AN ANALYSIS OF BEEF-FORAGE GRAZING SYSTEMS

by

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CHAPTER I

INTRODUCTION

The abundant natural resource of grazing lands in Kansas has had a major influence upon its position as a leading beef producing state. Total grazing lands in Kansas are estimated to be 18,975,000 acres. Of this total, 16,272,000 are native grass species, including tall and short grass rangelands.[1] Nearly 4,000,000 acres of this total rangeland comprise the Flint Hills region in eastern Kansas. The Flint Hills alone can provide summer forage for over 500,000 mature beef cows. Introduced forage species account for 2,703,000 acres.[2] This acreage can be combined with native grass species to develop total beef-forage systems.

Hay production is vital to a strong beef industry. Hay acreage in Kansas averaged 2,326,000 acres, with a yearly average production of 5,063,900 tons for a ten year period from 1971 to 1980.[3] The 1980 value of beef, produced in Kansas, was $1,811,855,000 not including inventories.[4]

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[1]U.S. Department of Agriculture, Soil Conservation Service, "Soil and Water Resources Conservation Act," Washington, D.C., (April, 1979), pp. 13.

[2]Ibid., pp. 14.

[3]Kansas State Board of Agriculture, "The 64th Annual Report and Farm Facts," Topeka, Kansas, 1981, pp. 225.

[4]Ibid., pp. 224.

The state has an annual inventory of approximately 6,000,000 head of beef cattle.[5] Cattle utilize much of the feed and forage produced from approximately 49,500,000 acres of Kansas crop and grass lands.[6] These combined resources of land, forages and cattle place Kansas in the top ten beef producing states.

Grazed forages are often not utilized in the proper combination to support beef systems that maximize profits. A method is needed to select combinations of forage species adapted to the land base and beef enterprises. Producers face a complex set of variables and uncertainties when making these selections. A model is needed to generate useful, objective information when selecting forage combinations to support beef programs. This information should assist producers and agricultural advisors when making production decisions. The model should also be a useful teaching tool for students in the study of beef-forage systems. A properly designed model should be applicable for researching innovative grazing systems that would require a number of years to obtain actual production data.

General knowledge of applied beef and forage production practices must be combined with economic principles to identify the inner-relationships of production and economic variables involved in a beef-forage system. It will be assumed that the basic goal of the farmer is to produce beef cattle with the fixed forage resources. An optimal solution of resource use might suggest the most profit could be obtained without a beef enterprise. A solution of this type would violate the assumed basic goal of the producer. The intent should be to identify the most profitable beef-forage system,

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[5]Kansas State Board of Agriculture, Crop and Livestock Reporting Service, "Kansas Livestock Statistics 1979-1980," Topeka, Kansas, (April, 1981) pp. 3.

[6]Kansas State Office of the U.S. Department of Agriculture, "Kansas Conservation Needs Inventory - 1967," Salina, Kansas, (December, 1969), pp. 1.

assuming the producer's major goal is to produce beef with the resources available.

The needed conceptional model should be formalized through a set of input forms that can be hand calculated by producers and agricultural advisors. Once the basic concepts of analysis have been identified and the formats developed the calculations should be advanced to a computerized system.

Problem

This thesis will develop a model to assist producers, agricultural advisors, students and researchers to select combinations of forage species and beef enterprises to maximize profit from various classes of land. Individuals involved in Kansas beef production are concerned that these resources are often not combined to achieve maximum profit. The relationships associated with the combinations of economic and production coefficients are complex. The major problem confronting decision makers in the beef industry is the lack of a system that allows each segment of a beef-forage system to be analyzed individually.

A successful model must be well adapted to the producer's needs. The system must provide a means by which the model user can easily input and output the model. Physical and economic coefficients for average conditions should be incorporated into the model. However, the model must have the flexibility to allow variable coefficient values to be used that will conform to individual farm enterprises. Credibility of the models output will be more convincing when output data is based on specific individual farm coefficients rather than average values. This study will develop economic and production default coefficients to assist producers that are unable to provide individual coefficient values.

It is impossible to incorporate all the causal variables that influence the profitability of a beef-forage system. The model developed in this study will use only selected major production and economic variables.

When considering alternative grazing systems it is often necessary to shift forage production to land resources that are being used for crop production. Less productive cropland is the most likely land resource to be used for forage production. More productive land may be used for beef production, if beef returns are greater than crop returns. It is important to have an inventory of land classes and their availability when considering increasing forage production for beef enterprises.

This model will evaluate combinations of selected variations of land, forages and cattle. Land will be divided into three production levels; low, medium, and high. Six grass species and two cattle types will be included in the model.

The analysis of this study will be designed to generate planning information. The goal of this model is not to generate a total farm resource optimizing solution. The model will be specific to the summer grazing segment of the beef enterprise. The emphasis will be economical utilization of grazing forages via beef cattle, no other livestock species will be considered. A mechanical hay harvest option will be included to allow the harvest of forages. This option allows producers the opportunity to harvest forages at desirable quantity and quality levels, if it cannot be harvested by cattle.

This thesis will develop a systematic problem solving method to evaluate beef-forage systems. The producer, student or researcher will be able to combine the resources of land, forage and beef cattle in numerous ways and select a profitable beef-forage system for a specific set of conditions indentified by the model user.

CHAPTER II

LITERATURE REVIEW

Beef-forage models which analyze the production variables of land, cattle and forages are not readily accessible to producers and agricultural advisors. This has been a long-standing problem. The complex relationships involving input and output data associated with beef-forage systems has been a barrier to the development of practical beef-forage models.

Kansas producers routinely use combinations of grazing forages in their beef production operations. Generally native short and tall grass ranges account for the major portion of the grazing program. These native ranges make up approximately 86% of all grazing lands in Kansas.[1]

The problem of evaluating the economic returns of each individual forage must be addressed. A systematic approach to solving this problem is vital to the development of a useful model. To determine the value of any individual forage it must be separated from the whole and analyzed independently. If each forage contained in the overall system is not analyzed separately the danger of misallocation of resources exists.

A decision making model to evaluate forages must combine production and economic coefficients to aid the farmer in production decisions. The term coefficient will be used throughout this thesis to identify physical values of production such as forage yields and animal stocking rates. The term will

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[1] U.S. Department of Agriculture, Soil Conservation Service, "Soil and Water Resource Conservation Act," Washington, D.C., (April, 1979).

also describe economic values of returns and costs. A computer program (FMUP) which analyzes the production and beef requirement coefficients was developed at Kansas State University by Buller, Posler, and Munyan (1981).[2] Inputs for this model are number and type of cattle, forage species and acreage, and potential yield. The program analyzes this information and reports a table of the amount of forage required per month and a list of the forages available per month. The output gives the surplus or deficit forage production for each month and for the year.

This model provides useful information to the producer in evaluating feed requirements and an inventory of available forages, but does not incorporate economic values. The FMUP model could be modified to include economic coefficients and produce output data that would be beneficial to a producer in selecting the most economical combinations of beef-forage systems and cattle types. The FMUP program was used in the development of the beef-forage model of this study.

The importance of a practical approach to the analysis of beef-forage systems has been emphasized in Chapter I. Schwab (1974) developed a complex model of the total beef production enterprise. The model "A Computerized Decision Making Model for the Beef-Forage Enterprise," is a linear program optimizing tool.[3] Schwab's model addresses many segments of the beef enterprise including the long term planning, growth and capital investment, discounting for risk and time, technological change, etc. The model attempts to encompass many segments of a very large proglem resulting in one optimum solution. The major disadvantage is not the quality of results produced but the magnitude of input data that must be gathered by the producer.

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[2]Buller, Orlan, Ralph F. Munyan, and Gerry Posler, "Computer Programs of Forage Management and Utilization (FMUP I and FMUP II)", Paper 82-191-D, Department of Economics (Manhattan, Kansas State University).

[3]Schwab, G. D., "A Computerized Decision-Making Model for the Beef-forage Enterprise" (Unpublished Ph.D. thesis, West Lafayette, Purdue University, 1974).

Schwab's model was not used in this study. Its complexity is in conflict with the basic model requirements set forth in Chapter I. The usefulness of Schwab's model to large number of producers would be limited. Decision makers seeking solutions to production problems need access to a model that requires a manageable amount of input data. The input data must be easily gathered and compiled. Schwab's model may be more adapted to research work similar to the Kentucky beef model.

Kentucky researchers (Loewer et al., 1978) developed "A Simulation Model For Assessing Alternative Strategies of Beef Production With Land, Energy and Economic Constraints."[4] The model is a comprehensive simulation of a multitude of factors effecting the total beef production enterprise. It analyzes alternate management stragegies of beef and crop production with land, energy and economic constraints. During this simulated period dry matter production, beef production, resources and net worth are inventoried.

The daily growth rates of forages are simulated as functions of soil fertility, pH, weather conditions, cultural practices, etc. Animals are moved throughout the season to utilize the growing crops. The grazing effects of the animals on a growing forage are simulated by the model.

The complexity of the inputs necessary to use this model may be a barrier to producer acceptance. The model should be an excellent tool for large scale beef production and analysis of regional research work.

The Kentucky and Schwab models have not been accepted by producers due to their complexity. The complexity of these two available beef-forage models emphasizes the need of a producer orientated beef-forage model.

Forage systems present difficult problems that are not present in crop system models. Crop production can easily be measured on a per acre basis.

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[4]Loewer, O. J., et al., "A Simulation Model For Assessing Alternative Strategies For Beef Production With Land, Energy and Economic Constraints," paper presented at the American Society of Agricultural Engineers' Meeting, (June, 1978).

Inputs and outputs associated with production can be identified specifically for a given time period. There is a vast amount of documented experimental crop production data available for model design and validation. Unfortunately there is a limited amount of experimental data available for grazing forage species and combinations of those species under different beef-forage systems, grown on different land classes.

Certain types of beef production enterprises, such as cow/calf operations, involve long production periods. During a production period a number of forage inputs may be used. The quality and quantity of a forage species varies over its growing season which also adds to the complexity of analyzing individual forage species when utilized by grazing animals.

Six forage species will be included in this model. The species are native shortgrass, native tallgrass, smooth bromegrass, tall fescue, bermudagrass, and summer annual grass. Coefficient values vary considerably among data sources making it difficult to establish standard forage production coefficients. Several sources of forage production coefficients were reviewed and from this body of information default coefficient values were developed.

The selected forage production values used as default values by the model were averages based on three sources of information; 1) available research data, 2) conversations with forage and beef specialists, 3) available producer records.

The native grass species make up the largest part of the forage program, these forages are warm season grasses. The basic growing season is May 1 to September 30. The highest production quantity and quality is in May and June. Owensby and Launchbaugh summarized their own work and that of others in an overview of fifty years of Kansas native range research.[5] This publication

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[5]Launchbaugh, J. L. and C. E. Owensby, "Kansas Rangelands," Research Bulletin 622, Kansas State University, (October, 1978).

provides coefficients and will be used as a standard for production practices and rangeland management. Cattle performance under various production practices on native range is thoroughly discussed in the publication "Growing *Cattle on Grass*".[6] The Kansas Soil Conservation Service has conducted extensive studies on the rangelands of Kansas. The information from these studies is included in draft copies of range site descriptions, which were used in the development of this model. These range site descriptions are scheduled to be published at a future date, they include topography, soil characteristics, management implications, production coefficients and suggested stocking rates.[7]

The three native grass references discussed above were used in combination with data compiled by Posler in the FMUP computer program.[8] A data base was developed from these sources for final determination of native grass production coefficients.

The four selected alternative forages used in this study are introduced species not native to Kansas. They account for a relatively small part of the total grass production in Kansas, but play an important role in beef-forage systems. The forages are smooth brome, tall fescue, bermuda and summer annuals, which allow for the potential expansion of forage production. The forages can be grown on land presently producing cash crops, primarily small grains. In this study it will be assumed that native grass establishment will not be an alternative to expanding the grass resource. The time and expense involved in the establishment of native grass places it at a disadvantage to the four introduced species.

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[6]Smith, Ed F., "Growing Cattle on Grass," Bulletin 638, Kansas State University, (October, 1981).

[7]kansas State Office of the USDA Soil Conservation Service, "Range Site Descriptions," unpublished draft, Salina, Kansas.

[8]Buller, op. cit..

It is important to review the available crop acres in Kansas that could be shifted to forage production. Favorable economic profits in the cattle industry may make it beneficial for producers to shift less productive cropland to forage production.

Kansas land area is estimated to be 52,425,275 acres excluding large lakes and rivers. Federal non-cropland, urban development, small streams and ponds account for 3,009,268 acres, leaving a net inventory acreage of 49,416,007. The land classifications and crop acreage in each are listed below:

Capability Class	Acres in Cropland
I	3,170,573
II	11,417,948
III	9,951,475
IV	4,036,892
V - VIII	1,046,905
Total	29,623,793

Hay crops are being produced on a large part of Capability Classes V - VIII. Expansion of additional forage production would utilize land resources within these classes. The land in these classes accounts for 3.53% of the total cropland in Kansas.[9]

Don Cooper, Riley County District Conservationist was consulted to condense the eight capability classes into three basic soil categories, bottomland, upland and hill land. Bottomland includes all of Class I and 50% of Class II. Upland includes 50% of Class II, all of Classes III, IV and V. Hill land includes Classes VI, VII and VIII. The productivity level of each of these three will be categorized low, medium and high. Upland and hill land using this classification would account for approximately 20,700,000 acres. Forage production expansion, for grazing cattle, would

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[9]Kansas State Office of the U.S. Department of Agriculture, "Kansas Conservation Needs Inventory-1967," Salina, Kansas, (December, 1969), pp.1.

most likely occur on the less productive acreage included in these classes of land. Favorable economic returns may make forage production feasible on the higher valued productive bottomland.

Production information and coefficient values are more limited on the four alternative forage species. Coefficient values for these species will be determined from Posler's work and a number of extension and research publications listed in the bibliography.[10]

Smooth bromegrass is a perennial cool season grass, produced primarily in the eastern third of Kansas. It is the predominate species of the introduced grasses. Approximately 70% of its production occurs in the early spring and summer months and 30% in the fall.

Tall fescue is also a cool season perennial grass grown in eastern Kansas, primarily southeastern Kansas. It is a very productive forage, used for grazing and hay production.

Bermudagrass is a perennial warm season grass grown primarily in the southeast corner of Kansas. Extremely high levels of production have been achieved with this forage under intensive management. Bermuda has a production season similar to the native grass species.

Summer annuals are warm season sorghum type forages and must be established annually. They are well adapted to hot, dry weather and are often used as emergency forage sources.

Livestock production coefficients are more specific than forage coefficients and are well documented. These coefficient values were derived from "Nutrient Requirements of Beef Cattle."[11] Coefficients developed for FMUP were also incorporated into the model.[12]

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[10]Buller, op. cit., pp. 37, 49.

[11]National Academy of Sciences, Nutrient Requirements of Beef Cattle, Fifth revised edition, (Washington, D.C., Printing and Publishing Office), 1976.

[12]Buller, op. cit., pp. 34.

Beef cow requirements were based on production periods according to the stage of reproduction. The cow nutrient requirements were separated into four periods. Coefficients for these four periods were taken from "Cow Herd Nutrition" written by Corah.[13]

Although not officially documented most producers and agricultural specialists indicate 80% of the Kansas cow herds are on spring calving programs. Weaning weights and calving percentages were based on research from the U.S. Meat Animal Research Center.[14]

The basic principles of production economics were followed in the model development of this study. Basic principles of profit maximization, marginal returns, product and input relationships and others are discussed thoroughly in the production economic textbook of Doll and Orazem.[15] This text provides an excellent review of production principles and was used as a basic information source.

The analytical tools used to achieve the desired results of this study must be carefully selected. It is possible to obtain similar results with different methods of analysis, but certain methods of analysis may be more desirable and efficient for a specific problem. The available analytical tools must be reviewed and studied carefully.

Traditionally farm management advisors have used the total and partial budgeting techniques. Agricultural production is adaptable to the basic theory and assumptions underlying the budgeting technique. Marshall is credited with summarizing and organizing relevant information into a body of theory that has had a pronounced effect upon American agricultural

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[13]Corah, Larry R., "Cow Herd Nutrition," Bulletin C-582, Kansas State University, (December, 1977).

[14]Roman L. Huskra U.S. Meat Animal Research Center, "Germ Plasm Evaluation Program," by Larry V. Cundiff, Kieth E. Gregory and Robert M. Koch, Progress Report No. 9, Clay Center, Nebraska, (October, 1981).

[15]Doll, John P., and Frank Orazem, Production Economics (Theory With Application), 1st ed, (Columbus, Ohio, Grid Inc., 1978).

economics.[16] Budgeting has been accepted as one of the most useful and powerful tools available to managers in determining the proper allocations of scarce resources.[17] It is a foward planning tool that allows the decision maker an opportunity to estimate the results of resource returns based upon economic theory and judgment. It is a flexible tool that allows the producers to vary input coefficients. Future expectations must be estimated in constructing budgets. The major disadvantage with the budgeting technique is the time required to investigate alternative situations.

The budget formats for crop, forage, and beef were developed from budget worksheets of the "Kansas Farm Management Handbook."[18] The budgets from the "TI-59 Programmable Calculator Handbook" were also used in developing budgets for this study.[19]

Total budgets may overemphasize adverse economic results in short term cash flow analysis. Expert judgment is important in evaluating budgeting results. Major investments in fixed resources may show an economic disadvantage in the short run but may produce desirable long term growth and asset accumulation. The problem can be resolved by segmenting the total budget cost into variable and fixed costs, resulting in cash expense and total expense. The total budget technique was used in this study.

Linear programming (LP) is a planning method that gained wide acceptance in the field of agriculture following WW II. It advanced rapidly with the advent of the computer age. The efficiency and time savings provided by computer calculations made LP models more accessible to a large number of users.

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[16]Fellows, Irving F., "Budgeting," Bulletin 357, Kansas State University, August, 1960, pp. 7.

[17]Ibid., pp. 13.

[18]Kansas Cooperative Extension Service, Department of Economics, "Kansas Farm Management Handbook," Manhattan, Kansas State University.

[19]Kansas Cooperative Extension Service, Department of Economics, "TI-59 Programmable Calculator Handbook," Manhattan, Kansas State University.

Linear programming is a method of analysis that addresses the problem of efficient resource use. It selects alternatives to maximize or minimize one objective subject to specific constraints, or limitations. The criteria of selecting resource combinations is the same as the theory used in production economics. The advantage of the LP model is that it determines an optimal solution. When the budgeting technique is used it is necessary to calculate numerous combinations to identify the optimum solutions. The problems associated with agricultural LP models include the assumptions of linearity, additivity, divisibility and single-value expectations.

