COST-SIZE RELATIONSHIPS OF NORTH DAKOTA RANCHES

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Ranchers have observed that costs of resources used in their businesses are increasing at a faster rate than the prices they receive for their product, beef cattle. This phenomenon, often termed the "cost-price squeeze," tends to reduce the margin between receipts and costs per animal sold.

One way a rancher may adjust to these changing economic conditions is to increase the size of his ranch. Ranch enlargement allows income to be received from more units of output. In addition, if costs per unit of output decrease as the size of the ranch increases, the net income received per unit of output also increases. The relationship between ranch size and production costs is, therefore, of considerable interest to ranch operators.

Several researchers have studied ranch cost-size relationships using ranch survey data. However, a disadvantage of the survey method is that the cost-size relationship may be obscured by differences in management ability, range condition and related factors among ranchers surveyed. These difficulties can be avoided by the use of linear programming to simulate the operations of ranches of various sizes. Linear programming was employed in a recent study to determine economies of size for typical North Dakota ranches.

The purpose of the study was to determine production costs for ranches of different sizes in southwestern North Dakota. The study area, the 14 North Dakota counties south and west of the Missouri River, is the principal ranching area of the state. Native rangeland of the mixed grass prairie type comprises about 60 per cent of the total land area. Wheat, hay and oats are the leading crops.

Procedures

Ranches were synthesized based on data obtained in surveys of actual ranch operations in the region. Superior management was assumed in estimating crop yields and calving percentages. Ranch size was defined by the number of full-time workers and the size of machinery available. Machinery size was measured with reference to the size of the largest tractor. Tractor size, in turn, was measured by the number of moldboard plows pulled. Six ranch sizes were studied: a one-man ranch with a four-plow set of machinery; a one-man ranch with a six-plow set of machinery; a one-man ranch with an eight-plow set of machinery; and two-, three-, and four-man ranches each with eight-plow machinery.

Land was a variable factor in the model and could be adjusted according to the number of workers and size of machinery. For all ranch sizes, land was assumed to have the same cropland-rangeland composition as in the study area as a whole. Crop alternatives allowed included hay, corn silage, oats, barley, flax and wheat. Table 1 shows yields and prices for these crops. The provisions of the 1971 government wheat and feed grain programs were used as restrictions in the model. The important restrictions included (1) the conserving base requirement—each ranch or farm was required to maintain a minimum acreage in conserving uses (hay, tame pasture and summer fallow would qualify), and (2) the set-aside requirement—each ranch or farm was required to divert a percentage of its wheat allotment acreage from crop production (the diverted land could be summer fallowed).

Table 1. Yields and Prices for Crop Enterprises, Southwestern North Dakota.

Crop	Yield per acre	Price per unit[1]
Wheat after fallow	31 bu.	$1.40
Barley after fallow	47 bu.	.84
Barley after small grain	33 bu.	.84
Oats after small grain	50 bu.	.55
Flax	11 bu.	2.36
Corn silage	5.0 tons	[2]
Tame hay mixture	1.5 tons	[2]
Native hay	0.85 tons	[2]

[1]Government payments not included.
[2]The model did not provide for sale of forage crops.

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Native rangeland could be grazed during spring (May 10-June 15), summer (June 15-August 30), and fall (September-October). However, if part of the native range was used for spring grazing, the production of that part was assumed to be reduced by 45 per cent. Native rangeland could be fertilized with 40 to 80 pounds of available nitrogen if either alternative was found to be profitable. The same fertilization alternatives were available for tame pasture (crested wheatgrass-alfalfa mixture), which could be used for either spring or fall grazing. Fall grazing could be obtained from hay and crop aftermath. Table 2 shows forage production under the various grazing alternatives.

Table 2. Forage Production Per Acre on Tame Pastureland and Native Rangeland.

	Tame pastureland			Native rangeland[1]		
Grazing period	0 lbs N	40 lbs N	80 lbs N	0 lbs N	40 lbs N	80 lbs N
Spring grazing	375	652	688			
Summer grazing				246	483	608
Fall grazing	56	98	103			

[1]If native range was used for spring grazing, yield was assumed to be reduced by 45 per cent.

Livestock enterprises were based upon spring calving (April). Several alternative dates for selling calves and yearlings were considered. Calves could be (1) sold in the fall after weaning (October 31), (2) pre-conditioned and sold in midwinter (January 31), (3) wintered and sold in early spring (April 15), or (4) summered on grass as yearlings. Yearlings could be sold on three alternative dates, June 15, July 31 or August 31.

Cattle prices were based on monthly price quotations from the West Fargo market during the period 1963-1970. A deduction of $0.25 per cwt. was made on all classes to account for the differential between West Fargo prices and those of the study area. While the prices used are considerably lower than those prevailing presently, use of higher prices would not result in major changes in ranch organization.

In this study, ranch expenses assumed included charges for capital and for the ranch operator's labor. These charges included a seven per cent interest on market value of land, depreciated value of machinery, and value of the breeding herd, and eight per cent interest on working capital. The ranch operator's services were valued at $6,500 per year. Hired labor costs were $5,500 annually for a full-time employee, and $1.70 per hour for seasonal labor.

