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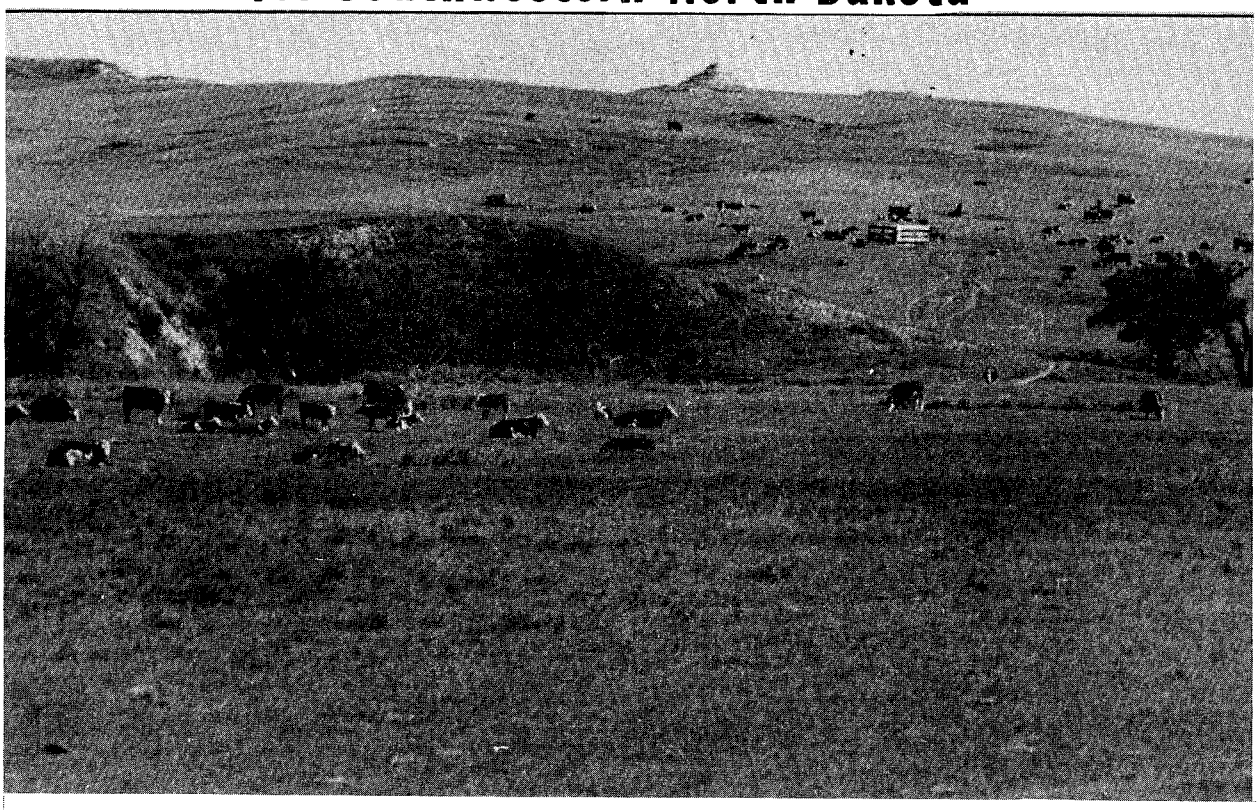
An economic analysis of

PASTURE MANAGEMENT ALTERNATIVES

for Southwestern North Dakota



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FOREWORD

This report represents a continuation of investigation of factors influencing the profitability of livestock production in North Dakota.

The authors wish to extend their appreciation to the plant and animal scientists who freely contributed their time and knowledge. Without their help, this study would not have been possible. The authors also wish to acknowledge the encouragement and valuable suggestions received from their colleagues in the Department of Agricultural Economics. Dr. Robert D. Carver, Dr. Roger G. Johnson, and Professor LeRoy W. Schaffner provided assistance from the beginning of the study. The authors, of course, assume full responsibility for any errors.

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TABLE OF CONTENTS

HIGHLIGHTS

This study examines the profitability of increasing grassland production in southwestern North Dakota by fertilization or by conversion of marginal cropland to tame pasture.

Linear programming techniques were employed to determine which alternatives maximize net returns to land, labor, capital, and management. The typical ranch consisted of 1,572 acres of native rangeland and 65 acres of native hayland. Cropland was divided into 351 acres of good cropland and 255 acres of marginal cropland. Yields were adjusted to correspond with good and marginal cropland for the study area. A high level of management was assumed with labor being provided by the operator and his family. Additional labor could be hired on a yearly basis if needed.

Three cattle marketing activities were available to the operator:

1) Calf weaned and sold around November 1.
2) Calf weaned in November, backgrounded, and sold the end of April.
3) Calf weaned in November, fed through the winter, fattened on grass, and sold in either June, August, or October.

Various pasture management strategies were available for six- and eight-month grazing seasons. Those included were:

1) Establishing and fertilizing tame pasture in spring in order to defer grazing native rangeland until later in the season.
2) Establishing and fertilizing tame pasture in spring and fall.
3) Fertilizing native rangeland.
4) Fertilizing native hayland.

Optimum (profit-maximizing) ranch organizations were developed. These optimum plans indicated the cattle production alternatives and pasture management practices which were most profitable given the assumptions of the linear programming model. The most profitable cattle activity was yearlings sold about August 1. Selling calves at weaning was the least profitable cattle activity, given the cattle and input prices employed in the analysis.

Wheat was the only cash crop grown. Oats was selected by the model as the least-cost feed-grain for cows and calves. Tame and native hay were grown to supply the roughage required. Corn silage as roughage was not profitably produced for any cow-calf operation. Crested wheatgrass pasture for spring grazing was a profitable alternative in almost all situations. Crested wheatgrass replaced wheat on marginal cropland (at a wheat price of $2.05 per bushel). Alfalfa hay also was produced on marginal cropland and in many cases all of the marginal cropland was used for forage production. Native hayland fertilization was profitable in all ranch situations. A six-month grazing season was slightly more profitable than the eight-month season for all cattle enterprises and pasture alternatives.

Conclusions drawn from the analysis include:

1) Grazing yearlings should be considered as a more profitable alternative than backgrounding or selling calves at weaning.
2) Crested wheatgrass for tame pasture was competitive with wheat at $2.05 per bushel on marginal cropland.

3) Good cropland should not be seeded to tame pasture unless extremely high cattle prices exist (i.e., weaned calves priced above $70 per hundredweight compared to a wheat price of $2.05 per bushel).
4) Wheat acreage controls may make tame pasture more profitable in the future. Acreage restrictions for various crops similar to the previous farm program would allow tame pasture to compete with less profitable small-grains for use of good cropland.
5) Tame pasture should be fertilized at 40 pounds of actual nitrogen per acre. If high fertilizer costs make fertilization unprofitable, then it was generally unprofitable to establish tame pasture also.
6) Profitable fertilization of native range required fertilizer (ammonium nitrate) prices less than $65 per ton unless an increase greater than 80 percent in carrying capacity could be obtained.
7) Suitable native hayland should be fertilized. This will allow either an increase in cattle production or a reduction in the amount of cropland used for forage production.

An Economic Analysis of Pasture Management Alternatives for Southwestern North Dakota

By
Neil J. Qualey and F. Larry Leistritz*

Sales of cattle and calves accounted for 25 percent of total cash receipts of North Dakota farmers and ranchers in 1973.[1] Thus, the cattle industry ranked second only to wheat as a source of agricultural income. The profitability of both cash grain and livestock production is influenced by a wide variety of forces. In recent years substantial changes have occurred in demand and supply relationships and in production technology. These changes have resulted in greater capital requirements, greater productive capacity of labor, higher prices for most inputs, and rapidly fluctuating prices of output. Farm and ranch managers face many challenges because of these developments.

The fundamental management problem facing North Dakota stockmen concerns the allocation and use of scarce resources in such a way as to maximize profits. Specific questions concern the relative profitability of alternative livestock production programs, of alternative pasture management systems, and of converting cropland to pasture. The objectives of this study were to:

1) Determine costs and returns associated with alternative management systems for native range and tame pasture.
2) Determine costs and returns associated with alternative beef cattle production systems.
3) Determine the profitability of (a) applying fertilizer to native range and tame pasture and (b) converting cropland to pasture.