Only variable cost coefficients are used in LP models, the profit objective is the return to the fixed resources and their associated cost. LP models have been promoted on their ability to generate optimal solutions.

An example of LP analysis was included in this study to demonstrate the potential of the technique for beef-forage system analysis. LP models must be carefully designed for beef-forage systems because of the unique combination of forage species and land types. Many forage species are perennials, grown on land that is not suitable for the production of alternative crops. Many forages have a fixed relationship with the land type on which they are produced. LP models must be carefully developed so these relationships are not violated. Constraints must be included in the model to force specified management practices to be maintained.

In the late 1950's the prevailing thought was that linear programming produced better answers than the budgeting technique. The literature of this period suggested that LP models produced the best possible answer and that budgeting only indicated the best direction toward the solution. Linear programming calculates marginal returns associated with variable costs.

The same economic principle can be accomplished with the partial budgeting technique. Partial budgeting is simliar in purpose to linear

programming. The method of the two differ primarily on the basis of data manipulation.[20]

The main body of this study and the model will be based on the total budgeting technique. One of the main objectives proposed by the model set forth in this study was to evaluate each segment of the forage system based on the amount of beef produced. A value must be determined for the beef to accomplish this objective. Seasonal price changes and price changes associated with various weight classes must be considered. The "Livestock and Meat Statistics" supplements contain data for a wide range of cattle weight classes by months for each year.[21] Data from this source for a number of years was used to develop a table of price trends based on seasonal prices and prices according to weight classes.

No single information source is available to develop coefficients, model structure and analytical technique. A number of information sources and proven analytical tools were considered in the development of the model set forth by this study.

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[20]Kottke, Marvin W., "Obtaining Identical Solutions Using Linear Programming and Partial Budgeting," Bulletin 359, University of Connecticut, (September, 1960), pp. 15.

[21]U.S. Department of Agriculture, Economics and Statistics Service, Agricultural Marketing Service, "Livestock and Meat Statistics: Consecutive Supplements For 1975-1980," Bulletin 522, Washington, D.C., (September, 1981).

CHAPTER III

METHODOLOGY

The development of the model must evolve through a systematic process. A general overview of the model will be discussed first, followed by descriptions of the individual segments of the model. The basic objectives are 1) an easily accessed model, 2) input coefficient flexibility, and 3) output that can be easily understood by the decision maker.

The conceptional model is a simplified representation of reality and will only address the major variables. A model allows many alternative production possibilities to be evaluated without actually performing the production practices under field conditions.

The budgeting technique was the major analytical tool utilized. Worksheets were developed to organize and compile economic and production coefficients. Coefficients needed for the budgeting process can then be easily transferred to budgeting worksheets. Budget worksheets were developed so returns above variable cost and total cost could be identified. Livestock budgets were specially formatted to develop total non-forage cost coefficients. Beef returns were incorporated into the individual forage production analysis, reflecting the beef-forage return for each forage period.

The model evaluates the forage production per acre and equates it with beef production per acre, for specific grazing practices identified by the producer. When applicable, the value of mechanically harvested forage was included in the total production value of the forage being analyzed.

Default coefficient values were formulated and are available when the model user does not have individual data. Production coefficient values for each forage species and cattle type are included in Tables 1 through 19.

The model is comprised of a number of worksheets which analyze combinations of forages, land and cattle. The worksheets will be organized so that information data will flow through the model, be analyzed and reported on output worksheets. The output worksheets report individual results of specific resource combinations and aggregated results of the total grazing enterprise. The formatted output allows the decision maker the opportunity to compare beef-forage returns and crop returns for each of the selected forages and then compare forage returns to cash crop returns.

The resource relationships of beef-forage systems possess unique characteristics. Forages that have a fixed relationship with a land resource are referred to as factor-product relationships. These particular forages can only be used by grazing beef; this is quite common to much of the rough topography of native range.

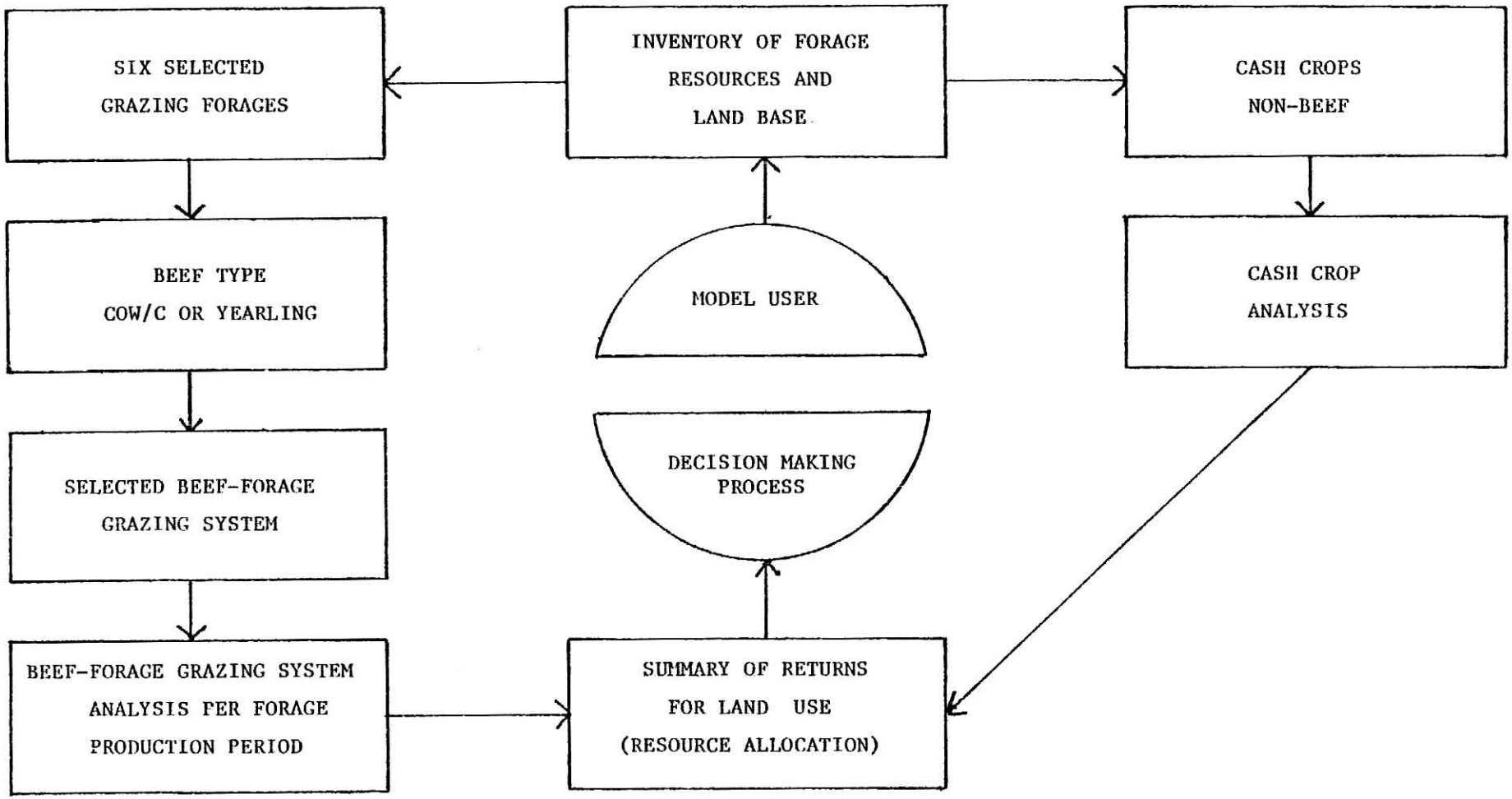
The introduced forage species discussed in Chapter II are generally grown on land that allows the forage to be grazed or harvested as hay. This is often called a product-product relationship, one input capable of producing more than one product. The products of this type of relationship often have complementary and supplementary characteristics.

Risk, uncertainty and production constraints are economic principles that were not specifically incorporated into this model. They were indirectly considered in the selection of coefficients that reflect average values and resource inventories specified by the model user.

A general overall view of the model proposed by this study is illustrated by the basic flow diagram (Figure 1).

FIGURE 1

CONCEPTIONAL MODEL FLOW DIAGRAM



CHAPTER IV

THE MODEL

It is assumed the basic objective of the producer is to combine the resources of land, forage and beef cattle to maximize profit with a beef-forage system. The purpose of this chapter is to illustrate the use of the model developed by this study as an aid in achieving this objective. The model will be an applied problem solving technique designed for easy accessibility. It will also provide a systematic procedure allowing a number of specified forage systems and cattle enterprises to be combined and analyzed. The producer will be able to input the model with individual farm production and economic coefficients. It will be possible to evaluate current or alternative beef-forage enterprises or projected enterprises selected by the model user.

The model will develop through a systematic procedure that can be hand calculated. A number of combinations are possible which allows the model to be adapted to many farm situations.

The cattle types will be limited to starting yearling weights of 400#, 450#, 500#, 550#, 600# or cows calving March 1 and weaning a calf at seven months. The forage species will be limited to native shortgrass, native tallgrass, bermudagrass, smooth bromegrass, tall fescue and summer annuals. The use of these forages will be limited to fifteen forage grazing periods, listed in Table 7.

The input coefficients for stocking rates, average daily gains, price trends, and forage productivity levels can be provided from producer records

or selected from default values provided by the model. The input coefficients for weaning weights, calving percentages, forage and beef production costs and starting calf prices are provided by the producer.

The format of the analysis will be illustrated using two beef-forage systems. A beef-forage system shall be defined as a combination of one cattle type and one or more forage systems. The two examples will include (1) a cow/calf (cow/c) enterprise and (2) a yearling summer graze enterprise, using several combinations of forage and forage production periods.

A data base was developed for forage production values, beef requirements, average daily gains, price trends and forage and beef production costs. These data have been developed through a series of tables to provide the needed default coefficient variable values for input into the model. The tables will be explained individually before illustrating the examples of beef-forage system analysis. Coefficients for the examples were taken from the data base presented by the tables.

Forage Production Tables

The production coefficients for the six selected forage species are listed in Tables 1 and 2. The expected forage production under grazing conditions is shown in Table 1. The seasonal production of each forage is segmented by months on a percentage basis. The total seasonal production is measured in animal unit months (AUMs). An AUM is defined as the amount of feed required by a 1,000# beef cow to maintain weight for one month.

Table 2 shows hay production coefficients, which are used when hay harvest is included in the forage system. AUM production values for hay harvest are considerably higher than those for grazing. Hay harvest is more efficient than grazing, utilizing a higher percent of all the forage produced. The values included in Table 2 are based upon the assumption that the total seasonal production is harvested. Tables 1 and 2 are used as the forage production data base throughout this study.

TABLE 1

FORAGE RESOURCES FOR GRAZING*

Forage	% Production by months							Total (AUM/Acre)		
	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Low	Med.	High
1. Native Shortgrass		10	35	35	10	10		.4	.6	.8
2. Native Tallgrass		35	33	18	10	4		1	1.4	1.9
3. Smooth Bromegrass	20	50	10			15	5	3.9	4.7	6.0
4. Tall Fescue	20	35	15			25	5	3.8	4.7	6.0
5. Bermudagrass		15	30	20	15	20		8.0	12.0	16.0
6. Summer Annuals				45	45	10		2.0	3.5	5.0

*Adapted from Department Paper 82-191-D, (Computer Programs of Forage Management and Utilization), Department of Economics, Kansas State University, Appendix III, pg. 37.

TABLE 2

YIELD POTENTIALS AND FEEDING VALUE OF SELECTED HAYS*

Forage (fed as is)	AUM/Ton	Assumed Yield (ton/acre)		
		Low	Med.	High
1. Native Shortgrass	2.9	0.32	0.45	0.64
2. Native Tallgrass	2.9	0.92	1.3	1.8
3. Smooth Bromegrass	3.3	2.7	3.3	4.2
4. Tall Fescue	3.3	2.7	3.3	4.2
5. Bermudagrass	3.3	5.6	8.4	11.2
6. Summer Annuals	3.3	2.5	4.5	6.0

*Adapted from Department Paper 82-191-D, (Computer Programs of Forage Management and Utilization), Department of Economics, Kansas State University, Appendix VI, pg. 49.

Animal Requirement Tables

Beef cattle requirements used in this study are listed in Table 3. The requirements are listed both as pounds of total digestable nutrients (TDN) per head, per day and as AUMs per head, per month. It is assumed one AUM equals 320 pounds of TDN. The coefficients in Table 3 were taken from Appendix I of FMUP.[1]

The feed requirements for yearlings, from FMUP, were graphically compared to the universally accepted NRC requirements.[2] The two sources are graphed in Figure 2, which illustrates no significant difference between them. The yearling coefficients in Table 3 assume an average daily gain per head of 1.65 lbs. and a monthly gain of 49.5 lbs. per head for all yearling weights.

The forage requirements for a 1,000# cow are modified from the publication "Cow Herd Nutrition."[3]

Table 3 is used to develop Tables 4 and 5. Table 4 contains the cumulative AUM requirements for increments of 50 pounds of gain per month from various yearling starting weights.

Table 5 has the cumulative AUM requirements per cow/c unit starting at different months of the forage grazing season. The cows reproductive cycle determines AUMs required per grazing period. Correlating the production of the forage period with the months of the cows reproductive cycle is important in determining correct stocking rates per cow/c unit. The coefficients assume a 1,000# cow calving March 1 and weaning a calf at seven months. Examples are listed in Tables 4 and 5 to illustrate their use.

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[1]Buller, Orlan, Ralph F. Munyan, and Gerry Posler, "Computer Programs of Forage Management and Utilization (FMUP I and FMUP II)," Paper 82-191-D, Department of Economics (Manhattan, Kansas State University), pp. 34.

[2]National Academy of Sciences, Nutrient Requirements of Beef Cattle, Fifth revised edition, (Washington, D.C., Printing and Publishing Office), 1976, pp. 22-23.

[3]Corah, Larry R., "Cow Herd Nutrition," Bulletin C-582, Kansas State University, (December, 1977), pp. 3-5.

Tables 4 and 5 are the data base for determining cattle AUM requirements and stocking rates for each production period in Tables 8 - 13. The coefficients in Table 4 assume a season long average daily gain of 1.65 pounds. This rate of daily gain does not account for changes of forage quality. Tables 4 and 5 will be used only to determine stocking rates and will not be used to determine daily gain of yearlings. The variation of grass quality is not as critical to the cow/c as it is to the yearling. The problem of grass quality and its effect on yearling gains will be discussed in the next section.

FIGURE 2

YEARLING TDN REQUIREMENTS PER HEAD PER DAY
(NRC AND FMUP 1)

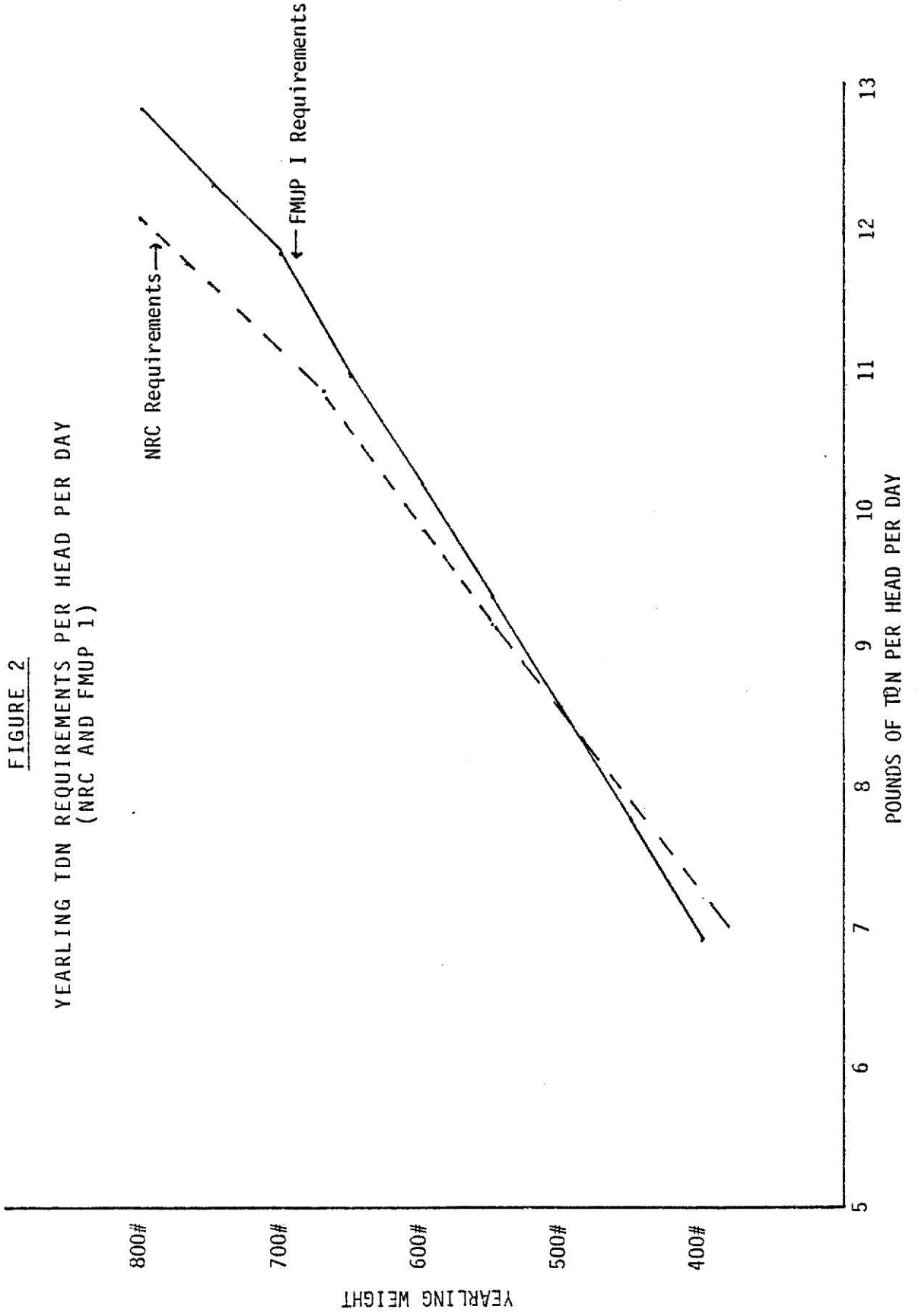

TABLE 3

BEEF ANIMAL REQUIREMENTS*

The amount of TDN or ENE per animal unit month (AUM) has been reported in a range of at least 270-480 pounds TDN/AUM. The following information assumes 320 pounds TDN/AUM.

