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**SIMULATION ANALYSIS OF EXTENSIVE AND INTENSIVE
GROWTH OF A NEBRASKA SANDHILLS RANCH**

by

Robert Dean Carver

A DISSERTATION

Presented to the Faculty of

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In Partial Fulfillment of Requirements

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Department of Agricultural Economics

Under the Supervision of Professor Glenn A. Helmers

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A Simulation Analysis of Extensive and Intensive Growth

of a Nebraska Sandhills Ranch

BY

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CHAPTER I

"Between the gleam in a bull's eye as he chases a heifer across a meadow and a cut of prime steak at the Waldorf-Astoria, is a vast and complicated business."¹

INTRODUCTION

The revolutionary changes that have occurred in United States agriculture in the Twentieth Century has been phenomenal. In general, agriculture has changed from an industry that was largely land and labor based to an industry relying heavily on capital with increasing financial, technological, organizational and managerial components. One of the more pronounced adjustments in the past two decades has been the structural change to fewer and larger farms. Farm numbers in Nebraska, after reaching a peak of 135,000 in 1934, declined to 73,000 in 1970. During this same time period, the average farm size increased from 350 to 659 acres.²

Because this trend to fewer and larger farms will continue, individual farmers must make changes in their operations in order to obtain and maintain adequate living standards and family income. Economies of size, income stability, retirement security, capital accumulation or any combination of these are a few of the factors pressuring farmers to expand their operating units.

¹Harold L. Oppenheimer, Cowboy Arithmetic (The Interstate, Danville, Illinois, 1961), p. 3.

²Nebraska Agricultural Statistics, State Federal Division of Agricultural Statistics, Lincoln, Nebraska.

The trend in capital requirements per farm unit has also been on the upswing. As a result of inflation and firm growth, average investment per farm has increased over 10 times since 1940. (Table 1).³

Averages, of course, are inadequate both as a concept and as a measurement when discussing commercial agriculture. Henderson and Quenemoen estimated capital requirements needed for the various types of farms for the 1970's (Table 2).⁴ This projection considered size of investment needed by farm units which would pay all operating expenses, interest on capital at five percent, and a return to the manager of \$12,000 to \$15,000 for his labor and management. As noted by the figures in Tables 1 and 2, estimated capital requirements for the 1970's far exceed the 1969 average.

It is inevitable that this trend toward fewer and larger farms will continue. The young farmer wishing to enter farming or the farmer wishing to remain must realize this trend and have expansion as one of his goals if he wishes to remain a viable part of American agriculture.

Ranching enterprises in the Sandhills of Nebraska are faced with many of the same problems confronting the farm unit. Traditionally, however, Great Plains ranching enterprises have trailed farming enterprises in capital intensification and the resulting substitution of capital for labor. This has occurred, not because the ranching industry

³Ibid.

⁴Philip Henderson and M. E. Quenemoen, "Farming in the 1970's," Progress, Problems, People in Mid-America, Great Plains Agricultural Council Publication No. 43, p. 3.

Table 1. Average Value Per Farm in Nebraska for Selected Years.

Year	Average Value Per Farm
	($\$$)
1940	9,399
1945	15,205
1950	25,517
1954	33,713
1959	46,796
1964	66,232
1969	97,931

Source: Nebraska Agricultural Statistics, State-Federal
Division of Agricultural Statistics, Lincoln, Nebraska.

Table 2. Estimated Amount of Capital Required by Various Types of Farms for the 1970's to Pay Interest on Capital and \$12,000 to \$15,000 to the Operator for His Labor and Management.

Type of Farm	Amount of Capital Required
Grade A Dairy, Crop	\$ 265,000
Swine, Crop	225,000
Irrigated Cash Grain, Beef Herd	390,000
Beef Feeding, Crop	400,000
Wheat	920,000
Cow-Calf Ranch	2,300,000

Source: Philip Henderson and M. E. Hennemoen, "Farming in the 1970's," Progress, Problems, People in Mid-America, Great Plains Agricultural Council Publication No. 43, p. 3.

is lacking in innovators, but is dictated more by the very nature of the ranching industry. From the ranching regions of the arid Southwest up through the plains of western Kansas, the Sandhills of Nebraska, to the northern regions of Montana and the Dakotas, extensive type operations prevail.

