A COMPREHENSIVE MODEL TO DEVELOP AND ANALYZE ALTERNATIVE BEEF FARM ORGANIZATIONS IN EASTERN OKLAHOMA

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PREFACE

This dissertation is based in part on research developed from regional research project S-67, "Evaluation of the Beef Production Industry in the South". This project is a cooperative effort of Agricultural Experiment Stations in 12 southern states, the Farm Production Economics Division of the Economic Research Service, and the Tennessee Valley Authority.

The overall objectives of the regional project are (1) to determine various resource characteristics and combinations employed in beef production in the South, evaluate selected operator attributes and appraise adjustment trends that have occurred, (2) to evaluate the micro and macro economic effects of selected aspects of alternative beef production systems, and (3) to estimate for selected alternative systems of beef production the relative effects on farm survival and/or growth of constraints such as forage production risks, price risks, institutional restrictions, and changes in value of assets.

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TABLE OF CONTENTS

Chapter		Page

Chapter Page

LIST OF TABLES

Table		Page
XIV.	Farm Tenure and History with Average Acres Operated for Beef Farm Operators Surveyed in Eastern Oklahoma by Study Area, 1969.	39
XV.	Percent of Land Inventory by Land Use in Eastern Oklahoma by Study Area, 1969.	44
XVI.	Percent of Land Base in Each Soil Productivity Level in Eastern Oklahoma by Study Area, 1969	47
XVII.	Percent of Native Pasture Base in Each Soil Productivity Level in Eastern Oklahoma by Study Area, 1969.	49
XVIII.	Percent of the Land Base by Soil Productivity Levels and Land Use in Eastern Oklahoma by Study Area, 1969. . .	50
XIX.	Example of Budget Format Used for all Forages included as Alternative Land Uses in Eastern Oklahoma.	53
XX.	Summary of Forage Budgets Prepared for Area 1 of Eastern Oklahoma.	56
XXI.	Summary of Forage Budgets Prepared for Area 2 of Eastern Oklahoma.	57
XXII.	Summary of Forage Budgets Prepared for Area 3 of Eastern Oklahoma.	58
XXIII.	Summary of Forage Budgets Prepared for Area 4 of Eastern Oklahoma.	59
XXIV.	Yield Adjustment Indexes for Soil Productivity Levels Occurring in Eastern Oklahoma by Study Area	63
XXV.	Forages, Yields, Annual Costs, Capital, and Labor Requirements Included in the Model as Alternative Uses of S_2 Land for Area 2 of Eastern Oklahoma.	67
XXVI.	Grazed Forest Land Nutrient Yields Per Acre for Eastern Oklahoma by Study Area.	69
XXVII.	Calving, Buying, and Selling Dates for Livestock Alternatives in the Model.	72
XXVIII.	Type, Number, and Weight of Animals Included in a Cow-Calf Activity and Type of Feed Requirements for Specified Months Postpartum	74
XXIX.	Nutrient Requirements per Breeding Unit per Day for Specified Months, Postpartum.	75

Table		Page

Table		Page

LIST OF FIGURES

CHAPTER I

INTRODUCTION

Beef production is the principal agricultural activity in eastern Oklahoma. The eastern 21 counties of Oklahoma sold more than $84 million of cows and calves in 1969, over 56 percent of the total value of farm products sold [1]. Crops represented only 17 percent of the total value. Sale of forest products, fruit and vegetable crops, and other types of livestock accounts for the remaining 26 percent. The economic importance of the agricultural sector, and particularly the livestock sector, is reflected in the total agricultural sales of almost $150 million for the area.

From 1959 to 1969, the number of cows and calves in eastern Oklahoma increased almost 31 percent, while the value sold increased more than 68 percent in the same period of time. Beef production is expanding in eastern Oklahoma. General questions about the future of beef production are of interest to farmers and others. What technology is being applied to encourage this growth, and how is this growth affecting resource availability? Has beef production been developed to its fullest economic potential? Do the effects of management problems cause differences in expected farm organizations and those actually achieved?

This study is based on data collected and developed as part of the regional research project, Evaluation of the Beef Industry in the South.

This dissertation is limited to the microeconomic effects of resource use in beef production for representative situations identified from survey data. The development of a model that will allow the analysis of these effects is of primary concern.

Data developed and analyzed in this dissertation will make available to beef farm operators technical and economic information which will provide more knowledge about the profitability of the application of new technology. Livestock budgets developed for this study will reflect the complete resource cost structure. Forage budgets developed will show yields of various nutrients that can be used in balancing livestock grazing "rations". Such information can provide more knowledge for the farm operator about the conditions under which his land could be more profitably developed for use as a production resource. Inefficient resource use causes farm firms in eastern Oklahoma to earn returns less than is possible if all resources were used at their maximum potential.

Full-time beef producers are trying to expand or improve their resource use. Many small producers, who do not have a viable operation, use off-farm employment to supplement their farm income. These operators may use different criteria in the analysis of their farm operation. It may be that they are minimizing the labor subject to a given set of resources used on the farm, rather than maximizing returns. The objectives or goals of the operators may have an effect on their pattern of resource use with changes in prices of inputs.

What is the minimum size of organization that will give returns comparable to other employment opportunities in eastern Oklahoma? The questions of firm size in relation to survival and the influence of off-farm income on resource use and product mix are relevant to livestock farmers in eastern Oklahoma.

Are certain activities better suited to large units, and others to small units? It may be that small farms cannot afford the investment necessary to produce certain types of forages and are therefore limited to native pasture to be able to survive, unless an external source of capital is available.

Which combination of beef alternatives will give the greatest return to owned resources, and best use the resources available on representative farms? The limited resources on a farm should be used as efficiently as possible. Combining forage and beef production alternatives in the proper mix will give a farm organization that is efficiently using available resources and achieving the most return to owned resources.

What types of forage enterprises will most economically meet the nutrient requirements for the alternative livestock activities in eastern Oklahoma? Each beef production system has a unique distribution of nutrient requirements. An analysis of the types of forages and timing of the grazing of production for each beef production system would aid in planning and management of a beef farm organization.

Answers to these questions will serve as guides in further developing beef production and in making inferences regarding aggregate levels of input demand and product availability in eastern Oklahoma.

Statement of the Problem

Underdeveloped organizations and inefficient resource use are major problems of beef production in eastern Oklahoma. Advanced production techniques, which are commercially available, have not had widespread acceptance throughout eastern Oklahoma. An evaluation of alternative organizational strategies of resource use for beef producing units in eastern Oklahoma is needed to give a basis for additional study of beef farm organizations and of macroeconomic implications.

Statement of the Hypothesis

An analytical model that will provide knowledge about the structure, income potential, and resource use on beef farms could have an effect on increasing the efficiency in the use of, and returns to, owned resources on beef producing units in eastern Oklahoma. Such a model can furnish estimates needed to evaluate the growth potential of the beef industry in eastern Oklahoma and be used to show the possible impact on related agricultural businesses.

Objectives

The objectives of this study are to:

1. Develop a system for grouping soils into productivity and land use groups in eastern Oklahoma.
2. Develop activity budgets reflecting price and quantity estimates of all resources used in the production process. Forage production will be specified in nutrients, as will livestock consumption.
3. Develop an analytical model which can be used to evaluate resource requirements, production estimates, and organization composition for different goal-oriented farming strategies.

4. Test the validity of the model in the evaluation of different goal-related objectives according to resource use and organization composition.
5. Demonstrate the use of the model as a continuous source of data for farm resource demand and product supply estimates.

Area of Study

This study has application in approximately the eastern one-third of Oklahoma. The total area is as specified by the Regional Research Project S-67, Evaluation of the Beef Industry in the South [2, p. 4]. Resource and budget data will be developed for the 21 counties shown in Figure 1.

The land resource in the study area is primarily in livestock supportive use and forest land. In 1964, only 14.6 percent of land in farms was in crops that were harvested [1]. Forest land accounts for 48 percent of the total land base of which 41 percent is grazed by livestock [3]. The area is climatically suited for the production of a large variety of forage crop and livestock enterprises. The abundance of rainfall, combined with fertilizer and proper management, can give excellent forage yields. The average annual rainfall ranges from 38 inches in northeastern Oklahoma to 47 inches in southeastern Oklahoma [4].

Source of Resource Data

The primary resource data were developed following guidelines established by the Regional Research Project [2]. A survey of beef farms

Figure I. Counties of Eastern Oklahoma Included in the Study Area.

in eastern Oklahoma was taken to collect primary data to help in the evaluation of present conditions in the study area. These data have been used in establishing estimates of resources available and livestock and cropping systems used. A general summary of the collected data is presented in Chapter II.

Soil resource data were obtained from soil survey maps and soil classification data published by the Soil Conservation Service [5]. As explained in Chapter III, soil productivity level estimates were developed from these data to form a comprehensive land resource base upon which to base this study. The specific areas used in the development of this land resource base coincide with those areas for the survey. The sampling technique is explained in Chapter II.

CHAPTER II

AN OVERVIEW OF BEEF PRODUCTION IN EASTERN OKLAHOMA

Purpose of Survey

Throughout the South, beef production is an important agricultural activity. In Oklahoma, sales of cattle and calves have increased in proportion to total crop sales from 99 percent in 1959 to 208 percent in 1969 [1]. Cattle and calves accounted for 58 percent of the total sales of farm products in Oklahoma in 1969. The number of cattle and calves on Oklahoma farms has increased 48 percent in this same ten year period.

Farms in the eastern 21 counties of Oklahoma have shown 30 percent increase in number of cattle and calves from 1959 to 1969. The sale of cattle and calves in proportion to total farm sales was 56 percent in 1969, an increase of 4 percent from 1959. Cattle and calf sales as a percent of crop sales increased from 164 percent in 1959 to 330 percent in 1969. However, eastern Oklahoma farms sold almost 20 percent of the total value of all cattle and calves sold in Oklahoma in 1959, but not quite 16 percent in 1969.

Census data give an indication of the present relative position of beef production in eastern Oklahoma to the total state. Knowledge of the present structure of beef production in the study area is essential before the future potential of beef production can be evaluated.

Such knowledge will furnish a base for more accurate estimation of future use of resources, potential production, and readjustment alternatives for the study area.

An understanding of attitudes and goals of beef producers is needed to establish guidelines and limitations for use in the regional project. Such guidelines and limitations are essential in developing a model to depict situations as realistically as possible, and in selecting decision alternatives for beef farm operators. As an alternative to maximizing returns to owned resources, beef producers may minimize costs, capital, land, or even labor. Off-farm employment alternatives may cause a reevaluation of the farm organization, using a different set of decision rules than would be used if full-farm employment is considered. This difference in possible objectives may lead to less than maximum returns to owned resources, even though the farm is maintaining a satisfactory level of consumption.

The objective of the regional survey was to determine various resource characteristics and combinations employed in beef production in the South, to evaluate selected operator attributes, and to appraise adjustment trends that have occurred [6]. This chapter reports data for eastern Oklahoma in conjunction with the regional project.

Regional Survey Area

The area of the United States involved in the regional project included 13 southeastern states, of which 11 took schedules to obtain primary data. Alabama, Arkansas, Georgia, Kentucky, Louisiana, Mississippi, Oklahoma, South Carolina, Tennessee, Texas and Virginia collected primary data. The Farm Production Economics Division of the United

States Department of Agriculture and the Tennessee Valley Authority cooperated in the project. All subregions included in the study are shown in Figure 2.

Oklahoma Survey Area

Oklahoma is characterized by two general agricultural areas. The low rainfall, high and rolling plains, suited for crop production and shortgrass pastures, are in the panhandle and western part of the state. The eastern area, with much undulating land, is dominated by tall grasses, scrub trees, and forest intermingled with areas suited for crop production. There is a large transition area through the center of the state marked by a "tree belt".

This study is concerned with the tall grass and forested area, which includes the 21 eastern counties of Oklahoma. The subregions are shown in Figure 3. Two subregions, three Oklahoma counties in one and six Oklahoma counties in the other, were joined with adjoining counties in Arkansas to form Subregions 27 and 28. Subregions 29 and 30 are entirely in Oklahoma. Subregion 27 includes Adair, Cherokee, and Delaware counties. Subregion 28 includes Pittsburg, Latimer, LeFlore, Atoka, Pushmataha, and McCurtain counties. Subregion 29 includes Ottawa, Craig, Nowata, Washington, Rogers, and Mayes counties. Subregion 30 includes Wagoner, Okmulgee, Muskogee, McIntosh, Haskell and Sequoyah counties.

Sampling Technique

The technique used to draw the sample for this study was the Master Frame Sample Technique developed by Rensis Likert [7]. This

CODE	SUBREGION	CODE	SUBREGION
01.	Lower Piedmont (Ga., Ala. & S. C.)	17.	Kentucky 3
02.	Upper Coastal (Ga. & S. C.)	18.	Kentucky 4
03.	Ga. and Ala. Peanut Area	19.	Mississippi Brown Loam
04.	South Carolina Tobacco Area	20.	Mississippi Clay Hills
05.	Lower Coastal (Ga. & S. C.)	21.	Delta (Miss., Ark., La.)
06.	Alabama Limestone	22.	Upper Coastal, South Central (Ark., La., & Texas)
07.	Blackbelt (Ala., Miss.)	23.	Lower Coastal, South Central (Miss. & La.)
08.	Tennessee Brown Loam	24.	Southwest Rice (La.)
09.	Tennessee Highland Rim & Central	25.	Alluvial Mixed (La.)
10.	Tennessee Appalachian	26.	Arkansas Richland Prairies
11.	Virginia Appalachia	27.	Ozark Highland (Ark. & Okla.)
12.	Virginia Shenandoah Valley	28.	Central Ark. & Southeast Okla.
13.	Virginia Upper Piedmont	29.	Northeast Oklahoma
14.	Virginia Tidewater	30.	East Central Oklahoma
15.	Kentucky 1	31.	Central Texas
16.	Kentucky 2	32.	Texas Blackland

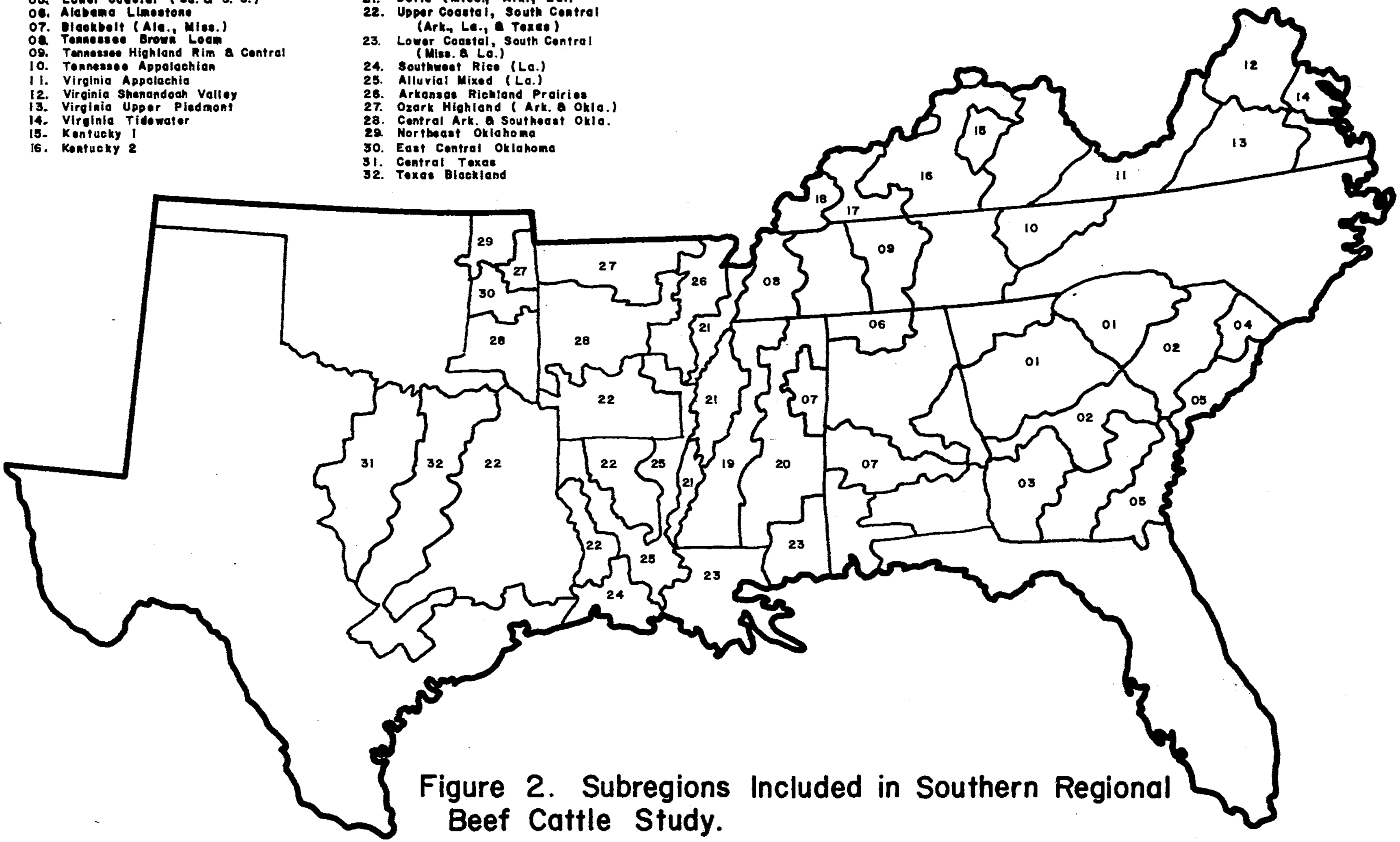

Figure 2. Subregions Included in Southern Regional Beef Cattle Study.

Figure 3. Oklahoma Counties Included in Subregions of the Southern Regional Beef Cattle Study.

technique divides the total area into three primary strata: incorporated areas, densely populated unincorporated areas, and open country. The design is satisfactory for geographical or population sampling. Since this study concerned only the open country area, the procedure discussed below applies only to the open country sampling technique.

The base geographical unit used was individual counties. Maps for every county in the United States have been prepared by the Statistical Reporting Service of the United States Department of Agriculture and were made available for this study. Three area classifications are coded on each map. The largest area, called minor civil division, refers to general trade areas within the county. The numbering of the minor civil divisions within a county always follows the pattern of right to left and top to bottom in a serpentine fashion throughout the county.

Each minor civil division within the county is divided into smaller units called count units. A count unit refers to an area of the minor civil division that can be divided by some natural boundary such as a road, railroad, or stream to provide an area that includes not less than six farms or eight dwellings and not more than 30 farms. The count units are numbered in a serpentine fashion throughout each minor civil division of the county. The numbering is done from right to left and top to bottom.

The number of sampling units for each count unit is specified on the maps. The sampling units reflect the number of census farms that occur within each specified count unit. Though these sampling units are not geographically divided within each count unit, they are the basis for drawing the sample. An estimate of the total number of qualifying farms in the region is divided by the total number of sampling units in the survey area to estimate the expected number of qualifying farms per sampling unit within the survey area. The number of sampling units to be surveyed is obtained by dividing the desired number of schedules by the expected number of qualifying farms per sampling unit.

An estimate of the number of sampling units which an enumerator can complete per day is defined as a segment. The number of segments to be sampled is obtained by dividing the total number of schedules desired for that survey area by the number of expected farms per segment.

The sampling units are used as the counting factor to move through the survey area in a serpentine fashion to determine the location of the segments to be sampled. The interval between segments is established by dividing the total number of sampling units in the survey area by the number of segments to be sampled.

With a random number as a starting point, the segments are selected at the end of each interval while moving through the accumulative sampling unit numbers. If it is necessary to divide a count unit to complete a segment, then those sampling units within that count unit should be selected so that all sampling units for that segment are always contiguous.

The preliminary data necessary for drawing the sample for Subregion 27 are presented in Table I. Projecting total farms to 1969 from 1954, 1959, and 1964 census data for Adair, Cherokee, and Delaware counties resulted in an estimate of 4,140 total farms. To find the number of beef farms expected in Subregion 27 in 1969, it is necessary to calculate the number of qualifying farms and beef farms in 1964.

TABLE I

CENSUS DATA AND SAMPLING INFORMATION FOR OKLAHOMA COUNTIES IN SUBREGION 27

Category	Counties			Subregion Total
	Adair	Cherokee	Delaware	
All Farms				
1954[a]	1,590	1,798	1,974	5,362
1959[a]	1,231	1,422	1,546	4,199
1964[a]	1,295	1,445	1,422	4,162
1969 (Projected)				4,140
1964 Farms				
Sales $\geq$ $1,000[a]	1,841	546	681	3,068
Cows and Calves $\geq$ 10[a]	803	946	914	2,663
Dairy Farms[a]	127	78	164	369
Percent Qualifying Farms (1964)				73.7
Percent Beef Farms (1964)				55.1
Number Qualifying Farms (1969)				3,051
Number Beef Farms (1969)				1,681
Number Sampling Units	323	520	598	1,441
Expected Beef Farms per Sampling Unit				1.170
Number of Segments	2	3	3	8

[a]Source: [1].

It is assumed that there will be little change in the distribution of types of farms or in size of farms so that projections to 1969 are valid. A qualifying farm is defined as a farm having sales greater than $1,000. In 1964, the 3,068 qualifying farms in Subregion 27 represented 73.7 percent of total farms in the subregion. The number of farms with more than 10 head of cows and calves in 1964 was corrected for the number of dairy farms in the subregion. This number of beef farms was then divided by the number of qualifying farms in the subregion. The percent of qualifying farms that were beef farms in Subregion 27 was 55.1 percent. The expected number of qualifying farms in 1969 was 3,051, and the expected number of beef farms was 1,681 in Subregion 27. The number of sampling units for the three counties in Subregion 27 was 1,441. Thus, the expected number of beef farms per sampling unit was 1.17 (1,681/1,441).

The sampling data used for the six counties included in Subregion 28 are presented in Table II. The 1969 estimate of total number of farms for this subregion was 7,880. In 1964, only 43.3 percent of all farms had sales greater than $1,000. There were 3,452 qualifying farms in 1964 of which 70.3 percent were beef farms. In 1969, the expected number of qualifying farms was 3,412 farms and the number of beef farms was 2,399 for Subregion 28. The number of sampling units in the six counties of Subregion 28 was 2,955 which gave .812 beef farms expected per sampling unit.

Tables III and IV present data for Subregions 29 and 30 respectively, and can be interpreted as discussed for Subregions 27 and 28.

Sampling unit, segment, and interval length information for the four subregions in Oklahoma are summarized in Table V. In Subregion 27,

TABLE II

CENSUS DATA AND SAMPLING INFORMATION FOR OKLAHOMA COUNTIES IN SUBREGION 28

Category	Counties						Subregion Total
	LeFlore	McCurtain	Pushmataha	Latimer	Pittsburg	Atoka	
All Farms							
1954[a]	2,541	2,799	1,223	965	2,071	1,489	11,088
1959[a]	1,991	1,947	977	709	1,556	1,053	8,233
1964[a]	1,804	1,973	891	730	1,461	1,108	7,967
1969 (Projected)							7,880
1964 Farms							
Sales $\geq$ \$1,000[a]	771	676	379	263	800	563	3,452
Cows and Calves $\geq$ 10[a]	1,205	1,242	696	496	1,149	853	5,641
Dairy Farms[a]	10	18	2	2	4	3	39
Percent Qualifying Farms (1964)							43.3
Percent Beef Farms (1964)							70.3
Number Qualifying Farms (1969)							3,412
Number Beef Farms (1969)							2,399
Number Sampling Units	698	733	302	244	616	362	2,955
Expected Beef Farms per Sampling Unit							.812
Number of Segments	3	3	1	2	2	2	13

[a]Source: [1].

TABLE III

CENSUS DATA AND SAMPLING INFORMATION FOR OKLAHOMA COUNTIES IN SUBREGION 29

Category	Counties						Subregion Total
	Ottawa	Craig	Mayes	Rogers	Nowata	Washington	
All Farms							
1954[a]	1,301	1,602	1,836	1,929	1,080	757	8,505
1959[a]	1,198	1,336	1,580	1,517	824	689	7,144
1964[a]	990	1,324	1,433	1,568	882	722	6,919
1969 (Projected)							6,825
1964 Farms							
Sales ≥ $1,000[a]	602	910	819	783	536	387	4,037
Cows and Calves ≥ 10[a]	689	1,042	1,083	1,062	632	509	5,072
Dairy Farms[a]	81	89	149	81	80	33	513
Percent Qualifying Farms (1964)							58.3
Percent Beef Farms (1964)							65.2
Number Qualifying Farms (1969)							3,979
Number Beef Farms (1969)							2,594
Number Sampling Units	409	277	536	426	295	289	2,232
Expected Beef Farms per Sampling Unit							1.162
Number of Segments	4	3	5	5	2	3	22

[a]Source: [1].

TABLE IV

CENSUS DATA AND SAMPLING INFORMATION FOR OKLAHOMA COUNTIES IN SUBREGION 30

Category	Counties						Subregion Total
	Sequoyah	Haskell	Muskogee	Wagoner	Okmulgee	McIntosh	
All Farms							
1954[a]	1,774	1,271	2,387	1,478	1,720	1,565	10,195
1959[a]	1,362	896	1,814	1,218	1,180	1,156	7,626
1964[a]	1,465	930	1,590	1,076	1,185	1,039	7,285
1969 (Projected)							7,150
1964 Farms							
Sales ≥ $1,000[a]	511	437	798	600	582	576	3,504
Cows and Calves ≥ 10[a]	941	720	1,082	758	835	813	5,149
Dairy Farms[a]	7	10	71	69	25	13	195
Percent Qualifying Farms (1964)							48.1
Percent Beef Farms (1964)							68.0
Number Qualifying Farms (1969)							3,439
Number Beef Farms (1969)							2,339
Number Sampling Units	463	504	781	537	518	560	3,363
Expected Beef Farms per Sampling Unit							.696
Number of Segments	3	3	4	3	3	3	19

[a]Source: [1].

TABLE V

SAMPLING UNIT, SEGMENT, AND INTERVAL LENGTH DATA FOR OKLAHOMA SUBREGIONS

	Subregion			
	27	28	29	30
Expected Beef Farms per Sampling Unit	1.170	.812	1.162	.696
Desired Number of Beef Farms	15	30	50	50
Number of Sampling Units	15	40	45	75
Number of Sampling Units per Segment	2	3	2	4
Expected Beef Farms per Segment	2,340	2.436	2.324	2.784
Needed Number of Segments	7.5	13.33	22.5	18.75
Actual Number of Segments	8	13	22	19
Interval Length (Sampling Units)	192.13	221.68	99.20	179.36
Starting Random Number	029	183	61	027
Expected Beef Farms	18.720	31.668	51.128	52.896
Number Obtained	14	38	49	41

1.17 beef farms were expected per sampling unit. Fifteen schedules were needed from this study region. Allowing two sampling units per segment gave 2.34 expected beef farms per segment. If 2.34 beef farms are expected per segment and 15 schedules are needed, 7.5 segments should provide the adequate number of schedules. Dividing the number of sampling units in the subregion by the number of segments provides an interval length. From a random number in Subregion 27 of 029, segments to be sampled were drawn. Fourteen beef farm schedules were obtained from Subregion 27.

Thirty beef farm schedules were needed in Subregion 28. The interval length was 221.68, and 31.668 beef farm schedules were expected. Thirty-eight schedules were obtained. Fifty schedules were needed from each of Subregions 29 and 30. In Subregion 29, 51.128 beef farms were expected with only 49 actually sampled. Only 41 beef farms were sampled in Subregion 30, while 52.896 farms had been expected.

Oklahoma Sample Data

All heads of household living or operating land in each segment selected were contacted. Of those heads of household operating land but not living in the segment, only those with headquarters within the segment or within city limits were included in the survey. Information from all households within the segment were recorded on farm classification listing sheets and each operator was classified by the type of farm operated. The classification sheet used is presented in Appendix A. If the gross farm receipts in 1968 were less than $1,000, the operator was classified as a nonfarm respondent. If the total openland operated was 50 or more acres, with gross receipts of $1,000 or more for 1968, and the largest number of beef cows and yearlings on the farm at one time was less than 10 head, the respondent was classified as a nonbeef operator. If there were more than 10 beef cows and yearlings on the farm at one time, more than 50 acres of openland operated, and gross receipts greater than $1,000 for 1968, the respondent was classified as a beef operator and a schedule was taken.