1,000 Pound Beef Cow (equal 12 AUM)

Period	Days	Weight of animal (pounds)	Average Daily Gain (pounds)	TDN per head per day (pounds)	AUMs per head per month
COWS					
I. Post calving	90			12.80	1.2
II. Lactating and pregnant	120			11.20	1.05
III. Mid-gestation	90			7.47	0.7
IV. Precalving	60			10.67	1.0
CALVES					
I.			1.60	1.07	0.1
II.			1.60	3.20	0.3
STEERS AND HEIFERS					
		200	1.65	3.20	0.3
		250	1.65	4.00	0.375
		300	1.65	4.80	0.45
		350	1.65	5.87	0.55
		400	1.65	6.94	0.65
		450	1.65	7.74	0.725
		500	1.65	8.54	0.8
		550	1.65	9.34	0.875
		600	1.65	10.14	0.95
		650	1.65	10.94	1.025
		700	1.65	11.74	1.1
		750	1.65	12.27	1.15
		800	1.65	12.8	1.2
		850	1.65	13.34	1.25
		900	1.65	13.87	1.3

*Adapted from Department Paper 82-191-D, (Computer Programs of Forage Management and Utilization), Department of Economics, Kansas State University, Appendix I, pg. 34.

TABLE 4

ACCUMULATIVE AUM REQUIREMENTS

FOR YEARLING CATTLE*

Column	A	B	C	D	E	F	G	H	I	J	K
Line Number	Starting Weights	Ending Weights									
1		450#	500#	550#	600#	650#	700#	750#	800#	850#	900#
2	400#	.65	1.375	2.175	3.05	4	5.025	6.125	7.275	8.475	9.725
3	450#		.725	1.525	2.4	3.35	4.375	5.475	6.625	7.825	9.075
4	500#			.8	1.675	2.625	3.65	4.75	5.9	7.1	8.35
5	550#				.875	1.825	2.85	3.95	5.1	6.3	7.55
6	600#					.95	1.975	3.075	4.225	5.425	6.675

This table gives the accumulative AUMs required per head. Starting weights are in Column A and ending weights are in Columns B through K. It is assumed the cattle gain 50 pounds per month and the change from column to column represents one month.

Example: The AUM requirements for a 500 pound yearling gaining 250 pounds in 5 months would be 4.75, found in Line 4, Column H.

* Developed from Table 3.

TABLE 5

ACCUMULATIVE AUM REQUIREMENTS

PER COW / CALF UNIT*

Column	A	B	C	D	E	F	G	H	I	J
Line Number	Month	AUM/ Cow	AUM/ Calf	AUM/ Cow/Calf						
1	Jan.	1.0	0	1.0						
2	Feb.	1.0	0	1.0						
3	Mar.	1.2	0	1.2						
4	Apr.	1.2	.1	1.3						
5	May	1.2	.2	1.4						
6	Jun.	1.0	.3	1.35						
7	Jul.	1.0	.3	1.35						
8	Aug.	1.0	.3	1.35						
9	Sep.	1.0	.3	1.35						
10	Oct.	.7	0	.7						
11	Nov.	.7	0	.7						
12	Dec.	.7	0	.7						
13	Total	11.9	1.5	13.4						

The top part of this table lists the monthly requirements of a 1,000 lb. cow, calving March 1 and weaning a calf in seven months. These values are used to develop the accumulative AUM table below.

14		Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.
15	Apr.	1.3	2.7	4.05	5.4	6.75	8.1	8.8	9.5	10.2
16	May		1.4	2.75	4.1	5.45	6.8	7.5	8.2	8.9
17	Jun.			1.35	2.7	4.05	5.4	6.1	6.8	7.5
18	Jul.				1.35	2.7	4.05	4.75	5.45	6.15
19	Aug.					1.35	2.7	3.4	4.1	4.8
20	Sep.						1.35	2.05	2.75	3.45
21	Oct.							.7	1.4	2.1
22	Nov.								.7	1.4
23	Dec.									.7

The lower part of this table lists the accumulative AUM requirements per cow - calf. Starting months are in Column A and ending months are in Columns B through K.

Example: The AUM requirements from May 1 to Oct. 30 are 7.5, found in line 16, Column H.

* Developed from Table 3.

Average Daily Gain Table

It is a well documented fact that yearling per head, per day gains change during the forage production season. "Most grasses commonly grazed by cattle are highest in nutritive value in their early, immature growth stage, then steadily decline in nutritive value through dormancy and weathering. So growing cattle make their greatest gain when plants are immature and actively growing."[4] It is important to recognize this variability of gain when analyzing segments of a forage season represented by different specific production periods. An example of this situation is the variation in livestock gains when grazing spring and fall smooth bromegrass production.

Table 6 was developed to include the effects of forage quality on daily yearling gains. The daily gains listed in Table 6 were determined from numerous research and extension publications and conversations with beef and forage specialists.

Table 6 lists the expected daily gains for average weight yearling cattle by months for each of the six selected forages. The accumulative average gain per head, per day for each additional month following the beginning month is also given.

> Example: The average daily gain on April smooth bromegrass is 1.6 pounds, line 2, column B. The gain in May is 1.9 pounds, line 2, column C. The period April through May has a cumulative average daily gain of 1.75 pounds, line 2, column D.

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[4] Smith, Ed F., "Growing Cattle on Grass," Bulletin 638, Kansas State University, (October, 1981), pp. 1.

TABLE 6

PROJECTED AVERAGE DAILY GAIN PER HEAD FOR YEARLING CATTLE

ON SIX FORAGE SPECIES BY MONTHS

Columns Line No.	A Forage	B	C	D	E	F	G	H	I	J	K	L	M	N
1		Apr.	May	Apr.-May	Jun.	Apr.-Jun.	Jul.	Apr.-Jul.	Aug.	Apr.-Aug.	Sept.	Apr.-Sept.	Oct.	Apr.-Oct.
2	Smooth Bromegrass	1.6	1.9	1.75	1.6	1.7	0	1.275	0	1.02	1.25	1.06	1	1.05
3	Tall Fescue	1.5	1.25	1.38	1	1.25	0	.94	0	.75	1.25	.83	1	.86
4		Sept.	Oct.	Sept.-Oct.	Nov.	Sept.-Nov.								
5	Smooth Bromegrass	1.25	1	1.125	-	-								
6	Tall Fescue	1.25	1.1	1.18	1	1.12								
7		May	Jun.	May-Jun.	Jul.	May-Jul.	Aug.	May-Aug.	Sept.	May-Sept.				
8	Native Tallgrass	2.2	1.9	2.05	1.6	1.9	1.2	1.73	1.1	1.6				
9	Native Shortgrass	2.0	1.8	1.9	1.4	1.73	1	1.55	.7	1.38				
10	Bermudagrass	2.0	2.2	2.1	.8	1.66	1.4	1.6	1.2	1.52				
11		Jul.	Aug.	Jul.-Aug.	Sept.	Jul.-Sept.								
12	Summer Annuals	1.2	1	1.1	.8	1								

Forage Grazing Systems Table

A forage grazing system in this model shall be defined as one or more specific forage production periods utilizing a particular forage over its grazing season for a specific level of production. In this study a forage production period is also referred to as a forage period or production period. A forage grazing system and a beef-forage system shall be recognized as being different by definition.

Fifteen forage grazing systems using the six forage species have been selected for this study and are listed in Table 7. Each system represents one forage species and its use during one grazing season. The uses of each forage are represented by one or more production periods. The production periods are on a monthly basis which represent grazing periods commonly used in Kansas. Grass production and available forage will vary with any forage system as a result of the variable growing conditions, fertility levels and management. Average or better forage production will be assumed. The forage systems selected contain both warm and cool season grasses providing the producer the opportunity to develop a flexible beef-forage system.

Each individual forage production period within a forage system will be analyzed separately according to its use. Variations in productivity of the fifteen forage systems are recognized as low, medium and high production.

TABLE 7

FORAGE GRAZING SYSTEMS

System No.	Forage	Production Periods
1	Smooth Bromegrass	April 1 - April 30 May 1 - June 30 (Hay) Sept. 1 - Oct. 30
2	Smooth Bromegrass	April 1 - June 30 Sept. 1 - Oct. 30
3	Smooth Bromegrass	April 1 - May 30 Sept. 1 - Oct. 30
4	Smooth Bromegrass	April 1 - Oct. 30
5	Tall Fescue	April 1 - Oct. 30
6	Tall Fescue	April 1 - June 30 Sept. 1 - Nov. 30
7	Native Tallgrass	May 1 - Sept. 30
8	Native Tallgrass	May 1 - Oct. 30
9	Native Tallgrass	June 1 - Oct. 30
10	Native Tallgrass	May 1 - July 15
11	Native Shortgrass	May 1 - Sept. 30
12	Native Shortgrass	May 1 - Oct. 30
13	Bermudagrass	May 1 - Sept. 30
14	Bermudagrass	May 1 - June 1 (Hay) June 1 - Sept. 30
15	Summer Annuals	July 1 - Sept. 30 (Hay or Graze)

Forage production and animal requirements were presented in Tables 1 through 5 in the standard measure of AUMs. Tables 8 through 13 (Stocking Rates and Animal Requirements) show the correlation of AUMs of forage production with animal requirements. Figure 3 illustrates the AUMs of forage production for 3.39 acres of medium level production native tallgrass and the AUM requirements of a 500# yearling May 1 through September 30. The figure indicates surplus forage production early in the season and deficit production the last part of the season. The example is typical of most full season forage grazing systems. The average grazing rates developed must include surplus and deficit production for the total grazing period.

Tables 8 through 13 are referenced with line numbers down the left column and column letters across the top of the table. The forage production periods are correlated with 400#, 450#, 500#, 550#, and 600# animals and cow/c units. The forage system number and the production periods are listed in column A. The level of forage production is listed in column B.

Animal unit months per head (AUM/HD) are listed in column C, the AUM/HD coefficient values for each cattle type are listed in columns D through H and J. The AUM/HD values in these tables represent the cumulative AUM/HD requirements for the specified forage period listed in Column A for each of the cattle types.

> Example: A 500# yearling grazed on smooth bromegrass April 1 through June 30 would require 2.625 AUMs. This value is found in Table 8, System 2, line 22, column F.

Acres per head (AC/HD) and head per acre (HD/AC) are also listed in Column C for low, medium and high production. The AC/HD were calculated by dividing AUM/HD by the AUMs of forage production for the specified period. The HD/AC was calculated by dividing the AUMs of forage production for the specified period by the AUM/HD. These two stocking rate coefficients (AC/HD and HD/AC) will be used by the model.

Example: The AC/HD requirements for a 500# animal grazing high production bromegrass April 1 through June 30 would be .67, this value is found in Table 8, System 2, line 27, Column F. The HD/AC value for this weight animal is 1.5, found in Table 8, System 2, line 28, column F.

Tables 8 through 13 are all formatted identically allowing the model user to locate and reference coefficients easily as illustrated by the two examples.

The production capacity of each forage period within each forage grazing system was based on the data from Tables 1 and 2. The monthly production percentages were combined to determine the percent of production for the various selected forage production periods. The percentage factor of each production period was multiplied by the total AUMs produced per acre for the total forage season. The values obtained from this calculation were correlated with cattle requirements to determine the stocking rates in Tables 8 through 13.

April production of the two cool season grasses, smooth bromegrass and tall fescue, is lower than May production. Stocking rates for April-May or April-June grazing periods are restricted to April stocking rates. This restriction does not allow all forage produced to be utilized with cattle for those production periods. Surplus generated by this restriction was transferred to the next forage production period, which would be the fall grazing periods for the cool season grasses. The variability of surplus forage transferred causes the fall stocking rates for cool season grasses to vary slightly.

Tables 14 and 15 are summary tables of acres per head from Tables 8 through 13. The tables include AC/HD for all forage production periods at each production level, for each cattle type. Tables 14 and 15 were developed as a quick reference for the model user to compare specific farm AC/HD values to the default values of the model. The two tables also serve as a general reference of standard stocking rates for the six forage species at three levels of productivity.

FIGURE 3

YEARLING REQUIREMENTS AND NATIVE TALLGRASS PRODUCTION

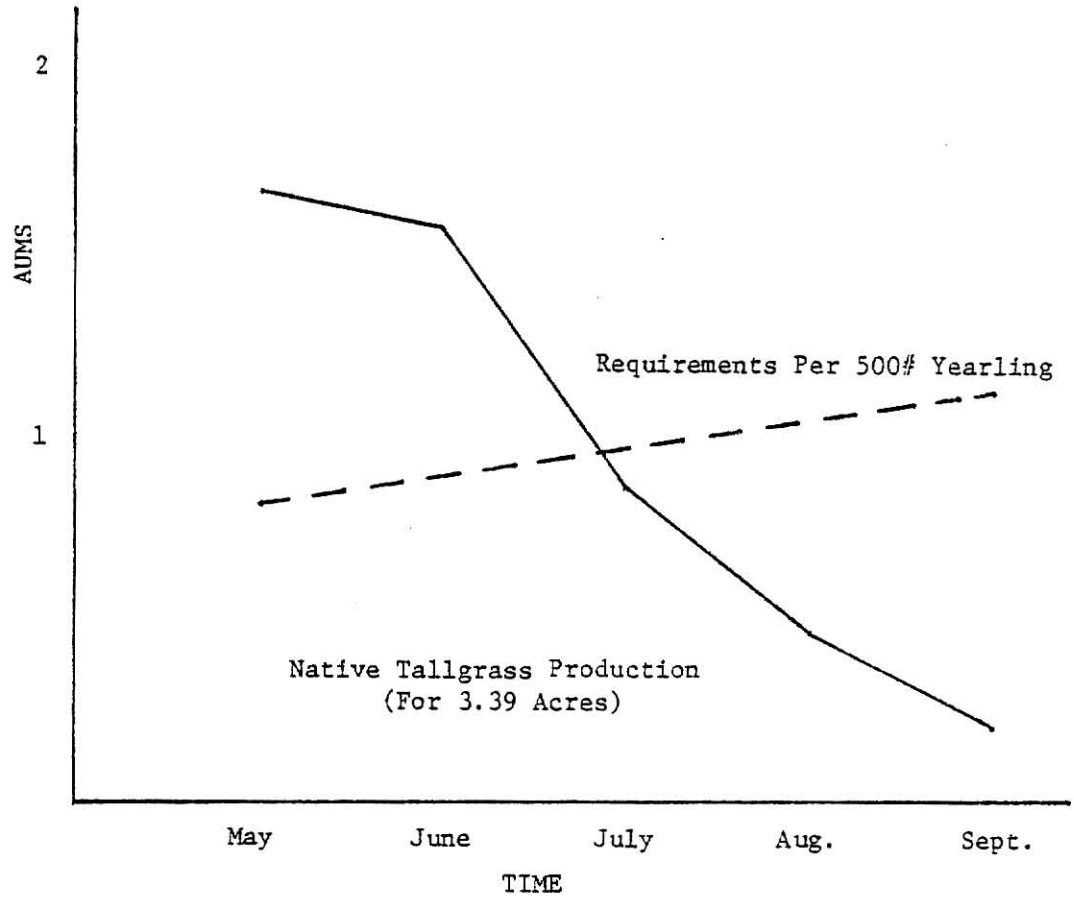

TABLE 8

STOCKING RATES AND ANIMAL AUM REQUIREMENTS

PER PRODUCTION PERIOD

SMOOTH BROMEGRASS SYSTEM 1

Column	A	B	C	D	E	F	G	H	I	J
Line Number	Production Periods	Production Level							TON/AC	
1	System 1			400#	450#	500#	550#	600#		Cow/C
2			AUM/HD	.65	.725	.8	.875	.95		1.3
	April 1									
3	through	low	AC/HD	.83	.93	1.03	1.12	1.22		1.67
4	April 30		HD/AC	1.20	1.08	.98	.89	.82		.60
	(1 mo.)									
5		medium	AC/HD	.69	.77	.85	.93	1.01		1.38
6			HD/AC	1.45	1.30	1.18	1.07	.99		.72
7		high	AC/HD	.54	.60	.67	.73	.79		1.08
8			HD/AC	1.85	1.66	1.50	1.37	1.26		.92
9	May 1 through June 30 (Hay)									
10		low							1.62	
11		medium							1.98	
12		high							2.52	
13			AUM/HD	1.375	1.525	1.675	1.825	1.975		2.05
14	Sept. 1	low	AC/HD	1.76	1.96	2.15	2.34	2.53		2.63
15	through		HD/AC	.57	.51	.47	.43	.39		.38
	Oct. 30									
16	or	medium	AC/HD	1.46	1.62	1.78	1.94	2.10		2.18
17	Oct. 1		HD/AC	.68	.62	.56	.52	.48		.46
	through									
18	Nov. 30	high	AC/HD	1.15	1.27	1.39	1.52	1.65		1.70
19	(2 mo.)		HD/AC	.87	.79	.72	.66	.61		.59

TABLE 8 - CONTINUED

STOCKING RATES AND ANIMAL AUM REQUIREMENTS

PER PRODUCTION PERIOD

SMOOTH BROMEGRASS SYSTEM 2

Column	A	B	C	D	E	F	G	H	I	J
Line Number	Production Periods	Production Level								
21				400#	450#	500#	550#	600#		Cow/C
22	System 2		AUM/HD	2.175	2.4	2.625	2.85	3.075		4.05
23	April 1	low	AC/HD	.83	.93	1.03	1.12	1.22		1.67
24	through June 30		HD/AC	1.20	1.08	.98	.89	.82		.60
25	(3 mo.)	medium	AC/HD	.69	.77	.85	.93	1.01		1.38
26			HD/AC	1.45	1.30	1.18	1.07	.99		.72
27		high	AC/HD	.54	.60	.67	.73	.79		1.08
28			HD/AC	1.85	1.66	1.50	1.37	1.26		.92
29			AUM/HD	1.375	1.525	1.675	1.825	1.975		2.05
30	Sept. 1	low	AC/HD	1.07	1.18	1.30	1.41	1.53		1.59
31	through Oct. 30		HD/AC	.94	.85	.77	.71	.65		.63
32	or	medium	AC/HD	.89	.98	1.08	1.18	1.27		1.32
33	Oct. 1 through		HD/AC	1.12	1.02	.92	.85	.78		.76
34	Nov. 30	high	AC/HD	.69	.77	.83	.92	1.00		1.04
35	(2 mo.)		HD/AC	1.44	1.30	1.18	1.08	1.00		.96

