 100 pounds nitrogen per acre was produced. Small grain acreage decreased, but forage sorghum increased.

The most significant shift of resource use was in labor hired. Total labor hired was only 69 hours less than for the initial solution, but need by period ranged from 62.5 hours in period 5 to 1,691.77 hours in period 1.

The third solution deleted both COW 4 and COW 1 resulting in negative returns to the operator's labor and management of $1,731.70. The livestock was again heavily cow-calf with 267.17 COW 2 and 229.7 COW 3. Fall stocker steers were transferred from the COW 2 activity.

A major change in bermuda production occurred in this solution. Unfertilized bermuda was reduced to 91.65 acres. The remaining bermuda was fertilized with 100 pounds of nitrogen per acre. Only minor changes were noted in other forages.

The cost figures are comprised of all cash costs including interest charges on investment capital. Of the $6,000 difference in cost between the first two solutions, less than $1,000 can be attributed to capital charges, indicating the reduced profitability is associated with production requirements and prices. COW 4 is in the range of $20 more profitable per head than COW 1. The same holds in comparing the last solution.

The preceding summarized general characteristics of three profit maximization solutions for the representative large farm. A comparison of the labor and capital resources used and ratios of selected items yields more specific insight of the changes between solutions. A detailed comparison of resource usage will be presented for these three maximum profit solutions. Table XXII gives some comparative figures for analysis.

Returns per hour of operator labor ranged from $2.54 to a loss of $.69. These returns are net of all costs including interest on investment capital. Deleting only the COW 4 alternative reduced returns to an insignificant amount, while eliminating the second alternative caused a net loss to operator labor and management. This result is particularly

TABLE XXII

COMPARISON OF RETURNS PER HOUR OF OPERATOR LABOR, STOCKING RATES, LABOR, AND CAPITAL REQUIREMENTS FROM PROFIT MAXIMIZATION SOLUTIONS WITH DIFFERENT LIVESTOCK ALTERNATIVES FOR 1280 ACRE FARM

Item	Units	All Activities	All Except COW 4	All Except COW 1 and COW 4
Returns Per Hour of Operator Labor	dol.	2.54	0.022	(0.69)
Stocking Rate:				
Acres/Animal Unit		2.195[a]	2.238[a]	2.30[a]
(Acres/Animal Unit)/Year		2.36[b]	2.393[b]	2.433[b]
Total Labor Hired Per Ac.	hrs.	2.8	2.74	2.63
Labor Hired Per Hour of Operator Labor				
Period 1	hrs.	1.653	4.014	1.365
2	hrs.	2.222	1.24	2.495
3	hrs.	0.86	0.443	0.368
4	hrs.	1.914	2.428	1.827
5	hrs.	1.162	0.144	1.347
6	hrs.	0.951	0.451	0.776
Nonland Capital Per Acre	dol.	148.04	143.21	146.79
Operating Capital Per Acre	dol.	23.10	17.40	15.61
Cost Per Acre	dol.	67.44	62.80	59.91

[a]Each stocker is counted as 1/2 animal unit to represent the stocking rate for that time of the year when both cows and stockers are grazing.

[b]Each stocker is counted as 1/4 animal unit to represent average annual stocking rate.

significant to farms that are largely rental or have low equities. If the operation were to pay all costs (opportunity cost of land for example) there is little choice of alternatives. However, if interest on land investment were only 5 percent, it would mean an additional $2,560 to operator labor, another dollar per hour and sufficient to give positive labor-management returns in all three organizations. For farms with high equity positions and/or a preference for certain organizations, the solutions without all activities could be reasonable. The solution without COW 4 could achieve the $8,215 income if interest on land capital were reduced to 2.8 percent or if about one-half the land was owned. For the third solution land interest would have to be as low as 2.1 percent.

An indication of the level of technology needed can be examined by determining the stocking rates. Two stocking rates were given to illustrate how the intensity of grazing can vary within a year. Two stocking rates were determined for each solution. The first and highest level of intensity is the number of acres per animal unit during the year when there are both stockers and cows. Stockers were converted to a cow unit equivalent. There was little difference in these rates between solutions. The second stocking rate measured the acres per animal unit per year. The second rate could be compared to that found in survey results (Figure 9, Chapter III). Optimal stocking rates, however, were considerably higher than that generally found in surveyed farms. The solution without COW 4 and COW 1, the least intensive grazing farm organization, had less than 2.5 acres per animal unit.

The amount of labor hired per year did not differ to a great extent. The most profitable solution only hired 69 hours more than the one without COW 4. The least profitable needed over 200 hours less, a variation of less than 10 percent of the total labor hired. Labor hired per acre operated was 2.8 hours for the solution with all activities, 2.74 hours without COW 4, and 2.63 with no COW 1 or COW 4.

The kind of labor needed, whether seasonal, part-time, or full-time, can be interpreted by looking at the hours of hired labor per hour of operator labor. A ratio of unity in every period would reflect to a full-time hired hand if it occurred in every period. Variations from this would be viewed as part-time or seasonal. The difference in total labor is small, but labor hired per hour of operator labor by period shows the least variation by period of labor hired. A low of 0.86 hour was needed in period 3 to 2.2 hours in period 2, a difference of 1.34 hours. The high and low periods were the same for the solution without COW 4 and COW 1, though the spread was even greater, 2.3 hours. The organization with only COW 4 eliminated showed the greatest labor variability between periods. In three periods, less than one-half of hired labor per hour of operator labor was needed. In period 1, over four hours was required and over two hours in period 4. With all livestock activities (utilizing COW 4 and COW 2), one full-time hand could be used. The low in period 3 of 0.86 hours would allow for time off. Additional hiring of part-time labor would also be needed seasonally, 2.22 hours in period 2 and 0.91 in period 4.

Without COW 4 a strong tendency to seasonal hiring of labor was indicated, there was no possibility of a full-time hired hand, but requirements were heavily concentrated in periods and 4. The solution without COW 1 or COW 4 hired labor more evenly, but did not require enough in periods 3 and 6 to justify full-time help.

The last three rows in Table XXII relate to the financial requirements for each operation. Nonland capital per acre was greatest, $148.04, for the basic initial solution and the least, $143.21, with COW 4 deleted. This indicates a higher investment level than was found in the survey. Table VII in Chapter III showed a total capital investment of $180.96 for the study region. Land capital of $200 per acre increases the total capital requirement for the program solutions to over $300. However, the level of investment (in nonland capital) depends to a great extent on the alternatives available as shown by the increase of $3.58 per acre from the no COW 4 to the no COW 1 or COW 4 solution. Operating capital and cost per acre declined as alternatives were deleted. The latter point emphasizes the importance of the COW 4 alternative in profitability compared to the other livestock activities. Returns were higher with the activity included though costs were greater.

Analysis of the Part-Time Farm

Handling the representative part-time farm in the same manner as the full-time operation, the response to changing the number of alternatives available to small or part-time farmers are shown in Table XXIII. Limits on cropland acres and alternatives were the same as for the large farm. Operator labor available was shown in Table XVII, Chapter IV.

The solution with all livestock activities available returned $2,125 to the operator's labor and management. This was from a combination of heavy fall calves (COW 4) and the spring calves (COW 2) activities with the steers from the spring system transferred to a fall stocker activity.

TABLE XXIII

ESTIMATED RESOURCE COMBINATIONS FOR MAXIMUM PROFIT FOR THE 280 ACRE FARM WITH TWO ENTERPRISE COMBINATION ALTERNATIVES[a]

Item	Units	Designated Solution: All Enterprises	Designated Solution: All Except COW 4
Income to Operator Labor and Management	dol.	2,125	605
Idle Native Range	acres	16.4	26.4
Forages			
Unfertilized Bermuda	acres	33.56	24.38
Bermuda, 200 lbs. N			
Seasonal Graze	acres	61.56	28.35
Deferred Graze	acres	4.73	--
Hay and Graze	acres	14.93	24.04
Bermuda, 100 lbs. N.			
Seasonal Graze	acres	--	17.51
Deferred Graze	acres	--	20.55
Fescue	acres	25.76	25.76
Native			
Graze	acres	10.03	--
Hay and Graze	acres	38.73	39.62
Forage Sorghum	acres	5.55	13.07
Small Grain	acres	34.89	27.37
Rye-Vetch	acres	12.77	12.77
Total Cows	hd.	112.06	118.52
COW 1	hd.	--	68.74
COW 2	hd.	56.03	24.89
COW 3	hd.	--	24.89
COW 4	hd.	56.03	--
Stockers			
FLSTS	hd.	24.6	10.93
AUGSTKH[b]	hd.	--	19.21
Hay Fed (periods)		1,2,6	1,2,5,6
Hay Volume	cwt.	1,679.6	2,271.1
Concentrate Fed	cwt.	--	372.03
Labor Hired			
Period 1	hrs.	106.02	260.75
2	hrs.	128.76	102.65
3	hrs.	--	--
4	hrs.	28.06	73.55
5	hrs.	47.62	--
6	hrs.	32.91	22.38
Total	hrs.	343.77	459.33
Nonland Capital	dol.	41,693.77	43,991.00
Operating Capital	dol.	5,361.80	4,851.28
Cost	dol.	15,901.66	17,686.28

[a]Tables XLI and XLIII in the Appendix give the specific soils on where the forages were produced.

[b]Stocker heifers beginning in August.

About 12 percent of the land was used for unfertilized bermuda. Over 80 acres were in bermuda with 200 pounds nitrogen per acre. Most of the native pasture was used for a combination of hay and grazing. Hay was fed in periods 1, 2 and 6. Annual forages were planted to the limit allowed. Labor was hired in all periods except 3. Periods 1 and 2 required over two-thirds of the total labor hired of 343.8 hours. In periods 4 and 6 less than an hour of hired labor was needed per acre.

The next solution eliminated the heavy fall calves (the COW 4 alternative) and returns declined to $605. The livestock system became a fall through spring calving combination of COW 1, COW 2, and COW 3. Steers from COW 1 transferred in August to a stocker system.

Hay was fed in periods 1, 2, 5, and 6 in this case with hired labor again most used in winter periods. Over 360 hours of the total 459 hired were needed in these two periods. All operator labor was not used in periods 3 and 4.

Idle native range increased by ten acres. Both the amounts of unfertilized and fertilized bermuda pasture declined. More emphasis was placed on hay and grazing with the heavily fertilized bermuda that was produced. Bermuda with 100 pounds N. was used for seasonal and deferred grazing. All native pasture was utilized in a combination of hay and grazing. The same annual forages were used but some shift out of small grain pasture to forage sorghum occurred when COW 4 was eliminated.

