DYNAMIC AND STATIC ANALYSES OF CATTLE SYSTEMS AND RANGE IMPROVEMENT PRACTICES, NORTHEASTERN OKLAHOMA

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of the requirements for the degree of
DOCTOR OF PHILOSOPHY
August, 1960

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AND RANGE IMPROVEMENT PRACTICES,

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ACKNOWLEDGMENTS

I am deeply indebted to Dr. James S. Plaxico, Chairman of my graduate committee, for his supervision and advice during the course of this study and for his counsel and encouragement throughout all phases of the graduate program.

I wish to express appreciation to the Department of Agricultural Economics of Oklahoma State University, Stillwater, Oklahoma, for making this study possible. In addition, I am indebted to the Department for the financial aid received while pursuing graduate study.

Indebtedness is also extended to Dr. W. B. Back and John Goodwin for reading a previous draft and for their valuable comments.

Appreciation is extended for assistance received from the secretarial and statistical staff of the Department of Agricultural Economics, especially to Miss Patricia Lou Cundiff for her assistance with the computations and Mrs. Marijean Schrick for the speed and skill with which she prepared the various drafts.

The writer is indebted to Mrs. Jerry Martin for the final typing of the thesis.

Special appreciation is extended to my wife, Eva Jean, for her encouragement and forbearance during the entire course of study. Finally, sincere appreciation is extended to my parents, Mr. and Mrs. Earl Barr, for their encouragement and financial aid throughout the period of my formal education.

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CHAPTER I

INTRODUCTION

Statement of Problem

Northeastern Oklahoma is a beef producing area characterized by ranch type operations. A relatively high percentage of the pasture in the area is native pasture, abandoned or idle cropland, and woodland pasture (Table I). Ranchers in the area are confronted with a twofold problem. They are faced with the problem of range development and improvement and also with the determination of the most profitable livestock system for utilizing range resources. Northeastern Oklahoma ranch managers are, therefore, concerned with such questions as: (1) What range improvement and development practices would prove to be profitable? (2) What livestock enterprise(s) will most economically utilize the forage that is produced?

Control of brush, reseeding abandoned or idle cropland to native grasses, sprigging bermuda grass on idle cropland, overseeding of native range with legumes and spraying of weeds are practices which have been used by northeastern Oklahoma ranchers in recent years to increase the quantity and/or quality of forage produced. The value of an increase in forage output may be measured in terms of its market value if sold as hay or rented out as pasture. Often, however, pasture crops have no direct market value or if such a value exists, it is normally lower than utilization value. Thus, forage values may best be measured in terms of

TABLE I

LAND IN FARMS, OPEN AND WOODLAND PASTURE BY COUNTY AND FOR THE STUDY AREA, 1954

County	Land in Farms (Acres)	Farm Land in Pasture (Percent)	Farm Land in Pasture (Acres)	Farm Land in Open Pasture (Percent)	Farm Land in Open Pasture (Acres)	Farm Land in Woodland Pasture (Percent)	Farm Land in Woodland Pasture (Acres)
Craig	426,587	58.61	250,023	52.31	223,148	6.30	26,875
Mayes	308,819	49.26	152,124	31.57	97,494	17.69	54,630
Nowata	298,376	62.82	187,440	58.05	173,207	4.77	14,233
Osage	1,223,381	82.86	1,013,693	55.87	683,503	26.99	330,191
Ottawa	217,107	39.32	85,366	23.37	50,736	15.95	34,627
Rogers	360,822	66.47	239,838	52.51	189,468	13.96	50,371
Washington	230,333	74.14	170,769	65.72	151,375	8.42	19,394
Total	3,065,425		2,099,253		1,568,931		530,321

Source: U. S. Census of Agriculture, 1954.

their worth as livestock feed. The profitability of any range improvement practice will therefore depend not only on the increase in forage produced but also upon the livestock system through which the forage is utilized.[1] This study is designed to determine the profitability of range improvement practices and the livestock system which will most economically utilize the forage produced.

Objectives of the Study

Three range improvement practices are analyzed in this study. These are: (1) brush control or elimination by aerial spraying, (2) reseeding abandoned or idle cropland to native grass and (3) the establishment of bermuda grass on idle or abandoned cropland. These three practices are analyzed because of the vast acreage of land in the area on which these practices, if economically feasible, could be adopted. Other improvement practices such as weed control and elimination are not considered in the present analysis because of the inadequacy of the observations currently available.

The specific objectives of this study are:

(1) To estimate input-output relationships for alternative range improvement practices.

(2) To estimate the input-output relationships for alternative beef enterprises adaptable to the northeastern Oklahoma ranching area.

(3) To determine the optimum range development and beef cattle program, giving various resource restrictions and for alternative maximization

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[1]For a more complete analysis of methods of forage evaluation, see Glenn L. Johnson and Lowell S. Hardin, Economics of Forage Evaluation, Purdue Agricultural Experiment Station Bulletin 623, April, 1955.

criteria. The alternative criteria will include: (a) net revenue given the usual static conditions, (b) the discounted net revenue over alternative planning periods with various rates of discount, and (c) the present value of the stream of net income under dynamic conditions.

Methods of Analysis

The resource inputs and product outputs associated with each of the range improvement practices are estimates from: (1) a survey of professional agricultural workers in the area, (2) experimental results, and (3) judgment estimates of qualified agricultural scientists. Inputs for each improvement practice are classified into two categories, establishment and maintenance.

The derived physical input-output flows permit partial budgeting of each improvement practice. Partial budgets of other forage producing enterprises adaptable to the area were developed in the same manner as those for improvement practices. Yields were determined in terms of animal unit months of grazing (A.U.M.)[2] per acre for those alternatives producing grazing and tons of hay for hay producing alternatives. As the assumption was made that use-value would exceed market value, no attempt is made to put a direct monetary value on grazing produced.

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[2]The concept, animal unit month (A.U.M.), is used as a measure of production and grazing requirements throughout this study. An animal unit month is the grazing requirement for one cow, one bull, or a 1,000 pound steer or heifer for one month. Thus, an animal unit month grazing would provide the required forage for a cow for one month, a bull for one month or for two steers whose average weight is 500 pounds for one month.

Necessary input-output data for developing partial budgets for the various beef systems adaptable to the northeastern ranching area are based on results of experiments conducted by the Department of Animal Husbandry at Oklahoma State University. Regression analysis was used to provide estimates of calf weights relative to age with respect to sex and for creep and noncreep fed calves. Experimental data provide the coefficients of feeding requirements for steer and calf production for given steer and calf weights. Adjustments in requirements and production were made for area differences as recommended by scientists of the Animal Husbandry Department of Oklahoma State University. Labor requirements and other miscellaneous input-output coefficients were based on results of a similar study and were adjusted for area and size of operation differences.[3] Land resources were determined from U. S. Census materials. Only ranches of 1,000 acres or larger were considered. The average size and distribution of land for ranches of 3,000 acres and larger was assumed to be typical for all ranch-size operations and was used as a basis for programming.

Linear programming analyses were used to determine the optimum range development plans and beef cattle systems, with various resource combinations. Linear programming is a tool capable of selecting the best resource-technique combination from the discrete alternatives considered.[4] It

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[3]Paul Andrilenas, "Beef Production Systems in South Central Oklahoma," an unpublished Ph.D. thesis manuscript, Department of Agricultural Economics, Oklahoma State University, Stillwater, Oklahoma.

[4]James S. Plaxico, "Linear Programming Technique-Discussion," Journal of Farm Economics, December 1954, p. 1,048-50.

provides for the maximization (or minimization) of a criterion relation subject to a system of relations of a special form. The special postulates of linear programming are linearity, divisibility, additivity and finiteness.[5]

The assumption of linearity requires that for each activity the ratios between all inputs and the ratio between each input and each product are fixed and, hence, independent of the level at which the activity operates. The divisibility assumption means that, given the process or activity, all non-negative levels of the process are considered as possibilities. Since activity levels are not forced to take integral values, neither are resource requirements required to do so. The additivity assumption implies that with the simultaneous operation of two or more activities, the total product produced is the sum of the products produced by the individual processes and the quantities of inputs required are the sums of the requirements of the individual activities. The assumption of finiteness indicates that of all possible processes, only a relatively few are considered as alternatives.

Subject to the above assumptions, optimum beef cattle systems were determined for eight land resource situations. The quantity of capital available was varied with each land resource situation with the absolute amount available determined by its marginal value product. The decision maker is assumed to determine *a priori* the level of return (internal or

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[5]See Earl R. Swanson, "Programming Optimal Farm Plans," in James S. Plaxico, *et al*., (editors), *Farm Size and Output Research*, Southern Cooperative Series Bulletin No. 56, June, 1958, pp. 47-72.

external interest rate) he wishes to receive at the margin and use additional capital as long as it returns a rate equal to or greater than his predetermined rate.[6]

This is accomplished by assuming that the entrepreneur is willing to invest his own or borrowed capital as long as returns exceed some preselected rate. Assuming that the law of diminishing returns holds for the use of capital with a given land acreage, the quantity of capital that can be profitably used increases as the preselected rate is lowered. This can be demonstrated by reference to Figure 1. The marginal value product for capital utilized with a fixed set of other resources is represented by the curve, AB. If the rate of return selected is OR_1,

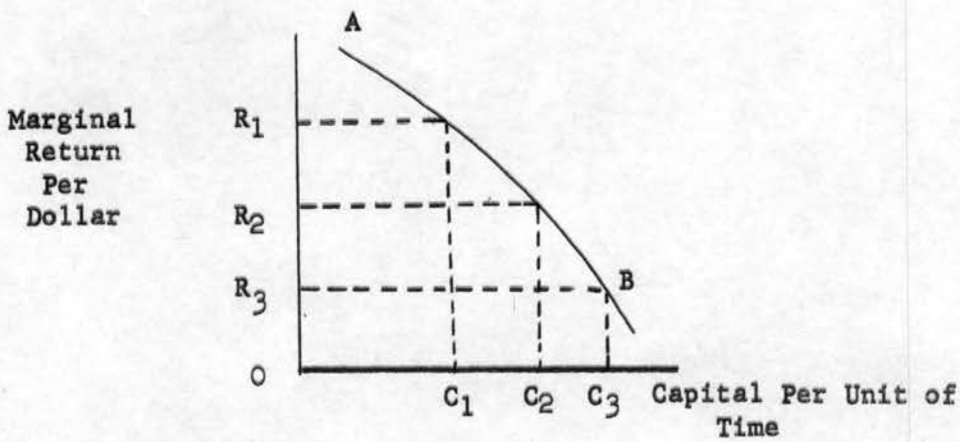

Figure 1

the amount of capital which will yield a return equal to or exceeding this rate is OC_1; at a lower rate OR_2, a larger amount, OC_2, of capital will be used. If OR_3 represents the external or market rate of interest, then OC_3 is the maximum amount of capital which could be utilized by the rancher as none would be available at a lower rate. Thus, at different

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[6]If capital is rationed by forces external to the firm, the selected marginal rate of return is assumed to reflect the requirements of the lending institution.

rates, the marginal value product curve shows the amounts of capital which the entrepreneur will use per production period.

If capital is restricted in the manner mentioned, only those activities returning a rate equal to or greater than the predetermined rate will be included in the programmed optimum. Thus, a given range improvement practice will appear as an activity in the optimal program only if (1) its return as measured in terms of value of beef produced with the optimum system is equal to or higher than the selected rate and (2) only if it yields a higher return than that of any alternative use of resources allowed by the model. The optimum beef system and the profitability of various range improvement practices are thus simultaneously determined for each selected rate of return.

If the predetermined rate of return on capital is high, capital may be restricted to the extent that returns will exceed this rate only on the most productive land and with a beef system which has a relatively high land requirement and a relatively low capital requirement. As the rate is lowered, use of more capital will be profitable and land yielding lower returns will be brought into production with the emphasis on the production of enterprises yielding a high return to capital and a low return to land. As the required return is lowered further, it will become profitable to shift to alternatives yielding a low return to capital and a higher return to land. Land will become the scarce resource when all land is brought into production.

It may be argued that plans can be made more realistic by incorporating time into the analysis. When time is injected into the model as a decision variable, the primary objective of the rancher is assumed to be that of maximizing returns, for some given period of time, to the ranch unit. The length of the time period over which returns are to be maximized and the rate at which future returns are discounted are different for different ranchers. The optimum organization and the profitability of various improvement practices are determined for different length periods and for different discount rates assuming that the quantity of capital used is that required to equate the marginal value product and the discount rate.[7]

The optimum organization is also determined for maximizing the present value of the net revenue flow under a dynamic system with a fixed land area, and with given capital resources. The model then becomes one of capital accumulation. Production in the first period becomes an input for subsequent periods. The best plan is then determined for a series of years instead of for some specific point in time. The model used is dynamic in a Hicksian sense as inputs and outputs are dated, but risk and uncertainty considerations are omitted.

Area in the Study

The area of inference for this study includes much of the area in the counties of Osage, Washington, Nowata, Craig, Ottawa, Rogers and Mayes. Beef cattle ranching is the main enterprise in this area. The increase in the number of ranches of 1,000 acres and over from 290 in 1939 to 429 in

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[7]The discount rate chosen will affect the amount of capital which can be profitably used in a manner similar to the predetermined capital level. A high discount rate will restrict the amount of capital that will be employed more than a low rate.

1954 indicates the growing importance of large scale ranching in these counties.[8] Of the 429 ranches of over 1,000 acres making up 45.5 percent of the total land in farms in 1954, 114 were 3,000 acres and over and included 29.8 percent of all land in farms for the area.

Census data indicate that beef cattle numbers are also increasing in the area (Table II) and the percent of the farm land in pasture in the study counties has also increased while that in other crops has declined, (Table III). In 1954, approximately 68 percent of the land in the 429 ranches of 1,000 acres and over was in open pasture and only 6.5 percent was harvested cropland. For the larger ranches (3,000 or more acres), more than 76 percent of the land was in open pasture and only 2.4 percent was in harvested cropland.

Soil Types and Climatic Influences

Soil Types. One of the factors contributing greatly to the development of ranching in the northeastern area of Oklahoma is the nature of the topography and soils of the area. The area may be subdivided into three distinctly different soil resource situations on the basis of parent material from which the soil developed. The three subdivisions are commonly called: (1) the eastern or sandstone prairies, (2) the Cross-Timbers or Savanna and (3) the limestone prairies.

The Eastern or Sandstone Prairies. The eastern or sandstone prairies are often called the Cherokee prairies. Large areas of this type prairie

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[8] U. S. Census of Agriculture, 1939-1954, U. S. Department of Commerce, Bureau of Census, (Washington 25, D. C.).

TABLE II

NUMBER OF BEEF CATTLE AND CALVES ON FARMS AND RANCHES, JANUARY 1, UNITED STATES, OKLAHOMA AND STUDY COUNTIES, 1930-60

Year	United States	Oklahoma	Study Counties[a]
	(1,000)	(1,000)	(1,000)
1930	27,921	968	147
1931	29,059	1,028	165
1932	30,436	1,131	176
1933	33,420	1,294	207
1934	36,381	1,461	224
1935	32,489	1,414	210
1936	32,395	1,271	199
1937	31,245	1,166	198
1938	30,475	1,074	198
1939	30,403	1,081	204
1940	31,877	1,162	227
1941	34,372	1,240	225
1942	37,188	1,427	242
1943	40,964	1,671	265
1944	44,077	1,723	264
1945	44,724	1,752	249
1946	43,686	1,630	235
1947	42,871	1,589	219
1948	41,002	1,470	222
1949	41,560	1,513	233
1950	42,508	1,615	251
1951	46,685	1,870	271
1952	52,837	2,252	318
1953	58,320	2,464	336
1954	59,518	2,596	339
1955	61,231	2,563	339
1956	62,067	2,538	330
1957	60,232	2,374	314
1958	59,937	2,344	297
1959	63,915	2,712	330
1960	68,536	2,942	

[a]Craig, Mayes, Nowata, Osage, Ottawa, Rogers and Washington counties.

Source: Regional Trends in Livestock Numbers, Statistical Bulletin No. 146, Agricultural Marketing Service, USDA, (Washington D. C.), August 1954.

A Statistical Handbook of Oklahoma Agriculture, Experiment Station Miscellaneous Publication No. MP-14, Okla. State Univ., (Stillwater, Oklahoma), January 1949.

"Estimated Numbers on Farms", Oklahoma Crop and Livestock Service, (Oklahoma City).

TABLE III

LAND IN FARMS, OPEN PASTURE AND CROPLAND FOR THE STUDY AREA, 1930-54

Year	Land in Farms (Acres)	Farm Land in Open Pasture (Percent)	Farm Land in Open Pasture (Acres)	Acres of Cropland (Percent)	Acres of Cropland (Acres)
1930	2,706,657	32.20	871,486	--	*
1935	2,971,563	35.59	1,057,627	--	*
1940	2,999,997	--	*	48.74	1,462,321
1945	3,349,129	43.80	1,466,857	32.74	1,096,375
1950	3,284,801	44.79	1,471,306	29.88	981,574
1954	3,065,425	51.18	1,568,931	27.12	831,359

*Not available.

Source: U. S. Census of Agriculture, 1930-1954.

are found in Nowata, Craig, Washington, Rogers, and Mayes counties as indicated in Figure 2. The Cherokee prairies are, for the most part, quite level and flat, and the soil is medium or fine textured usually with a very dense layer rather close to the surface.[9] Both surface and internal drainage is very poor. Water may stand on the surface for considerable periods in rainy weather and the land is difficult to handle under cultivation. Thus, many areas of the eastern prairie have never been plowed.

> Oklahoma usually produces somewhat more than 400,000 tons of native prairie hay annually on about 450,000 to 500,000 acres of native hay meadow land. About 90 percent of the production and acreage is found in the eastern prairie area. In addition, about two million acres of native rangeland is eastern prairie grassland.[10]

<u>The Cross-Timbers</u>. The Cross-Timbers or Savanna is a large wooded area of rolling to hilly sandstone uplands extending from the Kansas line to Texas. It extends between the eastern and limestone prairies in the study area (See Figure 2). It is an area of scrubby timber dominated by blackjack-post oak types.

> Over many square miles of the Oklahoma Oak Savanna, the brush has thickened to the point that there is very little grass to be grazed and production is extremely low. Many brush infested pastures are producing only 300-400 pounds of dry forage per acre and 30-40 acres are required to support a cow. The cow is not likely to be well-fed at that. On the other hand, if the stand is confined to widely scattered large trees, grass production may be about as great as on the adjacent prairie and 10 acres could support an animal unit in reasonably good fashion.

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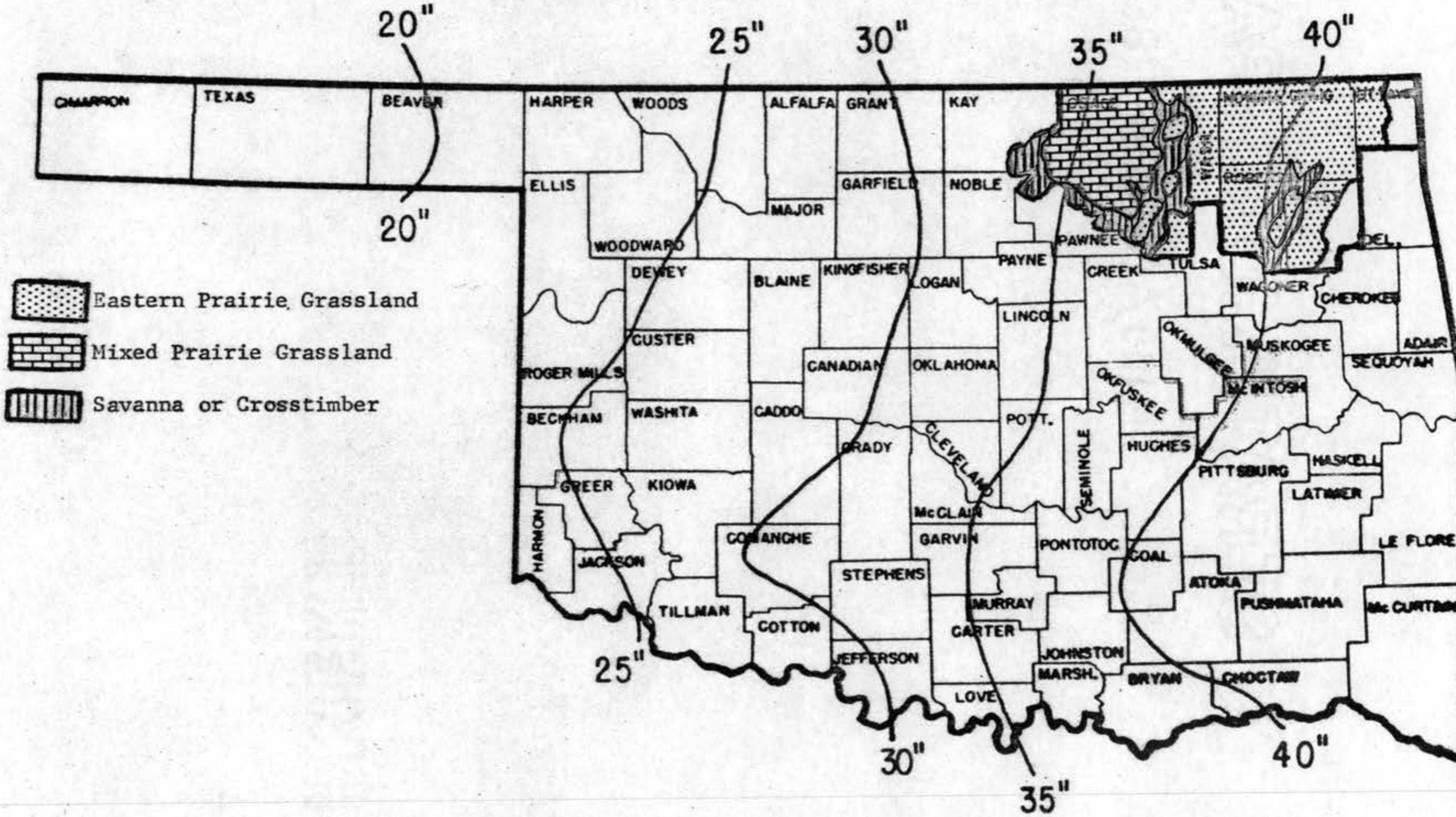
[9] Jack R. Harlan, <u>Grasslands of Oklahoma</u>, An unnumbered mimeographed publication of the Oklahoma State University Agronomy Department.

[10] <u>Ibid</u>., p. 84.

Figure 2 . Normal Precipitation for Oklahoma and Grassland Types for the Study Area



Source: Jack R. Harlan, Grassland of Oklahoma, a mimeographed publication of the Oklahoma State University Agronomy Department.

> The greatest challenge and the greatest opportunity in grassland management of the Oak Savannas is in brush control together with proper management...
>
> An aerial spraying program has been quite popular and successful in the northern counties for years. Many thousands of acres are covered annually in this section...[11]

The Limestone Prairies. That part of the limestone prairie included in the study area lies to the north and west of the Cross-Timbers (see Figure 2). Included within this area are the Bluestem Hills which developed from limestone and limy clays.[12] The soil in much of the area is very shallow. Much of the land is too rocky and the terrain too steep for crop production. Practically all of it is presently used for grazing and several large ranches are located in the Bluestem Hills. Narrow fertile valleys can in some instances be cultivated.

Climatic Influences. The climate of northeastern Oklahoma has been quite influential in its development as a ranching area. Most ecologists agree that within a given range of temperatures, effective moisture is the most important feature determining the climax vegetation of an area. Average annual rainfall in the study area is considered nearly ideal for the growth of tall grasses such as the native species predominantly found there. Average annual rainfall in the study area ranges from approximately 35 inches on the west to approximately 40 inches on the east (see Figure 2).

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[11]Ibid., p. 96.

[12]Fenton Gray and H. M. Galloway, Soils of Oklahoma, Oklahoma State University Miscellaneous Publication, MP-56, July, 1959, p. 27.

Temperature is also important as it affects the length of the growing season. Warm summers and comparatively short mild winters are typical for the area. Snow-fall seldom exceeds two inches and rarely lasts more than three or four days. Thus, any forage not utilized during the growing season can be grazed during the winter months. Many of the ranchers in the area winter their livestock on range, feeding a protein supplement. Hay is fed only when snow covers the native vegetation.

CHAPTER II

RESOURCE AND PRODUCTION REQUIREMENTS

For any linear programming or budgeting analysis, the requirements and production of each alternative enterprise must be determined. An enterprise budget is a systematic tool for evaluating specific alternatives and for explicitly defining the relationships between factor inputs and production. Enterprise budgets were developed for enterprises considered to be feasible alternatives for ranches in the northeastern Oklahoma study area.[1]

Selection of Data

The basic input-output data for this study were derived from three sources: (1) previous studies,[2] (2) experimental results, and (3) judgments of qualified agricultural scientists.

Data from previous studies were adjusted for area differences as suggested by area and state specialists. Calf weights at different

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[1]Individual livestock, crop and resource development budgets are given in Appendix A.

[2]Labor requirements, marketing and hauling costs, tax rates and veterinary and medical expenses used in the budgets were developed by Paul Andrilenas for the South Central Oklahoma ranching area. These data appear in Chapter III, "Beef Production Systems in South Central Oklahoma," an unpublished Ph.D. thesis manuscript, Department of Agricultural Economics, Oklahoma State University,(Stillwater, Oklahoma).

ages were determined by subjecting experimental data to regression analysis.[3] Regression estimates were adjusted for levels of feeding and area differences.[4] In the construction of the budgets, it is assumed that optimum production techniques are used. The production coefficients for each enterprise may be viewed as expected values under the stated assumptions.

Price and Cost Data Used

Prices used in computing returns are projected area prices adjusted for seasonal variation. The 1952-56 average price for choice slaughter steers on the Oklahoma City, Oklahoma, market is used as a base price for computing beef prices.[5] Prices used for specific weights and sale dates are estimates based on the computed monthly prices (Table IV).

Costs of machinery used include all variable costs: oil, grease, lubrication, repairs, and depreciation due to use (see Table V). Depreciation is included as a variable cost as the assumption is made that the machine will be worn out before it became obsolete. Costs of seed, feed, fertilizer and lime as used in the calculations are projected price estimates and are presented in Table VI.

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[3]The experiments were conducted by the Animal Husbandry Department of Oklahoma State University and are described in A. B. Nelson, et al., Creep Feeding Spring Calves, Bulletin B-462, Oklahoma State University, Agricultural Experiment Station, (Stillwater, Oklahoma), November 1955.

[4]Results of the regression analysis are summarized in Appendix B.

[5]Price assumptions derived by the Low Plains Sub-Committee of the S-42 Technical Committee and reported in an unpublished mimeographed report "Resource and Product Price Assumptions," December 4, 1958.

TABLE IV

ASSUMED PRICES FOR VARIOUS GRADES AND CLASSES OF BEEF ANIMALS, SELECTED DATES AS USED IN THE BUDGETS

Class of Livestock	Date of Sale	Price Per Cwt.
Cull Cows	July 20	$15.40
	May 30	15.90
	Oct. 10	14.50
Good and Choice Feeder Steers Under 500 Lbs.	July 20	25.60
	May 30	26.50
	Oct. 10	25.00
Good and Choice Creep-Fed Feeder Steers Over 500 Lbs.	July 20	26.00
Good and Choice Feeder Heifers Under 500 Lbs.	July 20	26.00
	Oct. 10	23.60
Good and Choice Creep-Fed Feeder Heifers Over 500 Lbs.	July 20	24.00
Choice Slaughter Heifers Under 500 Lbs.	May 30	24.50
Good Feeder Steers 500-800 Lbs.	April 1	27.00
	Aug. 10	23.00
	May 10	25.00
	Sept. 1	22.70

Source: Based on data from Jackson L. James and James S. Plaxico, Beef Cattle Prices; Seasonal Movements and Price Differentials on the Oklahoma City Market, Oklahoma Agricultural Experiment Station Bulletin B-486, February 1957.

TABLE V

ESTIMATED COSTS OF USING FARM MACHINERY, NORTHEASTERN OKLAHOMA

Machine	Size	Variable Costs Per Hour[a]
Tractor	2-plow	.81
Mower	7' mounted	.60
Plows	2-14"	.37
Tandem disk	6'	.21
Spike-tooth harrow	12'	.15
Grain drill	10'	.84
Side delivery rake	-	.66
Pickup baler	-	1.43
Hoeme	10'	.57
Truck	1 1/2 ton	1.00

[a]Includes fuel, oil, lubrication, repair and wear depreciation and based on a procedure recommended by the American Society of Agricultural Engineers for estimating the cost of owning and using the machines listed:

$$\frac{\text{Original Cost} + \text{Repair Cost Over Life of Machine}}{\text{Hours to Wear Out}} + \text{Fuel, Oil, and}$$

Lubrication Costs Per Hour.

For example, the cost per hour of owning and using a $2,500 tractor, requiring 12,000 hours to wear out and with repair cost over the life of the machine equal to 45 percent of original cost and fuel, oil and lubrication costs 51 cents per hour, is 81 cents:

$$\left(\frac{2500 + (2500 \times .45)}{12,000} + 51 = 81 \right)$$

TABLE VI

ASSUMED SEED, FEED AND MATERIALS COSTS, NORTHEASTERN OKLAHOMA

Item	Unit	Cost
Seed:		
Native grass mixture	pound	$ .60
Vetch	pound	.13
Lespedeza	pound	.17
Big hop clover	pound	1.00
Seed rye	bushel	1.50
Alfalfa	pound	.30
Brome grass	pound	.20
Seed oats	bushel	1.10
Sudan grass	pound	.07
Fertilizer Materials:		
10-20-10	ton	79.00
0-20-0	ton	39.00
5-10-5	ton	47.00
Ground Limestone	ton	4.50
Feeds:		
Cottonseed cake	ton	76.00
Alfalfa hay	ton	29.00
Prairie hay	ton	18.00

Livestock Alternatives

For purposes of this study, livestock alternatives are limited to beef cattle only. Consideration is further limited to forage using systems. Thus, systems primarily dependent on grain feeding are not considered in the analysis. Broadly speaking, beef cattle systems in the area may be classified as: (1) cow-calf or (2) steer (or heifer) buy-sell. Many factors affect the decision of a rancher when he is confronted with choosing between these two types of systems. Some of these factors are: (1) the personal preferences of the rancher, (2) his acquaintance with and managerial training for a system, (3) the amount and type of capital available, (4) size of ranch, (5) the rancher's beliefs concerning the "riskiness" or uncertainty of an operation, and (6) the relative profitability of the systems. In this study, choices are assumed to depend chiefly on the relative profitability of the various systems in the utilization of available resources; however, optima are presented with certain alternatives not commonly found in the area excluded from consideration to determine the effect on profits of omitting such alternatives from consideration.

Cow-Calf Enterprises

Alternative cow-calf budgets are derived to represent various calving, feeding, and marketing practices now commonly found in or technically feasible for the area. Variations of cow-calf production systems are budgeted in Appendix A, Tables 1.1-1.7. The various systems include different calving dates, different marketing dates, and different feeding practices. Table VII summarizes the more pertinent aspects of

TABLE VII

CHARACTERISTICS OF ALTERNATIVE COW-CALF SYSTEMS CONSIDERED IN THE PROCESS BUDGETS

Process	Appendix "A" Table	Calving Season	Approximate Marketing Date	Calves Creep Fed	Components of Winter Ration
P_1	1.1	fall	July 20	no	CSC and range
P_2	1.2	fall	July 20	no	Alfalfa hay and range
P_3	1.3	fall	July 20	no	Prairie hay and range
P_4	1.4	fall	May 30	no	Oat-vetch grazing, CSC, prairie hay and range[a]
P_5	1.5	spring	Oct. 10	no	CSC and range
P_6	1.6	fall	July 20	yes	CSC and range
P_7	1.7	spring	Oct. 10	yes	CSC and range

[a]A one-third ration of CSC, prairie hay and range is included to supplement the oat-vetch grazing when it is unavailable.

the various cow-calf systems budgeted. In all cases, it is assumed that the herd is of such a quality as to allow the production of good-choice feeder animals.

Both fall and spring calving are considered. The assumed average date of calving in the fall is October 30 and for spring calving the assumed average date is March 5. Feeding alternatives considered are concerned with both the feeding program of the cows and calves. The summer ration for the breeding stock is assumed to be comprised of range alone for all alternatives considered.

Process P_1 (Appendix A, Table 1.1) is a fall-calving system with the cows and calves being wintered on native range with cottonseed cake fed as a supplement. Prairie hay is fed during inclement weather.

Process P_2 (Appendix A, Table 1.2) is a cow-calf system similar to P_1 with alfalfa replacing a part of the cottonseed as a supplement and also reducing the range required. Process P_3 (Appendix A, Table 1.3) also represents a fall calving cow-calf system, with the winter ration comprised of prairie hay and cottonseed cake. Prairie hay, being higher in protein than native range grasses during winter months, reduces the cottonseed cake as well as the AUM (grazing) or range requirement in Process P_1.

A cow-calf system utilizing small grain grazing is also considered, Process P_4, (Appendix A, Table 1.4). Small grain grazing replaces a part of the hay, cottonseed cake and native range required by Process P_3. One-third of the normal ration of hay, cottonseed cake and range are required for days when small grains cannot be grazed or when grazing is inadequate. Process P_5 (Appendix A, Table 1.5) is a cow-calf system similar to that of Process P_1, except calves are spring-born. Cottonseed cake requirements are lower for spring than fall calving cows; range requirements are also lower as calves are kept a shorter period of time. This cow-calf system, P_5, is the most common spring-calving system in the area.