TABLE 8 - CONTINUED

STOCKING RATES AND ANIMAL AUM REQUIREMENTS

PER PRODUCTION PERIOD

SMOOTH BROMEGRASS SYSTEM 3, 4

Column	A	B	C	D	E	F	G	H	I	J
Line Number	Production Periods	Production Level								
36				400#	450#	500#	550#	600#		Cow/C
37	System 3		AUM/HD	1.375	1.525	1.675	1.825	1.975		2.7
38	April 1 through	low	AC/HD	.83	.93	1.03	1.12	1.22		1.67
39	May 30 (2 mo.)		HD/AC	1.2	1.08	.98	.89	.82		.6
40		medium	AC/HD	.69	.77	.85	.93	1.01		1.38
41			HD/AC	1.45	1.30	1.18	1.07	.99		.72
42		high	AC/HD	.54	.60	.67	.73	.79		1.08
43			HD/AC	1.85	1.66	1.50	1.37	1.26		.92
44			AUM/HD	1.375	1.525	1.675	1.825	1.975		2.05
45	Sept. 1 through Oct. 30 or Oct. 1 through Nov. 30 (2 mo.)	low	AC/HD	.61	.68	.74	.81	.88		.91
46			HD/AC	1.64	1.48	1.34	1.23	1.14		1.10
47		medium	AC/HD	.51	.56	.62	.67	.73		.76
48			HD/AC	1.97	1.77	1.62	1.48	1.37		1.32
49		high	AC/HD	.39	.44	.48	.53	.57		.59
50			HD/AC	2.51	2.26	2.06	1.89	1.75		1.68
51				400#	450#	500#	550#	600#		Cow/C
52	System 4		AUM/HD	6.125	6.625	7.1	7.55	7.975		8.8
53	April 1 through Oct. 30 (7 mo.)	low	AC/HD	1.57	1.70	1.82	1.94	2.04		2.26
54			HD/AC	.64	.59	.55	.52	.49		.44
55		medium	AC/HD	1.30	1.41	1.51	1.60	1.70		1.87
56			HD/AC	.76	.71	.66	.62	.59		.53
57		high	AC/HD	1.02	1.10	1.18	1.26	1.33		1.47
58			HD/AC	.98	.91	.85	.79	.75		.68

TABLE 9

STOCKING RATES AND ANIMAL AUM REQUIREMENTS

PER PRODUCTION PERIOD

TALL FESCUE SYSTEM 5, 6

Column	A	B	C	D	E	F	G	H	I	J
Line Number	Production Periods	Production Level								
1				400#	450#	500#	550#	600#		Cow/C
2	System 5		AUM/HD	6.125	6.625	7.1	7.55	7.975		8.8
3	April 1	low	AC/HD	1.61	1.74	1.87	1.99	2.10		2.30
4	through Oct. 30		HD/AC	.62	.57	.54	.50	.48		.43
5	(7 mo.)	medium	AC/HD	1.30	1.41	1.51	1.60	1.70		1.87
6			HD/AC	.76	.71	.66	.62	.59		.53
7		high	AC/HD	1.02	1.10	1.18	1.26	1.33		1.47
8			HD/AC	.98	.91	.85	.79	.75		.68
9			AUM/HD	2.175	2.4	2.625	2.85	3.075		4.05
	System 6									
10		low	AC/HD	.86	.95	1.05	1.15	1.25		1.71
11	April 1 through		HD/AC	1.17	1.05	.95	.87	.80		.58
12	June 30	medium	AC/HD	.69	.77	.85	.93	1.01		1.38
13	(3 mo.)		HD/AC	1.45	1.30	1.18	1.07	.99		.72
14		high	AC/HD	.54	.60	.67	.73	.79		1.08
15			HD/AC	1.85	1.66	1.50	1.37	1.26		.92
16			AUM/HD	2.175	2.4	2.625	2.85	3.075		2.75
17		low	AC/HD	1.73	1.90	2.08	2.26	2.44		2.18
18	Sept. 1 through		HD/AC	.58	.53	.48	.44	.41		.46
19	Nov. 30	medium	AC/HD	1.40	1.55	1.69	1.84	1.98		1.77
20	(3 mo.)		HD/AC	.71	.64	.59	.54	.50		.56
21		high	AC/HD	1.10	1.21	1.33	1.44	1.55		1.39
22			HD/AC	.91	.83	.75	.69	.64		.72

TABLE 10

STOCKING RATES AND ANIMAL AUM REQUIREMENTS

PER PRODUCTION PERIOD

NATIVE TALL GRASS SYSTEM 7, 8, 9

Column	A	B	C	D	E	F	G	H	I	J
Line Number	Production Periods	Production Level								
1				400#	450#	500#	550#	600#		Cow/C
2	System 7 May 1		AUM/HD	4	4.375	4.75	5.1	5.425		6.8
3	through	low	AC/HD	4.00	4.38	4.75	5.10	5.43		6.80
4	Sept. 30 (5 mo.)		HD/AC	.25	.23	.21	.20	.18		.15
5		medium	AC/HD	2.86	3.13	3.39	3.64	3.88		4.86
6			HD/AC	.35	.32	.29	.27	.26		.21
7		high	AC/HD	2.10	2.30	2.50	2.68	2.86		3.58
8			HD/AC	.48	.43	.40	.37	.35		.28
9	System 8 May 1		AUM/HD	5.025	5.475	5.9	6.3	6.675		7.5
10	through	low	AC/HD	5.03	5.48	5.90	6.30	6.68		7.50
11	Oct. 30 (6 mo.)		HD/AC	.20	.18	.17	.16	.15		.13
12		medium	AC/HD	3.59	3.91	4.21	4.50	4.77		5.36
13			HD/AC	.28	.26	.24	.22	.21		.19
14		high	AC/HD	2.64	2.88	3.10	3.32	3.51		3.95
15			HD/AC	.38	.35	.32	.30	.28		.25
16	System 9 Deferred		AUM/HD	4	4.375	4.75	5.1	5.425		6.1
17	June 1	low	AC/HD	4.00	4.38	4.75	5.10	5.43		6.10
18	through		HD/AC	.25	.23	.21	.20	.18		.16
19	Oct. 30 (5 mo.)	medium	AC/HD	2.86	3.13	3.39	3.64	3.88		4.36
20			HD/AC	.35	.32	.29	.27	.26		.23
21		high	AC/HD	2.10	2.30	2.50	2.68	2.86		3.21
22			HD/AC	.48	.43	.40	.37	.35		.31

TABLE 10 - CONTINUED

STOCKING RATES AND ANIMAL AUM REQUIREMENTS

PER PRODUCTION PERIOD

NATIVE TALLGRASS SYSTEM 10

Column	A	B	C	D	E	F	G	H	I	J
Line Number	Production Periods	Production Level								
23				400#	450#	500#	550#	600#		Cow/C
24	System 10 May 1		AUM/HD	1.775	1.963	2.15	2.338	2.525		NA
25	through	low	AC/HD	2.00	2.19	2.38	2.55	2.72		NA
26	July 15 (2½ mo.)		HD/AC	.50	.46	.42	.40	.37		NA
27		medium	AC/HD	1.43	1.58	1.70	1.82	1.94		NA
28	Intensive Stocking		HD/AC	.70	.63	.59	.55	.52		NA
29		high	AC/HD	1.05	1.15	1.25	1.34	1.43		NA
30			HD/AC	.95	.87	.80	.74	.70		NA

TABLE 11

STOCKING RATES AND ANIMAL AUM REQUIREMENTS

PER PRODUCTION PERIOD

NATIVE SHORTGRASS SYSTEM 11, 12

Column	A	B	C	D	E	F	G	H	I	J
Line Number	Production Periods	Production Level								
1				400#	450#	500#	550#	600#		Cow/C
2	System 11		AUM/HD	4	4.375	4.75	5.1	5.425		6.8
3	May 1	low	AC/HD	10.00	10.94	11.88	12.75	13.56		17
4	through Sept. 30		HD/AC	.100	.091	.084	.078	.074		.059
5	(5 mo.)	medium	AC/HD	6.67	7.29	7.92	8.5	9.04		11.33
6			HD/AC	.150	.137	.126	.118	.110		.088
7		high	AC/HD	5	5.47	5.94	6.38	6.78		8.5
8			HD/AC	.200	.183	.168	.157	.147		.118
9	System 12		AUM/HD	5.025	5.475	5.9	6.3	6.675		7.5
10	May 1	low	AC/HD	12.56	13.69	14.75	15.75	16.69		18.75
11	through Oct. 30		HD/AC	.079	.073	.068	.063	.059		.053
12	(6 mo.)	medium	AC/HD	8.38	9.13	9.83	10.5	11.13		12.50
13			HD/AC	.119	.110	.102	.095	.090		.080
14		high	AC/HD	6.28	6.84	7.38	7.88	8.34		9.38
15			HD/AC	.159	.146	.136	.127	.120		.107

TABLE 12

STOCKING RATES AND ANIMAL AUM REQUIREMENTS

PER PRODUCTION PERIOD

BERMUDAGRASS SYSTEM 13, 14

Column	A	B	C	D	E	F	G	H	I	J
Line Number	Production Periods	Production Level								
1				400#	450#	500#	550#	600#	Ton/Ac	Cow/C
2	System 13		AUM/HD	4	4.375	4.75	5.1	5.425		6.8
3	May 1 through	low	AC/HD	.54	.60	.67	.73	.79		1.17
4	Sept. 30 (5 mo.)		HD/AC	1.85	1.66	1.50	1.37	1.26		.86
5		medium	AC/HD	.36	.40	.44	.49	.53		.77
6			HD/AC	2.77	2.48	2.25	2.06	1.89		1.29
7		high	AC/HD	.27	.30	.33	.36	.40		.58
8			HD/AC	3.69	3.31	3.00	2.74	2.53		1.71
	System 14									
9	May 1 through June 1 (Hay)									
10		low							2.52	
11		medium							3.78	
12		high							5.04	
13			AUM/HD	3.05	3.35	3.65	3.95	4.225		5.4
14	June 1 through	low	AC/HD	.45	.49	.54	.58	.62		.79
15	Sept. 30 or		HD/AC	2.23	2.03	1.86	1.72	1.61		1.26
16	June 15	medium	AC/HD	.30	.33	.36	.39	.41		.53
17	through		HD/AC	3.34	3.04	2.79	2.58	2.41		1.86
18	Oct. 15 (4 mo.)	high	AC/HD	.22	.25	.27	.29	.31		.40
19			HD/AC	4.46	4.06	2.73	3.44	3.22		2.52

TABLE 13

STOCKING RATES AND ANIMAL AUM REQUIREMENTS

PER PRODUCTION PERIOD

SUMMER ANNUALS SYSTEM 15

Column	A	B	C	D	E	F	G	H	I	J
Line Number	Production Period	Production Level								
1				400#	450#	500#	550#	600#	Ton/Ac	Cow/C
2	System 15		AUM/HD	2.175	2.4	2.625	2.85	3.075		4.05
3	July 1 through	low	AC/HD	1.09	1.20	1.31	1.43	1.54		2.03
4	Sept. 30 (3 mo.)		HD/AC	.92	.83	.75	.70	.65		.49
5		medium	AC/HD	.62	.69	.75	.81	.88		1.16
6			HD/AC	1.61	1.46	1.33	1.23	1.14		.86
7		high	AC/HD	.44	.48	.53	.57	.62		.81
8			HD/AC	2.30	2.08	1.90	1.75	1.63		1.23
9	July 1 through Sept. 30 (Hay)									
10		low							2.5	
11		medium							4.5	
12		high							6.0	

TABLE 14

SUMMARY OF STOCKING RATES FOR LOW, MEDIUM AND HIGH

FORAGE PRODUCTION LEVELS

Acres Per Head for 400#, 450# and 500# Yearlings

Column Line No.	A Forage Systems	B	C 400#	D	E	F 450#	G	H	I 500#	J
1	Smooth Bromegrass	low	med.	high	low	med.	high	low	med.	high
2	(1)April 1-April 30	.83	.69	.54	.93	.77	.60	1.03	.85	.67
3	May 1-June 30 (Hay)									
4	Sept. 1-Oct. 30	1.76	1.46	1.15	1.96	1.62	1.27	2.15	1.78	1.39
5	(2)April 1-June 30	.83	.69	.54	.93	.77	.60	1.03	.85	.67
6	Sept. 1-Oct. 30	1.07	.89	.69	1.18	.98	.77	1.30	1.08	.83
7	(3)April 1-May 30	.83	.69	.54	.93	.77	.60	1.03	.85	.67
8	Sept. 1-Oct. 30	.61	.51	.39	.68	.56	.44	.74	.62	.48
9	(4)April 1-Oct. 30	1.57	1.30	1.02	1.70	1.41	1.10	1.82	1.51	1.18
10	Tall Fescue									
11	(5)April 1-Oct. 30	1.61	1.30	1.02	1.74	1.41	1.10	1.87	1.51	1.18
12	(6)April 1-June 30	.86	.69	.54	.95	.77	.60	1.05	.85	.67
13	Sept. 1-Nov. 30	1.73	1.40	1.10	1.90	1.55	1.21	2.08	1.69	1.33
14	Native Tallgrass									
15	(7)May 1-Sept. 30	4.00	2.86	2.10	4.38	3.13	2.30	4.75	3.39	2.50
16	(8)May 1-Oct. 30	5.03	3.59	2.64	5.48	3.91	2.88	5.90	4.21	3.10
17	(9)June 1-Oct. 30	4.00	2.86	2.10	4.38	3.13	2.30	4.75	3.39	2.50
18	(10)May 1-July 15	2.00	1.43	1.05	2.19	1.58	1.15	2.38	1.70	1.25
19	Native Shortgrass									
20	(11)May 1-Sept. 30	10.00	6.67	5.00	10.94	7.29	5.47	11.88	7.92	5.94
21	(12)May 1-Oct. 30	12.56	8.38	6.28	13.69	9.13	6.84	14.75	9.83	7.38
22	Bermudagrass									
23	(13)May 1-Sept. 30	.54	.36	.27	.60	.40	.30	.67	.44	.33
24	(14)May 1-June 1 (Hay)									
25	June 1-Sept. 30	.45	.30	.22	.49	.33	.25	.54	.36	.27
26	Summer Annaul									
27	(15)July 1-Sept. 30 (Hay or Graze)	1.09	.62	.44	1.20	.69	.48	1.31	.75	.53

TABLE 15

SUMMARY OF STOCKING RATES FOR LOW, MEDIUM AND HIGH

FORAGE PRODUCTION LEVELS

Acres Per Head for 550#, 600# Yearlings and Cow/Calf

Column Line No.	A Forage Systems	B	C 550#	D	E	F 600#	G	H	I Cow/C	J
1	Smooth Bromegrass	low	med.	high	low	med.	high	low	med.	high
2	(1)April 1-April 30	1.12	.93	.73	1.22	1.01	.79	1.67	1.38	1.08
3	May 1-June 30 (Hay)									
4	Sept. 1-Oct. 30	2.34	1.94	1.52	2.53	2.10	1.65	2.63	2.18	1.70
5	(2)April 1-June 30	1.12	.93	.73	1.22	1.01	.79	1.67	1.38	1.08
6	Sept. 1-Oct. 30	1.41	1.18	.92	1.53	1.27	1.00	1.59	1.32	1.04
7	(3)April 1-May 30	1.12	.93	.73	1.22	1.01	.79	1.67	1.38	1.08
8	Sept. 1-Oct. 30	.81	.67	.53	.88	.73	.57	.91	.76	.59
9	(4)April 1-Oct. 30	1.94	1.60	1.26	2.04	1.70	1.33	2.26	1.87	1.47
10	Tall Fescue									
11	(5)April 1-Oct. 30	1.99	1.60	1.26	2.10	1.70	1.33	2.30	1.87	1.47
12	(6)April 1-June 30	1.15	.93	.73	1.25	1.01	.79	1.71	1.38	1.08
13	Sept. 1-Nov. 30	2.26	1.84	1.44	2.44	1.98	1.55	2.18	1.77	1.39
14	Native Tallgrass									
15	(7)May 1-Sept. 30	5.10	3.64	2.68	5.43	3.88	2.86	6.80	4.86	3.58
16	(8)May 1-Oct. 30	6.30	4.50	3.32	6.68	4.77	3.51	7.50	5.36	3.95
17	(9)June 1-Oct. 30	5.10	3.64	2.68	5.43	3.88	2.86	6.10	4.36	3.21
18	(10)May 1-July 15	2.55	1.82	1.34	2.72	1.94	1.43	NA	NA	NA
19	Native Shortgrass									
20	(11)May 1-Sept. 30	12.75	8.50	6.38	13.56	9.04	6.78	17.00	11.33	8.50
21	(12)May 1-Oct. 30	15.75	10.50	7.88	16.69	11.13	8.34	18.75	12.50	9.38
22	Bermudagrass									
23	(13)May 1-Sept. 30	.73	.49	.36	.79	.53	.40	1.17	.77	.58
24	(14)May 1-June 1 (Hay)									
25	June 1-Sept. 30	.58	.39	.29	.62	.41	.31	.79	.53	.40
26	Summer Annual									
27	(15)July 1-Sept. 30 (Hay or Graze)	1.43	.81	.57	1.54	.88	.62	2.03	1.16	.81

Price Trend Tables

Data in Tables 16 and 17 were developed to measure the effects of weight change and season (by *months*) on cattle prices. The tables were developed from six years of data (1975 - 1980).[5] Prices are based on Kansas City choice steers (1975 - 1978) and Kansas City medium frame #1 steers (1979 - 1980). The purpose of these two tables is to determine discount rates on cattle from the beginning to the end of forage periods. The tables are developed for two starting weights (400# and 500#) and three starting months (April, May and September). The weight and month combinations fit most forage grazing systems commonly used in Kansas. The six years of data from which Tables 16 and 17 were developed are listed in Tables 18 and 19, respectively. Tables 18 and 19 are in the appendix. The original data list weights in the ranges of 300#-400# through 700#-800#. For this study it was assumed a 300#-400# animal would be classified as a 400# animal. This procedure was continued through all weight ranges.

Table 16 is based on a 400# starting weight in each of the three months, (April, May and September). It is assumed cattle gain 50# per month and price change percentages are on a monthly basis. The percent change per month is listed in lines 4, 9 and 14 for April, May and September, respectively. The cumulative percent change is progressively totaled for each additional month so that the percent change for any combination of *months* listed in the chart can be determined. The cumulative values are listed on lines 5, 10, and 15 for April, May and September, respectively.