Changes in the capital accounts were also noted. Nonland capital increased to almost $44,000 from $41,693.77 while borrowed operating capital declined $510.52 to $4,851. Cash costs increased to $17,686.28 from $15,901.06. Two factors contributed to the increased cost; greater capital needs increased interest cost and more labor was hired than in the initial solution.

Table XXIV compares selected resource ratios for these two solutions. These can then be used for examining input requirements, and for later comparison to the full-time situation. Only two solutions were obtained because the second solution was diversified and it was not clear which activity should be deleted for a third solution structure.

The part-time farm with all activities returned $2.26 per hour of operator labor compared to $.64 with COW 4 eliminated. Returns were lower without COW 4 in spite of a higher stocking rate achieved. With COW 4 the acres per animal unit was 2.35, without, 2.22.

The more profitable solution required 1.23 hours of hired labor per acre. However, by periods, less than one hour of hired labor was needed for each hour of operator labor. Without COW 4 included, over two hours of hired labor was needed per hour of operator time. In period 1, a total of 1.64 hours per acre was hired. The increased cost of labor accounted for part of the decline in returns.

Eliminating COW 4 increased nonland capital needs by over $8 per acre. Although borrowed operating capital declined by almost $2, cost per acre rose $4.23. Here again, investment capital was higher than that found in the survey.

Comparison of Large and Small Farm Solutions

The solutions with all livestock alternatives were similar in organization. The same forages were utilized and hay was fed in the same periods. A more complete comparison can be made by examining the ratios in Tables XXII and XXIV.

TABLE XXIV

COMPARISON OF RETURNS PER HOUR OF OPERATOR LABOR, STOCKING RATES, LABOR AND CAPITAL REQUIREMENTS FROM PROFIT MAXIMIZATION SOLUTIONS WITH DIFFERENT LIVESTOCK ALTERNATIVES FOR 280 ACRE FARM

Item	Units	All Activities	All Except COW 4
Returns Per Hour of Operator Labor	dol.	2.26[a]	.64[a]
Stocking Rate: Acres/Animal Unit		2.24[b]	2.1[b]
(Acres/Animal Unit)/Year		2.35[c]	2.22[c]
Total Labor Hired Per Acre	hrs.	1.23	1.64
Labor Hired Per Hour of Operator Labor			
Period 1	hrs.	0.84	2.06
2	hrs.	0.84	0.67
3	hrs.	--	--
4	hrs.	0.15	0.4
5	hrs.	0.3	--
6	hrs.	0.24	0.16
Nonland Capital Per Acre	dol.	148.91	157.11
Operating Capital Per Acre	dol.	19.15	17.33
Cost Per Acre	dol.	56.79	61.02

[a]Determined by using hours of operator labor available, if calculated per hour used it would be only one cent greater.

[b]Each stocker equals one-half cow unit to represent the stocking rate for that time of the year when both cows and stockers are grazing.

[c]Each stocker equals one-fourth cow unit to represent average annual stocking rate.

The large farm returned $2.54 per hour of operator labor when all alternatives were considered, compared to $2.26 for the part-time. On a per acre basis, the part-time farm returned $7.56 and the large $4.99 to operator risk, labor, and management. Nonland capital requirements were about the same per acre. However, the large farm required more operating capital, and the cost per acre was more than $10 higher.

The full-time farm followed a slightly higher stocking rate when stockers were pastured, but the rates were more nearly equal on an average annual rate. The level of intensity indicates similar resource use characteristics; however, more than twice as much labor was hired per acre on the large farm.

Without COW 4 the part-time farm yielded greater returns per hour of operator labor. The organizations also were different. The large farm used only the winter calving system, while the small combined all three basic calving times. The part-time farm also shifted land use to the 100 lbs. N. bermuda while the full-time farm continued with the heavy fertilization rates.

The part-time farm equaled the stocking rate of the large when stockers were grown and averaged more intense use the year round (by 0.17 acres per animal unit). The labor hired per acre was closer than between the previous solutions, but the full-time operator hired over one hour more per acre. The part-time farm required $14 more nonland capital per acre, but borrowed operating capital was almost equal. Cash cost was more than $1 per acre greater on the large farm.

Income on the large farm was more adversely affected by eliminating COW 4 as an alternative. This was largely explained by operator labor. The large farm required 4.77 hours of labor per acre with COW 4 and 4.68 without. Of the total labor hired labor accounted for 2.8 and 2.74 hours respectively. For the comparable situations the small farm needed 4.56 and 4.87 hours total labor per acre and hired 1.23 and 1.64 hours. The part-time farm, by having relatively more operator labor available, hired additional labor to partially offset the loss of the COW 4 enterprise without greatly increasing operating costs. The part-time operator would appear to be more flexible in choice of enterprises.

Comparison of Responses to Changing Interest Rates

Changing interest rates of land capital to illustrate the response to changes in equity or represent renting situations was discussed in Chapter IV. Interest rates on nonland capital can be varied as well to compare responses of the representative farm situations to higher costs. Table XXV compares the solutions for both farming situations at 18 percent interest on nonland capital.

The higher interest resulted in a negative return to operator labor and management on the large farm, while the part-time farm return remained positive, but was reduced to about half the income obtained under a 7 percent interest charge. The return was a -$4.54 per hour of operator labor on the full-time farm and +$1.10 for the part-time.

Some differences between the two organizations were noted in forage systems at the higher interest rate. The small farm utilized the unfertilized and 200 pounds of nitrogen per acre bermuda, but less than 2 acres with 100 pounds nitrogen. The full-time farm produced more of the bermuda with 100 pounds of nitrogen per acre but none under heavy fertilization. Fescue was produced on the part-time farm but not on the large. Hay was fed in periods 1, 5, and 6 for both situations.

The result of the forage changes lowered the stocking rate achieved compared to the 7 percent interest solution as shown in Table XXVI. The full-time situation had 4.01 acres per animal unit. However, 117.78

TABLE XXV

ESTIMATED RESOURCE COMBINATION FOR MAXIMUM PROFIT AT 18 PERCENT INTEREST ON NONLAND CAPITAL FOR FULL-TIME AND PART-TIME FARMS[a]

Item	Unit	Full-Time Situation	Part-Time Situation
Income to Operator Labor and Management	dol.	(13,401.51)	1,030.00
Idle Cropland	acres	117.78	17.67
Idle Native	acres	215.94	40.48
Forages			
Unfertilized Bermuda	acres	411.01	98.67
Bermuda, 200 lbs. N.			
Hay and Graze	acres	--	14.21
Bermuda, 100 lbs. N.			
Seasonal Graze	acres	19.29	--
Deferred Graze	acres	--	1.92
Hay and Graze	acres	94.5	--
Fescue	acres	--	8.76
Native Grazing and Hay	acres	85.88	25.57
Forage Sorghum			
Graze	acres	46.89	12.89
Hay and Graze	acres	6.81	--
Small Grain	acres	131.14	27.54
Rye-Vetch	acres	48.22	12.77
Weeping Love	acres	10.15	--
Periods Hay Fed		1,5,6	1,5,6
Hay	acres	6484.27	1566.1
Total Cows	hd.	281.04	69.16
COW 2	hd.	140.52	34.58
COW 4	hd.	140.52	34.58
Stockers			
FLSTS	hd.	152.63	32.67
FLSTS (Bought)	hd.	90.92	17.48
Unused Operator Labor			
Period 1		--	--
Period 2		--	--
Period 3	hrs.	--	71.41
Period 4	hrs.	--	35.46
Period 5	hrs.	--	4.54
Period 6	hrs.	--	9.41
Hired Labor			
Period 1	hrs.	290.75	37.9
Period 2	hrs.	375.37	40.11
Period 3	hrs.	24.94	--
Period 4	hrs.	296.4	--
Period 5	hrs.	117.14	--
Period 6	hrs.	160.52	--
Total	hrs.	1265.12	78.01
Nonland Capital	dol.	113,170.56	27,365.22
Borrowed Operating Capital	dol.	18,532.09	3,980.93
Cost	dol.	89,223.65	14,015.28

[a]Table XLII in the Appendix gives a breakdown on the specific soils where the forages were produced.

acres of cropland was idle at the high interest. If the idle cropland were not considered, the stocking rate would be 3.64 acres per animal unit. For the part-time organization the stocking rate was 3.62 acres per animal unit if acres operated were used and 3.39 if idle cropland of 17.67 acres were left out of the ratio.

TABLE XXVI

AVERAGE ANNUAL STOCKING RATES FOR FULL-TIME AND PART-TIME OPERATIONS AT 7 AND 18 PERCENT INTEREST ON NONLAND CAPITAL

Interest	Stocking Rate 7%	Stocking Rate 18%
Full-Time	2.36	4.01
Part-Time	2.35	3.62

The large farm hired labor in every period, but needed less than one hour per acre or only one-half hour for each hour of operator labor. The part-time farm only required hired labor in periods 1 and 2. The total labor hired amounted to just less than one hour per acre on the full-time farm and 0.28 hour per acre on the part-time.

Capital requirements changed between the representative situations at the higher interest. The full-time farm needed $88.41 of nonland capital per acre and the part-time $97.73 or more than 10 percent more. Operating capital was nearly equal per acre, $14.48 and $14.21, for the full-time and part-time operations respectively, but cost per acre was greater by almost $20 for the large farm.

Compared to the basic solution charging 7 percent interest on nonland capital, overall use of resources declined. Less hay was fed and hired labor was reduced greatly. Nonland capital was reduced from $148.04 on the full-time farm to $88.41 at the high interest. The part-time situation needs declined from $148.91 to $97.73. In either case, capital requirements per acre were still higher than found in the survey.

Comparison of the 18 Percent Nonland Interest on the Part-Time Operation to the 7 Percent Interest on the Full-Time Operation.

In some cases a small farming operation may be expected to have higher input costs than a larger unit. Smaller equipment may cost more to operate, or low volume purchasing of inputs may be more costly. An approximation of higher costs for the part-time operator can be examined by comparing the results with 18 percent interest on nonland capital to the 7 percent interest for the full-time farm. Table XXVII compares selected ratios for the two solutions.