The Study Area

The study area consists of the 14 counties in North Dakota located south and west of the Missouri River (Figure 1). This area has become increasingly important as a livestock producing area. Total beef cattle numbers in the area increased 83 percent from 1960 to 1974, representing an increase from 34 to 36 percent of the state's total beef cattle numbers.[2] Approximately 56 percent of the study area's total agricultural land is native range and pasture and most of this land is considered unsuitable for other agricultural purposes.

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*Mr. Qualey was Research Assistant and Dr. Leistritz is Associate Professor of Agricultural Economics, North Dakota State University, Fargo.

[1]Price, J. R., and Fred R. Taylor, North Dakota Crop and Livestock Statistics, 1973, Agricultural Statistics No. 32, Statistical Reporting Service, USDA, and Department of Agricultural Economics, North Dakota State University, Fargo, North Dakota, 1974, p. 65.

[2]Ibid., p. 50, and USDA, Statistical Reporting Service, in cooperation with North Dakota State University, Agricultural Experiment Station, Department of Agricultural Economics, North Dakota Crop and Livestock Statistics, Agricultural Statistics No. 6, Fargo, North Dakota, May, 1961, p. 29.

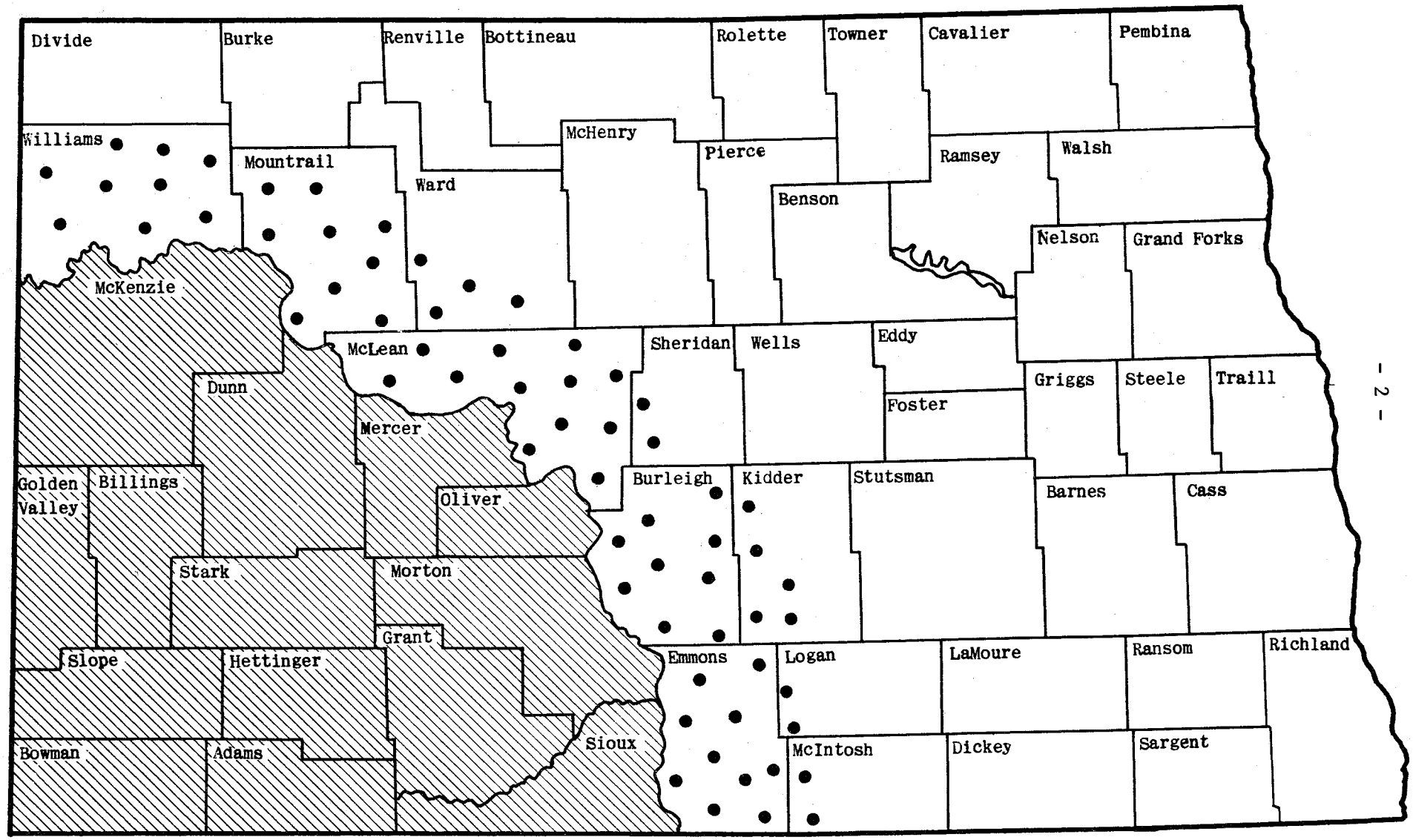

Figure 1. Area of Study, Southwestern North Dakota

The climate of southwestern North Dakota is semiarid.[3] Annual precipitation varied greatly between years within the region over a 40-year period ending in 1969. Annual precipitation at Dickinson, North Dakota, averaged approximately 15 inches, but ranged from 6.72 inches to 22.15 inches.[4] Temperatures reach extremes in both summer and winter, with a long-term annual mean of approximately 42° F.[5]

Dark brown (Chestnut) soils cover a large portion of the central region of the study area.[6] They occur on gently rolling land and are used primarily for crop production. The west and east regions contain soils (Regosal and Lithosol) used mainly for pasture and rangeland. They are generally hilly and productivity is limited by the rapid runoff, shallow root zone, and low water-holding capacity.

Native vegetation in western North Dakota is of the mixed prairie type. Cool-season grasses produce the major portion of the forage; the prominent ones being western wheatgrass (Agropyron smithii) and needle-and-thread (Stipa comata).[7] The dominant warm-season grass is blue grama (Bouteloua gracilis) which makes up most of the basal cover. Cool-season vegetation produces most of the spring and early summer growth. Warm-season grasses predominate in the summer and early fall. Growth of native vegetation is normally complete around the first part of August, depending on moisture supply.[8]

Two introduced grasses of considerable importance in western North Dakota pasture management programs are crested wheatgrass (Agropyron desertorum) and Russian wildrye (Elymus junceus). Crested wheatgrass is a cool-season perennial bunchgrass, which is very hardy and drought resistant. Growth begins early in the spring and provides excellent pasture from early

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[3]Omodt, H. W., G. A. Johnsgard, D. D. Patterson, and O. P. Olson, The Major Soils of North Dakota, Bulletin No. 472, Department of Soils, Agricultural Experiment Station, North Dakota State University, Fargo, North Dakota, January, 1968, p. 6.

[4]Weather Bureau, Climatic Summary of the United States, North Dakota Section, USDA, Washington, D.C., published annually.

[5]Ibid., p. 6.

[6]Omodt, H. W., et al., op. cit.

[7]Rogler, G. A., and R. J. Lorenz, "Nitrogen Fertilization of Natural Grasslands in the Northern Plains of the United States," in Proceedings Ninth International Grassland Congress, Volume II, Department of Animal Nutrition, Sao Paulo, Brazil, January, 1965, p. 1,328.

[8]Rogler, G. A., R. J. Lorenz, and H. M. Schaaf, Progress With Grass, Bulletin No. 439, USDA, Agricultural Research Service, Crops Research Division in cooperation with North Dakota Agricultural Experiment Station, North Dakota State University, Fargo, North Dakota, May, 1962, p. 7.

May until late June.[9] It is characterized by being very palatable with high nutritive quality and providing good beef gains during spring grazing. Russian wildrye is a long-lived perennial bunchgrass introduced from Siberia.[10] Its growth begins early in the spring with less vigor than crested wheatgrass, but continues throughout the summer. Its main assets are its high nutritive retaining qualities, rapid recovery after grazing, and resistance to cold and drought.

Analytical Procedure

Survey data from previous studies of livestock production in southwestern North Dakota were used in defining a typical ranch for this study. Costs and returns of various livestock and crop enterprises were developed from the results of production experiments and surveys of farm and ranch operators. Similar procedures were used to develop costs and returns for pasture management alternatives. A profit maximizing linear programming model was used to determine the optimum combination of crop and livestock enterprises and the optimum pasture management system, given various levels of cattle prices.