Data generated from this table can be used several ways. The table provides general trends over normal grazing seasons that are correlated with

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[5]U.S. Department of Agriculture, Economics and Statistics Service, Agricultural Marketing Service, "Livestock and Meat Statistics: Consecutive Supplements For 1975-1980," Bulletin 522, Washington, D.C., (September, 1981).

the forage production periods selected by this study. The percent of starting price listed in lines 6, 11 and 16, column A will be used as the discount factor for example two that will be presented later. The percentage is multiplied by the selected starting value per pound of the animals to determine the discounted ending animal value per pound.

> Example: The value of a 400# animal from May through September would be priced the first of October at 86.32% of its original value. This coefficient is found in Table 16, line 6, column H.

Table 17 contains data for an animal starting weight of 500# and is formatted and used exactly like Table 16.

TABLE 16

SEASONAL AND WEIGHT PRICE TRENDS*

Column / Line No.	A	B	C	D	E	F	G	H	I	J
		400# Starting weight for April, May, September								
1		Apr.	May	Jun.	Jul.	Aug.	Sept.	Oct.	Nov.	Dec.
2	Starting Weight	400#	450#	500#	550#	600#	650#	700#	750#	800#
3	Avg. Price/100 lbs.	64.68	62.85	61.02	59.67	58.31	57.31	56.31	55.84	55.36
4	% Change/mo.		-2.83	-2.91	-2.21	-2.28	-1.71	-1.74	-.83	-.86
5	Accumulative % change		-2.83	-5.74	-7.95	-10.23	-11.94	-13.68	-14.51	-15.37
6	% of Starting Price		97.17	94.26	92.05	89.77	88.06	86.32	85.49	84.63
7	Starting Weight		400#	450#	500#	550#	600#	650#	700#	
8	Avg. Price/100 lbs.		65.96	63.03	60.10	60.45	60.79	58.36	55.92	
9	% Change/mo.			-4.44	-4.65	.58	.56	-4.00	-4.18	
10	Accumulative % change			-4.44	-9.09	-8.51	-7.95	-11.95	-16.13	
11	% of Starting Price			95.56	90.91	91.49	92.05	88.05	83.87	
12	Starting Weight						400#	450#	500#	
13	Avg. Price/100 lbs.						67.32	64.02	60.71	
14	% Change/mo.							-4.90	-5.17	
15	Accumulative % change								-4.90	-10.17
16	% of Starting Price								95.10	89.83

*Adapted from "Livestock and Meat Statistics," U.S. Department of Agricultural Economics and Statistics Service, Agricultural Marketing Service. Supplements 1975-1980. (Six year average)

TABLE 17

SEASONAL AND WEIGHT PRICE TRENDS*

Column / Line No.	A	B	C	D	E	F	G	H	I
		500# Starting Weight for April, May, September							
1		Apr.	May	Jun.	Jul.	Aug.	Sept.	Oct.	Nov.
2	Starting Weight	500#	550#	600#	650#	700#	750#	800#	
3	Avg. Price/100 lbs.	62.48	60.27	58.05	56.86	55.68	55.08	54.48	
4	% Change/mo.		-3.54	-3.68	-2.05	-2.08	-1.08	-1.09	
5	Accumulative % change		-3.54	-7.22	-9.27	-11.35	-12.43	-13.52	
6	% of Starting Price		96.46	92.78	90.73	88.65	87.57	86.48	
7	Starting Weight		500#	550#	600#	650#	700#	750#	800#
8	Avg. Price/100 lbs.		63.88	60.83	57.78	57.39	57.00	55.75	54.50
9	% Change/mo.			-4.77	-5.01	-.67	-.68	-2.19	-2.24
10	Accumulative % change			-4.77	-9.78	-10.45	-11.13	-13.32	-15.56
11	% of Starting Price			95.23	90.22	89.55	88.87	86.68	84.44
12	Starting Weight						500#	550#	600#
13	Avg. Price/100 lbs.						64.52	61.47	58.42
14	% Change/mo.							-3.05	-3.05
15	Accumulative % Change							-3.05	-6.10
16	% of Starting Price							96.95	93.90

*Adapted from "Livestock and Meat Statistics," U.S. Department of Agriculture Economics and Statistics Service, Agricultural Marketing Service, Supplements 1975-1980. (Six year average)

The Specific Flow Diagram, Figure 4, illustrates the use of worksheets that will be presented and discussed in the rest of this chapter. The broken directional lines indicate the sequence for completing Worksheets 1 through 11. The solid directional lines represent the transfer of gathered and calculated data from each worksheet to subsequent worksheets.

The first step in the use of the model is to select one of two basic objectives. The first objective assumes the producer wishes to select a specific number of cattle to be combined with selected forage grazing systems from Table 7. It is also assumed that the forage resources are not fixed and the number of acres needed for each forage grazing system can be secured for the specific number of cattle selected by the model user.

The model user takes default coefficient values from model tables or provides individual farm values. Producers will commonly have AC/HD values for their individual operations. AC/HD and HD/AC will be used throughout the model. The formula $1 \div$ AC/HD is used to calculate HD/AC when AC/HD is known. The formula $1 \div$ HD/AC is used to calculate AC/HD when HD/AC is known.

The first objective of the model is listed as Method I in the model format. Worksheet 1, Specified Number of Cattle, is completed when Method I is used. Instructions at the bottom of Worksheet 1 reference the sources of coefficients. Worksheet 1 will determine the number of acres needed for each production period of each forage grazing system.

The base data gathered and calculated by Worksheet 1 is transferred to the appropriate subsequent worksheets for each production period. Data that is transferred to subsequent worksheets will not be referenced again. Forages, production periods and levels, AC/HD and hay ton/AC are transferred to each Worksheet 7. Hay ton/AC, forages, production periods and levels and HD/AC are transferred to each Worksheet 9. Forages and utilized acres of each are transferred to Worksheet 11. The next step in this method is to proceed to and complete Worksheet 6.

The second objective assumes forage resources and land available for increased forage production are given and fixed. This is the general situation of most producers wishing to analyze a beef-forage system. This objective is listed as Method II in the model format. The producer may or may not be able to adjust cattle numbers according to variations in carrying capacities associated with different production periods. The producer must select forage grazing systems from Table 7 that correspond with fixed available forage resources. Any of the six selected forages can be introduced when land is available for increased forage production. The next step in the use of Method II is to complete Worksheet 2, Inventory of Resources. The producer inventories forage resources, land available (bottom land, hill land or upland) for increased forage production and selects one cattle type and one or more forage grazing systems.

METHOD I

WORKSHEET 1

SPECIFIED NUMBER OF CATTLE

Cattle Type _____

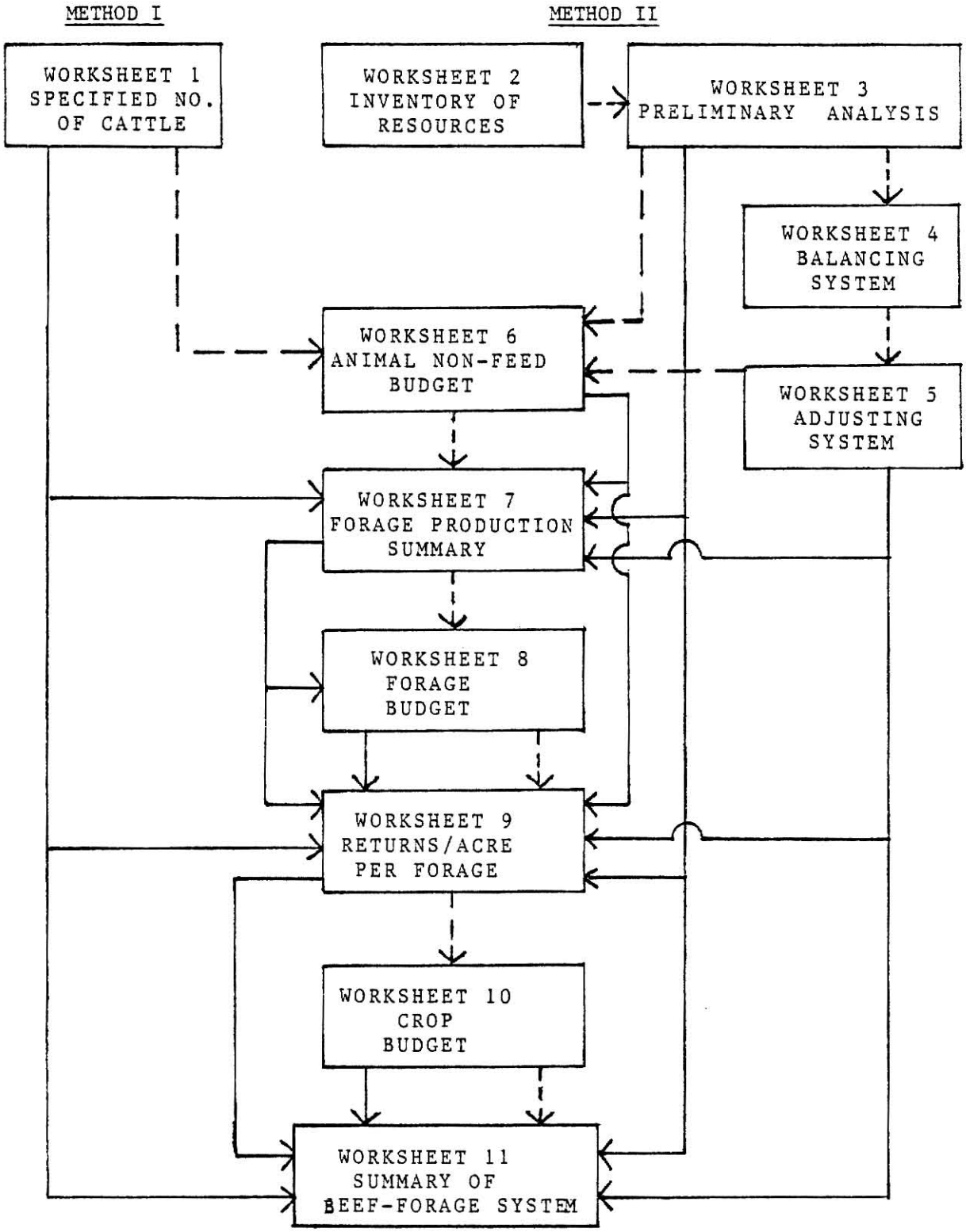
A	B	C	D	E	F		G		H
Forage & Prod. Period	Prod. Level	Hay Ton/AC	Yearling Weight	HD/AC	AC/HD	X	No. HD Specified	=	No. Acres Recq. Per Prod.Period

Column Instructions

Column	Source	Column	Source
A	Table 7	G	Producer Records
D	Producer Records	H	(Column F) X (Column G)
B, C, E, F	Tables 8 - 13 or Producers Records		

FIGURE 4

SPECIFIC MODEL FLOW DIAGRAM



Broken lines indicate the sequence for completing worksheets.

Solid directional lines represent the transfer of data to subsequent worksheets.

Example 1

The first example, illustrating the use of the model, will be a cow/c enterprise and will be analyzed with Method II. It is assumed the producer cannot adjust cattle numbers. In this example the producer has 40 acres of high production smooth bromegrass, 240 acres of medium production native tallgrass and 40 acres of high production upland that can be used for forage production. Forage Grazing System 1, smooth bromegrass, and System 7, native tallgrass (from Table 7) are used in this example. Worksheet 2 is completed with this information. All worksheets used in example 1 are included at the end of the discussion of the example.

Worksheet 3, Preliminary Forage Analysis, is completed next. Instructions at the bottom of Worksheet 3 reference the sources of coefficients. Each forage grazing system and its production period(s) are listed in Table 7. The example references Systems 1 and 7 of this table. The number of acres of each forage are transferred from Worksheet 2 to column B. Production level, AC/HD, HD/AC and hay ton/AC are recorded in Worksheet 3, columns C, D, E and F, respectively. The values are taken from Table 8, System 1 (high production smooth bromegrass), and Table 10, System 7 (medium production native tallgrass) for this example. The Sept. 1 - Oct. 30 grazing period of System 1 will be used Oct. 1 - Nov. 30 for the cow/c example. The producer would use appropriate tables in the same manner or provide individual production values. The next step is to divide the number of acres (column B) by AC/HD (column D) to determine the maximum number of cattle that can be grazed for each forage production period. The resulting value is recorded in column G. The most limiting forage production period is identified by evaluating the values in column G.

When the number of cattle can be adjusted for each forage period the data gathered by Worksheet 3 is transferred to the appropriate subsequent worksheets for each production period. Forages, production periods and levels, AC/HD

and hay ton/AC are transferred to each Worksheet 7. Forages, production periods and levels, HD/AC and hay ton/AC are transferred to each Worksheet 9. Forages and acres of each utilized are transferred to Worksheet 11. Under this condition proceed to and complete Worksheet 6.

When the number of cattle cannot be adjusted the beef-forage system will need to be balanced for a specific number of cattle.

In most farm situations forages will not be combined in a balanced relationship to support a specific number of cattle. Worksheet 4, Balancing the Beef-Forage System, is completed and adjustments made when it is not feasible to adjust cattle numbers for each production period. The adjustments made will be determined by the situation and objectives of the producer. One of the forage production periods must be designated as the base period.

The base period will be the period limiting the maximum number of cattle that can be grazed if additional forage cannot be added to the system. The base period may not always be the period limiting the maximum number of cattle, if additional land is available to increase forage production. The producer must now evaluate the specific situation and select a base forage period.

Worksheet 4 determines the number of acres needed of each non-base forage period to support the number of cattle grazed by one acre of the base forage period by developing an acreage ratio between the base period and each non-base period. The ratio is calculated by dividing the AC/HD of the non-base forage period by the AC/HD of the base forage period. The ratio is multiplied by the number of acres of the base forage period to obtain the number of acres of each non-base forage period to balance the selected beef-forage system.

Coefficients for AC/HD and total acres in the base forage period are transferred from Worksheet 3 to Worksheet 4 and calculations made. The data generated provides information to the producer for adjusting the beef-forage system.

In the example being presented the base forage period will be 240 acres of native tallgrass. The data generated for the example coefficients indicates for each acre of native tallgrass .222 acres of April smooth bromegrass and .349 acres of October-November smooth bromegrass are required. Grazing 49 cow/c units, the capacity of the base forage period, requires 53.28 acres of April smooth bromegrass and 83.76 acres of October-November smooth bromegrass.

The two smooth bromegrass production periods make up one forage grazing system, making it impossible to balance both periods with the base period. One of the two periods must be selected to be balanced with the base forage period. The alternative to this solution would be to select different forage grazing systems that might better correlate livestock to the producer's available forages. It will be assumed in this example the producer wishes to balance April smooth bromegrass production with the base period, native tallgrass.

In most situations it will be possible to balance only two production periods. Generally a surplus or deficit will result in the other production periods.

The final adjustments are made on Worksheet 5, Adjusted Beef-Forage System. A brief description of the adjustments is recorded in the first part of Worksheet 5. The coefficients of the adjusted beef-forage system are recorded in the second part of Worksheet 5. Relative data from Worksheets 3 and 4 are transferred to Worksheet 5. The procedure used for completing Worksheet 3 is followed if additional or new production period coefficients are added to the adjusted system on Worksheet 5.

The adjustments for the example problem and the coefficients for the adjusted system are listed in Worksheet 5. The maximum number of animals per period in column G must be recalculated using the procedure described in Worksheet 3. April smooth bromegrass and native tallgrass are balanced,

both have a carrying capacity of 49 cow/c units. The October-November smooth bromegrass production period has a carrying capacity of 31 cow/c units. The producer would need to supplement the cattle during this period or reduce the length of the grazing period.

Under certain conditions a balanced system may have one or more production periods with a surplus cattle carrying capacity greater than that of the balanced forages. A surplus forage must be adjusted to acres utilized, so that the unused surplus will not be valued in the total economic returns. Acres available and acres utilized for non-surplus forages will be the same and the number of available acres will be recorded in column H of Worksheet 5. A formula is included in the last part of Worksheet 5 for adjusting a surplus production period.

The base data gathered and calculated by Worksheet 5 is transferred to the appropriate subsequent worksheets for each production period. Forages, production periods and levels, AC/HD and hay ton/AC are transferred to each Worksheet 7. Hay ton/AC, HD/AC, forages and production periods and levels are transferred to each Worksheet 9. Forages and acres of each utilized are transferred to Worksheet 11.

Worksheet 6, Cow Non-Feed Budget, is completed next. It is assumed in this model that replacement cows are purchased and all heifer and steer calves are sold. The model user supplies the economic and production coefficients. Selected economic and production coefficients have been used in this example to complete Worksheet 6. The format of the Cow Non-Feed Budget is adapted from KSU Farm Management Guide MF-266.[6]

The data generated by Worksheet 6 is transferred to the appropriate subsequent worksheets. The average calf weaning weight is transferred to each

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[6]Kansas Cooperative Extension Service, Department of Economics, "Kansas Farm Management Handbook," Manhattan, Kansas State University.

Worksheet 7. The total non-feed cost per head per day and the average calf selling price per pound are transferred to each Worksheet 9.

Worksheets 7, 8 and 9 must be completed for each forage grazing system in the beef-forage model. Each of these three worksheets will be completed for System 1, high production smooth bromegrass and System 7, medium production native tallgrass for the present example.

Worksheet 7, Forage Production Summary - cow/c, analyzes each individual production period separately. The formula presented on Worksheet 7 determines the pounds of beef produced per acre for each individual production period. The formula develops a ratio between the number of AUMs used per cow/c unit for each production period and the total AUMs required yearly per cow/c unit. The percentage ratio is multiplied by the average weaning weight per cow/c unit divided by AC/HD for the production period being evaluated, to put production on a per acre basis. The number of AUMs produced per acre, per period and total AUMs produced for the forage grazing system are calculated.

The data generated by Worksheet 7 is transferred to the appropriate, subsequent worksheets. Total AUMs per acre are transferred to each Worksheet 8. Pounds of beef and AUMs per acre per production period are transferred to each Worksheet 9.

Worksheet 8, Forage Budget, is completed with producer input values. Selected economic coefficients have been used for the two example budgets. The purpose of this worksheet is to compute total variable cost (TVC) and total fixed cost (TFC) per AUM of production for each specific forage grazing system. The values for TVC/AUM and TFC/AUM are transferred to each Worksheet 9, as desired for each production period.

Worksheet 9, Returns Per Acre Per Forage Period - cow/c, analyzes each forage production period of each overall forage grazing system. The worksheet uses data generated by the model to evaluate returns above TVC per acre and returns above total cost (TC) per acre for each individual forage period.