If the part-time farm situation had higher costs than the full time, very different rates of resource use and returns to operators would occur. The returns per hour of operator labor on the full-time operation were more than twice as great as for the part-time. The stocking rate for the part-time operator was 3.62 acres per animal unit compared to 2.36 for the full-time farm. As seen in Table XXVII, the part-time operation hired less than one-half hour of labor per acre compared to

2.8 hours on the full-time farm. Nonland and operating capital use were also significantly less on the part-time operation.

TABLE XXVII

RETURNS PER HOUR OF OPERATOR LABOR, STOCKING RATES, LABOR, AND CAPITAL REQUIREMENTS FOR MAXIMUM PROFIT CHARGING 18 PERCENT INTEREST FOR THE PART-TIME AND 7 PERCENT INTEREST FOR THE FULL-TIME FARM

Item	Units	Full-Time	Part-Time
Returns Per Hour of Operator Labor	dol.	2.54	1.10
Stocking Rate (Acres/Animal Unit)/Year[a]		2.36	3.62
Labor Hired Per Acre	hrs.	2.8	0.28
Nonland Capital Per Acre	dol.	148.04	97.73
Operating Capital Per Acre	dol.	23.10	14.21
Cost Per Acre	dol.	67.44	50.00

Results of Price Variation on Farm Organizations

Comparison of responses to price variations is an additional way of evaluating differences between full-time and part-time farms. Examining response to price changes of each type of operation would give indications of the overall change to expect. In this study livestock prices below and two above the base level were used for both farm situations.

The prices[1] used were $10 below, $5 below, and $5 and $10 above the base price for 460 pound steers. Prices of the other classes of animals kept in the same relationship to each new price as with the base price. After determining the price of each class of livestock, prices were seasonally adjusted. The solutions obtained will be compared to the results obtained using the base prices.

Ranging Prices on the 1280 Acre Farm

Table XXVIII summarizes the results for the full-time solution under each price structure. The 1280 acre operation resulted in a net loss for both the $5 and $10 decreases in price per cwt. of beef cattle. Income fell over $11,000 with the first $5 decrease and another $8,500 for the next $5. Solution costs were $86,321.75 for the base price and $65,059.62 and $46,930.50 for the $5 and $10 decrease respectively. The livestock activities were the same as for the base price solution for each of the lower prices. The number of brood cows at the lowest price was over 100 less than the number for the base price. There were less than half as many stockers, none of which were purchased. Stocking intensity was reduced to 3.9 acres per animal unit on an average annual rate at the lowest price.

As the price was reduced, more native pasture remained idle. Bermuda shifted to either no fertilizer or to 100 pounds nitrogen per acre. No fescue was grown at the lowest price. Forage sorghum increased as the beef price fell and weeping love replaced rye-vetch at the lowest price.

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[1]See Table XL in Appendix B for the prices at all levels.

TABLE XXVIII

ESTIMATED RESOURCE COMBINATIONS FOR MAXIMIZING PROFITS FOR THE FULL-TIME FARM AT FIVE PRICE LEVELS[a]

Item	Unit	Level of Price From Base Price				
		-$10	-$5	0	+$5	+$10
Income to Operator						
Labor and Management	dol.	(14,298.61	(5718.10)	6343.15	19,532.64	33,933.30
Idle Native Range	acres	235.76	120.83	58.62	--	--
Forages						
Unfertilized Bermuda	acres	424.44	343.94	146.05	142.74	48.34
Bermuda, 200 lbs. N.	acres	--	113.8	279.55	382.1	476.47
100 lbs. N.	acres	100.36	67.08	--	--	--
Fescue	acres	--	117.76	117.76	117.76	117.76
Native	acres	66.06	180.99	243.21	301.82	301.82
Forage Sorghum	acres	51.63	49.99	30.69	37.01	--
Small Grain	acres	132.22	134.85	154.15	147.82	184.83
Rye Vetch	acres		58.27	58.37	58.37	58.37
Weeping Love	acres	58.37	--	--	--	--
COW 2	hd.	146.88	210.6	250.64	254.11	276.16
COW 4	hd.	146.88	210.6	250.64	254.11	276.16
FLSTS	hd.	64.5	102.13	163.72	174.12	222.17
FLSTS	hd.	--	9.6	53.66	63	100.9
Hay Fed	cwt.	4,127.57	6,918.74	9257.57	10,377.08	11,133.43
Concentrate Fed	cwt.	--	--	--	41.55	1,525.49
Labor Hired	hrs.	896.77	2,476.35	3579.72	3,820.2	4,618.09
Nonland Capital	dol.	113,225.13	159,470.63	189,489.34	192,902.06	208,860.32
Operating Capital	dol.	12,727.60	20,386.36	29,567.43	30,679.88	38,603.13
Cost	dol.	46,940.35	65,059.02	86,321.74	89,554.21	107,181.33

[a]Tables XLIV and XLV in the Appendix give the specific soils on which forages were produced for the -$10 and +$10 price levels.

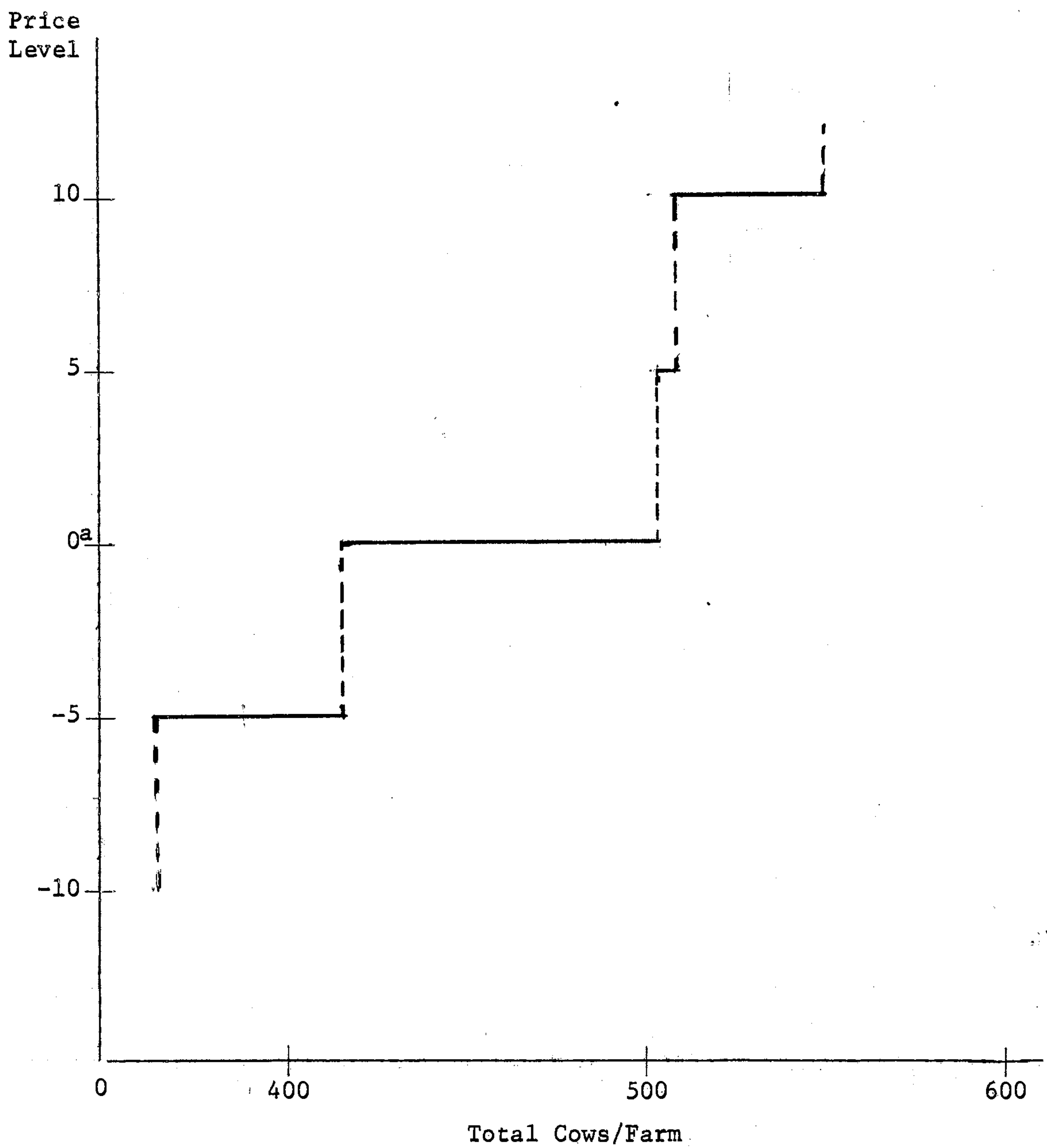
As price increased, income rose over $13,000 for the first $5 and another $14,000 for the next $5. This was accomplished by increasing the stocking rate to just under 2 acres per cow unit. No native pasture was idle and bermuda production was concentrated in heavily fertilized enterprises. Acreage used for forage sorghums was shifted to small grain pasture. Feeding of concentrates also became profitable.

The discussion of the resource combinations resulting from changing prices can readily be tied to facotrs affecting response discussed in Chapter II. With a fixed farm size the resource use shifted as price changed. Nonland capital required was $88.45 at the lowest price and $163.17 at the highest price. Labor hired ranged from a low of 0.7 hours per acre to 3.61 hours. The technology available to the operator would limit the extent of the response to a price change.

A graph of response of livestock numbers on the full-time farm to the price changes should aid in visualizing the influence price has on beef production. Figures 10 and 11 indicate respecitvely the numbers of cows and stockers with five price levels for the full-time farm. These relationships are shown in the discontinuous form generally associated with linear programming solutions.