Processes P_6 and P_7, Appendix A, Tables 1.6 and 1.7, combine the most commonly found fall calving cow-calf system, P_1, and the most commonly found spring cow-calf system, P_5, with creep feeding of calves. The cow feeding programs are the same as for P_1 and P_5, but fewer animal unit month's pasture is required as the creep feed will slightly reduce the grazing requirement of calves.

Marketing Practices

Fall calves are normally sold as good-choice feeders during late July or early August, and spring calves are usually sold as feeders in early October. Marketing dates selected for purposes of budgeting were July 20 and October 10. All calves are assumed to be marketed as feeders except those wintered on small grain pasture, in which case the calves are assumed to be marketed on May 30 for slaughter or as feeders.

The July 20 selling date for fall calves gives ranchers the opportunity to take advantage of abundant summer grazing and calves born in October reach an acceptable marketing weight for feeding purposes at that time. Furthermore, calves are marketed before the late summer decline in production of range forage. The October 10 selling date for spring calves gives the calves ample time to attain adequate growth. An earlier marketing date would mean selling the calves at an age when further growth could be attained while calves are nursing cows. A later date would require supplemental feed to replace both the decline in milk production of the cow and the deterioration in range forage.

When small grain grazing is utilized, calves reach desirable marketing weights earlier, thus May 30 is the assumed marketing date. Also, small grain grazing will be completely utilized in most years by this date. Another factor influencing the selection of May 30 as the selling date is the expected price of slaughter calves at that time. Under certain market conditions, it may be desirable to sell slaughter calves as the seasonal high for slaughter calves exists in late May and June. Thus, heifers and lower grades of steers may bring greater returns if sold as slaughter calves than if sold as feeders during the seasonal high for slaughter calves. Cull cows are normally sold at the time or soon after calves are weaned or sold. Thus, selling prices are assumed to be those existing at the time calves are marketed.

Feeder calves are commonly sold directly to feed-lot operators or to buyers representing feed-lot operators. When the rancher sells direct, all transportation costs are transferred to the buyer and marketing costs are reduced or eliminated. A charge for transportation and marketing is included in the budgets, but ranchers selling directly would not incur these costs. Cull cows are usually sold through terminal markets and costs of transportation and marketing are borne by the rancher.

Stocker-Feeder Enterprises

Intermingled with the cow-calf ranches of the area are stocker-feeder operations. Stocker-feeder steers require resources similar to those required by cows and can be substituted for cows on a ranch. Several types of steer operations are found in the area. Six types of operations are considered in this study. Partial budgets for these six alternatives are presented in Appendix A, Tables 2.1-2.6. The pertinent aspects of the budgeted buy-sell systems are summarized in Table VIII.

Process P_8 (Appendix A, Table 2.1) is a steer enterprise in which feeder calves are purchased in the fall and roughed through the winter on range and cottonseed cake and resold in the spring. Although this alternative is seldom used, the budget is revealing in that it demonstrates the low returns to winter feeding except in those years in which a substantial price increase occurs during the winter months. Normally, when calves are fall purchased, they are roughed through the winter and sold off grass in late summer. Process P_9 (Appendix A, Table 2.2) is representative of this type of system. Returns for keeping the steers through the summer can be calculated by subtracting returns in Process P_8 from those in P_9.

Process P_9 is representative of the steer system most commonly found in the area. Although winter gains and net returns are comparatively low, ranchers choose to buy in the fall when the supply of good feeder calves is more readily available than in the spring. If cattle are sold in late summer, grass usually makes sufficient growth to furnish the calves purchased in October with winter grazing. The abundance of good-quality native grasses make this steer system particularly adaptable to the area.

In Process P_{10} (Appendix A, Table 2.3) fall purchased steers are wintered on a ration of prairie hay and cottonseed cake. Prairie hay is normally of better quality than weathered range grasses and winter

TABLE VIII

CHARACTERISTICS OF ALTERNATIVE BUY-SELL SYSTEMS CONSIDERED IN THE PROCESS BUDGETS

Process	Appendix "A" Table	Buy Date	Sale Date	Buy Weight (lbs.)	Sell Weight (lbs.)	Components of Ration Winter	Components of Ration Summer
P_8	2.1	Oct.10	Apr. 1	450	500	CSC, Range	--
P_9	2.2	Oct.10	Aug.10	450	725	CSC, Range	Range
P_{10}	2.3	Oct.10	Aug.10	450	760	CSC, Prairie hay	Range
P_{11}	2.4	Oct.10	May 10	450	716	Oat-vetch grazing and prairie hay	--
P_{12}	2.5	Apr.1	Aug.10	500	725	--	Range
P_{13}	2.6	Apr.1	Sept.1	500	765	--	Range and sudan

gains are, therefore, greater. The quantity of cottonseed cake needed to meet protein requirements is also less when prairie hay is fed than when the cattle are wintered on the range.

Steer operations utilizing small grain grazing, Process P_{11} (Appendix A, Table 2.4) are also commonly found throughout the study area. Calves purchased in October graze small grain pasture when it is available. Prairie hay, native range, and cottonseed cake are utilized when small grain grazing, due to weather conditions, is not available. For budgeting purposes, oat-vetch grazing was assumed to provide sufficient grazing for two-thirds of the time from December 1 to April 15. During this period a one-third ration of cottonseed cake, prairie hay and range is considered adequate to meet the supplemental feed requirement.

Process P_{12} (Appendix A, Table 2.5) represents a spring buy, fall sell system. Although the supply of feeder calves may be limited during spring months, some ranches, not wishing to winter the calves, follow such a system. The calves, normally purchased in late March or early April, utilize native range grasses during the summer and are sold in late summer before native grass production declines. This system normally requires no supplemental feed and the per animal labor requirement is lower than for any other system considered.

In Process P_{13} (Appendix A, Table 2.6), steers to be grazed on sudan pasture are assumed to be purchased on April 1. From April 1 until June 1, at which time sudan grazing becomes available, the steers are grazed on native range. Sudan grazing is utilized during June, July and August. The steers are sold directly off sudan on September 1.

Range Improvement Alternatives

Range improvement is not a unique problem of economics. As in other phases of production economics, the problem is one of allocating scarce resources between competing alternatives. However, competition with respect to range improvement is between products of different time periods. Competition for resources may be for many time periods into the future.

In any given year, range improvement may result in a decrease in production of other enterprises. Furthermore, returns from a range improvement practice may be forthcoming only after a waiting period. The nature and timing of resource requirements and production affect the profitability of any range improvement practice.

Three range improvement practices are considered in this study: (1) reseeding abandoned or idle cropland to native grasses, (2) brush control, and (3) sprigging of abandoned or idle cropland to bermuda grass.

As the acreage of cropland in the study area has declined, much of the land has been abandoned or remained idle. On some of this land, native grass seed from surrounding pastures has blown in and seeded the land, but in most cases, weeds and low-quality grasses have developed on this land so that the quantity and quality of forage produced for grazing is nil.

Reseeding Abandoned or Idle Cropland to Native Grasses

One practice which will result in increased production on this land is that of reseeding it to a native grass mixture.[6] A partial budget

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[6]Big and little bluestems, switch grass and Indian grass are the constituents of the usually recommended mixture.

of expected costs and returns from reseeding cropland which has been taken out of production to native grasses appears in Appendix A, Table 3.1. Operations used in preparing the land, rate of seeding, and other practices included in the budget are those recommended by specialists acquainted with the area.

In most cases, land that has been in cropland is potentially more productive than adjacent range land. Thus, it is assumed that forage production on this land, once the grass is established, will equal that of the surrounding range.

The profitability of reseeding native grasses is estimated, with and without ACP cost sharing, as applied to both bottomland and upland. One of the stipulations for receiving ACP cost sharing payments is that grazing be deferred for two years. Thus, no production is assumed for the first two years after establishment. The practice of deferring grazing for two years is also recommended by area specialists.

Brush Control

As noted earlier, the cross-timbers which extend into the study area are characterized by the brush growing on the land. In the counties making up the eastern and limestone prairies, there are also many acres of brushland. In recent years, large acreages of this brushland have been treated with aerial applications of herbicides. Not all brushland in the area is suitable for clearing, but experimental tests results have been quite satisfactory on that which is suitable.[7] Experimental

[7]Harry M. Elwell, "Experiments on Brush Control of Hardwoods for Grass Production," Oklahoma Agricultural Experiment Station mimeographed circular M-240, and "Tests of Aerial Applications of Herbicides on Post Oak and Blackjack Brush in Oklahoma," Oklahoma Agricultural Experiment Station Mimeographed circular M-258.

results indicate that two aerial treatments, usually in consecutive years, are necessary to obtain satisfactory control of the oaks found in the area. A large percent of the brushland in the study area has in the past been grazed. Normally the carrying capacity of such land is very low and the estimated annual per acre production is .3 AUM.

A partial budget for aerial treatment of brushland is represented by Process P_{18} and P_{19} in Appendix A, Table 3.2. The profitability of brush control is determined under two assumptions, with and without ACP cost sharing. By deferring grazing during the growing season during the first two years following the initial treatment, existing grasses are allowed to seed in areas on which grasses are not already established. This practice is required for ACP cost sharing and is also recommended by specialists.

Sprigging Abandoned or Idle Cropland to Bermuda Grass

Another practice which will result in increased forage production on land that has been released from crop production is that of sprigging it to bermuda grass. A partial budget for establishing bermuda grass on such land appears in Appendix A, Table 3.3. Operations used in preparing land, fertilization rates, seeding rates and sprigs used are based on ACP Administration suggestions and requirements and on recommendations of other state and federal agricultural representatives in the area.

Annual input requirements and production are presented in Appendix A, Tables 3.3-3.8. Bermuda grass can, once the stand is established, be handled in several ways. All of the grass can be utilized as pasture as is assumed for Processes P_{20}-P_{23}, Appendix A, Table 3.4, or a part of the forage can be removed as hay and the aftermath grazed as assumed for Processes P_{24}-P_{27}, Appendix A, Tables 3.5-3.6. Another practice often observed in the area is that of overseeding the bermuda with rye in the fall to produce winter grazing and then grazing the bermuda during the regular growing season. Normally, when such a program is followed, none of the grass is harvested as hay because dry rye straw, which is not grazed, lowers the quality of the hay. Partial budgets for bermuda-legume pastures overseeded with rye are represented by Processes P_{28}-P_{31}, Appendix A, Tables 3.7 and 3.8.

Nature of and Timing of Inputs

Range improvement practices may be viewed as physical production techniques or groups of particular resource techniques. Any range improvement practice, if effective, will result in an increase in the output forthcoming from the use of given quantities of other inputs compared with the output obtained from the use of the same given resources without the improvement practice during the same period of time. For most range improvement practices, a large proportion of the inputs are usually required in the year when the practice is initiated. This is especially true for two of the practices considered in this study, namely, reseeding native grasses and brush elimination and control, and also to a lesser degree for the third practice, establishment of bermuda grass.

Maintenance inputs, mainly labor, fertilizer, and equipment time are in most cases required over the production period. Legumes must be reseeded periodically to maintain a stand in bermuda-legume pastures. The bermuda pasture must be fertilized for most economical production and brushland may have to be resprayed periodically to keep brush under control.

Although the bulk of inputs is required when a practice is established, annual expenses are quite important in determining the profitability of the practice. If the initial cost, although high, is a once-only cost and the added returns are to be received over a long period of time, the establishment cost when put on a per year basis is relatively low. However, all annual costs must be met out of each year's production and cannot be spread out over a long period as can the cost of establishment.

Annual inputs for reseeded native pasture are very low. As land reseeded will in most cases have been cultivated, weeds may present a problem and spraying may prove profitable. However, no other annual costs are anticipated.

Annual costs for brush elimination and control are likely to be higher relative to establishment costs than for reseeding native grasses. Two aerial applications, usually in consecutive years, are required to successfully eliminate brush. To keep brush under control, it is anticipated on the basis of past experience and the opinion of brush-control specialists that respraying will be necessary approximately one year in seven.

Per acre costs of establishing bermuda grass are considerably higher than for either of the other range improvement practices. Annual costs are also considerably higher. Establishment costs are higher than annual costs for any single year, but when establishment costs are spread over the expected production period, annual costs make up a much larger proportion of the total.

Nature of and Timing of Production

Outputs resulting from a range improvement practice are the yield differences in terms of animal units of pasture produced with and without the use of the specified practice. Thus, two production functions must be postulated for land for which a range improvement practice is being considered: one for the production process when no improvement practice is included and one for the production process when the improvement practice is included. The time element in each must also be explicit because of the differences in the input-output relationships with respect to time. Thus the production processes must specify the inputs and the yields in an annual sequence beginning with the year in which the improvement practice is initiated.

Forage yields on abandoned or idle cropland are usually very low, and undesirable weeds make up a high percent of the forage. Thus, in this study the value of grazing produced on abandoned or idle cropland is considered to be zero. All grazing produced on such land after the improvement practice is initiated is therefore attributed to the improvement practice.

Native Grass Production. When native grass is planted on abandoned or idle cropland, range management specialists recommend that grazing be deferred for two years to allow the grass to develop a root system and to become well established. No production is, therefore, assumed for the first two years. By the third year, production normally is equal to that of native pastures in the surrounding area. The normal recommended stocking rate for native pastures in counties included in the study area is 10 acres per animal unit for upland pastures and eight acres per animal unit for bottomland pastures.[8] Thus, annual per acre production on land reseeded to native grasses is assumed to be increased by 1.2 animal unit months on upland and 1.5 on bottomland.

Brush Control or Elimination. Grass production on brushland in northeastern Oklahoma is highly variable depending partially on the density of brush cover. The increase in production as a result of elimination of brush is also variable, being greater on areas where brush cover is dense, assuming other factors are equal. Average production on brushland suitable for spraying is estimated to be .3 AUM grazing.

Treatment is usually practiced in early spring, thus, an increase in growth of desired grasses is normal for the year of treatment. Deferred grazing is recommended. Thus, grazing is practiced only during the winter months for the first two years. Production is estimated to be .5 AUM during the first year and 1.0 the second year. By the third year, grazing on treated brushland is expected to equal that of upland native pastures.

Bermuda Grass Production. Bermuda grass is normally planted by placing sprigs in rows and then covering a part of the sprig with soil and packing it. Normally at least one year is required for the grass to cover the ground between the rows. Grazing before the ground is completely covered lengthens the time period required for a complete cover to develop. Therefore, it is usually recommended that grazing be deferred one year following sprigging.[9]

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[8]Harlan, pp. 121-122.

[9]If annual grasses or weeds become a problem, mowing or grazing is sometimes recommended to assist in controlling them and thus reduce competition with the Bermuda during the first year.

Estimated annual per acre production for bermuda-legume pastures is 3.0 and 4.0 animal unit months grazing for upland and bottomland respectively. Overseeding bermuda-legume pastures with rye for winter and early spring grazing is expected to provide an additional 1.5 AUM grazing. If bermuda grass is cut for hay during the growing season, the average expected yield is two tons per acre on upland soils and 2.5 tons on bottomland soils; in addition, the aftermath will provide approximately 1.0 AUM grazing on upland and 1.5 AUM grazing on bottomland.

Cropping Alternatives

Crops for harvest are grown on a relatively small acreage on ranches in the area. Budgets explicitly stating the input-output relations in the production of crops for harvested forage and temporary grazing are presented in Appendix A, Tables 4.1 to 4.5.[10] The budgets indicate the required establishment and annual inputs and expected annual production. Cropping enterprises may be divided into two groups: (1) hay producing and (2) pasture producing.

Native grass, Process P_{32} (Appendix A, Table 4.1) is the most important hay crop grown in the area. In some cases the native meadow is fenced separately and is used as a meadow year after year. In other cases, the land that is mowed for hay is alternated. Usually ranchers mow only the amount of native hay that they anticipate will be required for wintering their livestock and as a reserve for drought. The hay is

[10]Resource improvement budgets may also be viewed as crop alternatives in that they produce forage.

usually mowed in July and many ranchers graze the aftermath during the winter. Studies conducted by scientists of the Oklahoma State University Agronomy Department on eastern prairie grasses indicate that they are rather insensitive to fertilizer treatments.[11] Thus, the only variable annual expenses are those incurred in harvesting the hay.

Alfalfa, Process P_{33}, is also considered as a hay producing alternative for the study area. Alfalfa is grown on bottomland soils on some ranches in the area, but land in the area on which alfalfa can be produced is quite limited. Requirements for establishing alfalfa are presented in Appendix A, Table 4.2, and annual per-acre costs for maintaining the stand and haying and expected yields are presented in Appendix A, Table 4.3.

Inputs and expected production for winter oats-vetch pasture and sudan pasture are presented in Appendix A, Tables 4.4 and 4.5. The oats-vetch alternative is representative of small grain winter pastures and sudan is considered as a temporary summer pasture.

Integration of Crop and Livestock Enterprises

The small grain and sudan grazing enterprises were incorporated as an integral part of the livestock alternatives requiring these types of grazing in the problem matrix. Other cropping alternatives were introduced as separate enterprises. For the livestock enterprises requiring sudan or small grain grazing, the resources required for the production of these crop enterprises were added to the resources directly required by the livestock process. Production and resource requirements for the

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[11]Harlan, pp. 84-85.

temporary pasture producing processes were budgeted on a per acre basis, and these were converted to a per animal basis when incorporated into the livestock enterprise. Livestock enterprises to which costs and resource requirements of oats-vetch grazing were added are the cow-calf Process P_4 and the buy-sell Process P_{11}. Costs of sudan production were added to the buy-sell Process, P_{13}.

Alfalfa, native meadow, and the range improvement processes were incorporated as separate enterprises. Production for these enterprises is given as AUM's of pasture and tons of hay produced.

Resource Buying, Renting, Hiring and Borrowing Activities

To determine the profitability of hiring labor to supplement family and operator labor, labor hiring activities, P_{34}-P_{37}, were incorporated into the problem matrix. The year was divided into four time periods, each three months in length, with months requiring a specific type of labor grouped together.

The profitability of buying native or alfalfa hay was also determined. Process P_{38} represents the native hay buying alternative and Process P_{39} represents the alfalfa hay buying alternative.

The capital borrowing activities, Processes P_{40} and P_{41}, allow the individual to borrow capital. The cost of borrowing capital is assumed to regulate the quantity borrowed. Capital used for a period of longer than one year such as for purchasing brood cows and bulls, spraying brush, sprigging bermuda and other similar activities is referred to here as long-term capital. Capital used for less than one year such as for the purchase of steers, buying of feed, hiring of labor, etc., is referred to as operating capital.

Normally, capital can be borrowed for long-term projects at a lower rate of interest than can capital used for the purchase of steers or other short-term uses. For purposes of this study, the differential between the two rates is assumed to be three percent. Thus, if a rate of six percent was assumed for short-term loans, then the rate for short-term loans was assumed to be nine percent. These two rates, six percent and nine percent are used as external rates.

Process P_{43} is a land-buy alternative. This alternative was introduced after the optimum ranch program was determined for the size of ranch assumed to be owned. Optimum programs were determined at various interest rates with and without the land buy option and with the land buying activity at two levels, 640 and 1,280 acres.

Process P_{42} is included to allow any cropland to be transferred to idle land. Once the transfer is made, the land can be reseeded to native or sprigged to bermuda grass. Thus, cropland does not remain in crops in the optimum programs if it is more profitable to convert it to permanent grasses.

CHAPTER III

OPTIMUM ENTERPRISE COMBINATIONS IN A STATIC FRAMEWORK

The Static Model

Static economics is concerned with decision making in a timeless, changeless state in which knowledge is perfect. Inputs are assumed to be required and returns to be forthcoming instantaneously. The assumption is made that managers wish to employ resources in such a manner that some quantity, such as profit, is maximized.[1] To maximize profits, limited quantities of resources must be allocated among competing production alternatives in such a manner that no reallocation can result in an increase in net income.

In this chapter, profit maximization in a static framework is considered. Optimum ranch organization is determined, using linear programming procedures, for alternative resource situations. The linear programming model provides for the maximization (or minimization) of a selected criterion (profits) subject to a set of restrictions.[2] The profit equation to be maximized is of the general form:

$$Z = \sum_{j=1}^{n} c_j x_j \qquad (4.1)$$

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[1]Profits as used in this study are returns to owned factors.

[2]The additional special postulates of linear programming--linearity, divisibility, additivity, and finiteness are discussed in Chapter I.

where c_j's are the net costs per unit of input or net returns per unit of output, the x_j's are the activities or processes, and n is the number of activities considered. The profit equation is maximized subject to a set of restrictions,

$$\sum_{j=1}^{n} a_{ij}x_j \leq b_i \text{ (non-identity)} \qquad (4.2)$$

$$x_j \geq 0 \qquad (4.3)$$

where a_{ij} is the quantity of the i^{th} resource required in the production of one unit of the j^{th} process. The b_i's are the resource restrictions or requirements, with m being the number of restrictions. The equation, 4.2, is a non-identity, indicating that the quantity of any given resource used cannot exceed but can be equal to or less than the restriction, b_i.[3] Equation 4.3 stipulates that no product can be produced at a negative level.

The resource or requirement equations which make up the programming model are as follows:

$$a_{11}x_1 + a_{12}x_2 + \ldots. + a_{1n}x_n \leq b_1$$

$$a_{21}x_1 + a_{22}x_2 + \ldots. + a_{zn}x_n \leq b_2$$

$$\vdots$$

$$a_{m1}x_1 + a_{m2}x_2 + \ldots. + a_{mn}x_n \leq b_m$$

and the criterion equation to be maximized is:

$$Z = c_1x_1 + c_2x_2 + \ldots. + c_nx_n$$

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[3]The programming model provides a means whereby it is possible for resource levels to be increased through (1) resource hiring and buying activities, (2) transfer activities, and (3) the effect of the production of intermediate product activities. If

$$\sum_{j=1}^{n} a_{ij}x_j < b_i,$$ some of the resource is unused.

The matrix of input-output coefficients (A) and the "net return and cost matrix" (C) for the static analysis are given in Appendix C, Table 1.

Alternative Models

The linear programming model can be modified in four ways: (1) the resource restrictions (b values) can be altered, (2) admissible production activities or processes (x's) can be increased or decreased, (3) the returns per unit (c_j's) can be altered by changing prices (or costs), and (4) any requirement or production coefficient (a's) can be varied. To determine the effect of a given change in any b value, any x value, any c_j value or any a value on the optimum enterprise combination, profits, or production, all other data must remain unchanged.

Resource Restraints. Linear programming requires that two types of resource information be explicitly stated: (1) the resource requirement of each alternative activity or process considered (the a_{ij} values) and (2) the initial quantity of each of the resources which may become limiting (the b_i values). The resource requirements of each of the admissible alternatives considered are explicitly stipulated in the process budgets.

The typical resource situation, hereafter referred to as the basic resource situation, and other sets of resource situations assumed, for which optimum programs were determined, are presented in Table IX. Land acreage and composition for Resource Situation I, the basic resource situation, is based on census data relating to ranches of 3,000 or more acres in the study area. Labor restrictions are based on the assumption that operator and unpaid family labor is equivalent to that of two

TABLE IX

ASSUMED RESOURCE SITUATIONS ("B" MATRICES),
NORTHEASTERN OKLAHOMA BEEF CATTLE RANCHES

Resource Description	Unit	Resource Situation I	II	III	IV	V	VI
Land:							
Idle Bottomland	Acre	100	100	100	100	100	100
Idle Upland	Acre	300	300	300	300	300	300
Cropland	Acre	200	200	0	400	200	200
Brushland	Acre	1,080	1,080	1,080	1,080	0	2,160
ACP Cost Sharing:							
Brush Spraying	Dollars	1,200	1,200	1,200	1,200	1,200	1,200
Bermuda Establishment	Dollars	5,000	5,000	5,000	5,000	5,000	5,000
Total for All Uses	Dollars	10,000	10,000	10,000	10,000	10,000	10,000
Labor:							
Dec.-Feb.	Hour	960	960	960	960	960	960
Mar.-May	Hour	1,120	1,120	1,120	1,120	1,120	1,120
June-Aug.	Hour	1,200	1,200	1,200	1,200	1,200	1,200
Sept.-Nov.	Hour	1,040	1,040	1,040	1,040	1,040	1,040
Capital:							
Long-Term	Dollars	0	0	0	0	0	0
Operating	Dollars	0	0	0	0	0	0
Native or Bermuda Grazing	AUM	8,388	8,388	8,388	8,388	8,388	8,388
Hay:							
Prairie or Bermuda	Ton	0	0	0	0	0	0
Alfalfa	Ton	0	0	0	0	0	0
Native Meadow Land	Acre	320	[a]	320	320	320	320

[a]Restricted only by the total acreage of rangeland available.

full-time laborers. ACP cost share funds are restricted to the amount to which payments to any one rancher are currently limited by ACP regulations. Hay, comprised of alfalfa and native or bermuda, may be produced or purchased. Capital for the purchase of livestock, for range improvements, and annual operating expenses is assumed to be available up to the amount at which its marginal value productivity equals the _a priori_ determined rate. Thus, the MVP of capital and the level of the predetermined rate simultaneously determine the amount of capital used. All land included in the initial resource situation is assumed to be owned, and, as net returns are computed to owned factors, its returns are not computed separately.

In each of the other Resource Situations, II through VI, the value of a single restraint (b value) is altered as follows: (1) the restriction of 320 acres of native grass suitable for meadow was removed (Situation II), (2) cropland acreage reduced to zero (Situation III), (3) cropland acreage increased to 400 acres (Situation IV), (4) brushland acreage reduced to zero (Situation V), and (5) brushland increased to 2,160 acres (Situation VI).

The effect of each of the changes on the optimum can readily be determined by comparing the optimum for any other set of restraints with that of Resource Situation I.

Admissible Alternatives. The optimum program can be determined from any finite number of processes or alternatives (x's). However, if the effect on the optimum, profits, or production, of adding or dropping a given alternative from consideration is to be determined, all other alternatives must remain unchanged. A new activity, such as resource buying or hiring, can be included by simply adding to the program matrix a new column with the appropriate requirement and production coefficients; likewise, an activity can be dropped from consideration by removing all elements of the appropriate column from the matrix. Optimum programs for Resource Situation I were determined when: (1) a land buy activity was added,[4] (2) Process P_{33}, an alfalfa hay producing alternative for which soil on many ranches is not suitable, was dropped, (3) Process P_{10}, a steer enterprise not presently found in the study area, was eliminated, (4) all steer enterprises were eliminated to determine the optimum enterprise combination for ranchers who prefer to have a cow-calf operation, (5) Process P_1, the fall calving cow-calf alternative most commonly found in the area, Process P_5, the spring cow-calf alternative most common to the area, and P_9, the steer alternative most commonly found in the area, were the only livestock alternatives considered, (6) Processes P_1 and P_9 were the only livestock alternatives considered, and (7) Process P_9 was the only livestock alternative considered.

Price Changes. The optimum program can be determined given any set of prices for products or costs of resources. A price change will result in a change in returns (c_j's) to owned factors for the production activities affected, and a cost[5] change will similarly affect the returns to owned factors for resources used. The effect of two types of price changes were explored in this study, namely, the effect of changing the

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[4]All land available for purchase was assumed to be native grassland for grazing purposes.

[5]Costs are viewed as negative returns in linear programming analyses.

desired marginal rate of return on capital (by manipulation of the c_j value of capital) and the effect of cattle price changes.

Capital Rate Changes. As discussed in Chapter I, the quantity of capital used is determined by the marginal rate of return required, and by varying this rate, the quantity of capital which will be employed also varies. Optimum programs were computed for each set of resource restrictions and for each set of production processes considered with the required marginal rate of capital[6] set at the following seven levels: (1) 49 and 46 percent, (2) 39 and 36 percent, (3) 29 and 26 percent, (4) 24 and 21 percent, (5) 19 and 16 percent, (6) 14 and 11 percent, and (7) nine and six percent; the first rate in each case being for short-term or operating capital and the latter rate being for long-term capital.[7]

Cattle Price Changes. The effect of changes in the price of cattle on the optimum were also determined. A reduction in the price of cattle, assuming all other prices remain unchanged, results in a reduction in the per unit return to owned factors (c_j), and, conversely, an increase in the price of cattle results in an increase in these returns. Optimum ranch organizations were computed assuming livestock prices (a) 25 percent below long-term projected prices, (b) 25 percent above long-term projected prices, and (c) 50 percent above long-term projected prices.

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[6]These rates are hereafter referred to as "capital rates".

[7]The rates for the two types of capital differ as ranchers and other qualified personnel familiar with ranching operations indicate that a differential of about three percent exists in the rate ranchers pay for capital used to buy breeding livestock, land, and for making land improvements, and the rate they pay for capital used for purchasing steers and for annual operations.

Static Programming Results

The most profitable enterprise combinations were determined for each of the six resource situations at each capital rate.[8] These optimum ranch plans provide: (1) a comparison of net income for each resource situation at each capital level, (2) a comparison of the effect of changes in the amounts and combinations of various resources on the optimum enterprise combinations and the resulting effect on net income, and (3) as a basis for determining the effect of restricting capital at various levels, through manipulation of the capital rate, on the optimum enterprise combinations.

Optimum Enterprise Combinations for Various Resource Situations

Tables X through XV present the optimum enterprise combinations for each of the six resource situations and with capital rates at the seven selected levels. Also presented are the long-term and short-term capital requirements for the optimum plan. Returns are computed for each optimum with (1) the charge included for capital equal to the selected capital rate of level of marginal returns desired and under the assumption that all capital would be used for the full year, (Z), (2) the charge included for capital equal to the external interest rate (six percent for long-term and nine percent for short-term loans) and under the assumption that all capital would be used for the full year, (Z*), (3) the charge included for capital equal to the selected capital rate or level of

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[8]The computer operating procedure used is that developed by O. R. Perry and J. S. Bonner, "Linear Programming Code for the Augmented 650," 650 Program Library File Number 10.1.006.

marginal returns desired and with the charge made for only the period during which the capital would actually be used, (Z**), and (4) the charge included for capital equal to the external interest rate and with the charge made for only the period during which the capital would be employed (Z***).

Resource Situation I

Table X presents the optimum combination of enterprises for Resource Situation I at each capital rate. For this resource situation, as for all others considered, no enterprise or combination of enterprises will yield a return equal to that of the highest capital rate considered, 49 - 46 percent; thus, all owned resources remain idle at this level.

When the capital rate is at the 39 - 36 percent level, the optimum ranch organization is comprised of 651 cows (Process P_2) and 128 acres of alfalfa-brome hay; labor is hired during three of the four periods and $136,000 capital is required. The optimum for the 29 - 26 percent capital rate is the same as that for the 39 - 36 percent rate.

When the capital rate is 24 - 21 percent, 686 cows (Process P_2) and 74 steers (Process P_{11}) comprise the optimum livestock system. Also included in the optimum are 400 acres of reseeded native grass, 27 acres of native meadow, 135 acres of alfalfa-brome hay and labor is again hired during three periods and the amount of capital required is $157,000.

At the 19 - 16 percent rate, the optimum livestock system is comprised of 688 cows (Process P_2) and 74 steers (Process P_{11}). The acreage of reseeded native grass is 390 acres, 10 less than at the preceding rate, and 10 acres of bermuda grass (Process P_{26}) and 135 acres of alfalfa-brome

TABLE X

OPTIMUM ENTERPRISE COMBINATIONS AND RETURNS, INITIAL RESOURCE RESTRICTIONS, SITUATION I, WITH SELECTED MARGINAL RETURNS TO CAPITAL

		Required Marginal Returns to Capital ($)						
Operating Capital		.49	.39	.29	.24	.19	.14	.09
Long-Term Capital		.46	.36	.26	.21	.16	.11	.06
Activity	Unit							
Cow-Calf (P_2)	Each	0	651	651	686	688	561	544
Cow-Calf (P_5)	Each	0	0	0	0	0	132	0
Steer (P_{10})	Each	0	0	0	0	0	0	829
Steer (P_{11})	Each	0	0	0	74	74	102	106
Reseed Native (P_{14})	Acre	0	0	0	300	300	300	137
Reseed Native (P_{15})	Acre	0	0	0	100	90	85	0
Spray Brush (P_{18})	Acre	0	0	0	0	0	171	171
Spray Brush (P_{19})	Acre	0	0	0	0	0	0	909
Bermuda (P_{24})	Acre	0	0	0	0	0	0	163
Bermuda (P_{26})	Acre	0	0	0	0	10	15	100
Native Meadow (P_{32})	Acre	0	0	0	27	0	0	320
Alfalfa-Brome (P_{33})	Acre	0	128	128	135	135	110	107
Dec.-Feb. Labor (P_{34})	Hour	0	511	511	620	624	635	1,332
Mar.-May Labor (P_{35})	Hour	0	0	0	0	0	0	458
June-Aug. Labor (P_{36})	Hour	0	22	22	182	164	37	3,165
Sept.-Nov. Labor (P_{37})	Hour	0	503	503	802	805	665	1,047
L. T. Capital (P_{40})	$	0	127,942	127,942	137,684	138,186	139,825	126,782
Opr. Capital (P_{41})	$	0	8,227	8,227	19,222	19,289	23,849	140,342
Z (Returns[a])	$	0	5,811	19,428	27,086	35,657	42,755	52,568
Z*	$	0	46,663	46,663	50,622	51,405	50,940	52,568
Z**	$	0	7,467	21,084	29,011	37,539	44,003	54,166
Z***	$	0	47,045	47,045	51,344	52,296	51,742	54,166

Z (Quantity maximized) = Returns to owned factors with interest rate = MVP; interest charged for full year.
Z* = Returns with interest rate = .06 and .09; interest charged for full year.
Z** = Returns with interest rate = MVP; interest charged for time capital used.
Z*** = Returns with interest rate = .06 and .09; interest charged for time capital used.