The gross returns per acre for each production period are measured by calculating the value of the beef or hay produced per acre for the specified period. The forage cost per acre for each period is determined by calculating the TVC and TFC of the AUMs used per acre. The beef non-feed cost is calculated on a per acre basis. The Worksheet 9 examples for smooth bromegrass and native tallgrass demonstrate the format of this method of analysis. The model has now identified returns per acre over TVC and TC according to use for each production period. The information generated in each Worksheet 9 can be used to evaluate a current beef-forage production system or plan a future system.

The total returns for each forage grazing system per acre above TVC and TC from each Worksheet 9 are transferred to Worksheet 11.

Many of the introduced forage species are produced on land that can be used for crop production. Returns per acre of forage production should be compared to returns per acre of crop production when considering adding additional forage to a beef-forage system. This analysis is particularly important on high production crop land.

Additional smooth bromegrass is added to the beef-forage system in the example being presented. A sorghum grain budget is presented on Worksheet 10, Crop Budget. The sorghum grain budget is adapted from KSU Farm Management Guide MF-573.[7] The sorghum grain budget was based on the assumption that high level production smooth bromegrass would be equivalent to sorghum grain producing 75 bushels per acre. Sorghum grain returns over TVC and TC are transferred to Worksheet 11, to be compared to smooth bromegrass returns.

Worksheet 11, Summary of Returns For the Beef-Forage System, summarizes the total model analysis. Each forage grazing system is evaluated by returns per acre over TVC and TC, excluding land charge. Land charge will be assumed to be a residual factor. The total returns for each forage grazing system

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[7] Ibid.

are calculated by multiplying the number of acres utilized by the economic values per acre. Crops to be compared to forage production will also be listed on Worksheet 11.

The capitalization method is used to establish land values for each forage grazing system and comparative crops. The returns per acre above total cost are capitalized by a value of .03 (column E ÷ column G). The capitalization rate was based on the long run return to land of approximately 3%. In this example the land values calculated for smooth bromegrass, native tallgrass, and sorghum grain are $644.66, $174.00 and $1,271.33, respectively. The land value of $190.66 for native tallgrass clearly indicates that the current market value of native tallgrass land is out of balance with its productivity capabilities utilizing beef cattle. Smooth bromegrass production in this example is not competative with sorghum grain production.

METHOD II

WORKSHEET 2

INVENTORY OF RESOURCES

Forage	No./AC	Prod. Level
Bromegrass	40	high
Native grass	240	med.

Land Class Available for Forage Prod.	No./AC	Prod. Level
Upland	40	high

Selected Beef-Forage System

Cattle Type Cow/c Weight(s) NA

Forage	Forage Grazing System No.
Bromegrass	1
Native grass	7

WORKSHEET 3

PRELIMINARY FORAGE ANALYSIS

Cattle Type cow/c

A	B	C	D	E	F	G	H
Forage & Production Period	No./AC	Prod. Level	AC/HD	HD/AC	Hay Ton/AC	Max. No. HD.	Yearling Weight
April Bromegrass	40	high	1.08	.92		37	
May-June Bromegrass (Hay)	40	high			2.52		
Oct.-Nov. Bromegrass	40	high	1.7	.59		24	
May-Sept. Native grass	240	med.	4.86	.21		49	

Column Instructions

Column		Column	
A	Worksheet 2 & Table 7	G	(Column B) ÷ (Column D)
B	Worksheet 2	H	Producer Records
C-F	Tables 8-13 or Producer Records		

WORKSHEET 4

BALANCING THE BEEF-FORAGE SYSTEM*

Selected Base Forage Period Native grass

Number of Acres 240 Acres Per Head (AC/HD) 4.86

Non Base Period	AC/HD Per Non-Base Period	÷	AC/HD Per Base Period	=	Acreage Ratio	X	No. Ac. in Base Period	=	Ac. Recq. of Non-Base Forages
April Bromegrass	1.08		4.86		.222		240		53.28
Oct.-Nov. Bromegrass	1.7		4.86		.349		240		83.76

*Input coefficients transferred from Worksheet 3.

WORKSHEET 5

ADJUSTING THE BEEF-FORAGE SYSTEM

Cattle Type cow/c

List Adjustments

April bromegrass will be balanced with the base forage native grass. A total of 53 acres are needed, 40 acres are currently in production. Cropland is available for increased forage production, 13 acres of high level production bromegrass will be added to forage System 1. The Oct.-Nov. bromegrass will automatically be increased to 53 acres.

A	B	C	D	E	F	G	H	I
Forage and Production Periods	No. Ac.	Prod. Level	AC/HD	HD/AC	Hay Ton/AC	Max.No. HD/ period	No. Ac. Uti.	Year-ling Wt.
April Bromegrass	53	high	1.08	.92		49	53	NA
May-June Bromegrass (Hay)	53	high			2.52		53	NA
Oct.-Nov. Bromegrass	53	high	1.7	.59		31	53	NA
May-Sept. Bromegrass	240	med.	4.86	.21		49	240	NA

Adusting Surplus Forages

Surplus Forage Period	AC/HD of Surplus Forage	X	No. HD in Balanced System	=	Acres Utilized of Surplus Forage (Record in Column H above)

WORKSHEET 6

COW NON-FEED BUDGET

VARIABLE COST PER HEAD

1. Labor (8 hrs. X $/hr. 4) . . . . . $ 32.00
2. Breeding Charge 10.00
3. Veterinary, Drugs and Supplies 5.50
4. Fuel, Oil and Utilities 15.90
5. Marketing Cost (3% of line 24) 10.46
6. Repairs 12.00
7. Miscellaneous 3.50
8. Interest on ½ the Variable Cost @ 13 % 5.80
9. Cow Replacement Cost, Culling Rate 15 % X Purchase Price . . 30.00
   Per Head $600.00. Less Culling Rate 15 % X Salvage Val. $400.00
10. Total Non-Feed Variable Cost $125.16

FIXED COST PER HEAD

11. Depreciation-Facilities $105.00 ÷ 20 years . . . . . $ 5.25
12. Interest on Facilities $105.00 X 6 % 6.30
13. Taxes & Insurance on Facilities $105.00 X 2 % 2.10
14. Interest on Breed Stock $600.00 X 13 % 78.00
15. Taxes & Insurance on Breeding Stock $600.00 X 15 % 3.00
16. Depreciation on Cows $200.00 ÷ 7 yrs. 28.57
17. Total Non-Feed Fixed Cost $123.22
18. Total Non-Feed Cost (line 10 + line 17) 248.38
19. Total Non-Feed Cost Per Head Per Day 680
    (line 18 ÷ 365 days)

WEANING WEIGHTS AND PRICES

20. Steer Weight 525 lbs. + Heifer Weight 475 lbs. . . . . 1,000#
21. Steer $/lb. .80 + Heifer $/lb. .75 . . . . . $ 1.55
22. Average Weaning Weight Per cow/c Unit . . . . . 450#
    (Total of line 20 ÷ 2) X % Calves Weaned .90 . . . . . .
23. Average Price Per Pound . . . . . $ .775
    Total of line 21 ÷ 2
24. Average Selling Price Per Calf . . . . . $ 348.75
    (line 22 X line 23)

WORKSHEET 7

FORAGE PRODUCTION SUMMARY - COW/C

Forage Grazing System No. 1 Forage Bromegrass

Production Level high

Pounds of beef per cow/c unit per acre for each forage production period is calculated with the following formula.

$$\frac{\text{AUMs used per cow/c unit per period}^{a}}{\text{Total yearly AUMs required per cow/c unit}^{b}} \times \frac{\text{average weaning wt.}}{\text{AC/HD per prod. period}} = \text{lbs. beef per acre}$$

1. First Production Period, Months Grazed Bromegrass April
2. $\frac{1.3}{13.4^{b}} \times \frac{450}{1.80} = \ldots\ldots\ldots\ldots\ldots\ldots 40.4\#$ (lbs. beef/AC)
3. HD/AC .92 X AUMs used per cow/c unit per period[a] 1.3 = 1.2 (AUMs used/AC/period)
4. Second Production Period, Months Grazed Bromegrass Oct. - Nov.
5. $\frac{2.05}{13.4^{b}} \times \frac{450}{1.7} = \ldots\ldots\ldots\ldots\ldots\ldots 40.5\#$ (lbs. beef/AC)
6. HD/AC .59 X AUMs used per cow/c unit per period[a] 2.05 = 1.2 (AUMs used/AC/period)
7. Hay Production Period May - June
8. Tons/AC 2.52 X AUMs/Ton[c] 3.3 = ... 8.32 (AUMs used/AC/period)
9. Total AUMs used/AC (add lines 3, 6 and 8) 10.7

Source of Coefficients Not Previously Transferred

a. Appropriate Tables 8-13, Column J
b. Constant Value 13.4 AUMs
c. Table 2

WORKSHEET 7

FORAGE PRODUCTION SUMMARY - COW/C

Forage Grazing System No. 7 Forage Native grass

Production Level med.

Pounds of beef per cow/c unit per acre for each forage production period is calculated with the following formula.

$$\frac{\text{AUMs used per cow/c unit per period}^{a}}{\text{Total yearly AUMs required per cow/c unit}^{b}} \times \frac{\text{average weaning wt.}}{\text{AC/HD per prod. period}} = \text{lbs. beef per acre}$$

1. First Production Period, Months Grazed Native grass May-Sept.
2. $\frac{6.8}{13.4^{b}} \times \frac{450}{4.86} = \ldots\ldots\ldots\ldots\ldots\ldots = \frac{47\#}{\text{(lbs. beef/AC)}}$
3. HD/AC .21 X AUMs used per cow/c unit per period[a] 6.8 = 1.42 (AUMs used/AC/period)
4. Second Production Period, Months Grazed _____
5. $\frac{\quad}{13.4^{b}} \times \frac{\quad} = \ldots\ldots\ldots\ldots\ldots\ldots = \frac{\quad}{\text{(lbs. beef/AC)}}$
6. HD/AC _____ X AUMs used per cow/c unit per period[a] _____ = _____ (AUMs used/AC/period)
7. Hay Production Period _____
8. Tons/AC _____ X AUMs/Ton[c] _____ = ... (AUMs used/AC/period)
9. Total AUMs used/AC (add lines 3, 6 and 8) 1.42

Source of Coefficients Not Previously Transferred

a. Appropriate Tables 8-13, Column J
b. Constant Value 13.4 AUMs
c. Table 2

WORKSHEET 8

FORAGE BUDGET

Forage Grazing System No. 1 Forage Bromegrass

Production Level high

Cattle Type med.

VARIABLE COST PER ACRE

1.	Labor (1 hrs. X $/hr. 4)	$ 4.00
2.	Seed Cost ÷ No. Years of Grass Stand	.68
3.	Herbicide and Insecticide	
4.	Lime ÷ No. Years of Grass Stand	4.00
5.	Fertilizer	30.00
6.	Fuel and Oil	.50
7.	Machinery and Equipment Repairs	1.00
8.	Miscellaneous	1.50
9.	Interest on ½ Operating Capital @ 13 %	2.71
10.	Total Variable Costs Per Acre	$ 44.39
11.	Total Variable Costs Per AUM	4.14
	(TVC/AC $ 44.39 ÷ Total AUMs/AC used 10.72)	

FIXED COST PER ACRE (excluding land charge)

12.	Real Estate Taxes	$ 4.00
13.	Depreciation on Machinery	2.50
14.	Taxes, Insurance and Interest on Machinery	1.50
15.	Total Fixed Costs Per Acre	$ 8.00
16.	Total Fixed Costs Per AUM	.75
	(TFC/AC $ 8.00 ÷ Total AUMs/AC used 10.72)	

WORKSHEET 8

FORAGE BUDGET

Forage Grazing System No. 7 Forage Native grass

Production Level med.

Cattle Type cow/c

VARIABLE COST PER ACRE

1.	Labor (.5 hrs. X $/hr. 4)	$ 2.00
2.	Seed Cost ÷ No. Years of Grass Stand	
3.	Herbicide and Insecticide	.50
4.	Lime ÷ No. Years of Grass Stand	
5.	Fertilizer	
6.	Fuel and Oil	.50
7.	Machinery and Equipment Repairs	.50
8.	Miscellaneous	1.00
9.	Interest on ½ Operating Capital @ 13 %	.29
10.	Total Variable Costs Per Acre	$ 4.79
11.	Total Variable Costs Per AUM (TVC/AC $4.79 ÷ Total AUMs/AC used 1.42)	3.37

FIXED COST PER ACRE (excluding land charge)

12.	Real Estate Taxes	$ 3.00
13.	Depreciation on Machinery	1.25
14.	Taxes, Insurance and Interest on Machinery	.75
15.	Total Fixed Costs Per Acre	$ 5.00
16.	Total Fixed Costs Per AUM (TFC/AC $5.00 ÷ Total AUMs/AC used 1.42)	3.52

WORKSHEET 9

RETURNS PER ACRE PER FORAGE PERIOD - COW/C

Forage Grazing System No. 1 Forage Bromegrass

Production Level high

1. First Production Period and Months Grazed Bromegrass April
2. Lbs. Beef/AC 40.4 X $/lb. .775 = ... $ 31.31
3. Less: TVC/AUM $ 4.14 X AUMs used/AC/period 1.2 = ... - 4.97
4. Less: Non-Feed cost/HD/day $ .68 X No. days 30 X HD/AC .92 = ... - 18.76
5. Returns Above TVC Per Acre 7.58
6. Less: TFC/AUM $ .75 X AUMs used/AC/period 1.2 = ... - .90
7. Returns Above TC Per Acre (land charge excluded) 6.68

8. Second Production Period and Months Grazed Bromegrass Oct.-Nov.
9. Lbs. Beef/AC 40.5 X $/lb. .775 = ... $ 31.39
10. Less: TVC/AUM $ 4.14 X AUMs used/AC/period 1.2 = ... - 4.97
11. Less: Non-Feed cost/HD/day $ .68 X No. days 60 X HD/AC .59 = ... - 24.07
12. Returns Above TVC Per Acre 2.35
13. Less: TFC/AUM $ .75 X No. AUMs used/AC/period 1.2 = . . - .90
14. Returns Above TC Per Acre (land charge excluded) 1.45

15. Hay Production Period May-June
16. Hay Tons/AC 2.52 X $/Ton 45 . . . . . $ 113.40
17. Less: TVC/AUM $ 4.14 X AUMs used/AC/period 8.32 = ... - 34.44
18. Less: Harvest Cost/Ton $ 24.41 X No. Tons 2.52 = ... - 61.51
19. Returns Above TVC Per Acre 17.45
20. Less: TFC/AUM $ .75 X AUMs used/AC/period 8.32 = ... - 6.24
21. Returns Above TC Per Acre (land charge excluded) 11.21

22. Total Returns Per Acre (all periods)
23. Returns Above TVC (add lines 5, 12, and 19) . . . . . $ 27.38
24. Returns Above TC (add lines 7, 14 and 21) 19.34
(land charge excluded)

WORKSHEET 9

RETURNS PER ACRE PER FORAGE PERIOD - COW/C

Forage Grazing System No. 7 Forage Native grass

Production Level med.

1. First Production Period and Months Grazed Native grass
2. Lbs. Beef/AC 47 X $/lb. .775 = ... $ 36.43
3. Less: TVC/AUM $3.37 X AUMs used/AC/period 1.42 = ... - 4.79
4. Less: Non-Feed cost/HD/day $.68 X No. days 150 X HD/AC .21 = ... - 21.42
5. Returns Above TVC Per Acre 10.22
6. Less: TFC/AUM $3.52 X AUMs used/AC/period 1.42 = ... - 5.00
7. Returns Above TC Per Acre (land charge excluded) 5.22

8. Second Production Period and Months Grazed _____
9. Lbs. Beef/AC _____ X $/lb. _____ = ... $ _____
10. Less: TVC/AUM $_____ X AUMs used/AC/period _____ = ... - _____
11. Less: Non-Feed cost/HD/day $_____ X No. days _____ X HD/AC _____ = ... - _____
12. Returns Above TVC Per Acre . . . . . _____
13. Less: TFC/AUM $_____ X No. AUMs used/AC/period _____ = . . - _____
14. Returns Above TC Per Acre (land charge excluded) . . . . . _____

15. Hay Production Period _____
16. Hay Tons/AC _____ X $/Ton _____ . . . . . $ _____
17. Less: TVC/AUM $_____ X AUMs used/AC/period _____ = ... - _____
18. Less: Harvest Cost/Ton $_____ X No. Tons _____ = ... - _____
19. Returns Above TVC Per Acre . . . . . _____
20. Less: TFC/AUM $_____ X AUMs used/AC/period _____ = ... - _____
21. Returns Above TC Per Acre (land charge excluded) . . . . . _____

22. Total Returns Per Acre (all periods)
23. Returns Above TVC (add lines 5, 12, and 19) . . . . . $ 10.22
24. Returns Above TC (add lines 7, 14 and 21) 5.22
(land charge excluded)

WORKSHEET 10

CROP BUDGET

Crop Produced Sorghum grain

VARIABLE COSTS PER ACRE

1.	Labor (2.3 hrs. X $/hr. 4)	$ 9.20
2.	Seed (5.5 lbs. X $/lb. .50)	2.75
3.	Herbicide $15. + Insecticide $10.	25.00
4.	Fertilizer and Lime	26.20
5.	Fuel and Oil	16.76
6.	Machinery and Equipment Repairs	13.35
7.	Crop Insurance	
8.	Custom Hire (Drying 10 ¢/bu.)	7.50
9.	Miscellaneous	3.00
10.	Interest on ½ Operating Capital @ 13 %	6.74
11.	Total Variable Cost Per Acre	$ 110.50

FIXED COSTS PER ACRE

12.	Real Estate Taxes	$ 4.00
13.	Depreciation on Crop Machinery	22.86
14.	Taxes, Insurance and Interest on Machinery	12.00
15.	Total Fixed Cost Per Acre	$ 38.86
16.	Total Cost Per Acre (line 11 + line 15)	149.36
17.	Yield Per Acre 75 bu.	
18.	Price Per Bushel $2.50	
19.	Returns (line 17 X line 18)	$ 187.50
20.	Returns Above Total Variable Cost/AC (line 19-line 11)	$ 77.00
21.	Returns Above Total Cost (line 19- line 16) (excluding land charge)	38.14

WORKSHEET 11

SUMMARY OF RETURNS FOR THE BEEF-FORAGE SYSTEM

A	B	C	D	E	F	G	H
Forage & Grazing System No. and Other Crop if Applicable	Acres Utilized	Returns Per Acre above TVC	Total Returns above TVC (column B X column C)	Returns Per Acre above TC	Total Returns above TC (column B X column E)	Capitalization Rate	Land Value (column E ÷ column G)
		$	$	$	$		$
Bromegrass No. 1	53	27.38	1,451.14	19.34	1,025.02	.03	644.66
Native grass No. 7	240	10.22	2,452.80	5.22	1,252.80	.03	174.00
Sorghum grain		77.00		38.14			1,271.33

Example 2

The second example, using Method II, is a yearling summer graze program. The example assumes that cattle numbers can be adjusted for each production period. The fixed forage resources available in this example are 640 acres of medium production native tallgrass and 80 acres of high production smooth bromegrass. Additional land is not available for increased forage production. Forage Grazing System 2 (smooth bromegrass) and System 7 (native tallgrass) will be used in this example. Default coefficients from model tables will be used throughout this example. It is always assumed the model user can override these values with specific coefficients. The two systems selected include three forage production periods, which will be used independantly with three groups of cattle. The April 1 - June 30 smooth bromegrass period is grazed with 500# yearlings, the September 1 - October 30 smooth bromegrass period is grazed with 400# yearlings and the May 1 - September 30 native tallgrass period is grazed with 500# yearlings.