Topographical and climatical conditions that characterize these regions have dictated the adoption of extensive units. The significant thing for the Plains region is the low average crop seasonal rainfall, at or below the margin for successful agriculture as practiced under humid-area conditions. Coupled with low average precipitation is the great variation in growing season precipitation from year to year and monthly variation within the same year. Almost everywhere the driest year brings less than 10 inches of rainfall and the wettest brings three times this amount. Thus, in the absence of high rainfall or irrigation, intensive machinery utilization and heavy fertilization do not lend themselves to the typical ranch operation.

Study Area

The Sandhills area of northcentral Nebraska present a unique opportunity for the study of firm growth in the ranching industry. The Sandhills represent the largest undivided expanse of grassland in the United States, combined with a single enterprise production system, cattle ranching (See Figure 1).⁵ This combination lends itself to the

⁵John F. Vallentine and Donald F. Burzlaff, Nebraska Handbook of Range Management, E.C. 68-131 (Lincoln: University of Nebraska Extension Service Bulletin, 1968).

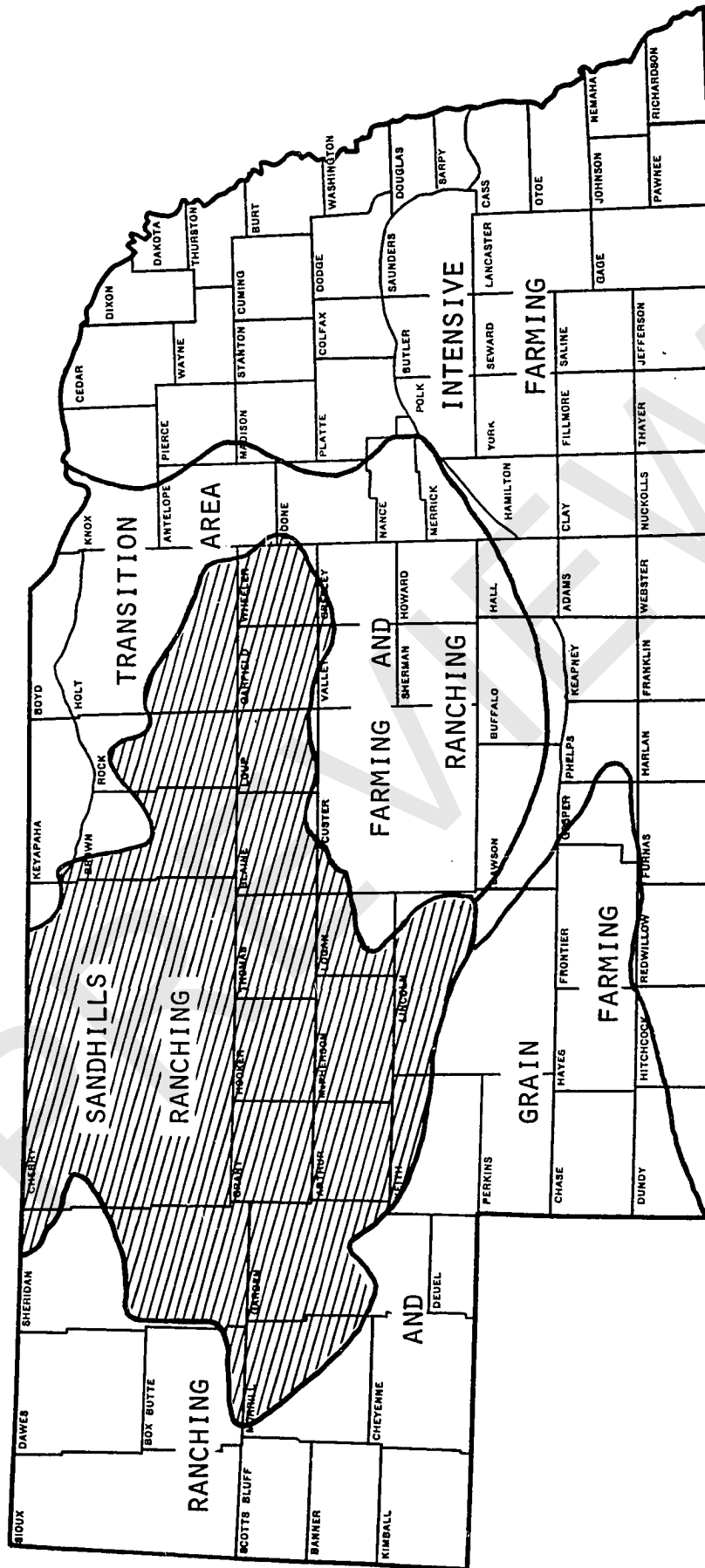


Figure 1. Map of Nebraska showing Sandhills area and major range livestock producing areas of the state.

study of "pure" extensive expansion.

Secondly, much of the Sandhills area has ample storage of groundwater for irrigation (Figure 2). With the recent advent of mechanical move center-pivot sprinkler irrigation systems, firm growth through intensive means via irrigation, where topographical conditions permit, can be examined using a basic ranch unit.

The specific area chosen for this study consists of a nine county area in the Nebraska Sandhills. The counties are Arthur, Blaine, Cherry, Grant, Hooker, Logan, Loup, McPherson and Thomas (Figure 3).

This "Sandhills proper" region was chosen for several reasons. As noted in Figure 1, these counties all lie within the cattle ranching area of Nebraska. The topography, climate and economic base of these counties are also very similar.

The parent soil material in this nine county area is composed of Valentine-Dunday sand and loamy sand.⁶ The landscape is a succession of dunes and swales with some narrow elongated dry valleys, scattered shallow lakes and infrequent streams. The cultivated acreage is small, localized along the stream valleys and on less sandy soils. The climate is one of relatively warm summers, cold winters and moderate precipitation (14-20 inches) that is highly seasonal or periodic. These Sandhill counties are known for their abundance of medium and tall warm season grasses and because of the sandy soils and limited rainfall, it is better suited for grazing than for crop production.

⁶J. A. Elder, Soils of Nebraska, University of Nebraska Conservation and Survey Division, Resource Report No. 2, p. 4.