THE PROGRAMMING MODEL

The programming model was developed to reflect average or normal climatic conditions. Crop yields and pasture stocking rates are those expected in a typical year. A producer adopting any of the practices described in this study should anticipate year-to-year yield variations caused by changing weather conditions. Yearly price variation also can be expected to occur.

Resources Available

The representative ranch was a small to medium cattle-wheat operation typical of southwestern North Dakota. The unit was assumed to be completely operator-owned and to consist of 2,243 acres.[11]

Land

Cropland, which made up 606 of the 2,243 total acres, could be used for wheat after fallow, barley after fallow, oats, corn for silage, alfalfa

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[9]Dodds, D. L., Grasses for North Dakota, Circular R-415 revised, USDA, Cooperative Extension Service, North Dakota State University, Fargo, North Dakota, May, 1970.

[10]Ibid., p. 12.

[11]Dunn, E. V. Cost-Size Relationships of Southwestern North Dakota Commercial Beef Cattle Ranches, unpublished M.S. thesis, Department of Agricultural Economics, North Dakota State University, Fargo, North Dakota, May, 1968, p. 46.

hay, or tame pasture.[12] Because of recent changes in the government farm program, no acreage limitation was placed on any crop; and the model was free to choose any quantity and combination of crop activities subject to acreage and other resource restraints in the program. Cost-sharing for establishing permanent tame pasture is currently available to ranchers through the Great Plains Conservation Program and was made available in the model.

The 606 acres of cropland were divided into two general productivity classes, good and marginal cropland. Good cropland comprised 57.9 percent of all cropland in the model, while marginal cropland made up the remaining 42.1 percent. Table 1 presents the assumed yield differentials between the two land classes. The marginal cropland class was important to the study because it is generally sandy soil on rolling land and would probably be the first portion of cropland converted to tame pasture.

TABLE 1. AVERAGE YIELDS FOR TWO CROPLAND CLASSES TYPICAL OF SOUTHWESTERN NORTH DAKOTA

Crop Activity	Cropland Class		
	Good	Marginal	Weighted Average
	yield per acre		
Wheat after fallow	33.7 bushels	23.7 bushels	29.5 bushels
Barley after fallow	54.8 bushels	38.5 bushels	48.0 bushels
Oats	57.0 bushels	40.2 bushels	50.0 bushels
Corn silage	5.3 ton	3.7 ton	4.6 ton
Alfalfa hay	1.5 ton	1.35 ton	1.44 ton
Tame pasture[a]	.649 AUM	.592 AUM	.626 AUM

[a]Yield is measured in the proportion of a month's forage requirement available from one acre for a cow-calf unit.

SOURCE: Derived from yields compiled by Donald Patterson, Department of Soils, North Dakota State University, Fargo.

Of the remaining 1,637 acres, 1,572 were native range, and 65 acres were used for native hay production.[13] It was assumed to be possible to fertilize 40 percent of the native pastureland and all 65 acres of native hayland, based on soil type and terrain in southwestern North Dakota.

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[12]Ibid.

[13]Four percent of all native range in southwest North Dakota is used for hay production. For further details, see Price, J. R., and Fred R. Taylor, op. cit., pp. 44-45.

The charge for land investment was 8.6 percent based on returns to rented land for 1973.[14] Real estate taxes were assumed to be 1.25 percent of current value, giving the land a net return of 7.35 percent. Cropland and native rangeland values were estimated to be $95.17 and $54.40 per acre, respectively.[15] The land charge was entered into the model as a fixed cost.

Labor

The ranch is essentially a one-family unit with the operator assumed to be willing to contribute up to 2,750 hours of labor and management per year. From March through September he will work up to 300 hours per month, except that during April, when both calving and spring planting occur, he will work a maximum of 375 hours. From October through February he is assumed to provide no more than 200 hours of labor and management per month. The operator retains $7,000 per year for his labor.

The operator was assumed to have a high school age son or other family help who would provide additional labor during critical periods, such as calving, spring planting, or haying. Family labor provided a total of 945 hours per year and was charged at a rate of $2.00 per hour. Seasonal labor is not readily available in the area, except for the summer months, and the rate would have to be increased if early spring or winter help was required to supplement family labor.

A full-time employee could be hired at a rate of $5,500 per year if the ranch operation expanded beyond the capabilities of family labor.[16] A full-time man was assumed to work 2,500 hours per year. Ten percent of the operator's total labor would be used for supervision if a full-time employee is hired (Table 2).

Livestock Activities

The basic livestock enterprise was the beef cow-calf herd with the rancher having three alternative methods of marketing the calf:[17]

1) Calves are weaned and sold around November 1.
2) Calves are weaned in November, backgrounded, and sold the end of April.

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[14] Farm Real Estate Values, Statistical Reporting Service, USDA, in cooperation with Department of Agricultural Economics, North Dakota State University, October 1, 1973.

[15] Johnson, J. E., "1972 North Dakota Farmland Prices," North Dakota Farm Research, Volume 30, No. 5, May-June, 1973.

[16] Schneeberger, W., Economies of Size of Southwestern North Dakota Beef Cattle-Small Grain Farms, unpublished M.S. thesis, Department of Agricultural Economics, North Dakota State University, Fargo, North Dakota, August, 1971, p. 72.

[17] Based on survey results reported by Dunn, op. cit., p. 48.

TABLE 2. HOURS OF LABOR AVAILABLE BY TIME PERIODS BY LABOR FORCES[a]

Time Period	Operator	Operator and Family Help	Operator and One Full-Time Man
		hours	
November 1-April 9	842	1,217	1,644
April 10-May 20	389	569	647
May 21-June 10	158	248	288
June 11-June 30	161	251	292
July 1-July 24	186	276	338
July 25-September 15	399	519	725
September 16-October 31	245	245	508
Total[b]	2,064	3,009	3,732

[a]Days per time period correspond to critical labor periods which are important in obtaining high efficiency of the ranch organization. Overhead and supervisory labor have been subtracted from hours available.

[b]The operator and full-time employees were allowed to work the maximum number of hours per month during critical labor periods. Labor must be less than maximum the remaining months to maintain a labor supply equal to or less than the total hours allowed per year.

3) Calves are weaned in November, fed through the winter, summer grazed, and sold in either June, August, or October depending on forage supply and market price.

A 90 percent calf crop and a 16 percent cow herd replacement rate were assumed with calves being born in March and April. One bull was required for every 25 cows and had a four-year useful breeding life.

Steer and heifer calves were weaned at 430 and 410 pounds, respectively.[18] Calves backgrounded during the winter and sold in April were fed a grain-roughage ration to gain either 1.5 or 1.75 pounds per day (average weighted daily gain for steers and heifers).[19] If the operator intended to summer graze yearlings they were wintered on a ration to gain 1.0 pound daily and placed on native range or crested wheatgrass, May 10 (see Appendix Table 1).

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[18] Weights based on Performance Testing Reports, North Dakota Cooperative Extension Service, North Dakota State University, Fargo, North Dakota, May, 1973.

[19]Odenbach, A. H., Economics of Backgrounding Feeder Calves in North Dakota, unpublished M.S. thesis, Department of Agricultural Economics, North Dakota State University, Fargo, North Dakota, July, 1971, p. 33.

The grazing season for yearlings is divided into three periods:

1) Spring grazing from May 10 to June 20. The yearlings gain at a rate of 2.25 pounds per day and are grazed on either native range or crested wheatgrass.
2) Summer grazing from June 20 to August 1. Yearlings graze native range and gain at a rate of 1.75 pounds per day.
3) Fall grazing from August 1 to October 1. Yearlings graze native range and gain 1.0 pound per day. The animals must be sold at the end of this period due to decreasing rate of gain and shortage of forage.[20]

The same spring gain for yearlings was used regardless of the pasture system as experiment station trials have shown similar gains on native range and crested wheatgrass for early season grazing.[21]

Beef Cattle Prices

Calf and yearling prices used in the model were based on a three-year average (1970-73) of prices received at the Union Stockyards, West Fargo, North Dakota. Monthly price differentials were estimated from a trend equation based on 1963-72 prices. Price differentials between weight classes also were estimated.

