EFFECT OF CAPITAL ON INCOME AND ORGANIZATION OF BEEF FARMS IN THE FLINT HILLS OF KANSAS

by

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CHAPTER I

INTRODUCTION

The Problem

The Flint Hills, also known as the Bluestem area, is famous throughout the world for its cattle production. This region includes all or part of twenty-two Kansas counties: Greenwood, Elk, Butler, Cowley, Wilson, Woodson, Chautauqua, Clay, Riley, Pottawatomie, Dickinson, Geary, Wabaunse, Shawnee, Morris, Marion, Chase, Lyon, Coffey, Marshall and Washington counties. (Figure 1).

Good pastures consisting of big bluestem, little bluestem, side-oats grama, hairy and blue grama, switch grass and indian grass are predominant in this region. Most of the land is in grass and the cropland available is usually rough with shallow soil. Cash crop acreages are usually small in this area although an abundant supply of feed grain is produced. The abundance of feed grains combined with the large acreages of excellent grass give this region a comparative advantage in certain types of beef enterprises.

Because of the economic importance of beef in the Flint Hills it is important to better understand the factors which determine the particular beef system which is best adapted to a given farm in this region. The purpose of this study is to gain some insights into these relationships.

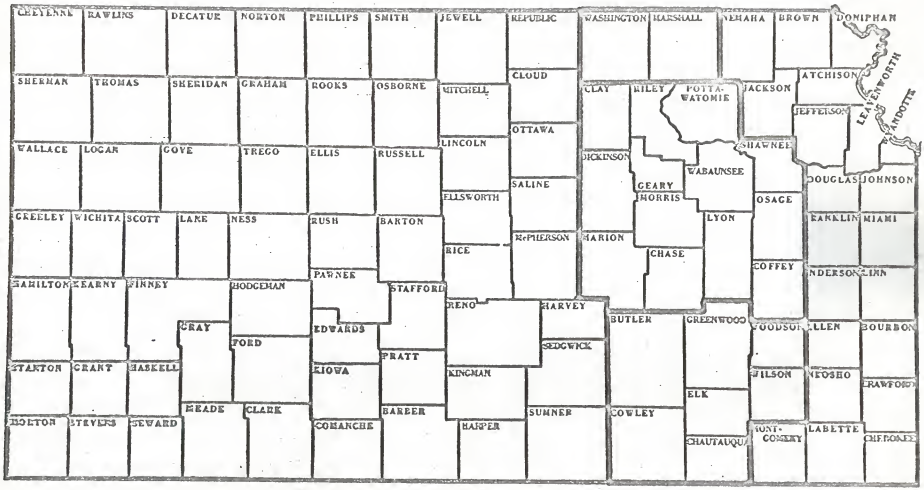

Fig. 1. FLINT HILLS REGION OUTLINED SHOWING THE THREE AREAS

Objectives

The objective of this study is to analyze the effect on income, organization, and returns to factors of production of varying the quantity of operating capital for a representative beef farm in the middle region of the Flint Hills. The quantity of operating capital is one of the most important factors of production in beef farming because beef enterprises are highly capital intensive. Much more capital is needed for livestock and pasture relative to labor or machinery and thus it is hypothesized that this factor would be of primary importance in determining the type of system which would be most profitable under a given set of circumstances.

CHAPTER II

SCOPE AND PROCEDURE

Division of the Region

A random sample of 1,851 farms was taken from county assessor's records[1] of the twenty counties in the Flint Hills region to determine the distribution of farm size and the percentage of farm land in grass. This was necessary to help construct a representative farm for the study. A wide range of farm size and grass percentage was found within the region. Because of this range the region was divided into three areas to reduce the dispersion in farm size, making the representative farm more meaningful. The southern area consists of Greenwood, Elk, Butler, Cowley, Wilson, Woodson and Chautauqua counties. The middle area includes Clay, Riley, Pottawatomie, Dickinson, Geary, Wabaunse, Shawnee, Morris, Marion, Chase, Lyon, Coffey and Osage counties. Marshall and Washington counties are the northern area.

In the Flint Hills, approximately 19.2 percent of the farms in 1964 were under 160 acres. These small farms were excluded from the study, however, because their resources were considered too limiting to make the necessary adjustments to provide a reasonable level of income.