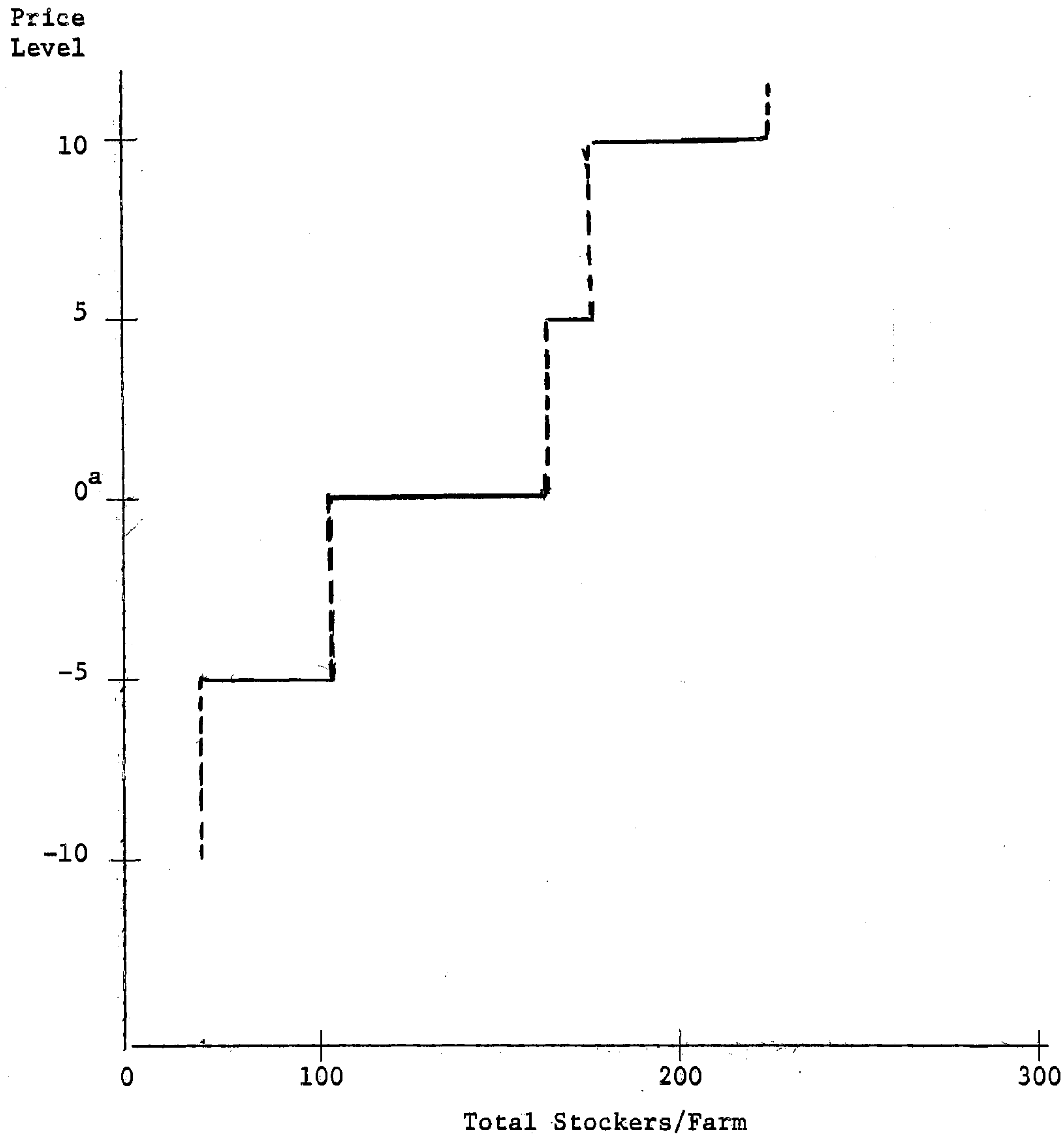
The response of cow numbers to price changes is not a true supply function. It does measure numbers of cows related to price levels. However, the assumption that all other prices are constant is not used to the extent that all livestock prices vary. All other prices, including heifers, cull animals, etc., are related to this price and move in the same direction as for the steer calf.

Cow numbers were most responsive to steer price increases at the low levels. Moving from the $10 decrease to the $5 decrease increases



[a]Base price level with steer calves at $32.50 per cwt.

Figure 10. Change in Cow Numbers with Assumed Price Level Changes on 1280 Acre Farm



[a]Base price level with steer calves at $32.50 per cwt.

Figure 11. Change in Stocker Calf Numbers with Assumed Steer Price Level Changes on 1280 Acre Farm

the number of cows on average of 1.96 percent for each percent increase in price. From $5 to $0 this was a 1.046 percent increase and from 0 to $5 a 0.09 percent increase. The final step increased cows by 0.651 percent on the average for a one percent price change. There appeared to be a logical explanation for the response becoming smaller and then larger again with successive price increases. At low prices stocking rates were low, which allowed intensive forage production as a means of increasing cow numbers with price increased. As the physical limits to stocking rates were approached through forage utilization, response was smaller (Table XXX, p. 101). As the price levels rose, further feeding concentrates became profitable which in turn allowed greater response to increased price.

The response of stocker numbers appears to follow that of the cow numbers to a great degree. The price levels were the same as for the cow relationships and should be viewed as based on the purchase price of the calves.

Price Ranging on the 280 Acre Farm

The small farm suffered losses at both the $5 and $10 price reductions. At the -$10 level the operators suffered a net loss of $2,725.72 or $2.90 per hour of labor available but received a return of $8,170.33 at the high price. As prices increased, income rose almost $3,000 for each $5 above the base price (Table XXIX).

Although relatively intensive forage systems were followed at all price levels, at the low price the rate of grazing was 3.9 acres per animal unit while at the high price grazing an intensity was less than

TABLE XXIX

ESTIMATED RESOURCE COMBINATIONS FOR MAXIMUM PROFIT UNDER FIVE PRICE LEVELS FOR THE PART-TIME FARM[a]

Item	Unit	Level of Price From Base Price				
		-$10	-$5	0	+$5	+$10
Income to Operator						
Labor and Management	dol.	(2,725.72)	(537.62)	2,125	5,017.63	8,170.33
Idle Native Range	acres	29.72	29.33	16.4	--	--
Forages						
Unfertilized Bermuda	acres	101.35	57.23	33.56	31.31	10.57
Bermuda, 200 lbs. N.	acres	4.03	46.23	81.22	83.49	104.20
100 lbs. N.	acres	9.42	11.9	--	--	--
Fescue	acres	11.44	25.76	25.76	25.76	25.76
Native	acres	26.30	26.69	48.76	66.02	66.02
Forage Sorghum	acres	11.44	7.34	5.55	7.5	--
Small Grain	acres	44.47	45.10	34.89	38.87	40.44
Rye Vetch	acres	0.76	0.76	12.77	6.84	12.77
Weeping Love	acres	7.48	--	--	--	--
COW 2	hd.	37.07	49.63	56.03	55.25	60.41
COW 4	hd.	37.07	49.63	56.03	55.25	60.41
FLSTS	hd.	16.28	21.79	24.6	39.16	48.6
FLSTS (bought)	hd.	--	--	--	4.91	22.1
Hay Fed	cwt.	1,289.03	1,380.22	1,679.6	2,255.54	2,435.44
Concentrate Fed	cwt.	--	--	--	4.91	333.7
Labor Hired	hrs.	60.5	198.88	343.77	421.19	597.67
Nonland Capital	dol.	28,431.91	37,240.54	41,693.77	42,050.47	45,688.19
Operating Capital	dol.	2,980.49	4,500.73	5,361.8	6,405.86	8,083.37
Cost	dol.	10,963.15	14,071.50	15,901.66	19,006.58	22,698.49

[a]Tables XL and XLI in the Appendix give specific soils on which forages were produced for the -$10 and +$10 price level.

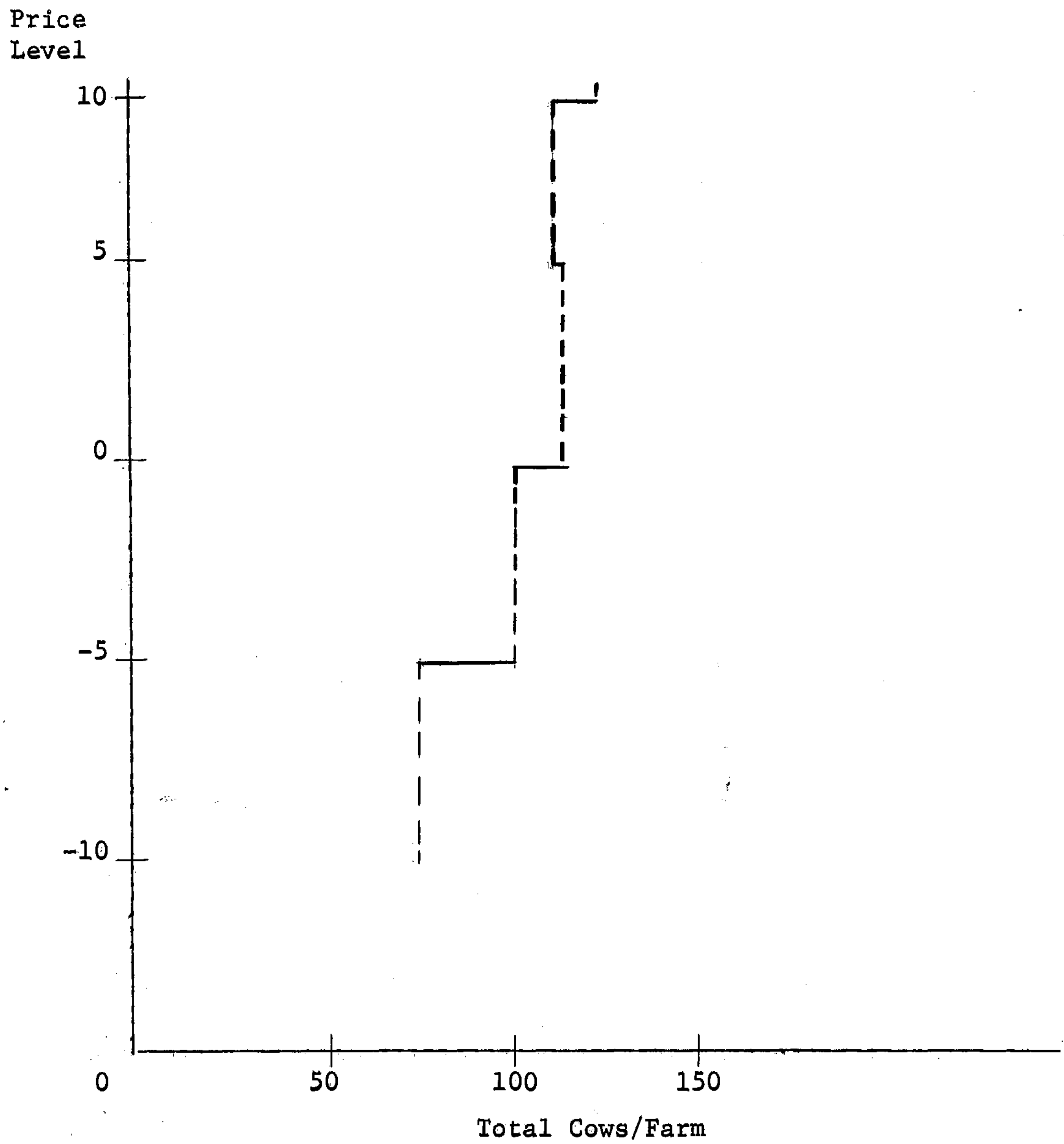
2 acres per animal unit. At the low price 101.35 acres of bermuda were unfertilized out of a total bermuda acreage of 114.8. At the high price, 104.20 acres of 200 pounds nitrogen per acre and 10.57 acres of unfertilized bermuda was produced.