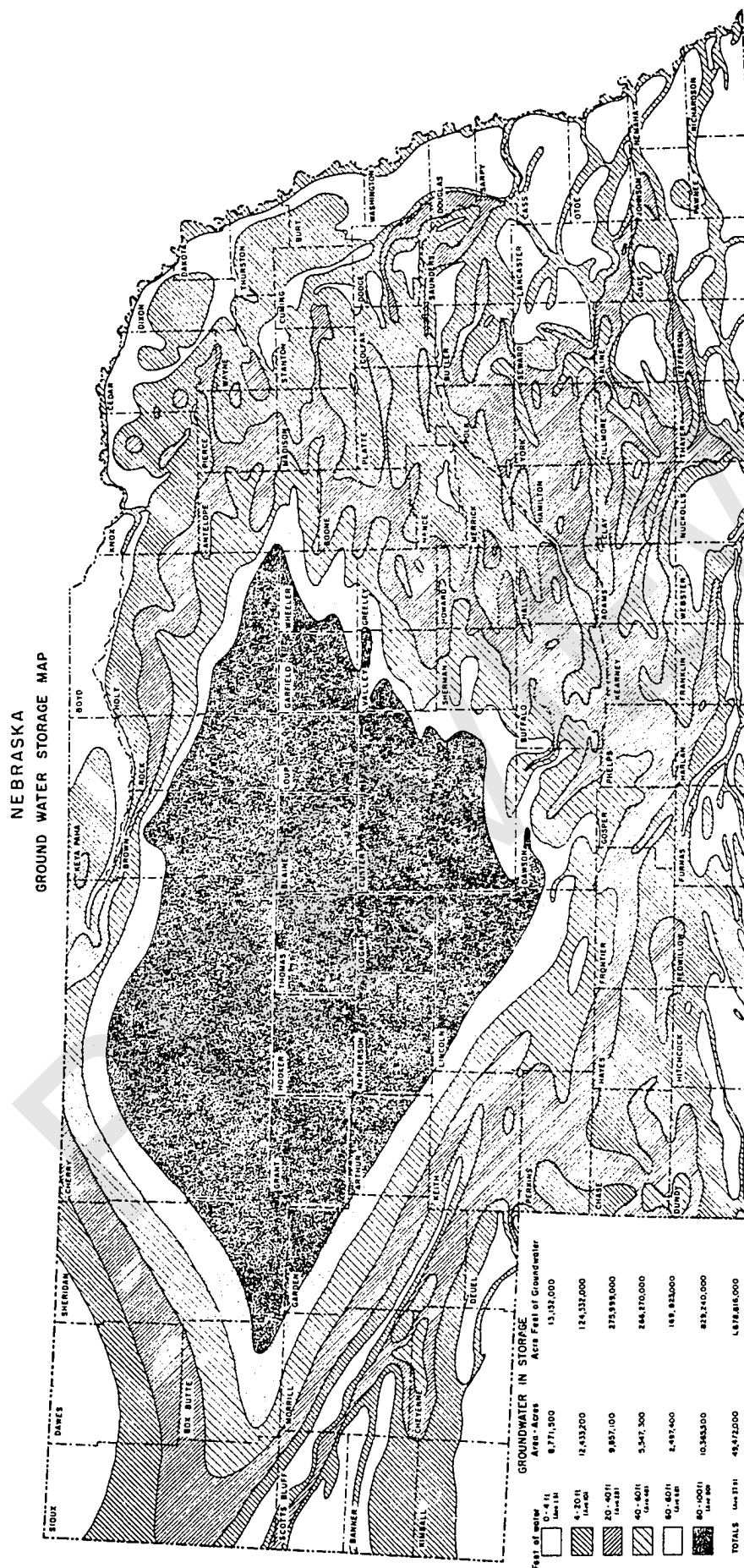