Linear programming was used to determine the costs and returns of each ranch size. Linear programming is a form of computerized budgeting which allows numerous production constraints (e.g., spring, summer, and fall range, winter feed, labor supply, etc.) to be considered simultaneously. Linear programming was used in this study to choose the combination of livestock and crop enterprises for each of the six ranch sizes which minimized the cost of producing specified levels of gross income. Thus, the crop and livestock combinations selected were the most efficient attainable given the resources available and the prices assumed.

Results

Enterprise combinations which gave minimum cost per unit of gross income for the six selected ranch sizes are shown in Table 3. The best cattle production program for all ranches was to winter the calves and sell them as yearlings at the end of July. Numbers of brood cows ranged from 78 on the smallest ranch to 457 on the largest. Numbers of cows per full-time worker increased from 78 for the one-man ranch with four-plow machinery to 114 for the four-man ranch.

Total acreage of land operated ranged from 1,780 acres for the one-man ranch with four-plow machinery to 9,734 acres for the four-man ranch. All ranches used part of their native rangeland for spring grazing despite the reduction in range forage production which resulted. The one-man ranch with eight-plow machinery and the four-man ranch used all of their native hayland for summer grazing and used tame hay to meet their winter feed requirements. The one-man ranch with six-plow machinery and the two-man ranch also grazed a portion of their native hayland. All six ranches produced wheat as a cash crop. Participation in the government wheat program was profitable for all ranch sizes. Tame pasture and hay were produced on all ranches, but only enough to satisfy conserving base requirements. Tame pasture and hay could not compete with grain crops once conserving base requirements were satisfied.

Table 4 shows the capital required by each of the six ranches studied. Total capital required ranged from $206,465 for the one-man ranch with four-plow machinery to $1,080,235 for the four-man ranch. Capital per full-time worker exceeded $200,000 for all six ranches, which indicates the capital intensive nature of modern ranchng. Machinery and field equipment accounted for a declining relative portion of total investment as ranch size increased. Machinery and equipment constituted 12.6 per cent of total investment for the one-man ranch

Table 3. Minimum Cost Production Plans for Ranches of Six Selected Sizes .

Item	Unit	Size of Ranch					
		1-man			2-man	3-man	4-man
		4-plow	6-plow	8-plow	8-plow	8-plow	8-plow
Total land operated	acres	1,780	1,961	2,674	4,817	7,464	9,734
Breeding cows	number	78	86	88	213	331	457
Yearling steers, sold July 31	"	35	38	39	94	147	203
Yearling heifers, sold July 31	"	22	25	26	61	95	131
Native rangeland, spring grazed	acres	209	253	258	624	904	1,111
Native rangeland, summer and fall grazed	"	783	870	846	2,093	3,254	4,498
Native hayland cut for hay[1]	"	34	7	0	54	143	0
Tame pasture, unfertilized	"	110	113	189	278	454	155
Tame pasture, 40 lbs. N.	"	0	0	0	0	0	297
Tame hay	"	112	132	145	323	477	762
Wheat following fallow	"	240	247	393	621	920	1,080
Barley following fallow	"	26	46	0	0	0	114
Flax	"	0	0	13	198	392	523
Gross income	$	31,000	34,000	41,000	85,000	132,000	176,000
Total cost	"	35,800	38,491	45,880	86,314	130,607	172,758
Cost per dollar of gross income	"	1.16	1.13	1.12	1.02	0.99	0.98

[1]Native hayland could be pastured as an alternative to cutting for hay. Some ranchers pastured part or all of their native hayland.

with four-plow equipment, but only 6.0 per cent of total investment for the four-man ranch.

Gross income ranged from $31,000 for the smallest ranch to $176,000 for the largest. Total ranch costs, including interest on investment and a $6,500 return to the operator's labor, ranged from $35,800 on the smallest ranch to $172,758 for the largest ranch. The cost-output relationship is presented in graphic form in Figure 1. When the ratio of cost to gross income exceeds 1.0, the ranch is not covering full costs (including return to operator labor and investment). Only the three- and four-man ranches had gross incomes large enough to cover their total costs and returns on economic profit or "pure profit" to the ranch operator.

The four smaller ranches were not able to cover their total costs, including interest on investment and an operator labor charge, but all four were able to cover their other operating costs and produce a substantial return to operator labor and long-term investment. Table 5 shows that this return ranged from $15,462 for the smallest ranch to $80,357 for the largest. When the imputed charges for operator labor ($6,500) and for nonland invest-

Table 4. Capital Requirements of Minimum Cost Ranch Production Plans.