The first worksheet completed in this example is Worksheet 2A, Inventory of Resources. The worksheets in example 2 will have a suffix A to distinguish them from example 1 worksheets. All worksheets used in example 2 are included at the end of the discussion of the example.

Worksheet 3A is completed with coefficients from Table 8, System 2 (smooth bromegrass), Table 10, System 7 (native tallgrass) and data from Worksheet 2A.

The data gathered by Worksheet 3A, Preliminary Forage Analysis, is transferred to the appropriate subsequent worksheets for each production period. Forages, production periods and levels, HD/AC, hay ton/AC and starting yearling weights are transferred to each Worksheet 7A. Forages, production periods and levels, HD/AC and hay ton/AC are transferred to each Worksheet 9A. Forages and acres of each are transferred to Worksheet 11A.

The system for this example does not have to be balanced or adjusted, because of the assumption that the number of yearlings are adjusted to the carrying capacities of the three forage production periods. The balancing and adjusting section would be completed if the producer objective was to maintain a specific number of yearlings using two or more production periods in a sequential system.

The next step in this example is completing a Worksheet 6A, Yearling Non-Feed Budget, for each set of yearling cattle. The yearling non-feed budget is adapted from KSU Farm Management Guide MF-951.[8] The interest cost on cattle between a five month and a two month grazing period differs considerably. A separate budget must be completed for each cattle forage period because of the effects of cattle production costs associated with time.

Selected production costs have been used to develop the three 6A Worksheets for this example. The starting yearling weights and starting prices per pound are selected by the model user. The starting yearling weights from each Worksheet 6A are transferred to each corresponding Worksheets 7A and 9A. The ending weights for this example are calculated by multiplying the number of days in each forage period times the average daily gain for each forage type listed in Table 6. The calculation is completed on each Worksheet 7A and transferred to line 19 of each corresponding Worksheet 6A.

The ending price per pound is calculated on Worksheet 6A by discounting the starting price per pound. The discount factor (percent of starting price) is taken from Table 16 or 17, according to the starting weight of the calf (400# or 500#). Tables 16 and 17 are specific to these two cattle weights. Variations in weights and time can be estimated from the two Tables, the producer may override these coefficients with projected ending cattle prices.

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[8] Ibid

The non-feed costs per head per day and the starting and ending yearling price per pound from each Worksheet 6A are transferred to the corresponding forage periods on each Worksheet 9A.

A Worksheet 7A, Forage Production Summary-Yearling Cattle, is completed for each forage grazing system in this example. Space is provided on each worksheet for two grazing periods and one hay production period, which is sufficient for any of the fifteen possible forage grazing systems.

The data gathered and calculated by each Worksheet 7A is transferred to the appropriate subsequent worksheets. Total AUMs per acre for each forage system are transferred to the corresponding 8A Worksheets. Ending weight per head and AUMs used per production period are transferred to the corresponding 9A Worksheets.

Worksheet 8A, Forage Budget, is completed for each forage grazing system used. The procedure for completing this worksheet is the same as discussed in example 1. The TVC/AUM and TC/AUM calculated on these forms are transferred to the corresponding 9A Worksheets.

A Worksheet 9A, Returns Per Acre Per Forage Period - Yearling Cattle, is completed next for each forage grazing system. Worksheet 9A uses data generated by the model to determine returns above TVC/AC and TC/AC for each individual forage production period. The production periods of each forage grazing system are totaled to give total returns above TVC/AC and TC/AC for the specific forage grazing system. The values of total returns are transferred to Worksheet 11A. The format analysis of Worksheet 9A is different from Worksheet 9 used in example 1, but generates the same type of output coefficients.

The sorghum grain budget on Worksheet 10 presented in example 1 will also be referenced in example 2. The values for sorghum grain returns above TVC/AC and TC/AC are transferred to Worksheet 11A, for example 2. It is assumed the land producing smooth bromegrass in example 2 could be reallocated to sorghum grain production.

Worksheet 11A summarizes the total model analysis for example 2.

The same comparisons discussed in example 1 apply to example 2. In example 2 the capitalized land values calculated for smooth bromegrass, native tallgrass and sorghum grain are $752.00, $279.33, and $1,271.33 respectively. The land value of native tallgrass in this example compares more favorably with the current market value than example 1. The land value for smooth bromegrass is higher in example 2. The use of smooth bromegrass with a summer steer grazing program is preferred over its use with a cow/c enterprise and hay production. A yearling summer grazing program would have a large advantage over a cow/c enterprise in the utilization of native tallgrass when comparing example 1 and 2.

Smooth bromegrass production on cropland utilized by grazing cattle in examples 1 and 2 is less profitable than producing sorghum grain on the same land. Assuming the price and production relationships of the model the results of the two examples indicate that even under good forage management sorghum grain production would be favored when the analysis is based strictly on economic criteria. Non-economic factors, under certain conditions, will influence land utilization and may conflict with the objective of profit maximization.

The general conclusion is a high level of beef production per acre is required before it is feasible to shift cropland to forage production. The importance of good management and efficient grass utilization must be carefully considered in the development or expansion of beef-forage systems.

Many combinations of the two cattle types and the fifteen forage grazing systems specified by the model could be analyzed. Two examples were presented in a systematic procedure to illustrate the format and logic of the model developed by this study. The two examples represent basic cattle enterprises and two forage species that account for a major percent of Kansas' forage resources.

An LP example was completed using the same production and economic coefficients used in example 2. The LP method and the total budgeting technique produce similar results. The LP example is included in the appendix.

METHOD II

WORKSHEET 2A

INVENTORY OF RESOURCES

Forage	No./AC	Prod. Level
Bromegrass	80	high
Native grass	640	med.

Land Class Available for Forage Prod.	No./AC	Prod. Level
None		

Selected Beef-Forage System

Cattle Type Yearlings Weight(s) 500# and 400#

Forage	Forage Grazing System No.
Bromegrass	2
Native grass	7

WORKSHEET 3A

PRELIMINARY FORAGE ANALYSIS

Cattle Type Yearling

A	B	C	D	E	F	G	H
Forage & Production Period	No./AC	Prod. Level	AC/HD	HD/AC	Hay Ton/AC	Max. No. HD.	Yearling Weight
Bromegrass April-June	80	high	.67	1.5		53	500#
Bromegrass Sept.-Oct.	80	high	.69	1.44		56	400#
Native grass May-Sept.	640	med.	3.39	.29		189	500#

Column Instructions

Column		Column	
A	Worksheet 2 & Table 7	G	(Column B) ÷ (Column D)
B	Worksheet 2	H	Producer Records
C-F	Tables 8-13 or Producer Records		

WORKSHEET 4A

BALANCING THE BEEF-FORAGE SYSTEM*

Selected Base Forage Period _____

Number of Acres _____ Acres Per Head (AC/HD) _____

Non Base Period	AC/HD Per Non-Base Period	÷	AC/HD Per Base Period	=	Acreage Ratio	X	No. Ac. in Base Period	=	Ac. Recq. of Non-Base Forages

*Input coefficients transferred from Worksheet 3.

WORKSHEET 6A

YEARLING NON-FEED BUDGET

Starting Weight 500# Forage Bromegrass

Forage Production Period (months) April-June

VARIABLE COSTS PER HEAD

1.	Mineral and Salt	$ .36
2.	Labor (.5 hrs. X $/hr. 4)	$ 2.00
3.	Veterinary, Drugs and Supplies	$ 2.55
4.	Marketing Costs (1% of line 19)	$ 4.44
5.	Death Loss (1% of line 19)	$ 4.44
6.	Repairs	$ .50
7.	Fuel, Oil and Utilities	$ .75
8.	Miscellaneous	$ .60
9.	Interest on Purchased Livestock + ½ Variable Cost @ 13 % for 3 Months	$ 12.44
10.	Total Non-Feed Variable Cost	$ 28.03

FIXED COST PER HEAD

11.	Depreciation on Equipment and Facilities ($20.00 ÷ 20 years)	$ 1.00
12.	Int. on Equipment and Facilities @ 8.5 %	$ 1.70
13.	Taxes and Ins. on Equipment and Facilities @ %	$ .30
14.	Total Non-Feed Fixed Cost	$ 3.00
15.	Total Non-Feed Cost (line 10 + line 14)	$ 31.03
16.	Total Non-Feed Cost Per Head Per Day (line 15 $31.03 ÷ No. Days Grazed 90)	$ .344

YEARLING WEIGHTS AND PRICES

17. Starting Wt. 500# X Price/lb. $ .75 = Starting Value . . . $ 375.00

18. The ending price is discounted for seasonal and weight trends.
Discount percents are given in Tables 16 and 17
Starting Price/lb. $ .75 X Discount % .907 = Ending Price/lb. $ .68

19. Ending Wt. 653# X Price/lb. $ .68 = Ending Value . . . . . $ 444.04

WORKSHEET 6A

YEARLING NON-FEED BUDGET

Starting Weight 400# Forage Bromegrass

Forage Production Period (months) Sept. - Oct.

VARIABLE COSTS PER HEAD

1.	Mineral and Salt	$ .24
2.	Labor (.4 hrs. X $/hr. 4)	$ 1.60
3.	Veterinary, Drugs and Supplies	$ 2.50
4.	Marketing Costs (1% of line 19)	$ 3.55
5.	Death Loss (1% of line 19)	$ 3.55
6.	Repairs	$ .50
7.	Fuel, Oil and Utilities	$ .50
8.	Miscellaneous	$ .40
9.	Interest on Purchased Livestock + ½ Variable Cost @ 13 % for 2 Months	$ 7.07
10.	Total Non-Feed Variable Cost	$ 19.91

FIXED COST PER HEAD

11.	Depreciation on Equipment and Facilities ($20.00 ÷ 20 years)	$ 1.00
12.	Int. on Equipment and Facilities @ 8.5 %	$ 1.70
13.	Taxes and Ins. on Equipment and Facilities @ 1.5 %	$ .30
14.	Total Non-Feed Fixed Cost	$ 3.00
15.	Total Non-Feed Cost (line 10 + line 14)	$ 22.91
16.	Total Non-Feed Cost Per Head Per Day (line 15 $22.91 ÷ No. Days Grazed 60)	$ .382

YEARLING WEIGHTS AND PRICES

17. Starting Wt. 400# X Price/lb. $ .80 = Starting Value . . . $ 320.00

18. The ending price is discounted for seasonal and weight trends.
Discount percents are given in Tables 16 and 17
Starting Price/lb. $ .80 X Discount % .951 = Ending Price/lb. $ .76

19. Ending Wt. 467.5# X Price/lb. $ .76 = Ending Value . . . . . $ 355.30

WORKSHEET 6A

YEARLING NON-FEED BUDGET

Starting Weight 500# Forage Native grass

Forage Production Period (months) May - Sept.

VARIABLE COSTS PER HEAD

1.	Mineral and Salt	$ .60
2.	Labor (1 hrs. X $/hr. 4)	$ 4.00
3.	Veterinary, Drugs and Supplies	$ 2.50
4.	Marketing Costs (1% of line 19)	$ 4.81
5.	Death Loss (1% of line 19)	$ 4.81
6.	Repairs	$ .50
7.	Fuel, Oil and Utilities	$ 1.25
8.	Miscellaneous	$ 1.00
9.	Interest on Purchased Livestock + ½ Variable Cost @ 13 % for .5 Months	$ 20.84
10.	Total Non-Feed Variable Cost	$ 40.31

FIXED COST PER HEAD

11.	Depreciation on Equipment and Facilities ($20.00 ÷ 20 years)	$ 1.00
12.	Int. on Equipment and Facilities @ 8.5 %	$ 1.70
13.	Taxes and Ins. on Equipment and Facilities @ 1.5 %	$ .30
14.	Total Non-Feed Fixed Cost	$ 3.00
15.	Total Non-Feed Cost (line 10 + line 14)	$ 43.31
16.	Total Non-Feed Cost Per Head Per Day (line 15 $43.31 ÷ No. Days Grazed 150)	$ .289

YEARLING WEIGHTS AND PRICES

17. Starting Wt. 500# X Price/lb. $ .75 = Starting Value . . . $ 375.00

18. The ending price is discounted for seasonal and weight trends.
Discount percents are given in Tables 16 and 17
Starting Price/lb. $ .75 X Discount % 86.68 = Ending Price/lb. $ .65

19. Ending Wt. 740# X Price/lb. $ .65 = Ending Value . . . . . $ 481.00

WORKSHEET 7A

FORAGE PRODUCTION SUMMARY - YEARLING CATTLE

Forage Grazing System No. 2 Forage Bromegrass Production Level high

1. FIRST PRODUCTION PERIOD, Months Grazed May - June Starting Weight 500#

2. SECOND PRODUCTION PERIOD, Months Grazed Sept. - Oct. Starting Weight 400#

	A		B		C		D	E		F		G	H		I		J
Period	No. Days	X	ADG/HD	X	HD/AC	=	lbs. beef Per Acre	Lbs. Gained Per HD	+	Starting Weight	=	Ending Weight	HD/AC	X	AUMs/HD /Period	=	AUMs used/AC Per Period
1	90		1.7		1.5		229.5	153		500#		653#	1.5		2.625		3.94
2	60		1.125		1.44		97.2	67.5		400#		467.5#	1.44		1.375		1.98

Column Instructions For Coefficients Not Previously Transferred

Column	Source	Column	Source
A	No. Months X 30	E	Column A X Column B
B	From Table 6	I	From Tables 8 through 13

3. HAY PRODUCTION PERIOD
Tons/AC _____ X AUMs/Ton (from Table 2) _____ = AUMs used/AC/period _____

4. Total AUMs used/AC (add AUMs for Periods 1 and 2 and Hay Production) 5.92

WORKSHEET 7A

FORAGE PRODUCTION SUMMARY - YEARLING CATTLE

Forage Grazing System No. 7 Forage Native grass Production Level med.

1. FIRST PRODUCTION PERIOD, Months Grazed May - Sept. Starting Weight 500#

2. SECOND PRODUCTION PERIOD, Months Grazed _____ Starting Weight _____

	A		B		C		D	E		F		G	H		I		J
Period	No. Days	X	ADG/HD	X	HD/AC	=	lbs. beef Per Acre	Lbs. Gained Per HD	+	Starting Weight	=	Ending Weight	HD/AC	X	AUMs/HD /Period	=	AUMs used/AC Per Period
1	150		1.6		.29		69.5	240		500#		740#	.29		4.75		1.38
2																	

Column Instructions For Coefficients Not Previously Transferred

Column	Source	Column	Source
A	No. Months X 30	E	Column A X Column B
B	From Table 6	I	From Tables 8 through 13

3. HAY PRODUCTION PERIOD
Tons/AC _____ X AUMs/Ton (from Table 2) _____ = AUMs used/AC/period _____

4. Total AUMs used/AC (add AUMs for Periods 1 and 2 and Hay Production) 1.38

WORKSHEET 8 A

FORAGE BUDGET

Forage Grazing System No. 2 Forage Bromegrass

Production Level high

Cattle Type Yearling

VARIABLE COST PER ACRE

1.	Labor (1 hrs. X $/hr. 4)	$ 4.00
2.	Seed Cost ÷ No. Years of Grass Stand	.68
3.	Herbicide and Insecticide	
4.	Lime ÷ No. Years of Grass Stand	4.00
5.	Fertilizer	30.00
6.	Fuel and Oil	.50
7.	Machinery and Equipment Repairs	1.00
8.	Miscellaneous	1.50
9.	Interest on ½ Operating Capital @ 13 %	2.71
10.	Total Variable Costs Per Acre	$ 44.39
11.	Total Variable Costs Per AUM (TVC/AC $44.39 ÷ Total AUMs/AC used 5.92)	7.50

FIXED COST PER ACRE (excluding land charge)

12.	Real Estate Taxes	$ 4.00
13.	Depreciation on Machinery	2.30
14.	Taxes, Insurance and Interest on Machinery	1.50
15.	Total Fixed Costs Per Acre	$ 8.00
16.	Total Fixed Costs Per AUM (TFC/AC $8.00 ÷ Total AUMs/AC used 5.92)	1.35

WORKSHEET 8 A

FORAGE BUDGET

Forage Grazing System No. 7 Forage Native grass

Production Level med.