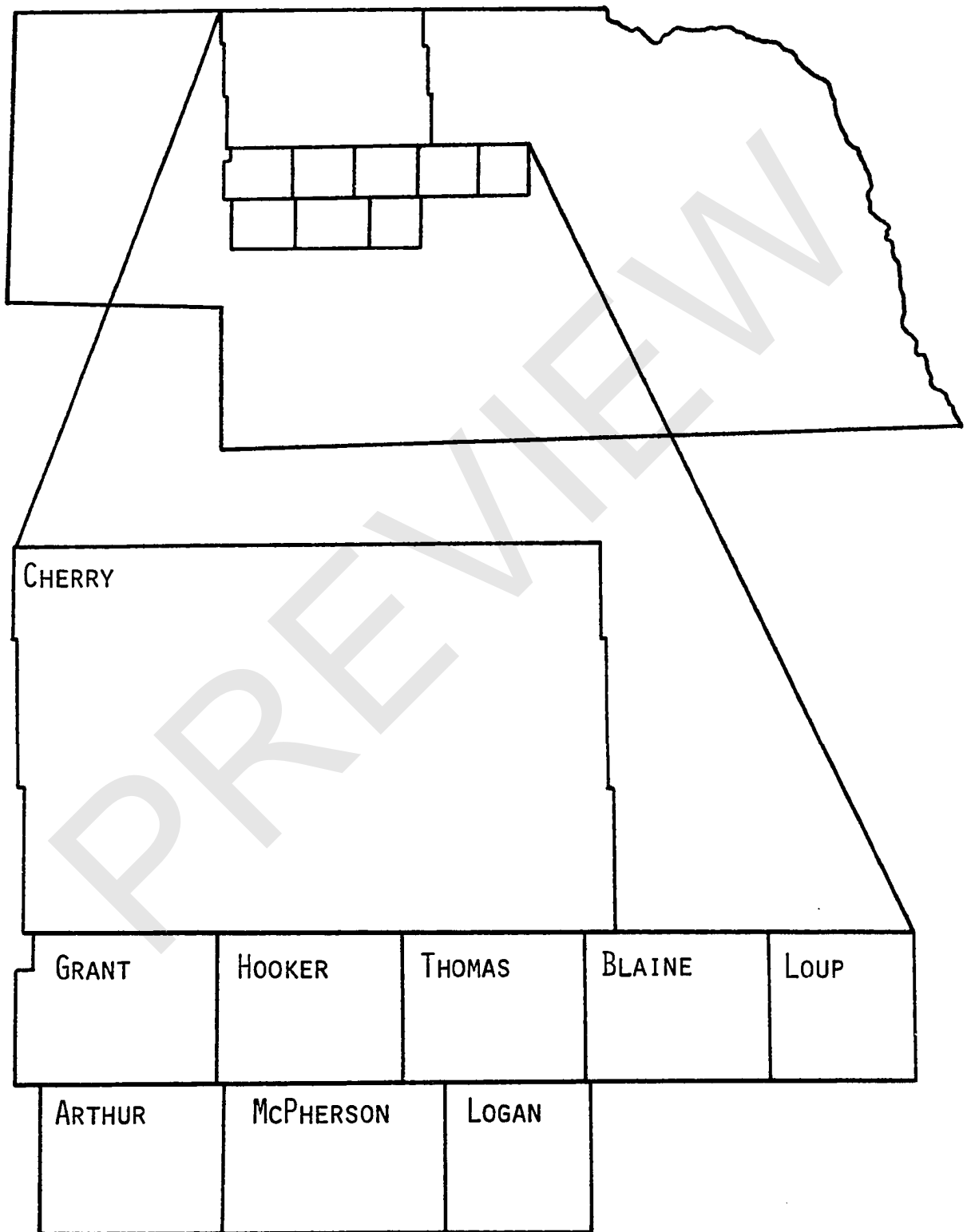