Table 3 gives the cattle prices initially used. Prices later were varied to reflect market uncertainty and indicate how the ranch organization is affected by higher and lower cattle prices.

Beef Cattle Production Costs

The cost of production is important in determining which cattle enterprise is the most profitable alternative for the rancher. Table 4 shows the production costs and capital requirements for beef cattle alternatives. Prices for protein supplement, salt, and mineral supplement were obtained from local feed dealers. Marketing costs were based on information from a report completed by Dunn.[22] Calves and yearlings were assumed to be sold at one of five major auctions in southwestern North Dakota, approximately 75 miles from the ranch. Cull cows and bulls can be marketed within 25 miles of the ranch at a local auction. Costs in marketing an individual animal included commission

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[20]Rogler, G. A., R. J. Lorenz, and H. M. Schaaf, Progress With Grass, Bulletin No. 439, USDA, Agricultural Research Service, Crops Research Division in cooperation with North Dakota Agricultural Experiment Station, North Dakota State University, Fargo, North Dakota, May, 1962, p. 10.

[21]Rogler, G. A., and R. J. Lorenz, Pasture Productivity of Crested Wheatgrass as Influenced by Nitrogen Fertilization and Alfalfa, Technical Bulletin 1402, Agricultural Research Service, USDA, in cooperation with Department of Animal Science, North Dakota Agricultural Experiment Station, North Dakota State University, Fargo, North Dakota, April, 1969, p. 7.

[22]Dunn, E. V., Costs and Considerations for Marketing Livestock in North Dakota, Agricultural Economics Report No. 74, Department of Agricultural Economics, North Dakota State University, Fargo, North Dakota, January, 1971, pp. 2-5.

TABLE 3. BEEF CATTLE PRICES USED IN THE RANCH MODEL

Animal Class	Selling Date	Average Weight[a]	Selling Weight[b]	Price
		- - - - pounds - - - -		$/cwt.
Weaned calf	Nov. 1	422	410	$47.85
Background calf (1.5 pound gain)	April 30	694	674	40.21
Background calf (1.5 pound gain)	April 30	739	717	39.23
Yearling, spring graze	June 20	708	687	41.55
Yearling, summer graze	Aug. 1	791	766	39.66
Yearling, fall graze	Oct. 1	843	818	39.10
Cull cow[c]	------	1,100	1,100	21.75
Bull[c]	------	1,800	1,800	26.00

[a]Sixty-one percent of a steer and 39 percent of a heifer.

[b]Three percent shrinkage subtracted.

[c]Cull cow and bull prices are based on three-year averages (1970-72) from Union Stockyards, West Fargo. Three percent shrinkage is not subtracted. No monthly price differentiation has been made for cull cows or slaughter bulls because a selling date is not established for them.

fee, trucking cost, and transit insurance.[23] The commission fee and trucking cost were based on the animal numbers sold and their weight. Linear interpolation was used to determine costs for different weight classes and the number of cattle marketed. Insurance rates were adjusted according to distance from the market and animal weight.

Winter Feed Requirements

Total digestible nutrients (TDN) was used as a measure of energy values necessary for maintenance and growth of cattle during the winter months (Table 5).

Calves can be wintered on either a ration of barley and alfalfa hay or oats and alfalfa hay. With this combination of grain and high-quality hay,

[23]Ibid.

TABLE 4. COST AND CAPITAL REQUIREMENTS FOR BEEF COW AND CALF ACTIVITIES[a]

Item	Cow-Calf 1[b]	Cow-Calf 2[c]	Sell Fed Calf April 30 (1.5 lb. gain)	Sell Fed Calf April 30 (1.75 lb. gain)	Sell Yearling June 20	Sell Yearling Aug. 1	Sell Yearling Oct. 1	Bull[d]
				dollars				
Direct Expenses:								
1. Protein supplement[e]	4.40	4.40	------	------	------	------	------	------
2. Salt & mineral sup.	1.38	1.38	1.04	1.04	1.32	1.55	1.93	1.38
3. Veterinary expenses	2.00	2.00	1.49	1.49	1.28	1.50	1.82	2.00
4. Miscellaneous expenses[f]	3.00	3.00	1.49	1.49	1.90	2.25	2.75	------
5. Bldg. & equip. reps., ins.	2.81	2.81	2.15	2.15	2.15	2.15	2.15	------
6. Marketing	6.03	6.03	1.00	1.25	1.00	1.50	1.75	2.47
Total direct expenses	19.62	19.62	7.17	7.42	7.65	8.95	10.40	5.85
Nonallocated Costs:								
1. Labor ($2.00/hr.)	11.44	13.00	4.10	4.10	4.96	5.28	5.90	18.30
2. Hay equivalent	35.70	44.10	14.05	15.61	11.53	11.53	11.53	34.65
3. Barley equivalent	4.52	4.52	24.41	27.41	18.82	18.82	18.82	6.78
4. Pasture charge	53.88	42.66	------	------	4.71	9.42	15.70	------
5. Bldg. & equip. dep.	7.48	7.48	6.01	6.01	6.01	6.01	6.01	------
6. Bldg. & equip. interest	4.77	4.77	3.63	3.63	3.63	3.63	3.63	------
7. Interest on cow investment	29.06	29.06	6.53	6.53	8.75	9.79	11.97	------
Total nonallocated costs	146.85	145.59	58.73	63.49	58.41	64.48	73.56	59.73
Total production costs	166.47	165.21	65.90	70.91	66.06	73.43	83.96	65.58
Average cattle investment	389.72	389.72	96.35	96.35	129.11	144.53	159.94	634.00
Average bldg. & equip. invest.	68.18	68.18	51.90	51.90	51.90	51.90	51.90	------
Average long-term capital	457.90	457.92	148.25	148.25	181.01	196.43	211.84	634.00
Operating capital	13.59	13.59	6.17	6.17	6.65	7.45	8.65	3.38

[a]Calf feeding activities are additive to either cow-calf enterprise.
[b]Cow grazed from May 10 to December 31. Costs and capital requirement include one-sixth replacement heifer.
[c]Cow grazed from May 10 to November 20. Costs and capital requirement include one-sixth replacement heifer.
[d]Investment in bull includes salvage value of $468.00. Four year useful life for bull with annual depreciation of $158.50.
[e]One hundred pounds of range cubes (22 percent protein).
[f]Includes sprays, telephone, electricity, accounting, and supplies.

TABLE 5. NUTRIENT REQUIREMENTS FOR WINTERING BEEF CATTLE

Activity	Beginning Weight	Final Weight	Daily Gain	Daily Feed Intake[a]	Average TDN Required Daily
			pounds		
Calf-summer graze	422	616	1.00	10.50	6.26
Background calf	422	694	1.50	13.50	8.20
Background calf	422	739	1.75	15.00	9.00
Cow	1,100	1,000	----	18.00	9.00
Bull	1,800	1,800	----	22.00	12.50

[a]Feed intake is dry weight and is at a maximum for calves.

SOURCE: - National Academy of Sciences, Nutrient Requirements of Beef Cattle, No. 4, Fourth Revised Edition, 1970.

no additional protein is required to attain the level of gain desired.[24] The above rations contain approximately 45 percent grain and 55 percent alfalfa hay.

A typical daily ration for brood cows was 20 pounds of an alfalfa and native hay mixture and one pound of range cubes for 100 days before calving. An alternative daily ration was 25 pounds of corn silage, 10 pounds of an alfalfa and native hay mixture, and one pound of protein supplement prior to calving. Both rations provided for additional hay and a grain supplement during the first month of lactation. A daily requirement of mineral and salt was provided for all cow and feed calf rations. The least-cost ration for cows and calves was determined within the program.

Bulls were wintered on a daily ration of 20 pounds of native and alfalfa hay and two pounds of oats. No alternative rations for the bull activity were considered.

Grazing Requirements

Animal unit equivalents and animal unit months (AUM) of grazing were used in determining forage requirements for pastured cattle. One animal unit (AU) was considered equivalent to a mature cow weighing approximately 1,000 pounds.[25] An animal unit month is the amount of feed (in this instance, forage) required for one animal unit for one month.