[a]Returns to owned factors including land, family and operator labor, and management.

hay is included in the optimum. Labor is hired during three periods and the amount of capital required is only $500 greater than for the preceding rate.

With the capital rate at 14 - 11 percent, 561 cows of Process P_2, 132 cows of Process P_5, 102 steers (Process P_{11}), 385 acres of reseeded native grass, 171 acres of sprayed brushland, 15 acres of bermuda, and 110 acres of alfalfa comprise the optimum system. Labor is again hired during three periods and $163,000 capital is required.

At the lowest capital rate considered, 9 - 6 percent, components of the optimum are 544 cows (Process P_2), 829 steers (Process P_{10}), 106 steers (Process P_{11}), 137 acres of reseeded native grass, 1,080 acres of sprayed brushland, 263 acres of bermuda grass, 320 acres of native meadow and 107 acres of alfalfa-brome hay. Labor is hired during all four periods and $267,000 capital is required.

The amount of capital used increases from $136,000 at the highest capital rate (39 - 36 percent) to $267,000 at the lowest rate (9 - 6 percent), while net returns to owned factors, with a charge of 6 percent for long-term and 9 percent for short-term made for capital, increased from $46,663 at the highest capital rate to $52,568. Thus, the increased $131,000 capital required by the optimum at the 9 - 6 percent capital rate results in an increase in net returns of less than $6,000, an increase in returns of less than 4.6 percent per dollar of additional capital used. When considering capital limitations and discounting by ranchers, this then may explain the prevalence of cow-calf systems in the area.

At the higher capital rates, the optimum livestock program is comprised of cows alone, but at lower rates, steers also are included. Thus, with a given acreage, cows are more profitable than steers when the capital rate is high, but at lower rates with more capital available with a given acreage, steers become relatively more profitable.

Reseeding native grass on abandoned cropland is included in the optimum when the capital rate is 24 - 21 percent. Thus, the return from reseeding such land to native grass must necessarily exceed 24 percent for short-term and 21 percent for long-term capital. Similarly, the inclusion of spraying brushland with ACP cost sharing at the 14 - 11 percent rate, and spraying brush without ACP assistance at the 9 - 6 percent rate, indicates the rate of return from brush control exceeds 14 and 11 percent for short-term and long-term capital respectively with ACP cost sharing and 9 and 6 percent without ACP assistance. A limited acreage of bermuda grass is included at the 19 - 16 percent rate, but the rate must be lowered to the 9 - 6 percent rate and steers be included in the optimum before all bermuda for which ACP assistance is available is included in the optimum.

Resource Situation II

Table XI presents the optimum combination of enterprises for Resource Situation II, which differs from Resource Situation I in that the acreage of native meadow is restricted only by the total acreage of native grass available. The optimum does not differ from that of Situation I except when the capital rate is at the lowest level, 9 - 6 percent. At this level, the steer processes, P_{10}, which utilizes prairie

TABLE XI

OPTIMUM ENTERPRISE COMBINATIONS, RESOURCE SITUATION II, WITH SELECTED MARGINAL RETURNS TO CAPITAL

		Required Marginal Returns to Capital ($)						
Operating Capital		.49	.39	.29	.24	.19	.14	.09
Long-Term Capital		.46	.36	.26	.21	.16	.11	.06
Activity	Unit							
Cow-Calf (P_2)	Each	0	651	651	686	688	561	0
Cow-Calf (P_5)	Each	0	0	0	0	0	132	0
Steer (P_{10})	Each	0	0	0	0	0	0	2,483
Steer (P_{11})	Each	0	0	0	74	74	102	227
Reseed Native (P_{14})	Acre	0	0	0	300	300	300	300
Reseed Native (P_{15})	Acre	0	0	0	100	90	85	0
Spray Brush (P_{18})	Acre	0	0	0	0	0	171	171
Spray Brush (P_{19})	Acre	0	0	0	0	0	0	909
Bermuda (P_{26})	Acre	0	0	0	0	10	15	100
Native Meadow (P_{32})	Acre	0	0	0	27	0	0	2,564
Alfalfa-Brome (P_{33})	Acre	0	128	128	135	135	110	0
Dec.-Feb. Labor (P_{34})	Hour	0	511	511	620	624	635	2,185
Mar.-May Labor (P_{35})	Hour	0	0	0	0	0	0	1,014
June-Aug. Labor (P_{36})	Hour	0	22	22	182	164	37	9,518
Sept.-Nov. Labor (P_{37})	Hour	0	503	503	802	805	665	1,088
L. T. Capital (P_{40})	$	0	127,942	127,942	137,684	138,186	139,825	17,956
Opr. Capital (P_{41})	$	0	8,227	8,227	19,222	19,289	23,849	378,624
Z	$	0	5,811	19,428	27,086	35,657	42,755	54,112
Z*	$	0	46,663	46,663	50,622	51,405	50,940	54,112
Z**	$	0	7,467	21,084	29,011	37,539	44,003	57,235
Z***	$	0	47,045	47,045	51,344	52,296	51,742	57,235

Z (Quantity maximized) = Returns to owned factors with interest rate = MVP; interest charged for full year.
Z* = Returns with interest rate = .06 and .09; interest charged for full year.
Z** = Returns with interest rate = MVP; interest charged for time capital used.
Z*** = Returns with interest rate = .06 and .09; interest charged for time capital used.

hay and P_{11}, which utilizes small grain pasture, make up the optimum livestock program. This program requires $123,500 more capital than the optimum program for the same capital rate with Resource Situation I. Net returns, however, are increased by only $1,544.

Resource Situation III

By assuming that no land can be planted to crops as in Resource Situation III, the possibility of growing alfalfa and small grain crops is eliminated. Table XII presents optimum plans at each capital rate given this assumption. The spring calving cow-calf system, P_5, replaces the alfalfa hay requiring cow-calf system, P_2, as the only livestock alternative at the higher capital rates. At lower rates, a steer process, P_{10}, is again included in the optimum system, but P_{11}, the steer enterprise which requires cropland for small grain grazing is absent. Capital requirements are lower than for the optimum of Situation I, but the reduction in returns is proportionally greater. All range improvement alternatives become profitable at the same level as under Situation I.

Resource Situation IV

When cropland acreage is increased to 400 acres (Situation IV) the optimum combination of enterprises remains the same as for Resource Situation I at the capital rate of 29 - 26 percent and above (see Table XIII). At lower levels, a greater number of cows and also a greater number of steers which utilize small grain grazing are included in the optimum. A fewer number of the prairie hay utilizing steers are included in the optimum as more native hay is required for the greater number of

TABLE XII

OPTIMUM ENTERPRISE COMBINATIONS, RESOURCE SITUATION III, WITH SELECTED MARGINAL RETURNS TO CAPITAL

		Required Marginal Returns to Capital ($)						
Operating Capital		.49	.39	.29	.24	.19	.14	.09
Long-Term Capital		.46	.36	.26	.21	.16	.11	.06
Activity	Unit							
Cow-Calf (P_5)	Each	0	623	623	661	661	620	521
Steer (P_{10})	Each	0	0	0	0	0	237	849
Reseed Native (P_{14})	Acre	0	0	0	300	300	100	137
Reseed Native (P_{15})	Acre	0	0	0	100	100	0	0
Spray Brush (P_{18})	Acre	0	0	0	0	0	171	171
Spray Brush (P_{19})	Acre	0	0	0	0	0	0	909
Bermuda (P_{24})	Acre	0	0	0	0	0	0	163
Bermuda (P_{26})	Acre	0	0	0	0	0	100	100
Native Meadow (P_{32})	Acre	0	21	21	22	22	6	320
Dec.-Feb. Labor (P_{34})	Hour	0	391	391	473	473	677	1,215
Mar.-May Labor (P_{35})	Hour	0	300	300	386	386	531	870
June-Aug. Labor (P_{36})	Hour	0	0	0	0	0	0	2,432
L. T. Capital (P_{40})	$	0	119,616	119,616	129,772	129,772	122,840	119,900
Opr. Capital (P_{41})	$	0	11,781	11,781	12,685	12,685	44,775	130,668
Z	$	0	2,956	16,097	22,930	30,052	38,169	47,487
Z*	$	0	42,376	42,376	44,298	44,298	46,549	47,487
Z**	$	0	5,216	17,776	24,416	31,229	39,275	48,723
Z***	$	0	42,897	42,897	44,856	44,856	47,260	48,723

Z (Quantity maximized) = Returns to owned factors with interest rate = MVP; interest charged for full year.
Z* = Returns with interest rate = .06 and .09; interest charged for full year.
Z** = Returns with interest rate = MVP; interest charged for time capital used.
Z*** = Returns with interest rate = .06 and .09; interest charged for time capital used.

TABLE XIII

OPTIMUM ENTERPRISE COMBINATIONS, RESOURCE SITUATION IV, WITH SELECTED MARGINAL RETURNS TO CAPITAL

		Required Marginal Returns to Capital ($)						
Operating Capital		.49	.39	.29	.24	.19	.14	.09
Long-Term Capital		.46	.36	.26	.21	.16	.11	.06
Activity	Unit							
Cow-Calf (P_2)	Each	0	651	651	671	679	685	553
Cow-Calf (P_5)	Each	0	0	0	0	0	6	0
Steer (P_{10})	Each	0	0	0	0	0	0	755
Steer (P_{11})	Each	0	0	0	304	303	302	331
Reseed Native (P_{14})	Acre	0	0	0	300	300	300	137
Reseed Native (P_{15})	Acre	0	0	0	100	60	60	0
Spray Brush (P_{18})	Acre	0	0	0	0	0	171	171
Spray Brush (P_{19})	Acre	0	0	0	0	0	0	909
Bermuda (P_{24})	Acre	0	0	0	0	0	0	163
Bermuda (P_{26})	Acre	0	0	0	0	40	40	100
Native Meadow (P_{32})	Acre	0	0	0	112	0	0	320
Alfalfa-Brome (P_{33})	Acre	0	128	128	132	134	135	109
Dec.-Feb. Labor (P_{34})	Hour	0	511	511	679	696	721	1,350
Mar.-May Labor (P_{35})	Hour	0	0	0	0	0	0	532
June-Aug. Labor (P_{36})	Hour	0	22	22	450	374	387	3,151
Sept.-Nov. Labor (P_{37})	Hour	0	503	503	1,440	1,453	1,467	1,682
L. T. Capital (P_{40})	$	0	127,942	127,942	134,734	136,670	140,310	128,548
Opr. Capital (P_{41})	$	0	8,227	8,227	51,034	50,881	51,141	161,263
Z	$	0	5,811	19,428	27,252	37,403	46,971	57,282
Z*	$	0	46,663	46,663	55,118	56,158	56,543	57,282
Z**	$	0	7,467	21,084	31,300	40,566	49,325	59,627
Z***	$	0	47,045	47,045	56,636	57,656	58,057	59,627

Z (Quantity maximized) = Returns to owned factors with interest rate = MVP; interest charged for full year.
Z* = Returns with interest rate = .06 and .09; interest charged for full year.
Z** = Returns with interest rate = MVP; interest charged for time capital used.
Z*** = Returns with interest rate = .06 and .09; interest charged for time capital used.

steers which utilize small grain grazing. The amount of capital required for this optimum is $290,000 with the capital cost level at 9 - 6 percent. This is $23,000 more than the amount required for the optimum of Situation I at the corresponding capital rate. Returns to owned factors for Situation IV exceed those of Situation I at the 9 - 6 percent capital rate by $4,714.

Resource Situation V

When brushland suitable for spraying is eliminated (Resource Situation V) the optimum enterprise combination is the same as that of Situation I at capital rates above the 14 - 11 percent rate (Table XIV). However, at the 14 - 11 percent rate the number of cows is reduced to compensate for the loss of AUM's of range land.

Livestock alternatives making up the optimum combination are the same as those for Resource Situation I, but are at different relative levels. The reduction in native range forces a greater decrease in the number of cows than in either of the two steer enterprises. Reseeding native grasses and sprigging bermuda grass become profitable at the same capital rate as in Situation I. Total capital required at the 9 - 6 percent rate is $238,000, a reduction of $29,000 from that needed for the optimum of the same rate of Situation I. Returns to owned factors at the 9 - 6 percent rate for Situation V are $1,165 less than those of the optimum of Resource Situation I.

Resource Situation VI

The effect of an increase in the acreage of brushland suitable for spraying on the optimum combination of enterprises at each capital rate

TABLE XIV

OPTIMUM ENTERPRISE COMBINATIONS, RESOURCE SITUATION V, WITH SELECTED MARGINAL RETURNS TO CAPITAL

		Required Marginal Returns to Capital ($)						
Operating Capital		.49	.39	.29	.24	.19	.14	.09
Long-Term Capital		.46	.36	.26	.21	.16	.11	.06
Activity	Unit							
Cow-Calf (P_2)	Each	0	651	651	686	688	534	469
Cow-Calf (P_5)	Each	0	0	0	0	0	146	0
Steer (P_{10})	Each	0	0	0	0	0	0	824
Steer (P_{11})	Each	0	0	0	74	74	108	122
Reseed Native (P_{14})	Acre	0	0	0	300	300	300	137
Reseed Native (P_{15})	Acre	0	0	0	100	90	84	0
Bermuda (P_{24})	Acre	0	0	0	0	0	0	163
Bermuda (P_{26})	Acre	0	0	0	0	10	16	100
Native Meadow (P_{32})	Acre	0	0	0	27	0	0	320
Alfalfa-Brome (P_{33})	Acre	0	128	128	135	135	105	92
Dec.-Feb. Labor (P_{34})	Hour	0	511	511	620	624	607	1,162
Mar.-May Labor (P_{35})	Hour	0	0	0	0	0	0	361
June-Aug. Labor (P_{36})	Hour	0	22	22	182	164	0	3,022
Sept.-Nov. Labor (P_{37})	Hour	0	503	503	802	805	627	916
L. T. Capital (P_{40})	$	0	127,942	127,942	137,684	138,186	136,027	98,114
Opr. Capital (P_{41})	$	0	8,227	8,227	19,222	19,289	24,666	139,482
Z	$	0	5,811	19,428	27,086	35,657	42,317	51,403
Z*	$	0	46,663	46,663	50,622	51,405	50,351	51,403
Z**	$	0	7,467	21,084	29,011	37,539	43,585	52,944
Z***	$	0	47,045	47,045	51,344	52,250	51,166	52,944

Z (Quantity maximized) = Returns to owned factors with interest rate = MVP; interest charged for full year.
Z* = Returns with interest rate = .06 and .09; interest charged for full year.
Z** = Returns with interest rate = MVP; interest charged for time capital used.
Z*** = Returns with interest rate = .06 and .09; interest charged for time capital used.

was also determined (see Table XV). As brush control was not profitable at capital rates above 14 - 11 percent, the optima are the same for all higher rates for Resource Situations I and VI. ACP cost sharing limits acreage which could profitably be sprayed at 14 - 11 percent to 171 acres, but when the capital rate is 9 - 6 percent, spraying without ACP cost sharing is profitable for all available brushland. At this rate, the number of cows (Process P_2) in the optimum combination is greater than for higher rates, and the acreage of alfalfa required to produce the hay for these cows also increases over that in the optimum for Situation I. This increase in alfalfa acreage reduces the acreage of cropland available for small grain grazing and therefore the number of small grain grazing steers in the optimum. Total capital requirements for the optimum at the 9 - 6 percent level is approximately $297,000 or $30,000 above that required for the optimum of the corresponding rate of Situation I; returns to owned factors are $1,084 greater than for Resource Situati on I.

Optimum Enterprise Combinations with Given Resource and Matrix Modifications

Land Buy Alternative Considered. An alternative to improving existing grassland is that of purchasing additional grassland. Optimum enterprise combinations and the profitability of land purchase were determined under the assumption that the quantity of range land available for purchase was limited to (1) 640 and (2) 1,280 acres, given Resource Situation I (see Tables XVI and XVII). Land buying was found to be unprofitable when the capital rate was as high or higher than the 14 - 11 percent level, and the optimum livestock program is the same as for

TABLE XV

OPTIMUM ENTERPRISE COMBINATIONS, RESOURCE SITUATION VI, WITH SELECTED MARGINAL RETURNS TO CAPITAL

		Required Marginal Returns to Capital ($)						
Operating Capital		.49	.39	.29	.24	.19	.14	.09
Long-Term Capital		.46	.36	.26	.21	.16	.11	.06
Activity	Unit							
Cow-Calf (P_2)	Each	0	651	651	686	688	561	619
Cow-Calf (P_5)	Each	0	0	0	0	0	132	0
Steer (P_{10})	Each	0	0	0	0	0	0	835
Steer (P_{11})	Each	0	0	0	74	74	102	89
Reseed Native (P_{14})	Acre	0	0	0	300	300	300	137
Reseed Native (P_{15})	Acre	0	0	0	100	90	85	0
Spray Brush (P_{18})	Acre	0	0	0	0	0	171	171
Spray Brush (P_{19})	Acre	0	0	0	0	0	0	1,989
Bermuda (P_{24})	Acre	0	0	0	0	0	0	163
Bermuda (P_{26})	Acre	0	0	0	0	10	15	100
Native Meadow (P_{32})	Acre	0	0	0	27	0	0	320
Alfalfa-Brome (P_{33})	Acre	0	128	128	135	135	110	122
Dec.-Feb. Labor (P_{34})	Hour	0	511	511	620	624	635	1,501
Mar.-May Labor (P_{35})	Hour	0	0	0	0	0	0	554
June-Aug. Labor (P_{36})	Hour	0	22	22	182	164	37	3,307
Sept.-Nov. Labor (P_{37})	Hour	0	503	503	802	805	665	1,179
L. T. Capital (P_{40})	$	0	127,942	127,942	137,684	138,186	139,825	156,648
Opr. Capital (P_{41})	$	0	8,227	8,227	19,222	19,229	23,849	139,997
Z	$	0	5,811	19,428	27,086	35,657	42,755	53,652
Z*	$	0	46,663	46,663	50,622	51,405	50,940	53,652
Z**	$	0	7,467	21,084	29,011	37,539	44,003	55,195
Z***	$	0	47,045	47,045	51,344	52,250	51,742	55,195

Z (Quantity maximized) = Returns to owned factors with interest rate = MVP; interest charged for full year.
Z* = Returns with interest rate = .06 and .09; interest charged for full year.
Z** = Returns with interest rate = MVP; interest charged for time capital used.
Z*** = Returns with interest rate = .06 and .09; interest charged for time capital used.

TABLE XVI

OPTIMUM ENTERPRISE COMBINATIONS, RESOURCE SITUATION I, WITH LAND-BUY ALTERNATIVE LIMITED TO 640 ACRES, WITH SELECTED MARGINAL RETURNS TO CAPITAL

		Required Marginal Returns to Capital ($)						
Operating Capital		.49	.39	.29	.24	.19	.14	.09
Long-Term Capital		.46	.36	.26	.21	.16	.11	.06
Activity	Unit							
Cow-Calf (P_2)	Each	0	651	651	686	688	561	603
Cow-Calf (P_5)	Each	0	0	0	0	0	132	0
Steer (P_{10})	Each	0	0	0	0	0	0	834
Steer (P_{11})	Each	0	0	0	74	74	102	92
Reseed Native (P_{14})	Acre	0	0	0	300	300	300	137
Reseed Native (P_{15})	Acre	0	0	0	100	90	85	0
Spray Brush (P_{18})	Acre	0	0	0	0	0	171	171
Spray Brush (P_{19})	Acre	0	0	0	0	0	0	909
Bermuda (P_{24})	Acre	0	0	0	0	0	0	163
Bermuda (P_{26})	Acre	0	0	0	0	10	15	100
Native Meadow (P_{32})	Acre	0	0	0	27	0	0	320
Alfalfa-Brome (P_{33})	Acre	0	128	128	135	135	110	119
Dec.-Feb. Labor (P_{34})	Hour	0	511	511	620	624	635	1,465
Mar.-May Labor (P_{35})	Hour	0	0	0	0	0	0	534
June-Aug. Labor (P_{36})	Hour	0	22	22	182	164	37	3,277
Sept.-Nov. Labor (P_{37})	Hour	0	503	503	802	805	665	1,151
L. T. Capital (P_{40})	$	0	127,942	127,942	137,696	138,186	139,825	189,587
Opr. Capital (P_{41})	$	0	8,227	8,227	19,222	19,289	23,849	140,219
Buy Range Land (P_{43})	Acre	0	0	0	0	0	0	640
Z	$	0	5,811	19,428	27,086	35,657	42,755	52,588
Z*	$	0	46,663	46,663	50,622	51,405	50,940	52,588
Z**	$	0	7,467	21,084	29,011	37,539	44,003	54,196
Z***	$	0	47,045	47,045	51,344	52,250	51,742	54,196

Z (Quantity maximized) = Returns to owned factors with interest rate = MVP; interest charged for full year.
Z* = Returns with interest rate = .06 and .09; interest charged for full year.
Z** = Returns with interest rate = MVP; interest charged for time capital used.
Z*** = Returns with interest rate = .06 and .09; interest charged for time capital used.

TABLE XVII

OPTIMUM ENTERPRISE COMBINATIONS, RESOURCE SITUATION I, WITH LAND-BUY ALTERNATIVE LIMITED TO 1,280 ACRES, WITH SELECTED MARGINAL RETURNS TO CAPITAL

		Required Marginal Returns to Capital ($)						
Operating Capital		.49	.39	.29	.24	.19	.14	.09
Long-Term Capital		.46	.36	.26	.21	.16	.11	.06
Activity	Unit							
Cow-Calf (P_2)	Each	0	651	651	686	688	561	768
Cow-Calf (P_5)	Each	0	0	0	0	0	132	0
Steer (P_{10})	Each	0	0	0	0	0	0	529
Steer (P_{11})	Each	0	0	0	74	74	102	45
Reseed Native (P_{14})	Acre	0	0	0	300	300	300	300
Reseed Native (P_{15})	Acre	0	0	0	100	90	85	0
Spray Brush (P_{18})	Acre	0	0	0	0	0	171	171
Spray Brush (P_{19})	Acre	0	0	0	0	0	0	909
Bermuda (P_{26})	Acre	0	0	0	0	10	15	100
Native Meadow (P_{32})	Acre	0	0	0	27	0	0	320
Alfalfa-Brome (P_{33})	Acre	0	128	128	135	135	110	151
Dec.-Feb. Labor (P_{34})	Hour	0	511	511	620	624	635	1,410
Mar.-May Labor (P_{35})	Hour	0	0	0	0	0	0	422
June-Aug. Labor (P_{36})	Hour	0	22	22	182	164	37	2,340
Sept.-Nov. Labor (P_{37})	Hour	0	503	503	802	805	665	1,208
L. T. Capital (P_{40})	$	0	127,942	127,942	137,696	138,186	139,825	271,293
Opr. Capital (P_{41})	$	0	8,227	8,227	19,222	19,289	23,849	92,529
Buy Range Land (P_{43})	Acre	0	0	0	0	0	0	1,280
Z	$	0	5,811	19,428	27,086	35,657	42,755	54,328
Z*	$	0	46,663	46,663	50,622	51,405	50,940	54,328
Z**	$	0	7,467	21,084	29,011	37,539	44,003	55,568
Z***	$	0	47,045	47,045	51,344	52,250	51,742	55,568

Z (Quantity maximized) = Returns to owned factors with interest rate = MVP; interest charged for full year.
Z* = Returns with interest rate = .06 and .09; interest charged for full year.
Z** = Returns with interest rate = MVP; interest charged for time capital used.
Z*** = Returns with interest rate = .06 and .09; interest charged for time capital used.

Resource Situation I without the land buying alternative. With the cost of capital at 9 - 6 percent, all available land can be profitably purchased.

When land available for purchase is limited to 640 acres, the number of cows in the optimum plan is greater than the number in the optimum plan for Resource Situation I, and the number of steers remains virtually unchanged (see Table X and XVI). The greatest change in the steer program is a reduction of the number of small grain grazed steers due to the fact that some of the cropland used in the optimum for Resource Situation I for the production of small grains is used for alfalfa production to meet the needs of the increased number of cows (Process P_2). Although capital requirements for the optimum when the land buy alternative is included are $63,000 greater than without the land buy alternative, returns to owned factors are increased by only $20.

When range land which can be purchased is increased to two sections (1,280 acres), the number of cows in the optimum plan at the capital rate of 9 - 6 percent is greater than the number at higher rates (Table XVII). However, as steers which are absent at the higher capital rates are found in the optimum enterprise combination, the effect of the lower capital rate on the relative scarcity of land and capital is the same as for Resource Situation I, but to a lesser degree.

Capital requirements for the optimum plan are $364,000, an increase of $97,000 over that required for the optimum of Resource Situation I and $34,000 over that required for the optimum plan when the land buy activity was restricted to 640 acres. Returns to owned factors are $1,760 above those for Resource Situation I and $1,740 greater than returns when land buy was restricted to 640 acres.

Alfalfa Producing Alternative Omitted. As many ranches in the area have no cropland suitable for the production of alfalfa, optimum programs were computed for each capital rate with the alfalfa production alternative (Process P_{33}) omitted. The cow-calf process, P_2, which utilizes alfalfa hay was replaced in the optimum plan by the cow-calf process, P_5, at the 39 - 36 percent capital rate (Table XVIII). Capital required for the optimum plan at the 39 - 36 percent rate is $132,000 as compared to a requirement of $136,000 when alfalfa production was included as an alternative and at this level returns to owned factors with capital rate effects removed (Z*) are $4,287 lower than for the optimum when alfalfa production is included as an alternative. Process P_{11}, the small grain grazing steer enterprise, is included in the optimum at the 29 - 26 percent rate. As alfalfa, which in other programs uses a part of the cropland, is not considered, cropland is diverted to the next most profitable alternative, the production of small grain grazing. The maximum number of steers for which small grain grazing is available when all cropland is used in this manner is 227. This maximum number appears in the optimum program for the 29 - 26 percent capital rate level and for all lower levels. The number of cows in the program for capital rates 29 - 26, 24 - 21, and 19 - 16 percent are determined by the amount of grazing available after requirements of the steers are met. The amount of grazing and therefore the number of cows is greater at the 24 - 21 percent rate than at the 29 - 26 percent rate since reseeding native grasses is profitable at the lower rate.

At the 9 - 6 percent capital rate, the optimum enterprise combination is similar to that for Resource Situation I with alfalfa considered, in

TABLE XVIII

OPTIMUM ENTERPRISE COMBINATIONS, RESOURCE SITUATION I, ALFALFA PRODUCTION (PROCESS P_{33}) OMITTED AS AN ALTERNATIVE, WITH SELECTED MARGINAL RETURNS TO CAPITAL

		Required Marginal Returns to Capital ($)						
Operating Capital		.49	.39	.29	.24	.19	.14	.09
Long-Term Capital		.46	.36	.26	.21	.16	.11	.06
Activity	Unit							
Cow-Calf (P_5)	Each	0	623	609	647	647	627	529
Steer (P_{10})	Each	0	0	0	0	0	168	773
Steer (P_{11})	Each	0	0	227	227	227	227	227
Reseed Native (P_{14})	Acre	0	0	0	300	300	300	137
Reseed Native (P_{15})	Acre	0	0	0	100	100	0	0
Spray Brush (P_{18})	Acre	0	0	0	0	0	171	171
Spray Brush (P_{19})	Acre	0	0	0	0	0	0	909
Bermuda (P_{24})	Acre	0	0	0	0	0	0	163
Bermuda (P_{26})	Acre	0	0	0	0	0	100	100
Native Meadow (P_{32})	Acre	0	21	104	105	105	13	320
Dec.-Feb. Labor (P_{34})	Hour	0	391	452	534	534	697	1,231
Mar.-May Labor (P_{35})	Hour	0	300	391	476	476	614	952
June-Aug. Labor (P_{36})	Hour	0	0	0	0	0	0	2,407
Sept.-Nov. Labor (P_{37})	Hour	0	0	0	5	5	92	392
L. T. Capital (P_{40})	$	0	119,616	116,928	127,084	127,084	125,614	121,436
Opr. Capital (P_{41})	$	0	11,781	42,073	42,980	42,980	66,268	151,425
Z	$	0	2,956	16,320	24,831	33,335	41,983	52,522
Z*	$	0	42,376	48,029	50,341	50,341	51,578	52,522
Z**	$	0	5,216	20,344	28,258	36,048	44,191	54,540
Z***	$	0	42,897	49,368	51,626	51,626	52,997	54,540

Z (Quantity maximized) = Returns to owned factors with interest rate = MVP; interest charged for full year.
Z* = Returns with interest rate = .06 and .09; interest charged for full year.
Z** = Returns with interest rate = MVP; interest charged for time capital used.
Z*** = Returns with interest rate = .06 and .09; interest charged for time capital used.

that the number of cows is nearly the same but of a different system. The number of small grain grazing steers is greater when alfalfa is not considered but fewer other steers are included in the optimum.

Total capital required for the optimum enterprise combination for the 9 - 6 percent rate is \$273,000 or \$6,000 more than for the optimum for Situation I with alfalfa included as an alternative. Returns to owned factors at this level are only \$46 less than returns with alfalfa included as an alternative.

Process P_{10} Excluded from Consideration. Optimum enterprise combinations were also determined for Resource Situation I at each capital rate with Process P_{10}, an alternative rarely found in the area excluded from consideration (Table XIX). Process P_{10} is included in the optimum for Situation I at the 9 - 6 percent capital rate only, so no changes occur in the optima of higher levels. When P_{10} is excluded as an alternative, a cow-calf system, P_5, is included in the optimum at the 9 - 6 percent capital rate. This cow-calf system is included in the optimum for the 14 - 11 percent level but not for the 9 - 6 percent when P_{10} is included as an alternative. When P_{10} is excluded, the optimum number of cows of Process P_2 also is lower than the optimum number when P_{10} is included.

Bermuda grass acreage included in the optimum at the 9 - 6 percent rate is also much lower and native grass acreage is higher when P_{10} is excluded. Thus, land is used less intensively when the cow-calf alternative, P_5, replaces the steer alternative, P_{10}, in the optimum enterprise combination. Capital required for the optimum at the 9 - 6 percent rate is \$192,000; this is \$75,000 less than that required by the

TABLE XIX

OPTIMUM ENTERPRISE COMBINATIONS, RESOURCE SITUATION I, PROCESS P_{10} OMITTED AS AN ALTERNATIVE, WITH SELECTED MARGINAL RETURNS TO CAPITAL

		Required Marginal Returns to Capital ($)						
Operating Capital		.49	.39	.29	.24	.19	.14	.09
Long-Term Capital		.46	.36	.26	.21	.16	.11	.06
Activity	Unit							
Cow-Calf (P_2)	Each	0	651	651	686	688	561	490
Cow-Calf (P_5)	Each	0	0	0	0	0	132	261
Steer (P_{11})	Each	0	0	0	74	74	102	117
Reseed Native (P_{14})	Acre	0	0	0	300	300	300	300
Reseed Native (P_{15})	Acre	0	0	0	100	90	85	81
Spray Brush (P_{18})	Acre	0	0	0	0	0	171	171
Spray Brush (P_{19})	Acre	0	0	0	0	0	0	909
Bermuda (P_{26})	Acre	0	0	0	0	10	15	19
Native Meadow (P_{32})	Acre	0	0	0	27	0	0	0
Alfalfa-Brome (P_{33})	Acre	0	128	128	135	135	110	96
Dec.-Feb. Labor (P_{34})	Hour	0	511	511	620	624	635	760
Mar.-May Labor (P_{35})	Hour	0	0	0	0	0	0	208
June-Aug. Labor (P_{36})	Hour	0	22	22	182	164	37	0
Sept.-Nov. Labor (P_{37})	Hour	0	503	503	802	805	665	618
L. T. Capital (P_{40})	$	0	127,942	127,942	137,684	138,186	139,825	163,411
Opr. Capital (P_{41})	$	0	8,227	8,227	19,222	19,289	23,849	28,557
Z	$	0	5,811	19,428	27,086	35,657	42,755	51,775
Z*	$	0	46,663	46,663	50,622	51,405	50,940	51,775
Z**	$	0	7,467	21,084	29,011	37,539	44,003	52,742
Z***	$	0	47,045	47,045	51,344	52,250	51,742	52,742

Z (Quantity maximized) = Returns to owned factors with interest rate = MVP; interest charged for full year.
Z* = Returns with interest rate = .06 and .09; interest charged for full year.
Z** = Returns with interest rate = MVP; interest charged for time capital used.
Z*** = Returns with interest rate = .06 and .09; interest charged for time capital used.

optimum for Situation I with P_{10} included; however, returns to owned factors are reduced by only $793.

Optimum Enterprise Combinations with All Steer Alternatives Omitted. Optimum enterprise combinations for each capital rate and for Resource Situation I with all steer alternatives omitted are presented in Table XX. As no steer enterprise was included in the optimum combination for Situation I at a capital rate of 29 - 26 percent and above, the optimum at these levels remained unchanged. The cow-calf process, P_2, is the most profitable at all capital cost levels, the number at each level being restricted by the amount of grazing available.

Reseeding land to native grasses is profitable at the 24 - 21 percent level for all idle land and also for all cropland not needed for the production of alfalfa required by the cows. Brush control with ACP cost sharing is profitable at a higher capital rate than when steer alternatives were considered. This occurs because the restricting factor at this level is grazing alone when only cow-calf alternatives are considered, but when steer alternatives are also included, cropland as well as grazing is limited and an increase in cow numbers of Process P_2 would necessarily result in a decrease in cropland acreage available for the production of small grain grazing. When steer alternatives are omitted, bermuda grass activities do not appear in the optimum combination of enterprises even at the lowest capital rate considered.