The data from the farm classification listing sheets are summarized in Table VI. Information presented includes the number of respondents in each classification, the total acres within each classification, the total beef animals within each classification, and the average size and number of beef animals for each classification.

Subregion 27 had 100 respondents that were contacted of whom 15 were classified as beef, 11 as nonbeef and 74 as nonfarm. The average of beef farms operated 201.3 acres openland with 38.7 beef animals per farm. The nonbeef farms averaged 123.5 acres of openland with 1.9 beef animals per farm. The nonfarm category averaged 10.5 acres of openland and less than one beef animal per farm.

There were 123 respondents contacted in Subregion 28 of whom 40 were classified as beef, 23 as nonbeef, and 60 as nonfarm. The beef farms in Subregion 28 averaged 398.2 acres openland with 53.4 beef animals per farm. The average of nonbeef farms operated 217 acres openland and had three beef animals per farm. The nonfarm group averaged 17.2 acres openland with 1.4 beef animals per farm in Subregion 28.

One hundred ninety-five respondents were contacted in Subregion 29 of whom 66 were classified as beef, 50 as nonbeef and 79 as nonfarm. The average of the beef farms operated 351.9 acres of openland and had

57.2 beef animals. The average of the nonbeef farms operated 185 acres of openland with 1.9 beef animals. The average of the nonfarms had .9 beef animals and 13.9 acres of openland.

TABLE VI

SUMMARY OF NUMBER OF RESPONDENTS, ACRES OF OPENLAND, AND NUMBER OF BEEF ANIMALS FROM SURVEY CLASSIFICATION SHEETS FOR OKLAHOMA SUBREGIONS, 1969

Classification	Number	Total Acres	Average Size	Total Beef	Average Beef
Subregion 27					
Beef	15	3,020	201.3	581	38.7
Nonbeef	11	1,358	123.5	21	1.9
Nonfarm	74	779	10.5	63	0.9
Subregion 28					
Beef	40	15,928	389.2	2,135	53.4
Nonbeef	23	4,990	217.0	69	3.0
Nonfarm	60	1,031	17.2	83	1.4
Subregion 29					
Beef	66	23,225	351.9	3,774	57.2
Nonbeef	50	9,249	185.0	95	1.9
Nonfarm	79	1,102	13.9	75	0.9
Subregion 30					
Beef	49	36,374	742.3	2,994	61.1
Nonbeef	34	4,621	135.9	72	2.1
Nonfarm	106	1,373	13.0	86	0.8

One hundred eighty-nine respondents were contacted in Subregion 30 representing 49 beef farms, 34 nonbeef farms, and 106 nonfarms. The beef farms averaged 742.3 acres openland and 61.1 beef animals per beef farm. The average nonbeef farm consisted of 135.9 acres openland and 2.9 beef animals per farm. The average of nonfarms operated 13 acres and had 18 beef animals.

There is little difference in the average of the nonfarm categories among the four subregions in the study area. This nonfarm category includes all households in the survey area that do not derive family income from the land, or do not have adequate land resources to earn a farm income of $1,000 or more. The average of the nonfarm category ranges from 10.5 acres in Subregion 27 to 17.2 acres in Subregion 28. Subregion 29 and 30 were very similar with an average of approximately 13 acres per nonfarm respondent.

The average of the beef farm category had more variation across subregions ranging from 201.3 acres in Subregion 27 to 742.3 acres in Subregion 30. Subregion 27, the Ozark Highlands area of Oklahoma, shows the smallest average land for all three categories, beef, nonbeef, and nonfarm, and a smaller average number of beef animals on beef and nonbeef farms for the study area.

The size of beef herds is of major interest in this study. The resources per cow can be used as a common denominator for comparisons since land resources vary in grazing capacity as well as managerial capabilities. Grazing intensity can be varied by management and can influence variation in land resources necessary to sustain a desired level of income. Table VII summarizes the number of beef farms and the average number of beef animals for five (all inclusive) herd sizes for the subregions under study.

No farms were found with more than 500 cows in any subregion. The herd size of beef farms in the Ozark Highlands (Subregion 27) tend to

TABLE VII

NUMBER OF BEEF FARMS AND AVERAGE NUMBER OF BEEF ANIMALS FOR DIFFERENT HERD SIZES FOR SUBREGIONS IN OKLAHOMA, 1969

Herd Size	Subregion 27		Subregion 28		Subregion 29		Subregion 30	
	Farms	Average Animals	Farms	Average Animals	Farms	Average Animals	Farms	Average Animals
Less Than 20 Cows	5	10	9	15	21	12	13	12
20-49 Cows	7	27	21	29	20	32	16	29
50-99 Cows	2	86	5	88	4	62	11	63
100-499 Cows	0	0	3	175	4	168	2	317
Over 500 Cows	0	0	0	0	0	0	0	0

be smaller than all other subregions. The grazing capacity, accessibility, type of vegetation, and off-farm employment opportunities are factors that may cause smaller herd sizes in Subregion 27.

In all subregions at least 50 percent of the beef herds had less than 50 cows. If 50 cows are less than the size adequate to earn returns necessary for maintenance of the farm and for family living expenses, then many labor and management resources are going unused, many beef producers are using off-farm alternatives for some of their labor and management resources, or some operators are using returns to factors other than their labor and management for family consumption.

Oklahoma Survey Data

After the schedules were taken, the subregions in Oklahoma were restructured to match the soil groupings agreed upon by soil scientists at Oklahoma State University and described in Chapter III. Since the programming and additional research on the project are based on soil resources, the study area is delineated according to general soil classifications.

The restructured areas in Oklahoma are illustrated in Figure 4. Area 1 includes those three counties previously included in Subregion 27 for the regional study. Area 2 includes those six counties in Subregion 29, in addition to Wagoner, Muskogee, and Okmulgee counties from Subregion 30. Area 3 includes Sequoyah, Haskell, and McIntosh counties from Subregion 30 and Pittsburgh County of Subregion 28. The remaining five counties of southeastern Oklahoma, previously in Subregion 28, are called Area 4. The summary of the data from the beef farm schedules is presented for the restructured study areas based on

Figure 4. Counties Included in the Study Areas of Eastern Oklahoma Based on Soil Groupings.

soil resources. All analyses from this point use this reorientation based on soil classifications.

Land Resources

The average land resources per beef farm in the four study areas are summarized in Table VIII. The average size of farm for all areas is 400.28 acres. This figure includes 110.73 acres of openland suitable for crops, 210.73 acres of openland suitable for pasture, 77.71 acres of woodland and .31 acres of orchard. Openland suitable for crops includes land currently tilled, or tillable, for the production of cash crops. Land that is in native or introduced permanent pasture and not covered by forest growth is classified as openland suitable for pasture. Woodland and other includes land that has woody plants as primary growth, land for the farmstead and corrals, minepits, and other wasteland. Area 1 has 239.29 total acres average for beef farms, the smallest amount of the four areas. Area 1 also has less acres of openland suitable for crops than any of the other areas and more acres of woodland than in Areas 2 and 3. Since 49 percent of the acres of an average of the beef farms in Area 4 is in woodland and other, the total potential productiveness for beef production per acre is less than for the other three areas.

Area 1 has 75 percent openland, of which most is suitable only for pasture. Only small acreages of tilled crops are possible in Area 1, with only 10 percent of the total operated acres suitable for crops. Areas 2 and 3 reflect only small amounts of woodland and other, with 92.8 and 87.5 percent of openland respectively.

TABLE VIII

AVERAGE LAND RESOURCES PER BEEF FARM SURVEYED IN EASTERN OKLAHOMA BY STUDY AREA, 1969

	Area				Survey
	1	2	3	4	
Number Farms	14	73	29	27	143
			(Average Acres)		
Openland, Crops	23.57	152.16	107.31	47.59	110.73
Openland, Pasture	156.79	216.34	217.38	216.89	210.83
Woodland and Other	58.93	27.99	42.76	259.44	77.71
Orchards	0.00	0.59	0.03	0.00	0.31
Total	239.29	397.08	370.93	523.93	400.28

In addition to looking at the average land resources per farm for the study areas, it is also helpful to look at the land resources per cow on beef farms, as presented in Table IX. Resources per cow give a better basis of comparison between areas because of the different sizes of farms. A clue to the difference in farm sizes may become apparent when comparing the land mix per cow. The average for all four areas is 9.63 acres operated per cow. Area 1 has the least number of total acres per cow (7.96 acres) as well as the least openland per cow (5.99). The largest number of acres per cow occurs in Area 4 with 10.06 acres per cow. However, the acres of openland suitable for pasture are almost constant across Areas 1, 2, and 3. Assuming the same level of management and stocking rate potential, forage production from pasture land has little variation across Areas 1, 2, and 3 if cropland is used for crops harvested for sale. If cropland in Areas 2 and 3 contributes forage for livestock, then cattle from these areas may be of higher quality and give higher returns to owned resources than in the other areas, or forage resources are not being fully utilized. If not, then Table IX overstates the required acres per cow in Areas 2 and 3. The least acres of soil resources per cow occurs in the study area with the smallest average size of farm per cow (Area 1), and the largest amount of acres per cow occurs in Area 4 that has the largest total acres per farm. Area 4 shows the largest amount of woodland and other per cow, 4.98 acres. There is a difference of 2.5 acres in total per cow between Areas 1 and 4, although Area 4 has 3.0 acres more woodland and other per cow.

TABLE IX

LAND RESOURCES PER COW FOR BEEF FARMS SURVEYED IN EASTERN OKLAHOMA BY STUDY AREA, 1969

	Area				Survey Average
	1	2	3	4	
Openland, Crops	0.7838	3.8159	2.5847	0.9139	2.6649
Openland, Pasture	5.2138	5.4253	5.2359	4.1650	5.0737
Woodland and Other	1.9596	0.7018	1.0299	4.9822	1.8702
Orchards	0.0000	0.0148	0.0008	0.0000	0.0074
Total	7.9572	9.9577	8.9344	10.0612	9.6331

The percent of openland in different types of crops is presented in Table X. Small grains such as wheat and oats, alfalfa and other temporary pastures are included as annual crops. All other introduced forage grasses, except bermuda and fescue, are grouped as improved pastures. Forages included in this group are bahiagrass, orchardgrass, dallisgrass, clovers, and lespedezas. Information in Table X can be used to form alternatives for land use to include in the model described in Chapter V. Estimates of land use differences such as for native pasture, improved pasture, temporary pasture, or hay production provide limits that can be used in constructing the representative situation to be analyzed in Chapter VI.

TABLE X

LAND USE ON BEEF FARMS BY PERCENT OF OPENLAND SURVEYED IN EASTERN OKLAHOMA BY STUDY AREA, 1969

	Area				Survey Average
	1	2	3	4	
Number of Farms	14	73	29	27	
Type of Crops as Percent of Openland:					
Annual Crops	1.2	20.2	8.5	4.6	14.3
Bermuda	61.0	43.9	71.5	27.3	47.9
Fescue	0.0	2.5	0.0	1.9	1.8
Native	33.5	25.4	15.7	53.4	28.2
Other Improved Pastures	0.6	4.4	3.0	10.7	4.8
Hay	3.6	3.8	1.2	2.0	3.0
Acres Openland	180.36	368.50	324.69	264.48	321.56

The Oklahoma sample averaged 321.56 acres of openland for beef farms, of which, 14.3 percent is in annual crops and 47.9 percent in bermuda. There is 28.2 percent in native pasture with the remainder made up of lesser amounts in fescue, hay, and other improved pastures. Areas 1 and 3 show a significant amount of openland in bermuda with 61.0 percent and 71.5 percent, respectively. Area 4 has only 27.3 percent openland in bermuda pasture. Area 4 shows 53.4 percent openland in native pasture with Area 1 showing 33.5 percent, Area 2 with 25.4 percent, and Area 3 only 15.7 percent in native pasture. The importance of bermuda and native pastures is apparent.

All areas, except Area 2, show only small percentages of openland in annual crop production. In addition, the large acreages of different types of pasture and forage crops give an indication that the land is basically used for forage production for livestock consumption in those areas.

Livestock Characteristics

The livestock operations in the study areas can be partly described by summarizing the average number of animals per farm. On the 143 farms in the study area there is an average of 56.17 animals per farm (Table XI). Seventy-four percent of all animals or 41.55 animals per farm are beef cows. An average of 6.59 replacements and 5.27 animals are fed or grazed. Animals fed or grazed are animals not used for breeding purposes and either graze forages, are fed concentrates and graze forages or are confined and fed all nutrients. Farms averaged 2.45 bulls and only .3 dairy cows. Replacement heifers equal 16 percent of beef cow numbers.

TABLE XI

AVERAGE ANIMALS PER BEEF FARM SURVEYED IN EASTERN OKLAHOMA BY STUDY AREA, 1969

	Area				Survey Average
	1	2	3	4	
Number Farms	14	73	29	27	
Beef Cows	30.07	39.88	41.52	52.07	41.55
Replacements	6.50	6.53	5.14	7.30	6.59
Fed or Grazed	3.00	7.92	0.93	3.96	5.27
Bulls	1.79	2.36	1.90	3.67	2.45
Dairy Cows	2.64	0.01	0.10	0.07	0.30
Total Animals	44.00	56.70	50.59	67.07	56.17
Percent Beef Cows	68.344	70.331	82.072	77.637	73.97

Table XI also indicates that Area 4 had the largest average herd size, with 52.07 beef cows and 67.07 animals per farm. Beef cows are predominant in all areas compared to fed or grazed animals, such as stocker animals. There is an average of 17 cows per bull for all study areas.

The amount of hay and/or protein fed and the number of days fed are summarized and presented in Table XII. The average hay fed per cow for all areas is 158.18 pounds over a 148 day period. An average of 179.61 pounds of protein is fed over a 130 day period. Farmers in Area 2 feed hay over a longer period of time than the other three areas, averaging 156 days per year. Area 4 averages feeding 200 pounds of protein per cow for a 147 day period. Area 4, which has the largest amount of woodland and less cropland suitable for hay crops and cash crops, feeds protein for the longest period of time and feeds the largest amount per cow. Beef farmers in Areas 1, 2, and 3, which have more openland per farm feed hay about 150 days during the winter feeding period, while beef farmers in Area 4 feed hay less than 130 days per year.

TABLE XII

WINTER FEEDING PROGRAM PER COW FOR BEEF FARMS SURVEYED IN EASTERN OKLAHOMA BY STUDY AREA, 1969

	Area				Survey
	1	2	3	4	
Number Farms Feeding:					
Hay and Protein	14	53	22	27	116
Hay	14	55	24	27	120
Protein	14	60	27	27	128
Hay Feeding:					
Days Fed	153.21	156.27	152.50	127.78	148.75
Pounds Fed	187.86	178.73	97.92	154.44	158.17
Protein Feeding:					
Days Fed	98.57	124.75	141.67	147.22	130.20
Pounds Fed	107.14	182.67	190.00	200.00	179.61

Farm Assets

The capital structure of beef farms in the study area will also be analyzed in the model developed for this study with the objective of answering such questions as: Can farms expand their operations with their present capital structure? What are the capital requirements necessary for maintenance of beef farms? What is the equity position of the average of beef farms in the study areas? The survey gives some estimates that will serve as a reference in the development of the model described in Chapter V. The results of the survey related to farm assets are presented in Table XIII. Information from 103 respondents providing farm asset data for the survey is included in Table XIII.

The average size of the 103 farms from which responses were received regarding farm assets is 399.12 acres. The average total investment in land and buildings, livestock, machinery, and equipment is $71,551.13. The average value of land and buildings for the four areas is $54,905.82. Livestock account for $11,442.45, while machinery and equipment account for $5,202.91 of the average total investment. Livestock investment is one-fifth the investment in land and buildings.

Area 4 shows the largest average value per farm for land and buildings with $65,494.12 and $12,455.88 for livestock. Since there is little difference in the average farm size of beef farms in Area 4 compared to Area 2, and since Area 4 is smaller in farm size than Area 3, then either land values are higher or farms have greater investment in buildings in Area 4. With the larger proportion of forest land, (Table VIII), lumber may be contributing to the additional land value for Area 4 in Table XIII.

TABLE XIII

REPORTED FARM ASSETS FOR BEEF FARMS SURVEYED
IN EASTERN OKLAHOMA BY STUDY AREA, 1969

	Area				Survey Average
	1	2	3	4	
Number Farms	13	53	20	17	
Acres Per Farm	253.85	416.64	431.90	417.00	399.12
Average Value Per Farm					
Land and Buildings	$38,884.61	$58,166.04	$47,850.00	$65,294.12	$54,905.82
All Livestock	9,426.92	11,197.58	12,540.00	12,455.88	11,442.45
Machinery and Equipment	2,707.69	6,032.07	4,840.00	4,952.94	5,202.91
Total	51,019.23	75,395.69	65,230.00	82,702.94	71,551.13
Average Value Per Acre					
Land and Buildings	153.18	139.61	110.79	156.58	137.57
All Livestock	37.14	26.88	29.03	29.87	28.67
Machinery and Equipment	10.66	14.48	11.21	11.88	13.04
Total	200.98	180.96	151.03	198.33	179.27

The largest average farm size for beef farmers reporting was 431.9 acres in Area 3, with $65,230 of total assets. Area 4 averaged $82,782 total assets and 417 acres per farm. Area 2, which has the largest amount of openland suitable for crops (Table VIII), has the largest investment in machinery and equipment. Area 1, with very little tillable land, has the smallest average farm size and has the smallest investment in machinery and equipment ($2,707.69).

Beef farms in Area 1 have the highest total value per acre ($200.98) and the highest value for livestock per acre ($37.14). Area 1 appears to be heavier stocked per acre than other areas even though a large portion of each acre is forest land, assuming the survey values are reliable. The average value of machinery and equipment of $10.66 for Area 1 is the lowest of all areas. Area 1 also has the smallest amount of openland suitable for crops. The average value of machinery and equipment per acre is largest in Area 2 ($14.48), the area with the largest proportion of openland suitable for crops per acre. The average total value of farm assets in Area 2 is $180.96, which is $20.02 less than for Area 1 and about one dollar more than the survey average.

Beef farms in Area 3 have the lowest average value of land and buildings ($110.79) of all areas as well as the lowest average total value of farm assets per acre. Beef operators reporting their farm assets in Area 3 have the largest average number of acres per farm of all areas.

Area 4 has the largest average value of land and buildings and average total value of farm assets. Land and buildings represent about three-fourths of the total value of assets per acre for all areas.

Farm Tenure and History

The survey also obtained information regarding the farming history of the survey respondents. Such information can give some insight into the experience of operators, the growth patterns of beef farms, and the stability of livestock farming. A summary of this information is presented in Table XIV. Control of land is relatively stable in all areas with approximately 70 percent of beef farmers with ten years of tenure. More than 85 percent have been operating at least five years. Acres operated have decreased over ten years; however, this decrease might be explained by the entrance of new operators into beef farming that may be using off-farm employment for some of their resources rather than fully employing them on the farm. Apparently very little expansion of acres operated is occurring in the study areas, and the amount of land operated is stable.

The survey shows that the average of all beef farmers in the four study areas owns 292.96 acres and rents 107.32 acres. Over 25 percent of operated land is rented. Most land in Area 1 is operated by the owner, with rented land being 4.5 percent of that operated. Area 2 has both an inflow and an outflow of rented land. An average of operators in Area 2 rents out 2.89 acres while renting in 125.82 acres. Land owned accounts for 68.3 percent of land operated. Area 3 beef farm operators average renting a larger percentage of land operated than operators in other areas, with 34.2 percent rented. Operators in Area 4 own 82 percent of land operated.

The information in Table XIV concerning rented land could be contributing to the large variations in value of land and buildings across areas as shown in Table XIII. Areas 2 and 3 show the highest proportion of rented land per farm and show the smallest average value of land and buildings per acre.

TABLE XIV

FARM TENURE AND HISTORY WITH AVERAGE ACRES OPERATED FOR BEEF FARM OPERATORS SURVEYED IN EASTERN OKLAHOMA BY STUDY AREA, 1969

Area	Year	1969 Farms Existing In:		Average Acres		
		Number	Percent	Owned	Rented	Operated
1	1969	14		228.57	10.72	239.29
	1964	13	92.86			201.54
	1959	10	71.43			254.90
2	1969	73		274.15	125.82	397.08
	1964	63	86.30			350.00
	1959	52	71.23			413.23
3	1969	29		243.97	126.96	370.93
	1964	25	86.21			349.32
	1959	20	68.97			366.90
4	1969	27		429.85	94.07	523.93
	1964	26	96.30			510.04
	1959	24	88.89			577.17
Average	1969	143[a]		292.96	107.32	400.28
	1964	127[a]	88.81			367.43
	1959	106[a]	74.13			426.67

[a]Survey total.

Survey Data Not Summarized

The survey information presented in this chapter is only a part of the data collected in the survey. Information about price and yield expectations and reasons for being in livestock farming were obtained from most respondents. Information regarding management and marketing practices collected in the survey was useful in developing enterprise budgets applicable to the areas. Information about the family members and the amount of labor each contributed to the farm operation was also collected. Attitudes toward equity positions and capital borrowing were also obtained.

Summary

Data from the survey that are presented in this chapter give an insight into beef farm characteristics in the four study areas. Livestock (particularly beef) is the major agriculture enterprise. More nonbeef farms than beef farms were encountered during the survey. A large number of people living in rural areas derive much of their income from some source other than agriculture. The majority of beef farms surveyed had less than 50 cows.

The primary source of forage for beef is from pasture, though small contributions are made from annual crops (small grain grazing and sorghum-sudan forage) and from forest land.

Farms in Areas 1 and 4 include large amounts of forest land with smaller amounts on farms in Areas 2 and 3. Representative land situations developed for this study need to reflect the forest land category of land use, as well as forest land that is grazed by livestock. The other land use categories defined by the survey should also be used in the development of the representative situations. Included are openland suitable for crops, tilled cropland, and native pasture. Areas 2 and 3 have large amounts of openland suitable for crops planted to improved pasture forages rather than annual crops.

Bermuda and native pasture are the primary forage crops grown in the areas. Smaller amounts of fescue, temporary pastures, and less known improved forages are also grown.

Assuming that beef farms surveyed in the study areas are relatively stable, cow herds are replaced at about a 12 percent rate per year. Most beef farms use some hay and protein supplement as winter feed for their cow herds. The value of animals is only about 16 percent of the total assets involved in the maintenance of a beef farm.

This descriptive information furnishes a base to begin development of coefficients for the forage and livestock budgets (Chapter IV) used on the representative resource situation developed in Chapter III. To develop a normative study, it is necessary to have a beginning point, and the survey data perform this function.

CHAPTER III

DEVELOPMENT OF THE LAND RESOURCE BASE

Land resources need to be identified for the development of a representative farm situation for each study area. Soils with similar productivity and land use characteristics can be combined to form soil groups that will respond similarly to given management practices. Some types of land use, such as openland suitable for pasture and forest land, are restricted as to the choices management has in improving the quality and quantity of forage produced. This chapter develops the procedure and data needed for constructing soil productivity groupings and land use estimates that form the land resource mix.

Area Soils - An Overview

Eastern Oklahoma has diverse soil types ranging from the flood plains and bottomlands on benches next to streams and rivers to slopes greater than 30 percent. The depth of the soils varies from very deep on the bottomland to very shallow, with occasional exposure of parent material in the mountainous areas. The land in the study areas has been placed into three general classifications by Gray and Calloway [8].

The Cherokee Prairie soils developed over sedimentary shales, sandstones, and clays. Stratification of these materials occurs with layers varying in texture. Tall grasses are the natural vegetation of the Cherokee Prairies.

The Ozark Highlands are generally formed on a base of cherty limestones and dolomites. Limestones, sandstones, and shales occur in different localities throughout the area. The area contains numerous streams and rivers, and generally supports an oak-hickory type forest.

The third category is the Washita Highlands which have formed from shales and sandstones. This very mountainous area, with narrow valleys throughout, has very little tillable or open pasture land. Oak-pine forest covers the Washita Highlands area.

Smaller areas of bottomlands and Forested Coastal Plains also occur within the study areas in eastern Oklahoma. Some loblolly pine occurs on the Forested Coastal Plains in southeastern Oklahoma and a cross timber area is mixed with bottomlands in the Arkansas River bottom area.

Due to the wide variation of soils and type of cover growing on the land, eastern Oklahoma is divided into four areas for this study as illustrated in Figure 4. Area 1 includes the Ozark Highlands area which is mountainous with many streams and rivers that generally have very little associated bottomland. Area 2 includes the Cherokee Prairies that are well-suited for tillable crops. Area 3 is delineated as the Arkansas River bottom area and includes some cross timbers and tall grasses. Land along the river bottoms is suitable for growing cultivated crops. Area 4 includes the Washita Highlands area plus a small area of the Forested Coastal Plains. This area is mountainous with narrow valleys that generally run from east to west with very little land suitable for tillage, except on the Forested Coastal Plain that is both tillable and very productive. The Forested Coastal Plain occurs along the Red River in the southern part of McCurtain County.

Land Use Estimates

The four general land use categories used in developing land use estimates are cropland, native pasture, grazed forest land, and non-grazed forest land. It is necessary to know how much forest land, both grazed and nongrazed, exists in the representative situations. Estimates of the amount of the land resources by type of land use are summarized from data in the Oklahoma Conservation Needs Inventory [3].

Cropland is defined as land in tillage, land formerly in tillage, and land primarily producing an introduced species of forage plant [3, p. 133]. Pasture is land with primary natural plant cover of native grasses and shrubs for forage production [3, p. 134]. Grazed forest land is commercial and noncommercial forest land grazed by livestock [3, p. 134]. Commerical and noncommercial forest land not grazed is included as nongrazed forest land [3, p. 134]. The percent of inventory by total land use for the study areas in eastern Oklahoma is presented in Table XV.

TABLE XV

PERCENT OF LAND INVENTORY BY LAND USE IN EASTERN OKLAHOMA BY STUDY AREA, 1969

Land Use	Percent of Land Area			
	Area 1	Area 2	Area 3	Area 4
Cropland	28.70	50.19	33.31	22.50
Pasture	7.60	33.36	21.01	6.60
Grazed Forest Land	47.10	12.50	44.30	47.20
Nongrazed Forest Land	16.60	4.15	1.38	23.70

The survey also provided an estimate of the current land use on beef farms. For example, using Table VIII as a basis, Area 2 has 38.32 percent openland suitable for crops, 54.48 percent openland suitable for pasture, 7.05 percent woodland. These estimates pertain to existing beef farms and are more representative of soil resources beef farmers are now using. They indicate that beef farmers have less cropland, more pasture, and less woodland than an average acre in the area. One can surmise that crop farms have the greater proportion of cropland and that substantial acres of woodland are in the non-farm category.

The Oklahoma Conservation Needs Inventory data were used rather than beef farm survey data to develop a representative acre because of uncertainty about land definitions used in the survey. The definitions are clear for the Oklahoma Conservation Needs Inventory as indicated above. However, in the survey data, bermuda pasture could have been included in cropland or pasture land. Similarly, some of the "openland" pasture may have included parcels of forest land mixed with the pasture. That is, the survey results may have been tabulated by tracts of land rather than by the precise definition of land use. This definition is critical in evaluation of forage production because of the difference between yields of grazed woodland and pasture. Woodland within pasture land must be classified as grazed and nongrazed. The survey does not distinguish between grazed and nongrazed woodland as is done in the Oklahoma Conservation Needs Inventory. The estimates of grazed and non-grazed woodland provide data that allows more exact specification of yields for different types of land use.

Soil Productivity Groups

Many different soil types and classifications occur in the four areas of eastern Oklahoma under study. The number of soil types, and the fact that many soil types are similar in characteristics and management requirements, encourage the combination of similar soils into groups so that the task of budget preparation is not insurmountable. It was decided that soils would be combined into 14 different soil productivity levels for the four areas of study. The areas are delineated in Figure 4. Soil survey maps from each of the counties included in the study areas were used to obtain a list of the soil series and characteristics of each soil type to use in determining the corresponding soil productivity level [5].

Five general soil groups are used to represent the different soil series in the study areas. Soils with rapidly permeable characteristics are included in the sandy category. Moderately permeable to permeable soils are included in the loam category. Clay soils are slowly to very slowly permeable. The two bottomland groups are those soils with moderately permeable to permeable characteristics and those with slowly to very slowly permeable characteristics. Each category (sandy, loam, and clay) is subdivided into four soil productivity levels. Each soil type was evaluated with respect to expected yields, slope, capability class, and erosion to determine the appropriate soil productivity level. Each soil type, its slope, and capability class, with respect to each soil productivity level, are presented in Appendix B.