Resource use changed considerably over the price ranges. At the low price level only 0.21 hours of hired labor were needed per acre; at the high price the comparative figure was 2.13 hours. Over the same range, nonland capital per acre was $101.54 and $163.17. Cost per acre went from $39.15 to $81.07.

Figures 12 and 13 represent the responses of cow and stocker numbers on the small farm to changes in price levels. Price levels are the same as for the large farm. Between the -$10 and -$5 increase in cow numbers was 1.52 for a one percent price increase. From $5 below to $0, the average percent increase was 0.709. However, from $0 to $5 above the direction was negative -0.09, a price increase led to a small decline in cow numbers. The final step increased cows by 0.701 percent for each one percent price increase.

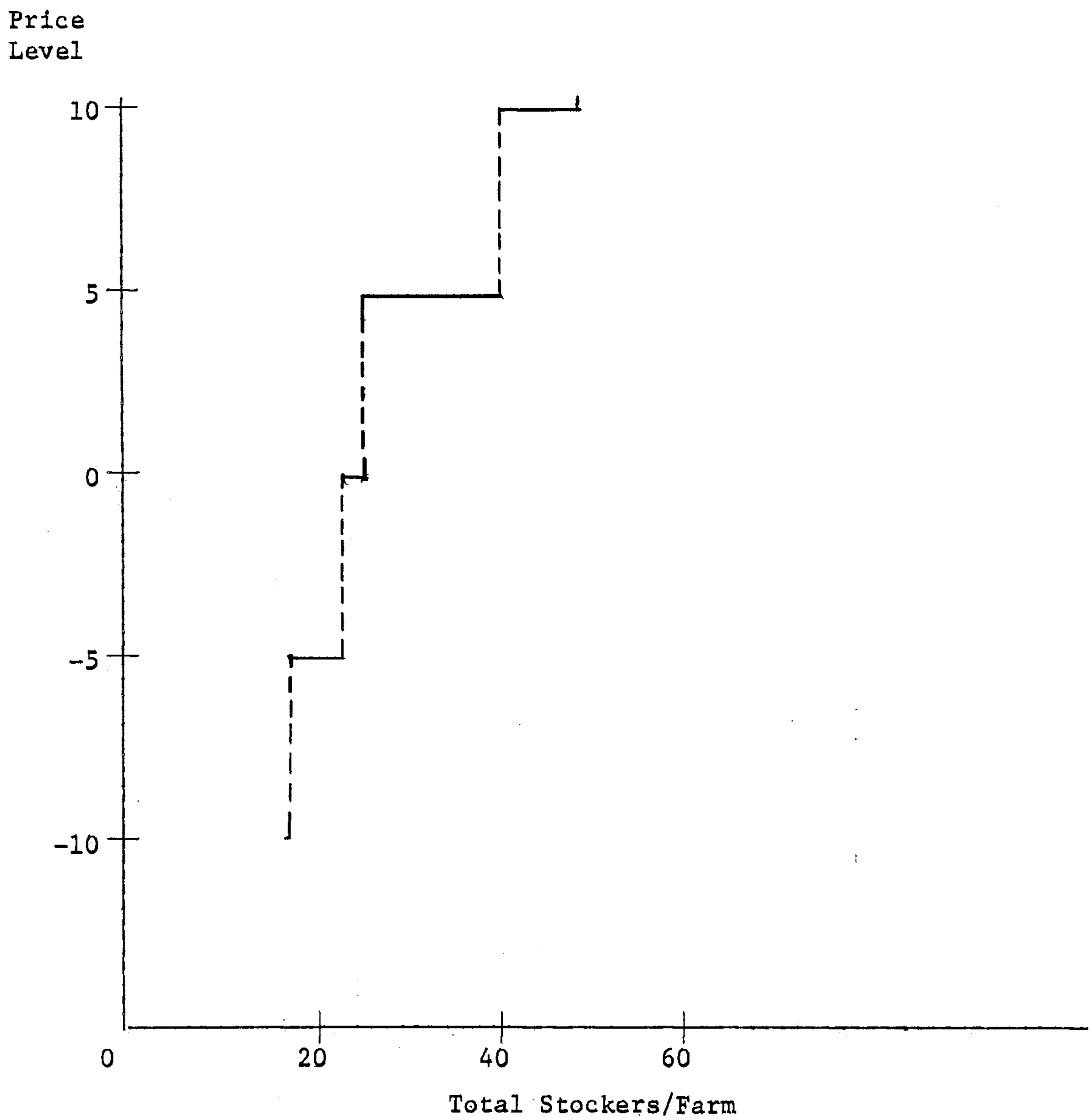
The response of the part-time situation was as expected except for the negative sign between the base price and the $5 increase. The reason for this type of change appears to be in the stocker-calf relationship. At the base price level the stocker activity became competitive with cows to a greater degree. This can be seen by the length of the horizontal segment at the 0 price level in Figure 13. It was in this price range that feeding concentrate became feasible, allowing stockers to replace some cows.

The part-time farm was more stable under changing prices than the large at the lower levels. Table XXX gives the average response for both



[a]Base price level with steer calves at $32.50 per cwt.

Figure 12. Change in Cow Numbers with Assumed Price Level Changes on 280 Acre Farm



[a]Base price level with steer calves at $32.50 per cwt.

Figure 13. Change in Stocker Calf Numbers with Assumed Prive Level Changes on 280 Acre Farm

situations for the price levels discussed. Comparison of the responses indicates there is good reason to consider the part-time farmer when estimating beef production from a particular region.

TABLE XXX

AVERAGE RESPONSE OF PART-TIME AND FULL-TIME FARMING SITUATIONS IN COW NUMBERS TO CHANGING PRICE LEVELS

Price Level and Changes	Full-Time	Part-Time
-$10 to -$5	1.96	1.52
-$ 5 to 0	1.046	0.709
0 to $5	0.09	-0.09
$ 5 to $10	0.651	0.701

An example of the importance of the part-time farm in an overall response can be developed from Table II, p. 5 and the method of aggregating discussed in Chapter II. Table V, p. 36 gave estimated aggregates of the number of brood cows by herd size in Eastern Oklahoma. Making the assumption that any group with less than 100 cows would be represented by the part-time situation and those with larger herd sizes represented by the full-time operation, the percent of total cows can be used as weights. The proportion of total cows represented by part-time farms would be 60.9 percent. Thus, aggregate response given an an increase in the lowest price level would be:

$$0.399\ (1.96) + 0.609\ (1.52) = 1.71$$

In 1968 the total number of beef cows in Eastern Oklahoma was 537,012 (Table V). Using the above aggregate response, total cows would increase to 918,290 with a one percent increase in price. Using the full-time response alone to represent aggregate change in the same price range would estimate an increase to 1,052,543 cows. Given different farm proportions Table XXXI gives some examples of aggregate responses for the lowest and highest price levels.

An examination of some specific resource use ratios that influence the general response of farm operators can yield insight into the overall effects of changes in resources. Table XXXII summarizes selected items from the price ranging solutions for each situation.

Both situations had negative returns at the two lower price levels, the full time operator had a greater loss per hour of operator labor and per acre. However, at the three upper levels returns were positive for both, and higher per hour of operator labor for the full-time operation.

Stocking rate in acres per animal unit shows a high grazing intensity at all price levels for each situation. The part-time farm was more intensive at the lower prices, but at the base price level and higher the stocking rates were equal. Related to grazing intensity were the amount of hay and concentrate feeding. At the lowest price the part-time farm fed more hay per animal unit, but less at every other level except the highest price. The only significant feeding of of concentrates was at the highest price level and no difference was noted between operations on a per acre basis.

TABLE XXXI

AGGREGATE RESPONSE OF PART-TIME AND FULL-TIME FARM OPERATIONS AT THE $-10 AND +$10 PRICE LEVELS ASSUMING DIFFERENT PROPORTIONS OF PRODUCTION

Item	Proportion by Full-Time Operations	Proportion by Part-Time Operations	Aggregate Response
	Percent	Percent	
-$10 Level	100	0	1.96
	30	70	1.65
	50	50	1.74
	70	30	1.83
+$10 Level	100	0	0.65
	30	70	0.65
	50	50	0.676
	70	30	0.666

The part-time farm hired less labor per acre, and had lower costs except at the lowest price level. Feeding more hay per animal unit and production of heavily fertilized bermuda explain this. Nonland capital requirements were greater on the part-time farm at both prices under the base level, but were equal for both situations thereafter.

TABLE XXXII

COMPARISON OF LEVEL OF USE OF SELECTED RESOURCES AND NET RETURNS TO OPERATOR LABOR, RISK, AND MANAGEMENT AT FIVE PRICE LEVELS FOR FULL-TIME AND PART-TIME FARMING SITUATIONS

		Price Level From Base Price									
		-$10		-$5		0		$5		$10	
Item	Unit	Full	Part	Full	Part	Full	Part	Full	Part	Full	Part
Net Returns to Operator Labor, Risk, and Mgmt.											
per hr.	dol.	(5.71)	(2.90)	(2.28)	(0.61)	2.54	2.26	7.81	5.34	13.57	8.70
per ac.	dol.	(11.17)	(9.73)	(4.47)	(2.05)	4.96	7.59	15.26	17.92	26.51	29.18
Stocking Rate, Acres/Animal Unit		3.9	3.58	2.87	2.67	2.36	2.35	2.32	2.33	2.1	2.1
Labor Hired Per Acre	hrs.	0.7	0.21	1.93	0.71	2.8	1.23	2.98	1.50	3.61	2.13
Hay Fed Per Animal Unit	cwt.	13.32	16.48	15.49	13.18	17.07	14.2	18.81	18.75	18.32	18.32
Concentrate Fed Per Animal Unit	cwt.	0.0	0.0	0.0	0.0	0.0	0.0	0.075	0.04	2.51	2.51
Nonland Capital Per Acre	dol.	88.45	101.54	124.59	133.00	148.04	150.70	150.70	150.18	163.17	163.17
Cost Per Acre	dol.	36.67	39.15	50.83	50.26	67.44	56.79	69.96	67.88	83.74	81.06

The ratios in Table XXXII illustrate the differences in resource use for maximum profit organizations. Note also that at higher prices many of the technical relationships become equal between the two organizations. An important point in the use of inputs; however, is their availability. Hired labor is an example of a resource that may not be available in amounts needed. Hired labor more than tripled on the full-time operation from the low to the base price and increased over five times for the part-time farm. Capital requirements increased as well. Competition for both of these inputs might deplete the supply, raise the price of the factor, or both.