Cattle Type Yearling

VARIABLE COST PER ACRE

1.	Labor (.5 hrs. X $/hr. 4)	$ 2.00
2.	Seed Cost ÷ No. Years of Grass Stand	
3.	Herbicide and Insecticide	.50
4.	Lime ÷ No. Years of Grass Stand	
5.	Fertilizer	
6.	Fuel and Oil	.50
7.	Machinery and Equipment Repairs	.50
8.	Miscellaneous	1.00
9.	Interest on ½ Operating Capital @ 13 %	.29
10.	Total Variable Costs Per Acre	# 4.79
11.	Total Variable Costs Per AUM	3.47
	(TVC/AC $ 4.79 ÷ Total AUMs/AC used 1.38)	

FIXED COST PER ACRE (excluding land charge)

12.	Real Estate Taxes	$ 3.00
13.	Depreciation on Machinery	1.25
14.	Taxes, Insurance and Interest on Machinery	.75
15.	Total Fixed Costs Per Acre	# 5.00
16.	Total Fixed Costs Per AUM	3.62
	(TFC/AC $ 5.00 ÷ Total AUMs/AC used 1.38)	

WORKSHEET 9A

RETURNS PER ACRE PER FORAGE PERIOD - YEARLING CATTLE

Forage Grazing System No. 2 Forage Bromegrass

Production Level high

1.	FIRST PRODUCTION PERIOD	April- June							
2.	Ending Weight	653#	X HD/AC	1.5	X $/lb.	.68	=		$ 666.06
3.	Starting Weight	500#	X HD/AC	1.5	X $/lb.	.75	=	-	562.50
4.	Gross Returns/AC								103.56
5.	Less: TVC/AUM$	7.50	X AUMs/AC	3.94	=			-	29.55
6.	Less: Non-feed cost/HD/day							-	46.44
		$ .344	X No. Days	90	X HD/AC	1.5	=		
7.	Returns Above TVC/AC								27.57
8.	Less: TFC/AUM$	1.35	X AUMs/AC	3.94	=			-	5.32
9.	Returns Above TC/AC (land charge excluded)								22.25
10.	SECOND PRODUCTION PERIOD	Sept. - Oct.							
11.	Ending Weight	467.5#	X HD/AC	1.44	X $/lb.	.76	=		$ 511.63
12.	Starting Weight	400#	X HD/AC	1.44	X $/lb.	.80	=		460.80
13.	Gross Returns/AC								50.83
14.	Less: TVC/AUM$	7.50	X AUMs/AC	1.98	=			-	14.85
15.	Less: Non=feed cost/HD/day							-	33.00
		$ .382	X No. Days	60	X HD/AC	1.44	=		
16.	Returns Above TVC/AC								2.98
17.	Less: TFC/AUM$	1.35	X AUMs/AC	1.98	=			-	2.67
18.	Returns Above TC/AC (land charge excluded)								.31
19.	HAY PRODUCTION PERIOD								
20.	Tons Per Acre		X $/Ton		=				$
21.	Less: TVC/AUM$		X AUMs used/AC/period				=	-	
22.	Less: Harvested cost/ton				XNo.Tons		=	-	
23.	Returns Above TVC/AC								
24.	Less: TFC/AUM$		X AUMs used/AC/period				=	-	
25.	Returns Above Tc/AC (land charge excluded)								
26.	Total Returns Per Acre (all periods)								
27.	Returns Above TVC/AC (add lines 7, 16 and 23)								$ 30.55
28.	Returns Above TC/AC (add lines 9, 18 and 25)								22.56

WORKSHEET 9A

RETURNS PER ACRE PER FORAGE PERIOD - YEARLING CATTLE

Forage Grazing System No. 7 Forage Native grass

Production Level med.

1.	FIRST PRODUCTION PERIOD May - Sept.								
2.	Ending Weight	740#	X HD/AC	.29	X $/lb.	.65	=	. . $	139.49
3.	Starting Weight	500#	X HD/AC	.29	X $/lb.	.75	=	. . -	108.75
4.	Gross Returns/AC								30.74
5.	Less: TVC/AUM$	3.47	X AUMs/AC	1.38	=			-	4.79
6.	Less: Non-feed cost/HD/day							-	12.57
		$.289	X No. Days	150	X HD/AC	.29	=		
7.	Returns Above TVC/AC								13.38
8.	Less: TFC/AUM$	3.62	X AUMs/AC	1.38	=			-	5.00
9.	Returns Above TC/AC (land charge excluded)								8.38
10.	SECOND PRODUCTION PERIOD								
11.	Ending Weight		X HD/AC		X $/lb.		=	. . $	
12.	Starting Weight		X HD/AC		X $/lb.		=	. .	
13.	Gross Returns/AC								
14.	Less: TVC/AUM$		X AUMs/AC		=			-	
15.	Less: Non=feed cost/HD/day							-	
		$	X No. Days		X HD/AC		=		
16.	Returns Above TVC/AC								
17.	Less: TFC/AUM$		X AUMs/AC		=			-	
18.	Returns Above TC/AC (land charge excluded)								
19.	HAY PRODUCTION PERIOD								
20.	Tons Per Acre		X $/Ton		=			$	
21.	Less: TVC/AUM$		X AUMs used/AC/period				=	-	
22.	Less: Harvested cost/ton				XNo.Tons		=	-	
23.	Returns Above TVC/AC								
24.	Less: TFC/AUM$		X AUMs used/AC/period				=	-	
25.	Returns Above Tc/AC (land charge excluded)								
26.	Total Returns Per Acre (all periods)								
27.	Returns Above TVC/AC (add lines 7, 16 and 23)							$	13.38
28.	Returns Above TC/AC (add lines 9, 18 and 25)								8.38

WORKSHEET 11A

SUMMARY OF RETURNS FOR THE BEEF-FORAGE SYSTEM

A	B	C	D	E	F	G	H
Forage & Grazing System No. and Other Crop if Applicable	Acres Utilized	Returns Per Acre above TVC	Total Returns above TVC (column B X column C)	Returns Per Acre above TC	Total Returns above TC (column B X column E)	Capitalization Rate	Land Value (column E ÷ column G)
Bromegrass No. 2	80	$ 30.55	$ 2,444.00	$ 22.51	$ 1,804.80	.03	$ 752.00
Native grass No. 7	640	13.38	8,563.20	8.38	5,363.20	.03	279.33
Sorghum grain		77.00		38.14			1,271.33

CHAPTER V

CONCLUSION

The purpose of this study was to develop a model that would aid producers and agricultural advisors in the selection of profitable beef-forage systems. Land resources, grazing forages and cattle may not be combined in proper combinations to support beef-forage systems to maximize profit.

The model developed in this thesis is a systematic method for selecting profitable combinations of forages, land and cattle types. The model proceeds through a series of worksheet forms using default production and economic values which can be overridden with producer coefficients. The series of hand calculated worksheets provide a structured system to inventory, combine and evaluate the total beef-forage system using specified combinations of cattle types and forage grazing systems. It also allows the producer to evaluate individual segments of the selected system. Individual evaluation identifies unprofitable resources that may be masked by profitable components of the overall system.

One of the major objectives in the development of this model was to provide a system that is easily accessed and understood by the producer. The objective of maintaining simplicity is difficult to achieve when flexibility of input coefficients is allowed. A degree of compromise must be made between simplicity and flexibility.

Additional work is needed to transfer the conceptional model to electronic analysis to allow for more efficient use. Feasible alternatives include programmable calculators, mini-computers and main frame computer analysis. The hand calculated method limits the number of beef-forage

grazing systems that can be evaluated because it is time consuming.

Electronic analysis would be time efficient making the model a more useful and accepted tool. The data base and inputs of the model could be expanded using electronic analysis.

Several economic conclusions can be made from the analysis of the two examples presented in Chapter IV. Capitalized land values for forage production, grazed with beef cattle, tend to be lower than crop returns on the same class of land. Returns to grazed forages are sensitive to beef gains and trends in beef prices over the grazing season. The conclusions stated are basic to the profitability of most beef-forage grazing systems.

One of the major problems in this study was collection of universally accepted forage production coefficients. Wide variations occur in numerous documented sources. A second area of coefficient variability occurred in average daily gains of yearlings for forage grazing seasons. Representative average values assuming good management skills, were selected from various sources for base default coefficients.

The model identifies fifteen specific forage grazing systems based on monthly production periods, which restricts the model flexibility. Forages that have more than one production period during a normal grazing season are difficult to balance when combined with a second forage and a specific number of cattle. The problem results from variations in carrying capacities of one forage composed of more than two production periods. The use of a cool season forage consisting of a spring and a fall production period with a warm season forage is an example of this problem. The problem is difficult to resolve. A surplus or deficit will generally result in one of the forage periods due to the variations in their carrying capacities.

The model attempts to resolve this problem in the forage adjustments section of Worksheet 5. This section of the model needs additional work so that the utilization of forages can be determined on a daily basis and grazing seasons would not be restricted to multiples of thirty days.

Producer objectives, individual farm resources and production and economic coefficients are utilized by the model to obtain a solution unique to each individual farm situation. This model addresses a specific segment of the beef enterprises, the beef-forage grazing system. Additional research, development and study will be required to build a comprehensive beef production model.

APPENDIX

TABLE 18

PRICES PER 100# 1975-1980 BEGINNING WEIGHT 400#

BEGINNING MONTHS APRIL, MAY AND SEPTEMBER*

Column Line No.	A	B Apr.	C May	D June	E Jul.	F Aug.	G Sept.	H Oct.	I Nov.	J Dec.
1		400#	450#	500#	550#	600#	650#	700#	750#	800#
2	1980	87.86	83.76	79.65	78.03	76.40	76.23	76.05	74.09	72.12
3	1979	112.45	104.42	96.38	92.88	89.36	85.33	81.29	80.47	79.64
4	1978	63.73	65.37	67.00	67.08	67.15	66.02	64.88	65.33	65.78
5	1977	45.62	44.04	42.46	43.23	44.00	42.41	40.82	40.56	40.30
6	1976	47.13	45.97	44.81	42.33	39.84	38.28	36.72	36.22	35.72
7	1975	31.28	33.55	35.82	34.46	33.09	35.59	38.09	38.34	38.58
8	Ave.	64.68	62.85	61.02	59.67	58.31	57.31	56.31	55.84	55.36

9		400#	450#	500#	550#	600#	650#	700#
10	1980	84.75	80.94	77.12	80.07	83.02	78.39	73.75
11	1979	113.05	105.89	98.72	96.94	95.16	88.80	82.44
12	1978	70.50	69.46	68.42	68.87	69.31	67.08	64.85
13	1977	45.30	44.22	43.14	43.19	43.24	41.59	39.94
14	1976	47.74	44.19	40.64	39.02	37.39	36.83	36.26
15	1975	34.42	33.50	32.58	34.60	36.61	37.44	38.26
16	Ave.	65.96	63.03	60.10	60.45	60.79	58.36	55.92

17		400#	450#	500#
18	1980	90.15	85.36	80.57
19	1979	115.65	104.32	92.99
20	1978	78.20	75.62	73.03
21	1977	47.66	45.31	42.95
22	1976	38.74	38.60	38.46
23	1975	33.50	34.88	36.26
24	Ave.	67.32	64.02	60.71

*Adapted from "Livestock and Meat Statistics," U.S. Department of Agriculture Economics and Statistics Service, Agricultural Marketing Service. Supplements 1975-1980. (Six year average)

TABLE 19

PRICES PER 100# 1975-1980 BEGINNING WEIGHT 500#

BEGINNING MONTHS APRIL, MAY AND SEPTEMBER*

Column Line No.	A	B Apr.	C May	D Jun.	E Jul.	F Aug.	G Sept.	H Oct.	I Nov.	J Dec.
1		500#	550#	600#	650#	700#	750#	800#		
2	1980	83.99	80.44	76.88	76.64	76.40	74.83	73.26		
3	1979	105.62	96.50	87.38	83.35	79.31	77.75	76.19		
4	1978	61.10	61.75	62.40	62.74	63.08	62.84	62.59		
5	1977	45.72	43.71	41.70	41.85	41.99	40.98	39.96		
6	1976	47.01	45.45	43.89	41.42	38.94	37.36	35.78		
7	1975	31.45	33.74	36.02	35.18	34.34	36.73	39.11		
8	Ave.	62.48	60.27	58.05	56.86	55.68	55.08	54.48		
9			500#	550#	600#	650#	700#	750#	800#	
10	1980		81.00	78.22	75.44	76.52	77.60	75.05	72.50	
11	1979		106.68	98.46	90.24	87.79	85.34	82.37	79.39	
12	1978		68.17	66.84	65.50	64.98	64.46	63.11	61.75	
13	1977		45.20	43.58	41.95	41.40	40.85	40.01	39.16	
14	1976		47.58	43.83	40.08	38.13	36.18	35.74	35.30	
15	1975		34.66	34.05	33.44	35.52	37.59	38.24	38.88	
16	Ave.		63.88	60.83	57.78	57.39	57.00	55.75	54.50	
17							500#	550#	600#	
18	1980						87.90	82.52	77.14	
19	1979						104.29	96.24	88.18	
20	1978						74.51	71.98	69.45	
21	1977						47.06	44.01	40.95	
22	1976						38.18	37.78	37.37	
23	1975						35.15	36.30	37.44	
24	Ave.						64.52	61.47	58.42	

*Adapted from "Livestock and Meat Statistics." U.S. Department of Agricultural Economics and Statistics Service, Agricultural Marketing Service. Supplements 1975-1980. (Six year average)

Linear Program Example

The intent of this example is to demonstrate the use of LP analysis for analyzing a beef-forage system. The LP model inputs will be designed specifically for a selected beef-forage system. Constraints must be included in the LP model to force specific management practices and forage utilization. This is one of the major disadvantages to using the LP method for beef-forage analysis. The fixed relationships of forage resources makes it difficult to develop one LP model to analyze a number of forage resources.

The example assumes forage and land combinations are fixed and capital and labor are not limiting factors. The LP example will use the same cattle and forage combinations, and economic and production coefficients used in example 2. The matrix will be designed to force the utilization of each forage period with a specific cattle type. Different forages will not compete with each other. Different production periods within a forage grazing system will not compete with each other.

Table 20 lists the coefficients for the LP matrix (Section 1), rows (Section 2) and columns (Section 3). Notations and abbreviations for columns and rows used in Table 20 are listed below.

Rows - Resources

Z - Marginal returns or cost per unit of activity

NA5MO - Native tallgrass for a May-Sept. grazing season

BR3MO - Bromegrass for a April-June grazing season

BR2MO - Bromegrass for a Sept.-Oct. grazing season

YL5MO - Transfer row for grazing native tallgrass with 500# yearlings, May-September

YL3MO - Transfer row for grazing bromegrass with 500# yearlings, April-June

YL2MO - Transfer row for grazing bromegrass with 400# yearlings, Sept.-Oct.

Columns - Activities

N*MAY*S - Native tallgrass used May-September

B*APR*J - Bromegrass used April-June

B*SEP*O -- Bromegrass used Sept.-Oct.

YL*MAY*S - 500# yearlings grazed May-Sept.

YL*APR*J - 500# yearlings grazed April-June

YL*SEP*O - 400# yearlings grazed Sept.-Oct.

Marginal returns and costs for the six activities were calculated from the budgets used in example 2. Returns to land is excluded, but other fixed costs are included. Returns and costs for the six activities are summarized under INPUT COST, Section 3, Table 20. The dual value for April-June bromegrass utilized with cattle is $22.02 and for Sept.-Oct. the value is $.54, totaling $22.56 per acre. The dual value for native tallgrass is $8.38 per acre. These values are the same as returns per acre above total cost listed in Worksheet 11A, for example 2.

The LP example demonstrates that comparable results can be obtained using either the budgeting method or the LP method. The disadvantage of the LP method is that the matrix must be carefully developed to recognize the specific utilization and combinations of forages and beef cattle. Many forages are fixed resources and can not compete with alternative crops. The time required to develop a specific matrix for each forage grazing system is the main reason for not using the LP method in this model.

TABLE 20

RESULTS OF THE LINEAR PROGRAM EXAMPLE

MATRIX, ROW AND COLUMN VALUES

SECTION 1 - MATRIX

	N*MAY*S	B*APR*J	B*SEP*O	YL*MAY*S	YL*APR*J	YL*SEP*O	B
Z	9.790-	35.100-	17.290-	62.650	38.080	12.380	.
NA5MO	1.000	.	.	.	.	.	640.000
BR3MO	.	1.000	.	.	.	.	80.000
BR2MO	.	.	1.000	.	.	.	80.000
YL5MO	1.377-	.	.	4.750	.	.	.
YL3MO	.	3.937-	.	.	2.625	.	.
YL2MO	.	.	1.980-	.	.	1.375	.

SECTION 2 - ROWS

NUMBER	ROW	AT	ACTIVITY	SLACK ACTIVITY	LOWER LIMIT	UPPER LIMIT	DUAL ACTIVITY
1	Z	BS	7166.816	7166.816-	NONE	NONE	1.000
2	NA5MO	UL	640.000	.	NONE	640.000	8.378-
3	BR3MO	UL	80.000	.	NONE	80.000	22.020-
4	BR2MO	UL	80.000	.	NONE	80.000	.537-
5	YL5MO	UL	.	.	NONE	.	13.189-
6	YL3MO	UL	.	.	NONE	.	14.506-
7	YL2MO	UL	.	.	NONE	.	9.003-

SECTION 3 - COLUMNS

NUMBER	COLUMN	AT	ACTIVITY	INPUT COST	LOWER LIMIT	UPPER LIMIT	REDUCED COST
8	N*MAY*S	BS	640.000	9.790-	.	NONE	.
9	B*APR*J	BS	80.000	35.100-	.	NONE	.
10	B*SEP*O	BS	80.000	17.290-	.	NONE	.
11	YL*MAY*S	BS	185.600	62.650	.	NONE	.
12	YL*APR*J	BS	120.000	38.080	.	NONE	.
13	YL*SEP*O	BS	115.200	12.380	.	NONE	.

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AN ANALYSIS OF BEEF-FORAGE GRAZING SYSTEMS

by

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Abstract

The purpose of this study was to develop a model and methodology that would aid producers and agricultural advisors in the selection of profitable beef-forage systems. The model developed is a systematic method for selecting profitable combinations of forages, land and cattle types.

One of the major objectives in the development of this model was to provide a system that is easily accessed and understood by the beef producer. The model was designed with adequate flexibility to allow each unique farm situation to be analyzed.

A data base of default coefficients was generated to provide the model user with representative average values for economic and production coefficients. The producer can override the default values with specific farm inputs.

The budgeting technique was selected as the major analytical tool upon which the model was based. The model proceeds through a systematic flow of hand calculated worksheets that provide a structured system to organize, compile and evaluate economic and production coefficients of the beef-forage system.

The producer first inventories forage resources and land available for increased forage production. Forage grazing systems and cattle types are restricted to those identified in the model. The model user combines the selected resources and develops a beef-forage system to be analyzed.

Forage production per acre is evaluated and equated with beef production per acre for each specific production period, identifying the profitability of resource allocation. Returns for cash crops are compared to those of grazed forages being produced on cropland. The results of the analysis of each individual production period are summarized for the overall beef-forage grazing system.

Returns above total variable costs and total fixed costs per acre are the final economic values generated. Land returns in this model are defined as a residual and are not included in the beef-forage economic analysis.

Returns above total cost are used to calculate land values using the capitalization method. The summary of returns per acre and capitalized land values provides the decision maker with a data base for evaluating the beef-forage system and making resource allocations.

The beef-forage grazing model developed is a tool for producers to identify the profitability of current or alternative beef-forage systems.