Capital requirements for the optimum program at the 9 - 6 percent capital rate are $180,000. This is $87,000 less than the requirement for the optimum when steer alternatives are considered. Returns to

TABLE XX

OPTIMUM ENTERPRISE COMBINATIONS, RESOURCE SITUATION I, STEER PROCESSES NOT CONSIDERED, WITH SELECTED MARGINAL RETURNS FOR CAPITAL

		Required Marginal Returns to Capital ($)						
Operating Capital		.49	.39	.29	.24	.19	.14	.09
Long-Term Capital		.46	.36	.26	.21	.16	.11	.06
Activity	Unit							
Cow-Calf (P_2)	Each	0	651	651	698	710	710	772
Reseed Native (P_{14})	Acre	0	0	0	300	300	300	300
Reseed Native (P_{15})	Acre	0	0	0	163	160	160	148
Spray Brush (P_{18})	Acre	0	0	0	0	171	171	171
Spray Brush (P_{19})	Acre	0	0	0	0	0	0	909
Alfalfa-Brome (P_{33})	Acre	0	128	128	137	140	140	152
Dec.-Feb. Labor (P_{34})	Hour	0	511	511	617	644	644	784
June-Aug. Labor (P_{36})	Hour	0	22	22	110	132	132	249
Sept.-Nov. Labor (P_{37})	Hour	0	503	503	614	642	642	789
L. T. Capital (P_{40})	$	0	127,942	127,942	140,484	144,033	144,033	168,854
Opr. Capital (P_{41})	$	0	8,227	8,227	9,117	9,506	9,506	11,500
Transfer Cropland (P_{42})	Acre	0	0	0	63	60	60	48
Z	$	0	5,811	19,428	26,737	34,233	41,909	50,690
Z*	$	0	46,663	46,663	49,177	49,586	49,586	50,690
Z**	$	0	7,467	21,084	27,866	35,166	42,597	51,228
Z***	$	0	47,045	47,045	49,601	50,028	50,028	51,228

Z (Quantity maximized) = Returns to owned factors with interest rate = MVP; interest charged for full year.
Z* = Returns with interest rate = .06 and .09; interest charged for full year.
Z** = Returns with interest rate = MVP; interest charged for time capital used.
Z*** = Returns with interest rate = .06 and .09; interest charged for time capital used.

owned factors at this rate are \$1,878 greater when steers are considered than when they are omitted from the optimum plan.

Optima with Only P_1, P_5, and P_9 Considered as Livestock Alternatives. Optima were determined for each capital rate with only Processes P_1, the fall-calving cow-calf alternative most commonly found in the area, P_5, the most common spring calving cow-calf system, and P_9, the most common buy-sell alternative, considered. These optima are presented in Table XXI. At all capital rates Process P_5, the spring calving cow-calf system alone makes up the optimum livestock system.

Reseeding cropland to native grass is included in the optimum at the 24 - 21 percent capital rate and at all lower rates. Spraying brushland with ACP cost sharing is included in the optimum of the 14 - 11 and 9 - 6 percent capital rates and spraying brushland without ACP is included at the 9 - 6 percent rate. Nine acres of bermuda grass are included in the optima of the two lowest rates.

Capital requirements range from \$131,000 at the 39 - 36 percent rate to \$180,000 at the 9 - 6 percent rate and returns to owned factors range from \$42,376 at the former rate to \$46,733 at the latter rate with 9 percent charged for short-term and 6 percent for long-term capital. Thus, capital requirements at the 9 - 6 percent capital rate are \$87,000 less than when all 13 livestock alternatives which were budgeted are considered and net returns to owned factors at the same rate are \$5,835 lower when only the three commonly found alternatives are considered.

Optima with Only P_1 and P_9 Considered as Livestock Alternatives. If Processes P_1 and P_9 are the only alternatives considered, returns fail to equal the 39 - 36 percent capital rate, thus, at this level all resources remain idle, Table XXII. At all lower rates, the optimum livestock system

TABLE XXI

OPTIMUM ENTERPRISE COMBINATIONS, RESOURCE SITUATION I, WITH P_1, P_5 AND P_9 BEING THE ONLY LIVESTOCK PROCESSES CONSIDERED, WITH SELECTED MARGINAL RETURNS TO CAPITAL

		Required Marginal Returns to Capital ($)						
Operating Capital		.49	.39	.29	.24	.19	.14	.09
Long-Term Capital		.46	.36	.26	.21	.16	.11	.06
Activity	Unit							
Cow-Calf (P_5)	Each	0	623	623	683	683	695	757
Reseed Native (P_{14})	Acre	0	0	0	300	300	300	300
Reseed Native (P_{15})	Acre	0	0	0	300	300	291	291
Spray Brush (P_{18})	Acre	0	0	0	0	0	171	171
Spray Brush (P_{19})	Acre	0	0	0	0	0	0	909
Bermuda (P_{26})	Acre	0	0	0	0	0	9	9
Native Meadow (P_{32})	Acre	0	21	21	23	23	0	0
Dec.-Feb. Labor (P_{34})	Hour	0	391	391	522	522	550	682
Mar.-May Labor (P_{35})	Hour	0	300	300	437	437	471	610
L. T. Capital (P_{40})	$	0	119,616	119,616	135,426	135,426	139,014	163,662
Opr. Capital (P_{41})	$	0	11,781	11,781	13,207	13,207	13,694	15,987
Transfer Cropland (P_{42})	Acre	0	0	0	200	200	200	200
Z	$	0	2,956	16,097	23,154	30,585	38,141	46,733
Z*	$	0	42,376	42,376	45,449	45,449	45,776	46,733
Z**	$	0	5,216	17,776	24,690	31,801	38,171	48,127
Z***	$	0	42,897	42,897	46,025	46,025	46,439	48,127

Z (Quantity maximized) = Returns to owned factors with interest rate = MVP; interest charged for full year.
Z* = Returns with interest rate = .06 and .09; interest charged for full year.
Z** = Returns with interest rate = MVP; interest charged for time capital used.
Z*** = Returns with interest rate = .06 and .09; interest charged for time capital used.

TABLE XXII

OPTIMUM ENTERPRISE COMBINATIONS, RESOURCE SITUATION I, WITH P_1 AND P_9 BEING THE ONLY LIVESTOCK PROCESSES CONSIDERED, WITH SELECTED MARGINAL RETURNS TO CAPITAL

		Required Marginal Returns to Capital ($)						
Operating Capital		.49	.39	.29	.24	.19	.14	.09
Long-Term Capital		.46	.36	.26	.21	.16	.11	.06
Activity	Unit							
Cow-Calf (P_1)	Each	0	0	594	626	652	662	722
Reseed Native (P_{14})	Acre	0	0	0	0	300	300	300
Reseed Native (P_{15})	Acre	0	0	0	300	300	300	291
Spray Brush (P_{18})	Acre	0	0	0	0	0	171	171
Spray Brush (P_{19})	Acre	0	0	0	0	0	0	909
Bermuda (P_{26})	Acre	0	0	0	0	0	0	9
Native Meadow (P_{32})	Acre	0	0	20	21	22	22	0
Dec.-Feb. Labor (P_{34})	Hour	0	0	3	55	96	114	210
Sept.-Nov. Labor (P_{37})	Hour	0	0	369	444	505	531	671
L. T. Capital (P_{40})	$	0	0	114,048	122,337	129,474	132,591	156,943
Opr. Capital (P_{41})	$	0	0	13,637	14,523	15,251	15,688	18,229
Transfer Cropland (P_{42})	Acre	0	0	0	200	200	200	200
Z	$	0	0	11,051	17,520	24,691	31,948	39,682
Z*	$	0	0	36,588	38,049	39,164	39,362	39,682
Z**	$	0	0	20,084	19,307	26,174	33,073	40,531
Z***	$	0	0	37,218	39,166	39,944	40,085	40,531

Z (Quantity maximized) = Returns to owned factors with interest rate = MVP; interest charged for full year.

Z* = Returns with interest rate = .06 and .09; interest charged for full year.

Z** = Returns with interest rate = MVP; interest charged for time capital used.

Z*** = Returns with interest rate = .06 and .09; interest charged for time capital used.

is comprised of cows alone, Process P_1. Thus by referring to Table XXI and Table XXII, the spring and fall calving cow-calf alternatives most commonly found in the area can be compared.

When the spring-calving cow-calf system comprises the optimum livestock system, the ranch unit can be profitably operated at the 39 - 36 percent capital rate, but if the fall-calving cow-calf system is used, the unit can not be profitably operated at rates above the 29 - 26 percent rate. Capital required by the optima is slightly less when a fall-calving system is used, being $3,000 less at the 29 - 26 percent rate and slightly more than $4,000 less at the 9 - 6 percent rate. Returns to owned factors vary from $6,000 more for the spring-cow calf system at the 29 - 26 percent capital rate to more than $7,000 more at the 9 - 6 percent rate.

Reseeding native grasses on bottomland is profitable at the same capital rate, 24 - 21 percent, with fall and spring calving cow-calf systems; but returns for reseeding native on upland are lower when the spring calving system is omitted. Brush control is included in the optima at the same rates for both systems, but bermuda establishment is profitable only at the 9 - 6 percent rate when a fall-calving system is used.

<u>Optima with P_9 Alone Considered as a Livestock Alternative</u>. If the steer alternative, Process P_9, most commonly found in the area is the only livestock alternative considered, returns on capital fail to equal the 29 - 26 percent rate;thus at this rate all resources remain idle, Table XXIII. Capital required by the optimum at the 24 - 21 percent and lower rates exceeds that required by either of the two cow-calf alternatives, P_1 or P_5, at the corresponding rates and returns to owned factors are much lower at each rate.

TABLE XXIII

OPTIMUM ENTERPRISE COMBINATIONS, RESOURCE SITUATION I, WITH P_9 BEING THE ONLY LIVESTOCK PROCESS CONSIDERED, WITH SELECTED MARGINAL RETURNS TO CAPITAL

		Required Marginal Returns to Capital ($)						
Operating Capital		.49	.39	.29	.24	.19	.14	.09
Long-Term Capital		.46	.36	.26	.21	.16	.11	.06
Activity	Unit							
Steer (P_9)	Each	0	0	0	1,280	1,386	1,520	1,559
Reseed Native (P_{14})	Acre	0	0	0	0	0	300	300
Reseed Native (P_{15})	Acre	0	0	0	0	0	300	269
Spray Brush (P_{18})	Acre	0	0	0	0	0	0	171
Bermuda (P_{26})	Acre	0	0	0	0	0	0	31
Native Meadow (P_{32})	Acre	0	0	0	71	77	84	0
Dec.-Feb. Labor (P_{34})	Hour	0	0	0	0	80	180	209
L. T. Capital (P_{40})	$	0	0	0	0	0	4,290	5,851
Opr. Capital (P_{41})	$	0	0	0	169,253	183,350	201,212	206,791
Transfer Cropland (P_{42})	Acre	0	0	0	0	0	200	200
Z	$	0	0	0	1,428	10,614	20,519	31,018
Z*	$	0	0	0	26,816	28,949	30,794	31,018
Z**	$	0	0	0	2,962	11,933	21,582	31,739
Z***	$	0	0	0	28,350	29,574	31,477	31,739

Z (Quantity maximized) = Returns to owned factors with interest rate = MVP; interest charged for full year.
Z* = Returns with interest rate = .06 and .09; interest charged for full year.
Z** = Returns with interest rate = MVP; interest charged for time capital used.
Z*** = Returns with interest rate = .06 and .09; interest charged for time capital used.

Reseeding native grasses is profitable at the 14 - 11 and 9 - 6 percent capital rates, spraying brush with ACP assistance at the 9 - 6 percent rate and establishment of bermuda at the 9 - 6 percent rate.

Effect of Beef Price Variation on the Optimum

Beef cattle prices as used in the livestock process budgets are estimated long-term projected prices. Prices in any given year and even long-run average prices may vary considerably from these projected prices. In this section, the effect of a realized price different from the long-term projected price on the optimum combination of resources is explored. Optimum plans are presented for Resource Situation I when (1) the realized price is 25 percent below the long-term projected price, (2) the realized price is 25 percent above the long-term projected price, and (3) when the realized price is 50 percent above the long-term projected price. Returns to selected factors (the c_j values) per specified unit of production for each of the livestock enterprises under each of the three price assumptions are presented in Table XXIV. All other prices are assumed to remain unchanged from the prices used in the process budgets.

Price 25 Percent Below Projected Level

The optimum combination of enterprises for each capital rate, given Resource Situation I, with beef prices 25 percent below the projected level is given in Table XXV.

At the 39 - 36 percent capital rate, the optimum consists of 439 cows and 86 acres of alfalfa hay. Thus, the optimum number of cows is fewer than when price is at the projected level (see Table X). At the 29 - 26 percent and the 24 - 21 percent rate, the optimum combinations

TABLE XXIV

RETURNS[1] PER SPECIFIED UNIT OF PRODUCTION FROM LIVESTOCK ALTERNATIVES WITH PRICE 25 PERCENT BELOW, 25 AND 50 PERCENT ABOVE PROJECTED AVERAGE

Process	Unit	25 Percent Below Average	25 Percent Above Average	50 Percent Above Average
P_1	Cow	51.43	100.51	125.05
P_2	Cow	65.40	114.48	139.02
P_3	Cow	57.30	107.22	132.18
P_4	Cow	46.39	94.93	119.20
P_5	Cow	57.46	107.54	132.58
P_6	Cow	39.14	94.86	122.72
P_7	Cow	48.86	101.98	128.54
P_8	Steer	.03	10.61	15.91
P_9	Steer	19.95	46.26	59.41
P_{10}	Steer	28.90	59.19	74.33
P_{11}	Steer	27.83	60.19	76.37
P_{12}	Steer	15.50	30.55	38.07
P_{13}	Steer	15.48	33.95	43.19

[1] Returns to owned factors including land, family and operator labor and management.

TABLE XXV

OPTIMUM ENTERPRISE COMBINATIONS, INITIAL RESOURCE RESTRICTIONS, WITH SELECTED MARGINAL RETURNS TO CAPITAL, CATTLE PRICES 25 PERCENT BELOW PROJECTED AVERAGE

		Required Marginal Returns to Capital ($)						
Operating Capital		.49	.39	.29	.24	.19	.14	.09
Long-Term Capital		.46	.36	.26	.21	.16	.11	.06
Activity	Unit							
Cow-Calf (P_2)	Each	0	439	651	651	698	688	700
Steer (P_{11})	Each	0	0	0	0	0	74	71
Reseed Native (P_{14})	Acre	0	0	0	0	300	300	300
Reseed Native (P_{15})	Acre	0	0	0	0	163	90	91
Spray Brush (P_{18})	Acre	0	0	0	0	0	0	171
Bermuda (P_{26})	Acre	0	0	0	0	0	10	9
Alfalfa-Brome (P_{33})	Acre	0	86	128	128	137	135	138
Dec.-Feb. Labor (P_{34})	Hour	0	32	511	511	618	624	650
June-Aug. Labor (P_{36})	Hour	0	0	22	22	110	164	184
Sept.-Nov. Labor (P_{37})	Hour	0	0	503	503	615	805	826
L. T. Capital (P_{40})	$	0	65,198	96,694	96,694	106,980	105,161	108,143
Opr. Capital (P_{41})	$	0	4,876	8,228	8,228	9,117	16,490	16,565
Land Transfer (P_{42})	Acre	0	0	0	0	63	0	0
Z	$	0	1,710	11,589	16,835	22,461	28,488	34,693
Z*	$	0	22,732	32,573	32,573	34,071	34,571	34,693
Z**	$	0	2,658	12,820	17,854	23,368	29,469	35,333
Z***	$	0	22,951	32,955	32,955	34,501	35,201	35,333

Z (Quantity maximized) = Returns to owned factors with interest rate = MVP; interest charged for full year.
Z* = Returns with interest rate = .06 and .09; interest charged for full year.
Z** = Returns with interest rate = MVP; interest charged for time capital used.
Z*** = Returns with interest rate = .06 and .09; interest charged for time capital used.

are the same when the cattle prices are 25 percent below the projected level as for the 39 - 36 and 29 - 26 percent levels when prices are at the projected average. At the two lowest capital rates, 14 - 11 percent and 9 - 6 percent, the optima include steers in addition to cows, but fewer in number than for the corresponding levels when price is at the projected level.

A reduction in average price of cattle to 25 percent below the projected average has the effect of reducing the amount of capital which can be profitably used at each capital rate. Thus, the number of cows in the optimum at the higher capital levels is lower than for the corresponding levels with projected average prices, and at lower levels fewer steers are included in the optimum.

As all forage produced is marketed through livestock, its value is determined by the price of the livestock. Thus, a decrease in the price of livestock decreases the profitability of range improvement practices. Reseeding native grass, which is profitable at 24 - 21 percent capital rate given projected prices, is not profitable at levels higher than the 19 - 16 percent rate when prices are 25 percent below this level. Likewise, brush control with ACP, profitable at the 14 - 11 percent level with projected prices, is profitable at only the 9 - 6 percent level when price is 25 percent lower. Brush control without ACP assistance and bermuda grass which are profitable at the 9 - 6 percent level, with projected prices are unprofitable with price 25 percent lower.

When livestock prices are lower, the amount of capital used is also reduced. This is due in part to the reduction in the amount required for the purchase of livestock at lower prices and in part to the fact that returns on capital are reduced, i.e., a shifting to the left of the MVP curve, thus reducing the amount of capital that can be profitably used at each capital rate.

In general, it can be said that a reduction in price will: (1) make cow-calf systems more profitable relative to steers at low capital rates, (2) tend to reduce the optimum number of cows but leave the system unchanged at higher rates, and (3) reduce the profitability of range improvement activities. Further, it will reduce both, the amount of capital that can be profitably used at any given capital rate and resulting returns to owned factors.

Price 25 Percent Above Projected Level

The optimum combination of enterprises for each capital rate, given Resource Situation I with beef prices 25 percent above the projected level are presented in Table XXVI. At the 39 - 36 percent capital rate, the optimum is the same as for the 39 - 36 and 29 - 26 percent rates with price at the projected level. However, more capital is required because of the increased value of livestock. At the 29 - 26 percent capital rate, the optimum livestock system consists of both cows and steers, and at lower rates, steers increase relative to cows and at the 9 - 6 percent rate, the livestock system is comprised of steers alone.

Reseeding native grass is included in the optimum at the 29 - 26 percent capital rate, brush control with ACP at the 19 - 16 percent rate, brush control without ACP at the 14 - 11 rate and bermuda grass establishment with ACP is included in limited acreage, at the 24 - 21 percent rate

TABLE XXVI

OPTIMUM ENTERPRISE COMBINATIONS, INITIAL RESOURCE RESTRICTIONS, WITH SELECTED MARGINAL RETURNS TO CAPITAL, CATTLE PRICES 25 PERCENT ABOVE PROJECTED AVERAGE

		Required Marginal Returns to Capital ($)						
Operating Capital		.49	.39	.29	.24	.19	.14	.09
Long-Term Capital		.46	.36	.26	.21	.16	.11	.06
Activity	Unit							
Cow-Calf (P_2)	Each	0	651	686	534	34	0	0
Cow-Calf (P_5)	Each	0	0	0	146	597	529	0
Steer (P_{10})	Each	0	0	0	0	160	773	3,136
Steer (P_{11})	Each	0	0	74	108	220	227	227
Reseed Native (P_{14})	Acre	0	0	300	300	300	137	0
Reseed Native (P_{15})	Acre	0	0	100	84	0	0	0
Spray Brush (P_{18})	Acre	0	0	0	0	171	171	171
Spray Brush (P_{19})	Acre	0	0	0	0	0	909	909
Bermuda (P_{24})	Acre	0	0	0	0	0	163	263
Bermuda (P_{25})	Acre	0	0	0	0	0	0	37
Bermuda (P_{26})	Acre	0	0	0	16	100	100	0
Bermuda (P_{27})	Acre	0	0	0	0	0	0	100
Native Meadow (P_{32})	Acre	0	0	27	0	0	320	320
Alfalfa-Brome (P_{33})	Acre	0	128	135	105	7	0	0
Dec.-Feb. Labor (P_{34})	Hour	0	511	620	607	697	1,231	2,988
Mar.-May Labor (P_{35})	Hour	0	0	0	0	582	952	1,680
June-Aug. Labor (P_{36})	Hour	0	22	182	0	0	2,407	4,024
Sept.-Nov. Labor (P_{37})	Hour	0	503	802	627	128	392	1,474
Buy Native Hay (P_{38})	Ton	0	0	0	0	0	0	2,073
L. T. Capital (P_{40})	$	0	159,190	170,612	168,668	156,831	146,828	24,078
Opr. Capital (P_{41})	$	0	8,228	20,586	26,438	72,878	177,471	584,343
Z	$	0	10,549	28,030	37,689	47,750	61,070	85,678
Z*	$	0	60,775	66,269	66,954	70,721	77,285	85,678
Z**	$	0	12,205	30,199	39,809	50,622	64,160	89,349
Z***	$	0	61,157	66,943	67,749	72,081	79,272	89,349

Z (Quantity maximized) = Returns to owned factors with interest rate = MVP; interest charged for full year.
Z* = Returns with interest rate = .06 and .09; interest charged for full year.
Z** = Returns with interest rate = MVP; interest charged for time capital used.
Z*** = Returns with interest rate = .06 and .09; interest charged for time capital used.

and in greater acreage at lower rates. All available cropland is sprigged to bermuda grass at the 9 - 6 percent rate, even though ACP funds are not available for all of it.

Thus, an increase in beef prices of 25 percent: (1) increases the profitability of steers relative to cows at all capital levels below the 39 - 36 percent rate, (2) raises the capital rate at which reseeding native grass and spraying brush can be profitably practiced, (3) increases the relative profitability of bermuda grass establishment at lower capital rates and (4) increases both the quantity of capital employed and the returns to owned factors at all capital rates.

Price 50 Percent Above Projected Level

The optimum combination of enterprises for each capital rate, given Resource Situation I, with beef prices 50 percent above the projected level are given in Table XXVII. At the 39 - 36 percent rate, the optimum is the same when prices are 50 percent above the projected level, 25 percent above the projected level and at the projected level. At lower capital rates, the optima are different for each of the three price levels. With prices 50 percent above the projected level, the optimum livestock system at the 29 - 26 percent capital rate is comprised of cows (Processes P_2 and P_5) and of steers (Process P_{11}). At this rate, reseeding native is included in the optimum. At the 24 - 21 percent rate, the optimum consists of a greater number of steers and fewer cows than at the 29 - 26 percent rate. At the 19 - 16 percent rate, brush control with ACP and sprigging bermuda with ACP are included in the optimum. At the 19 - 16 percent rate, the number of steers is greater than at the 24 - 21

TABLE XXVII

OPTIMUM ENTERPRISE COMBINATIONS, INITIAL RESOURCE RESTRICTIONS, WITH SELECTED MARGINAL RETURNS TO CAPITAL, CATTLE PRICES 50 PERCENT ABOVE PROJECTED AVERAGE

		Required Marginal Returns to Capital						
Operating Capital		.49	.39	.29	.24	.19	.14	.09
Long-Term Capital		.46	.36	.26	.21	.16	.11	.06
Activity	Unit							
Cow-Calf (P_2)	Each	0	651	498	0	0	0	0
Cow-Calf (P_5)	Each	0	0	177	627	529	0	0
Steer (P_{10})	Each	0	0	0	168	773	3,136	3,482
Steer (P_{11})	Each	0	0	116	227	227	227	227
Reseed Native (P_{14})	Acre	0	0	300	300	137	0	0
Reseed Native (P_{15})	Acre	0	0	100	0	0	0	0
Spray Brush (P_{18})	Acre	0	0	0	171	171	171	171
Spray Brush (P_{19})	Acre	0	0	0	0	909	909	909
Bermuda (P_{24})	Acre	0	0	0	0	163	163	0
Bermuda (P_{25})	Acre	0	0	0	0	0	137	0
Bermuda (P_{26})	Acre	0	0	0	100	100	100	100
Bermuda (P_{28})	Acre	0	0	0	0	0	0	163
Bermuda (P_{29})	Acre	0	0	0	0	0	0	137
Native Meadow (P_{32})	Acre	0	0	48	13	320	320	0
Alfalfa-Brome (P_{33})	Acre	0	128	98	0	0	0	0
Dec.-Feb. Labor (P_{34})	Hour	0	511	597	697	1,231	2,988	3,414
Mar.-May Labor (P_{35})	Hour	0	0	18	614	952	1,680	1,954
June-Aug. Labor (P_{36})	Hour	0	22	0	0	2,407	4,024	1,063
Sept.-Nov. Labor (P_{37})	Hour	0	503	584	92	392	1,473	1,828
Buy Native Hay (P_{38})	Ton	0	0	0	0	0	2,073	3,307
L. T. Capital (P_{40})	$	0	190,438	199,519	185,806	172,220	24,078	24,078
Opr. Capital (P_{41})	$	0	8,228	30,953	86,507	205,591	678,909	760,222
Z	$	0	15,275	37,089	49,132	64,072	93,171	129,504
Z*	$	0	74,875	83,183	89,979	101,853	128,320	129,504
Z**	$	0	16,931	39,965	53,227	68,569	99,110	133,662
Z***	$	0	75,257	84,076	91,514	103,983	132,138	133,662

Z (Quantity maximized) = Returns to owned factors with interest rate = MVP; interest charged for full year.
Z* = Returns with interest rate = .06 and .09; interest charged for full year.
Z** = Returns with interest rate = MVP; interest charged for time capital used.
Z*** = Returns with interest rate = .06 and .09; interest charged for time capital used.

percent rate and the number of cows is lower; at the 19 - 16 percent rate, all 1,080 acres of brushland is sprayed even though ACP funds are assumed to be available for only 171 acres. At the lower capital rates, steers alone are included in the optimum and all available brushland is sprayed and all available cropland is sprigged to Bermuda.

When beef prices are 50 percent above the projected level, the quantity of capital which can be profitably employed at each capital rate greatly exceeds the quantity which can be employed at the corresponding levels with projected prices, and resulting returns to owned factors are also greater.

Summary and Implications of Static Programming Results

The optimum combination of enterprises for the basic set of resource restrictions, Resource Situation I, consists of:

(1) Cow-calf processes alone when the capital rate exceeds the 24 - 21 percent rate but lower than the 49 - 46 percent rate.

(2) Cow-calf and steer processes at the lower capital rates with the relative importance of steers increasing as the capital rate is lowered.

(3) Native grass reseeding alternatives at the 24 - 21 percent capital rate and at all lower rates.

(4) Brush control activities with ACP cost sharing at the 14 - 11 percent rate and brush control activities both with and without ACP cost sharing at the 9 - 6 percent capital rate.

(5) A Bermuda grass establishment activity with ACP cost sharing on bottomland for hay and grazing at the 19 - 16 percent

rate and at lower rates, and on upland with ACP cost sharing at the 9 - 6 percent rate.

When the capital rate is at the 9 - 6 percent rate, the amount of capital required by the optimum is $267,000; this is $131,000 greater than when the rate is at the 39 - 36 percent level. Net returns at the 9 - 6 percent rate exceed those of the 39 - 36 percent rate by about $6,000. Thus, the net return to owned factors is increased less than 4.6 percent per dollar of the additional $131,000 capital[9] required by the optimum of the 9 - 6 percent rate.

Resource restrictions were altered to determine the effect on net returns and on the optimum at each capital level of:

(1) an increase in the acreage of native grass which could be mowed for hay (Resource Situation II);

(2) elimination of all cropland (Resource Situation III);

(3) an increase in the acreage of cropland (Resource Situation IV);

(4) excluding of brushland available for spraying (Resource Situation V);

(5) an increase in the acreage of brushland available for spraying (Resource Situation VI).

An increase in the acreage of native grass that can be harvested as hay results in an increase in the number of steers and the exclusion of cow-calf alternatives from the optimum at the lowest capital rate. The

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[9]A charge of nine percent for short-term and six percent for long-term capital has been deducted; thus, this is a return to land, operator and family labor, and management.

steer alternative, making up a large part of the optimum livestock system, Process P_{10}, is a prairie hay utilizing activity and is restricted at the 9 - 6 percent rate only by the amount of prairie hay available. This system, although the most profitable, is seldom found in the area.

Elimination of cropland from available resources eliminates the alternatives of growing alfalfa and oat-vetch grazing. As a result, another cow-calf alternative replaces the alfalfa requiring alternative and the oat-vetch grazing steers are also replaced. However, the relative importance of cows and steers in the optimum of each capital rate remains virtually unchanged. The amount of capital required by the optimum for each capital rate is reduced, but net returns to owned factors are reduced proportionally much more. The profitability of range improvement activities is unaffected by the elimination of cropland.

If the acreage of cropland is doubled (increased to 400 acres) the number of cows requiring alfalfa hay and the number of oats-vetch grazing steers increases at the lower capital rates with almost all of the increased acreage being used in producing oat-vetch grazing. The optimum at the 9 - 6 percent capital rate requires $23,000 more than that required for the optimum for Resource Situation I at the corresponding rate; net returns at this rate exceed those of Situation I by $4,714, a return of $23.70 per acre per year for the 200 additional acres of cropland.

Exclusion of brushland for spraying has no effect on the optimum at capital levels above the 14 - 11 percent rate. At the lower rates, the number of cows in the optima is lower than for the corresponding rates and Resource Situation I as the amount of available grazing declines. The amount of capital required at the 9 - 6 percent rate is reduced by $29,000 and returns are also reduced by $1,165.

If the acreage of brushland available for spraying is increased to 2,160 acres, assuming no increase in ACP funds for spraying, all brushland for which ACP funds are available will be sprayed at the 14 - 11 percent capital rate. The remainder for which no funds are available will be sprayed at the 9 - 6 percent rate. This results in an increase in available native grazing and a resulting increase in the number of cows in the optimum relative to steers over that of the corresponding rate for Resource Situation I. Capital requirements at this rate are $30,000 greater, and annual returns to owned factors exceed those of Resource Situation I by $1,084, an annual net return of slightly more than $1.00 per acre for the additional brushland.

The profitability of buying additional range land was also determined. Land buying is unprofitable if the capital rate exceeds the 9 - 6 percent rate. At the 9 - 6 percent rate, additional land can be profitably purchased, and the number of cows relative to steers increases. When the land purchasing activity is limited to 640 acres, $63,000 of additional capital is required and returns to owned factors are increased by only $20.

If the alfalfa producing alternative is excluded from alternatives considered, the cow-calf Process P_2 is no longer profitable, and is replaced by a different cow-calf system, P_5. At the lower capital rates, all cropland is used to produce oat-vetch grazing which is used by steers. At the higher rates, returns to owned factors are greatly reduced when the alfalfa alternative is excluded. However, at the lowest rate, returns are reduced by only $46 as a result of excluding this alternative, but the amount of capital required by the optimum is $6,000 greater.

The omission of steer alternatives from consideration, results in an increase in the acreage reseeded to native grass at the 24 - 21 percent and lower rates, an increase in the profitability of spraying brushland, and a decrease in the profitability of bermuda grass. The capital requirements for the optimum program at the 9 - 6 percent capital rate is $87,000 less when steers are excluded and returns are $1,878 less.

Comparison of the most commonly found (1) spring calving cow-calf system, Process P_5, and (2) fall calving cow-calf system, Process P_1 and steer system, Process P_9, indicates that the spring calving system is more profitable at all capital rates than is the fall calving system or steer system, and the fall calving system is more profitable than is the steer system. The optimum steer system requires more capital than does either of the cow-calf systems.

The effects of price changes on the optimum were also investigated. A reduction in the price of livestock increases the profitability of cow-calf systems relative to steers, reduces the optimum number of livestock, and reduces the profitability of range improvement activities. It also reduces the amount of capital that can be profitably used at a given capital rate as well as resulting returns to owned factors; a price increase tends to have the opposite effect.

In general, the static programming results suggest that on the typical northeastern Oklahoma ranch and with long-term projected prices: (1) cows are more profitable than steers when the capital rate is high, i.e., when capital is limited, but steers are more profitable when capital is unlimited, (2) reseeding abandoned cropland to native grasses will yield returns of 24 percent on short-term and 21 percent on long-term capital,

(3) aerial brush control will yield returns of 14 percent on short-term and 11 percent on long-term capital when ACP cost sharing is available and 9 - 6 percent respectively without ACP assistance, (4) bermuda establishment with ACP assistance on bottomland for hay and pasture will yield returns of 19 percent for short-term and 16 percent on long-term capital, and establishment on upland will yield returns of 9 - 6 percent for short-term and long-term capital.

In general, a price decline reduces the profitability of all pasture improvement alternatives, and increases the profitability of cows relative to steers. A price increase to 50 percent above the projected price level will not alter the optimum program at capital levels equal to or higher than the 39 - 36 percent level; however, at lower levels steer alternatives become relatively more profitable than cows. Also, higher livestock prices increase the rate of return to range improvement practices, thus, making them profitable at higher capital levels than when projected prices are realized.

CHAPTER IV

OPTIMUM ENTERPRISE COMBINATIONS IN A PSEUDO-DYNAMIC FRAMEWORK

The Pseudo-Dynamic Model[1]

In the pseudo-dynamic analysis, time is considered to be a decision variable and interest is focused on the maximization of the present value of the stream of net incomes, given the planning horizon or time period. This is a pseudo-dynamic model since decisions made and action taken in an early time period are assumed to have no impact on available alternatives in a later period. Economic criteria specify as optimum that ranch organization which yields the maximum streams of discounted net income.