Figure 2. Ground water storage in Nebraska.

Figure 3. Map of Nebraska with Enlargement of Counties Included in Study Area.



These counties are also very similar economically. As can be observed in Table 3, personal income for the area comes primarily from agriculture. The area also exhibits the typical extensive ranch-type growth problems. Land is not always readily available for rent or purchase in ranch areas at a competitive price. Land that is put on the market for sale usually occurs when a rancher retires or the land is sold through an estate.⁷ Even when this occurs, the land may not be close enough to a rancher interested in growth to make the transfer feasible. When an additional unit is purchased, it results in growth that is "lumpy" and requires large amounts of investment capital. Table 4 shows number of farms by county from 1960 to 1970. An examination of farm numbers in Arthur County, for example, shows no change in number of farms for a period of 5 years, 1960-64. Thus, the availability of land for rent or purchase to the operator interested in growth may be non-existent during the years he wishes to expand, or when land becomes available it is an entire ranch unit that is likely to be passed on or sold to someone beginning ranching.

Purposes and Objectives

The primary purpose of this study is to simulate the extensive and intensive growth potential of a typical Nebraska Sandhills ranch in a dynamic and uncertain environment.

⁷Bruce B. Johnson, Larry Leistritz and James D. Greer, Farm Real Estate Market in Nebraska, Nebr. Agr. Exp. Sta. Bull. No. 495. Lincoln, September, 1967.

Table 3. Sources of Personal Income for Selected Nebraska Counties, 1969. (percent)

County	Farm Income	Wholesale and Retail Trade	Government	Other
Arthur	86	2.4	7	4.6
Blaine	72	8	14	6
Cherry	61	12	12	15
Grant	71	9	12	8
Hooker*	--	--	--	--
Loup	67	6	18	9
Logan	62	9	14	15
McPherson	79	3	15	3
Thomas	56	12	23	9

*Figures not available.

Source: Office of Business Economics, Lincoln, Nebraska

A number of studies have determined the existence of decreasing average costs and increasing returns to size of farm firms. Table 5 shows the average investment, costs and earnings of medium size Sandhill ranches for 1960 and 1970.⁸ Although the 1960 and 1970 Ranch Business Studies did not include the same ranches in the two periods, certain economic relationships are evident. Unit costs of production for the different size classes of Sandhill ranches are shown in Figure 4. Though the studies exhibit differences in unit costs and incomes between the two periods, both studies have a range of first decreasing and then increasing costs. It appears that the average size units (Table 5) could

⁸Unpublished summaries of the 1960 and 1970 Sandhill Ranch Business Studies prepared by A. W. Epp, Dept. of Ag. Econ., Univ. of Nebraska.