Summary

This chapter examined the maximum profit solutions for two representative farm situations in Eastern Oklahoma. The two situations were for a 1280 acre and a 280 acre operation considered representative of a full-time and a part-time farm respectively.

The more profitable livestock alternative in either case was a fall calving activity carrying the calves until June and a weight of 580 pounds for steers and heifers to 554 pounds before selling. This activity was also used in combination with a cow activity having a spring calving date. Both operator situations yielded a positive net return to operator labor, risk, and management.

Eliminating the most profitable cow activity, COW 4, more severely affected the large operation. It virtually eliminated returns to the operator's labor after paying all other costs. If the full-time operator did not have to pay all interest, for example on land, income would still be positive. The small farm still achieved a return to the operator of $.64 per hour without the most profitable enterprise available.

With all activities included, nonland capital requirements were approximately equal per acre for the part-time and full-time, although the part-time operation would need less operating capital per acre. Cost per acre was also lower on the small farm. With COW 4 eliminated, nonland capital requirements increased on the part-time farm and were greater per acre than for the large farm. Borrowed operating capital per acre was nearly the same, but cost per acre was more than $1.50 per acre less on the small farm under the restricted situation. The forages were similar between the two although the small farm did appear to change relative intensities and kinds of forages to a greater degree.

With all alternatives available but increased interest on nonland capital, the organizations remained very similar with respect to forages produced and livestock; however, the large farm suffered a net loss while the small achieved a positive return. Some minor differences in forages produced were noted. The part-time operation continued to produce heavily fertilized bermuda and fescue and did not produce weeping love. The part-time farm needed 10 percent more nonland capital per acre than the large, but cost per acre was almost $20 less under the increased interest condition.

Results of the solutions for this chapter indicated that large amounts of hired labor were necessary to achieve optimal farm organizations, especially for the large farm. At the base price with 7 percent nonland interest charges and 6 percent land capital charges, the large farm required over 3500 hours of hired labor were needed. As the enterprises available were limited, this total declined only about 200 hours, and would be more than provided by a full-time hired hand working as many hours as the operator. However, except for the base solution at 7 percent interest there did not appear to be a situation that would warrant full-time help since labor requirements varied by production periods. In the base solution hired labor ranged from 0.86 to 2.22 hours per hour of operator labor.

The part-time or small farm situation needed 343.37 hours of hired labor for the base resource situation, just over one hour per acre. The elimination of COW 4 as an alternative increased this to more than one and one-half hours per acre. In either case, only part-time labor would be hired.

Prices over five price levels for each situation were used to compare response in beef cow numbers, effects on income, and resource use to price change. The full-time farm was more responsive to price increases at the lower levels, but the opposite occurred at the higher price levels. The primary differences in resource use between part-time and full-time operators were noted at lower prices. Stocking rates and capital requirements per acre were equal at the high price. Only hired labor required per acre was significantly different over all prices for the two farm operations.

CHAPTER VI

SUMMARY AND CONCLUSIONS

The primary objective of this study was to give an economic comparison between a full-time beef farm operation and a part-time operation in Eastern Oklahoma. More specific objectives were to estimate the representative resource situations and resource use combinations for each type of operation. Following the objectives of the Regional Project, S-67, the resources for the full-time farm would be the minimum sufficient to achieve an income of $8,215 for the operator, a $7,000 disposable income and $1,215 overhead. Resources allocation was estimated using minimum resource models. The size of the small farm was estimated using survey data. The technical input/output coefficients were based on technology that was available in 1969. Returns to operator labor, risk, and management were maximized using the representative resource situations.

Beef cattle and related feeding and forage activities were the only alternatives considered in this model. Grain and protein supplement for feeding could be purchased but not produced.

The model balances livestock rations by the most efficient use of forages, hay, and concentrate. Feed requirements are in terms of total digestible nutrients, digestible protein, and dry matter. The production year was represented by six, two month periods in which resources and production were allocated.

The land resource was based on proportions of soil productivity levels found in the study area. Each acre was proportioned to represent all land in the area. Some broad restraints were placed on land use within the model. It was necessary to limit production of annual crops such as wheat pasture. These tended to be dominating when allowed to be used freely. Annual forages were limited to no more than 19 percent of the total land. Bermuda, commonly grown in the study area, was assumed already established on the land. The model required at least 41 percent of the total land used for bermuda. Native range was forced to a minimum of 23.5 percent of total land. Such limitations were necessary to keep the model within what could be expected to be in common practice by 1975.

The representative large farm was determined through use of minimization solutions and varying equity levels in land. A minimum land model to achieve an income of $8,215 was used. Equity levels were represented by changing the interest charged on land capital. A full interest rate of 6 percent represented zero equity. A charge of 3 percent represented 50 percent land equity. At the 50 percent equity, 537 acres of land were needed to reach the target income. For no equity in land 2800 acres were needed. The representative full-time farm (1280 acres) was chosen on the basis of a 12 1/2 percent equity solution. The small size or part-time farm had 280 acres.

Profit maximization solutions using the basic inputs and then eliminating the primary enterprise were obtained for both full and part-time farm situations. Limiting enterprises in this manner allowed a comparison of flexibility and a determination of the importance of the most profitable alternative. Evaluation of this nature also allowed an examination of adjustments for preferences of specific activities.

The large farm suffered heavy declines in returns as alternatives were eliminated. Heavy fall calves were the most profitable enterprise. When this enterprise was eliminated returns fell from $6,343.15 to $55.78. The next best alternative was winter calving, but only three fewer cows were used. Hired labor needs although about the same in total regardless of enterprises allowed became more concentrated in periods 1 and 4 with reduced alternatives.

The small farm more readily adapted to changes in alternatives. Heavy fall calves were the most profitable enterprise. Eliminating it as a choice did not reduce net returns to as great a degree as was the case for the full-time operation. The small operation used a combination of calving dates and increased total cows when the primary enterprise was eliminated. Hired labor was increased and used largely in periods 1 and 2.

The small farm was also less adversely affected when interest on nonland capital was raised to 18 percent. The same general activities were used, for both situations, but the small farm reduced total hired labor to less than 100 hours and had surplus operator labor. The large farm hired labor in all periods. The part-time farm maintained an income of $1,030 while the large suffered a $13,401.51 loss with the increased interest charge.

Price ranging was also considered for each situation to determine the effect changing prices would have on the organizations. Prices of steer calves were allowed to range $5 and $10 above and below the base price. Other livestock class prices were varied in proportionate amounts.

Net returns ranged from a loss of $14,298.61 to a positive $33,933.30 on the full-time farm based on a $10 decrease and $10 increase in prices respectively. The stocking rate went from 3.9 acres to 2 acres per cow unit over the price range. A large part of the more intensive use at higher prices was due to increased fall stocker steers.

For the given price changes returns on the part-time farm ranged from a $2,725.72 loss to $8,170.33 positive income. The stocking intensity was the same as for the large farm, just less than 2 acres. Again this was due in large part to increased fall steers.

Conclusions and Implications

For both the land minimization and profit maximazation models as well as for each resource situation, grazing intensity was much greater than that found in the survey data. This implies that there is considerable potential for increasing calf production in the study area. The survey data indicated only 40 beef cows per farm while programming results indicated over 70 in the lowest price situation for the small part-time farm. Programming results indicated a more intense grazing operation was possible than was being practiced.

The small, part-time situation seemed better able to adjust to changing conditions. This result could be due to the operator labor assumed available, but does seem to be plausible since increased part-time farming has occurred. The part-time farm maintained positive net returns to operator labor and management longer under enterprise limitations and increased capital costs than did the full-time operation. Stated in other terms, in increasing cost or other profit reducing situations, the part-time farm was more capable of meeting capital charges and other costs than the full-time operation. Part-time farming would appear to be a more stable situation and could possibly acquire or borrow capital more easily.

However, returns for the profit maximizing solutions were net of interest on nonland and land capital. If farmers have high equities and returns to land capital were not necessary, returns to the full-time operator would be considerably higher. For example, charging 3 percent on land capital instead of 6 would have meant an additional $7,680 to the full-time farmer and $1,680 for the part-time. This was higher per hour of operator labor for the full-time operation.

With low equity the minimum farm size necessary to achieve the $8,215 income was considerably larger than commonly found in the survey. To remain in beef farming as a full time occupation would require a considerable overall expansion and/or a reduction in the income target. A move to expansion of farm size should lead to an upward pressure on land prices, making the part-time alternative more attractive.

Hired labor requirements were relatively heavy for both full-time and part-time situations. Whether or not adequate farm labor to meet both regular and seasonal needs is available is questionable. The degree to which this need is met will directly influence achievements of the intensive stocking rates.

There is potential for increased production from cow-calf herds in eastern Oklahoma. Increasing production from larger sizes or greater numbers of full-time beef operations does not appear to be necessary. The potential to expand production from adoption of technological improvements is great. Part-time operators could achieve as intensive stocking rates as full-time operators, thus increases could be expected at all levels.

Limitations and Recommendations

Limitations

There are several limitations to this study that prevent specific projections of beef cow numbers and land use. No provision was made to study general farming situations that included other livestock or cropping situations in combination with beef. These kinds of farming situations could change the patterns of labor use and allow for a more efficient use of operator labor.

The hired labor supply was assumed unlimited for the representative farms. Competition for labor from other farming situations as well as beef may limit available labor in reality. The kind of labor available, regular or seasonal, and time of need may be as important as the overall supply.

Recommendations

Limited information was available regarding nutrient yields of forages. Further research should be done not only on yields, but livestock utilization of forage as well. The programmed stocking rates compared to actual practices were highly intensive. Further work is needed in using nutrient yields to balance rations within the model. Alternative courses of action should be evaluated and compared to the more common method of using animal unit months as a measure.