The model used two grazing season lengths (six and eight months) for pasturing cows. A six-month season (May 10 through November 20, including

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[24]Strum, G. E., L. Johnson, and E. V. Dunn, Backgrounding Feeder Calves, Circular A-568, Cooperative Extension Service, North Dakota State University, Fargo, North Dakota, November, 1971.

[25]Moberly, H. D., An Economic Analysis of Beef Production and Emerging Technology on Commercial Cattle Ranches in the Southwest Texas High Plains Area, unpublished Ph.D. thesis, Texas A&M University, College Station, Texas, May, 1968, p. 31.

crop and hay aftermath grazing) was used in the initial solutions. An eight-month season beginning May 10 and ending December 31, including crop and hay aftermath, was the alternative. The last 40 days of grazing were supplemented by one-half of the normal daily winter ration of hay. Hay would be fed only as deemed necessary to maintain desirable animal performance which usually involves increasing feeding as snow occurs. By the end of December, a fully hay ration would be fed (Table 6).

TABLE 6. ANIMAL UNIT EQUIVALENTS FOR CATTLE DURING GRAZING SEASON

Animal Type	Average Animal Weight	Animal Unit	Grazing Period
	- - - - *pounds* - - - -	- - (AU) - -	
Cow and-calf[a]	1,000	1.35	May 10-Nov. 20
Bull	1,700	1.40	May 10-Nov. 18
Cow[b]	1,000	1.00	Nov. 20-Dec. 31
Yearling	650	.70	May 10-June 20
Yearling	750	.80	June 20-August
Long yearling	815	.84	Aug. 1-Oct. 1

[a]Calf weight is not included. Heavier grazing by cow during lactation and calf grazing in the fall cause the increase in animal units over single cow.

[b]Grazing cow after weaning.

Pasture Activities

Three alternative pasture systems were available for grazing cows:

1) Graze native range continuously, starting May 10, plus crop and hay aftermath from September 10 until the end of the season.
2) Graze crested wheatgrass during spring (May 10-June 20) and defer native range for summer and fall use.
3) Same as two only move from native range September 10 to graze Russian wildrye until approximately November 1.

Native range could be fertilized with 40 pounds of actual nitrogen (N). Crested wheatgrass could be fertilized with either 40 or 80 pounds of actual N. If Russian wildrye pasture was established, fertilization was at a rate of 40 pounds of actual N per acre. The annual costs and capital requirements for the various pasture alternatives are summarized in Appendix Table 2.

Federal Cost-Share

Cost-sharing is available from the Great Plains Conservation Program administered by the United States Department of Agriculture. The program will

pay 80 percent of the initial cost for seed, seedbed preparation, and actual seeding for establishing permanent grass cover, but cost-sharing is not applicable where a companion crop intended for harvest is seeded. Cost-share for fencing is available only for cross-fences, which were not required in the model. Federal cost-share pays 60 percent of the cost per linear foot of well drilled and cased, if a well is required; but no cost-share payment is allowed for wells constructed primarily for use by the headquarters unit. Appendix Table 2 gives per acre costs for native rangeland and establishing tame pasture, with and without cost-share.

Carrying Capacities

The carrying capacity of native range and tame pasture for animal type, fertilization level, and pasture system are listed in Appendix Table 3.

Grain and Hay Production Costs

Production costs were assumed not to vary between good and marginal cropland. Wheat and barley planted after fallow are consistent with both soil classes. The prices received for small-grains were based on 1974 guarantee prices for wheat and barley of $2.05 and $1.13 per bushel, respectively. Oats was priced at 67 cents per bushel based on the historic relationship of oats and barley prices. An interest rate of 7 percent was used for intermediate and long-term credit. Operating capital was charged at a rate of 8 percent for six months. Appendix Table 4 gives production costs and returns for crop and hayland activities.

Enterprise Labor Requirements

The labor required for cattle and crop enterprises was calculated on a monthly basis and then divided into labor-time periods with the primary activity for each period listed below:[26]

November 1 to April 9 - cattle feeding
April 10 to May 20 - seeding small grains
May 21 to June 10 - planting corn
June 11 to June 30 - cut and stack alfalfa hay
July 1 to July 24 - cut and stack native hay
July 25 to September 15 - swath and harvest small grain
September 16 to October 31 - chop corn and fertilize pastureland

Livestock Labor

The labor requirement for each brood cow and feeder calf decreases as the herd size increases. Hours of labor per cow were derived from a survey

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[26]USDA, Statistical Reporting Service, North Dakota Weather - Crop Bulletin, 1950-65, Agricultural Statistics No. 14, Field Operations Division, Department of Agricultural Economics, North Dakota State University, Fargo, North Dakota, November, 1965.

of South Dakota ranches.[27] A functional relationship developed by Odenbach was used to determine hours of labor necessary for feeder calves and yearlings.[28] The labor requirements by time period are summarized in Table 7.

TABLE 7. LABOR REQUIREMENTS PER TIME PERIOD BY CATTLE ACTIVITIES BY HERD SIZES

Time Period	Cows[a]		Feeder Calves		Bull[b]
	280	150	250	125	
Nov. 1-April 9	4.01	5.28	1.92	2.13	----
April 10-May 20	1.38	1.81	.44	.49	1.10
May 21-June 10	.47	.62	.16	.18	.45
June 11-June 30	.09	.12	.11	.12	.40
July 1-July 24	.05	.07	.13	.14	.46
July 25-Sept. 15	.12	.16	.29	.33	1.04
Sept. 16-Oct. 31	.11	.14	.09	.11	.90
Total hours[c]	8.20	6.23	3.50	3.14	9.15

[a]Approximately a 10 percent decrease in total labor per cow, if an eight month grazing season is used.

[b]Total hours required does not vary with an increase or decrease in the number of bulls.

[c]Total hours are for each individual animal.

Labor Restrictions and Timeliness of Field Operations

In order to achieve the small-grain, corn silage, and hay yields used in the study proper timing is necessary for completing each field operation. The labor-time periods were chosen to limit the time each field activity can be performed to provide optimal yields. As an example the time allowed for cutting and stacking alfalfa hay was restricted to 20 days in June to prevent full maturity which would cause loss of nutritive value in the plant resulting in poorer animal performance. However, the haying period can be expanded by planting alfalfa varieties with different maturity dates and obtain good quality forage across more harvesting days.

The labor requirements for small-grain and haying activities are given in Appendix Table 5.

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[27]Allen, H. R., and R. D. Helfinstine, An Economic Analysis of Ranch Organization in Central South Dakota, Technical Bulletin 33, Agricultural Experiment Station, Economics Department, South Dakota State University, Brookings, South Dakota, April, 1969, p. 42.

[28]Schneeberger, op. cit., p. 33.

The number of work days within each time period was further restricted by weather conditions in order to bring the ranch model closer to reality and force the model to limit the acreage of each crop to the time available to complete required field operations (Table 8).

TABLE 8. ESTIMATED PLANTING AND HARVESTING HOURS AVAILABLE FOR CROP ALTERNATIVES ON TYPICAL RANCH UNIT

Time Period	Total Days	Actual Days	Hours Available	Operation
April 10-May 20[a]	41	25	350	Seed small-grain
May 21-June 10[b]	21	15	210	Plant corn[c]
June 11-June 30[d]	20	12	144	Harvest alfalfa hay
July 1-July 24[e]	24	17	204	Harvest native hay
July 25-Sept. 15[f]	53	42	504	Harvest small-grain

[a]Sixty percent of total days at 14 hours per day.

[b]Seventy percent of total days at 14 hours per day.

[c]Assume corn planted before May 28.

[d]Sixty percent of total days at 12 hours per day.

[e]Seventy percent of total days at 12 hours per day.

[f]Eighty percent of total days at 12 hours per day.

SOURCES: Olson, C. E., R. G. Johnson, B. B. Rice, and D. H. Eidsvig, Weather and Profitable Machinery Size, Circular A-534, Cooperative Extension Service, North Dakota State University, Fargo, North Dakota, August, 1969. Unpublished hay harvesting budgets developed by Randal Coon, Department of Agricultural Economics, North Dakota State University, Fargo, North Dakota, 1973.