> The problem of maximizing the present value of production plan is formally identical with the problem of maximizing the surplus of receipts over costs in the static problem of the firm. Outputs of different dates are to be regarded as different outputs; inputs of different dates as different inputs; and beyond that there is only one little difference. If, in static conditions, an entrepreneur employed one extra unit of a factor, that began reducing his surplus (the thing we supposed him trying to maximize) by an amount equal to the price of the factor. But if, in our new problem, we suppose an entrepreneur deciding to employ an extra unit of a factor at some particular date, it does not reduce the capitalized value of his surpluses (the thing he is now effectively trying to maximize) by the full price of the factor, not even by the expected price of the factor. Future costs only enter into the present value of the plan at their discounted values; and the same is true of future receipts.[2]

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[1]This model is similar to that used by Arthur J. Coutu, et al., in Methods for An Economic Evaluation of Soil Conservation Practices, Technical Bulletin 137, North Carolina State College, January, 1957.

[2]J. R. Hicks, Value and Capital, (Clarendon Press, Oxford), 1948, p. 197.

Let A_1 represent the animal product produced with a given livestock alternative in Time Period 1, denoted by T_1. In a similar manner A_2, represents the product in T_2, etc., A_i represents the product in T_i; i = 1, 2...n with n being the number of years in the planning period. If P_i represents the price of product in T_i, then the discounted price would be:

$$\frac{P_i}{(1 + r)} \tag{5.1}$$

where r is the discount rate, and

$$\frac{P_i A_i}{(1 + r)} \tag{5.2}$$

is the discounted value of animal product produced in T_i from the given alternative. This discounted value will be represented by the notation, R_i. The discounted gross return from the sale of livestock from a given livestock alternative is given by:

$$R_1T_1 + R_2T_2 + R_3T_3 + \dots + R_nT_n \tag{5.3}$$

The value of livestock produced using a given livestock alternative requires different inputs of labor and capital over time. These must be deducted if the present value of the net income stream is to be computed. Let C_i represent the costs of producing A_i in T_i, and C_i' represent the costs in T_i discounted to T_o. The discounted net return for each alternative would be given by:

$$\sum_{i=1}^{n} R_iT_i - C_i' \tag{5.4}$$

The ultimate objective, then is to select that set of livestock alternatives, forage producing enterprises and range improvement practices which will, for a given time period and discount rate, yield the largest discounted net return from a given set of resources.

The Discount Rate

When returns are received in a time period or periods after an investment is made, these must be discounted if they are to be compared with returns from an alternative investment received in a different time period. Returns from alternative range improvement practices which are received over a period of years subsequent to the initial investment can only be compared with each other and with investments which produce a single return in the year in which the investment is made if all of the returns are discounted to a common date, normally the present.

The discount rate used affects the comparative profitability of alternative investments. The higher the discount rate used, the lower the comparative value of revenues received in the distant future. Conversely, a low discount rate will penalize the values of distant returns less relative to those received in the immediate future, than will a high rate.[3] Thus, a person's discount rate will affect not only his decision as to whether he will or will not make a given investment, but also his decision as to which of two alternative investments to make. The effect of different discount rates on the economic feasibility of various improvement practices and on the optimum ranch organization are investigated in this chapter.

Factors Determining the Discount Rate

The discount rate relevant to an individual is determined by several factors. Chief among these are: (1) the amount of risk or uncertainty

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[3]See F. A. Lutz, "The Interest Rate and Investment in a Dynamic Economy," American Economic Review, Vol. 35, pp. 811-830.

of returns, (2) the opportunity rate and/or level of interest rate, and (3) the individual's time preference schedule for money.

In this study, an abstraction has been made from risk and uncertainty considerations and the discount rate has been used to reflect the external or market rate of interest, the opportunity cost or internal rate of interest, and the nature of the individual's time preference schedule for money.

The external or market rate of interest used, is the minimum current rate charged by agricultural lending agencies in the area. This is also considered to approximate the rate of the best nonfarm investment alternative. In this study, the rate assumed is six percent. The opportunity rate is the highest rate of return which can be received if resources are used in their best alternative uses. The internal rate of interest is that rate which the individual decision-maker requires as a rate of return before he is willing to commit his resources in the production of any of the many alternatives with which he is faced. The level of the internal rate is influenced by several factors. Chief among these are:

(1) an individual's demand for money to spend on current consumption goods. The greater one's demand for goods for current consumption, the higher the rate of return he will demand before he will be willing to commit his resources, and

(2) the desire of the individual to hold his resources as passive balances rather than have them invested in assets yielding low returns.[4]

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[4]The first is called the transactions demand for money and the latter is referred to as the liquidity preference for money by Keynesian Economists. For a more detailed discussion, see Joseph P. McKenna, Aggregate Economic Analysis, (The Dryden Press, New York), 1955, pp. 98-103.

If the internal rate of interest is higher than the opportunity rate, producers will be unwilling to commit resources to the production of any of the various alternatives, and hence, resources will remain idle. If the internal rate of interest is below the opportunity cost, production will be expanded until the opportunity rate is lowered to the internal rate. The internal rate concept is meaningful as a decision variable only if it is higher than the external rate. As long as the external rate is lower than or equal to the internal rate and the internal rate is below the opportunity rate, the manager would be willing to expand production through the use of borrowed funds.

The nature of the time-preference schedule which an individual holds for future incomes is affected by both economic and noneconomic factors. Factors of importance are the age of the individual, the monetary needs of the family for a minimum level of living and for educational purposes, and the value system of the individual.

The Planning Horizon

The planning horizon may be defined as the distance or period of time into the future for which producers can plan in a meaningful manner.[5] The length of time over which individuals plan economic activity is termed the economic horizon. The planning horizon of an individual is dependent on several factors including his age, personal values, amount of uncertainty of alternative actions, and, among other things, his capital position.

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[5]E. O. Heady, Economics of Agricultural Production and Resource Use,(New York, Prentice Hall Inc.),1952, p. 174.

Except for the complexities of varying time periods, improvement practice inputs do not differ from other inputs and may be considered in the same manner as any other inputs. Yields, however, must be determined for selected alternatives produced with and without the use of the specified improvement practice. The time element must be explicit because of the differences in the input-output relationships with respect to time. The production functions required must specify the inputs and yields in an annual sequence beginning with the year in which the improvement practice is initiated.

Given factor and product price expectations and the physical inputs and production flows, it is possible for one to determine expected costs and revenues for any appropriate time period or planning horizon selected.

Very little research has appeared on this specific topic, but scattered inferences are that the horizon is shorter now than it was 20 years ago and that nonagricultural planning horizons are shorter than those commonly employed in agricultural investment decisions.[6] One would expect a rancher who engages in range improvement to have a longer planning horizon than farmers producing row crops and it would probably be ten to twenty years, thus, the two time periods chosen for analysis in this study were ten and twenty years.

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[6]See F. A. Lutz, pp. 811-830, and Arthur James Coutu, "An Economic Analysis of Soil Conservation Practices in a Selected Area of North Carolina," unpublished Ph.D. thesis, North Carolina State College, (Raleigh), 1955, pp. 45-47.

The Pseudo-Dynamic Matrices

The input-output matrix and the net return and cost matrices for the pseudo-dynamic analyses are presented in Appendix C, Table II. Livestock alternatives are the same as those considered in the static analysis except that Process P_8 was not considered because returns from this alternative are so low relative to other alternatives that it obviously would never be included in the optimum combination of enterprises.

Capital requirements listed for each enterprise are the maximum required for any single year. For most of the activities considered, the initial year is the one requiring the largest amount of capital and the capital remains invested for the entire planning period.

Grazing and hay yields for the forage producing enterprises as shown in the matrix are averages for a 10-year period, assuming all range improvements are made in the first year. These coefficients were changed to 20-year averages when optima were computed for a 20-year planning horizon.

Discounted net returns (the C matrices) per unit of output are given for:[7]

(1) A 10-year planning period using a six percent discount rate,

(2) A 20-year planning period using a six percent discount rate,

(3) A 10-year planning period using a 15 percent discount rate,

(4) A 20-year planning period using a 15 percent discount rate,

(5) A 20-year planning period using a 20 percent discount rate.

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[7]These five combinations of discount rates and planning periods are hereafter referred to as Cases I through V.

A single resource situation was selected for the pseudo-dynamic analyses. All resources are assumed to be at the same level as for Resource Situation I used in the static analysis except for the amount of ACP funds available; these were assumed to be unlimited as the processes requiring such funds can be spread out over the planning period in such a way that ample funds are available to spray all available brushland, reseed all cropland to native or sprig it to bermuda.

Pseudo-Dynamic Programming Results

Optimum enterprise combinations for Resource Situation I were determined for each of the five cases. These provide (1) a means for determining the effect of time as expressed by discounted revenues on the optimum and as (2) a means for determining the influence of the discount rate on the optimum.

Returns to owned factors were computed and are presented in four ways:

(1) As discounted returns for the entire planning period. This is simply the summation of discounted returns to owned factors for the entire planning period, and is the value maximized by the program.

(2) As discounted average yearly returns. These were computed by dividing the discounted returns for the entire planning period by the number of years in the planning period.

(3) As undiscounted average yearly returns to selected factors with an annual interest rate charged equal to the rate used for discounting. This, in effect, is the return which will actually be received in each future year after an interest charge equal

to discount rate has been made for all capital required. The charge for time has been removed.

(4) As adjusted undiscounted average yearly returns to selected factors. Returns for the preceding method were adjusted so they would be comparable for all cases considered. The adjustment consisted of charging a uniform interest rate (six percent) for all cases instead of an interest equal to the discount rate. This, then, represents the average annual returns to owned factors which will actually be received from the optimum combination of enterprises, after an interest charge of six percent has been made for capital.

Optimum Enterprise Combinations

Table XXVIII presents the optimum enterprise combinations, given Resource Situation I[8], for each of the five cases considered.

For Case I, the optimum livestock system includes: (1) 499 cows of Process P_5 and (2) 1,190 buy-sell steers of which 963 are Process P_{10} and 227 are Process P_{11}. All brushland, 1,080 acres, is sprayed and all idle cropland, 400 acres, is sprigged to bermuda. All cropland, 300 acres, is used for small grain grazing, and all available meadow, 320 acres, is mowed for hay.

The 227 steers of Process P_{11} are the maximum number for which small grain grazing is available and the number of steers of Process P_{10} is restricted to 963 by the quantity of hay which can be produced above that

[8]This set of resource restrictions is the same as Resource Situation I used in the static analysis except the ACP cost-sharing restrictions were eliminated.

TABLE XXVIII

OPTIMUM ENTERPRISE COMBINATIONS, RESOURCE SITUATION I, SELECTED PLANNING PERIODS AND DISCOUNT RATES

		Case I	Case II	Case III	Case IV	Case V
Discount Rates (Percent)		6	6	15	15	20
Planning Period (Years)		10	20	10	20	20
Activity	Unit					
Cow-Calf (P_2)	Each	0	0	729	719	655
Cow-Calf (P_5)[5]	Each	499	499	43	50	0
Steer (P_{10})	Each	963	963	0	0	0
Steer (P_{11})	Each	227	227	64	67	81
Reseed Native (P_{14})	Acre	0	0	300	300	0
Reseed Native (P_{15})	Acre	0	0	90	100	100
Spray Brush (P_{18})	Acre	1,080	1,080	1,080	1,080	0
Bermuda (P_{24})	Acre	300	300	0	0	0
Bermuda (P_{26})	Acre	100	100	10	0	0
Native Meadow (P_{32})	Acre	320	320	0	26	30
Alfalfa-Brome (P_{33})	Acre	0	0	143	141	129
Dec.-Feb. Labor(P_{34})	Hour	1,397	1,397	806	801	553
Mar.-May Labor (P_{35})	Hour	1,100	1,100	0	0	0
June-Aug. Labor (P_{36})	Hour	3,424	3,424	266	268	134
Sept.-Nov. Labor (P_{37})	Hour	486	486	901	889	749
Capital Required[1]	$	290,293	290,293	182,685	182,278	149,063
Discounted Returns to Selected Factors for Planning Period[2]	$	436,818	685,148	186,189	234,168	138,787
Discounted Average Yearly Returns to Selected Factors	$	43,682	34,257	18,619	11,708	6,939
Undiscounted Average Yearly Returns to Selected Factors[3]	$	59,351	59,733	37,097	37,406	28,497
Adjusted Undiscounted Average Yearly Returns to Selected Factors[4]	$	59,351	59,733	53,539	53,811	49,366

[1]Maximum required in any given year.

[2]Returns to owned factors.

[3]Interest on capital used charged at discount levels.

[4]Interest on capital used adjusted to six percent.

required by the cow-calf enterprise. Discounted returns to owned factors for the 10-year period are $436,818, a yearly average of $43,682. If the charge for time is eliminated, average annual returns are $59,351.

The optimum program for Case II is identical with that of Case I; returns alone are affected by increasing the length of the planning horizon. When returns are discounted, returns of the near future are decreased less than returns of the distant future. Thus, the discounted average yearly returns are lower from the same combination of enterprises, and the same discount rate when a 20-year period is considered than when a 10-year period is considered. However, the average undiscounted returns are higher when the longer period is considered. This is due to the fact that costs of establishment of native and bermuda grasses and spraying brush are spread over a longer period of time, thus, reducing the average cost per year.

Case III differs from Case I in that the discount rate used is 15 percent. The optimum combination of livestock enterprises includes 772 cows, 729 of which are Process P_2 and 43 of Process P_5 and 64 steers of Process P_{11}. All cropland is utilized, 143 acres of it for the production of alfalfa and the remaining 57 acres for the production of small grain grazing. All idle land is also utilized, 390 acres of it is reseeded to native grass and 10 acres is sprigged to bermuda grass. All brushland available, 1,080 acres, is sprayed.

Case IV differs from Case III in that the length of planning horizon considered is lengthened to 20 years. The optimum for Case IV differs only slightly from that of Case III; all idle land is reseeded to native and bermuda grass is not included in the optimum combination for the longer planning horizon. Undiscounted returns are approximately the same for both cases.

The effect of a higher discount rate (20 percent) on the optimum combination of resources for the 20-year planning period was also determined, Case V. The optimum program closely resembles that for the static optima at the higher capital cost levels. All cows are of the P_2 alternative and all cropland not used in the production of alfalfa is used for producing small grain grazing on which steers are grazed. Reseeding native grasses is profitable only on bottomland, and brush control and bermuda establishment are unprofitable at this discount level.

Capital used at the 20 percent discount level is slightly more than one-half that used at the six percent discount rate. Both, discounted and undiscounted returns are much lower at the higher discount level.

Programming results as presented in Table XXVIII for the five cases involving three discount levels and two planning horizons indicate that the length of the planning horizon has little effect on the optimum combination of enterprises if the planning horizon is 10 to 20 years in length.

The rate at which future returns are discounted greatly influences the optimum. Discount rates have the same effect on the amount of capital that can be profitably used as does the capital rate of the static model (at the higher discount rates, less capital can be profitably employed).[9] At low discount rates, (high level of capital) bermuda grass establishment on idle cropland and steer alternatives are found in the optima; at slightly higher rates, idle cropland is seeded to native grasses and cow-calf alternatives replace steers. At the 20 percent level much of the idle cropland remains unused and brush control is unprofitable as at the higher capital rates under static conditions.

Matrix Modifications

Optima were determined for each of the five cases when:

(1) Process P_1, the fall calving cow-calf alternative most common to the area; Process P_5, the spring calving cow-calf alternative most common to the area, and Process P_9, the steer alternative most common to the area, were the only livestock alternatives considered.

(2) Processes P_1 and P_9 were the only livestock alternatives considered, and

(3) Process P_9 was the only livestock alternative considered.

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[9] In the static analysis costs are assumed to be incurred and returns received instantaneously. In the pseudo-dynamic analysis, costs are assumed to be incurred at one time and returns received at a later time, and both costs and returns are discounted to the present. Thus, the effect of a discount rate would be to decrease the profitability of an alternative requiring cost outlays in the immediate future and yielding returns only in the distant future in a greater proportion than the profitability of an alternative requiring equal costs and yielding equal returns in all time periods, and the higher the discount rate the greater this effect. It is conceivable, therefore, that although a high discount rate will reduce the amount of capital that can be profitably used in the same manner as a high capital rate will, the relative profitability of improvement practices could be altered by the discounting.

Optimum with P_1, P_5, and P_9 Considered

Optima for each of the five cases when Processes P_1, P_5, and P_9 were considered as livestock alternatives are presented in Table XXIX. For all cases, the only livestock alternative included in the optima is Process P_5, with livestock numbers being larger at the lower discount rates. Bermuda grass sprigging is profitable on a small acreage at only the lowest discount rate considered; reseeding native grass is profitable at all levels and brush control is profitable for Cases I through IV, but not for V.

At the six percent discount level, $174,000 of capital is used. This is $116,000 less than that required for Case I when all alternatives were considered. Discounted average yearly returns are also $7,878 lower.

These optima closely resemble those of the static analysis with Processes P_1, P_5 and P_9 considered (see Table XXI). In both instances, the spring cow-calf alternative, Process P_5 is the only livestock alternative included in the optima. In the static analysis, all cropland is reseeded to native grass at the 24 - 21 percent rate and at all lower rates except for nine acres which are planted to bermuda grass at the 9 - 6 percent rate. In the pseudo-dynamic analysis, all bottomland is reseeded to native grasses at the 20 percent discount rate and both bottomland and upland are reseeded to native at lower rates except for ten acres which are planted to bermuda at the six percent discount rate.

Brush control appears to be more profitable in the pseudo-dynamic analysis than in the static as all brushland is srpayed at 15 percent and lower discount rates; however, this is due to the fact that ACP assistance is assumed to be limited in the static analysis to the ACP

TABLE XXIX

OPTIMUM ENTERPRISE COMBINATIONS, RESOURCE SITUATION I, P_1, P_5, AND P_9 CONSIDERED AS LIVESTOCK ALTERNATIVES, SELECTED PLANNING PERIODS AND DISCOUNT RATES

		Case I	Case II	Case III	Case IV	Case V
Discount Rates (Percent)		6	6	15	15	20
Planning Period (Years)		10	20	10	20	20
Activity	Unit					
Cow-Calf (P_5)	Each	762	762	760	760	649
Reseed Native (P_{14})	Acre	300	300	300	300	0
Reseed Native (P_{15})	Acre	290	290	300	300	300
Spray Brush (P_{18})	Acre	1,080	1,080	1,080	1,080	0
Bermuda (P_{26})	Acre	10	10	0	0	0
Native Meadow (P_{32})	Acre	0	0	25	25	22
Dec.-Feb. Labor (P_{34})	Hour	693	693	689	689	449
Mar.-May Labor (P_{35})	Hour	622	622	612	612	361
Transfer Cropland (P_{42})	Acre	200	200	200	200	200
Capital Required[1]	$	174,388	174,388	173,767	173,767	139,162
Discounted Returns to Selected Factors for Planning Period[2]	$	358,042	563,742	162,489	205,044	118,581
Discounted Average Yearly Returns to Selected Factors	$	35,804	28,187	16,249	10,252	5,929
Undiscounted Average Yearly Returns to Selected Factors[3]	$	48,647	49,149	32,375	32,754	24,349
Adjusted Undiscounted Average Yearly Returns to Selected Factors[4]	$	48,647	49,149	48,014	48,393	43,832

[1]Maximum required in any given year.

[2]Returns to owned factors.

[3]Interest on capital used charged at discount levels.

[4]Interest on capital used adjusted to 6 percent.

funds available in a single year but in the pseudo-dynamic, such funds are assumed to be available over the planning period for all brushland.

Optimum with P_1 and P_9 Considered

When Process P_5 is excluded and only Processes P_1 and P_9 considered as livestock alternatives, the optimum livestock system for all cases is composed of only Process P_1, with a larger number of cows being included in the optima at the lower discount rates than at the higher (Table XXX). Range improvement practices appearing in the optima are the same as when Process P_5 was included except that reseeding native is not profitable at the 20 percent discount level. Capital requirements and returns to owned factors are both reduced when Process P_5 is excluded.

As the spring cow-calf alternative, Process P_5, alone comprised the optimum livestock system for all discount rates when it was included and Process P_9 alone comprised the optimum when P_5 was excluded, a comparison can be made between the fall-cow calving system and a spring-cow calving system.

Fewer cows are included in the optimum, less capital is required and returns are lower when the fall calving system is used. Brush control is included in the optima for both systems for Cases I through IV, but not V. Reseeding native grass on bottomland is included in the optima for all five cases for the spring calf system, but it is not in the optimum for Case V of the fall cow-calf system.

A comparison of Table XXII and XXX indicates the similarity of the optima for various capital rates under static conditions and the optima for various discount rates and planning periods under pseudo-dynamic assumptions when Processes P_1 and P_9 were the livestock alternatives considered.

TABLE XXX

OPTIMUM ENTERPRISE COMBINATIONS, RESOURCE SITUATION I, P_1 AND P_9 CONSIDERED AS LIVESTOCK ALTERNATIVES, SELECTED PLANNING PERIODS AND DISCOUNT RATES

		Case I	Case II	Case III	Case IV	Case V
Discount Rates (Percent)		6	6	15	15	20
Planning Period (Years)		10	20	10	20	20
Activity	Unit					
Cow-Calf (P_1)	Each	727	727	725	725	594
Reseed Native Upland, (P_{14})	Acre	300	300	300	300	0
Reseed Native Bottomland, (P_{15})	Acre	290	290	300	300	0
Spray Brush (P_{18})	Acre	1,080	1,080	1,080	1,080	0
Bermuda (P_{26})	Acre	10	10	0	0	0
Native Meadow (P_{32})	Acre	0	0	24	24	20
Dec.-Feb. Labor (P_{34})	Hour	218	218	215	215	3
Sept.-Nov. Labor (P_{37})	Hour	683	683	679	679	369
Transfer Cropland (P_{42})	Acre	200	200	200	200	0
Capital Required[1]	$	169,929	169,929	169,302	169,302	127,685
Discounted Returns to Selected Factors for Planning Period[2]	$	306,810	483,899	129,621	164,055	93,124
Discounted Average Yearly Returns to Selected Factors	$	30,681	24,195	12,962	8,203	4,656
Undiscounted Average Yearly Returns to Selected Factors[3]	$	41,686	42,188	25,826	26,208	19,121
Adjusted Undiscounted Average Yearly Returns to Selected Factors[4]	$	41,686	42,188	41,063	41,445	36,997

[1]Maximum required in any given year.

[2]Returns to owned factors.

[3]Interest on capital used charged at discount levels.

[4]Interest on capital used adjusted to six percent.

The optimum livestock system is comprised of cows alone in both instances at all discount and capital rates. Reseeding native grass is profitable at approximately the same rates and bermuda grass is profitable at the lowest rates only and then only in small acreage. Spraying brush again appears more profitable under pseudo-dynamic conditions for the same reason given above.

Optimum with Only P_9 Considered

The effect of the length of the planning period and discount rate on returns and on the profitability of range improvement practices was also determined when only Process P_9, the steer alternative most commonly noted in the area, was considered (see Table XXXI). The optima for Cases I and III are the same with 1,707 steers being the optimum number, and with all range improvement practices included. However, the acreage of bermuda is limited to that required to produce hay for feeding during inclement weather.

The optimum number of steers is lower for Cases III, IV, and V, and no improvement practice is included in the optima for III and V, but reseeding native on idle bottomland is profitable for Case IV.

Capital requirements are higher when Process P_1 alone is considered as a livestock alternative than when Processes P_1 and P_5 are included. Returns to owned factors are considerably lower when these cow-calf enterprises are excluded.

The optima for corresponding capital and discount rates are very similar under static and pseudo-dynamic assumptions with Process P_9 the only livestock alternative considered.

TABLE XXXI

OPTIMUM ENTERPRISE COMBINATIONS, RESOURCE SITUATION I, P_9 ALONE CONSIDERED AS A LIVESTOCK ALTERNATIVE, SELECTED PLANNING PERIODS AND DISCOUNT RATES

		Case I	Case II	Case III	Case IV	Case V
Discount Rates (Percent)		6	6	15	15	20
Planning Period (Years)		10	20	10	20	20
Activity	Unit					
Steer (P_9)	Each	1,707	1,707	1,386	1,446	1,386
Reseed Native Upland (P_{14})	Acre	300	300	0	0	0
Reseed Native, Bottomland (P_{15})	Acre	262	262	0	300	0
Spray Brush (P_{18})	Acre	1,080	1,080	0	0	0
Bermuda (P_{26})	Acre	38	38	0	0	0
Native Meadow (P_{32})	Acre	0	0	77	80	77
Dec.-Feb. Labor (P_{34})	Hour	320	320	80	124	80
Mar.-May Labor (P_{35})	Hour	60	60	0	0	0
Transfer Cropland (P_{42})	Acre	200	200	0	200	0
Capital Required[1]	$	239,828	239,828	183,350	193,516	183,350
Discounted Returns to Selected Factors for Planning Period[2]	$	285,545	450,740	90,098	112,648	42,767
Discounted Average Yearly Returns to Selected Factors	$	28,554	22,537	9,010	5,632	2,138
Undiscounted Average Yearly Returns to Selected Factors[3]	$	38,796	39,297	17,952	17,994	8,780
Adjusted Undiscounted Average Yearly Returns to Selected Factors[4]	$	38,796	39,297	34,453	35,410	34,450

[1]Maximum required in any given year.

[2]Returns to owned factors.

[3]Interest on capital used charged at discount levels.

[4]Interest on capital used adjusted to six percent.

Summary and Implications

Results indicate that over the range of time periods and discount rates considered, the length of the planning horizon is less important than the discount rate in determining the optimum improvement practice and enterprise combination. The discount rate as used in the pseudo-dynamic analyses has an effect on the amount of capital used similar to the effect of the capital rate as used in the static analyses. At high discount rates less capital is used with given land resources than at low discount rates. Cow-calf enterprises are more profitable when capital is severely restricted, and steer enterprises are relatively more profitable when more capital is available with given land resources.

Spraying brushland and reseeding native grass on idle cropland yields discounted returns exceeding 15 percent when both cow-calf and steer alternatives are considered and above six percent when only steers are considered. Returns for establishment of bermuda exceed 15 percent only if used for hay and six percent if grazed when both cow-calf and steer enterprices are considered. When steers alone are considered, returns exceed six percent only on the limited acreage required for hay production.

The length of the planning period, whether 10 or 20 years, has no effect on the optimum when both steers and cow-calf alternatives are considered. The same is true when only steers are considered and a six percent discount rate is used; however, the optima for 10 to 20 year periods are slightly different at the 15 percent discount level. This is due, in part, to the fact that discounted net returns for reseeding native grass are slightly less than 15 percent for a 10-year period, but slightly over 15 percent when costs of establishment are spread over the 20-year period.

CHAPTER V

OPTIMUM ENTERPRISE COMBINATIONS IN A DYNAMIC FRAMEWORK

The Dynamic Model

In the dynamic analysis, attention is directed to the maximization of the present value of the stream of net incomes. The model involves the simultaneous determination of optimum plans for a series of time periods with decisions of each period affecting alternatives in subsequent periods.[1]

A dynamic linear programming model can be developed by merely expanding the static model. Each coefficient is identified with a given activity in a specified time period. For example, a_{ij}, the input-output coefficient in the ordinary static model, refers to the amount of the i^{th} resource or restraint used per unit of the j^{th} activity in a single time period.

In the dynamic model, the a_{ij} of the static model is supplemented by a third subscript, k, which denotes the particular time period. Each coefficient is now identified by a_{ijk}, the amount of the i^{th} resource used per unit of the j^{th} activity in the k^{th} time period.

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[1]Laurel D. Loftsgard and Earl O. Heady, "Application of Dynamic Programming Models for Optimum Farm and Home Plans." Journal of Farm Economics, Vol. XLI, No. I, February, 1959, pp. 51-62; Robert Dorfman, et al. Linear Programming and Economic Analysis, (New York, 1958), pp. 265-345; Earl R. Swanson, "Integrating Crop and Livestock Activities in Farm Management Activity Analysis." Journal of Farm Economics, Vol. XXXVII, December 1955, pp. 1249-1258.

Each alternative production process for any year is expressed as x_j for a static model. To identify the activity x_j with a particular time period in the dynamic model, a subscript k is added to give x_{jk}. Likewise, requirements and restraints become b_{ik}, and reference is made to the i^{th} restraint in the k^{th} time period. Returns per specified unit of activity are denoted as c_{jk} to indicate the discounted return to the j^{th} activity in the k^{th} time period.[2]

In the usual static analyses, optimum alternative plans are compared one with the other and/or with the present plan. In such analyses no consideration is given to the problems associated with moving from the present to the various alternative plans. This applies to both budgeting and programming analyses. Thus a unique feature of dynamic programming is that the various conditions of intertemporal equilibrium are assured since both transition and final equilibrium plans are explicitly specified.

In working with dynamic problems, one must (1) ascertain or assume a planning period (planning horizon), and (2) develop a criteria equation in terms of the quantity to be maximized.[3]

> In defining the planning horizon for purposes of dynamic programming we may specify the periods in terms of any convenient period. For example the period might be one year, one week, one month, or five years. It is convenient, however, to

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[2]A dynamic linear programming model is outlined algebraically in Loftsgard and Heady, pp. 52-54 and by Dorfman, et al., pp. 265-345.

[3]James S. Plaxico, "Dynamic Programming and Management Strategies in the Great Plains," a paper presented to the GP No. 2 Technical Committee Methodology Conference,(Lincoln, Nebraska),May, 1959. Conference proceedings are in press and will be issued soon in the Great Plains Regional Series.

specify the period in terms of a production period from a technological viewpoint. For example, a period shorter than the production period required for the shortest term enterprise would not be reasonable and a period which would span several production periods for the longest term enterprise would in similar fashion appear unreasonable. In the first case, the too short a period would break the planning periods into shorter time spans than decisions would be possible, and the second would involve many choices or decisions within a planning period.[4]

In this study, the production period used is five years. Thus for a planning horizon of 20 years, four production periods are used, and the quantity to be maximized is the present value of the expected income stream over the length of planning horizon for different resource situations and admissible alternatives.

The dynamic programming model is given in Appendix C, Table III, using the average situation of a northeastern Oklahoma ranch of 3,000 acres and over. As the problem is formulated, there are eight resource restraints and nine production alternatives for each of the four periods. In addition, a labor hiring activity is included for each of the four periods; a capital transfer activity allowing income in one period to be transferred to the subsequent period is included for each of the first three periods and a capital borrowing activity is included for the first period. All requirements and production as presented are on an annual basis.

Resource Restraints

The eight restraints used are basically the same as those used in the pseudo-dynamic analysis except that available labor for all four periods

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[4] Ibid., p. 7.

is combined and no distinction is made between classes of capital. Land resources for each of the four time periods are the same as those used in the earlier analyses. However, if an acre of cropland is reseeded to native in one of the earlier periods, it is unavailable for other use in subsequent time periods. Thus, in the model, for each acre reseeded to native in Time Period I, an acre of cropland is required in each period. Also, an acre of cropland reseeded to native grass yields grazing in each subsequent time period.

The amount of capital used in the dynamic analysis is again assumed to be regulated by its marginal value productivity,[5] and the optimum combination of enterprises is determined for two discount rates, six, and twenty percent. All capital that can be profitably used at the discounted interest rate is assumed to be available in Time Period I and all returns to owned factors in the first period are transferred to the second period. No charge was made for transferring capital from one time period to the next. In this model no allowance is made for fixed expenses, consumption, etc. Such an allowance would reduce the amount of capital available for use in subsequent time periods, but not change the logic or interpretation of the results. As such charges were not made, the maximum possible accumulation is allowed.[6]

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[5]The discount rate failed to restrict the amount of capital used when the spring calving cow-calf activity was considered even when the rate was as high as 20 percent. Therefore, an arbitrary restriction of $100,000 was placed on the amount of capital available in the first time period. This limited production and income in the first period and the resulting income available to be transferred to subsequent periods.

[6]Such changes were omitted in the present analysis due to the limited computer facilities available.

The Productive Processes

It is assumed that the number of admissible activities is limited to nine for each of the four time periods. The activities are fall-calving cows (Process P_1), spring-calving cows (Process P_5), steer buy-sell (Process P_9), reseeding idle upland to native (Process P_{14}), reseeding idle bottomland to native (Process P_{15}), spraying brushland (Process P_{18}), bermuda establishment on upland (Process P_{24}), bermuda establishment on bottomland (Process P_{26}) and native hay production (Process P_{32}).

It is assumed that the cow activities, the steer buy-sell activity and the native hay producing activity are annual processes that may be operated at any positive level in each period consistent with the appropriate restrictions for each of the four time periods. On the other hand, it is assumed that land improved in one time period becomes a permanent production process for subsequent time periods.

The Criterion Equations

In this study the quantity chosen to be maximized is the discounted or present value of the stream of net incomes over the planning horizon. Other quantities which could have been chosen include the maximization of the undiscounted value of the stream of incomes or the maximization of the income stream after some development period. The discounted value of the stream of net incomes was chosen as the maximization criterion as it appears to be more consistent with expected producer actions than do the other criteria.

Returns and operating costs were discounted and the discounted operating costs were deducted from returns. However, capital costs of range improvements and other investments are not deducted; only interest charges and increased annual expenses are considered. It was assumed that any investment in range improvement, land purchase, etc. would increase the value of the land by the cost of the investment; thus, the costs and resulting increase in net inventory value are assumed to be offsetting.

Dynamic Programming Results

Optimum ranch programs were determined for each of 13 alternative situations referred to hereafter as cases. The 13 cases represent different combinations of livestock alternatives, discount rates, capital limitations, and amounts of land which can be purchased. The primary characteristics of each of the 13 cases are presented in Table XXXII, and optimum ranch plans for each, assuming other resources and alternatives remain unchanged, are presented in Table XXXIII.