The land area segments surveyed for the regional research project were measured by using a polarimeter and grouped according to soil productivity level. The soil productivity level totals are summarized according to the percent that each represented of the total land in each study area. The information is summarized in Table XVI. Table XVI indicates that a large percentage of the land in all the areas of study is rolling and/or wooded because of the large percentages occurring in the third and fourth soil productivity levels.

TABLE XVI

PERCENT OF LAND BASE IN EACH SOIL PRODUCTIVITY LEVEL IN EASTERN OKLAHOMA BY STUDY AREA, 1969

Soil Productivity Level	Percent of Land Base			
	Area 1	Area 2	Area 3	Area 4
S_1		0.06		
S_2	11.85	0.36	2.17	0.78
S_3	8.19	5.20	3.68	0.16
S_4	46.34	21.24	3.35	1.85
L_1	4.64	2.06	3.68	2.29
L_2	10.49	5.12	11.46	2.38
L_3	8.10	1.21	6.77	1.65
L_4	6.22	9.24	5.09	2.83
C_1		17.88	8.08	17.41
C_2	0.40	18.74	2.30	6.99
C_3		6.71	2.70	3.38
C_4		2.50	38.87	35.89
B_1	3.78	7.25	6.55	7.73
B_2		2.24	5.20	16.66
Total	100.00	100.00	100.00	100.00

Since management techniques will be different on land that is suitable for crops and that suitable only for pasture, it was necessary to obtain estimates of the amount of each soil productivity level that should remain in native pasture. Estimates of the acres in openland pasture were derived for each soil productivity level from data in the Oklahoma Conservation Needs Inventory [3]. The data from the Oklahoma Conservation Needs Inventory show acres of land use by soil capability class for each county. The amount of each soil productivity level representing each soil type and the soil capability class of that type was used to convert the soil capability class county estimates to soil productivity level estimates for each county. Counties were then summarized for the areas. Since the analytical model will be based on a representative acre, data about the amount of each productivity level allocated to pasture were converted to percentages. Estimates of the percent of the total pasture base occurring in each soil productivity level is presented in Table XVII.

Land Resource Mix

Representative land resource mixes were developed for each of the study areas using the soil productivity level estimates and total land use estimates. A representative acre can then be expressed in terms of proportional land use shares by soil productivity levels.

Soil productivity level percentages (Table XVI) were multiplied by the percent of cropland in each area (Table XV) to derive an adjusted cropland base for each area which is presented in Table XVIII as cropland estimates. An adjusted native pasture base was also derived for each area by multiplying the soil productivity estimates in Table

XVII by the percent of pasture in each area (Table XV). Table XVIII contains the derived estimates of the proportion of cropland and native pasture per acre by soil productivity level and shows the percent of an acre represented by cropland and native pasture.

TABLE XVII

PERCENT OF NATIVE PASTURE BASE IN EACH SOIL PRODUCTIVITY LEVEL IN EASTERN OKLAHOMA BY STUDY AREA, 1969

Soil Productivity Level	Percent of Native Pasture			
	Area 1	Area 2	Area 3	Area 4
S_1		0.07		
S_2	2.00	0.50	1.65	2.29
S_3	10.00	2.35	1.60	0.46
S_4	27.00	19.40	1.50	2.85
L_1	11.00	2.33	5.68	0.34
L_2	21.00	4.32	8.04	4.47
L_3	10.00	1.30	6.66	0.93
L_4	12.00	16.11	8.64	2.91
C_1		19.87	8.92	6.68
C_2	1.00	16.03	2.76	8.88
C_3		7.09	4.15	4.08
C_4		4.50	47.22	59.28
B_1	6.00	1.81	1.19	2.68
B_2		4.24	1.98	4.06
Total	100.00	100.00	100.00	100.00
Percent of All Land	7.60	33.36	21.01	6.60

TABLE XVIII

PERCENT OF THE LAND BASE BY SOIL PRODUCTIVITY LEVELS AND LAND USE IN EASTERN OKLAHOMA BY STUDY AREA, 1969

Soil Productivity Level	Area 1		Area 2		Area 3		Area 4	
	Cropland	Pasture	Cropland	Pasture	Cropland	Pasture	Cropland	Pasture
S_1			0.03	0.02				
S_2	4.15	0.15	0.13	0.17	0.83	0.35	0.08	0.15
S_3	2.21	0.76	3.56	0.78	1.66	0.34	0.02	0.03
S_4	14.77	2.05	11.30	6.44	1.50	0.32	0.35	0.19
L_1	0.84	0.84	0.95	0.77	0.81	1.19	0.65	0.02
L_2	2.21	1.60	2.85	1.43	4.54	1.69	0.39	0.30
L_3	2.18	0.76	0.58	0.43	2.28	1.40	0.42	0.06
L_4	1.35	0.91	2.37	5.35	0.96	1.81	0.63	0.19
C_1			8.33	6.60	2.53	1.87	4.63	0.44
C_2	0.07	0.08	10.33	5.32	0.67	0.58	1.44	0.59
C_3			3.25	2.35	0.58	0.87	0.71	0.27
C_4			0.60	1.49	11.23	9.92	6.53	3.91
B_1	0.91	0.46	5.45	0.60	3.31	0.25	2.07	0.18
B_2			0.46	1.41	2.41	0.42	4.58	0.27
Total	28.69	7.61	50.19	33.16	33.31	21.01	22.50	6.60

(Percent of Land Area by Land Use)

	Area 1	Area 2	Area 3	Area 4
Cropland	28.69	50.19	33.31	22.50
Pasture	7.61	33.16	21.01	6.60
Forest Land:				
Grazed	47.10	12.50	44.30	47.20
Nongrazed	16.60	4.15	1.38	23.70
Total	100.00	100.00	100.00	100.00

Table XVIII also contains the distribution of land use within a representative acre. Grazed and nongrazed forest land are shown only as the percentages presented in Table XV. It is assumed that grazed and nongrazed forest land is proportionately distributed over the soil productivity levels by undefined proportions. It may be that forest land is on the lower quality land, but lack of data with respect to soil productivity levels led to the use of aggregate estimates for forest land.

Summary

Eastern Oklahoma has a wide range of soil types and topography. Four study areas were delineated according to similar soil and topography characteristics (Figure 4).

The estimates presented in Table XVIII represent one acre of land in each of the study areas. For example, 50.19 percent of a "typical" acre in Area 2 can be considered as tillable land or planted to improved pastures while 33.16 percent of each acre is in native forage. The percent of each acre that is in each soil productivity level by cropland and pasture is also given by Table XVIII. The pasture estimates represent a minimum while cropland estimates represent a maximum. The remaining 16.65 percent of each acre is forest land, 12.50 percent of which is grazed.

Estimates in Table XVIII will represent an acre of land resource in the programming model presented in Chapter V. Chapter IV will present costs and levels of production for alternative activities for the land resources described in this chapter.

CHAPTER IV

BUDGET DEVELOPMENT

Livestock and crop activity budgets were developed to present, in a logical format, the yield and cost data for the production of a particular product. Crop and livestock budgets were developed with similar formats. This chapter presents the procedures used in deriving budget data, the alternative forage and livestock budgets prepared for this study, and a summary of production and costs for those budgets.

The production and specified costs sections present price and quantity information for the technical relationships used in the production process. Specified costs include all items used in the production process for which a cash outlay is necessary. The budget for bermuda fertilized with 100-40-0 fertilizer is shown in Table XIX. This budget shows all annual costs except the annual share of prorated establishment costs that varies by soil productivity level. Such annual costs are applicable to all soils even though yields vary. Yields were determined by periods and recorded separately for each soil.

The distribution of labor and capital use is presented by periods since either or both factors may be limited in any or all periods. This procedure facilitates conversion of annual costs to annual operating capital so that capital charges can be made for only the actual capital used and for the period of time used. Land and management charges are not included in the budgets. Land charges are made within the model

TABLE XIX

EXAMPLE OF BUDGET FORMAT USED FOR ALL FORAGES INCLUDED AS ALTERNATIVE LAND USES IN EASTERN OKLAHOMA

BERMUDA ANNUAL COSTS 100-40-40 FERTILIZER GRAZE
JOBES
5-111075

CATEGORY	UNITS	PRICE	QUANTITY	VALUE
PRODUCTION:				
TOTAL RECEIPTS				0.0
OPERATING INPUTS:				
NITROGEN	LBS.	0.075	100.000	7.50
PHOSPHATE	LBS.	0.080	40.000	3.20
POTASH	LBS.	0.050	40.000	2.00
FERT. SPREADER	ACRE	0.750	2.000	1.50
TRACTOR FUEL COST	ACRE			0.30
TRACT REPAIR COST	ACRE			0.30
TRACTOR LUBE COST	ACRE			0.04
EQUIP REPAIR COST	ACRE			0.11
TOTAL OPERATING COST				14.95
RETURNS TO LAND,LABOR,CAPITAL,MACHINERY, OVERHEAD,RISK,AND MANAGEMENT				-14.95
CAPITAL COST:				
ANNUAL OPERATING CAPITAL		0.070	10.267	0.72
TRACTOR INVESTMENT		0.070	4.381	0.31
EQUIPMENT INVESTMENT		0.070	2.104	0.15
TOTAL CAPITAL COST				1.17
RETURNS TO LAND, LABOR, MACHINERY, OVERHEAD, RISK AND MANAGEMENT				-16.12
OWNERSHIP COST: (DEPRECIATION, TAXES, INSURANCE)				
TRACTOR	DOL.			0.52
EQUIPMENT	DOL.			0.33
TOTAL OWNERSHIP COST				0.86
RETURNS TO LAND, LABOR, OVERHEAD, RISK AND MANAGEMENT				-16.98
LABOR COST:				
MACHINERY LABOR	HR.	1.750	0.653	1.14
TOTAL LABOR COST				1.14
RETURNS TO LAND, OVERHEAD, RISK AND MANAGEMENT				-18.12

BUDGET FOR ALL SOILS

BUDGET IDENTIFICATION NUMBER --- 83 5070 201 2
ANNUAL CAPITAL MONTH:12

for each representative acre that is in the organization.

This procedure was followed in developing production and costs for all activity budgets for this study. Labor and capital requirements by periods were thoroughly evaluated for accuracy.

Forage and Hay Budgets

This study is concerned with the profitability and organization of livestock farms. All cropland that can be tilled is assumed to be planted to forages for grazing or hay. No cash crops are allowed in the organization. Such an organization is not unrealistic when compared with the survey results taken for the S-67 Regional Project that is a basis for this dissertation [9]. Table X shows 20.2 percent of openland in annual crops for Area 2. Individual analysis of schedules taken reflects the influence of farms with large acreages used for cash crops. When the influence of these farms is eliminated, Area 2 compares with the other areas in the amount of annual crops which range from 1.2 to 8.5 percent of openland. This correction by the amount of cash crops per farm renders annual crops relatively insignificant in all areas.

Included Forages

The development of forage alternatives for livestock consumption included forages currently grown and other potentially excellent forage producers. Information in Table X indicates that bermuda and native pasture are the predominate forages in the study areas. Very small percentages of fescue and other improved pastures are also grown. Annual crops included forage sorghums and small grain pasture.

Agronomists and animal scientists were consulted about the feasibility of each crop, the yields possible, and the seasonal distribution of yields [10]. It was decided to develop budgets for four different levels of fertilizer on bermuda. Other forages selected were bermuda-fescue, fescue, sorghum-sudan, and small grains for grazing. Tables XX through XXIII summarize the forage budgets prepared for each area. The number of soils in these tables refer to the soil productivity levels developed in Chapter III. Only grazing alternatives are considered on the lowest soil productivity level of each category (L_4, C_4, and S_4). The remaining three soil productivity levels (1, 2, and 3) of each soil group (L, C, and S) and the bottomlands (B_1 and B_2) are suitable for annual crops. Bermuda, fescue, and bermuda-fescue alternatives are considered for all soil productivity levels. The land base currently in pasture is restricted to the native forage alternatives.

Grazing Systems

Four alternative grazing systems are considered for many of the forages as shown in Tables XX through XXIII. The first, seasonal grazing, uses the forage production during the season in which it is produced. The second system, a combination of hay production and deferred grazing, calls for harvesting much of the current season's growth as hay and grazing the remainder of the forage during other than the summer season. The third system, considered only for sorghum-sudan, is harvesting all the forage as hay to be fed as needed. The fourth system (deferred grazing) distributes the use of the forage produced throughout the year.

TABLE XX

SUMMARY OF FORAGE BUDGETS PREPARED FOR AREA 1 OF EASTERN OKLAHOMA

Forages	Number Soils	Fertilizer Levels	Grazing Systems	Total Budgets
Bermuda, Establishment	9[a]	1		9
Bermuda, Annual	9	4[b]	Seasonal	36
	7[c]	4	Deferred and Hay	28
	9	4	Deferred	36
Bermuda-Fescue, Establishment	9	1		9
Bermuda-Fescue, Annual	9	1	Seasonal	9
Fescue, Establishment	9	1		9
Fescue, Annual	9	1	Seasonal	9
Sorghum-Sudan, Annual	7	1	Graze out	7
	7	1	Grazing and Hay	7
	7	1	Hay	7
Small Grain, Annual	7	1	Graze out	7
Native, Annual	9		Deferred	9
	7		Deferred and Hay	7

[a]Soils include 3 sandy, 4 loam, 1 clay, and 1 bottomland.

[b]50, 100, 150, and 200 lbs. of N. with 40 lbs. P_2O_5 and 40 lbs. of K_2O.

[c]Hay is not harvested on the lowest quality of sand, clay and loam.

TABLE XXI

SUMMARY OF FORAGE BUDGETS PREPARED FOR AREA 2 OF EASTERN OKLAHOMA

Forages	Number Soils	Fertilizer Levels	Grazing Systems	Total Budgets
Bermuda, Establishment	14[a]	1		14
Bermuda, Annual	14	4[b]	Seasonal	56
	11[c]	4	Deferred and Hay	44
	14	4	Deferred	56
Bermuda-Fescue, Establishment	14	1		14
Bermuda-Fescue, Annual	14	1	Seasonal	14
Fescue, Establishment	14	1		14
Fescue, Annual	14	1	Seasonal	14
Sorghum-Sudan, Annual	11	1	Graze out	11
	11	1	Grazing and Hay	11
	11	1	Hay	11
Small Grain, Annual	11	1	Graze out	11
Native, Annual	14		Deferred	14
	11		Deferred and Hay	11

[a]Soils include 4 sandy, 4 loam, 4 clay, and 2 bottomland.

[b]50, 100, 150, and 200 lbs. of N. with 40 lbs. P_2O_5 and 40 lbs. of K_2O.

[c]Hay is not harvested on the lowest quality of sand, clay, and loam.

TABLE XXII

SUMMARY OF FORAGE BUDGETS PREPARED FOR AREA 3 OF EASTERN OKLAHOMA

Forages	Number Soils	Fertilizer Levels	Grazing Systems	Total Budgets
Bermuda, Establishment	13[a]	1		13
Bermuda, Annual	13	4[b]	Seasonal	52
	10[c]	4	Deferred and Hay	40
	13	4	Deferred	52
Bermuda-Fescue, Establishment	13	1		13
Bermuda-Fescue, Annual	13	1	Seasonal	13
Fescue, Establishment	13	1		13
Fescue, Annual	13	1	Seasonal	13
Sorghum-Sudan, Annual	10	1	Graze out	10
	10	1	Grazing and Hay	10
	10	1	Hay	10
Small Grain, Annual	10	1	Graze out	10
Native, Annual	13		Deferred	13
	10		Deferred and Hay	10

[a]Soils include 3 sandy, 4 loam, 4 clay, and 2 bottomland.

[b]50, 100, 150, and 200 lbs. of N. with 40 lbs. P_2O_5 and 40 lbs. of K_2O.

[c]Hay is not harvested on the lowest quality of sand, clay, and loam.

TABLE XXIII

SUMMARY OF FORAGE BUDGETS PREPARED FOR AREA 4 OF EASTERN OKLAHOMA

Forages	Number Soils	Fertilizer Levels	Grazing Systems	Total Budgets
Bermuda, Establishment	13[a]	1		13
Bermuda, Annual	13	4[b]	Seasonal	52
	10[c]	4	Deferred and Hay	40
	13	4	Deferred	52
Bermuda-Fescue, Establishment	13	1		13
Bermuda-Fescue, Annual	13	1	Seasonal	13
Fescue, Establishment	13	1		13
Fescue, Annual	13	1	Seasonal	13
Sorghum-Sudan, Annual	10	1	Graze out	10
	10	1	Grazing and Hay	10
	10	1	Hay	10
Small Grain, Annual	10	1	Graze out	10
Native, Annual	13		Deferred	13
	10		Deferred and Hay	10

[a]Soils include 3 sandy, 4 loam, 4 clay and 2 bottomland.

[b]50, 100, 150, and 200 lbs. of N. with 40 lbs. P_2O_5 and 40 lbs. of K_2O.

[c]Hay is not harvested on the lowest quality of sand, clay, and loam.

Sorghum-sudan budgets include three types of grazing systems. Budgets for native pasture include deferred grazing and hay, and deferred grazing.

The different grazing systems require the application of special management depending upon the types of forages being grazed, the soil productivity level, and other factors such as size and location of auxiliary equipment (water source, mineral feeders, supplement feeders, etc.).

Powell [11], proposes four principles of range management. He calls the principles the when, what, where, and how many of grazing management. The principles relate more to the management of the livestock than to the forage being grazed, although a knowledge of the forage bing grazed is necessary.

The first principle is to graze forages at the proper season of use. Use of the proper kind and class of grazing animal is Powell's second principle. The grazing behavior of different kinds and classes of cattle will affect management grazing systems to get maximum forage utilization. Principles three and four are related. Powell shows how they relate to the maintenance of the proper distribution of animals and use of the proper stocking rate. He discusses how methods of management can be used to eliminate, or reduce, the heavily concentrated areas of grazing that may occur.

It is necessary to have an inventory of the soils to properly apply these four principles of range management. Much additional information is also needed for proper application of the principles. A distribution of nutrient availability by periods is essential. The influence on grazing systems of factors such as rotation pattern, cross fencing, fertilization, and many more must be accounted for. Allowing different combinations of livestock will also help to maintain the proper kind and class of grazing animals that can be used to achieve the mix that will best use the forage resources available.

The model will determine the forages to include in the organization and select an associated forage use pattern grazing system needed to meet the requirements of the beef systems in the organization. The proper mix of beef activities to achieve specified goals will be determined by the model.

<u>Yields</u>

Pounds of nutrients available for livestock consumption are used as the measure of yield for the forage budgets in this study. The nutrients used are total digestible nutrients (TDN), digestible protein (DP), and dry matter (DM).

Forage production is seasonal, and the amount of nutrients available for livestock consumption depends upon when the forage is grazed. A decision about the periods for using the nutrients had to be made because of this seasonality factor. Innumerable forage use systems are possible. If bermuda is grazed during the growing season, the forage contains a larger percent of total digestible nutrients than if the grazing is deferred to some later period, such as winter and early spring. The pounds of dry matter available for livestock consumption are reduced only slightly, while the pounds of total digestible nutrients and digestible protein are greatly reduced.

The need to contain the size of the model and to simplify the interpretation of the budgets and the data from the model influenced the use of six, two-month periods to represent the production year. Thus the nutrients available for livestock consumption under each grazing system are estimated in the budget by the six periods.

Data needed to estimate the pounds of total digestible nutrients, digestible protein and dry matter available for livestock consumption for the different forages are from the Muskogee Agricultural Research Station [12]. These data are the results of clipping experiments for the included forages. Yields are usually specified in pounds of dry matter. Some method of converting clipping data to usable nutrient data is necessary to accomplish the objectives of this dissertation. Jones [13] developed and presented the procedure and the adjustment factors for converting clipping data to usable nutrient data. First, it is necessary to find the chemical analysis of the forages to allow dry matter yields to be converted to total digestible nutrient and digestible protein estimates. Second, factors have to be developed to adjust the data for livestock wastage and for nutrient loss when grazing is deferred. The yields and distribution of yields developed by Jones are used as a basis for the development of forage budget yields for this study.

Data on yields of dry matter from different soil categories and different soil productivity levels are very limited. The clipping data from the Muskogee Agricultural Experiment Station are for two clay soil productivity levels. The following procedure was used to expand these estimates to additional estimates needed for this study.

Adjustment factors were developed to convert nutrient data for one soil productivity level to any or all of the other 13 soil productivity levels used in this study. These adjustment factors were developed for the four study areas and the 14 soil productivity levels from data presented in the soil surveys for those counties in the study areas [5]. Potential yields of improved pasture under good management were used to develop the soil adjustment indexes that are presented in Table XXIV. These indexes make possible the conversion of yield estimates from any of the areas on any of the soil productivity levels to any needed estimates. Any cell in Table XXIV that equals 100 is considered as a base cell and yield estimates for that cell are base estimates and can be used to obtain all other yields directly.

TABLE XXIV

YIELD ADJUSTMENT INDEXES FOR SOIL PRODUCTIVITY LEVELS OCCURRING IN EASTERN OKLAHOMA BY STUDY AREA

Soil Productivity Level	Area 1	Area 2	Area 3	Area 4
S_1		126		
S_2	104	100	78	86
S_3	74	81	63	65
S_4	56	67	55	45
L_1	148	156	141	154
L_2	134	133	122	129
L_3	110	100	100	125
L_4	74	78	82	74
C_1		148	154	155
C_2	129	125	121	125
C_3		93	89	89
C_4		55	55	55
B_1	173	185	177	188
B_2		103	129	125

For example, if an estimate of the nutrient yield in Area 1 on L_2 soils is available, then that estimate could be converted to an estimate for Area 2, L_3 by taking 82 percent (100 ÷ 134) times that yield estimate. The result gives a base yield estimate; all other estimates can be obtained by multiplying the desired yield index of the soil productivity level and area needed times that base yield estimate. There are no soil adjustment indexes for the soil productivity levels of S_1 in Areas 1, 3, and 4 or C_1, C_3, C_4, and B_2 in Area 1 because these soil productivity levels did not occur in the areas surveyed.

Costs

Costs of purchased and owned resources used in the production of forages must be defined before budget development can proceed. A time horizon assumption is necessary to provide a date on which to base resource and product prices, technological advancement, and institutional conditions in the study areas. Because of the necessity of coordination, the difficulty in prediction, and "...the length of time to complete this study, ...the [Objective II] Subcommittee [S-67] decided to make 1975 the target date of the Objective II analyses" [2, p. 6]. The benchmark date of 1969 was also established for use in estimating some of the parameters necessary for the regional study.

Since 1975 is established as the target date, all prices of resources and products, levels of technology, management, and labor usage are estimated for applicability on this target date. The level of technology to be used in the study is established to be that which is known and is available through some commercial source in 1969, and which can be expected to be adopted by most farmers in 1975 [2, p. 6].

The level of technology and management competence are closely related. The level of management used in the study is assumed to be that level of management defined as advanced in 1969 and expected to be generally found in application on farms in 1975 [2, p. 7].

Capital is defined in three categories. The first category is operating capital, which includes the annual costs of production and machinery operating costs. Nonland capital includes all investment capital such as machinery investment and breeding livestock investment. Land capital is the third type of capital.

All crops in this study are forage crops to be consumed by livestock. Because no allotment crops are grown, it is assumed governmental restrictions are not applicable to the organization of the farms being studied.

After establishing the basic assumptions necessary for determining resources and prices for the forage and hay budgets included in this study, the data were arranged for use in the Oklahoma State University Budget Generator [14]. The level of inputs, time of operation, machinery complement, and the necessary prices were used in the Budget Generator to calculate the operating costs, ownership costs, capital requirements, machinery requirements, and labor requirements per acre for the production of the specified crop. An example of the cost section of a forage budget from the Budget Generator is shown in Table XIX. A distribution of labor and capital used by month was obtained for use in deriving the total labor and capital requirements for a farm organization by two-month periods. The machinery complement specified for the computations of the budget for this study includes a three-plow tractor and associated equipment.

All budgets developed for S_2 soil productivity level are summarized in Table XXV. The amount of TDN by periods and the total annual production of TDN, DP, and DM are shown as well as hay production expected from each budget. Total specified costs, annual operating capital, nonland capital and labor requirements are also summarized in Table XXV. Costs, capital, and labor included in Table XXV do not include requirements for grazing systems which are internally calculated. All hay harvesting is assumed to be done by custom operations, and harvest labor costs are included in the custom charge. Yields for other soil productivity levels can be obtained by using the yield indexes presented in Table XXIV.

Grazed Forest Land Activities

Much forest land is grazed by livestock. Table XV indicates that 47.1 percent of the land base in Area 1 is grazed forest land. In Area 2, 12.5 percent of the land base is grazed forest land. Large parts of Areas 3 and 4, 44.3 percent and 47.2 percent respectively, are grazed forest land. Because the scope of this study does not include improving or changing the type of forage that is produced on much of this land, it was decided that the nutrients produced by grazed forest land would be contributed directly into the nutrient rows of the model as land is added to the resource base of the farm operation. It was assumed that grazed forest land areas in a farm organization would be contiguous to, or included in, the native pasture.

It was assumed that the grazed forest land would provide approximately 25 percent of the nutrients that are provided by an acre of native grass on the L_3 soil productivity level of each study area.

TABLE XXV

FORAGES, YIELDS, ANNUAL COSTS, CAPITAL, AND LABOR REQUIREMENTS INCLUDED IN THE MODEL AS ALTERNATIVE USES OF S_2 LAND FOR AREA 2 OF EASTERN OKLAHOMA

Forage Crop	Grazing System	Lbs. of TDN by Period[a]						Total Annual Lbs.			Hay Harvested (cwt.)	Total Specified Costs	Annual Operating Capital	Nonland Capital	Labor Requirements (Hours)
		1	2	3	4	5	6	TDN	DP	DM					
Bermuda, 50 lb. N	Seasonal			1,427.30	522.80	310.00		2,260.10	393.60	3,818.00		$14.07	$5.91	$20.34	.59
	Deferred and Hay	117.90	105.80			141.70	126.80	492.20	46.60	1,048.00	36.91	28.90	5.91	20.34	.59
	Deferred	286.20	256.90	396.20	348.50	344.10	307.80	1,939.70	236.90	3,816.00		14.07	5.91	20.34	.59
Bermuda, 100 lb. N	Seasonal			1,836.60	672.90	398.20		2,907.70	554.60	4,912.00		18.78	9.04	21.10	.71
	Deferred and Hay	151.60	136.10			182.30	163.10	633.10	65.60	1,348.00	47.48	37.51	9.04	21.10	.71
	Deferred	368.10	330.50	509.60	448.30	442.50	395.90	2,494.90	333.30	4,908.00		18.78	9.04	21.10	.71
Bermuda, 150 lb. N	Seasonal			2,163.10	793.00	469.60		3,425.70	739.20	5,787.00		23.49	10.97	21.85	.83
	Deferred and Hay	179.10	160.80			215.30	192.60	747.80	88.20	1,592.00	55.93	45.34	10.97	21.85	.83
	Deferred	433.80	389.50	600.60	528.30	521.50	466.60	2,940.30	445.20	5,784.00		23.49	10.97	21.84	.83
Bermuda, 200 lb. N	Seasonal			2,748.10	1,062.00	596.70		4,406.80	1,022.50	7,352.00		28.20	12.51	22.60	.95
	Deferred and Hay	227.20	204.00			273.20	244.40	948.80	121.50	2,020.00	71.06	55.77	12.51	22.60	.95
	Deferred	551.20	494.90	763.20	671.30	662.70	592.90	3,736.20	615.40	7,350.00		28.20	12.51	22.60	.95
Bermuda-Fescue	Seasonal		366.60	1,509.60	550.90	509.40		2,936.50	367.50	5,466.70		29.75	11.41	26.58	.87
Fescue	Seasonal	277.10	366.60	340.90	123.50		712.70	1,820.80	266.40	3,279.90		21.24	4.88	26.83	.61
Sorghum-Sudan	Graze Out			934.70	2,804.20			3,738.90	626.90	5,648.00		12.60	1.90	17.87	1.55
	Graze and Hay					2,804.20		2,804.20	470.20	4,236.00	20.17	21.19	1.87	17.05	1.55
	Hay										80.69	43.81	1.87	17.05	1.55
Small Grain	Graze Out	278.20	1,613.30	85.40		129.20	709.10	3,524.41	536.30	3,724.00		14.26	4.80	12.93	1.14
Native Pasture	Deferred	139.70	139.70	687.10	108.90	54.50	171.50	1,301.40	305.30	2,223.30		1.24	.23	4.98	.47
	Deferred and Hay	39.60	39.60				48.60	127.80	6.10	270.00	24.00	11.37	.27	4.32	.45

[a]Periods are numbered from January-February (Period 1) to November-December (Period 6).