RESULTS OF EVALUATING ALTERNATIVE PASTURE MANAGEMENT SYSTEMS

A single period linear programming was used to determine optimum ranch organizations assuming alternative livestock production and pasture management systems. A series of analyses were performed to determine the effects of adding additional cattle marketing and pasture management alternatives of varying selling prices of cattle and of varying fertilizer prices. An initial or "baseline" solution, developed for purposes of comparison, provided the profit-maximizing ranch organization given that tame pasture establishment and native range fertilization were not allowed and that cattle marketing alternatives were limited to the sale of weaned calves. Subsequent analysis involved increasing the livestock marketing and pasture management alternatives.

Baseline Solution

The baseline solution provided the profit-maximizing ranch organization based on traditional pasture management techniques and cattle marketing practices (Table 9). No tame pasture establishment and native range fertilization were allowed and only sale of calves at weaning was permitted. Wheat after fallow occupied most of the good cropland with the remainder (11 acres out of 351) devoted to oats production. Oats was used as winter feed for the cow herd. Marginal cropland was used for wheat after fallow and for alfalfa hay production. The cow herd totaled 110 and 82 calves were sold annually. Return to labor and management was $6,787.

Alternative Cattle Marketing Programs

Solution 2 considered the alternatives of selling either backgrounded calves or yearlings. Sale of yearlings after summer grazing was the most profitable alternative. In order to provide additional winter feed, 26 acres of good cropland was shifted from wheat-fallow to oats (Table 9). Labor and management returns were $9,635, an increase of 42 percent from the Solution 1 level.

Alternative Pasture Management Programs

The alternatives of establishing tame pasture for spring grazing and of fertilizing tame pasture, native hayland, and native range were added to the model for Solution 3. The optimum ranch organization used 49 acres of good cropland for oats production with the remainder in wheat-fallow (Table 9). All marginal cropland was used for forage production - 142 acres for alfalfa hay and 113 acres for tame pasture. All tame pasture and native hayland was fertilized with 40 pounds of actual N, but no native range was fertilized. Of the 1,572 acres of native range, 650 acres were used for deferred grazing. Labor and management returns were $11,325 which is 67 percent greater that than of Solution 1 and 18 percent greater than that for Solution 2.

Extended Grazing Season (Solution 4)

An eight-month grazing season (May 10-December 31) was used to determine the effect on ranch organization of the reduced labor and winter feed requirements associated with this management strategy. The eight-month grazing season was analyzed using the livestock marketing and pasture management strategies included in Solution 3.

The livestock and crop production pattern with an eight-month grazing season does not differ greatly from that with a six-month season (see Table 11). The acreage of alfalfa hay was reduced by 33 acres as a longer grazing season implied a reduced hay requirement per head. No hired labor was used; whereas, 44 hours were needed in Solution 3. The major change in pasture management was the large increase in the acreage of native range on which deferred grazing was practiced, 1,380 acres compared to 650 acres for Solution 3. Returns to labor and management for Solution 4 were $11,022.

TABLE 9. OPTIMUM RANCH ORGANIZATION WITH VARIOUS ALTERNATIVE CATTLE MARKETING AND PASTURE MANAGEMENT PROGRAMS CONSIDERED

Activities \ Solution	Unit	1 Baseline Solution[a]	2 Alternative Cattle Marketing Programs[b]	3 Tame Pasture and Native Range Fertilization[c]	4 Extended Grazing Season[d]	5 Tame Pasture for Both Spring and Fall Grazing[e]
Good Cropland:						
Wheat	acres	170	157	151	152	152
Fallow	acres	170	157	151	152	152
Oats	acres	11	37	49	47	47
Marginal Cropland:						
Wheat	acres	65	64	0	0	18
Fallow	acres	65	64	0	0	18
Alfalfa hayland	acres	125	127	142	109	132
Tame pasture, spring - 40 lbs. N	acres			113	146	39
Tame pasture, fall - 40 lbs. N	acres					48
Native Rangeland:						
Native hayland - 0 lbs. N	acres	65	65	0	0	
Native hayland - 40 lbs. N	acres			65	65	65
Native grazing - 0 lbs. N	acres	1,572	1,572	922	192	1,197
Native grazing - 40 lbs. N	acres			0	0	140
Native grazing, deferred - 0 lbs. N	acres			650	1,380	235
Cattle:						
Cows	number	110	94	125	122	119
Bulls	number	4	4	5	5	5
Weaned calves[f]	number	82	0	0		
Background calves - 1.75 gain[g]	number			0		
Yearlings[h]	number		69	93	90	88
Cull cows	number	17	14	19	18	18
Operator Labor Used:	hours	1,552	1,715	1,940	1,778	1,948
Family Labor Used:						
November 1 - April 9	hours	0	0	39	0	0
April 10 - May 20	hours	0	0	5	0	0
Total hours hired	hours	0	0	44	0	0
Operating capital[i]		6,041	6,537	7,545	7,479	8,136
Long-term capital[j]		71,887	67,791	82,088	79,757	79,597
Labor, mgmt., returns[k]		6,787	9,635	11,325	11,022	10,591

[a]No tame pasture establishment or range fertilization allowed. Sale of calves at weaning was only cattle marketing alternative.

[b]Marketing of backgrounded calves and yearlings is allowed. Tame pasture management and range fertilization are not allowed.

[c]Tame pasture could be established to provide spring (May 10-June 20) grazing for cows and yearlings. Native range could be fertilized with 40 pounds of N. Native range grazing may be deferred until June 20.

[d]An eight-month grazing season (May 10-December 31) was used. Cattle marketing and pasture management alternatives were the same as in Solution 3.

[e]Tame pasture could be established for both spring and fall grazing for cows or for spring grazing of yearlings. If cows grazed tame pasture in spring, tame pasture must also be provided for fall grazing. Other management and marketing alternatives were the same as in Solution 3.

[f]Marketed about November 1.

[g]Marketed about April 30.

[h]Marketed about August 1.

[i]Interest rate on long-term capital was 7 percent.

[j]Interest rate on operating capital was 8 percent for six months.

[k]Net returns to operator for his labor and management, computed by subtracting interest on investment from net ranch income.

Tame Pasture for Fall Grazing (Solution 5)

The establishment of crested wheatgrass for spring grazing and Russian wildrye for fall grazing replaced the possibility of using tame pasture for spring grazing only. Other activities in the model were the same as for Solution 3. Tame pasture consisted of 39 acres of crested wheatgrass for spring grazing and 48 acres of Russian wildrye for fall grazing. Fertilizer was applied to all tame pasture and to 140 acres of native range. Labor and management returns for Solution 5 were $10,591, which was 6.5 percent less than for Solution 3 (see Table 9).

Effects of Varying Cattle Prices

Prices were varied over a considerable range to determine the effect of cattle prices on optimum ranch organization (Table 10). Prices were varied from $28.50 to $55.50 per hundredweight with prices for calves and backgrounded calves being varied correspondingly, while small grain and input prices were held constant. The pasture management alternatives included were the same as in Solution 3. As cattle prices increased, both the acreage devoted to forage production and the number of yearlings sold increased. At a yearling price of $28.50/cwt. only 65 acres of marginal cropland were used for forage production. Increasing the price to $34 caused forage production to increase from 65 to 101 acres as the cow herd increased from 88 to 99. At a yearling price of $40/cwt., 113 acres of crested wheatgrass were established for spring grazing and the alfalfa acreage increased to 142 acres as the cow herd was expanded from 99 to 125 cows. Thus, at the $40 price level, all marginal cropland was used for forage production. At a yearling price of $45.50, 492 acres of native range were fertilized. At a price level of $51, good cropland was used for both alfalfa and crested wheatgrass. At higher price levels, increasing amounts of good cropland were used for forage production.

Effects of Varying Fertilizer Prices

Fertilizer costs are a source of considerable uncertainty. Consequently, price of nitrogen fertilizer was varied to determine the effects of higher prices on the profitability of tame pasture and native range fertilization. Price of ammonium nitrate (33 percent actual nitrogen) was increased from $50 to $140 per ton. The prices of cattle, grain, and other inputs and the production activities were the same as in Solution 3. The effects of varying fertilizer prices are summarized in Table 11. At a fertilizer price of $50/ton, 492 acres of native range and 84 acres of crested wheatgrass were fertilized. When the price increased to $65 per ton, native range fertilization was eliminated, but crested wheatgrass increased to 113 acres. The acreage fertilized remained constant at all price levels up to $140 per ton, the highest price included in the analysis. Native hayland (65 acres) was fertilized at all price levels.