Optimum Enterprise Combinations

Case I. The livestock alternatives considered in Case I are Processes P_1, P_5, and P_9, the discount rate is six percent, all capital that could be profitably used is assumed available, and no land can be purchased. The optimum ranch program for this situation consists of 726 cows (Process P_5) in the first five year time period and 758 cows in each of the other three time periods. All available idle cropland is reseeded to native grass and all brushland is sprayed in the first period. Thus, the amount of grazing available is greater in the last three than in the first period. The annual capital required by the optimum system during the first time period is $162,794 and average annual undiscounted returns

TABLE XXXII

CHARACTERISTICS OF ALTERNATIVE SITUATIONS FOR WHICH OPTIMA WERE DETERMINED

Identification	Livestock Alternatives Considered (Processes)	Discount Rate (Percent)	Capital Limitation in Period I (Dollars)	Level of Land Buy Restriction (Acres)
Case I	P_1, P_5, P_9	6	Unlimited[a]	0
Case II	P_1, P_5, P_9	20	Unlimited[a]	0
Case III	P_1, P_9	20	Unlimited[a]	0
Case IV	P_1, P_5, P_9	6	100,000	0
Case V	P_1, P_5, P_9	20	100,000	0
Case VI	P_1, P_9	6	100,000	0
Case VII	P_1, P_9	20	100,000	0
Case VIII	P_9	6	100,000	0
Case IX	P_9	20	100,000	0
Case X	P_1, P_5, P_9	6	100,000	Unlimited[b]
Case XI	P_1, P_5, P_9	20	100,000	Unlimited[b]
Case XII	P_1, P_5, P_9	6	100,000	1,280
Case XIII	P_1, P_5, P_9	6	50,000	1,280

[a]Limited only by the discount rate.

[b]Limited only by profitability and capital availability.

TABLE XXXIII

OPTIMUM PROGRAMS FOR EACH OF THE THIRTEEN CASES CONSIDERED IN THE DYNAMIC ANALYSES

Activity and Time Period[a]	Process	Unit	Case Numbers I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	XIII
Time Period I															
Fall calving cow-calf	P_1	Cows	0	0	693	0	0	467	467	0	0	0	0	0	0
Spring calving cow-calf	P_5	Cows	726	726	0	477	477	0	0	0	0	477	477	477	238
Buy-sell steer	P_9	Steers	0	0	0	0	0	0	0	756	756	0	0	0	0
Reseed native	P_{14}	Acres	300	300	300	0	0	0	0	0	0	0	0	0	0
Reseed native	P_{15}	Acres	100	100	100	0	0	0	0	0	0	0	0	0	0
Spray brush	P_{18}	Acres	1,080	1,080	1,080	0	0	0	0	0	0	0	0	0	0
Native hay	P_{32}	Acres	24	24	23	16	16	16	16	42	42	16	16	16	8
Hire labor	P_{46}	Hours	0	0	0	0	0	0	0	0	0	0	0	0	0
Capital	P_{47}	$	162,794	162,794	159,010	100,000	100,000	100,000	100,000	100,000	100,000	100,000	100,000	100,000	50,000
Buy land	P_{48}	Acres	0	0	0	0	0	0	0	0	0	0	0	0	0
Time Period II															
Fall calving cow-calf	P_1	Cows	0	0	0	0	0	509	509	0	0	0	0	0	0
Spring calving cow-calf	P_5	Cows	758	758	0	726	726	0	0	0	0	756	756	756	468
Buy-sell steer	P_9	Steers	0	0	1,704	0	0	434	434	939	939	0	0	0	0
Reseed native	P_{14}	Acres	0	0	0	300	300	300	300	0	0	300	300	300	0
Reseed native	P_{15}	Acres	0	0	0	100	100	100	100	0	0	100	100	100	0
Spray brush	P_{18}	Acres	0	0	0	1,080	1,080	1,080	1,080	0	0	1,080	1,080	1,080	0
Native hay	P_{32}	Acres	25	25	95	24	24	41	41	52	52	25	25	25	16
Hire labor	P_{46}	Hours	4	4	0	0	0	0	0	0	0	0	0	0	0
Buy land	P_{48}	Acres	0	0	0	0	0	0	0	0	0	339	339	339	0
Time Period III															
Fall calving cow-calf	P_1	Cows	0	0	0	0	0	0	0	0	0	0	0	0	0
Spring calving cow-calf	P_5	Cows	758	758	0	758	758	0	0	0	0	909	909	873	753
Buy-sell steer	P_9	Steers	0	0	1,704	0	0	1,704	1,704	1,167	1,167	0	0	0	0
Reseed native	P_{14}	Acres	0	0	0	0	0	0	0	0	0	0	0	0	300
Reseed native	P_{15}	Acres	0	0	0	0	0	0	0	0	0	0	0	0	100
Spray brush	P_{18}	Acres	0	0	0	0	0	0	0	0	0	0	0	0	1,080
Native hay	P_{32}	Acres	25	25	95	25	25	95	95	65	65	30	30	29	25
Hire labor	P_{46}	Hours	4	4	0	4	4	0	0	0	0	859	859	656	0
Buy land	P_{48}	Acres	0	0	0	0	0	0	0	0	0	1,341	1,341	941	302
Time Period IV															
Fall calving cow-calf	P_1	Cows	0	0	0	0	0	0	0	0	0	0	0	0	0
Spring calving cow-calf	P_5	Cows	758	758	0	758	758	0	0	0	0	1,067	1,067	873	873
Buy-sell steer	P_9	Steers	0	0	1,704	0	0	1,704	1,704	1,398	1,398	0	0	0	0
Reseed native	P_{14}	Acres	0	0	0	0	0	0	0	0	0	0	0	0	0
Reseed native	P_{15}	Acres	0	0	0	0	0	0	0	0	0	0	0	0	0
Spray brush	P_{18}	Acres	0	0	0	0	0	0	0	0	0	0	0	0	0
Native hay	P_{32}	Acres	25	25	95	25	25	95	95	80	80	36	36	29	29
Hire labor	P_{46}	Hours	4	4	0	4	0	0	0	0	0	1,760	1,760	656	656
Buy land	P_{48}	Acres	0	0	0	0	0	0	0	0	0	1,769	1,769	0	978
Discounted net returns	Z	$	685,804	283,153	249,354	596,126	224,432	531,115	200,223	372,571	138,792	664,130	163,876	635,060	463,913
Undiscounted net returns		$	1,183,311	1,183,311	1,091,603	1,109,632	1,107,177	990,271	990,271	699,664	699,664	1,294,908	1,294,908	1,208,375	945,239
Average discounted annual returns		$	34,290	14,158	12,468	29,806	11,222	26,556	10,011	18,629	6,940	33,206	8,194	31,753	23,196
Average undiscounted annual returns		$	59,166	59,166	54,580	55,482	55,482	49,514	49,514	34,983	34,983	64,745	64,745	60,419	47,262

[a]These are the same identifications assigned in the static analysis. In the dynamic analysis different identifications were assigned to the same process for different time periods.

to owned factors (land, operator and family labor and management) are $59,166.

Case II. Case II differs from Case I in that the discount rate is 20 percent. The higher discount does not reduce the amount of capital which can be profitably used, therefore, the optimum combinations of enterprises is identical with that of Case I, with the only difference being in discounted returns which are much lower when a 20 percent discount rate is used.

Case III. In Case III the spring-calving cow-calf alternative is omitted and a 20 percent discount rate is used. In the first time period the livestock system is comprised of 693 fall-calving cows. All idle cropland is reseeded to native in Time Period I and all available brushland is sprayed. In the second time period sufficient capital is available and a switch is made to the steer system with 1,704 steers included in the optimum. In the third and fourth time periods the optimum livestock system is also comprised of 1,704 steers. This indicates that the 20 percent discount rate restricts capital in the first time period, but income available for transfer to the subsequent periods is sufficient for the change to steers. The number of cows in the optimum in the first period and the number of steers in the optimum in the last three periods are the maximum for which grazing is available.

Cases IV and V. In Case IV the amount of capital available in the first time period is restricted to $100,000, Processes P_1, P_5, and P_9 are considered as livestock alternatives, and returns are discounted at a rate of six percent. Again, the optimum livestock system is comprised of spring-calving cows only in all periods, but the number of cows is lower in the first period than for Cases I and II. In the first period none of the range improvement activities are included in the optimum as insufficient capital is available to purchase cows to utilize all of the native range available. However, returns from the first period which become capital for the second period are sufficient to allow the maximum number of cows for which grazing is available to be purchased, all brushland to be sprayed, and all abandoned cropland to be reseeded to native grasses. The optimum combination of enterprises for the second, third, and fourth period are the same as for the same periods of Cases I and II. The restriction placed on the amount of capital available for use in the first period results in a reduction in average annual undiscounted returns of $3,684. Case V differs from Case IV in that the discount rate is 20 percent. The higher discount rate does not affect the relative profitability of the various alternatives. Thus, the optimum combination of enterprises is the same as for Case IV.

Cases VI and VII. In Case VI, Process P_5 is omitted from consideration. Capital used in Period I is restricted to $100,000 and a six percent discount rate is used. In the first period the optimum livestock system is comprised of cows only, but in the second period both cows and steers are included. In Case III, only steers were included in the second period optimum as capital was less limited. In the third and fourth periods, steers alone make up the optimum and the number is the same as for Case III. All available brushland is sprayed and all abandoned cropland is reseeded to native grass in Time Period II. Case VII is identical to Case VI in all respects except that the discount rate is 20 percent. The higher discount rate does not alter the optimum.

<u>Cases VIII and IX</u>. In Cases VIII and IX steers alone are considered as a livestock alternative. The number of steers in each of the first three time periods is limited by the amount of capital available and in the fourth period by the amount of grazing available. When steers alone are considered and the amount of initial capital available is restricted to $100,000, none of the range improvement practices is profitable if the planning horizon is 20 or fewer years. Case IX differs from Case VIII in only one respect; the discount rate is 20 percent.

<u>Cases X and XI</u>. In Cases X and XI the initial capital restriction is $100,000 and beef cattle Processes P_1, P_5, and P_9 are considered. A land buy activity is included with the acreage available for purchase assumed to be unlimited. In the first time periods no land is purchased so the optimum combination of enterprises is the same as for Cases IV and V in which the alternatives are the same as for X and XI except that the land buy alternative is omitted. In the second period the amount of capital available is sufficient to permit all brushland to be sprayed, abandoned cropland to be reseeded, and additional land to be purchased, thus increasing the amount of grazing available and the number of cows. The fact that all brushland is sprayed and all abandoned cropland is reseeded to native grass during the second time period indicates that such range improvements are more profitable than purchasing land. If this were not true, the limited capital would have been used for additional purchase of land instead of improving owned land.

In the third and fourth time periods additional land is purchased as long as capital is available, and the number of cows is increased to 1,067 and the ranch is increased by 3,449 acres during the 20-year period.

Cases X and XI differ in only one respect, i.e., the discount rate used for Case X is six percent and for Case XI is 20 percent.

Case XII. Case XII is the same as Case XI except that the acreage of land available for purchase is assumed to be limited to 1,280 acres. The same acreage (339 acres) is purchased in Time Period II as for the same period of Cases X and XI, thus, the optimum ranch plan is the same for the first two periods. In the third time period the remaining 941 acres available are purchased, and the number of cows included in the optimum plan for the third and fourth periods is the maximum number for which grazing is available (873 head).

Case XIII. Case XIII differs from Case XII in that the initial amount of capital available in Time Period I is limited to $50,000. This restricts the number of cows in the optimum of Period I to 238, or one-half of the number of Case XII. Resulting income for the first period is, therefore, much lower as is capital for the second time period. Thus, the number of cows in Time Period II is lower for Case XIII than for Case XII. It is not until the third time period that capital is sufficient to permit land buying and range improvement. All available brushland is sprayed and all abandoned cropland is reseeded during the third time period; in addition, 302 acres of land are purchased. In the fourth time period, the remainder of the 1,280 acres of land available is purchased and the optimum enterprise combination is the same as for Case XII. Thus, the ranch organization is identical at the end of 20 years, even though the amount of initial capital was higher for Case XII. Returns for the 20-year time period are much higher for Case XII than for Case XIII.

A comparison of the optima of Cases I and II with the optima of the static analysis when Process P_1, P_5, and P_9 were the livestock alternatives considered shows the optima of Cases I and II to closely resemble the static optimum at the lowest capital rate (see Table XXI). The number of cows in the optimum of the static model is greater than the number in the first time period of Cases I and II as returns from the range improvement practices for the static analysis are assumed to be forthcoming instantaneously. But, in the dynamic analysis the increase in grazing is assumed to occur over a period of time. The number of cows in the optima of the last three time periods is virtually the same as for the static analysis. The amount of capital required by the static optimum is only $17,000 greater than that required by the optimum of Period I for Cases I and II. This indicates that the six and 20 percent discount rates were only slightly more effective in restricting capital than was the 9 - 6 percent capital rate.

Summary and Implications

Dynamic programming results for the 13 cases considered indicate that, when only the spring-calving cow-calf, the fall calving cow-calf, and the buy-sell steer systems most commonly found in the area are considered, the spring-calving cow-calf system is more profitable than either of the other two. This is true regardless of the amount of capital available or the cost of acquiring capital.

If only the fall-calving cow-calf system and the steer system are considered, the fall-calving cow-calf system is more profitable when capital is limited, but when the amount of capital available is unlimited, steers are more profitable. If the amount of capital is limited in the initial time period, the fall-calving cow system is predominant. But, if net returns are allowed to be transferred to future periods at no cost, steers replace the cow-calf system in the optimum ranch program. The greater the limitation on available capital during the initial time period, the more delayed will be the switch from cows to steers.

If the amount of capital available is unlimited, all brush is sprayed and all idle or abandoned cropland reseeded to native grasses in Time Period I. If the amount of capital is limited, these range improvement practices will be delayed until sufficient capital is accumulated to permit these practices to be included in the optimum ranch plan. The greater the limitation on capital, the greater the delay before such practices are included in the optimum plan. Bermuda grass establishment is not included in the optima for any of the 13 cases considered.

If additional land is available for purchase, net returns from early time periods can be profitably used to purchase additional land. However, brush control and reseeding idle cropland to native grasses yield a higher return on capital and would, therefore, have priority over the purchase of land. The acreage of land that can be profitably purchased in each time period is determined by the amount of capital available in the initial time period and net returns in subsequent time periods.

A comparison of the optimum ranch program of the dynamic analysis with the optimum program of the static analysis, with the three livestock alternatives Processes P_1, P_5, and P_9 considered, indicates that the optimum static plan at the lowest capital rate is very similar to the optimum dynamic plan when capital is unrestricted.

However, when Process P_5, the spring calving cow-calf system is omitted from consideration, the static and dynamic optima are different. Steers which are not included in the optimum static program constitute the livestock system after the first period in the dynamic analysis.

The purchase of land also appears to be much more profitable when evaluated in a dynamic framework than in a static framework.

CHAPTER VI

SUMMARY AND CONCLUSIONS

This study was designed specifically to evaluate economic aspects of cattle systems and range improvement and development practices in the beef cattle ranching area of Northeastern Oklahoma. Range improvement practices chosen for the analysis include brush control, reseeding abandoned or idle cropland to native grasses, and establishment of Bermuda grass on idle cropland.

The profitability of range improvement practices depends upon the livestock system through which the resulting increase in forage is marketed. Therefore, it was necessary to determine the input-output coefficients for beef cattle systems adaptable to the area as well as for the range improvement practices. Then, using linear programming analyses, the optimum range development and beef cattle programs were determined, given various resource restrictions, for alternative maximization models. The models included (a) the maximization of net revenue given the usual static conditions, (b) the maximization of the discounted net revenue for alternative length planning periods with various rates of discount and (c) the maximization of the present value of the net income flow under dynamic conditions.

Optimum ranch organizations were determined for eight land resource situations. The initial set of land resources was assumed to be owned. The amount of capital available was varied with each land resource situation, with the maximum amount available depending on the required rate of return selected _a priori_ and on the marginal value productivity of capital. Thus, by varying the required rate of return, the amount of capital was varied with each land resource situation. This method of limiting capital proved very effective in the static analysis and allowed the profitability of various actions to be determined.

Results of the static analysis indicate that, given long-term projected prices and the selected input-output data:

(1) Cow-calf systems are more profitable than buy-sell steer systems when capital is limited relative to land, but if land is limited relative to capital the reverse is true.

(2) Reseeding of idle or abandoned cropland to native grasses will yield a return of 24 percent on short-term or operating capital and 21 percent on long-term or investment capital.

(3) Spraying of brushland under present ACP cost sharing practices will yield a return of 14 percent on short-term and 11 percent on long-term capital and without ACP cost sharing the return is 9 and 6 percent for short and long-term capital, respectively.

(4) Establishment of Bermuda grass with ACP cost sharing on bottom-land soils, for use as hay and grazing, yields a return of 19 percent on operating and 16 percent on long-term capital; establishment on upland soils with ACP cost sharing returns 9 and 6 percent on operating and long-term capital.

(5) Purchase of additional land at existing prices is profitable if the rate of return required on investment capital is six percent or lower and the required return on operating capital is 9 percent or lower.

The effects of price changes on the optimum ranch plan were also determined. A reduction in the price of livestock increases the profitability of cow-calf systems relative to steers, reduces the optimum number of livestock and reduces the profitability of range improvement practices. The amount of capital that can be profitably used at each capital rate and returns to land, management and operator and family labor are also reduced. A price increase tends to have an opposite effect.

Through the maximization of net discounted returns, the effect on the optimum ranch organization of a lapse of time between the date when factors are used and the date when returns are received was determined. The discount rate and the length of the planning horizon are considered important factors in determining the relative profitability of various alternatives. Therefore, optima were determined for planning horizons of ten and twenty years using discount rates of six, fifteen and twenty percent. However, results indicate that for a given discount rate the optima are not different when a 10 year and a 20 year planning period is considered. The discount rate effects the relative profitability of alternatives considered in the same manner as the capital rate in the static analyses.

By the explicit introduction of time into the model, the effect of capital accumulation and the impact of a decision in one time period on production and income during subsequent periods was determined. The dynamic model allows for the transfer of income from productive processes to be transferred to capital for subsequent periods. The model used is dynamic in that action taken in one time period alters the input-output coefficients of later time periods. Any range improvement practice inaugurated in an early time period results in an increase in grazing available in future years. Thus, this model appears more realistic than the static model in that the assumption that resources are required and returns received simultaneously is not necessary.

Results of the dynamic analyses are similar to those of the static analyses when the spring calving cow-calf system most commonly found in the area is considered. However, time is required for the increased grazing resulting from range improvement practices to be realized; thus, a transitory period is required in which the number of animal units of livestock for which grazing is available is lower than under static assumptions. When only the fall calving cow-calf alternative and the buy-sell steer alternative are considered, the cow-calf system is the most profitable when analyzed in a timeless, static framework; this is also true for the initial period when time is an explicit factor, but, as capital is accumulated, the steer system becomes more profitable than the cow-calf system in subsequent periods.

The amount of capital available in the initial time period is effective in determining the optimum scale of operations in subsequent time periods. If the amount available is limited only by its profitability, range improvements can be profitably made on the typical Northeastern Oklahoma ranch in the initial time period, but if it is restricted to $100,000 such activities must be delayed until the second time period and a further restriction will further delay the period in which such practices can be profitably executed.

With existing land prices, spraying brushland and reseeding native grasses on abandoned or idle cropland are more profitable than is the purchase of additional land. The acreage of land which can be profitably purchased in each time period, assuming it is available to purchase, is also determined by the amount of capital available in the initial time period.

Limitations of the Study and Suggestions for Future Analyses

Any linear programming analysis is limited by the researcher's ability to select feasible alternatives for consideration and to develop appropriate input-output coefficients and prices. This study is no exception.

Throughout the study, use of cropland is limited to production of forage for beef cattle production. However, much of the cropland could be used for the production of grain sorghums, or small grains. Livestock alternatives other than forage consuming beef systems were also omitted from consideration. Inclusion of these and other alternatives may have resulted in different optimum plans for given resource situations.

An important factor affecting the profitability of any alternative is the level of technology used. In this analysis, optimum technology is assumed. A lower level of technology would be expected to reduce the profitability of each of the alternatives. It may result in a relatively greater reduction in the profitability of high capital requiring alternatives, such as buy-sell steers, than of lower capital requiring alternatives such as cow-calf enterprises. A study of the effect of varying technology levels on the optimum combination of activities for different resource situations may help to explain the existence of the different livestock systems in the area.

Another important factor not considered in this study is the impact of the existing tax structure on the relative profitability of various beef systems and range improvement practices. The cost of an income tax may shift the relative profitability of two production alternatives as net returns for various enterprises can be markedly changed when returns above taxes are maximized. The capital gains tax provision which limits the rate of taxation on income received from the sale of breeding stock may increase the profitability of cow-calf systems relative to steer systems for ranch operators in high income tax brackets. Tax deductions for making range improvements may also reduce the actual cost of making such improvements and, therefore, increase their profitability.

By including time as an explicit variable in the analysis, one is able to deal with problems of production timing, capital accumulation, and to study the effect of a decision in one time period on production in future time periods. However, when time is included the number of alternatives considered must necessarily be limited or the problem becomes both conceptually and empirically cumbersome. Thus, the realism gained by including time as a variable may be offset by that lost in restricting the number of admissible alternatives.

The programming models assume that resource supplies and input-output coefficients are known with certainty and that the variance of the coefficients is zero.[1] This is obviously not the case in the study area.

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[1]An alternative view is that the various coefficients are expected values.

However, one method of coping with risk and uncertainty is that of discounting returns at a rate commensurate with the manager's subjective evaluation of risk and uncertainty involved. Thus, the optimum programs for high capital and discount rates could be viewed as optima if risk and uncertainty are considered to be high.

Labor coefficients used are for relatively large scale ranches and would require adjusting if applied to smaller operations. However, it is believed that the range over which the results apply, if scaled to the size of operation, would include a high percentage of the ranches of Northeastern Oklahoma.

The assumption is also made throughout the study that all land is owned and that additional land can be obtained by purchase only. Thus, no consideration is given to rental possibilities. Partial budgets indicate, however, that it would be more profitable to rent land, if available, at present rental prices, than to buy.

The effect of range improvements on the value of land needs further investigation. If costs of improvements exceed the increase in land value, the results obtained in the dynamic analysis tend to over estimate the profitability of such improvements. If the value of land is increased more than the costs of improvements, the net amount should be reflected as an addition to returns for making the improvement.

A given set of practices and yields were assumed for each of the range improvement alternatives. Analysis with different practices and yields may have produced different results. For example, costs of establishing Bermuda grass are based on present custom rates. If the rancher has sufficient unpaid family labor, costs may be greatly reduced.

Recommended fertilization rates and resulting expected yields were used; lower fertilization rates and yields may result in a higher net rate of return to capital.

The procedures used in this study are generally applicable to any economic evaluation in which decisions are made among alternatives involving different investment and income patterns over time, or where income in one time period is an important source of investment capital in future periods. The application of results to any individual ranch will depend upon the degree to which the data used and assumptions made represent actual ranch conditions and situations.

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A P P E N D I C E S

APPENDIX A, TABLE 1.1

ESTIMATED PRODUCTION REQUIREMENTS AND INCOME FOR BEEF COW HERD (25 COW UNIT) FALL CALVING; NON-CREEP; CALVES BORN OCTOBER 30; WINTER RATION CSC, AND RANGE; SELLING GOOD-CHOICE FEEDER CALVES JULY 20 (PROCESS P_1)

Capital Item	Number	Total A. U.	Est. Value	Total Value	Requirement Per Cow
Brood cows	25	25	160.00	4,000.00	
Bulls	1	1	300.00	300.00	
Heifers > 1 yr.	4	2	125.00	500.00	
Calves Weaned	21	-	--	--	
Total		28		4,800.00	192.00

Production Item	Number	Weight	Price	Value Each	Total Value	Per Cow
Cull cows	3	987	15.40	152.00	456.00	
Heifer calves	7	450	23.60	106.20	743.40	
Steer calves	10	490	25.60	125.44	1,254.40	
Total Receipts					2,453.80	98.15

Annual Inputs Item	Unit	Rate	Number	Total	Price	Cost	Per Cow
Range	AUM		28	352.00			14.08
CSC, 2.25 lbs/day	Cwt.	3.28	28	91.84	3.80	349.00	
Hay (prairie)	Ton	0.025	28	.70			0.03
Minerals	Lbs.	30.00	28	840.00	.03	25.20	
Vet. and Med.	$	2.00	28	56.00		56.00	
Bull Depr.	$	35.00	1	35.00		35.00	
Hauling	Cwt.			110.11	.25	27.53	
Marketing cost	Cwt.			110.11	.25	27.53	
Tax	1/	4.30	8	34.40		34.40	
Total						554.66	22.18

Returns to Selected Factors 75.96

Labor Requirements Per Cow Unit (Hours):

Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Total
.32	.58	.40	.46	.10	.08	.34	.08	.42	.85	1.10	.72	5.45

[1]Tax computed on basis of $4.30 per $100.00 assessed value.

APPENDIX A, TABLE 1.2

ESTIMATED PRODUCTION REQUIREMENTS AND INCOME FOR BEEF COW HERD (25 COW UNIT) FALL CALVING; NON-CREEP; CALVES BORN OCTOBER 30; WINTER RATION ALFALFA HAY AND RANGE; SELLING GOOD-CHOICE FEEDER CALVES JULY 20 (PROCESS P_2)

Capital Item	Number	Total A. U.	Est. Value	Total Value	Requirement Per Cow
Brood cows	25	25	160.00	4,000.00	
Bulls	1	1	300.00	300.00	
Heifers > 1 yr.	4	2	125.00	500.00	
Calves weaned	21	-	--	--	
Total		28		4,800.00	192.00

Production Item	Number	Weight	Price	Value Each	Total Value	Per Cow
Cull cows	3	987	15.40	152.00	456.00	
Heifer calves	7	450	23.60	106.20	743.40	
Steer calves	10	490	25.60	125.44	1,254.40	
Total Receipts					2,453.80	98.15

Annual Inputs Item	Unit	Rate	Number	Total	Price	Cost	Per Cow
Range	AUM			322.00			12.88
Hay (alfalfa, 8 lbs/day)	Ton	.524	28	14.672			.59
Minerals	Lbs.	30.00	28	840.00	.03	25.20	
Vet. and Med.	$	2.00	28	56.00		56.00	
Bull depr.	$	35.00	1	35.00		35.00	
Hauling	Cwt.			110.11	.25	27.53	
Marketing cost	Cwt.			110.11	.25	27.53	
Tax	1/	4.30	8	34.00		34.00	
Total						205.26	8.21

Returns to Selected Factors 89.94

Labor Requirements Per Cow Unit (Hours):

Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Total
.52	.80	.62	.53	.10	.08	.34	.08	.42	.85	1.10	.94	6.38

[1] Tax computed on basis of $4.30 per $100.00 assessed value.

APPENDIX A, TABLE 1.3

ESTIMATED PRODUCTION REQUIREMENTS AND INCOME FOR BEEF COW HERD (25 COW UNIT) FALL CALVING; NON-CREEP; CALVES BORN OCTOBER 30; WINTER RATION CSC, PRAIRIE HAY AND RANGE; SELLING GOOD-CHOICE FEEDER CALVES JULY 20 (PROCESS P_3)

Capital Item	Number	Total A.U.	Est. Value	Total Value	Requirement Per Cow
Brood cows	25	25	160.00	4,000.00	
Bulls	1	1	300.00	300.00	
Heifers > 1 yr.	4	2	125.00	500.00	
Calves weaned	21	-	--	--	
Total		28		4,800.00	192.00

Production Item	Number	Weight	Price	Value Each	Total Value	Per Cow
Cull cows	3	987	15.40	152.00	456.00	
Heifer calves	7	460	23.60	108.56	759.92	
Steer calves	10	500	25.60	128.00	1,280.00	
Total Receipts					2,495.92	99.84

Annual Inputs Item	Unit	Rate	Number	Total	Price	Cost	Per Cow
Range	AUM			292.00			11.68
CSC, 1.5 lbs/day	Cwt.	2.19	28	61.32	3.80	233.02	
Hay (prairie 12 lbs/day)	Ton	.79	28	22.12			.88
Minerals	Lbs.	30.00	28	840.00	.03	25.20	
Vet. and Med.	$	2.00	28			56.00	
Bull depr.	$	35.00	1	35.00		35.00	
Hauling	Cwt.			111.81	.25	27.95	
Marketing cost	Cwt.			111.81	.25	27.95	
Tax	1/	4.30	8	34.40		34.40	
Total						439.52	17.58
Returns to Selected Factors							82.26

Labor Requirements Per Cow Unit (Hours):

Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Total
.52	.80	.62	.53	.10	.08	.34	.08	.42	.85	1.10	.94	6.38

[1]Tax computed on basis of $4.30 per $100.00 assessed value.

APPENDIX A, TABLE 1.4

ESTIMATED PRODUCTION REQUIREMENTS AND INCOME FOR BEEF COW HERD (25 COW UNIT) FALL CALVING; NON-CREEP; CALVES BORN OCTOBER 30; WINTER RATION OAT-VETCH GRAZING AND 1/3 RATION CSC, HAY AND RANGE; SELLING GOOD-CHOICE FEEDER AND SLAUGHTER CALVES MAY 30 (PROCESS P_4)

Capital Item	Number	Total A. U.	Est. Value	Total Value	Requirement Per Cow
Brood cows	25	25	160.00	4,000.00	
Bulls	1	1	300.00	300.00	
Heifers > 1 yr.	4	2	125.00	500.00	
Calves weaned	21	-	--	--	
Total		28		4,800.00	192.00

Production Item	Number	Weight	Price	Value Each	Total Value	Per Cow
Cull cows	3	987	15.90	156.93	470.79	
Heifer calves	7	430	24.50	105.35	737.45	
Steer calves	10	460	26.50	121.90	1,219.00	
Total Receipts					2,427.24	97.09

Annual Inputs Item	Unit	Rate	Number	Total	Price	Cost	Per Cow
Oat-vetch grazing	AUM			110.00			4.40
Range	AUM			226.00			9.04
CSC, 5 lbs/day	Cwt.	.73	28	20.44	3.80	77.67	
Hay (prairie, 4 lbs/day)	Ton	.20	28	7.34			
Minerals	Lbs.	30.00	28	840.00	.03	25.20	.29
Vet. and med.	$	2.00	28	56.00		56.00	
Bull depr.	$	35.00	1	35.00		35.00	
Hauling	Cwt.			105.71	.25	26.43	
Marketing cost	Cwt.			105.71	.25	26.43	
Tax	1/	4.30	8	34.40		34.40	
Total						281.13	11.25

Returns to Selected Factors 85.84

Labor Requirements Per Cow Unit (Hours):

Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Total
.52	.80	.62	.53	.10	.32	.10	.08	.42	.85	1.10	.94	6.38

[1]Tax computed on basis of $4.30 per $100.00 assessed value.

APPENDIX A, TABLE 1.5

ESTIMATED PRODUCTION REQUIREMENTS AND INCOME FOR BEEF COW HERD (25 COW UNIT) SPRING CALVING; NON-CREEP; CALVES BORN MARCH 5; WINTER RATION CSC, AND RANGE; SELLING GOOD-CHOICE FEEDER CALVES OCTOBER 10 (PROCESS P_5)

Capital Item	Number	Total A. U.	Est. Value	Total Value	Requirement Per Cow
Brood cows	25	25	160.00	4,000.00	
Bulls	1	1	300.00	300.00	
Heifers > 1 yr.	4	2	125.00	500.00	
Calves weaned	22	-	--	--	
Total		28		4,800.00	192.00

Production Item	Number	Weight	Price	Value Each	Total Value	Per Cow
Cull cows	3	987	14.50	143.12	429.36	
Heifer calves	7	460	23.00	105.80	740.60	
Steer calves	11	485	25.00	121.25	1,333.75	
Total Receipts					2,503.71	100.15

Annual Inputs Item	Unit	Rate	Number	Total	Price	Cost	Per Cow
Range	AUM			336.00			13.44
CSC, 1.5 lbs/day	Cwt.	2.19	28	61.32	3.80	233.02	
Hay (prairie)	Ton	.025	28	.70			.03
Minerals	Lbs.	30.00	28	840.00	.03	25.20	
Vet. and med.	$	2.00	28	56.00		56.00	
Bull depr.	$	35.00	1	35.00		35.00	
Hauling	Cwt.			115.20	.25	28.80	
Marketing cost	Cwt.			115.20	.25	28.80	
Tax	1/	4.30	8	34.40		34.40	
Total						441.22	17.65
Returns to Selected Factors							82.50

Labor Requirements Per Cow Unit (Hours):

Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Total
.72	1.15	1.23	.95	.10	.36	.10	.08	.10	.24	.25	.30	5.58

[1] Tax computed on basis of $4.30 per $100.00 assessed value.