Base prices, as well as costs, were lower than are being experienced at the present. If current conditions persist, prices and costs should be revised upward.

Further study should be made of the beef livestock alternatives. Specifically, the most profitable cow-calf alternative for this study was a fall calving system with a late weaning and heavier selling weight than commonly expected. This may be a more viable alternative for all calving dates rather than weaning and then grazing stockers. Studies should be made in this area for both production and marketability of different selling dates and weights.

Some study should be made in the area of farm labor supply. This would incorporate the competition for labor across kinds of farms as well as total supply.

Many of the limitations and recommendations for additional study are capable of being evaluated in the current model. Different forages and/or additional nutrients can be incorporated. Interest rates can be varied to approximate differing cost structures. Labor limitations can be imposed to conform to supply estimates.

If results obtained in the analysis of the representative beef situations approximate resource allocations that are most efficient, the need for further study is evident. Levels of capital use differ significantly from that practiced in the area. Fewer acres per animal unit were needed in study results than survey data indicated was in practice. Additional information is needed in determining factors that inhibit more efficient resource use.

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APPENDIX A

Equipment Usage

One of the concerns in using linear programming for analysis is the assumption of proportionality in the inputs. Economies of size due to increasing outputs are difficult to incorporate. For example, in this study the tractor was assumed to be used 600 hours per year to estimate operation costs. If the tractor is used less, costs may not be underestimated, or if used more the tractor may not have the appropriate capacity.

Table XXXIII gives the equipment usage of selected solutions for the full-time and part-time operations. The only solution resulting in less use than assumed for the tractor for the full-time farm was at the 50 percent equity land minimization. In most instances, use was more than one-third greater than that assumed. The use of a larger tractor size to shorten the time requirement would not present a problem. It may be possible to increase tractor size enough to do the 984.19 required hours in 600 hours; however, the 1062 hours might not be possible and it is still less than twice the hours one tractor of the size assumed, could cover. Only about a third of the assumed hours were used on the part-time operation.

Results indicate that tractor costs may be underestimated, at least for the part-time operation. Operating costs per hour may be higher. For this reason, a study of equipment requirements for different beef farming situations could be appropriate. However, tractor sizes can be adjusted up or down without great effects on cost. For example, if total per hour cost were underestimated by $.30 per hour for the part-time operation total cost would be understated by $63.76 at the 7 percent capital charge with base prices solution. Thus a relatively large error

TABLE XXXIII

HOURS OF TRACTOR USE FOR SELECTED SOLUTIONS OF 1280 ACRE FARM

Solution	Hours of Tractor Use
Land Minimization	
12 1/2 percent equity	970.63
25 percent equity	626.52
50 percent equity	422.28
Profit Maximization	
1280 Acre	
7 percent: Capital Charge	984.19
7 percent: COW 4, Deleted	880.49
COW 4, COW 1 Deleted	882.97
$10 price level incomes	1,062.03
$5	1,014.52
$5 price level decrease	984.19
$10	832.77
18 percent capital charge	677.55
280 Acre	
7 percent: Capital Charge	212.53
7 percent: COW 4 Deleted	204.21
$10 price level increase	232.32
$5	225.88
$5 price level decrease	119.02
$10	163.76
18 percent Capital Charge	157.98

in estimating operating cost for a tractor would have a small effect on total cost.

APPENDIX B

TABLE XXXIV

TND AND DP AVAILABLE AS A PERCENT OF DM FROM FORAGES BY PRODUCTION PERIOD

	Period											
	1		2		3		4		5		6	
	TDN	DP	TDN	DP	TDN	DP	TDN	DP	TDN	DP	TDN	DP
Bermuda Graze					62	13.7	55	7.6	54	7.9		
Bermuda Deferred Graze	45	3.7	40	3.8	62	13.7	55	7.6	54	7.9	48	4.1
Bermuda Fescue			57	9.4	55	6.6	53	6.2	49	5.9		
Fescue	57	9	57	9	53	5	48	4			57	9.4
Native	44	2			68	4.1	65	2.5	65	2.1	54	2.0
W8SB (Weeping Love)	56	3	56	2	63	6.9	56	3.4	56	1.9	56	1.9
RVSB (Rye-Vetch)	76	14	73	16	70	7	75	14.6	75	14.6	76	14
Small Grain	76	14	76	14	76	14.4	76	14.6	76	14.6	79	14
Sorghum-Sudan					55	11	55	11	55	11		
Native Hay	48	4.1	48	4.1	48	4.1	48	4.1	48	4.1	48	4.1
Bermuda Hay	51	6.3	51	6.3	51	6.3	51	6.3	51	6.3	51	6.3

TABLE XXXV

BASE PRICES AND SEASONAL INDEXES FOR FEEDSTUFFS[a]

Item	Base Price	Price Index for Each Month											
		Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
Grains (cwt.)													
Barley	2.63	104.6	104.8	105.4	105.1	101.4	91.8	94.0	95.2	97.0	98.1	100.1	102.1
Corn	3.13	100.5	100.5	99.8	100.7	102.6	102.8	101.7	100.4	96.8	96.0	98.6	99.5
Grain Sorghum	2.53	99.4	101.3	102.0	102.5	101.8	101.8	103.4	102.0	97.4	94.4	96.1	97.4
Oats	3.23	102.2	103.1	104.7	103.7	102.3	95.3	96.1	96.8	97.4	97.8	99.4	101.8
Supplements (cwt.)													
Soybean Meal	5.10	99.5	100.3	99.5	98.0	97.3	106.0	101.6	102.7	102.8	101.6	98.8	97.8
Cottonseed Meal	4.57	102.1	102.1	100.7	94.4	98.4	98.2	100.3	100.4	100.4	99.8	98.7	94.6
Cottonseed Cake	4.67	(Use Cottonseed Meal)											
20% Range Cubes	2.89	(Use Cottonseed Meal)											
40% Range Cubes	4.00	(Use Cottonseed Meal)											

[a]Based on data available in Department of Agricultural Economics, Oklahoma State University, farm year period ending November, 1970.

TABLE XXXVI

TDN AND DP NEEDED AS PERCENT OF DRY MATTER IN RATION FOR LIVESTOCK ALTERNATIVES BY PRODUCTION PERIOD

	1		2		3		4		5		6	
	TDN	DP	TDN	DP	TDN	DP	TDN	DP	TDN	DP	TDN	DP
Activity	Percent		Percent		Percent		Percent		Percent		Percent	
COW 1	54.3	4.5	57	5.4	57	5.3	57	5.1	52	3.4	52	3.4
COW 2	52	3.4	54	4.6	57	5.4	57	5.3	57	5.1	52	3.4
COW 3	57	5.3	57	5.1	54	3.4	52.3	3.4	54.5	4.6	57	5.4
COW 4	57	5.3	57.6	5.2	59.4	5.1	52.3	3.4	54.5	4.6	57	5.5
FLST	65	7.2	74	8							58	5.8
SPST					67	7.2	64	7.1	58	5.2		
FLSNSGR	63	6.6	64	7							63	7.0
SPSNSGR					68	7.1	64	6.8	60	6.5		
STHF1					69	7.3	62.8	6.3	58	6.2		
STHF2	64	6.9	67.6	7.6							62.5	7.0
SPHNSGR					63	7.1	61.4	6.4	58.6	6.4		
FLHNSGR	60.5	6.4	62.3	6.9							62.5	7.0
AUGSTKRS	64.2	7.0							62.3	7.0	63.5	6.9
AUGSTKRH	64.2	7.0							62.5	7.0	63.5	6.9

TABLE XXXVII

AVERAGE DAILY GAIN BY PERIODS FOR STOCKER ACTIVITIES

Activity	Period 1	2	3	4	5	6
FLST	1.50	2.1				1.1
SPST			2.0	1.1	1.3	
FLSNSGR	1.15	1.5				1.2
SPSNSGR			1.52	1.1	1.2	
STHFII			1.8	1.05	1.1	
STHF2	1.45	2.1				1.05
SPHNSGR			1.5	1.1	1.15	
FLHNSGR	1.1	1.42				1.15
AUGSTKRS	1.5		1.1	1.15		1.4
AUGSTKRH	1.45		1.0	1.05		1.3

TABLE XXXVIII

ESTIMATED OVERHEAD INVESTMENT AND EXPENSES FOR A LIVESTOCK FARM IN EASTERN OKLAHOMA

Item	Life	New Investment	Annual Cost
Utility Shed	10	$ 500	$ 50
Shop Tools	5	400	80
Pick-up	3	3000	650[a]
Telephone			70
Insurance			145
Bookkeeping and Tax Service			100
Utilities			120
		$3900	$1,215

[a]Includes $500 depreciation and $150 repairs.

TABLE XXXIX

SOIL RESOURCE MIX FOR THE PART-TIME AND FULL-TIME OPERATIONS

Land Class	Percent of Total	Farm Situation	
		Full-Time	Part-Time
		acres	acres
Openland			
LA	.01370	17.5	3.8
LB	.03740	47.9	10.5
LC	.00820	10.5	2.3
LD	.04800	61.4	13.4
SA	.00050	.6	.1
SB	.00220	2.8	.6
SC	.04290	54.9	12.0
SD	.15140	193.8	42.4
CA	.11910	152.4	33.3
CB	.13620	174.3	38.1
CC	.04570	58.5	12.8
CD	.01270	16.3	3.6
B1	.06310	80.77	17.7
B2	.01090	14.0	3.1
Native			
LA	.00550	7.0	1.5
LB	.01020	13.1	2.9
LC	.00310	4.0	.9
LD	.03800	48.6	10.6
SA	.00020	.3	.1
SB	.00120	1.5	.3
SC	.00550	7.0	1.5
SD	.04580	58.6	12.8
CA	.04690	60.0	13.1
CB	.04690	48.4	10.6
CC	.01670	21.4	4.7
CD	.01060	13.6	3.0
B1	.00430	5.5	1.2
B2	.01000	12.8	2.8
Woodland		92.53	20.3

TABLE XL

ASSUMED PRICES PER CWT. OF BEEF ANIMALS
USED IN THIS STUDY

Livestock Class	Price Level[a]				
	-$10	-$5	Base	$5	$10
Commercial Cows	13.55	16.56	19.57	22.58	25.59
Commercial Bulls	17.39	21.26	25.12	28.99	32.51
Good & Choice Steers: 500# or less	22.50	27.50	32.50	37.50	42.50
Good & Choice Steers: 500-800#	20.26	24.76	29.26	33.76	38.26
Good & Choice Heifers: 500# or less	19.58	23.93	28.28	32.63	36.98
Good & Choice Heifers: 550-750#	18.62	22.48	26.33	30.19	34.04
Cull Heifers	17.45	21.32	25.19	29.07	32.94

[a]These prices were indexed seasonally before using.