Table 4. Number of farms for selected Nebraska counties, 1960-1970.

County	1960	1961	1962	1963	1964	1965	1966	1967	1968	1969	1970
Arthur	105	105	105	105	105	100	95	95	90	90	90
Blaine	155	155	155	150	150	145	140	135	130	130	125
Cherry	755	740	740	730	710	700	690	680	660	650	605
Grant	80	80	75	75	70	65	65	60	60	60	60
Hooker	60	65	65	65	65	65	65	60	55	55	55
Logan	185	185	175	175	175	170	160	160	160	155	155
Loup	215	210	205	200	200	195	190	185	180	180	180
McPherson	150	155	155	160	160	160	160	155	150	150	145
Thomas	95	100	100	100	100	95	95	90	90	90	90
Nine County Total	1,800	1,795	1,775	1,760	1,735	1,695	1,660	1,620	1,575	1,560	1,550

Source: Nebraska Agricultural Statistics.

Table 5. Average investment and earnings, medium size Sandhill ranch, 1960 and 1970.

	1960	1970
Total Investment	\$368,160	\$588,322
Animal Units	410	486
Acres	6,272	7,345
Land and Improvements	260,441	328,909
Livestock	87,060	121,751
Hay and Feed	6,787	131,262
Equipment	13,872	24,400
Depreciation	3,939	4,514
Cash Expense	16,156	29,495
Gross Income	34,743	48,265
Net Income	14,638	14,256
Operator and Family Labor	4,214	6,942
Return to Capital	2.8%	1.5%
Percent of Land Leased	30.0%	21.8%

Source: Unpublished summaries of the 1960 and 1970 Sandhill Ranch Business Studies, prepared by A. W. Epp, Dept. of Ag. Econ., Univ. of Nebr.