Estimates of nutrients provided by an acre of forest land are presented in Table XXVI.

The yields developed for this study on grazed forest land represent a carrying capacity of 13 to 17 acres per animal unit depending upon the area considered. These yields compare favorably with estimates presented by Powell [11]. Powell states that 7.1 million acres of grazed noncommercial and commercial forest land could have an average stocking rate of 12 acres per animal unit per year. He bases this stocking rate on the assumption that forest land is handled under good management techniques. Application of intensive management to forest land could produce higher yields than those used in this study.

Livestock Budgets

Types of livestock systems and the budgets necessary to describe these systems in eastern Oklahoma will have little variation throughout the study areas. The cow-calf and stocker activity budgets prepared are applicable to all four study areas, and separate budgets for each area are not required.

Livestock Systems

Data from the schedules taken for the Regional Research Project, S-67 were summarized and evaluated to arrive at possible cow-calf systems to include in the study [9]. From this evaluation, a tendency toward four types of cow-calf systems in eastern Oklahoma is evident. These systems are based primarily on calving time. One system is fall calving, the second is early spring calving, and the third is a late spring calving system. The fourth system shows little or no breeding

TABLE XXVI

GRAZED FOREST LAND NUTRIENT YIELDS PER ACRE FOR EASTERN OKLAHOMA BY STUDY AREA

Area	Nutrient	Pounds of Nutrients						
		Period 1	Period 2	Period 3	Period 4	Period 5	Period 6	Total
1	TDN	34.60	34.60	170.13	26.95	13.50	42.48	332.26
	DP	1.73	1.73	62.18	2.70	2.70	8.83	79.87
	DM	95.90	95.90	251.63	20.98	20.98	78.63	564.02
2	TDN	31.35	31.35	154.10	24.43	12.23	38.45	281.91
	DP	1.28	1.28	56.30	4.93	2.45	8.00	74.24
	DM	71.23	71.23	227.93	38.00	19.00	71.23	498.62
3	TDN	31.53	31.53	154.90	24.55	12.30	38.68	293.49
	DP	1.28	1.28	56.60	4.95	2.45	8.03	74.59
	DM	71.60	71.60	229.15	38.20	19.10	71.60	572.85
4	TDN	39.33	39.33	193.33	30.73	15.35	48.25	366.22
	DP	1.60	1.60	70.65	6.20	3.05	10.03	93.13
	DM	89.35	89.35	285.98	47.68	23.85	89.35	625.56

management which gives a year-round calving season. This year-round system was not considered as relevant. After consulting with animal scientists about possible calving systems and the results from the survey, the following dates and systems were decided upon [10]. A calving date of October 1 and a selling date of April 24 are chosen for the fall cow-calf system. The early spring system is defined as calving February 1 and selling August 25. April 1 is the calving date for the late spring system with the calves sold October 23. Of course, calving is distributed around the day given.

Two basic stocker programs were developed for use in this study: a fall acquisition system and a spring acquisition system. Two types of budgets are included for the fall acquisition system with both beginning November 1. The first is a medium rate of gain (1.65 pounds per day), selling 750 pound animals on April 24. This budget represents one that typically could include small grain pasture during the winter and spring as a source of nutrients. A budget representing 1.1 pounds of gain per day is also included as an alternative fall system. This budget, selling 760 pound animals August 1, potentially includes native pasture with supplemental feeding during the winter period. The spring budget acquires stockers on April 20 and sells 750 pound steers August 12 averaging 1.65 pounds of gain per day.

Budgets for stocker heifers are also included using 1.65 pounds of gain per day, the same as the faster rate of gain for the stocker steers. For the fall stocker heifer budget, the heifers begin the feeding period November 1 and are sold April 24. The spring budget starts on April 20 and sells October 12. For purposes of this study, only heifers raised in the farm organization are considered for the stocker program.

The purchase dates for the stocker budgets are established so that the cow-calf budgets can supply the animals required as inputs for the stocker budgets. They either link with the cow-calf budgets as described in Table XXVII, or allow for steers to be purchased on the market. The early spring cow-calf budget does not link with any stocker budgets because calves are sold in August, and the period most desirable to begin the fall stocker operation is November. Therefore, the production from the early spring cow-calf budget is sold as weaning calves only.

Other Assumptions

Certain assumptions are necessary to determine the quantities and values of the resources necessary for the livestock activities. The cow-calf budgets are based on a 25 cow herd unit, with cows replaced every eight years.

It is assumed that 88 percent of the cows would wean calves of which four heifer calves are saved for replacements and the remainder sold. One replacement heifer is culled when 18 months old. Death loss is set at two percent of the herd investment.

The calves are sold or transferred to stocker activities at weaning (205 days of age). The steer calves weigh 460 pounds and the heifers weigh 440 pounds at the 205 day age. The culled cows weigh 980 pounds and culled heifers weigh 900 pounds when sold.

The average value of the herd bull for the unit is $465, assuming a $600 initial value with a salvage value of $22 per hundred pounds for

TABLE XXVII

CALVING, BUYING, AND SELLING DATES FOR LIVESTOCK ALTERNATIVES IN THE MODEL[a]

Cow Budget	Calving Date	Sell at Weaning	Stocker Budgets		
			STST1[b] (1.65# gain)	STST2[c] (1.65# gain)	STST3 (1.10# gain)
COW1[d]	February 1	August 25			
COW2	April 1	October 23		X	X
COW3	October 1	April 24	X		
Beginning Date			April 20	November 1	November 1
Selling			October 12	April 24	August 1

[a]Alternative to selling at weaning are represented by an X. For example, calves from COW2 can be used in STST2 or STST3.

[b]A comparable stocker heifer budget (STHF1) was prepared.

[c]A comparable stocker heifer budget (STHF2) was prepared.

[d]Calves produced are sold at weaning.

a 1500 pound bull. The brood cows in the cow herd are valued at $200 per head with the replacement heifers valued at $135 per head.

Feed Requirements

Nutrient requirements are specified in pounds of total digestible nutrients, digestible protein, and dry matter for each breeding unit or stocker animal. These requirements are derived from data published by the National Research Council [15]. Dry matter is used as a maximum constraint to reflect a limit in animal stomach capacity. The total digestible nutrients and digestible protein are minimum requirements which must be met to adequately maintain the animals in a satisfactory condition. The cows produce weaned calves in 205 days at the specified weights using the specified nutrient requirements in the defined periods. Nutrients are included for the replacement heifers to grow and mature; requirements for bulls are likewise included.

The nutrient requirements for the cow-calf budgets are developed for the total breeding herd which includes 25 cows and all supportive animals. Table XXVIII presents the number of each type of animal, the weight of those animals, and the category of requirements necessary for each of those animals for the months specified. The months are numbered with the first representing the month of calving. The pounds of total digestible nutrients, digestible protein, and dry matter required per breeding unit for each day specified by the month postpartum is presented in Table XXIX.

The requirements for growing steers, with 1.65 pounds of average gain per day, are used for the STST1 and STST2 budgets. The requirements for the STST3 budget, with 1.1 pounds of average gain per day,

TABLE XXVIII

TYPE, NUMBER, AND WEIGHT OF ANIMALS INCLUDED IN A COW-CALF ACTIVITY AND TYPE OF FEED REQUIREMENTS FOR SPECIFIED MONTHS POSTPARTUM[a]

Animal	Number	Months[b]	Weight (lbs.)	Requirement Cagegory[c]
Cow	25	1-4	992	Cows nursing calves, first 3-4 month postpartum
		5-7	992	(Dry cow + nursing cow)
		8-12	992	Dry pregnant mature cows
Bull	1	1-12	1,764	Bulls, growth and maintenance
Heifers	4	8-12	441	Growing heifers, 1.65 lbs. gain
		1-7	661	Growing heifers, 1.10 lbs. gain
Calves[d]	22	5-7	330	(1/2 growing steers, 1.65 lbs. gain + 1/2 growing heifers, 1.65 lbs. gain)

[a]The periods and weight in relation to types of requirements were developed with the assistance of Dr. Jack McCroskey, Animal Science Department, Oklahoma State University.

[b]Month 1 is defined as the month in which the calf is born.

[c]Source: Nutrient Requirements of Beef Cattle, Fourth Revised Edition, 1970, National Academy of Sciences.

[d]Calves receive one-half from the cow and one-half from other sources during this period.

are developed from data for growing steers with that rate of gain per day. The two budgets for stocker heifers (STHF1 and STHF2) specify an average of 1.65 pounds per day and use the feed requirements specified for growing heifers at that rate of gain per day. It is assumed that the requirements per period are specified so that the desired average rate of gain per day could be maintained over the growing period, thus achieving the desired final weight. Table XXX shows the nutrient requirements for stocker animals according to rate of gain for specified weights.

TABLE XXIX

NUTRIENT REQUIREMENTS PER BREEDING UNIT PER DAY FOR SPECIFIED MONTHS, POSTPARTUM

Months Postpartum	Pounds Per Breeding Unit Per Day		
	Total Digestible Nutrients	Digestible Protein	Dry Matter
1-4	14.47	1.39	25.54
5-7	14.56	1.31	25.53
8-11	9.28	.60	17.73
12	9.63	.65	18.72

TABLE XXX

NUTRIENT REQUIREMENTS PER STOCKER ANIMAL PER DAY FOR SPECIFIED WEIGHTS AND RATES OF GAIN

Weight of Animal (lbs.)	Requirements, Pounds Per Day		
	TDN	DP	DM
	(Stocker Steers, 1.65 lb. Gains Per Day)		
460-550	7.70	.79	11.00
550-660	9.35	1.01	14.30
660-710	11.00	1.25	17.60
710-770	12.43	1.19	19.58
	(Stocker Steers, 1.10 lb. Gain Per Day)		
460-550	6.82	.77	10.78
550-660	8.14	.90	13.86
660-710	9.68	1.03	16.94
710-770	10.78	1.06	19.14
	(Stocker Heifers, 1.65 lb. Gain Per Day)		
440-550	8.14	.84	11.88
550-660	9.90	1.08	15.40
660-770	11.88	1.34	18.92

Costs

The specified costs for the included livestock budgets are divided into feed and pasture costs and other costs. The feed and pasture costs are not predetermined, because one of the objectives of this study is to develop a model that will choose the "ration" and determine the feed costs. The amount and type of forage needed, hay and grain requirements, and additional supplements fed are to be determined by this model, using the balanced least cost ration concept.

Since minerals are not balanced within the model, the mineral costs are prespecified. According to Totusek [16, p. c-7], a mature lactating cow requires almost one ounce of salt per day. However, if the salt is fed free-choice, more than this quantity is often consumed or wasted. Therefore, the budgets allow 30 pounds of mineral per animal unit per year.

Actual farm data were summarized to obtain veterinarian and medicine expenses, supplies, and miscellaneous costs [17]. Miscellaneous costs include organization and registration fees, testing fees, magazine subscriptions, bank charges, and legal fees. Supplies include such items as bedding, maintenance of handling facilities, shop supplies, rope and twine, and other annual costs for equipment. Each breeding unit in a cow-calf budget costs $2.71 for veterinarian and medicine expense while each stocker unit costs $1.75. Actual farm data indicate that each cow-calf breeding unit costs $3.89 and each stocker unit costs $3.50 for supplies and miscellaneous.

Animals are marketed through central markets thus costs for commission and yardage fees were used to develop the marketing cost for the livestock budgets [18]. Each animal that is bought or sold through the central markets costs $2.57 per head for commissions and yardage. All charges by commission companies and the stockyards are on a per head basis. In the cow-calf budgets, each breeding unit costs $2.26 for marketing costs.

The Regional Research Project data show hauling charges for cow-calf enterprises generally are per head, while fat animals or stocker animals are hauled by weight. The charge for hauling in the cow-calf budgets is $2.00 per head, with fifty cents per hundred weight used in the stocker budgets.

The equipment charge in the budgets represents the annual cost of depreciation on the handling equipment, feed equipment, and water facilities necessary to handle the feeding and care requirements of the animals. A total herd size of three cow herd units (75 cows) which is assumed to be equivalent to 140 stockers was used for estimating equipment charges. Repair costs are included in the miscellaneous charge. Table XXXI presents the items, total cost, average investment, and annual costs for included equipment complement. The annual equipment charge is $4.00 per cow unit and $2.15 per steer.

TABLE XXXI

INVESTMENT AND COSTS OF EQUIPMENT NECESSARY FOR A 75 COW OR 140 STOCKER ENTERPRISE IN EASTERN OKLAHOMA

Item	Year's Life	Total Cost	Average Investment	Annual Cost
Corrals and Working Pens	10	$400	$200	$40
Bunk Feeders	10	900	450	90
Water Facilities	20	3,000	1,500	150
Salt and Mineral Feeders	10	200	100	20
Total		$4,500	$2,250	$300
Cost Per Cow		$60.00	$30.00	$4.00
Cost Per Steer		32.14	16.07	2.14

Taxes on animals were calculated from values obtained from the Oklahoma Personal Property Evaluation Schedule [19]. Taxes on all types of cattle, except stocker cattle are estimated on a per head basis. Stocker cattle are valued on a per pound basis. Taxes per breeding unit in the cow-calf budgets are $3.17. Only stocker animals owned at the time taxes are reported are valued. Stockers bought in April and sold in October are not owned when property is valued; therefore, no taxes are included in the STST1 and STHF1 budgets.

Prices

Because prices of feed resources and products have considerable variation during the year, budgets should reflect seasonality. Base prices and seasonal indexes for purchased feedstuffs and classes of animals are presented in Table XXXII.

The feedstuffs included for livestock consumption, in addition to grazed forages, are in the three categories of hays, grains, and supplements. The hays included are alfalfa, native, bermuda, and sorghum-sudan, with only alfalfa purchased outside the farm organization. Grains included are barley, grain sorghum, and oats. Supplements included for possible livestock consumption are soybean meal, cottonseed meal, cottonseed cake, 20 percent range cubes, and 40 percent range cubes. The prices for cottonseed cake and both range cubes are adjusted according to the seasonal index developed for cottonseed meal.

The animal base prices are established by the Procedural Guide for Objective II Southern Regional Project, S-67 [2, p. 18]. Since production from all livestock budgets range from good to choice animals, the average of the good and choice base prices are used in determining the

TABLE XXXII

BASE PRICES[a] AND SEASONAL INDEXES[b] FOR FEEDSTUFFS AND CLASSES OF LIVESTOCK USED IN BUDGET PREPARATION

Item	Base Price	Price Index for Each Month											
		January	February	March	April	May	June	July	August	September	October	November	December
Feedstuffs													
Hays (Tone):													
Alfalfa	$30.28	106.5	107.0	105.4	102.2	97.8	94.6	94.6	94.5	95.5	97.6	101.6	102.6
Grains (cwt.):													
Barley	2.63	104.6	104.8	105.4	105.1	101.9	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	103.9	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	100.0	101.6	102.7	102.8	101.6	98.8	97.8
Cottonseed Meal	4.57	102.1	102.1	100.7	99.4	98.4	98.2	100.3	100.4	100.4	99.8	98.7	99.6
Cottonseed Cake	4.67	(Use Cottonseed Meal)											
20% Range Cubes	2.89	(Use Cottonseed Meal)											
40% Range Cubes	4.00	(Use Cottonseed Meal)											
Livestock													
Steers (cwt.):													
Good, 250-500	$26.00	96.50	98.20	100.30	101.80	103.10	103.50	102.00	101.40	101.80	98.80	96.40	96.00
Good, 500-800	24.00	98.11	99.95	101.28	101.99	101.42	102.34	100.99	100.70	99.97	97.70	97.27	97.86
Choice, 350-500	29.00	95.83	98.39	100.37	103.38	102.58	103.60	101.12	101.35	101.70	98.69	97.52	95.45
Choice, 500-800	25.50	98.51	99.55	101.39	102.16	101.76	102.72	101.07	100.73	100.00	97.03	97.29	97.80
Hiefers (cwt.):													
Good, 250-500	23.50	97.20	99.20	99.90	101.30	101.70	103.40	102.00	101.80	102.00	98.00	97.10	96.20
Good, 500-800	21.50	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	25.00	96.30	97.82	99.89	101.90	102.24	104.67	102.21	102.17	101.95	98.38	96.69	95.79
Choice, 500-800	23.00	101.16	100.69	100.37	101.00	103.75	102.65	102.65	101.26	97.05	96.01	95.69	97.78

[a]Feedstuff base prices are a four year average ending November, 1970; Source of livestock base prices is the Procedural Guide for Objective II Southern Regional Project S-67, February, 1970.

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

prices for the budgets. The culled heifers are assumed to be good heifers, and the price is based accordingly. The assumed annual price for culled cows is $18 per hundred weight.

Labor Requirements

Labor is divided into care and feeding components. Care labor per breeding unit is separated into five kinds of functions. These are basic care, calf care, calving, breeding, and prepartum as presented in Table XXXIII. In addition to the basic care needed each period, calf care is necessary during the periods which the calf is owned after the calving period. The calving, breeding, and prepartum care labor requirements are added to the labor requirements for that period in which each is required.

TABLE XXXIII

LABOR REQUIREMENTS PER BREEDING UNIT BY TYPE OF ACTIVITY

Requirement	Hours Per Period					
	1	2	3	4	5	6
Basic Care	.72	.80	.56	.56	.48	.72
Calf Care[a]	.22	.22	.20	.20	.18	.18
Calving[b]	1.58	1.58	1.58	1.58	1.58	1.58
Breeding[b]	.10	.10	.10	.10	.10	.10
Prepartum[b]	.31	.31	.31	.31	.31	.31
	(Labor Requirements for COW2 Activity)					
Total Care	1.03	2.38	.76	.76	.48	.72

[a]Included only for periods the calf is owned.

[b]Included for the period which is applicable.

For example, when calving in April, in addition to the basic care requirements specified in Table XXXIII, 1.58 hours should be added to the basic care labor in period two for calving care, .31 hours in period one for prepartum care, .20 hours in period three and .10 hours in period four for calf care, (calf owned for one-half period four), and .10 hours in period four for breeding care. These figures as shown in the last line of Table XXXIII represent the total care requirements for April calving (COW2).

Feeding labor depends on the type of feed, the type of pasture, and the type of system associated with that pasture. The values for feed labor are determined within the programming model which is discussed in Chapter V.

Summary

Forage budgets summarized in Tables XX through XXIII were prepared for use in the model developed in Chapter V. The livestock activities in Table XXVII are budgets developed for use in the model.

Annual costs and labor are allocated by periods for each activity. A more complete analysis of operating capital and labor requirements can be made by a cash flow analysis.

Forage production and consumption are specified in pounds of nutrients. The nutrients used are total digestible nutrients, digestible protein, and dry matter. Total digestible nutrients and digestible protein are minimum requirements, and dry matter is a maximum allowance.

Each forage activity has a specified nutrient distribution available for grazing or harvesting as hay in predetermined periods. The concept of best use of the available resources to achieve the desired objective should allow selection of forage activities for each soil productivity level that, when considering the total farm organization, will achieve a "least cost balanced ration" for the included beef systems.

The farm organization, determined by the model to be developed in Chapter V, will be built on a land base representative of a specified area of eastern Oklahoma. This representative resource base, developed in Chapter III, has specified limits on types of land use.

Chapter V develops the model that will be used to determine the farm organization given the representative resource base developed in Chapter III and the activity budgets developed in this chapter.

CHAPTER V

MODEL DEVELOPMENT

The primary objective of this study is to develop a tool for decision-making with practical application for beef farms in eastern Oklahoma. The model needs to balance total livestock feed requirements with supplies by specified production periods. Capital requirements, labor requirements, and feed consumption will be determined by the model internally. An optimum combination of resources and products must be obtained for specified situations through the use of the model. The general concepts that are applied in the construction of this model are presented in this chapter.

Model Construction

The type and construction of the model developed are a vital part of this dissertation. The validity of solutions and their potential use hinge on the ability of the model to perform the desired mechanics and answer the relevant questions.

How much land is necessary to furnish the farm family's living needs? What combination of forages best meets the requirements of the livestock included in the farm organization? What level of fertility should be used on bermuda pasture? How much additional labor is needed to meet the requirements of the farm organization? What types of livestock best meet the objectives of the farm organization and how many animals are required? How sensitive are the resource and product combinations included in the farm organization? What happens to the organization when operator goals change? The developed model must answer such questions about the farm organization, resources used, and products produced.

As indicated by the questions, not only is the optimum organization important, but information about internally generated resources, intermediate products, and levels of certain purchased resources are also essential. The model must be versatile, adaptable to situations that reflect different operators' goals, and capable of easy modification for analysis of specific beef producer operations within the study area.

Linear programming is a well-known technique used to find the optimal combination of activities and resources [20]. The Mathematical Programming System (MPS) was used to facilitate analysis of the linear programming problems [21]. This system will allow desired information about resources and the production process to be extracted as needed. Specification of different objective functions, each related to different goals, is possible within MPS. Additional useful information about sensitivity of prices and activities can be obtained from this system. Thus, MPS is the structure within which the model is built.

In addition to choosing the structure, decisions had to be made concerning the time periods necessary to adequately describe each unique activity, the income target, and the objective functions.

Bi-monthly Periods

Considerable differences exist in forage production by types of land, grasses, and months. Seasonal variation in prices of different classes of livestock and feedstuffs occurs throughout a given year. Availability of labor, purchases of various inputs, and capital requirements all vary with combinations of enterprises that enter the program and the time of year. The six two-month periods are designed to reflect differences in timing of purchases and sales specified within a production year. The use of 12 periods would have made the model more sensitive. However, the additional programming requirements would make the model bulky and burdensome in the analysis and it is felt that the value of the additional degree of accuracy would not be that great. Periods are numbered from January-February (period one) to November-December (period six).

Data were prepared for use in the model based on six periods. Labor availability and requirements, nutrient production and consumption, and the cash flow had to be developed for each of the six periods. Even the family living requirement was distributed by periods.

Family Living and Overhead

An income target was built into the model to represent the farm family's required living expenses for the year. It was decided that allowances for the farm family's personal consumption and nonbusiness saving should be at least equal to the earnings obtained by skilled laborers within the area of the regional study. The average earnings for skilled laborers are approximately $7,000 per year [2, p. 8]. An allowance of $500 per month or $1,000 per period was made for family living with the additional $1,000 included in period six. Distribution of the family living expenses in periods, rather than a lump sum at one specified time, requires the model to consider this use of funds in determining a solution. The farm family's expectations can then be built around a specified level of consumption similar to a salaried worker's expectations.

Certain overhead expenses are not allocatable to individual alternative enterprises. Overhead expenses include total annual costs of a machine or utility shed and shop tools necessary to maintain the machinery and equipment for the farm operation. The farm share of a pick-up, utility expenses, and bookkeeping and tax service is also included. These expenses are estimated to amount to $1,215 per year and are required to be paid in period six in addition to the family living requirement. Table XXXIV itemizes the overhead expenses.

TABLE XXXIV

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	3,000	650[a]
Telephone			70
Insurance			145
Bookkeeping and Tax Service			100
Utilities			120
		$3,900	$1,215

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

Other expenses, such as land taxes, livestock equipment annual cost, hired labor, grazing and feed storage annual costs, and capital charges, are internally calculated and accounted for in the net return function.

Capital Accounting

Capital is one of the major resources in the production process of any type of agricultural firm. According to survey information presented in Chapter II, a cow requires a capital investment of $1,974.91 for land, buildings, equipment, and livestock. The stocker alternatives require large amounts of operating capital that includes the cost of the purchased or raised animal, plus specified costs. Because of the importance of the capital input, any model developed for analyzing alternative enterprises for beef farms should include a detailed accounting of the required capital. Capital must be accounted for by types (operating, nonland, and land) and by periods used.

Two methods of capital accounting are included in this model for separate purposes. The first method records capital requirements by three categories: annual operating capital, nonland investment, and land investment. Annual operating capital presents an accurate estimate from which to calculate the capital charges for short term capital involved in the productive processes of a farm organization. Included are cash expenditures used in the production of particular enterprises adjusted to an annual basis according to the length of time the expenditures are in the productive process.

The actual balance method records expenditures and receipts by calendar periods and gives an indication of the deficits or excesses in cash flows during the year. The actual balance operating capital (cash flow) method of evaluating the capital requirements for a farm estimates the net capital needs throughout the year. This method allows payments and recycling of capital within the farm unit and gives estimates of only the amount of capital that actually must be available from external sources rather than the total capital invested. Repayment plans that conform to the limits of the farm organization can be developed from the cash flow.

Capital use and gross income are compared by periods in this section of the model. Each period must balance with borrowing or transfer of excess as required.

Beginning with January, all expenses and receipts are recorded in the cash flow section. Since period six is the last period of the production year, it was decided that either all capital must be recovered (the end of the production process) or must be inventoried to record the amount of capital invested in the farm organization at the beginning of the next production year. It was decided that capital involved in forage production is recovered through the forage consumptive process of livestock at least by the end of the production year and, therefore, is not inventoried. Capital used in the cow-calf activities for periods after calves are sold or transferred and in the production of stocker animals held past period six is included in the capital inventory. The capital inventory represents required capital investment for continued maintenance of the derived farm organization. The values have been accounted for in the cash flow section of the model in the appropriate period and the net in period six reflects the inclusion of these values.

The cash flow section of the model requires two sections to accomplish a balance by periods and a movement of net capital to succeeding periods. The first section records transactions, both expenditures and receipts, by periods. The second section includes the comparison of expenditure to receipts and the borrowing or transfer of excess necessary to balance the accounts for that period. When borrowing occurs, repayment is required in the following period before that period's accounts are balanced. Each succeeding period is balanced by the same procedure so that period six provides information about the net results for the year.

Both capital accounting methods are important for the proper analysis and operation of any farm firm. Annual operating capital provides farm planning or evaluation information useful in analyzing the returns to factors of production and returns to owned resources. Annual operating capital, with the addition of nonland capital and land capital, provides a convenient and accurate means of charging for capital used in the farm organization so that returns to operator's labor and management can be derived.

The programming procedures used for both methods of capital accounting are explained and illustrated in Table LVI, Appendix C.

Objective Functions

Different objective functions can be used to analyze the beef farm represented in this model for a given income. The alternative objective functions represent possible alternative goals of a beef farm operator. Objective functions representing goals related to capital, land, costs, labor, and returns are included. Constraints are constructed within the model so that family living expenses (income target) and overhead expenses must be met.

Since capital investment is a major part of beef farming, beef farmers may be forced to follow a strategy that essentially minimizes capital used. Land is a major part of capital; so intensive use of land should occur when minimizing capital, assuming that land is more "expensive" than the inputs required in the intensive use. Forage systems with high fertilization and high yields would be in the farm organization to replace land. The livestock systems that require smaller amounts of investment would be included.

Minimizing land may be another possible objective of beef farmers because of their preference for an intensive economic situation. The effect of this objective function resembles minimizing capital due to the impact of land investment on capital. If the beef farmer has the goal of more efficiently using controlled resources, then the minimizing land objective function should contribute toward the analysis of intensity and efficiency.

A goal of beef farmers may be to minimize cost involved in the production processes. This strategy may be forced on an operator because of his solvency or equity position. Or, an operator may be forced to reduce or avoid risk in the farm organization. This goal may be used to restrict the cash outlay necessary for the production of forage and livestock enterprises.

Labor may also be of concern to beef producers. It may be that they prefer to use only their own labor or to minimize labor involved in the production processes. This objective function may also reflect the situation of beef farmers involved in beef production only part-time and using some labor in off-farm employment. Farmers may prefer to allow time for such things as recreation, family, or community activities and, therefore, may wish to minimize the farm use of their labor while maintaining adequate returns for family living.