TABLE XLI

SEASONAL INDEXES FOR CLASSES OF LIVESTOCK USED IN BUDGET PREPARATION[a]

Item	Price Index for Each Month											
	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
Steers:												
Good: 250-500#	96.50	98.20	100.3	101.80	103.10	103.5	102	101.4	101.8	98.8	96.40	96.00
Good: 500-800#	98.11	99.95	101.28	101.99	101.42	102.34		100.7	99.97	97.7	97.27	97.86
Choice: 350-500#	95.83	98.39	100.37	103.38	102.58	103.6	100.99	101.35	101.7	98.69	97.52	95.45
Choice: 500-800#	98.51	99.55	101.39	102.16	101.76	102.72	101.12	100.73	100	97.03	97.29	97.8
Good-Choice: 580#[b]	97.23	99.02	100.84	102.33	102.22	103.04	101.07 101.3	101.05	100.87	98.06	97.12	96.78
Heifers:												
Good: 250-500#	97.20	99.2	99.90	101.30	101.70	103.4	102.0	101.8	102.0	98.00	97.10	96.2
Good: 500-800#	97.25	99.25	99.95	101.30	101.72	103.37	101.99	101.84	102.01	98.06	97.11	96.16
Choice: 350-500#	96.30	96.30	99.89	101.90	102.24	104.67	102.21	102.17	101.95	98.38	96.69	95.79
Choice: 500-800#	101.16	101.16	100.37	101.00	103.75	102.65	102.65	101.26	97.05	96.01	95.69	97.78
Good-Choice: 554#[b]	97.98	98.98	100.03	101.38	102.35	103.52	102.21	101.77	100.75	97.61	96.65	96.48

[a]Based on last five years of data ending November, 1970 provided by Dr. Paul Hummer, Agricultural Economics Department, Oklahoma State University.

[b]Average of other four weight classes.

APPENDIX C

TABLE XLII

FORAGE COMBINATIONS BY SOIL TYPE FOR FULL-TIME AND PART-TIME FARM OPERATIONS FOR MAXIMUM PROFIT USING BASE PRICES AND 7 PERCENT INTEREST ON NONLAND CAPITAL

	Cropland														Native													
	S_1	S_2	S_3	S_4	L_1	L_2	L_3	L_4	C_1	C_2	C_3	C_4	B_1	B_2	S_1	S_2	S_3	S_4	L_1	L_2	L_3	L_4	C_1	C_2	C_3	C_4	B_1	B_2
	Acres														Acres													
Full-Time Farm																												
Forage:																												
Native															.3	1.5	7.0	13.1	4.0	48.6	60.0	48.6	60.0	48.4	21.4	13.6	5.5	12.8
Bermuda																												
No Fertilizer				54.4				61.4				16.3		14														
100 lbs. N																												
200 lbs. N				134.4			10.5		60.7	109.6	58.5																	
Fescue									53.1	64.7																		
Forage Sorghum													30.7															
Small Grain Pasture					17.5	47.9			38.7				50.1															
Rye-Vetch	.6	2.8	55.0																									
Part-Time Farm																												
Forage:																												
Native															.1	.3	1.5		1.5	2.9	.9	7.1	13.1	10.9	4.7	3.0	1.2	2.8
Bermuda																												
No Fertilizer				13.5				13.4				3.6		3.0														
100 lbs. N																												
200 lbs. N				28.9		2.3			24.8	12.4	12.8																	
Fescue									25.8																			
Forage Sorghum													5.6															
Small Grain Pasture					3.8	10.5			8.5				12.1															
Rye-Vetch	.1	.6	12.0																									

TABLE XLIII

FORAGE COMBINATIONS BY SOIL TYPE FOR FULL-TIME AND PART-TIME FARM OPERATIONS FOR MAXIMUM PROFIT USING BASE PRICES AND 18 PERCENT INTEREST ON NONLAND CAPITAL

	Cropland													
	S_1	S_2	S_3	S_4	L_1	L_2	L_3	L_4	C_1	C_2	C_3	C_4	B_1	B_2
	Acres													
Full-Time Farm														
Forage:														
Native														
Bermuda														
No Fertilizer				193.8			10.5	61.4		174.3	58.5	16.3		14.0
100 lbs. N									113.8					
200 lbs. N														
Forage Sorghum													53.7	
Small Grain Pasture					17.5	47.9			38.7				27.1	
Rye-Vetch	.6	2.8	44.8											
Weeping Love												10.1		
Part-Time Farm														
Forage:														
Native														
Bermuda														
No Fertilizer				42.4			2.3	13.4		38.1	12.8	3.6		3.0
100 lbs. N									2.0					
200 lbs. N									14.2					
Fescue									8.8					
Forage Sorghum													12.9	
Small Grain Pasture					3.8	10.5			8.5				4.8	
Rye-Vetch	.1	.6	12.0											

	Native													
	S_1	S_2	S_3	S_4	L_1	L_2	L_3	L_4	C_1	C_2	C_3	C_4	B_1	B_2
	Native													
Full-Time Farm														
Forage:														
Native	.3				7.0	13.0			60.0				5.5	
Part-Time Farm														
Forage:														
Native	.1	.3	1.5	12.8	1.5	2.9	.9	10.6	13.1	10.5	4.7	3.0	1.2	2.8

TABLE XLIV

FORAGE COMBINATIONS BY SOIL TYPE FOR FULL-TIME AND PART-TIME FARM OPERATIONS FOR MAXIMUM PROFIT WITHOUT COW 4

	Cropland														Native													
	S_1	S_2	S_3	S_4	L_1	L_2	L_3	L_4	C_1	C_2	C_3	C_4	B_1	B_2	S_1	S_2	S_3	S_4	L_1	L_2	L_3	L_4	C_1	C_2	C_3	C_4	B_1	B_2
Full-Time Farm																												
Forage:																												
Native															.3	1.5	7.0	58.6	7.0	13.0	4.0	48.6	60.0	48.4	21.4	13.6	5.5	12.8
Bermuda																												
No Fertilizer				193.8				61.4				16.3		14.0														
100 lbs. N.							10.5																					
200 lbs. N.									113.7	56.6	58.5																	
Fescue										117.8																		
Forage Sorghum					4.3								80.8															
Small Grain Pasture					13.2	47.9																						
Rye-Vetch	.6	2.8	55.0																									
Part-Time Farm																												
Forage:																												
Native															.1	.3	1.5	12.8	1.5	2.9	.9	10.6	13.1	10.9	4.7	3.0	1.2	2.8
Bermuda																												
No Fertilizer				4.3				13.4				3.6		3.0														
100 lbs. N				38.0																								
200 lbs. N							2.3		36.1	12.4	25.6																	
Fescue										25.8																		
Forage Sorghum													13.0															
Small Grain Pasture					3.8	10.5			8.5				4.6															
Rye-Vetch	.1	.6	12.0																									

TABLE XLV

FORAGE COMBINATIONS BY SOIL TYPE FOR FULL-TIME AND PART-TIME FARM OPERATIONS FOR MAXIMUM PROFIT AT THE -$10 PRICE LEVEL

	Cropland														Native													
	S_1	S_2	S_3	S_4	L_1	L_2	L_3	L_4	C_1	C_2	C_3	C_4	B_1	B_2	S_1	S_2	S_3	S_4	L_1	L_2	L_3	L_4	C_1	C_2	C_3	C_4	B_1	B_2
Full-Time Farm																												
Forage:																												
Native															.3	1.5	7.0	58.6	7.0	13.0	4.0	48.6	60.1	48.4	21.4	13.6	5.5	12.8
Bermuda																												
No Fertilizer					193.8		10.5	61.4	13.4	174.3	58.5	16.3		14.0														
100 lbs. N.									100.3																			
200 lbs. N.																												
Forage Sorghum		34.0											17.3															
Small Grain Pasture					17.5	47.9			38.7				29.1															
Weeping Love	.6	2.8	55.0																									
Part-Time Farm																												
Forage:																												
Native															.1	.3	1.5	12.8	1.5	2.9	.9	10.6	13.1	10.6	4.7	3.0	1.2	2.8
Bermuda																												
No Fertilizer				42.4			2.3	13.4		38.1	12.8	3.6		3.0														
100 lbs. N.									9.4																			
200 lbs. N.			4.0																									
Fescue									11.4																			
Forage Sorghum													11.4															
Small Grain Pasture					3.8	10.5			12.5				6.2															
Rye-Vetch	.14	.6																										
Weeping Love												8.0																

TABLE XLVI

FORAGE COMBINATIONS BY SOIL TYPE FOR FULL-TIME AND PART-TIME FARM OPERATIONS FOR MAXIMUM PROFIT AT THE +$10 PRICE LEVEL

	Cropland														Native													
	S_1	S_2	S_3	S_4	L_1	L_2	L_3	L_4	C_1	C_2	C_3	C_4	B_1	B_2	S_1	S_2	S_3	S_4	L_1	L_2	L_3	L_4	C_1	C_2	C_3	C_4	B_1	B_2
Full-Time Farm																												
Forage:																												
Native															.3		7.0	58.6	7.0	13.0	4.0	48.6	60.0	48.4	21.4	13.6	5.5	14.3
Bermuda																												
No Fertilizer								48.3																				
100 lbs. N.																												
200 lbs. N.				193.8			10.5	13.1	113.8	70.5	58.5	16.3																
Fescue										103.8				14.0														
Small Grain Pasture					17.5	47.9			38.7				80.8															
Rye Vetch	.6	2.8	55.0																									
Part-Time Farm																												
Forage:																												
Native															.1	.3	1.5	12.8	1.5	2.9	.9	10.6	13.1	10.6	4.8	3.0	1.2	2.8
Bermuda																												
No Fertilizer								10.6																				
100 lbs. N.																												
200 lbs. N.				42.4			2.3	2.9	24.9	15.4	12.8	3.6																
Fescue										22.7				3.0														
Small Grain Pasture					3.8	10.5			8.5				17.7															
Rye-Vetch	.1	.6	12.0																									

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VITA

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