TABLE 10. EFFECT OF VARYING CATTLE PRICES ON THE USE OF MARGINAL AND GOOD CROPLAND, NATIVE RANGE FERTILIZATION, AND THE SUPPLY OF CATTLE

Market Price/Cwt.[a] of Yearlings	Marginal Cropland[c]					Good Cropland[e] (acres)			Native Range Fertilized[f]	Cow Herd[g]	Yearlings Sold[g]
	Crested Wheatgrass	Wheat[b]	Fallow	Alfalfa	Total Forage[d]	Crested Wheatgrass	Alfalfa	Total Forage			
	acres					*acres*				*number*	
28.50	--	95	95	65	65	--	--	--	--	88	65
34.00	--	77	77	101	101	--	--	--	--	99	74
40.00	113	--	--	142	255	--	--	--	--	125	93
45.50	84	--	--	171	255	--	--	--	492	141	104
51.00	160	--	--	95	255	41	91	132	56	150	111
55.50[h]	249	--	--	6	255	38	168	206	80	153	113

[a]Prices are rounded to nearest $.50.

[b]Wheat priced at $2.05 per bushel.

[c]Totals 255 acres. Crested wheatgrass and Russian wildrye are fertilized with 40 pounds of actual nitrogen per acre.

[d]Acres devoted to tame pasture and alfalfa for hay.

[e]Totals 351 acres.

[f]Native range fertilized with 40 pounds actual nitrogen per acre.

[g]Cows and yearlings allowed to graze tame pasture in spring.

[h]Yearlings graze 45 and 32 acres of crested wheatgrass on marginal and good cropland, respectively.

TABLE 11. EFFECT OF VARYING FERTILIZER PRICES ON THE USE OF MARGINAL CROPLAND, NATIVE RANGE FERTILIZATION, AND THE SUPPLY OF CATTLE

Fertilizer Price/Ton	Marginal Cropland[a]						Native Range[b] Fertilized	Cow Herd[c]	Yearlings Sold[c]
	Crested Wheatgrass	Wheat	Fallow	Alfalfa	Total Forage	Total Forage Acres Fertilized			
	acres							*number*	
$ 50	84	--	--	171	255	84	492	141	104
$ 65	113	--	--	142	255	113	--	125	93
$ 80	113	--	--	142	255	113	--	125	93
$ 95	113	--	--	142	255	113	--	125	93
$110	113	--	--	142	255	113	--	125	93
$125	113	--	--	142	255	113	--	125	93
$140	113	--	--	142	255	113	--	125	93

[a]Totals 255 acres. All tame pasture is fertilized with 40 pounds actual nitrogen per acre.

[b]Includes native range fertilized for yearlings. Native rangeland is fertilized at 40 pounds actual nitrogen per acre. Native hayland acreage is not included.

[c]Cows and yearlings allowed to graze tame pasture in spring.

[d]Yearlings graze 127 acres of fertilized native rangeland.

CONCLUSIONS

Under the conditions imposed in the model ranch of this study, ranch income and returns to the operator's labor and management can be substantially increased through departures from traditional management practices. Sale of yearlings was more profitable than selling calves at weaning. Crested wheatgrass for spring grazing was a more profitable use of marginal cropland than wheat at yearling prices of $40/cwt. and higher compared to a wheat price of $2.05 per bushel. However, yearling prices of $51/cwt. would be needed before good cropland would be used for tame pasture. When crested wheatgrass was established, fertilization at a rate of 40 pounds of actual nitrogen per acre was substantially more profitable than the alternatives of either no fertilization or fertilization at the rate of 80 pounds of actual nitrogen per acre. Fertilization of suitable native hayland also was a profitable practice under a wide range of fertilizer prices. Profitable fertilization of native rangeland on an annual basis required ammonium nitrate prices $65 per ton or less. Thus, widespread fertilization of native range is unlikely given present cattle price-fertilizer cost conditions.

Recent increases in fertilizer and grain prices and changes in the cattle price structure will influence the profitability of the various alternatives. Prices of yearlings became much higher relative to the price of calves in 1974 than was the case in the 1970-1973 period. Production of yearlings will be even more profitable, relative to calves, under these conditions. Yearling production also provides the rancher with added flexibility to adjust his herd size to annual fluctuations in the range feed supply. Higher grain prices, of course, make the conversion of cropland to tame pasture less attractive. If high grain prices continue, future research might be directed to the use of selective fertilization to increase cool season grass production of selected native range sites for spring grazing. Periodic applications of herbicides in conjunction with nitrogen to improve range condition also may be a fruitful subject for economic analysis. If wheat acreage controls were imposed, tame pasture could become a more attractive alternative. Acreage restrictions similar to those of previous farm programs would allow tame pasture to compete with less profitable small grains for use of good cropland.

APPENDIX

APPENDIX TABLE 1. AVERAGE DAILY GAIN, AVERAGE SELLING WEIGHT, SELLING DATE, AND DEATH LOSS FOR CALF AND YEARLING ACTIVITIES

Animal Type	Selling Date	Gains Per Day for Each Feeding Period				Animal Weight[a]	Annual Death Loss
		Winter	Spring Graze	Summer Graze	Fall Graze		
		- - - - - - - - - pounds - - - - - - - - -					percent
Weaned calf	Nov. 1	----	----	----	----	422	----
Background calf	Apr. 30	1.50	----	----	----	694	.90
Background calf	Apr. 30	1.75	----	----	----	739	.90
Yearling	June 20	1.00	2.25	----	----	708	1.10
Yearling	Aug. 1	1.00	2.25	1.75	----	791	1.20
Long yearling	Oct. 1	1.00	2.25	1.75	1.00	843	1.30

[a]Three percent shrinkage is subtracted from animal selling weight.

[b]Interpolation is used to arrive at death loss percentages after April 30. Death loss for cows is 1 percent annually.

APPENDIX TABLE 2. PER ACRE COSTS AND CAPITAL REQUIREMENTS FOR NATIVE AND TAME PASTURE ESTABLISHMENT WITH AND WITHOUT FEDERAL COST-SHARE ASSISTANCE

Item	(Without Cost-Share)						(With Cost-Share)			
		Crested Wheatgrass		Russian Wildrye	Native Range			Crested Wheatgrass		Russian Wildrye
	0#N	40#N	80#N	40#N	0#N	40#N	0#N	40#N	80#N	40#N
	dollars per acre									
Variable Costs:[a]										
Establishing stand	1.07	1.07	1.07	1.51	----	----	.85	.85	.85	.94
Fence repair	.31	.31	.31	.31	.18	.18	.31	.31	.31	.31
Fertilizer	----	3.96	7.92	3.96	----	3.96	----	3.96	7.92	3.96
Fert. application	----	.51	.51	.51	----	.51	----	.51	.51	.51
Weed control	.09	.09	.09	.13	----	.19	.09	.09	.09	.13
Application of spray	.05	.05	.05	.03	----	.10	.05	.05	.05	.03
Total variable costs	1.52	5.99	9.95	6.45	.18	4.94	1.30	5.77	9.73	5.88
Fixed Costs:[a]										
Well depreciation[b]	----	----	----	----	.03	.03	----	----	----	----
Fence depreciation	.34	.34	.34	.34	.19	.19	.34	.34	.34	.34
Land change	8.14	8.14	8.14	8.14	4.65	4.65	8.14	8.14	8.14	8.14
Total fixed costs	8.48	8.48	8.48	8.48	4.87	4.87	8.48	8.48	8.48	8.48
Capital Requirements:										
Initial investment	14.49	18.45	22.41	27.16	----	----				
Average long-term cap. (without well)	4.26	4.26	4.26	4.26	2.65	2.65	4.26	4.26	4.26	4.26
Average long-term cap. (with well)	6.83	6.83	6.83	6.83	2.65	2.65	5.29	5.29	5.29	5.29
Operating capital	1.52	5.99	9.95	6.45	.18	4.94	1.30	5.77	9.73	5.88

[a]Costs for extablishing tame pasture were amortized over 20 years at 7 percent interest.

[b]If greater than 160 acres, well depreciation = $.21 per additional acre. If greater than 160 acres and cost-share utilized well depreciation = $.09 per additional acre.