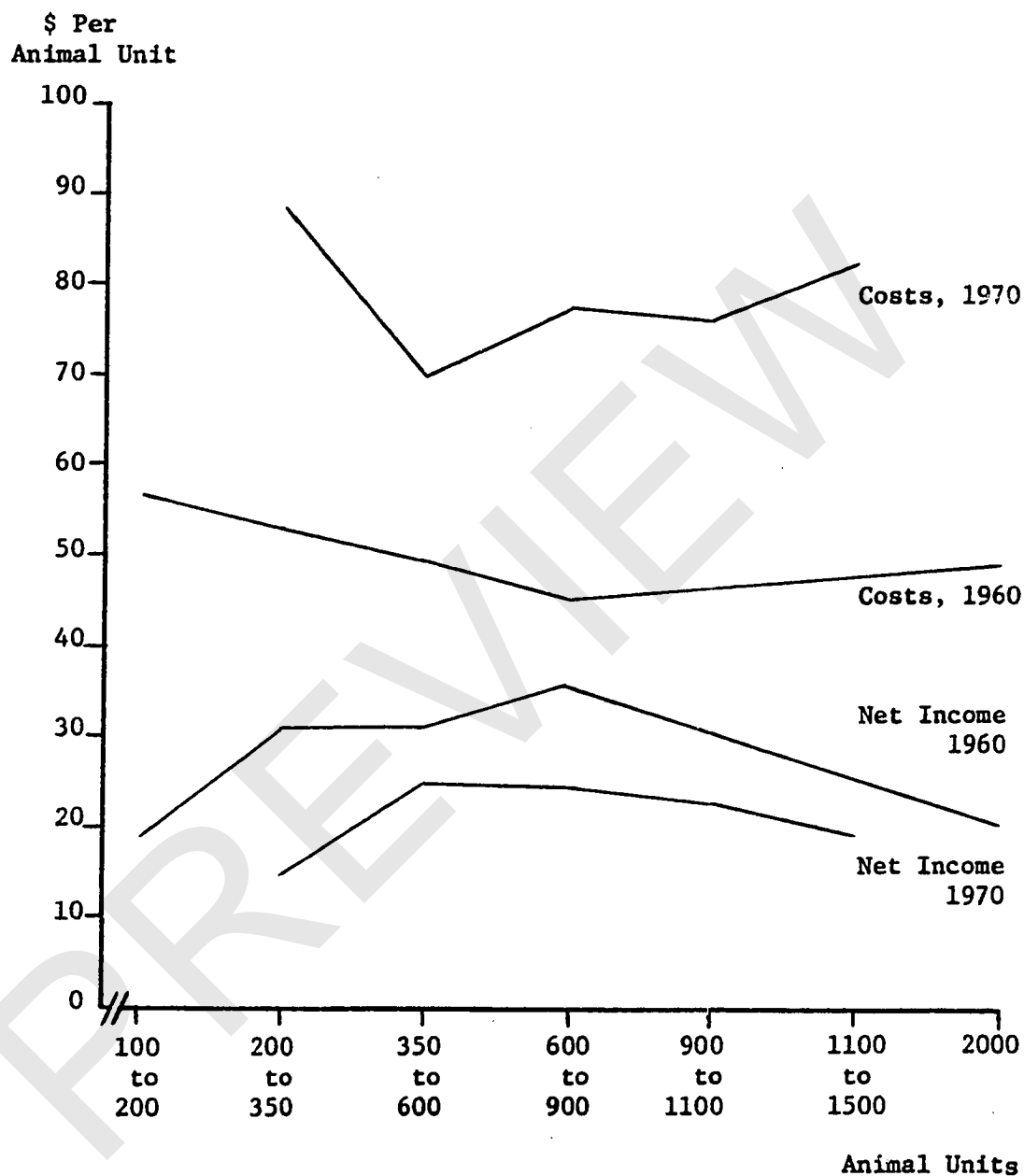


Figure 4. Sandhill ranch size, income and total production cost relationships, 1960 and 1970 (Data provided by unpublished summaries of the 1960 and 1970 Sandhill Ranch Business studies prepared by A. W. Epp).

improve their economic position with respect to unit costs and returns by expanding their operations to a 600-900 animal unit size.

The study objectives more specifically are to:

1. Analyze dynamic growth of an average ranch firm of 450 animal units as it grows to 600-900 animal units.
2. Study the effects of an uncertain environment on the long run growth opportunities of a ranch firm.
3. Compare and contrast extensive and intensive growth of a ranch firm.
4. Analyze the effects of adding complementary and supplementary enterprises to a ranch firm.

Ranchers as well as other rural businessmen in the area are concerned about the requirements for growth and the continuation of the ranch firm. This study will attempt to answer some questions being asked in this regard.

Previous Firm Growth Studies

The use of various computer programming techniques in firm growth research has been quite prevalent in recent years. The use of simulation and linear programming models has allowed for many variations in

⁹Ibid.

the procedures used and the nature of the parameters studied.

Several models mentioned repeatedly in the literature have been developed which appear to have been precursory in the development of firm growth procedures. Probably the first model to incorporate planning over time was published by Swanson in 1955.¹⁰ Rather than considering only one period of production, Swanson's linear programming model was for five years and attempted to deal with the problem of planning over time. Dynamic and polyperiod models advanced by Loftsgard and Heady,¹¹ Martin,¹² Johnson¹³ and Lentz¹⁴ have been applied to firm growth and investment strategies over time.

¹⁰Earl R. Swanson, "Integrating Crop and Livestock Activities in Farm Management Activity Analysis," Journal of Farm Economics, Volume 37, No. 5, December, 1955, p. 1250.

¹¹Laurel D. Loftsgard and Earl O. Heady, "Application of Dynamic Programming Models for Optimum Farm and Home Plans," Journal of Farm Economics, Volume 41, February, 1959, pp. 51-67.

¹²J. Rod Martin, "Polyperiod Analysis of Capital Accumulations and Growth Process of Farm Firms, Rolling Plains of Oklahoma and Texas" (unpublished Ph.D. thesis, Oklahoma State University, 1966).

¹³S. R. Johnson, "A Multiperiod Stochastic Model of Firm Growth," Economies of Firm Growth, South Dakota Agr. Exp. Sta. Bull. 541. June, 1967. (Great Plains Agricultural Publ. 29).

¹⁴Gary W. Lentz, "Investment Strategies for Grain Livestock Farms: A Polyperiod Linear Programming Analysis" (unpublished Ph.D. thesis, University of Nebraska, Lincoln, 1971).