The final objective function used in the study maximizes returns to the beef farmer's labor and management. Economists are generally concerned with the analysis of profit-maximizing goals for organizations such as have been developed in this dissertation. Maximizing returns is analogous with profit maximization in procedure; however, in this study returns are defined as returns to operator's labor and management. All other objective functions consider a given level of returns to operator's labor and management or family living requirement. The objective function considering maximizing returns sets a limit on acres of land as a constraint to insure that a solution will be achieved. The model will determine the combination of resources necessary to accomplish the goal of maximizing returns given the constraints built into the model which includes a limitation on land.

Other Constraints

Although a specified amount of operator labor is furnished free, additional labor is salaried. Additional labor is hired on an hourly basis with no restriction on units hired.

The nutrient rows are constructed so that total digestible nutrients and digestible protein requirements must be furnished while dry matter is the maximum stomach capacity of the animals.

No limit on capital was established. An interest charge is made on all capital used within the model according to the type of capital.

Segments of the model that internally generate grazing and feeding capacities that enter the model only as need are determined by included activities. Grazing and feeding capacities are a method developed in this model to properly identify and account for fixed and variable cost, labor, and capital required by grazing and feeding systems available for use in the organization.

Grazing capacity is established as forage activities enter the model and is expressed in terms of acres. Each acre of forage activity requires one unit of grazing capacity in each period grazed. The unit of grazing capacity requires the annual variable cost of fencing and labor requirements for maintenance associated with one acre of grazing for one period. One unit of grazing also requires payment of fixed costs (including depreciation and taxes for fencing), fixed labor requirements, and investment. When fixed costs and associated requirements are met for any period, an equal amount of capacity is generated in all periods. Only variable costs associated with actual use remain to be paid. This procedure requires payment of specified annual costs if the land is grazed in any period, but variable costs only in periods when grazed.

Two types of grazing capacities, rotation grazing and extensive grazing, are included in the model for which coefficients were developed by Jones [13]. Rotation grazing is an intensive grazing system for highly fertilized bermuda (150 and 200 pounds nitrogen), bermuda-fescue, fescue, sorghum-sudan, and small grain forages. Only native pasture and bermuda fertilized with 50 and 100 pounds of nitrogen use the second category, extensive grazing. The procedure is the same for both systems, only coefficients differ. Table LVII, Appendix C illustrates and explains the programming procedure.

Feeding also requires capacity which is generated separately for hay, concentrates, and supplements. As with grazing capacity, feeding capacity is a method by which fixed costs are paid annually but costs associated with use are payable only in the periods when used [14]. The procedure is presented and described in Table LVII, Appendix C.

Equipment required to support stocker enterprises can be used by more than one activity if periods of use do not overlap. Because of this possibility, stocker equipment capacity is generated by periods, as was done with grazing capacity, so that when annual costs are accounted for, capacity is generated in all six periods. Table LVII, Appendix C illustrates and describes how capacity is generated.

Limits on the amount of native pasture, discussed in the following sections, are included in the model. However, if the poorest producing soil productivity levels of all soil groups could not sustain improved pasture or tilled crops, those acres can be transferred to the native pasture alternatives. If such land can profitably produce native pasture, then an otherwise unused resource is productively contributing to the organization.

Resource Supply

The four categories of resources important in the model are land, labor, capital, and purchased inputs. Land is purchased in the model as necessary to achieve the stated income target. Labor provided by the operator is specified within the model at no charge, and additional hourly hired labor is available as needed. Annual, nonland, and land capital can be borrowed separately. Purchased inputs are bought in a competitive market and are available in quantities needed to achieve the production specified in the enterprise budgets. Individual accounting of purchased inputs, except feedstuffs and livestock, is not programmed into the model. Land, labor, and capital charges are presented in Table XXXV and are discussed in this section.

TABLE XXXV

PRICES OF LAND, LABOR, AND CAPITAL USED IN THE REPRESENTATIVE SITUATION FOR AREA 2 OF EASTERN OKLAHOMA

Item	Unit	Price Per Unit
Land	Acre	$130.00
Labor	Hour	1.75[a]
Capital Charges		
Annual Operating	$	.07
Nonland	$	.07
Land	$	.07

[a]Only for hired labor.

Land

The analysis of this study is based on a minimum size of unit which will pay all costs and will allow $7,000 for farm family living expenses. The soil group and land use limitation for an acre are specified in a land buy activity within the model. The percent of land base by soil productivity levels and by cropland, pasture land, and forest land for Area 2 is presented in Table XVIII. The cropland and pasture land account for 83.35 percent of the land base with 12.5 percent as grazed forest land. Very little cost is associated with forest land yields. The purpose of this study is not to evaluate changes in yields of grazed forest land. Therefore, nutrients from grazed forest land are contributed directly into the nutrient section of the model. Because 12.5 percent of each acre is in grazed forest land, a proportionate share of the nutrients specified for Area 2 in Table XXVI is contributed directly into the nutrient rows with each acre entering the solution. Nongrazed forest land or wasteland accounts for 4.15 percent of each acre.

In the survey more than 70 percent of each acre is in some type of pasture. It was assumed that a maximum of 18.7 percent of each acre or 20.2 percent of the openland per acre is allowed to be planted in tillable crops such as small grains and sorghum-sudan, primarily to represent current practices discovered in Area 2 of the survey (Table X). This restriction was relaxed when some alternative land use systems are evaluated.

Land is the major resource in the farm organization. Capital invested in land must be accounted for so that charges for the investment can be included. For this study, unimproved land with a value of $130 per acre, as projected from land value data developed by Parcher [22, p. 10], is used. Taxes per acre are $1.69 (20 percent of the land value at 65 mills). Unimproved land is used in this model because allowances for fencing, water facilities, and all necessary buildings are included in the prepared budgets or overhead costs that were used in developing the programming coefficients.

Labor

The distribution of hours which the operator has available for farm work is presented in Table XXXVI, as developed from specifications in the *Procedural Guide for the Regional Study* [2, p. 12]. It was assumed that the labor supply can be described by 50 weeks of 50 hours per week plus a two week vacation period occurring in August.

TABLE XXXVI

DISTRIBUTION OF HOURS OF OPERATOR LABOR BY PERIODS FOR BEEF FARM OPERATORS IN EASTERN OKLAHOMA

Period	Hours Available
1	421.5
2	434.5
3	434.5
4	341.0[a]
5	434.5
6	434.5

[a]Assume a two-week vacation is taken in August.

The availability of hired labor is assumed to be unlimited, given the wage rate of $1.75 per hour. The specification for determining the hired labor supply is presented in the Procedural Guide [2, p. 12].

Capital

Large amounts of different types of capital will be needed in the operation and maintenance of the programmed farm. Capital resources, just as other resources, should receive payments for use. The interest rates specified in Table XXXV for the three categories of capital are used to calculate capital charges [2, p. 17].

Total annual operating capital estimates that portion of total operating capital required for productive investment on which an annual interest rate, either actual opportunity cost or internal rate, is paid throughout the time period studied. Total annual operating capital required by the farm organization does not necessarily represent the amount of capital required from external sources (borrowed capital) because the production processes for different enterprises involve different time periods. Since some activities do not overlap periods, and others may only partially overlap, capital can be generated internally by these activities for use in following periods by other activities. The actual balance operating capital procedure of capital evaluation, discussed later in this section, considers such a cash flow concept.

Average investment in intermediate term capital items is included in nonland capital. This investment includes such items as breeding stock, equipment, machinery, and livestock handling and feeding equipment investment.

Land capital is accounted separately, and includes only investment in land with no improvements. Land improvements made through livestock and forage use activities are included in nonland capital so that land capital is accounted separately.

If a solution cannot be obtained when costs of all factors are paid, the equity level, or interest rates, can be varied. This method provides the versatility in the model to consider situations of partial resource ownership. Varying the interest rates can also be used to reflect a satisfactory level of returns to owned resources, but not 100 percent equitable returns due to price appreciation. Variation of land capital interest rate could also be used to represent varied rental rates which can be a specified level of return on land investment to the land owner.

The interest rate or each type of capital can be varied depending on the type and amount of equity assumed. If interest rates for operating capital, nonland capital, and land capital are divided by two, then one-half of the normal returns on investment, or 50 percent equity would be represented. Other combinations of interest rates could also be used to represent different equity levels as shown in Table XXXVII.

Purchased Inputs

Inputs within the crop and livestock budgets, such as fertilizers, chemicals, gasoline, livestock supplies, and minerals, that are purchased for use in the production process are assumed to be purchased at constant prices and are included in the cost coefficients of the model. However, feedstuffs purchased for livestock consumption can vary in price throughout the year depending upon the availability of the feedstuff. Certain grains, supplements, and alfalfa hay are included in the model as alternative feedstuffs to the farm-produced forages. Alfalfa hay can be purchased in any period and stored for livestock consumption in future periods. The model will select the most economical period to purchase the necessary alfalfa hay.

TABLE XXXVII

EQUITY LEVEL AND INTEREST RATE RELATIONSHIPS USED IN THE ANALYSIS OF THE REPRESENTATIVE SITUATION IN EASTERN OKLAHOMA

Equity Level (Percent)	Interest Rates (Percent)		
	Operating Capital	Nonland Capital	Land Capital
0	7.00	7.00	6.00
25	5.25	5.25	4.50
50	3.50	3.50	3.00
100	0.00	0.00	0.00

Grains and supplements will be purchased in the period they are fed or their prices are assumed to reflect storage costs. Prices of feedstuffs considered as alternatives within the programming model are based on prices and seasonal indexes presented in Table XXXII.

Products

Census data indicate that livestock is the main product from the farms in the study areas [1]. Sale of cows and calves represent 56.4 percent of the total farm products sold in 1969, while crops represent only 17.1 percent. Much of the production from tilled crops is utilized in the forage form for livestock consumption. With the large acreages of native and improved pasture, beef cattle are used to market the products of the land. Because of the organization and the systems prevalent on beef farms in eastern Oklahoma, two categories of products exist. There are intermediate products that are used on the farm and the final products that are sold for monetary return. The intermediate products include the forage production and weaned calves (if further feeding or grazing is done). The final products are weaned calves, if not fed, or feeder steers or heifers.

The model accomplishes optimum use of farm-produced forage. Through the process of determining optimum utilization, the model will determine whether calves produced by the cow-calf system are sold at weaning or kept and fed as stockers. The model will determine whether maintenance of a breeding herd is more, or less, profitable than maintenance of stocker animals. A definite advantage exists in producing and feeding calves from the cow herd rather than in buying stocker animals. Steers can be purchased off-farm for the stocker systems. Heifers can only enter the stocker segment of the program through transfer from the cow-calf system. If steers are bought off-farm and included in the stocker system, additional hauling and marketing expenses are incurred.

All operating costs are accounted for in the capital accounting rows in the period for which they occur, as previously described under capital accounting. Gross returns and costs of production are accumulated in the net revenue row that can be used as an objective function. All costs are also accumulated in a cost row that also can be used as an alternative objective function.

Summary

The model is constructed using the Mathematical Programming System developed by IBM. The construction of the model allows flexibility in types of analysis and in the choice of objective functions. If required, large numbers of alternatives can be easily considered, and coefficients can be easily changed to alter the representative farm situation. Accounting rows and transfer activities can be included for easier, more efficient analysis of the results from the model.

The period concept of capital accounting, and nutrient distribution and use add an additional dimension to farm organization analysis. Period analysis of cash flows provides valuable information for planning capital borrowing and repayment plans.

Specification of forage yields and livestock requirements in terms of nutrients allows range ration balancing using the least cost concept. Forage use can be better coordinated with the type of model developed in this chapter provided that adequate and reliable forage nutrient yield information is available.

It is intended that the model show a situation that will be representative of the study areas in 1975. Certain assumptions have been made in developing the model and in developing coefficients to anticipate this target date.

The current organization and operation of beef farms have been evaluated and analyzed (Chapter II), and land use restrictions (Chapter III) and enterprise budgets (Chapter IV) have been developed as closely as possible to represent beef farming in eastern Oklahoma in 1975. The application of the model presented in Chapter VI will determine the effectiveness of this model as an analytical tool.

CHAPTER VI

MODEL APPLICATION

The testing of a model after development should evaluate its consistency with the survey results or other empirical evidence and show what appears possible with the resources and alternatives available for use in the farm organization. If deviations occur, the validity of the reasoning that led to those deviations is examined. This chapter illustrates the application of the model, analyzes the results obtained when considering different goal-related objective functions, and evaluates the use of the different strategies obtained.

Organization Strategy Analysis

Goals of the farm firm are presented as objective functions within the model and are used in selecting the representative farm organization. So that solutions relating to different objective functions can be compared, those items that are relatively comparable in all solutions need to be specified.

The Representative Situation

All applications of the model, except when maximizing net return, allow land to be added as needed to furnish requirements necessary to meet specific levels of constraints, especially the income target. Each added acre is specified according to the proportion of each soil productivity level, amount of grazed forest land, nongrazed forest land, amount of native pasture, and land available for tilled crops for forage production as presented in Table XVIII and described in Chapter III. These figures form the land base of the representative situation because a representative acre of land is purchased, rather than acre of a specified soil productivity level on which a specific crop will be raised. The land use obtained from different solutions can be compared according to types of crops that are grown on the different soil productivity levels, rather than an analysis of the types of land in the solution, as would be the case, if a representative acre was not used.

Total resources used also form a basis for comparison of obtained solutions. Initially, resources available are the same for all solutions. The goal of the operator (objective function) emphasized in the solution causes different levels of resource use.

Labor is specified for the operator by periods with additional labor available at $1.75 per hour. The operator has 2,500 hours per production year available, as described in Table XXXVI.

Although the operator may furnish some capital used in the beef farm operation, charges are made on all capital involved in the organization. Returns in the solutions represent returns to operator's labor and management and, except for maximum net return are fixed at the income target level. Family living expenses (income target) must be maintained in all solutions. The $7,000 returns to labor and management and $1,215 for overhead, described in Chapter V, are specified within the model.

All coefficients with regard to prices and quantities of inputs used in the forage and livestock activities, available operator's labor, and capacity activities, are not changed for the basic solutions obtained for different goal-related objective functions. Certain restrictions on organizations are evaluated in later sections of this chapter after the basic solutions are evaluated.

Goal-Related Objective Functions

As explained in Chapter V, the alternative goal-related objective functions considered are minimum capital, minimum input costs, minimum land, and minimum total labor as well as maximum net return. The total capital minimized includes short term (operating), intermediate term (nonland), and long term (land) capital. The costs minimized include all costs of capital, annual operating costs, and hired labor. The operator labor and hired labor are both included when total labor is minimized. Only capital investment in land is considered when land is minimized, thus allowing nonland capital to substitute for land capital. When net returns are maximized, the restriction of an income target is released, but land is restricted so that results for similar sizes can be analyzed. If size is not restricted, a solution of reasonable size could not be obtained due to the linear relationships in the linear programming model. The acres obtained from the solution when minimizing capital are used as the limit on size when maximizing net returns.

Organization Analysis

Total Farm. The solutions for the different goal-related objective functions are presented in Table XXXVIII. The level of the item considered in the objective function is the lowest for that item of all solutions. For example, the minimum capital solution has the least

TABLE XXXVIII

SUMMARIES OF OPTIMAL ORGANIZATIONS FOR THE REPRESENTATIVE SITUATION WITH ALTERNATIVE OBJECTIVE FUNCTIONS FOR AREA 2 OF EASTERN OKLAHOMA

Item	Unit	Grazing System	Objective Function				
			Minimum Capital	Minimum Cost	Minimum Land	Minimum Labor	Maximum Net Returns[f]
Total Land	Acres		1,569.56	2,496.02	1,554.88	1,767.65	1,600.00
Annual Cost	$		186,907.54	131,931.86	172,550.20	218,381.61	177,026.73
Total Labor	Hours		4,834.28	8,630.79	5,350.33	4,761.05	5,489.61
Total Capital	$		343,831.44	597,824.66	359,019.77	366,823.89	369,001.95
Annual Operating Capital	$		75,394.92	56,000.67	70,284.23	87,441.82	72,099.67
Cropland Planted	Acres		293.51	466.76	290.76	330.55	299.20
Bermuda	Acres	2 and 4	37.93	23.71	53.76	30.94	53.89
Fescue	Acres	1	74.03	313.50	147.27	15.31	155.99
Native	Acres	1	760.68	933.90	738.41	797.86	759.84
Native	Acres	2	46.76	278.91	58.62	17.15	60.32
Sorghum-Sudan	Acres	1	105.99	151.74	100.88	120.23	103.16
Sorghum-Sudan	Acres	2	79.30	194.72	82.22	91.03	85.30
Small Grain	Acres	1	108.22	120.30	107.67	92.81	110.74
COW2	Head		112	639	188	53	193
STST1	Head		511	214	370	682	373
STST2	Head		11	0	30	0	29
STST3	Head		487	280	495	525	515
STHF2	Head		31	178	52	15	54
Hay Fed	cwt.		4,194.95	11,701.31	5,653.34	2,890.12	5,733.69
Concentrate Fed	cwt.		847.80	653.40	842.03	797.16	862.06
Cubes Fed	cwt.		0	0	0	148.58	0
Index of Land Use Intensity[b]	%		25.8	32.2	31.6	19.8	31.8
Requirement from Concentrates[c]	%		3.0	1.3	2.7	3.4	2.7
Animal Unit Equivalents[d]			508.39	945.39	566.47	502.87	582.28
Index of Animal Intensity[e]			3.09	2.64	2.74	3.52	2.75

[a]An average situation in Area 2 as described by land use and soil productivity levels in Table XVIII, available operator's labor in Table XXXVI, and a target income of $7,000.

[b]Percent of total acres in forages that require rotation grazing.

[c]Percent of total digestible nutrient requirements furnished by purchased feedstuffs.

[d]Each breeding unit represents 1.1 animal units, STST1, STST2, and STHF2 represent .29 animal units, and STST3 represents .46 animal units.

[e]Number of acres per animal unit equivalent.

[f]Total returns to operator's labor and management was $7,115.

amount of capital ($343,800) of the five solutions. The minimum cost solution shows $131,900 of annual costs although it has the largest amount of operating capital, labor, and total land involved of all solutions. The minimum land solution shows fewer acres than all other alternatives, although the difference between minimum land and minimum capital is not significant in terms of acres, annual cost, labor, and operating capital. The maximum net return solution, given 1,600 acres, does not show either high or low extremes in the use of any of the factors considered in the other solutions (capital, land, labor, and cost).

Only small variation occurs in the types and proportional amounts of different forages that entered the solutions. Grazing is available from some type of forage through the complete production year. The livestock systems selected by the model include only the COW2 cow-calf alternative in all solutions. In the minimum capital, minimum land, and maximum net return solutions, all three stocker steer enterprises are included in the organization. Two stocker enterprises are included in the minimum cost and minimum labor solutions. In addition, heifers raised in the cow-calf enterprise are fed on the farm through the STHF2 activity in all solutions. Cubes are purchased only in the minimum labor solution. Hay requires much more feeding labor than cubes. The amount of hay fed is decreased below all other situations with over 47 tons of concentrates and cubes purchased and fed.

The hay fed is harvested within the organization from those crops specified in Table XXXVIII as using grazing system two. Bermuda, native and sorghum-sudan hay are harvested to be fed when needed.

All solutions presented in Table XXXVIII achieve the income target of $7,000 at zero equity level. The differences in resource use and land use for the alternative organizations reflect the goal (objective function) considered in each solution. In an analysis of the differences between organizations each factor reflects a measure of size. The minimum capital solution includes costs for factors such as land, annual costs, and labor (only hired labor requires capital), also evaluated as independent objective functions. The minimum capital solution requires almost $344,000 of capital on 1,570 acres, only 15 more acres but almost $16,000 less capital than for the minimum land solution. The minimum capital solution requires $55,000 more cash outlay, $250,000 less capital, and 920 fewer acres than the minimum cost solution to achieve the income target. Seventy-three hours less labor are used by the minimum labor solution than in the minimum capital solution; however, an additional 200 acres, $23,000 capital, and $33,000 cash outlay are needed to produce the same return to operator's labor and management.

The maximum net return solution, given 1,600 acres, exceeded the income target by $115. When compared with the minimum capital solution, the maximum net return solution required $10,000 less cash outlay, $25,000 more capital, and 600 hours more labor.

<u>Per Unit Comparisons</u>. The organizations presented in Table XXXVIII can be compared from a slightly different viewpoint if the solutions are converted to a per acre or per animal unit basis. The information on a per acre basis is presented in Table XXXIX and on a per animal unit basis in Table XL.

All the organizations considered show intense use of each acre. The index of animal intensity, the number of acres per animal unit equivalent, varies from 2.64 for minimum cost to 3.54 for minimum labor.

TABLE XXXIX

SUMMARIES OF OPTIMAL ORGANIZATIONS PER ACRE FOR THE REPRESENTATIVE SITUATION WITH ALTERNATIVE OBJECTIVE FUNCTIONS FOR AREA 2 OF EASTERN OKLAHOMA[a]

Item	Unit	Grazing System	Objective Function				
			Minimum Capital	Minimum Cost	Minimum Land	Minimum Labor	Maximum Net Returns
Total Land	Acres		1.0	1.0	1.0	1.0	1.0
Annual Cost	$		119.08	52.86	110.97	123.54	110.64
Total Labor	Hours		3.08	3.46	.344	2.69	3.43
Total Capital	$		219.05	239.51	230.90	207.52	230.63
Annual Operating Capital	$		48.03	22.44	45.20	49.47	45.06
Cropland Planted	Acres		.19	.19	.19	.19	.19
Bermuda	Acres	2 and 4	.025	.009	.034	.017	.023
Fescue	Acres	1	.047	.125	.094	.008	.097
Native	Acres	1	.484	.374	.474	.451	.474
Native	Acres	2	.029	.111	.037	.009	.037
Sorghum-Sudan	Acres	1	.067	.060	.064	.068	.064
Sorghum-Sudan	Acres	2	.050	.078	.052	.051	.053
Small Grain	Acres	1	.068	.048	.069	.052	.069
COW2	Head		.071	.256	.121	.030	.120
STST1	Head		.325	.086	.238	.386	.233
STST2	Head		.007	0.000	.019	0.000	.018
STST3	Head		.310	.112	.318	.297	.322
STHF2	Head		.020	.071	.033	.008	.033
Hay Fed	cwt.		2.672	4.687	3.623	1.635	3.583
Concentrate Fed	cwt.		.540	.261	.541	.450	.538
Cubes Fed	cwt.		0.000	0.000	0.000	.084	0.000
Index of Land Use Intensity[b]	%		25.8	32.2	31.6	19.8	31.8
Requirement from Concentrates[c]	%		3.0	1.2	2.7	3.4	2.7
Animal Unit Equivalents[d]			.324	.379	.364	.284	.364
Index of Animal Intensity[e]			3.09	2.64	2.74	3.54	2.75
Capital Charge[f]	$		14.03	15.47	14.86	13.23	14.84
Labor and Management Returns[g]	$		4.46	2.80	4.50	3.96	4.45[h]

[a]An average situation in Area 2 as described by land use and soil productivity levels in Table XVIII, available operator's labor in Table XXXVI, and a target income of $7,000.

[b]Percent of total acres in forages that require rotation grazing.

[c]Percent of total digestible nutrient requirements furnished by purchased feedstuffs.

[d]Each breeding unit represents 1.1 animal units, STST1, STST2, and STHF2 represent .29 animal units, and STST3 represents .46 animal units.

[e]Number of acres per animal unit equivalent.

[f]Charge per acre for land capital is $7.80.

[g]Includes only operator's labor.

[h]Total returns to operator's labor and management was $7,115.

TABLE XL

SUMMARIES OF OPTIMAL ORGANIZATIONS PER ANIMAL UNIT EQUIVALENT FOR THE REPRESENTATIVE SITUATION WITH ALTERNATIVE OBJECTIVE FUNCTIONS FOR AREA 2 OF EASTERN OKLAHOMA[a]

Item	Unit	Grazing System	Objective Function				
			Minimum Capital	Minimum Cost	Minimum Land	Minimum Labor	Maximum Net Returns
Total Land	Acres		3.09	2.64	2.74	3.52	2.75
Annual Cost	$		367.65	139.55	304.61	434.27	304.02
Total Labor	Hours		9.51	9.13	9.45	9.47	9.43
Total Capital	$		676.31	632.36	633.78	729.46	633.72
Annual Operating Capital	$		148.30	59.24	124.07	173.89	123.82
Cropland Planted	Acres		.58	.49	.51	.66	.51
Bermuda	Acres	2 and 4	.074	.025	.095	.061	.092
Fescue	Acres	1	.146	.332	.260	.030	.268
Native	Acres	1	1.496	.988	1.304	1.587	1.305
Native	Acres	2	.092	.295	.103	.034	.104
Sorghum-Sudan	Acres	1	.208	.161	.178	.239	.177
Sorghum-Sudan	Acres	2	.156	.206	.145	.181	.146
Small Grain	Acres	1	.213	.127	.190	.185	.190
Hay Fed	cwt.		8.251	12.377	9.980	5.747	9.847
Concentrate Fed	cwt.		1.668	.691	1.486	1.585	1.480
Cubes Fed	cwt.		0.000	0.000	0.000	.295	0.000
Index of Land Use Intensity[b]	%		25.8	32.2	31.6	19.8	31.8
Requirement from Concentrates[c]	%		3.0	1.3	2.7	3.4	2.7
Animal Unit Equivalents[d]			1.0	1.0	1.0	1.0	1.0
Index of Animal Intensity[e]			3.09	2.64	2.74	3.52	2.75
Capital Charge[f]	$		43.33	40.83	40.80	46.49	40.79
Labor and Management Returns[g]	$		13.77	7.40	12.36	13.92	12.22[h]

[a]An average situation in Area 2 as described by land use and soil productivity levels in Table XVIII, available operator's labor in Table XXXVI, and an income target of $7,000.

[b]Percent of total acres in forages that require rotation grazing.

[c]Percent of total digestible nutrient requirements furnished by purchased feedstuffs.

[d]Each breeding unit represents 1.1 animal units, STST1, STST2, and STHF2 represent .29 animal units, and STST3 represents .46 animal units.

[e]Number of acres per animal unit equivalent.

[f]Charge per acre for land capital is $7.80.

[g]Includes only operator's labor.

[h]Total returns to operator's labor and management was $7,115.

The survey results in Chapter II show almost nine acres per animal unit for Area Z.

All animals in the organization are adjusted according to the length of time on the farm and the average weight of the animal in the conversion to animal unit equivalents. Each breeding unit represents 1.1 animal unit equivalents due to the supportive animals maintained in addition to the cow and her calf. Stocker alternatives one and two (STST1, STST2, and STHF2) convert to .29 animal unit equivalents. Stocker alternative three (STST3) converts to .46 animal unit equivalents.

The amount of capital invested in land, buildings, breeding livestock, and equipment in the organizations ranges from $158.02 per acre in the minimum labor solution to $217.07 per acre in the minimum costs solution. The results from the regional survey (Table XIII) show $180.96 of capital per acre and fit in the range covered by Table XXXIX. The minimum land and maximum net return solutions show an investment of approximately $185.00 per acre or $510.00 per animal unit, very close to the regional survey results.

The use of native pasture is very prevalent within the alternative organizations. However, when costs are minimized less of an acre is devoted to native pasture due to additional production per unit of cost obtained from other forages. There is a slight increase in the proportion of an acre planted to fescue when minimizing costs. Only small variation occurs in the other forages in the organizations of the different alternatives considered.

Table XXXIX shows the capital charges and operator's labor and management returns per acre. Because of substitution of land and nonland capital for operating capital in the minimum cost solution, the capital charges per acre ($15.47) are the highest of all solutions. In all solutions, the capital required per acre increases as the percent of land in an intensive use increases.

The operator's labor and management returns per acre range from $2.80 (minimum costs solution) to $4.50 (minimum land solution). Little difference in returns to operator's labor and management per acre exists among the minimum land, minimum capital, and maximum net return solutions.

Another way of looking at the results of the solutions of the alternative objective functions is to evaluate the summary on a per animal unit equivalent basis. The index of animal intensity for the alternative organizations is about three acres per animal unit equivalent (2.64 to 3.52).