APPENDIX A, TABLE 1.6

ESTIMATED PRODUCTION REQUIREMENTS AND INCOME FOR BEEF COW HERD (25 COW UNIT) FALL CALVING; CREEP FEED; CALVES BORN OCTOBER 30; WINTER RATION CSC, AND RANGE; SELLING GOOD-CHOICE FEEDER STEERS JULY 20 (PROCESS P_6)

Capital Item	Number	Total A. U.	Est. Value	Total Value	Requirement Per Cow
Brood cows	25	25	160.00	4,000.00	
Bulls	1	1	300.00	300.00	
Heifers > 1 yr.	4	2	125.00	500.00	
Calves weaned	21	-	--	--	
Total		28		4,800.00	192.00

Production Item	Number	Weight	Price	Value Each	Total Value	Per Cow
Cull cows	3	987	15.40	152.00	456.00	
Heifer calves	7	520	24.00	124.80	873.60	
Steer calves	10	560	26.00	145.60	1,456.00	
Total Receipts					2,785.60	111.42

Annual Inputs Item	Unit	Rate	Number	Total	Price	Cost	Per Cow
Range	AUM		28	336.00			13.44
CSC, 2.25 lbs/day	Cwt.	3.28	28	91.84	3.80	349.00	
Hay (prairie)	Ton	.025	28	31.70			.03
Creep feed	Cwt.	8.50	21	178.50	3.08	549.78	
Minerals	Lbs.	30.00	28	840.00	.03	25.20	
Vet. and med.	$	2.00	28	56.00		56.00	
Bull depr.	$	35.00	1	35.00		35.00	
Hauling	Cwt.			122.01	.25	30.50	
Marketing cost	Cwt.			122.01	.25	30.50	
Tax	1/	4.30	8	34.40		34.40	
Total						1,110.38	44.42

Returns to Selected Factors 67.00

Labor Requirements Per Cow Unit (Hours):

Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Total
.72	1.00	.80	.73	.20	.18	.34	.08	.42	.85	1.10	.94	7.36

[1]Tax computed on basis of $4.30 per $100.00 assessed value.

APPENDIX A, TABLE 1.7

ESTIMATED PRODUCTION REQUIREMENTS AND INCOME FOR BEEF COW HERD (25 COW UNIT) SPRING CALVING; CREEP; CALVES BORN MARCH 5; WINTER RATION CSC, AND RANGE; SELLING GOOD-CHOICE FEEDER CALVES; OCTOBER 10 (PROCESS P_7)

Capital Item	Number	Total A. U.	Est. Value	Total Value	Requirement Per Cow
Brood cows	25	25	160.00	4,000.00	
Bulls	1	1	300.00	300.00	
Heifers > 1 yr.	4	2	125.00	500.00	
Calves weaned	22	-	--	--	
Total		28		4,800.00	192.00

Production Item	Number	Weight	Price	Value Each	Total Value	Per Cow
Cull cows	3	987	14.50	143.12	429.36	
Heifer calves	7	495	23.00	113.85	796.95	
Steer calves	11	520	25.00	130.00	1,430.00	
Total Receipts					2,656.31	106.25

Annual Inputs Item	Unit	Rate	Number	Total	Price	Cost	Per Cow
Range	AUM	12	28	336.00			13.44
CSC, 1.5 lbs/day	Cwt.	2.19	28	61.32	3.80	233.02	
Hay (prairie)	Ton	.025	28	.70			.030
Creep feed (3 lbs/ day)	Cwt.	4.83	22	106.00	3.08	326.50	
Minerals	Lbs.	30.00	28	840.00	.03	25.20	
Vet. and med.	$	2.00	28	56.00		56.00	
Bull depr.	$	35.00	1	35.00		35.00	
Hauling	Cwt.			121.45	.25	30.36	
Marketing cost	Cwt.			121.45	.25	30.36	
Tax	1/	4.30	8	34.40		34.40	
Total						770.84	30.83
Returns to Selected Factors							75.42

Labor Requirements Per Cow Unit (Hours):

Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Total
.94	1.37	1.45	.95	.20	.56	.20	.28	.20	.34	.25	.52	7.26

[1]Tax computed on basis of $4.30 per $100.00 assessed value.

APPENDIX A, TABLE 2.1

ESTIMATED PER UNIT PRODUCTION REQUIREMENTS AND INCOME FOR WINTERING GOOD FEEDER STEERS, FALL-BUY OCTOBER 10; ROUGHED THROUGH WINTER ON RANGE, COTTON SEED CAKE SUPPLEMENT, SOLD APRIL 1 (PROCESS P_8)

Item	Unit	Amount	Price	Value
Process Inputs				
Calf	Cwt.	4.50	25.00	112.50
Native range	AUM	3.00		
CSC, 1.75 lbs/day	Cwt.	2.65	3.80	10.07
Prairie hay	Ton	0.05		
Vet. and med.	$	0.75		0.75
Minerals	Lbs.	8.30	0.03	0.25
Hauling	Cwt.	9.50	0.25	2.38
Marketing costs	Cwt.	9.50	0.25	2.38
Total				128.33
Returns	Cwt.	5.00	27.00	135.00
Less 1 percent shrinkage				133.50
Returns to Selected Factors				5.17

Labor Requirements Per Steer (Hours):

Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Total
.25	.25	.25	0.0	0.0	0.0	0.0	0.0	0.0	.18	.15	.25	1.33

APPENDIX A, TABLE 2.2

ESTIMATED PER UNIT PRODUCTION REQUIREMENTS AND INCOME FOR PRODUCING GOOD FEEDER STEERS; FALL-BUY OCTOBER 10; ROUGHED THROUGH WINTER ON RANGE, COTTON SEED CAKE SUPPLEMENT, SOLD OFF GRASS, AUGUST 10 (PROCESS P_9)

Item	Unit	Amount	Price	Value
Process Inputs				
Calf	Cwt.	4.50	25.00	112.50
Native range	AUM	6.00		
CSC, 1.75 lbs/day	Cwt.	2.90	3.80	11.02
Prairie hay	Ton	0.05		
Vet. and med.	$	1.45		1.45
Mineral	Lbs.	16.30	0.03	0.49
Hauling	Cwt.	11.75	0.25	2.94
Marketing costs	Cwt.	11.75	0.25	2.94
Tax	$100 assessed value	0.15	4.30	0.64
Total				131.98
Returns	Cwt.	7.25	23.00	166.75
Less 1 percent shrinkage				165.08
Returns to Selected Factors				33.10

Labor Requirements Per Steer (Hours):

Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Total
.25	.25	.25	.25	.18	.10	.18	.12	0.0	.18	.25	.25	2.26

APPENDIX A, TABLE 2.3

ESTIMATED PER UNIT PRODUCTION REQUIREMENTS AND INCOME FOR PRODUCING GOOD FEEDER STEERS; FALL-BUY OCTOBER 10; LATE SUMMER SELL AUGUST 10; WINTER RATION, COTTONSEED CAKE AND PRAIRIE HAY, SOLD OFF GRASS (PROCESS P_{10})

Item	Unit	Amount	Price	Value
Process Inputs				
Calf	Cwt.	4.50	25.00	112.50
Native range	AUM	3.00		
CSC, 1.25 lbs/day	Cwt.	2.07	3.80	7.87
Prairie hay, 12 lbs/ day	Ton	1.00		
Vet. and med.	$	1.45		1.45
Mineral	Lbs.	16.30	.03	.49
Hauling	Cwt.	12.10	.25	3.03
Buy-sell cost	Cwt.	12.10	.25	3.03
Tax	$100 assessed value	0.15	4.30	.64
Total				129.01
Returns	Lbs.	760.00	23.00	174.80
Less 1 percent shrinkage				173.05
Returns to Selected Factors				44.04

Labor Requirements Per Steer (Hours):

Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Total
.41	.41	.41	.20	.18	.10	.18	.12	0.0	.18	.41	.41	3.01

APPENDIX A, TABLE 2.4

ESTIMATED PER UNIT PRODUCTION REQUIREMENTS AND INCOME FOR PRODUCING GOOD FEEDER STEERS; FALL-BUY OCTOBER 10; SPRING SELL MAY 10; WINTER RATION, OAT-VETCH GRAZING AND PRAIRIE HAY (PROCESS P_{11})

Item	Unit	Amount	Price	Value
Process Inputs				
Calf	Cwt.	4.50	25.00	112.50
Native range	AUM	0.50		
Oats and vetch grazing	AUM	2.80		
Prairie hay	Ton	0.33		
Cottonseed cake	Cwt.	0.69		2.62
Vet. and Med.	$	1.45		1.45
Mineral	Lbs.	16.30	.03	.49
Hauling	Cwt.	11.66	.25	2.91
Buy-sell cost	Cwt.	11.66	.25	2.91
Tax	$100 assessed value	0.15	4.30	.64
Total				123.54
Returns	Lbs.	716.00	25.00	179.00
Less 1 percent shrinkage				177.21
Returns to Selected Factors				53.69

Labor Requirements Per Steer (Hours):

Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Total
.15	.15	.10	.10	.34	--	--	--	--	.18	.10	.10	1.22

APPENDIX A, TABLE 2.5

ESTIMATED PER UNIT PRODUCTION REQUIREMENTS AND INCOME FOR PRODUCING GOOD FEEDER STEERS; SPRING BUY APRIL 1; SELL AUGUST 10; GRAZING DURING SUMMER (PROCESS P_{12})

Item	Unit	Amount	Price	Value
Process Inputs				
Steer	Cwt.	5.00	27.00	135.00
Native range	AUM	3.00		
Vet. and med.	$	0.70		0.70
Mineral	Lbs.	16.30	0.03	0.24
Hauling	Cwt.	12.25	0.25	3.06
Buy-sell cost	Cwt.	12.25	0.25	3.06
Total				142.06
Returns	Lbs.	725.00	23.00	166.75
Less 1 percent shrinkage				165.08
Returns to Selected Factors				23.02

Labor Requirements Per Steer (Hours):

Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Total
--	--	--	.28	.10	.18	.10	.10	--	--	--	--	.76

APPENDIX A, TABLE 2.6

ESTIMATED PER UNIT PRODUCTION REQUIREMENTS AND INCOME FOR PRODUCING GOOD FEEDER STEERS; SPRING BUY APRIL 1; SELL SEPTEMBER 1; SUDAN GRAZING (PROCESS P_{13})

Item	Unit	Amount	Price	Value
Steer	Cwt.	5.00	27.00	135.00
Native range	AUM	1.20		
Sudan grazing	AUM	2.00		
Vet. and med.	$	0.70		0.70
Mineral	Lbs.	8.00	.03	0.24
Hauling	Cwt.	12.65	.25	3.16
Buy-sell cost	Cwt.	12.65	.25	3.16
Total				142.26
Returns	Lbs.	765.00	22.70	173.66
Less 1 percent shrinkage				171.92
Returns to Selected Factors				29.66

Labor Requirements Per Steer (Hours):

Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Total
--	--	--	.28	.10	.18	.10	.24	--	--	--	--	.90

APPENDIX A, TABLE 3.1

ESTIMATED PER ACRE REQUIREMENTS, COSTS, AND RETURNS FOR RESEEDING NATIVE GRASS FOR PASTURE ON IDLE CROPLAND, UPLAND, AND BOTTOMLAND (PROCESSES P_{14}, P_{15}, P_{16}, P_{17}) NORTHEASTERN OKLAHOMA

Operation	Equipment	Times Over	Labor Hours/Acre	Tractor Hours/Acre	Equipment Cost* Per Hour	Equipment Cost* Per Acre
Machine and Labor Requirements Per Acre for Establishment:						
Chisel	10' Hoeme	1.0	.3	.3	.57	.17
Disc	6' Tandem	2.0	1.0	1.0	.21	.21
Harrow	12' Spiketooth	1.0	.3	.3	.15	.05
Seed	10' Drill	1.0	.5	.5	.84	.42
Total			2.1	2.1		.85

Total Machinery Costs and Labor for Establishment:

Item	Per Acre
Tractor (2.1 hours at $.81)	$1.70
Other machinery	.85
Labor (February 1.3, April .8)	2.1 hours

Materials Per Acre:

Seed (10 lbs of 30-40 percent PLS at $.60)	$6.00
Spray (to control weeds first year)	1.50
Total Materials Cost	$7.50
Total Establishment Costs without ACP (Processes P_{14} and P_{15})	$10.05
Less Estimated ACP	5.00
Total Farmers Cost with ACP (Processes P_{16} and P_{17})	$ 5.05 plus 2.1 hours labor

Production:	Bottomland P_{15} and P_{17}	Upland P_{14} and P_{16}
First year	0	0
Second year	0	0
Third year and each year thereafter	1.5 AUM/Acre	1.2 AUM/Acre

Annual Costs:

Spray (one year in 10 at $1.50)	$.15

*Excluding tractor costs.

APPENDIX A, TABLE 3.2

ESTIMATED PER ACRE REQUIREMENTS, AND PRODUCTION FOR BRUSHLAND PASTURE, COSTS OF AERIAL TREATMENT AND ESTIMATED POST-TREATMENT COSTS AND PRODUCTION (PROCESSES P_{18} AND P_{19}) NORTHEASTERN OKLAHOMA

Native Range (Brushland Pasture) Before Treatment	
Establishment costs	None
Annual maintenance costs	None
Labor	None
Estimated production	.3 AUM Grazing
Native Range (Brushland Pasture) Brush Controlled:	
(Per Acre Cost for Aerial Treatment)	
Custom Aerial Spraying (2.0 times at $7.00)	$14.00
Less ACP	7.00
Total Farmer Cost	$ 7.00
(Annual Maintenance)	
Respraying (one year in 7 at $7.00)	$ 1.00
(Estimated Per Acre Production After Treatment)	
1st year (winter only)	.5 AUM/Acre
2nd year (winter only)	1.0 AUM/Acre
3rd year and thereafter	1.2 AUM/Acre

APPENDIX A, TABLE 3.3

ESTIMATED PER ACRE REQUIREMENTS AND COSTS FOR ESTABLISHING MIDLAND BERMUDA GRASS (PROCESSES P_{20} TO P_{31}) NORTHEASTERN OKLAHOMA

Operation	Equipment	Times Over	Labor Hours/Acre	Tractor Hours/Acre	Equipment Cost* Per Hour	Equipment Cost* Per Acre
Machine and Labor Requirements Per Acre for Establishment:						
Break	2'14" M.B.	1.0	1.2	1.2	.37	.44
Disc	6'Tandem	2.0	1.0	1.0	.21	.21
Harrow	3 Section	1.0	.7	.7	.15	.11
Fertilize and overseed:	10'Drill	1.0	.5	.5	.84	.42
Total			3.4	3.4		1.18

Total Machinery Costs and Labor for Establishment:

Item	Per Acre
Tractor (3.4 hours at $.81)	$2.75
Other machinery	1.18
Labor (April 1.7, May .5, July .7, Sept. .5)	3.4 hours
Contract sprigging (sprigs furnished-registered Midland)	14.00
Materials Per Acre:	
Fertilizer (200 lbs of 10-20-10 at $79/ton)	$7.90
Legume seed (10 lbs vetch at $.13/lb., 5 lbs lespedeza at $.17, 2 lbs big hop at $1.00)	4.15
Lime (1 ton at $4.50/ton)	4.50
Total Materials Cost	$16.55
Total Establishment Costs without ACP	$34.48
Less ACP	19.00
Total Farmer Cost with ACP	$15.48 plus 3.4 hours labor

*Excluding tractor costs.

APPENDIX A, TABLE 3.4

ANNUAL PER ACRE COSTS AND PRODUCTION FOR BERMUDA-LEGUME PASTURES BOTTOMLAND AND UPLAND SOILS, NORTHEASTERN OKLAHOMA (PROCESSES P_{20}, P_{21}, P_{22}, P_{23})

Operation	Equipment	Times Over	Labor Hours/Acre	Tractor Hours/Acre	Equipment Cost* Per Hour	Equipment Cost* Per Acre
Annual Machine and Labor Requirements Per Acre:						
Fertilize and overseed:	10' Drill	1.0	.5	.5	.84	.42
Mow	7' Mounted	1.0	.4	.4	.60	.24
Total			.9	.9		.66

Total Machinery and Labor: Item	Annual Per Acre
Tractor (.9 hours at $.81)	$ .73
Other machinery	.66
Labor (April .5, July .4)	.90 hours
Materials Per Acre:	
Fertilizer (200 lbs 10-20-10 at $79/ton)	$7.90
Legume seed (10 lbs vetch at $.13, 5 lbs lespedeza at $.17, 3 times in 10 years)	.64
Total Materials Cost	$8.54
Total Annual Costs Per Acre	$9.93 plus .90 hours labor

Production:	Bottomland P_{21} and P_{23}	Upland P_{20} and P_{22}
First year	0	0
Second year and each year thereafter	4.0 AUM/Acre	3.0 AUM/Acre

*Excluding tractor costs.

APPENDIX A, TABLE 3.5

ANNUAL PER ACRE COSTS AND PRODUCTION FOR BERMUDA-LEGUME HAY AND PASTURE ON UPLAND SOILS, (PROCESSES P_{24} AND P_{25}) NORTHEASTERN OKLAHOMA

Operation	Equipment	Times Over	Labor Hours/Acre	Tractor Hours/Acre	Equipment Costs* Per Hour	Equipment Costs* Per Acre
Equipment and Labor Requirements Per Acre:						
Fertilize and over-seed:	10' Drill	1.0	.5	.5	.84	.42
Mow	7' Mounted	2.0	.8	.8	.60	.48
Rake	Side Delivery	2.0	.8	.8	.66	.53
Bale	Pickup	2.0	1.2	1.2	1.43	1.72
Haul	1 1/2 Ton Truck	2.0	4.2	-	1.00	1.00
Total			7.5	3.3		4.15

Total Machinery and Labor:

Item	Per Acre
Tractor (3.3 hours at $.81)	$ 2.67
Other machinery	4.15
Labor (April .5, July 3.5, Aug. 3.5)	7.5 hours
Materials Per Acre:	
Baler Wire	$2.40
Fertilizer (200 lbs 10-20-10 at $79/ton)	7.90
Legume seed (10 lbs vetch and 5 lbs lespedeza, 3 times in 10 years)	.64
Total Materials Cost	$10.94
Total Annual Costs Per Acre	$17.76 plus 7.5 hours labor

Production:

First year	None
Second year and each year thereafter	2.0 Tons Hay and 1.0 AUM Grazing

*Excluding tractor costs.

APPENDIX A, TABLE 3.6

ANNUAL PER ACRE COSTS AND PRODUCTION FOR BERMUDA-LEGUME HAY AND PASTURE ON BOTTOMLAND SOILS, (PROCESSES P_{26} AND P_{27}) NORTHEASTERN OKLAHOMA

Operation	Equipment	Times Over	Labor Hours/Acre	Tractor Hours/Acre	Equipment Cost* Per Hour	Equipment Cost* Per Acre
Equipment and Labor Requirements Per Acre:						
Fertilize and over-seed	10' Drill	1.0	.5	.5	.84	.42
Mow	7' Mounted	2.0	.8	.8	.60	.48
Rake	Side Delivery	2.0	.8	.8	.66	.53
Bale	Pickup	2.0	1.2	1.2	1.43	1.72
Haul	1 1/2 Ton Truck	2.0	4.2	-	1.00	1.00
Total			7.5	3.3		4.15

Total Machinery and Labor:

Item	Per Acre
Tractor (3.3 hours at $.81)	$ 2.67
Other machinery	4.15
Labor (April .5, July 3.5, Aug. 3.5)	7.5 hours

Materials Per Acre:

Baler wire	$ 3.00
Fertilizer (200 lbs 10-20-10 at $79/ton)	7.90
Legume seed (10 lbs vetch and 5 lbs lespedeza - 3 times in 10 years)	.64
Total Materials Cost	$11.54
Total Annual Costs Per Acre	$18.36 plus 7.5 hours labor

Production:

First year	None
Second year and each year thereafter	2.5 Tons Hay and 1.5 AUM Grazing

*Excluding tractor costs.

APPENDIX A, TABLE 3.7

ANNUAL PER ACRE COSTS AND PRODUCTION FOR BERMUDA-LEGUME PASTURES OVERSEEDED WITH RYE ON UPLAND SOILS (PROCESSES P_{28} AND P_{29}) NORTHEASTERN OKLAHOMA

Operation	Equipment	Times Over	Labor Hours/Acre	Tractor Hours/Acre	Equipment Cost* Per Hour	Equipment Cost* Per Acre
Annual Machine and Labor Requirements Per Acre:						
Fertilize and Over-seed	10' Drill	2.0	1.0	1.0	.84	.84
Mow	7' Mounted	1.0	.4	.4	.60	.24
Total			1.4	1.4		1.08

Total Machinery and Labor:

Item	Per Acre
Tractor (1.4 hours at $.81)	$ 1.13
Other machinery	1.08
Labor (Sept. .5, July .4, April .5)	1.4 hours
Materials Per Acre:	
Fertilizer (200 lbs 10-20-10 at $79/ton)	$ 7.90
Legume seed (10 lbs vetch at $.13, 5 lbs lespedeza at $.17, 3 times in 10 years)	.64
Rye (1 bu. at $1.50)	1.50
Total Materials Cost	$10.04
Total Annual Costs Per Acre	$12.25 plus 1.4 hours labor
Production:	
First year	None
Second year and each year thereafter	3.5 AUM Grazing/Acre

*Excluding tractor costs.

APPENDIX A, TABLE 3.8

ANNUAL PER ACRE COSTS AND PRODUCTION FOR BERMUDA-LEGUME PASTURES OVERSEEDED WITH RYE ON BOTTOMLAND SOILS (PROCESSES P_{30} AND P_{31}) NORTHEASTERN OKLAHOMA

Operation	Equipment	Times Over	Labor Hours/Acre	Tractor Hours/Acre	Equipment Cost* Per Hour	Equipment Cost* Per Acre
Annual Machine and Labor Requirements Per Acre:						
Fertilize and Over-seed	10' Drill	2.0	1.0	1.0	.84	.84
Mow	7' Mounted	1.0	.4	.4	.60	.24
Total			1.4	1.4		1.08

Total Machinery and Labor:

Item	Per Acre
Tractor (1.4 hours at $.81)	$1.13
Other machinery	1.08
Labor (Sept. .5, July .4, April .5)	1.4 hours
Materials Per Acre:	
Fertilizer (200 lbs 10-20-10 at $79/ton)	$7.90
Legume seed (10 lbs vetch at $.13, 5 lbs lespedeza at $.17, 3 times in 10 years)	.64
Rye (1 bu. at $1.50)	1.50
Total Materials Cost	$10.04
Total Annual Costs Per Acre	$12.25 plus 1.4 hours labor
Production:	
First year	None
Second year and each year thereafter	4.5 AUM Grazing/Acre

*Excluding tractor costs.

APPENDIX A, TABLE 4.1

ANNUAL PER ACRE COSTS AND PRODUCTION FOR NATIVE GRASS MEADOWS (PROCESS P_{32}) NORTHEASTERN OKLAHOMA

Operation	Equipment	Times Over	Labor Hours/Acre	Tractor Hours/Acre	Equipment Cost* Per Hour	Equipment Cost* Per Acre
Annual Machine and Labor Requirements Per Acre:						
Mow	7' Mounted	1.0	.4	.4	.60	.24
Rake	Side Delivery	1.0	.4	.4	.66	.26
Bale	Pickup	1.0	.6	.6	1.43	.86
Haul	1 1/2 Ton Truck	1.0	2.1	-	1.00	.90
Total			3.5	1.4		2.26

Total Machinery and Labor:

Item	Per Acre
Tractor (1.4 hours at $.81)	$1.13
Other machinery	2.26
Labor (July 3.5)	3.5 hours

Materials Per Acre:

Baler wire	$1.10
Total Annual Costs Per Acre	$4.49 plus 3.5 hours labor

Production: .9 Tons Hay and .3 AUM Grazing

*Excluding tractor costs.

APPENDIX A, TABLE 4.2

ESTIMATED PER ACRE REQUIREMENTS AND COSTS FOR ESTABLISHING ALFALFA-BROME ON BOTTOMLAND SOILS (PROCESS P_{33}) NORTHEASTERN OKLAHOMA[1]

Operation	Equipment	Times Over	Labor Hours/Acre	Tractor Hours/Acre	Equipment Cost* Per Hour	Equipment Cost* Per Acre
Machine and Labor Requirements Per Acre for Establishment:						
Break	2-14" M.B.	1.0	1.2	1.2	.37	.44
Disc	6' Tandem	2.0	1.0	1.0	.21	.21
Harrow	12' Spike Tooth	2.0	.6	.6	.15	.09
Fertilize and seed	10' Drill	1.0	.5	.5	.84	.42
Total			3.3	3.3		1.16

Total Machinery Costs and Labor for Establishment:

Item	Per Acre
Tractor (3.3 hours at $.81)	$2.67
Other machinery	1.16
Labor (Aug. 1.2, Sept. 2.1)	3.3 hours
Materials Per Acre:	
Fertilizer (200 lbs 0-20-0 at $39.00)	$3.90
Seed (18 lbs alfalfa at $.30 and 5 lbs brome at $.20)	6.40
Lime (1.25 tons at $4.50/ton)	5.62
Total Materials Cost	$15.92
Total Establishment Costs	$19.75 plus 3.3 hours labor

*Excluding tractor costs.

[1]Estimated life of stand is five years.

APPENDIX A, TABLE 4.3

ANNUAL PER ACRE COST AND PRODUCTION FOR ALFALFA-BROME HAY ON BOTTOMLAND SOILS (PROCESS P_{33}) NORTHEASTERN OKLAHOMA

Operation	Equipment	Times Over	Labor Hours/Acre	Tractor Hours/Acre	Equipment Cost* Per Hour	Equipment Cost* Per Acre
Annual Machine and Labor Requirements Per Acre:						
Fertilize and seed	10' Drill	1.0	.5	.5	.84	.42
Mow	7' Mounted	2.0	.8	.8	.60	.48
Rake	Side Delivery	2.0	.8	.8	.66	.53
Bale	Pickup	2.0	1.2	1.2	1.43	1.72
Haul	1 1/2 Ton Truck	2.0	4.2	-	1.00	1.00
Total			7.5	3.3		4.15

Total Machinery and Labor:

Item	Per Acre
Tractor (3.3 hours at $.81)	$2.67
Other machinery	4.15
Labor (March .5, June 3.5, July 3.5)	7.5 hours
Materials Per Acre:	
Fertilizer (200 lbs 0-20-0 at $39.00)	$3.90
Baler wire	3.60
Total Materials Cost	$7.50
Total Annual Costs Per Acre	$14.32 plus 7.5 hours labor
Production:	3.0 Tons Hay

*Excluding tractor costs.

APPENDIX A, TABLE 4.4

PER ACRE COSTS AND PRODUCTION FOR WINTER OAT-VETCH GRAZING, NORTHEASTERN OKLAHOMA

Operation	Equipment	Times Over	Labor Hours/Acre	Tractor Hours/Acre	Equipment Cost* Per Hour	Equipment Cost* Per Acre
Equipment and Labor Requirements Per Acre:						
Fertilize and seed	10' Drill	1.0	.5	.5	.84	.42
Break	2-14" M.B.	1.0	1.2	1.2	.37	.44
Disc	6' Tandem	2.0	1.0	1.0	.21	.21
Harrow	12' Spike Tooth	1.0	.3	.3	.15	.05
Total			3.0	3.0		1.12

Total Machinery and Labor:

Item	Per Acre
Tractor (3.0 hours at $.81)	$2.43
Other machinery	1.12
Labor (Sept. 2.2, Oct. .8)	3.0 hours

Materials Per Acre:

Fertilizer (100 lbs 10-20-10 at $79/ton)	$3.95
Seed (2 bu. at $1.10 and 10 lbs vetch at $.13)	3.50
Total Materials Cost	$7.45
Total Cost Per Acre	$11.00 plus 3.0 hours labor
Production:	3.2 AUM Grazing

*Excluding tractor costs.

APPENDIX A, TABLE 4.5

PER ACRE COSTS AND PRODUCTION FOR SUDAN FOR GRAZING, NORTHEASTERN OKLAHOMA

Operation	Equipment	Times Over	Labor Hours/Acre	Tractor Hours/Acre	Equipment Cost* Per Hour	Equipment Cost* Per Acre
Equipment and Labor Requirements Per Acre:						
Fertilize and Seed	10' Drill	1.0	.5	.5	.84	.42
Break	2-14" M.B.	1.0	1.2	1.2	.37	.44
Disc	6' Tandem	2.0	1.0	1.0	.21	.21
Harrow	12' Spike Tooth	1.0	.3	.3	.15	.04
Total			3.0	3.0		1.12

Total Machinery and Labor:

Item	Per Acre
Tractor (3.0 hours at $.81)	$2.43
Other machinery	1.12
Labor (April 2.2, May .8)	3.0 hours

Materials Per Acre:

Fertilizer (100 lbs 5-10-5 at $47/ton)	$2.35
Seed (10 lbs at $.07/lb)	.70
Total Materials Cost	$3.05
Total Cost Per Acre	$6.60 plus 3.0 hours labor

Production: 2.66 AUM Grazing

*Excluding tractor costs.

APPENDIX B

STATISTICAL ESTIMATION OF CALF WEIGHTS

The calf weights used in the budgets are adjusted weights of regression estimates computed from experimental data on experiments conducted by the Animal Husbandry Department of Oklahoma State University. The experiments were conducted to determine the expected weights of calves at different ages and to determine the effects of creep-feeding on weight at different ages. The experiments provided data that made it possible to compare the weights of fall calves with the weights of spring calves at different ages, and also to compare Creep and Non-Creep fed calf weights.

The two groups of calves--spring and fall--were further divided on the basis of creep-fed and non-creep fed and also on the basis of sex; thus, the data were divided into eight sets:

(1) Creep-fed fall steers

(2) Non-creep fed fall steers

(3) Creep-fed fall heifers

(4) Non-creep fed fall heifers

(5) Creep-fed spring steers

(6) Non-creep fed spring steers

(7) Creep-fed spring heifers

(8) Non-creep fed spring heifers.

Weights were determined and recorded for each calf at regular intervals during the course of the experiment.

Statistical Procedures

Four different statistical models were fitted to each set of experimental data. These were:

(1) $\hat{Y} = a + b_1x_1$

(2) $\hat{Y} = a + b_1x_1 + b_2x_2$

(3) $\hat{Y} = a + b_1x_1 + b_2x_2 + b_3x_3$

(4) $\hat{Y} = a + b_1x_1 + b_3x_3$

with $\hat{Y}$ = estimated weight of calves, x_1 = age, $x_2 = x_1^2$, and x_3 = year.

Equation (1) is a linear equation using only age to estimate the weight of calves. Linear equations of this nature were fitted to all the data; however, other equations significantly reduced the variation and, therefore, gave better estimates of calf weight for all but two classes of the data. The two classes for which the linear equation gave as good an estimate of weight as either of the other two equations were (1) creep-fed spring steers and (2) non-creep fed spring heifers.

Equation (2) is a second degree polynomial. If the b_2 value is positive (assuming b_1 positive) the estimating line or curve will be concave upward; if the b_2 value is negative, the estimating line will be concave downward. This equation was the best fitting equation for three classes of the data, namely, (1) creep-fed fall heifers (2) non-creep fed fall heifers, (3) non-creep fed fall steers.

Equation (3) is also a second degree polynomial with an additional variable, year, added. This equation was fitted to test the hypothesis that the year in which the observations were made would affect the nature of the data. This equation proved to be the best fitting equation for only a single class of the data, creep-fed fall steers.

Equation (4) is a linear equation involving the use of two independent variables, age and year, to predict the weights of calves at various ages. This equation fitted the data significantly better than the other equations for two classes of calves (1) creep-fed spring heifers, (2) and non-creep fed spring steers.

CRITERIA FOR EVALUATING THE STATISTICAL MODELS

The t_{bi}, R^2, F and S^2 values are the statistical measurements that were used to determine the goodness of fit, or accuracy of estimation for each of the selected equations.

The t_{bi} is the symbol for the t or students test of the b_i values. It is a test to determine whether each of the b values differs significantly from zero.

The R^2 value is the coefficient of determination. It measures the closeness with which the estimated line fits the actual data. If the R^2 value is 1.0, all estimated values, for given x values, and actual values are identical, i.e., $\hat{Y} = Y$. The greater the departure of the R^2 value from 1.0, the less accurate the estimating equation.[1]

The F value is a ratio of the variance left unexplained after regression to that explained by regression. It is seldom, if ever, worthwhile to calculate both t and F values.

The S^2 value is the sum of squares of deviation or the amount of variation from the line of regression. It indicates the amount by which the estimated line fails to fit the actual data.

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[1]The R^2 value will never be more than 1 nor less than zero.

THE RESULTS WITH EXPERIMENTAL DATA

The results for the experimental data are presented in Appendix B, Tables 1, 2, and 3. The relevant statistical data for the estimating equation, $\hat{Y} = a + b_1x_1 + b_2x_2 + b_3x_3$ are presented in Appendix B, Table 1. It will be noted that only three of the b_3 values were significant at the 1 percent level. All of the b_3 values for the fall calves were negative; this is probably due to the fact that weather conditions were becoming increasingly adverse over the three year period in which the experiments were conducted, and not due to management practices. The b_3 values for the spring calf data are all positive; this can be attributed to favorable weather conditions and improved technology over the three year period during which the spring calving experiments were conducted.

As only three of the b_3 values were significant at the 1 percent level and weather, which is unpredictable for a given year, was believed to be the greatest contributing factor to the variation between years, the x_3 variable was dropped from the equation and the second degree binomial was fitted to the data.[2] These results are presented in Appendix B, Table 2.

After having fitted both the polynomial equation, $\hat{Y} = a + b_1x_1 + b_2x_2$ (where $x_2 = x_1^2$) and the equation $\hat{Y} = a + b_1x_1 + b_2x_2 + b_3x_3$, a simple linear equation, $\hat{Y} = a + b_1x_1$ was fitted to each class of the data. The results of fitting the data to this equation are presented in Appendix B, Table 3.