APPENDIX TABLE 3. ACRES OF GRAZING REQUIRED PER MONTH BY CATTLE ACTIVITIES

Type of Grazing	Cow-Calf (1.35 AU)	Cow (1.00 AU)	Spring Yearling (.70 AU)	Summer Yearling (.80 AU)	Fall Yearling (.84 AU)	Bull (1.40 AU)
	acres per month					
Native Range:						
0 lbs. N	2.28	----	1.18	1.35	1.42	2.37
40 lbs. N	1.27	----	.66	.75	.79	1.31
Crested Wheatgrass:						
0 lbs. N	1.69	----	.88	----	----	1.75
40 lbs. N	.99	----	.52	----	----	1.04
80 lbs. N	.92	----	.48	----	----	.97
Deferred Native Range:[a]						
0 lbs. N	1.71	----	----	1.02	1.07	1.78
40 lbs. N	.96	----	----	.57	.60	.99
Russian Wildrye:[b]						
40 lbs. N	.95	----	----	----	----	.98
Deferred Native Range:[c]						
0 lbs. N	1.38	----	----	----	----	1.43
40 lbs. N	.77	----	----	----	----	.80
Native Range (late fall):[d]						
0 lbs. N	----	1.18	----	----	----	----
40 lbs. N	----	.89	----	----	----	----

[a]Using crested wheatgrass in the spring to defer native range increases the carrying capacity of native by 25 percent.

[b]Yearlings are not grazed on Russian wildrye in the fall because they are marketed before tame grazing is exhausted and because of low gains per day obtained in trials.

[c]Using crested wheatgrass in the spring and Russian wildrye in the fall will allow an increase in the carrying capacity of native range by 40 percent due to deferment and increased grazing pressure on native during the summer.

[d]Applies to seven and one-half month grazing season for cows only. Carrying capacity increased by 30 percent due to season-long deferment.

SOURCES: 1) Rogler, G. A., and F. J. Lorenz, Pasture Productivity of Crested Wheatgrass as Influenced by Nitrogen Fertilization and Alfalfa, Technical Bulletin 1402, Agricultural Research Service, USDA in cooperation with Department of Animal Science, North Dakota Agricultural Experiment Station, North Dakota State University, Fargo, North Dakota, April, 1969, p. 7.

2) Rogler, G. A., and R. J. Lorenz, "Nitrogen Fertilization of Natural Grasslands in the Northern Plains of the United States," in Proceedings Ninth International Grassland Congress, Volume II, Department of Animal Nutrition, Sao Paulo, Brazil, January, 1965.

3) Rogler, G. A., and R. J. Lorenz, "Increasing Production of Native and Seeded Pastures With Nitrogen Fertilizer," Proceedings Twenty-Second Annual Fertilizer Conference of the Pacific Northwest, Bozeman, Montana, July, 1971.

4) Weins, J. B., and R. W. Lodge, Canadian Farm Economics, Volume VIII, No. 3, 1972, pp. 14-21.

APPENDIX TABLE 4. PRODUCTION COSTS AND RETURNS WITH ABOVE AVERAGE MANAGEMENT IN SOUTHWESTERN NORTH DAKOTA

Item	Wheat/ Fallow	Wheat/ Fallow	Barley/ Fallow	Barley/ Fallow	Oats Non-fallow	Oats Non-fallow	Corn[a] Silage	Corn[a] Silage	Alfalfa Hay	Alfalfa	Native Hayland: Native Unfert. Hay	Native Hayland: Native Fert. Hay[b]
	dollars											
	Good	Marg.	Good	Marg.	Good	Marg.	Good	Marg.	Good	Marg.		
Direct Costs:												
Seed	3.25	3.25	2.45	2.45	2.30	2.30	4.20	4.20	1.88	1.88	-----	-----
Fertilizer	2.40	2.40	2.40	2.40	6.00	6.00	4.88	4.88	1.15	1.15	-----	4.47
Chemicals	1.00	1.00	1.00	1.00	.40	.40	.56	.56	.70	.70	-----	-----
Machinery repairs	2.07	2.07	2.03	2.03	1.72	1.72	3.80	3.80	2.22	2.00	3.41	5.34
Fuel & lubricants	1.72	1.72	1.68	1.68	1.38	1.38	2.73	2.73	-----	-----	-----	-----
Crop insurance	1.89	1.89	2.06	2.06	1.81	1.81	-----	-----	-----	-----	-----	-----
Custom costs	1.08	1.08	1.11	1.11	.83	.83	-----	-----	-----	-----	-----	-----
Total direct costs	13.41	13.41	12.73	12.73	14.40	14.40	16.17	16.17	5.95	5.73	3.41	9.81
Fixed Costs:												
Mach., dep., & insur.	4.49	4.49	4.35	4.35	3.21	3.21	3.42	3.42	3.70	3.70	3.34	3.34
Interest on machinery	2.99	2.99	2.89	2.89	2.10	2.10	3.03	3.03	1.50	1.50	1.35	1.35
Labor ($2.00/hour)[c]	3.72	3.72	3.72	3.72	3.04	3.04	6.18	6.18	1.30	1.14	1.18	2.22
Land cost (includes tax)	16.28	16.28	16.28	16.28	8.14	8.14	8.14	8.14	8.14	8.14	4.65	4.65
Total fixed cost	27.48	27.48	27.24	27.24	16.49	16.49	20.77	20.77	14.64	14.48	10.52	11.56
Total costs per acre	40.89	40.89	39.97	39.97	30.89	30.89	37.18	37.18	20.59	20.21	13.93	21.37
Total returns per acre	69.08	48.58	61.92	43.50	38.19	26.93	-----	-----	-----	-----	-----	-----
Net returns	28.19	7.69	21.95	2.17	5.76	-3.96	-37.18	-37.18	-20.59	-20.21	-13.93	-21.37
Total yeild per acre	33.7 bu	23.7 bu	54.8 bu	38.5 bu	57.0 bu	40.2 bu	5.3 tn	3.7 tn	1.5 tn	1.35 tn	.95 tn	1.8 tn
Aftermath grazing (AUM)	.15	.15	.15	.15	.15	.15			.20	.20	.20	.20

[a]A 20 percent storage loss is subtracted out in the program.
[b]Fertilized at 40 pounds of nitrogen per acre.
[c]Overhead labor is not included.

SOURCES: Rice, B. B., L. W. Schaffner, R. Johnson, and L. J. Held, "Yields and Production Costs for Small Grains and Flax," Farm Management Planning Guide, Section VI, No. 8, Cooperative Extension Service, North Dakota State University, Fargo, North Dakota, September, 1973.

APPENDIX TABLE 5. PER ACRE LABOR REQUIREMENTS FOR SMALL-GRAIN, CORN SILAGE, AND HAYING ACTIVITES[a]

Time Period	Wheat[b]	Barley[b]	Oats	Corn Silage	Alfalfa Hay (Good)	Alfalfa Hay (Marg.)	Native Hay Unfertilized	Native Hay Fertilized (40#N)
April 10-May 20	.50	.50	.84	----	---	---	---	----
May 21-June 10	.10	.10	.10	.96	---	---	---	----
June 11-June 30	.17	.17	----	----	.65	.57	---	----
July 1-July 24	.17	.17	----	.30	---	---	.59	1.11
July 25-Sept. 15	.58	.58	.58	----	---	---	---	----
Sept. 16-Oct. 31	.34	.34	----	1.83	---	---	---	----
Total hours	1.86	1.86	1.52	3.09	.65	.57	.59	1.11

[a]Overhead labor is not included. Hours required for haying are based on yield per acre.

[b]Includes labor for fallow.

SOURCES:
1) Farm Management Planning Guide for North Dakota, Circular FM-1-67, Cooperative Extension Service, North Dakota State University, Fargo, North Dakota, August, 1967, p. 10.

2) Rider, A. R., and W. Bowers, Cost, Capacity, and Management of Oklahoma Hay Systems, Agricultural Experiment Station No. P-72, Stillwater, Oklahoma, p. 11.

3) Schaffner, L. W., B. B. Rice, and R. Johnson, Crop Costs and Returns, Circular A-550, 553, and 557, Cooperative Extension Service, North Dakota State University, Fargo, North Dakota, 1971.

LIST OF TABLES

APPENDIX TABLES