The labor requirement per animal unit equivalent has little variation between the alternative organizations. Although annual cost varies from $139 to $434 per animal unit equivalent between organizations, the total capital required varies less than $100 from $632 to $729. This variation in total capital is a function of land required to support the animal unit equivalent and the type of animal systems included in the organization. Organizations with large numbers of stocker animals per acre require large capital investment per animal unit equivalent. The annual costs and annual operating capital requirements, which are closely related, vary according to the intensity of land use. When costs are minimized, more hay is fed, less feedstuffs are bought, and land is more intensively used. The minimum labor solution requires the smallest amount of hay to be fed because of the additional labor that is required in the system of alternative feeding. Because larger quantities of feedstuffs are purchased, the annual costs per animal unit equivalent increase as does annual operating capital.

Table XL also presents the percent of the nutrient requirements furnished by purchased feedstuffs. Because of the cash outlay necessary for concentrates and cubes, only 1.3 percent of the nutrient requirements is furnished in the minimum cost solution. However, because of the labor requirement in feeding hay, 3.4 percent of the nutrient requirements is furnished from concentrates and cubes in the minimum labor solution.

Land Use. The land use is summarized for the five base solutions and presented in Table XLI. Native pasture represented the largest percentage of total land in all the organizations. The percentage of native pasture ranged from a low of 46.1 percent in the minimum labor solution to a high of 51.4 percent in the minimum capital solution. The amount of bermuda varies from almost one percent to 3.5 percent of total acres in the farm organizations which does not compare with 46.4 percent of total land in bermuda obtained in the regional survey (Table X). There could be some discrepancies in the forage yields used in this study, primarily due to the lack of nutrient yield data. Additional study is needed about specification of yield data, expected yield variability, and livestock conversion of grazed forage nutrients. A re-evaluation of yield data has already begun.

Small grains and sorghum-sudan show little variation between the different organizations. Fescue ranges from no acres when labor is minimized to 12.6 acres when costs are minimized. Fescue does not enter the labor organization due to the high labor requirements in relation to

TABLE XLI

SUMMARIES OF LAND USE OF OPTIMAL ORGANIZATIONS FOR THE REPRESENTATIVE SITUATION WITH ALTERNATIVE OBJECTIVE FUNCTIONS FOR AREA 2 OF EASTERN OKLAHOMA[a]

	Bermuda	Fescue	Native	Sorghum-Sudan	Small Grains	Grazed Forest Land	Nongrazed Land	Total Acres
(Minimum Capital)								
Acres	37.93	74.03	807.44	185.28	108.23	196.20	160.45	1,569.56
Percent	2.4	4.7	51.4	11.8	6.9	12.5	10.2	
(Minimum Cost)								
Acres	23.71	313.50	1,212.81	346.47	120.29	162.00	317.24	2,496.02
Percent	0.9	12.6	48.6	13.9	4.8	12.5	12.7	
(Minimum Land)								
Acres	53.77	147.28	781.31	183.10	107.67	194.36	87.39	1,554.88
Percent	3.5	9.5	50.2	11.8	6.9	12.5	5.6	
(Minimum Labor)								
Acres	46.26	0.0	815.02	211.26	119.30	220.96	354.85	1,767.65
Percent	2.6	0.0	46.1	12.0	6.7	12.5	20.1	
(Maximum Net Return)								
Acres	53.89	152.99	820.16	188.46	110.74	200.00	73.76	1,600.00
Percent	3.4	9.6	51.3	11.8	6.9	12.5	4.6	

[a]An average situation in Area 2 as described by land use and soil productivity levels in Table XVIII, available operator's labor in Table XXXVI, and an income target of $7,000.

the amount of production obtained from fescue pasture. However, larger amounts of yield per unit of cost allow fescue to enter the minimizing cost organization.

Grazed forest land was held constant for all organizations. Each acre that enters the model was externally specified to contain 12.5 percent grazed forest land. Nongrazed land includes that part of an acre that represents nongrazed forest land and any land upon which forages cannot profitably be grown.

Forage mixes are different in the solutions than in the regional survey summary. An analysis of the types of forages by soil productivity level show little variation between solutions. Native pasture is in the solutions at the specified limit, plus any additional land that might be transferred from the lower soil productivity levels of cropland if it was profitable to transfer from improved pasture or annual crops to native pasture.

Sorghum-sudan and small grains are generally included on sandy soils, the better clayey soils, and loamy bottomland soils. Fescue, when it enters the organization, is allocated to the higher soil productivity levels of the clayey soils. Bermuda occurs on the more productive loamy soils, and if additional acreage is required, on the sandy soils.

<u>Livestock Systems</u>. The livestock systems in the organizations for all the alternative objective functions include the late spring calving cow-calf system (COW2). The timeliness of labor and nutrient requirements is an influencing factor for the use of the COW2 alternative in the solutions.

The stocker systems in the organizations include all three of the stocker steer alternatives at various levels depending upon the alternative evaluated. The STHF2 stocker heifer enterprise is in all organizations.

The feeding system, though not completely identifiable within the organization, can be interpreted in general terms. Even if all the hay and concentrate fed in the solutions were fed to stocker animals in the minimum capital solution, about 37 percent of the required total digestible nutrients would be furnished by these sources. The additional 63 percent is furnished by grazed forages. Thus, the stocker animals primarily depend on forages to obtain the nutrients necessary for the specified production. A feedlot situation is not occurring.

Labor Requirements. The labor requirements for the alternative solutions considered vary from 2,300 hours to over 6,000 hours of hired labor. The minimum capital, land and labor solutions require similar amounts of hired labor. The hired labor requirements by periods for the alternative solutions are presented in Table XLII. The percent of the total annual costs represented by labor payments is also presented.

The differences in the percent of total costs show very small variation (from 1.8 to 3 percent), except when costs are minimized. Hired labor is 8.1 percent of the total costs in the minimum cost solution. Period five labor requirements in most organizations are met by the labor furnished by the operator. Labor is hired in all other periods. Periods two, three, and four require larger amounts of hired labor due to the pasture production and the livestock care that must be done. Higher requirements are required in April due to the labor requirements of calving. Early summer requirements are increased because of the time

TABLE XLII

SUMMARIES OF LABOR REQUIREMENTS OF OPTIMAL ORGANIZATIONS FOR THE REPRESENTATIVE SITUATION WITH ALTERNATIVE OBJECTIVE FUNCTIONS FOR AREA 2 OF EASTERN OKLAHOMA[a]

	Periods						Total	Percent of Total Cost
	1	2	3	4	5	6		
			(Minimum Capital)					
Hours	149.55	774.38	444.55	831.34		133.96	2,333.78	
Cost ($)	261.71	1,355.17	777.96	1,454.85		234.43	4,084.12	2.2
			(Minimum Cost)					
Hours	810.04	2,739.97	716.11	1,142.12	218.06	503.99	6,130.29	
Cost ($)	1,417.57	4,794.95	1,253.19	1,998.71	381.61	881.98	10,728.01	8.1
			(Minimum Land)					
Hours	299.62	1,045.05	438.02	833.59		233.75	2,850.03	
Cost ($)	524.34	1,828.84	766.54	1,458.78		409.06	4,987.56	2.9
			(Minimum Labor)					
Hours	73.10	653.67	531.51	901.95		100.33	2,260.56	
Cost ($)	127.93	1,143.92	930.14	1,578.41		175.58	3,955.98	1.8
			(Maximum Net Return)					
Hours	323.23	1,084.26	459.43	866.32		255.87	2,989.11	
Cost ($)	565.65	1,897.46	804.00	1,516.06		447.77	5,230.94	3.0

[a]An average situation in Area 2 as described by land use and soil productivity levels in Table XVIII, available operator's labor in Table XXXVI, and an income target of $7,000.

required in caring for the calf. Pastures and crops must be cared for through the summer months and require additional labor in these periods.

Capital Requirements. The capital requirements in Table XLIII vary according to the goal-related objective for which analysis was made. For example, in the minimum capital solution, total capital is minimized. However, in the minimum land solution only land capital is minimized and the total value of land capital is decreased by $2,000. Nonland capital requirements are increased and annual operating capital requirements are decreased in the minimum land solution compared to the minimum capital solution.

The total capital charge is also included in Table XLIII. There is less than $2,000 variation in the capital charge between the minimum capital, minimum land, minimum labor, and maximum net return solutions. However, the minimum cost solution increases the capital charge to $38,600, representing 29.3 percent of the total annual costs of the organization. The total capital requirement for the minimum cost solution increases because of the additional land capital requirement. Only annual costs are minimized and land capital is not included, thus allowing land capital to be substituted for annual costs. When the minimum cost solution is compared with the minimum capital solution, additional land is purchased and operating costs are reduced.

Within the model, capital requirements are inventoried in terms of annual operating capital, nonland capital, and land capital. However, the cash flow method of capital accounting included in the model can be used for comparison with annual operating capital. The cash flow method gives detailed information about the amount of external capital needed to operate the representative farm. It does not convert the operating

TABLE XLIII

SUMMARIES OF CAPITAL REQUIREMENTS OF OPTIMAL ORGANIZATIONS FOR THE REPRESENTATIVE SITUATION WITH ALTERNATIVE OBJECTIVE FUNCTIONS FOR AREA 2 OF EASTERN OKLAHOMA[a]

	Types of Capital				
	Annual Operating Capital	Nonland Capital	Land Capital	Total	Percent of Total Costs
			(Minimum Capital)		
Amount	75,394.92	64,393.43	204,043.10	343,831.44	
Capital Charge	5,277.64	4,507.54	12,242.59	22,027.77	11.8
			(Minimum Cost)		
Amount	56,000.67	217,340.86	324,483.13	597.824.66	
Capital Charge	3,920.05	15,213.86	19,468.99	38,602.90	29.3
			(Minimum Land)		
Amount	70,284.24	86,600.51	202,135.02	359,019.77	
Capital Charge	4,919.90	6,062.04	12,128.10	23,110.04	13.4
			(Minimum Labor)		
Amount	87,441.82	49,587.20	229,794.88	366,823.89	
Capital Charge	6,120.93	3,471.10	13,787.69	23,379.72	10.7
			(Maximum Net Return)		
Amount	72,009.67	88,902.29	208,000.00	369,001.95	
Capital Charge	5,046.98	6,223.16	12,480.00	23,750.14	13.4

[a]An average situation in Area 2 as described by land use and soil productivity levels in Table XVIII, available operator's labor in Table XXXVI, and an income target of $7,000.

capital used to an annual basis, so that the total charges for operating capital can be made as can also be done through the use of annual operating capital. However, in farm financial planning cash flow information can be beneficial and can provide guidelines for the operator to use in establishing the capital needs from external sources and feasible repayment plans. Cash flows for the alternative solutions are presented in Table XLIV.

The net return from the cash flow section of the model approximates the net return from the row used for objective function used to maximize net returns when adjustments are made for items not included in the cash flow. Those items not included in the cash flow are the annual charges for pasture establishment depreciation, machinery depreciation, livestock equipment depreciation, and capital required in the organization. When the charge for the total capital of $22,027.77 used in the minimum capital solution is subtracted from period six's cash balance of $30,110.17 and adjustments are made for the factors not charged as annual cash costs, then the net returns from the cash flow are comparable to the solution of the net return row, since the balance in period six approximates zero and the income target has been met.

Alternative Organization Strategies

Several types of resource use strategies are open to the operator of the representative situation considered with this model. The operator might desire to select one or a combination of the alternative organizations previously presented. The minimum capital objective function was selected for the analysis of the different strategies presented in this section. These strategies relate to alternative livestock

TABLE XLIV

SUMMARIES OF ACTUAL BALANCE OPERATING CAPITAL[a] OF OPTIMAL ORGANIZATIONS FOR THE REPRESENTATIVE SITUATION[b] WITH ALTERNATIVE OBJECTIVE FUNCTIONS FOR AREA 2 OF EASTERN OKLAHOMA

	Periods					
	1	2	3	4	5	6
			(Minimum Capital)			
Expenses	5,118.52	72,232.88	5,658.70	10,802.94	5,711.86	65,487.46
Income		7,278.56		94,786.41	93,057.57	
Borrowed	5,118.52	70,072.85	75,731.55			
Cash Balance				8,251.93	95,597.63	30,110.17
			(Minimum Cost)			
Expenses	7,006.88	38,633.82	7,427.86	13,513.89	7,336.84	13,686.69
Income		29,310.05		66,823.45	44,013.36	
Borrowed	7,006.88	16,330.65	23,758.51			
Cash Balance				29,551.05	66,227.57	52,540.88
			(Minimum Land)			
Expenses	5,652.73	54,846.43	5,636.81	11,399.85	5,665.36	65,568.81
Income		14,442.36		97,962.04	68,360.81	
Borrowed	5,652.73	46,056.80	51,693.61			
Cash Balance				34,868.58	97,564.02	31,995.22
			(Minimum Labor)			
Expenses	5,325.96	94,357.98	6,269.43	10,978.14	6,177.74	72,030.00
Income		2,463.15		100,638.81	123,494.66	
Borrowed	5,325.96	97,220.80	103,490.23	13,829.56		
Cash Balance					103,487.35	31,457.36
			(Maximum Net Return)			
Expenses	5,798.14	55,426.79	5,765.18	11,705.10	5,765.10	67,907.31
Income		14,473.84		101,866.62	69,015.94	
Borrowed	5,798.14	46,751.09	52,516.27			
Cash Balance				37,645.26	100,896.09	32,988.78

[a]Cash flow.

[b]An average situation in Area 2 as described by land use and soil productivity levels in Table XVIII, available operator's labor in Table XXXVI, and an income target of $7,000.

systems and to alternative land use systems. However, all the strategies use the same representative base and prices of resources such as capital, labor, and land used in the production process of the final products from the cow-calf or stocker activities.

<u>Livestock Strategies</u>

The alternative livestock strategies for the representative farm situation are presented in Table XLV. The first strategy considered allows the model to select any of the livestock alternatives (same as in Table XXXVIII). Allowing only a cow-calf system and selling 460 pound steer calves and 440 pound heifer calves at the age of 205 days is the second strategy. The third strategy is an integrated system in which all stockers fed on the farm must be raised within the organization. Calves produced in the cow-calf alternative are either sold as calves or grazed in the farm organization to 750 pounds and then sold.

As restrictions are put on the type of systems considered, the animal unit equivalents included in the organization to earn the specified level of income increase to tremendous size. The system of only cow-calf alternatives requires 34,684 animal unit equivalents to earn the $7,000 returns to labor and management. The index of animal intensity is 2.4 with 0.2 percent of the nutrient requirements furnished by concentrates purchased outside the organization for such a cow-calf system. Labor requirements for this system are almost 308,000 hours. The system would require over 100 full-time hired men to meet the labor requirements. This alternative is not reasonable. However, one factor to consider with the strategy restricted to cow-calf alternatives is that with the size obtained in the solution some economies to size,

TABLE XLV

SUMMARIES OF OPTIMAL ORGANIZATIONS OF ALTERNATIVE LIVESTOCK STRATEGIES FOR THE REPRESENTATIVE SITUATION WITH A MINIMUM CAPITAL GOAL FOR AREA 2 OF EASTERN OKLAHOMA[a]

Item	Unit	Grazing System	All Alternatives	Cow-Calf System	Integrated System
Total Land	Acres		1,569.56	83,176.06	3,674.05
Annual Cost	$		186,907.54	3,667,956.84	153,254.28
Total Labor	Hours		4,834.28	307,850.18	12,991.10
Total Capital	$		343,831.44	21,167,195.83	901,307.41
Annual Operating Capital	$		75,394.92	553,106.09	53,706.02
Cropland Planted	Acres		293.51	15,553.92	687.05
Bermuda	Acres	2 and 4	37.93	2,374.67	63.83
Fescue	Acres	1	74.03	8,862.41	449.43
Native	Acres	1	760.68	32,942.34	1,541.21
Native	Acres	2	46.76	9,211.29	320.80
Sorghum-Sudan	Acres	1	105.99	5,402.15	221.35
Sorghum-Sudan	Acres	2	79.30	5,571.60	307.54
Small Grain	Acres	1	108.22	4,580.18	158.16
COW1	Head		0.00	31,530.68	0.00
COW2	Head		112.54	0.00	1,136.93
STST1	Head		511.04	0.00	0.00
STST2	Head		11.24	0.00	0.00
STST3	Head		487.66	0.00	499.26
STHF2	Head		31.46	0.00	0.00
Hay Fed	cwt.		4,194.95	460,266.82	17,084.08
Concentrate Fed	cwt.		847.80	3,534.48	218.40
Cubes Fed	cwt.		0.00	0.00	0.00
Index of Land Use Intensity[b]	%		25.8	32.2	32.7
Requirement from Concentrates[c]	%		3.0	0.2	0.3
Animal Unit Equivalents[d]			508.39	34,683.75	1,480.28
Index of Animal Intensity[e]			3.09	2.40	2.48

[a]An average situation in Area 2 as described by land use and soil productivity levels in Table XVIII, available operator's labor in Table XXXVI, and an income target of $7,000.

[b]Percent of total acres in forages that require rotation grazing.

[c]Percent of total digestible nutrient requirements furnished by purchased feedstuffs.

[d]Each breeding unit represents 1.1 animal units, STST1, STST2, and STHF2 represent .29 animal units, and STST3 represents .46 animal units.

[e]Number of acres per animal unit equivalent.

which have not been considered in the budgets prepared for this study, may exist. The model used for these analyses assumes a linear relationship through size and does not allow adjustments for economies.

The index of animal intensity for the organization considering all livestock alternatives, is 3.09 with 508 animal unit equivalents. Only the labor of one half-time hired man is required. As can be observed in Table XLV, by any measure of size chosen, the strategy considering all livestock alternatives is smaller. This strategy requires fewer animals, less capital, less labor, less annual costs, and less intensive use of land.

The integrated system requires almost 3,700 acres to achieve the income target that is earned on less than 1,600 acres when all livestock alternatives are considered. The number of animal unit equivalents required is 1,480. The index of animal intensity for the integrated system is 2.48, which is a more intense animal unit to land ratio than occurs when all livestock alternatives are considered. Both restricted strategies have a higher index of land use intensity than the strategy that considers all livestock alternatives as shown in Table XLV.

The alternative livestock strategies are presented on a per acre basis in Table XLVI and on an animal unit equivalent basis in Table XLVII. When the unrestricted strategy is compared to the restricted strategies, annual costs and annual operating capital per unit are higher, but the total capital requirement per unit is less. The greatest difference in the forages included in the organizations occurs in the amount of native pasture which is higher in the unrestricted strategy organization. Operator's labor and management return per acre is significantly higher for the unrestricted system ($4.46) than for the

TABLE XLVI

SUMMARIES OF OPTIMAL ORGANIZATIONS OF ALTERNATIVE LIVESTOCK STRATEGIES PER ACRE FOR THE REPRESENTATIVE SITUATION WITH A MINIMUM CAPITAL GOAL FOR AREA 2 OF EASTERN OKLAHOMA[a]

Item	Unit	Grazing System	All Alternatives	Cow-calf System	Integrated System
Total Land	Acres		1.0	1.0	1.0
Annual Cost	$		119.08	44.10	41.71
Total Labor	Hours		3.08	3.70	3.54
Total Capital	$		219.05	254.49	245.32
Annual Operating Capital	$		48.03	6.65	14.62
Cropland Planted	Acres		.19	.19	.19
Bermuda	Acres	2 and 4	.023	.029	.017
Fescue	Acres	1	.047	.107	.122
Native	Acres	1	.484	.396	.419
Native	Acres	2	.029	.111	.087
Sorghum-Sudan	Acres	1	.067	.065	.060
Sorghum-Sudan	Acres	2	.050	.067	.084
Small Grain	Acres	1	.068	.055	.043
COW1	Head		0.000	.379	0.000
COW2	Head		.171	0.000	.309
STST1	Head		.325	0.000	0.000
STST2	Head		.007	0.000	0.000
STST3	Head		.310	0.000	1.36
STHF2	Head		.020	0.000	0.000
Hay Fed	cwt.		2.672	5.534	4.650
Concentrate Fed	cwt.		.540	.042	.059
Cubes Fed	cwt.		0.000	0.000	0.000
Index of Land Use Intensity[b]	%		25.8	32.2	32.7
Requirement from Concentrates[c]	%		3.0	0.2	0.3
Animal Unit Equivalents[d]			.324	.417	.403
Index of Animal Intensity[e]			3.09	2.40	2.48
Capital Charge[f]	$		14.03	25.26	15.87
Labor and Management Returns[g]	$		4.46	0.08	1.91

[a]An average situation in Area 2 as described by land use and soil productivity levels in Table XVIII, available operator's labor in Table XXXVI, and an income target of $7,000.

[b]Percent of total acres in forages that require rotation grazing.

[c]Percent of total digestible nutrient requirements furnished by purchased feedstuffs.

[d]Each breeding unit represents 1.1 animal units, STST1, STST2, and STHF2 represent .29 animal units, and STST3 represents .46 animal units.

[e]Number of acres per animal unit equivalent.

[f]Charge per acre for land capital is $7.80.

[g]Includes only operator's labor.

TABLE XLVII

SUMMARIES OF OPTIMAL ORGANIZATIONS OF ALTERNATIVE LIVESTOCK STRATEGIES PER ANIMAL UNIT FOR THE REPRESENTATIVE SITUATION WITH A MINIMUM CAPITAL GOAL FOR AREA 2 OF EASTERN OKLAHOMA[a]

Item	Unit	Grazing System	All Alternatives	Cow-calf System	Integrated System
Total Land	Acres		3.09	2.40	2.48
Annual Cost	$		367.65	105.75	103.53
Total Labor	Hours		9.51	8.88	8.78
Total Capital	$		676.31	610.29	608.88
Annual Operating Capital	$		148.30	15.95	36.28
Cropland Planted	Acres		.58	.45	.46
Bermuda	Acres	2 and 4	.074	.068	.043
Fescue	Acres	1	.146	.256	.304
Native	Acres	1	1.496	.950	1.041
Native	Acres	2	.092	.266	.217
Sorghum-Sudan	Acres	1	.208	.156	.150
Sorghum-Sudan	Acres	2	.156	.161	.208
Small Grain	Acres	1	.213	.132	.107
Hay Fed	cwt.		8.215	13.270	11.541
Concentrate Fed	cwt.		1.668	.102	.148
Cubes Fed	cwt.		0.000	0.000	0.000
Index of Land Use Intensity[b]	%		25.8	32.2	32.7
Requirement from Concentrates[c]	%		3.0	0.2	6.3
Animal Unit Equivalents[d]			1.0	1.0	1.0
Index of Animal Intensity[e]			3.09	2.40	2.48
Capital Charge[f]	$		43.33	60.57	39.39
Labor and Management Returns[g]	$		13.77	0.20	4.73

[a]An average situation in Area 2 as described by land use and soil productivity levels in Table XVIII, available operator's labor in Table XXXVI, and an income target of $7,000.

[b]Percent of total acres in forages that require rotation grazing.

[c]Percent of total digestible nutrient requirements furnished by purchased feedstuffs.

[d]Each breeding unit represents 1.1 animal units, STST1, STST2, and STHF2 represent .29 animal units, and STST3 represents .46 animal units.

[e]Number of acres per animal unit equivalent.

[f]Charge per acre for land capital is $7.80.

[g]Includes only operator's labor.

cow-calf and integrated systems ($0.08 and $1.91, respectively).

Table XLVII shows that the restricted systems are more intensive systems and require less acres per animal unit equivalent, although larger amounts of hay are fed in both systems.

Land Use Strategies

Annual crops produce large amounts of nutrients during certain seasons of the year and can effectively supplement native and improved pasture forages. How is the organization of the representative situation affected when the use of annual crops is restricted? Is it necessary for beef farm operators to plant annual crops to maintain his organization? Answers to such questions will be forthcoming from the following analysis and discussion.

The limited cropland strategy restricts tilled crops (sorghum-sudan and small grains) to 18.7 percent of the total land base. The restriction on tilled cropland was lifted for the unrestricted strategy. In this strategy all openland suitable for crops could be planted to improved pastures such as bermuda, bermuda-fescue or fescue, as well as to sorghum-sudan or small grains, with no restriction on the amount of sorghum-sudan and small grains.

The third strategy does not allow any cropland to be tilled. The cropland can be planted in bermuda, bermuda-fescue, fescue, native, or remain idle. Solutions for these strategies are presented in Table XLVIII.

The solution for the unrestricted cropland strategy plants more acres of sorghum-sudan and small grains and meets the $7,000 return to labor and management for family living expenses with fewer resources

TABLE XLVIII

SUMMARIES OF OPTIMAL ORGANIZATIONS OF ALTERNATIVE LAND USE STRATEGIES FOR THE REPRESENTATIVE SITUATION WITH A MINIMUM CAPITAL GOAL FOR AREA 2 OF EASTERN OKLAHOMA[a]

Item	Unit	Grazing System	Limited Cropland	Unrestricted Cropland	No Cropland 50% Equity
Total Land	Acres		1,569.56	697.93	4,521.89
Annual Cost	$		186,907.54	127,303.64	252,903.43
Total Labor	Hours		4,834.28	2,580.12	19,852.99
Total Capital	$		343,831.44	163,471.41	1,178,565.89
Annual Operating Capital	$		75,394.92	51,131.21	108,169.10
Cropland Planted	Acres		293.51	244.07	0.00
Bermuda	Acres	2 and 4	37.93	6.63	674.08
Bermuda-Fescue	Acres	1	0.00	0.00	103.31
Fescue	Acres	1	74.91	0.00	652.88
Native	Acres	1	760.68	274.62	2,171.15
Native	Acres	2	46.78	56.41	146.78
Sorghum-Sudan	Acres	1	105.99	61.98	0.00
Sorghum-Sudan	Acres	2	79.30	51.74	0.00
Small Grain	Acres	2	108.22	130.36	0.00
COW1	Head		0.00	15.42	8.46
COW2	Head		112.54	0.00	1,367.88
STST1	Head		511.04	459.83	0.00
STST2	Head		11.24	237.15	0.00
STST3	Head		487.66	31.75	948.30
STHF2	Head		31.46	0.00	0.00
Hay Fed	cwt.		4,194.95	2,314.45	51,470.39
Concentrate Fed	cwt.		847.80	648.86	5,805.78
Cubes Fed	cwt.		0.00	22.92	0.00
Index of Land Use Intensity[b]	%		25.8	35.9	31.6
Requirement from Concentrates[c]	%		3.0	5.2	5.4
Animal Unit Equivalents[d]			508.39	233.69	1,950.19
Index of Animal Intensity[e]			3.09	2.99	2.32

[a]An average situation in Area 2 as described by land use and soil productivity levels in Table XVIII, available operator's labor in Table XXXVI, and an income target of $7,000.

[b]Percent of total acres in forages that require rotation grazing.

[c]Percent of total digestible nutrient requirements furnished by purchased feedstuffs.

[d]Each breeding unit represents 1.1 animal units, STST1, STST2, and STHF2 represent .29 animal units, and STST3 represents .46 animal units.

[e]Number of acres per animal unit equivalent.

than the restricted cropland strategy. The unrestricted strategy requires only 234 animal unit equivalents and has an index of animal intensity of 2.99. Thirty-six percent of the land included is intensively used and 5.2 percent of the nutrient requirements are met by purchased feedstuffs. Only three percent of the nutrient requirements are purchased in the limited cropland alternative.

If all capital used in the organization is charged at the appropriate interest rate, the strategy of no cropland planted in sorghum-sudan or small grains could not develop a solution that would earn $7,000 return to labor and management. The organization with no cropland that is presented in Table XLVIII reflects 50 percent equity on all types of capital. This equity level implies that the operator is earning no returns on half of his land capital, investment in working assets, and annual operating capital. Although only 4,500 acres are required in this solution, total capital required is over one million dollars. This alternative requires the purchase of greater amounts of feedstuffs to furnish a larger proportion of livestock nutrients than all other organizations considered (5.4 percent). Because wheat pasture is not available in early spring, supplemental feeding is needed.

As additional land is planted in tilled crops, the early spring calving system enters the organization replacing the late spring calving system. This change in calving systems reflects the availability of nutrients from small grain grazing in early spring. Nutrients being provided by forages such as native pasture and bermuda that have low nutrient yields in this period need to be supplemented to support the early calving system. Table XLVIII illustrates that as sorghum-sudan and small grains are restricted, costs increase, the required number of animal unit equivalents increase, and other associated inputs such as capital and labor also increase in trying to maintain the $7,000 income target that is required. Those forages replacing sorghum-sudan and small grains in the organization do not have as high nutrient yields per acre. Additional land and animal unit equivalents are required to just maintain the income target.