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[2]The b_2 value for the creep-fed spring steer, creep-fed spring heifer, non-creep spring steer, and non-creep fed spring heifer data were not significant at the 5 percent level so the second degree polynomial was not fitted to these data.

A comparison of the S^2 values in each of the three tables containing equations and statistics for the experimental data will indicate that most of the S^2 values are reduced relatively little by including the x_2 and x_3 variables in the equation even though the b_2 variable is significant for 4 of the 8 equations and the b_3 variable is significant for three of the equations. This would indicate that the equation $\hat{Y} = a + b_1x_1$ would, for most purposes, be the more practical equation to use. The R^2 values also remain nearly as high for the simple linear equation.

APPENDIX B, TABLE 1

SELECTED STATISTICS RELATED TO ALTERNATIVE EQUATIONS FOR CALVES, EXPERIMENTAL DATA 1954-55-56

Equation	a value		b_i value	S_{bi}	t_{bi}	R^2	F	S^2
$\hat{Y} = a + b_1x_1 + b_2x_2 + b_3x_3$								
Creep fall steers	94.953	b_1	.951**	.097	9.777	.966	1507.118**	879.360
		b_2	.003691**	.360	10.238			
		b_3	-5.913	3.438	- 1.720			
Creep fall heifers	119.868	b_1	1.062**	.110	9.664	.914	838.150**	1841.496
		b_2	.002065**	.383	5.393			
		b_3	-16.949**	3.400	- 4.984			
Non-creep fall steers	94.810	b_1	.880**	.119	7.395	.892	570.094**	1926.544
		b_2	.001775**	.386	4.597			
		b_3	-5.521	3.890	-1.419			
Non-creep fall heifers	84.697	b_1	.867**	.097	8.952	.910	824.603**	1500.644
		b_2	.001753**	.316	5.542			
		b_3	-3.280	3.082	- 1.064			

Appendix B, Table 1 (Continued)

Equation	a value		b_i value	S_{bi}	t_{bi}	R^2	F	S^2
1951-1952-1953								
$\hat{Y} = a + b_1x_1 + b_2x_2 + b_3x_3$								
Creep spring steers	65.694	b_1	1.750**	.102	17.164	.946	3732.999**	1068.483
		b_2	.000794	.428	1.853			
		b_3	3.617	2.773	1.304			
Creep spring heifers	49.773	b_1	1.786**	.085	3.990	.955	2467.702**	809.172
		b_2	.000207	.360	.575			
		b_3	9.272**	2.324	3.939			
Non-creep spring steers	44.199	b_1	1.782**	.153	11.644	.864	450.334**	2341.720
		b_2	-.000235	.640	-.368			
		b_3	13.134**	3.962	3.315			
Non-creep spring heifers	60.073	b_1	1.762**	.074	23.927	.962	1998.078**	620.753
		b_2	-.000049	.311	-.156			
		b_3	2.872	2.035	1.411			

**Significant at .01 level.

APPENDIX B, TABLE 2

SELECTED STATISTICS RELATED TO ALTERNATIVE EQUATIONS FOR CALVES, EXPERIMENTAL DATA

Equation	a value		b_i value	S_{bi}	t_{bi}	R^2	F	S^2
$\hat{Y} = a + b_1x_1 + b_2x_2$ (1954-56)								
Creep fall steers	78.83	b_1	.958**	.098	9.804	.965	2232.066**	890.050
		b_2	.003642**	.362	10.071			
Creep fall heifers	65.624	b_1	1.116**	.115	9.726	.904	1131.450**	2025.984
		b_2	.001794**	.398	4.513			
Non-creep fall steers	78.273	b_1	.891**	.119	7.492	.891	849.989**	1935.939
		b_2	.001715**	.385	4.458			
Non-creep fall heifers	74.931	b_1	.875**	.097	9.064	.910	1235.672**	1501.452
		b_2	.001706**	.313	5.445			
$\hat{Y} = a + b_1x_1$ [1] (1951-53)								
Non-creep spring steers	71.558	b_1	1.716**	.048	35.848	.857	1285.112**	2441.522
Creep-spring steers	65.959	b_1	1.928**	.032	61.098	.945	1265.154**	1084.839
Creep-spring heifers	64.902	b_1	1.832**	.027	67.971	.951	4620.089**	859.092
Non-creep spring heifers	65.586	b_1	1.751**	.023	77.409	.961	5992.328**	620.744

[1] b_2 not significant at 5 percent level, so not included. (See Appendix B, Table 1).

**Significant at .01 level.

APPENDIX B, TABLE 3

SELECTED STATISTICS RELATED TO ALTERNATIVE EQUATIONS FOR CALVES, EXPERIMENTAL DATA

Equation	a value		b_i value	S_{bi}	t_{bi}	R^2	F	S^2
$Y = a + b_1x_1$								
Creep fall steers[1]	42.053	b_1	1.899**	.036	51.894	.943	2692.98**	1441.902
Non-creep fall steers[2]	54.476	b_1	1.399**	.036	39.255	.881	1540.98**	2110.730
Creep fall heifers[2]	44.656	b_1	1.610**	.035	45.546	.897	2074.46**	2190.128
Non-creep fall heifers[2]	51.218	b_1	1.378**	.029	46.764	.899	2186.97**	1676.328
Creep spring steers	65.959	b_1	1.928**	.032	61.098	.945	1265.154**	1084.839
Non-creep spring steers[3]	71.558	b_1	1.716**	.048	35.848	.857	902.28**	2441.522
Creep spring heifers[3]	64.902	b_1	1.832**	.027	67.971	.951	4620.089**	859.092
Non-creep spring heifers	65.586	b_1	1.751**	.023	77.409	.961	5992.328**	620.744

**Significant at .01 level.

[1] $Y = a + b_1x_1 + b_2x_2 + b_3x_3$ best fitting equation.

[2] $Y = a + b_1x_1 + b_2x_2$ best fitting equation.

[3] $Y = a + b_1x_1 + b_3x_3$ best fitting equation.

APPENDIX C, TABLE 1

SUMMARY OF INPUT REQUIREMENTS, PRODUCTION RATES, AND INCOME OR COST EXPECTATIONS FOR CROP AND LIVESTOCK ALTERNATIVES CONSIDERED

Resource	Unit	P_1	P_2	P_3	P_4	P_5	P_6	P_7	P_8	P_9	P_{10}	P_{11}	P_{12}	P_{13}	P_{14}	P_{15}	P_{16}	P_{17}	P_{18}	P_{19}	P_{20}	P_{21}
Idle Bottomland	Acre	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	1.00	.00	1.00	.00	.00	.00	.00
Idle Upland	Acre	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	1.00	.00	1.00	.00	.00	.00	1.00	1.00
Cropland	Acre	.00	.00	.00	1.38	.00	.00	.00	.00	.00	.00	.88	.00	.75	.00	.00	.00	.00	.00	.00	.00	.00
Brushland	Acre	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	1.00	1.00	.00	.00
ACP for Brush	Dollars	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	7.00	.00	.00	.00
ACP for Bermuda	Dollars	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	19.00	.00
Total ACP	Dollars	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	5.00	5.00	.00	.00	7.00	.00	19.00	.00
Dec.-Feb. Labor	Hour	1.62	2.26	2.26	2.26	2.17	2.66	2.83	.75	.75	1.23	.40	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
March-May Labor	Hour	.96	1.25	1.25	1.25	2.28	1.73	2.60	.25	.68	.79	.54	.38	2.63	.00	.00	.00	.00	.00	.00	.50	.50
June-Aug. Labor	Hour	.50	.50	.50	.50	.54	.60	1.04	.00	.40	.40	.00	.38	.52	.00	.00	.00	.00	.00	.00	.40	.40
Sept.-Nov. Labor	Hour	2.37	2.37	2.37	6.51	.59	2.37	.79	.33	.43	.59	2.92	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
Long-Term Capital	Dollars	192.00	192.00	192.00	192.00	192.00	192.00	192.00	192.00	.00	.00	.00	.00	.00	7.15	7.15	12.15	12.15	7.00	14.00	18.88	37.88
Operating Capital	Dollars	22.18	8.23	17.58	26.43	17.65	44.42	30.83	128.13	131.98	129.01	133.22	142.06	147.21	.15	.15	.15	.15	1.00	1.00	9.93	9.93
Native and/or Bermuda Grazing	A.U.M.	14.08	12.88	11.68	9.04	13.44	13.44	13.44	3.00	6.00	3.00	.50	3.00	1.20	-1.20	-1.50	-1.20	-1.50	-.90	-.90	-3.00	-3.00
Prairie and/or Bermuda Hay	Ton	.03	.00	.88	.29	.03	.03	.03	.05	.05	1.00	.33	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
Alfalfa Brome Hay	Ton	.00	.59	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
Native Meadow Land	Acre	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
Returns per Unit (C_j)	Dollars	75.96	89.94	82.26	70.66	82.50	67.00	75.42	5.17	33.10	44.04	44.01	23.02	24.71	-.87	-.87	-1.37	-1.37	-1.70	-2.40	-11.81	-13.72

APPENDIX C, TABLE 1 (Continued)

Resource	P_{22}	P_{23}	P_{24}	P_{25}	P_{26}	P_{27}	P_{28}	P_{29}	P_{30}	P_{31}	P_{32}	P_{33}	P_{34}	P_{35}	P_{36}	P_{37}	P_{38}	P_{39}	P_{40}	P_{41}	P_{42}	P_{43}
Idle Bottomland	1.00	1.00	.00	.00	1.00	1.00	.00	.00	1.00	1.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	-1.00	.00
Idle Upland	.00	.00	1.00	1.00	.00	.00	1.00	1.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
Cropland	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	1.00	.00	.00	.00	.00	.00	.00	.00	.00	1.00	.00
Brushland	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
ACP for Brush	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
ACP for Bermuda	19.00	.00	19.00	.00	19.00	.00	19.00	.00	19.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
Total ACP	19.00	.00	19.00	.00	19.00	.00	19.00	.00	19.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
Dec.-Feb. Labor	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	-1.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
March-May Labor	.50	.50	.50	.50	.50	.50	.50	.50	.50	.50	.00	.50	.00	-1.00	.00	.00	.00	.00	.00	.00	.00	.00
June-Aug. Labor	.40	.40	7.00	7.00	7.50	7.50	.40	.40	.40	.40	3.50	7.00	.00	.00	-1.00	.00	.00	.00	.00	.00	.00	.00
Sept.-Nov. Labor	.00	.00	.00	.00	.00	.00	.50	.50	.50	.50	.00	.00	.00	.00	.00	-1.00	.00	.00	.00	.00	.00	.00
Long-Term Capital	18.88	37.88	18.88	37.88	18.88	37.88	18.88	37.88	18.88	37.88	.00	23.05	.00	.00	.00	.00	.00	.00	-1.00	.00	.00	80.00
Operating Capital	9.93	9.93	17.76	17.76	18.36	18.36	12.25	12.25	12.25	12.25	4.49	14.32	1.00	1.00	1.00	1.00	18.00	29.00	.00	-1.00	.00	.00
Native and/or Bermuda Grazing	-4.00	-4.00	-1.00	-1.00	-1.50	-1.50	-3.50	-3.50	-4.50	-4.50	.90	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	-1.20
Prairie and/or Bermuda Hay	.00	.00	-2.00	-2.00	-2.50	-2.50	.00	.00	.00	.00	-.90	.00	.00	.00	.00	.00	-1.00	.00	.00	.00	.00	.00
Alfalfa Brome Hay	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	-3.00	.00	.00	.00	.00	.00	-1.00	.00	.00	.00	.00
Native Meadow Land	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	1.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
Returns per Unit	-11.81	-13.72	-19.65	-21.55	-20.25	-22.15	-14.14	-16.04	-14.14	-16.04	-4.49	-18.93	-1.00	-1.00	-1.00	-1.00	-18.00	-29.00	-0.56	-0.59	.00	-.75

APPENDIX C, TABLE 2

SUMMARY OF INPUT REQUIREMENTS, PRODUCTION RATES AND DISCOUNTED INCOME OR COST EXPECTATIONS FOR CROP AND LIVESTOCK ALTERNATIVES CONSIDERED

Resource	Unit	P_1	P_2	P_3	P_4	P_5	P_6	P_7	P_9	P_{10}	P_{11}	P_{12}	P_{13}	P_{14}	P_{15}	P_{18}
Idle Bottomland Cropland	Acre	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	1.00	.00
Idle Upland Cropland	Acre	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	1.00	.00	.00
Cropland	Acre	.00	.00	.00	1.38	.00	.00	.00	.00	.00	.88	.00	.75	.00	.00	.00
Brushland	Acre	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	1.00
Dec.-Feb. Labor	Hours	1.62	2.26	2.26	2.26	2.17	2.66	2.83	.75	1.23	.40	.00	.00	.00	.00	.00
March-May Labor	Hours	.96	1.25	1.25	1.25	2.28	1.73	2.60	.68	.79	.54	.38	.38	.00	.00	.00
June-Aug. Labor	Hours	.50	.50	.50	.50	.54	.60	1.04	.40	.40	.00	.38	.52	.00	.00	.00
Sept.-Nov. Labor	Hours	2.37	2.37	2.37	6.51	.59	2.37	.79	.43	.59	2.92	.00	.00	.00	.00	.00
Long-Term Capital	$	192.00	192.00	192.00	192.00	192.00	192.00	192.00	.00	.00	.00	.00	.00	7.15	7.15	7.00
Short-Term Capital	$	22.18	8.23	17.58	26.43	17.65	44.42	30.83	131.98	129.01	133.22	142.06	147.21	.15	.15	1.00
Native and/or Bermuda Grazing	AUM	14.08	12.88	11.68	9.04	13.44	13.44	13.44	6.0	3.0	.50	3.00	1.20	-.96	-1.20	-1.11
Prairie and/or Bermuda Hay	Ton	.03	.00	.88	.29	.03	.03	.03	.05	1.00	.33	.00	.00	.00	.00	.00
Alfalfa Hay	Ton	.00	.59	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
Native Meadow Land	Acre	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
Returns Per Unit (C_j):																
6 Percent 10 yr.	$	559.06	661.81	605.43	520.06	607.20	493.12	555.09	243.62	324.13	323.91	169.42	181.87	-7.15	-7.15	-11.39
6 Percent 20 yr.	$	871.26	1,031.38	943.52	810.47	946.28	768.49	865.07	379.66	505.14	504.79	264.04	283.42	-7.94	-7.94	-14.31
15 Percent 10 yr.	$	381.32	451.40	412.95	354.71	414.15	336.34	378.61	166.16	221.08	220.93	115.56	124.04	-7.15	-7.15	-9.29
15 Percent 20 yr.	$	475.51	562.90	514.95	442.33	516.45	419.42	472.13	207.21	275.69	275.50	144.11	154.68	-7.47	-7.47	-10.15
20 Percent 20 yr.	$	369.93	437.91	400.61	344.11	401.78	326.29	367.30	161.20	214.47	214.33	112.11	120.34	-7.35	-7.35	-9.09

APPENDIX C, TABLE 2 (Continued)

Resource	P_{20}	P_{22}	P_{24}	P_{26}	P_{28}	P_{30}	P_{32}	P_{33}	P_{34}	P_{35}	P_{36}	P_{37}	P_{38}	P_{39}	P_{40}	P_{41}	P_{42}
Idle Bottomland Cropland	.00	1.00	.00	1.00	.00	1.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	-1.00
Idle Upland Cropland	1.00	.00	1.00	.00	1.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
Cropland	.00	.00	.00	.00	.00	.00	.00	1.00	.00	.00	.00	.00	.00	.00	.00	.00	1.00
Brushland	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
Dec.-Feb. Labor	.00	.00	.00	.00	.00	.00	.00	.00	-1.00	.00	.00	.00	.00	.00	.00	.00	.00
March-May Labor	.50	.50	.50	.50	.50	.50	.00	.50	.00	-1.00	.00	.00	.00	.00	.00	.00	.00
June-Aug. Labor	.40	.40	7.00	7.50	.40	.40	3.50	7.00	.00	.00	-1.00	.00	.00	.00	.00	.00	.00
Sept.-Nov. Labor	.00	.00	.00	.00	.50	.50	.00	.00	.00	.00	.00	-1.00	.00	.00	.00	.00	.00
Long-Term Capital	18.88	18.88	18.88	18.88	18.88	18.88	.00	23.05	.00	.00	.00	.00	.00	.00	-1.00	.00	.00
Short-Term Capital	9.93	9.93	17.76	18.36	12.25	12.25	4.49	14.32	1.00	1.00	1.00	1.00	18.00	29.00	.00	-1.00	.00
Native and/or Bermuda Grazing	-2.7	-3.6	-.9	-1.35	-3.15	-4.05	.90	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
Prairie and/or Bermuda Hay	.00	.00	-1.8	-2.25	.00	.00	-.90	.00	.00	.00	.00	.00	-1.00	.00	.00	.00	.00
Alfalfa Hay	.00	.00	.00	.00	.00	.00	.00	-3.0	.00	.00	.00	.00	.00	-1.00	.00	.00	.00
Native Meadow Land	.00	.00	.00	.00	.00	.00	1.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
Returns Per Unit:																	
6 Percent 10 yr.	-82.59	-82.59	-132.83	-136.68	-97.48	-97.48	-33.95	-139.32	-7.36	-7.36	-7.36	-7.36	-132.48	-213.44	-.442	-.442	0
6 Percent 20 yr.	-132.41	-123.41	-205.84	-212.16	-147.84	-147.84	-51.50	-217.13	-11.47	-11.47	-11.47	-11.47	-206.46	-332.63	-.688	-.688	0
15 Percent 10 yr.	-60.08	-60.08	-92.57	-95.06	-69.71	-69.71	-22.54	-95.01	-5.02	-5.02	-5.02	-5.02	-90.34	-145.55	-.753	-.753	0
15 Percent 20 yr.	-73.01	-73.01	-115.69	-118.96	-85.65	-85.65	-28.11	-118.50	-6.26	-6.26	-6.26	-6.26	-112.68	-181.54	-.939	-.939	0
20 Percent 20 yr.	-58.97	-58.97	-90.58	-93.00	-68.33	-68.33	-21.87	-92.19	-4.87	-4.87	-4.87	-4.87	-87.66	-141.23	-.974	-.974	0

APPENDIX C, TABLE 3

SUMMARY OF INPUT REQUIREMENTS, PRODUCTION RATES AND DISCOUNTED INCOME OR COST EXPECTATIONS FOR CROP AND LIVESTOCK ALTERNATIVES CONSIDERED IN THE DYNAMIC ANALYSES

Resource	Time Period	Unit	Time Period I												Income Transfer
			P_1	P_5	P_9	P_{14}	P_{15}	P_{16}	P_{24}	P_{26}	P_{32}	P_{46}	P_{47}	P_{48}	
Idle Bottomland	I	Acre	0	0	0	0	1.0	0	0	1.00	0	0	0	0	0
Idle Upland	I	Acre	0	0	0	1.00	0	0	1.00	0	0	0	0	0	0
Brushland	I	Acre	0	0	0	0	0	1.00	0	0	0	0	0	0	0
Labor	I	Hour	5.45	5.58	2.26	0	0	0	7.5	7.5	3.5	-1.00	0	0	0
Capital	I	$	214.18	209.65	131.98	7.30	7.30	7.00	36.64	37.24	4.49	1.00	-100.0	80.00	0
Native or Bermuda Grazing	I	Acre	14.08	13.44	6.0	-.72	-.90	-.98	-.80	-1.20	-.30	0	0	-1.20	0
Prairie or Bermuda Hay	I	Acre	.03	.03	.05	0	0	0	-1.6	-2.0	-.90	0	0	0	0
Native Meadow	I	Acre	0	0	0	0	0	0	0	0	1.0	0	0	0	0
Idle Bottomland	II	Acre	0	0	0	0	1.00	0	0	1.00	0	0	0	0	0
Idle Upland	II	Acre	0	0	0	1.00	0	0	1.00	0	0	0	0	0	0
Brushland	II	Acre	0	0	0	0	0	1.00	0	0	0	0	0	0	0
Labor	II	Hour	0	0	0	0	0	0	7.5	7.5	0	0	0	0	0
Capital	II	$	0	0	0	.15	.15	1.40	17.76	18.36	0	0	0	.75	-1.00
Native or Bermuda Grazing	II	Acre	0	0	0	-1.20	-1.50	-1.20	-1.0	-1.50	0	0	0	-1.2	0
Prairie or Bermuda Hay	II	Acre	0	0	0	0	0	0	-2.0	-2.5	0	0	0	0	0
Native Meadow	II	Acre	0	0	0	0	0	0	0	0	0	0	0	0	0
Idle Bottomland	III	Acre	0	0	0	0	1.00	0	0	1.00	0	0	0	0	0
Idle Upland	III	Acre	0	0	0	1.00	0	0	1.00	0	0	0	0	0	0
Brushland	III	Acre	0	0	0	0	0	1.00	0	0	0	0	0	0	0
Labor	III	Hour	0	0	0	0	0	0	7.5	7.5	0	0	0	0	0
Capital	III	$	0	0	0	.15	.15	1.40	17.76	18.36	0	0	0	.75	0
Native or Bermuda Grazing	III	Acre	0	0	0	-1.20	-1.50	-1.20	-1.0	-1.5	0	0	0	-1.2	0
Prairie or Bermuda Hay	III	Acre	0	0	0	0	0	0	-2.0	-2.5	0	0	0	0	0
Native Meadow	III	Acre	0	0	0	0	0	0	0	0	0	0	0	0	0
Idle Bottomland	IV	Acre	0	0	0	0	1.00	0	0	1.00	0	0	0	0	0
Idle Upland	IV	Acre	0	0	0	1.00	0	0	1.00	0	0	0	0	0	0
Brushland	IV	Acre	0	0	0	0	0	1.00	0	0	0	0	0	0	0
Labor	IV	Hour	0	0	0	0	0	0	7.5	7.5	0	0	0	0	0
Capital	IV	$	0	0	0	.15	.15	0	17.76	18.36	0	0	0	.75	0
Native or Bermuda Grazing	IV	Acre	0	0	0	-1.20	-1.50	-1.20	-1.0	-1.50	0	0	0	-1.2	0
Prairie or Bermuda Hay	IV	Acre	0	0	0	0	0	0	-2.0	-2.5	0	0	0	0	0
Native Meadow	IV	Acre	0	0	0	0	0	0	0	0	0	0	0	0	0
Income		$	-379.80	-412.50	-165.50	7.90	7.90	7.00	107.68	110.68	22.45	5.00	25.3	0	1.00
Returns to Owned Factors:															
6 Percent 20 yr.		$	319.94	347.49	139.42	-8.86	-8.86	-14.31	-205.84	-212.16	-18.91	-4.21	-25.3	-8.70	
20 Percent 20 yr.		$	227.12	246.68	98.97	-7.88	-7.88	-9.09	-90.58	-92.99	-13.43	-2.99	-59.8	-3.65	

APPENDIX C, TABLE 3 (Continued)

Resource	Time Period	Time Period II P_1	P_5	P_9	P_{14}	P_{15}	P_{18}	P_{24}	P_{26}	P_{32}	P_{46}	P_{48}	Income Transfer
Idle Bottomland	I	0	0	0	0	0	0	0	0	0	0	0	0
Idle Upland	I	0	0	0	0	0	0	0	0	0	0	0	0
Brushland	I	0	0	0	0	0	0	0	0	0	0	0	0
Labor	I	0	0	0	0	0	0	0	0	0	0	0	0
Capital	I	0	0	0	0	0	0	0	0	0	0	0	0
Native or Bermuda Grazing	I	0	0	0	0	0	0	0	0	0	0	0	0
Prairie or Bermuda Hay	I	0	0	0	0	0	0	0	0	0	0	0	0
Native Meadow	I	0	0	0	0	0	0	0	0	0	0	0	0
Idle Bottomland	II	0	0	0	0	1.00	0	0	1.00	0	0	0	0
Idle Upland	II	0	0	0	1.00	0	0	1.00	0	0	0	0	0
Brushland	II	0	0	0	0	0	1.00	0	0	0	0	0	0
Labor	II	5.45	5.58	2.26	0	0	0	7.50	7.50	3.50	-1.00	0	0
Capital	II	214.18	209.65	131.98	7.30	7.30	7.00	36.64	37.24	4.49	1.00	80.00	0
Native or Bermuda Grazing	II	14.08	13.44	6.00	-.72	-.90	-.98	-.80	-1.20	-.30	0	-1.20	0
Prairie or Bermuda Hay	II	.03	.03	.05	0	0	0	-1.60	-2.00	-.90	0	0	0
Native Meadow	II	0	0	0	0	0	0	0	0	1.00	0	0	0
Idle Bottomland	III	0	0	0	0	1.00	0	0	1.00	0	0	0	0
Idle Upland	III	0	0	0	1.00	0	0	1.00	0	0	0	0	0
Brushland	III	0	0	0	0	0	1.00	0	0	0	0	0	0
Labor	III	0	0	0	0	0	0	7.50	7.50	0	0	0	0
Capital	III	0	0	0	.15	.15	1.40	17.76	18.36	0	0	.75	-1.00
Native or Bermuda Grazing	III	0	0	0	-1.20	-1.50	-1.20	-1.00	-1.50	0	0	-1.2	0
Prairie or Bermuda Hay	III	0	0	0	0	0	0	-2.00	-2.50	0	0	0	0
Native Meadow	III	0	0	0	0	0	0	0	0	0	0	0	0
Idle Bottomland	IV	0	0	0	0	1.00	0	0	1.00	0	0	0	0
Idle Upland	IV	0	0	0	1.00	0	0	1.00	0	0	0	0	0
Brushland	IV	0	0	0	0	0	1.00	0	0	0	0	0	0
Labor	IV	0	0	0	0	0	0	7.50	7.50	0	0	0	0
Capital	IV	0	0	0	.15	.15	1.40	17.76	18.36	0	0	.75	0
Native or Bermuda Grazing	IV	0	0	0	-1.20	-1.50	-1.20	-1.00	-1.50	0	0	-1.2	0
Prairie or Bermuda Hay	IV	0	0	0	0	0	0	-2.00	-2.50	0	0	0	0
Native Meadow	IV	0	0	0	0	0	0	0	0	0	0	0	0
Income		-379.80	-412.50	-165.50	7.90	7.90	7.00	107.68	110.68	22.45	5.00	0	1.00
Returns to Owned Factors:													
6 Percent 20 yr.		239.05	259.63	104.17	-6.12	-6.12	-11.03	-142.99	-147.34	-14.13	-3.15	-5.44	
20 Percent 20 yr.		91.38	99.25	39.82	-7.43	-7.43	-3.82	-40.98	-42.10	-5.40	-1.20	-1.41	

APPENDIX C, TABLE 3 (Continued)

Resource	Time Period	Time Period III											
		P_1	P_5	P_9	P_{14}	P_{15}	P_{18}	P_{24}	P_{26}	P_{32}	P_{46}	P_{48}	Income Transfer
Idle Bottomland	I	0	0	0	0	0	0	0	0	0	0	0	0
Idle Upland	I	0	0	0	0	0	0	0	0	0	0	0	0
Brushland	I	0	0	0	0	0	0	0	0	0	0	0	0
Labor	I	0	0	0	0	0	0	0	0	0	0	0	0
Capital	I	0	0	0	0	0	0	0	0	0	0	0	0
Native or Bermuda Grazing	I	0	0	0	0	0	0	0	0	0	0	0	0
Prairie or Bermuda Hay	I	0	0	0	0	0	0	0	0	0	0	0	0
Native Meadow	I	0	0	0	0	0	0	0	0	0	0	0	0
Idle Bottomland	II	0	0	0	0	0	0	0	0	0	0	0	0
Idle Upland	II	0	0	0	0	0	0	0	0	0	0	0	0
Brushland	II	0	0	0	0	0	0	0	0	0	0	0	0
Labor	II	0	0	0	0	0	0	0	0	0	0	0	0
Capital	II	0	0	0	0	0	0	0	0	0	0	0	0
Native or Bermuda Grazing	II	0	0	0	0	0	0	0	0	0	0	0	0
Prairie or Bermuda Hay	II	0	0	0	0	0	0	0	0	0	0	0	0
Native Meadow	II	0	0	0	0	0	0	0	0	0	0	0	0
Idle Bottomland	III	0	0	0	0	1.00	0	0	1.00	0	0	0	0
Idle Upland	III	0	0	0	1.00	0	0	1.00	0	0	0	0	0
Brushland	III	0	0	0	0	0	1.00	0	0	0	0	0	0
Labor	III	5.45	5.58	2.26	0	0	0	7.5	7.5	3.5	-1.00	0	0
Capital	III	214.18	209.65	131.98	7.30	7.30	7.00	36.64	37.24	4.49	1.00	80.00	0
Native or Bermuda Grazing	III	14.08	13.44	6.0	-.72	-.90	-.98	-.80	-1.2	-.30	0	-1.20	0
Prairie or Bermuda Hay	III	.03	.03	.05	0	0	0	-1.6	-2.0	-.90	0	0	0
Native Meadow	III	0	0	0	0	0	0	0	0	1.0	0	0	0
Idle Bottomland	IV	0	0	0	0	1.00	0	0	1.00	0	0	0	0
Idle Upland	IV	0	0	0	1.00	0	0	1.00	0	0	0	0	0
Brushland	IV	0	0	0	0	0	1.00	0	0	0	0	0	0
Labor	IV	0	0	0	0	0	0	7.5	7.5	0	0	0	0
Capital	IV	0	0	0	.15	.15	1.40	17.76	18.36	0	0	.75	-1.00
Native or Bermuda Grazing	IV	0	0	0	-1.20	-1.50	-1.20	-1.0	-1.5	0	0	-1.2	0
Prairie or Bermuda Hay	IV	0	0	0	0	0	0	-2.0	-2.5	0	0	0	0
Native Meadow	IV	0	0	0	0	0	0	0	0	0	0	0	0
Income		-379.80	-412.50	-165.50	7.90	7.90	7.00	107.68	110.68	22.45	5.00	0	1.00
Returns to Owned Factors:													
6 Percent 20 yr.		178.66	194.04	77.85	-4.38	-4.38	-6.51	-83.53	-85.99	-10.56	-2.35	-3.08	
20 Percent 20 yr.		36.69	39.85	15.99	-7.25	-7.25	-1.45	-15.08	-15.49	-2.17	-.48	-.51	

APPENDIX C, TABLE 3 (Continued)

Resource	Time Period	Time Period IV										
		P_1	P_5	P_9	P_{14}	P_{15}	P_{18}	P_{24}	P_{26}	P_{32}	P_{46}	P_{48}
Idle Bottomland	I	0	0	0	0	0	0	0	0	0	0	0
Idle Upland	I	0	0	0	0	0	0	0	0	0	0	0
Brushland	I	0	0	0	0	0	0	0	0	0	0	0
Labor	I	0	0	0	0	0	0	0	0	0	0	0
Capital	I	0	0	0	0	0	0	0	0	0	0	0
Native or Bermuda Grazing	I	0	0	0	0	0	0	0	0	0	0	0
Prairie or Bermuda Hay	I	0	0	0	0	0	0	0	0	0	0	0
Native Meadow	I	0	0	0	0	0	0	0	0	0	0	0
Idle Bottomland	II	0	0	0	0	0	0	0	0	0	0	0
Idle Upland	II	0	0	0	0	0	0	0	0	0	0	0
Brushland	II	0	0	0	0	0	0	0	0	0	0	0
Labor	II	0	0	0	0	0	0	0	0	0	0	0
Capital	II	0	0	0	0	0	0	0	0	0	0	0
Native or Bermuda Grazing	II	0	0	0	0	0	0	0	0	0	0	0
Prairie or Bermuda Hay	II	0	0	0	0	0	0	0	0	0	0	0
Native Meadow	II	0	0	0	0	0	0	0	0	0	0	0
Idle Bottomland	III	0	0	0	0	0	0	0	0	0	0	0
Idle Upland	III	0	0	0	0	0	0	0	0	0	0	0
Brushland	III	0	0	0	0	0	0	0	0	0	0	0
Labor	III	0	0	0	0	0	0	0	0	0	0	0
Capital	III	0	0	0	0	0	0	0	0	0	0	0
Native or Bermuda Grazing	III	0	0	0	0	0	0	0	0	0	0	0
Prairie or Bermuda Hay	III	0	0	0	0	0	0	0	0	0	0	0
Native Meadow	III	0	0	0	0	0	0	0	0	0	0	0
Idle Bottomland	IV	0	0	0	0	1.00	0	0	1.00	0	0	0
Idle Upland	IV	0	0	0	1.00	0	0	1.00	0	0	0	0
Brushland	IV	0	0	0	0	0	1.00	0	0	0	0	0
Labor	IV	5.45	5.58	2.26	0	0	0	7.5	7.5	3.5	-1.00	0
Capital	IV	214.18	209.65	131.98	7.30	7.30	7.00	36.64	37.24	4.49	1.00	80.00
Native or Bermuda Grazing	IV	14.08	13.44	6.0	-.72	-.90	-.98	-.80	-1.2	-.30	0	-1.20
Prairie or Bermuda Hay	IV	.03	.03	.05	0	0	0	-1.6	-2.0	-.90	0	0
Native Meadow	IV	0	0	0	0	0	0	0	0	1.0	0	0
Income		-379.80	-412.50	-165.50	7.90	7.90	7.00	107.68	110.68	22.45	5.00	0
Returns to Owned Factors:												
6 Percent 20 yr.		133.54	145.04	58.19	-3.08	-3.08	-2.92	-39.10	-40.15	-7.89	-1.76	-1.32
20 Percent 20 yr.		14.74	16.01	6.42	-7.18	-7.18	-.46	-4.67	-4.79	-.87	-.19	-.13

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