Item	Unit	1-man			2-man	3-man	4-man
		4-plow	6-plow	8-plow	8-plow	8-plow	8-plow
Long-term capital	$	196,611	215,874	274,511	503,260	770,675	1,008,790
Land and buildings	"	128,160	141,192	192,528	346,824	537,408	700,848
Machinery	"	26,017	27,935	32,921	41,834	55,242	65,836
Livestock and other	"	42,434	46,747	49,062	114,602	178,025	242,106
Average operating capital	"	9,854	10,692	12,901	31,620	51,688	71,445
Total capital	"	206,465	226,566	287,412	534,890	822,363	1,080,235
Total capital per full-time worker	"	206,465	226,566	287,412	267,445	274,121	270,059

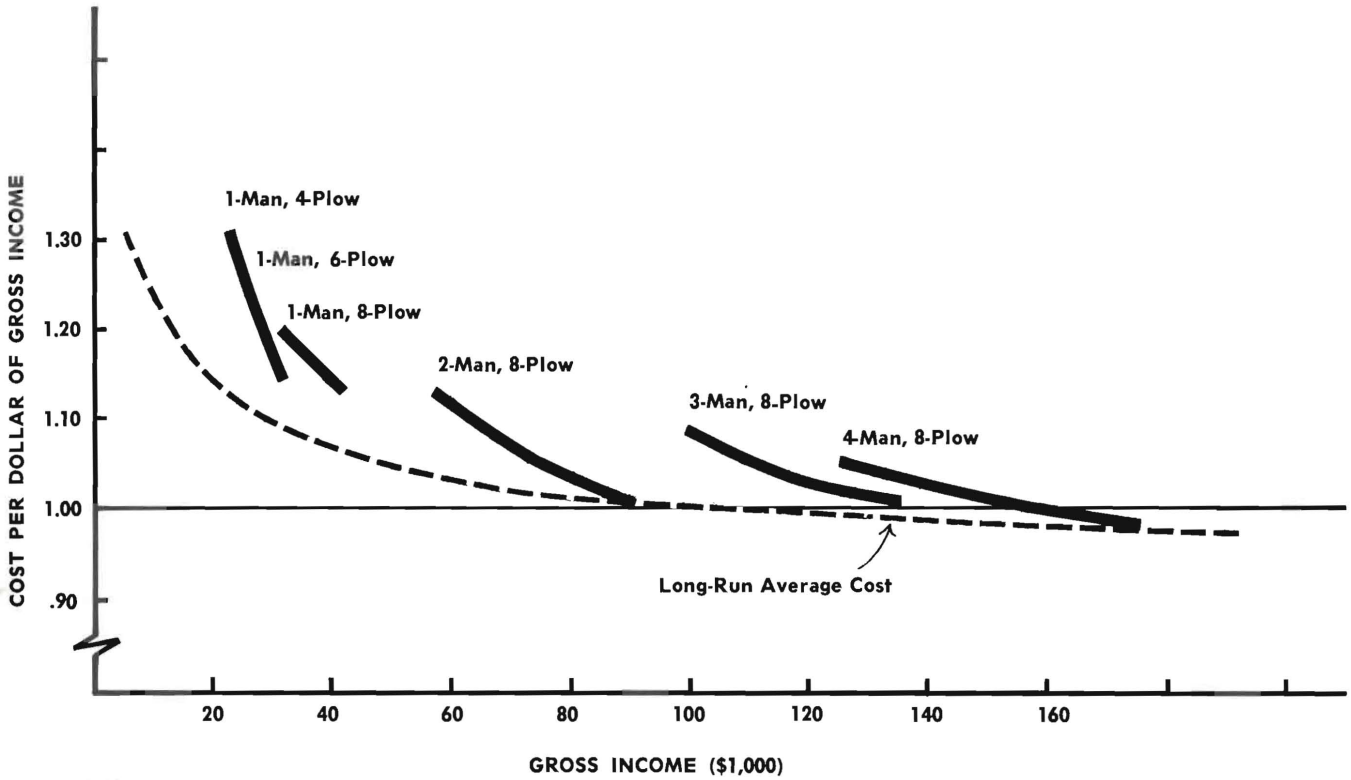

Figure 1. Short-Run Average Cost Curves and Planning Curve for Southwestern North Dakota Ranches of Six Selected Sizes.

ment (seven per cent) were subtracted, the return on land investment was obtained. The return on land investment, shown in Table 5, ranged from 3.25 per cent for the smallest ranch to 7.46 per cent for the largest ranch.

Conclusions

Substantial economies of size are present in North Dakota cattle ranching. Costs per unit of gross income decrease sharply as ranch size increases from a one-man operation to a two-man ranch. Further cost decreases occur as ranch size increases to a three-man operation. Cost differences between three- and four-man ranches are very slight. On the basis of this cost-size relationship, a continued trend of ranch expansion can be expected. With the product prices and resource costs that have prevailed in recent years, large and well-managed ranches can earn returns on investment which are equivalent to market interest rates.

References

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Table 5. Return to Operator Labor and Long-term Investment and Return on Land Investment for Ranches of Six Selected Sizes.

	Size of Ranch					
	1-man			2-man	3-man	4-man
Item	4-plow	6-plow	8-plow	8-plow	8-plow	8-plow
Return to operator labor and long-term investment	$15,462	$17,120	$25,716	$41,710	$61,840	$80,357
Return on land investment	4,171	5,392	8,597	22,963	39,012	52,301
Return on land investment, %	3.25	3.82	4.47	6.62	7.26	7.46