The conversion of solutions in Table XLVIII to a unit basis allows comparisons on a common base. Solutions from alternative land use strategies are presented in Table XLIX on a per acre basis and in Table L on a per animal unit basis.

The more that cropland use is restricted, the more annual costs per acre and annual operating capital per acre decrease. The returns to operator's labor and management per acre also decrease with more rigid restrictions on cropland use.

Although the index of land use intensity is higher for the no cropland strategy than for limited cropland strategy, the index of animal intensity for the no cropland strategy is the lowest of all land use strategies. The amount of hay fed and concentrates bought per animal unit equivalent is significantly higher for the no cropland strategy than for unrestricted or limited cropland strategy (almost three times more hay and almost 10 percent more concentrates).

It is apparent from Tables XLVIII, XLIX, and L that some cropland for temporary pasture is essential for a viable beef farm organization in eastern Oklahoma that can pay equitable returns to all factors of production and earn a $7,000 return to operator's labor and management.

TABLE XLIX

SUMMARIES OF OPTIMAL ORGANIZATIONS OF ALTERNATIVE LAND USE STRATEGIES PER ACRE FOR THE REPRESENTATIVE SITUATION WITH A MINIMUM CAPITAL GOAL FOR AREA 2 OF EASTERN OKLAHOMA[a]

Item	Unit	Grazing System	Limited Cropland	Unrestricted Cropland	No Cropland 50% Equity
Total Land	Acres		1.0	1.0	1.0
Annual Cost	$		119.08	182.40	55.93
Total Labor	Hours		3.08	3.70	4.39
Total Capital	$		219.05	234.22	260.64
Annual Operating Capital	$		48.03	73.26	23.92
Cropland PLanted	Acres		.19	.34	0.00
Bermuda	Acres	2 and 4	.023	.009	.149
Bermuda-Fescue	Acres	1	0.000	0.000	.023
Fescue	Acres	1	.047	0.000	.144
Native	Acres	1	.484	.393	.480
Native	Acres	2	.029	.081	.032
Sorghum-Sudan	Acres	1	.067	.089	0.000
Sorghum-Sudan	Acres	2	.050	.074	0.000
Small Grain	Acres	2	.068	.187	0.000
COW1	Head		0.000	.022	.002
COW2	Head		.071	0.000	.303
STST1	Head		.325	.659	0.000
STST2	Head		.007	.340	0.000
STST3	Head		.310	.045	2.100
STHF2	Head		.020	0.000	0.000
Hay Fed	cwt.		2.672	3.316	11.382
Concentrate Fed	cwt.		.540	.930	1.284
Cubes Fed	cwt.		0.000	0.33	0.000
Index of Land Use Intensity[b]	%		25.8	35.9	31.6
Requirement from Concentrates[c]	%		3.0	5.2	5.4
Animal Unit Equivalents[d]			.324	.335	.431
Index of Animal Intensity[e]			3.09	2.99	2.32
Capital Charge[f]	$		14.03	15.10	16.94
Labor and Management Returns[g]	$		4.46	10.03	1.55

[a]An average situation in Area 2 as described by land use and soil productivity levels in Table XVIII, available operator's labor in Table XXXVI, and an income target of $7,000.

[b]Percent of total acres in forages that require rotation grazing.

[c]Percent of total digestible nutrient requirements furnished by purchased feedstuffs.

[d]Each breeding unit represents 1.1 animal units, STST1, STST2, and STHF2 represent .29 animal units, and STST3 represents .46 animal units.

[e]Number of acres per animal unit equivalent.

[f]Charge per acre for land capital is $7.80.

[g]Includes only operator's labor.

TABLE L

SUMMARIES OF OPTIMAL ORGANIZATIONS OF ALTERNATIVE LAND USE STRATEGIES PER ANIMAL UNIT FOR THE REPRESENTATIVE SITUATION WITH A MINIMUM CAPITAL GOAL FOR AREA 2 OF EASTERN OKLAHOMA[a]

Item	Unit	Grazing System	Limited Cropland	Unrestricted Cropland	No Cropland 50% Equity
Total Land	Acres		3.09	2.99	2.32
Annual Cost	$		367.65	544.75	129.68
Total Labor	Hours		9.51	11.04	10.18
Total Capital	$		676.31	699.52	604.33
Annual Operating Capital	$		148.30	218.80	55.47
Cropland Planted	Acres		.58	1.04	0.00
Bermuda	Acres	2 and 4	.074	.028	.346
Bermuda-Fescue	Acres	1	0.000	0.000	.053
Fescue	Acres	1	.146	0.000	.335
Native	Acres	1	1.496	1.175	1.113
Native	Acres	2	.092	.241	.075
Sorghum-Sudan	Acres	1	.208	.265	0.000
Sorghum-Sudan	Acres	2	.156	.221	0.000
Small Grain	Acres	2	.213	.558	0.000
Hay Fed	cwt.		8.251	9.904	26.393
Concentrate Fed	cwt.		1.668	2.777	2.977
Cubes Fed	cwt.		0.000	.098	0.000
Index of Land Use Intensity[b]	%		25.8	35.9	31.6
Requirement from Concentrates[c]	%		3.0	5.2	5.4
Animal Unit Equivalents[d]			1.0	1.0	1.0
Index of Animal Intensity[e]			3.09	2.99	2.32
Capital Charge[f]	$		43.33	45.08	39.29
Labor and Management Returns[g]	$		13.77	29.95	3.59

[a]An average situation in Area 2 as described by land use and soil productivity levels in Table XVIII, available operator's labor in Table XXXVI, and an income target of $7,000.

[b]Percent of total acres in forages that require rotation grazing.

[c]Percent of total digestible nutrient requirements furnished by purchased feedstuffs.

[d]Each breeding unit represents 1.1 animal units, STST1, STST2, and STHF2 represent .89 animal units, and STST3 represents .46 animal units.

[e]Number of acres per animal unit equivalent.

[f]Charge per acre for land capital is $7.80.

[g]Includes only operator's labor.

Model Evaluation

The farm organizations presented in the tables in this chapter illustrate the type of information obtainable with little or no revisions from the solutions made by the model developed for this dissertation. Checks have been made on the mechanics of the model to qualify the validity of results. The nutrient balancing, capital accounting, and feeding and grazing capacities sections, as well as the representative land base segment were included in the mechanical checks. All parts perform as planned and provide the information as desired.

If the model performs as expected, why the large deviation from the observed situation (Chapter II)? Part of the divergence may be the result of high levels of technology applicable in 1975 (target period) and not used in 1969. The model developed for this study is normative and evaluates a single goal at one time. If farmers have a combination of goals of which some are in conflict with others, a less than optimal organization could result and thus could cause divergence.

It also should be mentioned that the results from the model are only as valid as the data used as input. Additional research needs to be done in the area of consistency and seasonal distribution of forage nutrient yields and of livestock use of grazed forage nutrients. More reliable input data would add strength to the model. Suggestions for additional research are presented in Chapter VII.

Summary

An evaluation of the organizations presented in Table XXXVIII, shows that the minimum land solution is very similar to that of minimum capital and can be eliminated as a distinctly different goal to consider. The investment in land is the largest component of total capital and is reflected in the solution when capital is minimized.

The investment in land required to meet the organization requirements is increased considerably over the other solutions in the minimum cost solution. This increase occurs because only annual costs are considered and investment in land and working assets are ignored except for the interest charge made on capital. It is less costly to purchase land than to obtain more nutrients from forage alternatives with higher annual costs.

Established operators could have alternative uses for their labor and may prefer the minimum labor alternative. With this alternative the distribution of labor can be specified according to the goals of the operator and reflected in the programming results.

The alternatives of minimum capital and maximum net return reflect only small differences. Maximum net return reflects a more intense operation than the minimum capital alternative. However, because the land base is set from the minimum capital solution, the maximum net return organization should show some similarity. The procedure of minimizing capital to obtain the land base and of using this land base as the restriction for maximizing net return offers some flexibility in applying both goals. If the land base is previously established, then maximum net return reflects the average situation for most of the alternative objective functions considered and does not show the extremes obtained in the other solutions.

The section on actual balance operating capital included in this model offers assistance in planning the financial requirements and structure of the evaluated farm firm. This procedure aids in determining the amount of external capital required and a feasible repayment plan. Although this method does not reflect capital charges that are accomplished by the use of the annual operating capital method, it should be included in the model because of the assistance gained from the results of this section. The conventional method of capital accounting using land capital, nonland capital, and annual operating capital should be used to calculate charges for capital use in the organization.

This model can offer assistance in organizational and financial planning to any beef farm operator that would provide his coefficients for programming within the model. Possible applications of the model, limitations of the model and input data, and suggestions for additional research that would improve the model and input data are presented in Chapter VII.

CHAPTER VII

SUMMARY AND CONCLUSIONS

Beef production is expanding as a source of farm income in eastern Oklahoma. Adjustments in resource use that rely heavily on management decisions are required in this expansion process. The input data and the results of the representative situation analysis can provide management information for beef farm operators in eastern Oklahoma. The model provides additional information that will be helpful when attempting to achieve the farm organization that meets the objectives of the beef farm operator. Assistance to beef farm operators in farm financial planning can be obtained from segments of the model. A summary and use of the data and results are discussed in the following sections.

The Model

A model constructed within the framework of the Mathematical Programming System (IBM) can be versatile, adapted to reflect unique situations, and modified easily. Such a model as constructed for this dissertation and described in Chapter V has many uses as well as some limitations.

Model Application

The model can provide answers to questions concerning beef farm organizations in eastern Oklahoma. It is first necessary that the goals of the beef farm operator be known. An operator can then choose any of the goal-related objective functions described in Chapter V to use in the analysis of his farm organization. The alternative objective functions to select from are: minimum capital, minimum land, minimum costs, minimum labor, or maximum net returns. The flexibility of the model allows consideration of the goals selected by the operator and will solve for the optimum organization, subject to associated specified restrictions.

Beef activities are the only livestock enterprises included for consideration in the farm organization. The model balances a range ration for the beef systems included in the farm organization so that pasture, hay, and concentrate are used to the best advantage for the total farm organization in relation to costs, investment, and time. The range ration obtained balances the total digestible nutrients, digestible protein, and dry matter requirements specified within the model. Dry matter is a maximum constraint and total digestible nutrients and digestible protein are minimum requirements.

The accounting of resource use is accomplished through the use of six two-month periods that represent a complete production year. Nutrient production and consumption are specified by periods so that if adequate nutrients are not available in a period, supplemental feeding can be used. Analysis by periods allows the model to time resource use to meet the requirements within the model.

The representative land resource base developed in Chapter III defines each acre used in the representative situation by types of use and percentage of each soil productivity level for the total land in each area. The land activity that includes the proportion of an acre allocated to each soil productivity level and types of use can be modified to reflect the soils and land use of a specific organization.

The capital accounting section of the model can offer assistance in planning and evaluating the capital structure of beef farms. That section provides information about cash flow, external capital requirements, and possible repayment plans for borrowed capital. Information about total capital requirements by types of capital is also provided. The categories of annual operating capital, nonland capital, and land capital are used to represent all capital used in the organization. Capital charges on capital required in the beef farm organization are calculated for each category of capital.

Grazing and feeding systems used in the farm organization reflect different intensities of land use and management requirements. Capacities for different types of grazing are generated internally in the model according to the type of system required in the organization. Annual costs, capital required, and labor required are unique to each type of capacity included in the model. Cost estimates associated with grazing and feeding capacities are more accurately reflected by the process of generating capacity as needed. This procedure reduces extra unnecessary costs associated with unused feeding equipment and grazing facilities because of the ability of the model to use equipment and facilities by different animal activities to accomplish as near full usage as feasible.

Grazing capacities are generated according to the type of grazing system required, either intensive (rotation) or extensive (regular grazing), and depend on what types of forages are included in the organization. The structure of the grazing capacities section of the model is explained and illustrated in Appendix C.

Limitations

The linear programming technique of solving for the optimum organization has certain limitations. These limitations involve the concept of linear relationships, analysis of single objectives, and identification of individual resource use levels.

Input data developed for this study used the survey results presented in Chapter II as a general guide for size of operation and types of activities considered for inclusion. The linear programming model assumes linear relationships in terms of size. An activity within the model is used for small farm organizations as well as large farm organizations. If the size of organization used in the development of budget coefficients and the size determined in the solutions from the model are greatly different, then budget coefficients would need to be reevaluated. One set of coefficients cannot be used to reflect economies of size that may result from the larger size of the farm organization. For example, the machinery complement used in developing the forage budgets may be suitable for a 1,500 acre organization, but not for a 3,000 acre organization.

Goals of beef farm operators must be quantified to be analyzed for a solution in the model developed for this study. Joint relationships of goals are difficult to quantify in a single solution. Higher priority goals are generally reflected in the objective function, with lower priority goals either neglected in the analysis or stated in terms of minimum or maximum requirements that must be maintained.

MPS has no restriction on model size in terms of number of activities and rows. What does restrict the effective size of the model, however, is bulkiness and difficulty in recognizing significant data in solutions. The amount of data generated for a solution illustrates the desirability to restrict the model size to that necessary to adequately interpret the solutions. Many activity inputs are represented as aggregate costs, and to determine the level of such inputs, it is necessary to use the budgets developed as a basis for the livestock and crop activities included in the model.

Summary and Use of Data and Results

Data developed by this study can provide information for beef farm operators in eastern Oklahoma to use in making management decisions. The analysis of solutions presented in Chapter VI provides information about inter-relationships of the livestock systems as well as forage and livestock relationships and total farm resource use such as land, labor, and capital. The input data can provide a basis for additional study in relation to resource substitution, definition of a finite set of differentiated representative situations for each area and within an area, and the effects of such differentiated situations on total resource use in the study areas.

The representative resource situation developed in Chapter III provides a basis for analysis of representative situations and can be used for periodic analysis so that comparison of a series of results over time can be used to reflect changes in product supply and resource demand in the study areas. The indexes developed in Chapter IV that were used to convert nutrient data from one soil productivity level to other soil productivity levels will enable future nutrient production research data to be converted for applicability on all soil productivity levels. Such information will complement budget revision and preparation.

The crop budgets used in this dissertation were developed as explained in Chapter IV and reflect an initial attempt to estimate forage yields in terms of available nutrients. Though few data are available concerning forage nutrient yields, the model shows that such information can be useful to beef farm operators. The use of nutrient data for yield specifications allows a "range" ration to be balanced according to production and use patterns, considering the total resource use on the farm.

The production costs in the livestock activities, presented in Chapter IV, were extensively evaluated through the development process. The costs used actual farm data as a basis for development. The completeness of the cost data in the livestock budgets will enable beef farm operators to make a more complete analysis of their beef enterprises than was previously possible.

The input data used in this study need to be continually updated and revised. The results of any model are only as valid as the accuracy of the input data. Specific recommendations for reevaluation and revision of the input data will be discussed in the following section.

The specification of alternative goal-related objective functions allows flexibility in the analysis of beef farm organizations in the study areas. Each beef farm operator may have a different goal when organizing his beef farm. The objective functions specified in the model, described in Chapter V and used in Chapter VI, illustrate the effects of different goals on the farm organization of the representative situation.

The size of organization obtained from the model varied considerably according to the goal analyzed. Acres ranged from 1,555 acres in the minimum land solution to 2,500 acres for the minimum cost solution. Total capital used in the organization varied from $344,000 in the minimum capital solution to almost $600,000 in the minimum cost solution. The livestock system and amounts included were different in each solution and when converted to animal unit equivalents, ranged from 503 to 945.

The minimum capital objective function includes items evaluated separately by other objective functions. The capital that was minimized included annual operating capital, nonland capital, and land capital. By including capital requirement for annual cost, land investment charges, and hired labor charges, which are analyzed in separate objective functions, the minimum capital objective function is more comprehensive than others considered and was used in the analysis of alternative strategies.

Land use strategies restricted the use of sorghum-sudan or small grains on openland suitable for crops. The acres required to earn $7,000 for family living increase and more of other resources is required as the restriction on tilled crops is increased. As more permanent pasture forages are included in the farm organization, more supplemental feeding of hay, concentrates, or cubes is required.

The effects of limiting stocker animal activities in the model are: increased acres, greater amounts of resources, and more intensive land use necessary to maintain $7,000 income for family living. An integrated system, feeding only calves raised in the organization, more than doubled the required acres, and almost tripled the required capital and labor necessary to maintain the same income for family living. The exclusively cow-calf system solution required such a large land base that it is regarded as unrealistic.

Should this model be used in the analysis of specific situations or representative situations, additional research on input data will be required to maintain and improve the validity of such estimates.

Recommendations for Further Study

Research such as that proposed by the Regional Research Project used as a basis for this study provides an opportunity to try innovative concepts. Implementation and use of resulting data and models that are products of such research are a basis for establishing additional research needs.

New methods of evaluating the production yields of forages were attempted for this study. The use of such estimates has been illustrated by the solutions obtained from the model. Nutrient yield data required for a complete set of forage budgets for all soil groups are not readily available. Estimates were derived for soil groups and soil productivity levels for which nutrient yield data are unavailable by the use of indexes developed in Chapter IV. More accurate measurements of nutrient yield data of forages for all soil groups would provide greater accuracy in the solutions obtained from the model when balancing range rations. The divergence in the use of bermuda between the survey results presented in Chapter II and the solutions analyzed in Chapter VI raises questions concerning the forage relationships and the nutrient yields specified in the forage activities. Refinement and more reliable estimates of such yields would give greater accuracy and validity to the results obtained from the model.

Livestock nutrient requirements developed by the National Research Council cannot be used to effectively reflect feeding patterns that are used in Oklahoma. Specification of animal requirements in terms of nutrients for growth and nutrients for maintenance would allow more versatility in the types of livestock systems analyzed. Allowances for weight loss in winter feeding periods and recovery in summer periods are difficult to reflect in the nutrient requirements available for use. Information about nutrient requirements for such systems would permit a model as developed for this study to more accurately estimate grazed forage usage and supplemental feeding requirements necessary to balance a more representative range ration.

Additional study is needed to evaluate economies of size that may occur in the beef production industry. If livestock alternatives are restricted to a cow-calf system and large organizations occur, evaluation of the types of economies of size that may exist in such an organization would aid in the planning and management of a beef farm limited to cow-calf systems.

The capital accounting section of the model functions properly and provides information that is useful for financial planning in a farm organization. Additional study concerning the inclusion of annual charges for intermediate term investments required in a farm organization needs attention. Such items as annual charges for pasture establishment costs, machinery depreciation, and the annual costs of certain overhead items such as buildings, fences, and livestock equipment are included in this category. Since these items are not annual cash costs, they are not included in the cash flow section of capital accounting. The development of a procedure to include such costs in the cash flow section would add to the accuracy of the cash flow analysis. If charges for borrowed capital used in the farm organization are included in the cash flow system, results from the cash flow section would be useful in farm financial management.

Refining the model so that resources used by individual beef activities included in the organization could be identified would aid in budget preparation and provide additional management information. For example, the types and amount of forages used by a fall calving cow-calf system would aid in planning the management of forage use systems and in the operational management of the farm. Supplemental feeding of hay, concentrates, or supplement should also be identified by the livestock activity using the items in relation to the time and amounts used. Such information would aid in identifying whether the intensity of certain sections of the organization has become so great that a feedlot situation has developed.

If the results obtained in the analysis of the representative situations approximate the beef farm organizations needed to earn $7,000 for family living, then the need for additional research concerning the average returns to operator's labor and management for family living on beef farms in eastern Oklahoma is evident. The results differ drastically from the results obtained from the regional study (Chapter II). Attaining and maintaining a satisfactory level of income for family living above all costs appears to be a continual problem for beef farm operators in eastern Oklahoma. Analysis of different types of situations, including different levels of part-time farming, could furnish additional information in clarifying the problem of inadequate returns for family living.

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APPENDIX A

FARM CLASSIFICATION SHEET

Listing Sheet for Classification of Farms

Subregion______________ State______________ County______________ Segment______________

Operator's name	What was the largest number of beef cattle (cows and yearlings) on your farm at one time in 1968?	What was the total acres of open land (cropland plus open pasture) on your farm in 1968?	Did the gross receipts from your farm in 1968 amount to $1000 or more? (Yes or no)	Enumerators check (✓) Classification		
				Farm		
				Beef	Non-Beef	Non-Farm
1.						
2.						
3.						
4.						
5.						
6.						
7.						
8.						
9.						
10.						
11.						
12.						
13.						
14.						
15.						

Enumerator Note: For the purposes of this survey, a farm is a place with 50 or more acres of open land, or with gross farm receipts amounting to $1,000 or more in 1968.

If the farm operator meets either of the above requirements, and has 10 or more head of beef cattle, he is considered a beef farmer and a beef questionnaire should be taken. If he has fewer than 10 head, but qualifies as a farm, a nonbeef questionnaire should be taken.

In any case, be sure to get the information requested on the screening sheet since it will be needed to expand the sample for the total universe.

Beef cattle are defined as cows or yearlings, other than those used primarily to produce milk, or dairy replacement stock.

APPENDIX B

THE RELATIONSHIP OF SOIL TYPES TO SOIL PRODUCTIVITY LEVELS FOR EACH STUDY AREA IN EASTERN OKLAHOMA

TABLE LI

SOIL TYPES AND CHARACTERISTICS FOR EACH SOIL PRODUCTIVITY LEVEL FOR AREA 1 OF EASTERN OKLAHOMA

Soil Productivity Level	Soil Type and Slope	Capability Class
L_1	Eldorado silt loam, 1-3% slope	II-e
	Etowah gravelly silt loam, 1-3% slope	II-e
	Jay silt loam, 1-3% slope	II-e
	Newtonia silt loam, 1-3% slope	II-e
	Sallisaw gravelly silt loam, 1-3% slope	II-e
	Sallisaw silt loam, 1-3% slope	II-e
L_2	Baxter silt loam, 1-3% slope	II-e
	Captina silt loam, 1-3% slope	II-e
	Dickson silt loam, 1-3% slope	II-e
	Eldorado silt loam, 3-5% slope	III-e
	Lawrence silt loam	II-s
	Sallisaw gravelly silt loam, 3-8% slope	IV-e
L_3	Locust cherty silt loam, 1-3% slope	III-s
	Dickson cherty silt loam, 1-3% slope	III-s
	Etowah-Greendale soils, 3-8% slope	IV-e
	Linker fine sandy loam, 1-5% slope	III-e
L_4	Baxter cherty silt loam, 1-3% slope	III-e
	Baxter Locust complex, 3-5% slope	IV-s
	Eldorado soils, 3-12% slope	VI-s
	Linker fine sandy loam, eroded, 3-5% slope	III-e
S_2	Bodine very cherty silt loam, 1-8% slope	IV-s
S_3	Clarksville very cherty silt loam, 1-8% slope	IV-s
	Elsah soils	V-w
	Hector-linker fine sandy loam 1-5% slope	IV-e
	Gravelly alluvial land	V-w
S_4	Bodine stony silt loam, 5-15% slope	VI-s
	Bodine stony silt loam, steep	VII-s
	Clarksville silt loam, 5-20% slope	VI-s
	Clarksville stony silt loam 20-50% slope	VII-s
	Hector complex	V-w
	Sogn soils	VII-c
	Talpa rock outcrop complex 2-8% slope	VII-s
C_2	Stigler silt loam, 0-1% slope	II-w
	Summit silty clay loam, 1-3% slope	II-e

TABLE LI (CONTINUED).

Soil Productivity Level	Soil Type and Slope	Capability Class
B_1	Huntington gravelly loam	II-w
	Huntington silt loam	I-1
	Staser gravelly silt loam, 0-1% slope	II-w
	Staser silt loam, 0-1% slope	II-w

TABLE LII

SOIL TYPES AND CHARACTERISTICS FOR EACH SOIL PRODUCTIVITY LEVEL FOR AREA 2 OF EASTERN OKLAHOMA

Soil Productivity Level	Soil Type and Slope	Capability Class
L_1	Bates loam, 1-3% slope	II-e
	Baxter silt loam, 1-3% slope	II-e
	Etowah silt loam, 0-3% slope	II-e
	Hartsells fine sandy loam, 1-3% slope	II-e
	Linker fine sandy loam, 1-3% slope	II-e
	Newtonia silt loam, 0-1% slope	I
	Newtonia silt loam, 1-3% slope	II-e
L_2	Bates loam, 3-5% slope	III-e
	Craig silt loam, 1-3% slope	II-e
	Eldorado silt loam, 3-5% slope	III-e
	Etowah gravelly silt loam, 3-8% slope	IV-e
	Huntington gravelly silt loam, 0-1% slope	II-w
	Linker fine sandy loam, 3-5% slope	III-e
	Lula silt loam, 1-3% slope	II-e
	Sallisaw gravelly silt loam, 1-3% slope	II-e
	Sallisaw silt loam, 0-3% slope	II-e
	Vanoss loam and silt loam, 0-2% slope	II-e
	Broken alluvial land, 0-1% slope	V-w
L_3	Bates loam, eroded, 2-5% slope	III-e
	Bates & Dennis soils, eroded, 3-5% slope	III-e
	Claremore silt loam, 0-3% slope	III-e
	Lawrence silt loam, 0-1% slope	II-s
	Linker & Enders fine sandy loam, 2-6% slope	III-e
	Sallisaw gravelly silt loam, 3-8% slope	IV-e
	Stephenville fine sandy loam, 0-3% slope	II-e
	Stephenville fine sandy loam, 1-5% slope	III-e
	Teller fine sand loam & silt loam 2-6% slope	
L_4	Bates fine sandy loams, 2-6% slope	IV-e
	Bates fine sandy loam, shallow, 2-6% slope	IV-e
	Bates loam, shallow, 1-5% slope	IV-e
	Bates-Collinsville complex, 1-5% slope	IV-e
	Claremore silt loam, 1-5% slope	III-e
	Dougherty fine sandy loam, 3-20% slope	VI-e
	Eldorado stony silt loam, 1-8% slope	VI-s
	Eldorado soils, 1-8% slope	VI-s
	Newtonia-Sogn complex, 1-8% slope	VI-s
	Verdigris soils channeled, 0-15% slope	V-w
	Verdigris breaks complex	VI-e
	Alluvial, 0-1% slope	V-w

TABLE LII (CONTINUED).

Soil Productivity Level	Soil Type and Slope	Capability Class
L_4	Alluvial & Broken land	VI-e
	Breaks-Alluvial land complex	VI-e
	Narrow sloping drainageways	VI-e
S_1	Riverton gravelly silt loam, 1-5% slope	III-e
	Riverton loam, 1-3% slope	II-e
	Riverton silt loam, 1-3% slope	II-e
S_2	Bodine cherty silt loam, 0-3% slope	IV-e
	Clarksville very cherty silt loam, 1-8% slope	IV-s
	Riverton gravelly loam, 3-5% slope	III-e
	Riverton fine sandy loam, 3-6% slope	II-e
S_3	Bodine cherty silt loam, 1-8% slope	IV-s
	Bodine very cherty silt loam, 1-8% slope	IV-s
	Darnell-Stephenville complex, 1-5% slope	IV-e
	Hector-Hartsells fine sand loam, 1-5% slope	IV-e
	Hector-Linker fine sandy loam, 1-5% slope	IV-e
	Hector-Linker complex, 1-5% slope	IV-e
S_4	Bodine stony silt loam, 1-15% slope	VI-s
	Bodine stony silt loam, steep slope	VII-s
	Collinsville stony loam, 3-20% slope	VII-s
	Collinsville soils	VII-s
	Collinsville-Talihina Complex, 5-20% slope	VI-s
	Collinsville-Vinta complex, 2-30% slope	VII-s
	Darnell stony sandy loam, 5-30% slope	VII-s
	Eufaula loamy fine sand, 3-20% slope	IV-s
	Hector stony sandy loam, 3-30% slope	VII-s
	Hector stony fine sandy loam, 6-20% slope	VIII-s
	Hector complex, 5-30% slope	VII-s
	Hector-Linker complex, 5-20% slope	VI-s
	Sogn stony clay loam, 6-20% slope	VII-s
	Sogn stony silty clay loam, 6-20% slope	VII-s
	Sogn soils, 3-20% slope	VII-s
	Sogn soils, very shallow, 1-20% slope	VII-s
	Talpa soils, 0-3% slope	VII-s
	Talpa stony soils	VII-s
	Talpa-Summit complex, 1-8% slope	VI-s
	Gravel & borrow pits	
	Rough stony land, 20-35% slope	VII-s
	Strip mines & dumps	VII-s
C_1	Bonham silt loam, 1-3% slope	II-e
	Choteau silt loam, 0-1% slope	I
	Dennis silt loam, 0-1% slope	I

TABLE LII (CONTINUED).

Soil Productivity Level	Soil Type and Slope	Capability Class
L_4	Dennis silt loam, 1-3% slope	II-e
	Okemah silty clay loam, 0-1% slope	I
	Okemah silt loam, 0-1% slope	I
	Okemah silt loam, 1-3% slope	II-e
	Summit silty clay loam, 1-3% slope	II-e
C_2	Cherokee silt loam, 0-1% slope	
	Choteau silt loam, 1-3% slope	II-e
	Choteau silt loam, 2-6% slope	II-e
	Dennis silt loam, 3-5% slope	III-e
	Dennis silt loam, eroded, 2-5% slope	III-e
	Okemah silty clay loam, 1-3% slope	II-e
	Okemah silty clay loam, eroded, 1-3% slope	III-e
	Okemah-Eram clay loams, 1-3% slope	III-e
	Summit silty clay loam, 3-5% slope	III-e
	Taloka silt loam, 0-1% slope	II-s
C_3	Dennis-Bates complex, 2-5% slope	III-e
	Parsons silt loam, 0-1% slope	II-s
	Parsons silt loam, 1-3% slope	III-e
	Parsons silt loam, eroded, 1-3% slope	IV-e
	Summit silty clay loam, eroded, 2-5% slope	III-e
	Woodson silty clay loam, 0-1% slope	II-s
C_4	Dennis silt loam, severely eroded, 2-6% slope	VI-e
	Dwight-Parsons silt loam, 0-1% slope	IV-s
	Enders stony loam, 6-20% slope	
	Eram clay loam, 5-15% slope	VI-e
	Talihina stony clay loam, 6-20% slope	
	Oil wasteland	VIII-s
B_1	Cleora fine sandy loam, 0-2% slope	I
	Huntington silt loam, 0-1% slope	I
	Lincoln fine sand, 1-6% slope	
	Mason silt loam, 0-1% slope	I
	Radley silt loam, 0-1% slope	II-w
	Reinach silt loam, 0-1% slope	I
	Staser silt loam, 0-1% slope	II-w
	Verdigris clay loam, 0-1% slope	II-w
	Verdigris silt loam, 0-1% slope	II-w
	Verdigris silty clay loam, 0-1% slope	II-w
	Yahola fine sand loam, 0-2% slope	II-w
	Yahola silt loam, 0-2% slope	II-w
	Yahola silty clay loam, 0-2% slope	II-w

TABLE LII (CONTINUED).

Soil Productivity Level	Soil Type and Slope	Capability Class
B_2	Lela soils silted and sands, 0-1% slope	
	Lightning silt loam, 0-1% slope	III-w
	Lightning clay	
	Lightning-Carytown complex, 0-1% slope	III-w
	McLain silty clay loam, 0-1% slope	III-w
	McLain soils imperfectly drained, 0-1% slope	
	Miller clay, 0-1% slope	VI-e
	Osage clay, 0-1% slope	III-w
	Osage silty clay loam, 0-1% slope	II-s

TABLE LIII

SOIL TYPES AND CHARACTERISTICS FOR EACH SOIL PRODUCTIVITY LEVEL FOR AREA 3 OF EASTERN OKLAHOMA

Soil Productivity Level	Soil Type and Slope	Capability Class
L_1	Bates fine sandy loam, 1-3% slope	II-e
	Bates fine sandy loam, 3-5% slope	III-e
	Hartsells fine sandy loam, 1-3% slope	II-e
	Linker fine sandy loam, 1-3% slope	II-e
	Pickwick loam, 1-3% slope	II-e
	Pickwick loam, 3-5% slope	III-e
	Rexor silt loam	II-w
	Sallisaw loam, 1-3% slope	II-e
	Spiro silt loam, 1-3% slope	II-e
	Stidham loamy fine sand, 0-3% slope	III-e
	Vian silt loam, 1-3% slope	II-e
L_2	Bates fine sandy loam, eroded, 2-5% slope	III-e
	Bernaldo fine sandy loam, 3-5% slope	III-e
	Dougherty loamy fine sand, 3-8% slope	IV-e
	Hartsells fine sandy loam, 3-5% slope	III-e
	Hartsells fine sandy loam, eroded, 2-5% slope	III-e
	Linker fine sandy loam, 3-5% slope	III-e
	Linker-Hector complex, 2-5% slope	IV-e
	Spiro silt loam, 3-5% slope	III-e
	Spiro silt loam, 2-5% slope	IV-e
L_3	Bates-Collinsville fine sandy loam, 2-5% slope	IV-e
	Bernaldo fine sandy loam, eroded, 2-5% slope	III-e
	Linker fine sandy loam, eroded, 2-5% slope	III-e
	Linker-Hector complex, 5-8% slope	IV-e
	Pickwick loam, eroded, 2-5% slope	III-e
	Spiro silt loam, eroded, 2-5% slope	III-e
L_4	Konawa soils, severely eroded, 3-8% slope	VI-e
	Linker & bernaldo soils, severely eroded, 2-8% slope	VI-e
	Linker and Stigler soils, 2-8% slope	VI-e
	Rexor soils, broken	V-w
S_2	Hector-Hartsells complex, 2-5% slope	IV-e
S_3	Hector fine sandy loam, 2-12% slope	VI-e
	Hector-Hartsells complex, severely eroded, 3-8% slope	VI-e

TABLE LIII (CONTINUED).

Soil Productivity Level	Soil Type and Slope	Capability Class
S_4	Collinsville complex, 5-40% slope	VII-s
	Hector-Linker-Enders complex, 5-40% slope	VII-s
	Strip Mines	VII-s
C_1	Choteau loam, 0-1% slope	I
	Choteau loam, 1-3% slope	II-e
	Dennis loam, 1-3% slope	II-e
	Dennis loam, 3-5% slope	III-e
	Stigler silt loam, 0-1% slope	II-s
	Stigler silt loam, 1-3% slope	II-e
C_2	Dennis loam, eroded, 2-5% slope	III-e
	Taloka silt loam, 1-3% slope	II-e
	Tamaha silt loam, 1-3% slope	II-e
C_3	Enders clay loam, 2-5% slope	IV-e
	McKamie fine sandy loam, 3-8% slope	IV-e
	Parsons silt loam, 0-1% slope	II-s
	Parsons silt loam, 1-3% slope	III-e
	Stigler silt loam, eroded, 2-5% slope	III-e
	Stigler-Wrightsville silt loam, 0-1% slope	III-w
	Tamaha silt loam, eroded, 2-5% slope	III-e
	Wrightsville silt loam, 0-2% slope	IV-w
C_4	Counts-Tamaha-Robinsville complex	VI-e
	Dennis-Dwight complex, severely eroded, 2-5% slope	VI-e
	Enders stony loam, steep slope	VII-e
	Enders-Hector complex, 3-15% slope	VII-s
	Enders-Hector complex, 5-30% slope	VII-s
	Enders-Hector complex, 15-30% slope	VII-s
	Eram clay loam, eroded, 2-5% slope	IV-e
	Liberal-Spiro complex, 2-5% slope	IV-e
	McKamie fine sandy loam, eroded, 3-8% slope	IV-e
	Parsons-Dwight complex, eroded, 1-3% slope	VI-e
	Talihina-Collinsville, complex, 5-20% slope	VII
	Tamaha silt loam, severely eroded, 3-8% slope	VI-e
B_1	Ennis silt loam, 0-1% slope	II-w
	Ennis and Verdigris soils, broken	V-w
	Reinach silt loam, 0-1% slope	I
	Robinsville fine sand loam	II-w
	Verdigris silt loam, 0-1% slope	II-w

TABLE LIII (CONTINUED).

Soil Productivity Level	Soil Type and Slope	Capability Class
B_2	Chastain silty clay loam, 0-2% slope	III-w
	Guyton silt loam	III-w
	Rosebloom silt loam, 0-1% slope	III-w
	Rosebloom and Ennis soils, broken	V-w

TABLE LIV

SOIL TYPES AND CHARACTERISTICS FOR EACH SOIL PRODUCTIVITY LEVEL FOR AREA 4 OF EASTERN OKLAHOMA

Soil Productivity Level	Soil Type and Slope	Capability Class
L_1	Hartsells fine sandy loam, 1-3% slope	II-e
	Kullit fine sandy	II-w
L_2	Bates fine sandy loam, eroded, 2-5% slope	III-e
	Blevins fine sandy loam, 1-3% slope	II-e
	Bowie fine sandy loam, 1-3% slope	II-e
	Cahaba loamy fine sand	III-e
	Hartsells fine sandy loam, 3-5% slope	III-e
	Ruston fine sandy loam, 3-5% slope	III-e
	Wagram loamy fine sand, 0-3% slope	III-e
L_3	Bates-Collinsville fine sandy loam, 2-5% slope	IV-e
	Bowie fine sandy loam, eroded, 1-5% slope	III-e
	Claremore silt loam, 1-3% slope	III-s
L_4	Ruston fine sandy loam, 5-8% slope	IV-c
	Ruston soils, severely eroded, 2-8% slope	VI-e
	Ruston fine sandy loam, 3-8% slope	IV-e
S_2	Hector-Hartsells complex, 2-5% slope	IV-e
S_3	Lucy loamy fine sand, 3-8% slope	IV-e
S_4	Tarrant stony clay, 1-20% slope	VII-s
C_1	Counts loam, 0-2% slope	II-e
	Dennis loam, 1-3% slope	II-e
	Felker loam, 0-1% slope	II-w
	San Saba clay, 0-1% slope	II-s
	Fiák fine sandy loam	II-e
C_2	Boswell fine sandy loam, 1-3% slope	III-e
	Dennis loam, eroded, 2-5% slope	III-e
	Durant loam, 1-3% slope	II-e
	Hollywood silty clay, 1-3% slope	II-e
	San Saba clay, 1-3% slope	II-e
	Sawyer fine sandy loam, 0-2% slope	II-s
	Tiak fine sandy loam, 3-5% slope	III-e
C_3	Boswell fine sandy loam, 3-5% slope	IV-e
	Cadeville loam	IV-e
	Hollywood silty clay, 3-5% slope	III-e
	Wrightsville silt loam, 0-1% slope	IV-w
	Parsons silt loam, 0-1% slope	II-s

TABLE LIV (CONTINUED).

Soil Productivity Level	Soil Type and Slope	Capability Class
C_4	Boswell fine sandy loam, 5-8% slope	VI-s
	Denton clay loam, 8-25% slope	VI-s
	Enders-Hector complex, 5-30% slope	VII-s
	Enders-Hector complex, 30-50% slope	VII-s
	Enders-Hector fine sandy loam, 5-8% slope	VI-e
	Eram clay loam, 3-5% slope	IV-e
	Samnter silty clay loam	VI-e
	Talihina-Collinsville complex, 5-20% slope	VII-s
	Tiak-Ruston complex, 5-15% slope	VI-e
B_1	Oaspiana loam	I
	Coushatta silty clay loam	I
	Ennis soils, broken, 0-2% slope	V-w
	Gowen clay loam, 0-2% slope	I
	Idabel very fine sandy	I
	Iuka fine sandy loam, non acid, 0-2% slope	V-w
	Ochlockonee fine sandy loam	III-s
	Oklared very fine sandy loam	III-s
	Pulaski fine sandy loam 0-2% slope	II-w
	Rexor loam	II-w
	Savern silt loam	II-s
B_2	Bibb-Iuka complex	V-w
	Garton silt loam	I
	Guyton-Elysian complex, mounded	III-w
	Kaufman clay	II-s
	Kinta clay loam, 0-2% slope	IV-w
	Osage and Gowen, 0-1% slope	V-w
	Pledger clay	II-w
	Pledger-Roebuck complex, undulating	III-w
B_2	Redlake clay	II-w
	Roebuck clay, ponded	V-w
	Tomast silt loam	II-w
	Trinity clay, 0-2% slope	II-s
	Tuscumbia clay	V-w

APPENDIX C

DESCRIPTION OF THE MECHANICS OF SECTIONS OF THE MPS MODEL

Certain segments of the developed model require additional explanation about the mechanics and construction. Transferring of products between activities within the model, maintenance of specified levels of inputs, generating internal capacities required by specific actitivities and balancing the cash flow of the capital accounting segment are further explained here.

Coefficients in the tables of this appendix are represented by either a one or an asterisk (*) if the coefficient is nonzero. The letter immediately following the row names represents the sign of that row in the model so that the coefficients within that row times the level of the activity, summed for all activities, is neutral (N), less than (L), or greater than (G) the right hand side or limit value.

Livestock Section

The columns and rows related to the nutrient balancing and buying, selling and transferring of animals for the livestock activities are presented in Table LV. Three cow-calf activities (COW1, COW2, and COW3) and five stocker activities (STST1, STST2, STST3, STHF1, and STHF2) are included in the model. The remaining activities in Table LV represent transfer, buy, and sell activities for specified periods, designated by the number following each name. Calves can be transferred from the cow-calf activities to the stocker activities through the transfer activities (STCAT2, STCAT5, HFCAT2, and HFCAT5). If the calves produced in the cow-calf activities are not transferred to the stocker activities, they are sold through the sell activities (STCAS2, STCAS4, STCAS5, HFCAS2, HFCAS 4, and HFCAS5). In addition to the transfer of calves from the cow-calf activities to the stocker activities, steer calves can be purchased outside the farm organization through the activities STSTB2

TABLE LV

ILLUSTRATION OF THE LIVESTOCK SECTION OF THE MODEL

		COW1	COW2	COW3	STST1	STST2	STST3	STHF1	STHF2	STCAT2	STCAT5	STCAS2	STCAS4	STCAS5	STSTB2	STSTB6	STSTS2	STSTS4	STSTS5	HFCAT2	HFCAT5	HFCAS2	HFCAS4	HFCAS5	STHFS2	STHFS5	CULCS	CULHFS4	CULHFS5	CULHFS2	RHS1
NETREVEN	G	-*	-*	-*	-*	-*	-*	-*	-*	*	*	*	*	*	-*	-*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	
NETREV	N	*	*	*	*	*	*	*	*	-*	-*	-*	-*	-*	*	*	-*	-*	-*	-*	-*	-*	-*	-*	-*	-*	-*	-*	-*	-*	
COST	N	*	*	*	*	*	*	*	*	-*	-*				*	*				-*	-*										
TLABOR	N	*	*	*	*	*	*	*	*																						
1TDN	L	*	*	*		*	*		*																						
1DP	L	*	*	*		*	*		*																						
1DM	G	*	*	*		*	*		*																						
2TDN	L	*	*	*	*	*	*	*	*																						
2DP	L	*	*	*	*	*	*	*	*																						
2DM	G	*	*	*	*	*	*	*	*																						
3TDN	L	*	*	*	*		*	*																							
3DP	L	*	*	*	*		*	*																							
3DM	G	*	*	*	*		*	*																							
4TDN	L	*	*	*	*		*	*																							
4DP	L	*	*	*	*		*	*																							
4DM	G	*	*	*	*		*	*																							
5TDN	L	*	*	*	*			*																							
5DP	L	*	*	*	*			*																							
5DM	G	*	*	*	*			*																							
6TDN	L	*	*	*		*	*		*																						
6DP	L	*	*	*		*	*		*																						
6DM	G	*	*	*		*	*		*																						
SCULLC	L	-*	-*	-*																							1				
SCULHF2	L			-*																										1	
SCULHF4	L	-*																										1			
SCULHF5	L		-*																										1		
PSTCALF2	L			-*						1		1																			
PSTCALF4	L	-*											1																		
PSTCALF5	L		-*								1			1																	
PHFCALF2	L			-*																1		1									
PHFCALF4	L	-*																					1								
PHFCALF5	L		-*																		1			1							
BSTST2	L				*					-1					-1																
BSTST6	L					*	*				-1					-1															
TSTHF2	L							*												-1											
TSTHF6	L								*												-1										
SSTST2	L					-*											1														
SSTST4	L						-*											1													
SSTST5	L				-*														1												
SSTHF2	L								-*																1						
SSTHF5	L							-*																		1					

and STSTB6. Heifer calves cannot be purchased. The remaining activities in Table LV are sell activities. Cull cows are sold through the activity CULCS, and cull heifers are sold through the activities CULHFS2, CULHFS4, and CULFHS5.

The cow-calf and stocker activities, or the livestock production activities show entries in the net revenue rows (NETREVEN and NETREV) which are production costs required by that activity. The coefficients that represent annual costs occur in the COST row which is used as an objective function. The negative entries in the NETREVEN row represent costs while positive entries represent returns. The NETREV row is identical to NETREVEN except all coefficients are multiplied by a minus one (-1) and does not contain consumption requirements. All sell activities show gross returns in the net revenue rows.

The nutrient rows used to balance the range ration are labeled by the abbreviations of TDN (total digestible nutrients), DP (digestible protein), and DM (dry matter) preceded by the period number. Livestock nutrient requirements are represented by positive entry in each row. Forage activities used to meet these requirements have negative entries in the nutrient rows.

Rows were needed to transfer animals from one production activity to another. For example, steer calves are transferred from the COW2 budget to the STST2 or STST3 stocker steer budgets through PSTCALF5. Additional rows were needed to account and transfer cull animals to be sold, animals bought for the stocker activities, and animals produced in the production activities. Cull cows are transferred from the cow-calf budget through SCULLC to the activity selling cull cows (CULLCS). Cull heifers from the cow-calf activities are transferred through SCULHF2, SCULHF4, SCULHF5 rows to the sell activities (CULHFS2, CULHFS4, and CULHFS5) selling cull heifers in the appropriate periods. Calves produced in the cow-calf activities are accumulated in rows labeled with a prefix P then followed with ST or HF for steer or heifer and CALF followed by a period number for use either in an activity that transfers those animals into the stocker activities or sells them as weaned calves. The rows, BSTST2 and BSTST6, accumulate stocker steers for the stocker steer activities. Steers in these rows are provided by the steer calf transfer activity (STCAT2 or STCAT5) or steer calves bought outside the farm organization through the STSTB2 and STSTB6 activities. Heifer calves for the stocker heifer activities must be raised within the organization and are transferred from the HFCAT2 and HFCAT5 activities through the rows, TSTHF2 and TSTHF6 to the stocker heifer activities. Animals fed in the stocker activities are transferred from the feeding activities to the sell activities through the rows SSTST2, SSTST4, SSTST5, SSTHF2 and SSTHF5 when the animals reach finish weight.

The procedure of transferring animals out of the production activities to be sold and into the production activities when bought so that the transactions occur in separate activities allows closer accounting of numbers of animals in the organization as well as providing flexibility in making and evaluating price changes.

Capital Section

The capital accounting section also requires further explanation. Capital accounting within the model as illustrated in Table LVI, consists of a subsection used to record and charge for capital used in the farm organization and a cash flow subsection. Annual operating capital, nonland investment capital, and land investment capital are accounted

TABLE LVI

ILLUSTRATION OF THE CAPITAL ACCOUNTING AND CONSUMPTION SECTIONS OF THE MODEL

		LANDCAP	NONLCAP	OPCAPB	CASHFL1	CASHFL2	CASHFL3	CASHFL4	CASHFL5	CASHFL6	CASHRE1	CASHRE2	CASHRE3	CASHRE4	CASHRE5	CASHRE6	BORROW1	BORROW2	BORROW3	BORROW4	BORROW5	BORROW6	PAYTR1	PAYTR2	PAYTR3	PAYTR4	PAYTR5	PAYTR6	CONSUME1	CONSUME2	CONSUME3	CONSUME4	CONSUME5	CONSUME6	TINVENT	BLAND	RHS1
TOTCAP	N	-1																																			
OPCAP	G			1																																	
NONLINV	L		-1																																		
LANDINV	L	-1																																		*	
INVENTOR	L																																		-1		
CASHOUT1	L				-1																								*								
CASHOUT2	L					-1																								*							
CASHOUT3	L						-1																								*						
CASHOUT4	L							-1																								*					
CASHOUT5	L								-1																								*				
CASHOUT6	L									-1																								*		*	
OUT1	G				-1																								*								
OUT2	G					-1																								*							
OUT3	G						-1																								*						
OUT4	G							-1																								*					
OUT5	G								-1																								*				
OUT6	G									-1																								*		*	
CASHREC1	L										1																										
CASHREC2	L											1																									
CASHREC3	L												1																								
CASHREC4	L													1																							
CASHREC5	L														1																						
CASHREC6	L															1																					
REC1	G										1																										
REC2	G											1																									
REC3	G												1																								
REC4	G													1																							
REC5	G														1																						
REC6	G															1																					
CASHNET1	L				1						-1						-1						1														
CASHNET2	L					1						-1					1	-1					-1	1													
CASHNET3	L						1						-1					1	-1					-1	1												
CASHNET4	L							1						-1					1	-1					-1	1											
CASHNET5	L								1						-1					1	-1					-1	1										
CASHNET6	L									1						-1					1	-1					-1	1									
NET1	G				1						-1						-1						1														
NET2	G					1						-1					1	-1					-1	1													
NET3	G						1						-1					1	-1					-1	1												
NET4	G							1						-1					1	-1					-1	1											
NET5	G								1						-1					1	-1					-1	1										
NET6	G									1						-1					1	-1					-1	1									
CONSUM1	E																												*								*
CONSUM2	E																													*							*
CONSUM3	E																														*						*
CONSUM4	E																															*					*
CONSUM5	E																																*				*
CONSUM6	E																																	*			*

and charged for through separate activities. Annual operating capital is recorded in the OPCAP row and capital charges are calculated on that amount through OPCAPB activity at a specified interest rate. Nonland investment capital is recorded in the NONLINV row with the charges for use made through the NONLCAP activity. Land capital is recorded in the LANDINV row with the charges for use made through the LANDCAP activity. All capital used in the organization is totaled in the TOTCAP row which is used as the objective function when minimizing capital.

The cash flow subsection of capital accounting was constructed in two parts to accomplish balancing of cash spent and received by periods. The first part accumulates the cash expenses and receipts of the organization. Expenses are recorded in the CASHOUT and OUT rows by periods. Receipts are recorded in the CASHREC and REC rows by periods. Two sets of rows in the expense and receipt recording sections insure that all expenses and receipts will be transferred to the balancing section. The first set of rows has a less than sign on the rows while the second set of rows has a greater than sign.

Expenses and receipts are balanced for each period in the CASHNET and NET rows. Each period requires two rows to force complete balancing within that period. Expenses from the CASHOUT and OUT rows are transferred to the balancing rows (CASHNET and NET) by the CASHFL activities for each period. Receipts in the CASHREC and REC rows are transferred to the balancing rows by the CASHRE activities. The expenses and receipts are balanced in the CASHNET rows for each period. If money must be borrowed for balancing to occur, capital is borrowed through the BORROW activities. If capital is borrowed in a period it remains a cash need in suceeding periods until repaid. If receipts exceed expenses in a given period, the excess is transferred by the PAYTR activities to the following period and can be used in balancing the cash flow for that period. The use of the double rows in this procedure assures that all borrowing and excess returns are transferred to successive periods through period six so that the net difference between expenses and receipts can be evaluated from the BORROW6 or PAYTR6 activities. If the net difference for the production year is negative, the result will show for the BORROW6 activity or, if positive, for the PAYTR6 activity.

The cash flow section of this model was not used for calculation of the interest charges on operating capital. However, to force the model to transfer excess returns to successive periods rather than borrowing, small charges were made on capital borrowed in the NETREVEN, NETREV, and COST rows.

Consumption Section

Table LVI also contains the consumption section of the model. The CONSUM rows for each period set the conditions for requiring a specified amount for family living within the model. The amount is specified in the right hand side called RHS1. This forces the CONSUME activities to enter the solution at the specified level for each period and causes that amount specified to be met.

Capacity Section

Feeding and grazing capacities are internally generated in the model according to the type of feed fed and type of forage grazed as shown in Table LVII. The activities for native pasture and bermuda

TABLE LVII

ILLUSTRATION OF THE CAPACITIES AND LAND TRANSFER SECTIONS OF THE MODEL

		TRNATLC	TRNATLD	TRNATSC	TRNATSD	TRNATCC	TRNATCD	CGRAZE1	CGRAZE2	CGRAZE3	CGRAZE4	CGRAZE5	CGRAZE6	CROTAT1	CROTAT2	CROTAT3	CROTAT4	CROTAT5	CROTAT6	STEQUIP	FCGRAZE	FCROTAT	RHS1
NETREVEN	G							-*	-*	-*	-*	-*	-*	-*	-*	-*	-*	-*	-*	-*	-*	-*	
NETREV	N							*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	
COST	N							*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	
TLABOR	N							*	*	*	*	*	*	*	*	*	*	*	*		*	*	
LANDLC	L	1																					
LANDLD	L		1																				
LANDSC	L			1																			
LANDSD	L				1																		
LANDCC	L					1																	
LANDCD	L						1																
NLANDTR	N	-1	-1	-1	-1	-1	-1																
NLANDLC	L	-1																					
NLANDLD	L		-1																				
NLANDSC	L			-1																			
NLANDSD	L				-1																		
NLANDCC	L					-1																	
NLANDCD	L						-1																
GRAZE1	L							-*															
GRAZE2	L								-*														
GRAZE3	L									-*													
GRAZE4	L										-*												
GRAZE5	L											-*											
GRAZE6	L												-*										
VGRAZE1	L							*													-*		
VGRAZE2	L								*												-*		
VGRAZE3	L									*											-*		
VGRAZE4	L										*										-*		
VGRAZE5	L											*									-*		
VGRAZE6	L												*								-*		
ROTAT1	L													-1									
ROTAT2	L														-1								
ROTAT3	L															-1							
ROTAT4	L																-1						
ROTAT5	L																	-1					
ROTAT6	L																		-1				
STEQUIP1	L																			-1			
STEQUIP2	L																			-1			
STEQUIP3	L																			-1			
STEQUIP4	L																			-1			
STEQUIP5	L																			-1			
STEQUIP6	L																			-1			
VROTAT1	L													1								-*	
VROTAT2	L														1							-*	
VROTAT3	L															1						-*	
VROTAT4	L																1					-*	
VROTAT5	L																	1				-*	
VROTAT6	L																		1			-*	

fertilized with 50 and 100 pounds of nitrogen, use an extensive grazing system. They require a unit of grazing capacity for each period in which they are grazed. This grazing capacity is accounted in the GRAZE rows for each period. Capacities required in each period for the grazing system are met by the CGRAZE activities which include the variable costs and labor requirements associated with that type of grazing. The CGRAZE activities require volume to be generated in the VGRAZE rows which must be met by the FCGRAZE activity. This activity includes the fixed costs associated with the extensive type of grazing system which includes fencing costs primarily. FCGRAZE provides equal volume in all periods that is used to fulfill the required capacities for the included forages.

Intensive grazing system capacity requirements are accounted in the ROTAT rows by periods. Forage activities that use the intensive grazing system are bermuda, fertilized with 150 and 200 pounds of nitrogen, bermuda-fescue, fescue, sorghum-sudan, and small grain pastures. The capacities for this intensive system are generated through the same procedure as the extensive grazing system.

Stocker equipment has the capabilities of being used throughout the production year. Because most stocker activities do not continue throughout the full production year, excess capacity can be available in remaining periods of the production year for use by other stocker animals. To make more efficient use of stocker equipment, capacity is required for this equipment in the STEQUIP rows by periods of use. This capacity is met by the STEQUIP activity which includes the associated costs. The STEQUIP activity generates equal capacity in all six periods which can be used to fulfill equipment requirements of any stocker activities in the organization. Table LVII illustrates how stocker equipment capacity is generated.

Land Transfer Section

The lower quality soil productivity levels in each soil type for openland suitable for crops are allowed to be transferred for use in native pasture. This transfer is made if production of native pasture is more profitable than producing improved pastures or tilled crops. This section of the model is also presented in Table LVII. The TRNAT activities representing specific soil productivity levels can use units of that specific type of soil from the LAND rows and transfer that unit to the NLAND rows for use in the native forage activities. Such a procedure gives an additional alternative for the use of that land rather than allowing it to be unused within the model.

2

VITA

Raleigh Alvin Jobes, III

Candidate for the Degree of

Doctor of Philosophy

Thesis: A COMPREHENSIVE MODEL TO DEVELOP AND ANALYZE ALTERNATIVE BEEF FARM ORGANIZATIONS IN EASTERN OKLAHOMA

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