1/ This data is made available through Mr. J. E. Pallesen of the Kansas State Board of Agriculture cooperating with the USDA Statistical Reporting Service.

After the area had been divided, data from beef farms in the Farm Management[2] Associations was used to determine the resources for the representative farm. Farms in the Farm Management Associations in this region are considerably larger than the average size of all farms in this area. (Table 1). Because of this larger size, it was assumed that a representative farm based on an average Farm Management Association farm would be more meaningful than one based on the average farm of this region.

Table 1. COMPARISON OF FARM SIZE BETWEEN FARMS IN FARM MANAGEMENT ASSOCIATIONS 1, 4 & 6 AND ALL FARMS IN THE FLINT HILLS

Farm size (acres)	Number of farms		Percentage of farms		Cumulative percentage	
	Farm Mgt.	Flint Hills Region	Farm Mgt.	Flint Hills Region	Farm Mgt.	Flint Hills Region
0-159	2	355	0.50	19.18	0.50	19.18
160-319	29	567	7.23	30.63	7.73	49.81
320-479	68	354	16.95	19.12	24.68	68.93
480-639	64	221	15.96	11.94	40.64	80.87
640-799	65	119	16.21	6.43	56.85	87.30
800-959	57	74	14.21	4.00	71.06	91.30
960-1119	35	45	8.72	2.43	79.78	93.73
1120-1279	19	34	4.74	1.84	84.52	95.57
1280&over	62	82	15.46	4.43	100.00	100.00

Data was collected on acres of cropland and pasture, size of enterprise

2/ Dale Knight, Associate Professor of Economics, Kansas State University, is responsible for compiling these reports.

and total farm assets from 1964 Farm Management reports. Average farm size in the southern region in 1964 was 1,637 acres, with 76.8 percent in grass and total assets of $73,546. Average size in the middle region was 893 acres, 58.6 percent grass and total assets of $57,503. Average size in the northern region was 682 acres, 40.3 percent grass and total assets were $45,100. (Table 2).

Table 2. LAND, CAPITAL AND GRASS PERCENTAGE FOR FARMS IN FARM MANAGEMENT ASSOCIATIONS BY REGIONS, 1964

Resources	Southern area	Middle area	Northern area
Average farm acreage	1,637	893	682
Grass acreage	1,258	524	279
Crop acreage	379	369	403
Percentage of total acreage in grass	76.8	58.6	40.9
Ratio of grass to cropland	3.3	1.4	.7
Average total assets	$73,546	$57,503	$45,100
Working capital	26,733	24,503	19,100
Fixed capital	46,813	33,493	25,836

The Representative Farm

Results are based on a study of the representative farm in the middle area of the Flint Hills. Counties included are Clay, Riley, Pottawatomie, Dickinson, Geary, Wabaunse, Shawnee, Morris, Marion, Chase, Lyon, Coffey and Osage. Resource restrictions are the average of the quantities of resources

(land, labor and capital) on farms in the Farm Management Association in this area as shown in Table 2. It is assumed that the operator will furnish 60 hours of labor per week from March through October and 48 hours per week from November through February, making a total of 2,688 hours per year. Either a full time laborer or seasonal labor during June, July and August can be hired if additional labor is needed. Purchase or renting of additional cropland and pasture is permitted.

The Model

Linear programming[3] is used to help analyze the effect of varying capital on income, farm organization and returns to factors of production. It selects from the various production alternatives considered to obtain a combination of enterprises that maximize returns subject to resource limitations. Linear programming is considered the most appropriate procedure because of the many alternative enterprise combinations, resource restrictions, and the goal of maximizing net returns from resources.

Linear programming, as a method of analysis, has several limitations. One of the limitations is that it does not account for risk and uncertainty and so it is difficult to specify exact outcomes for real situations. Another limitation is that input-output relations are assumed to be linear when in fact they are probably non linear. Also, input-output coefficients may vary between farms due to differences in technology or resources available. The analysis of a representative farm, however, may provide valuable insights into the relationships among enterprises studied and among factors of

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3/ Earl O. Heady and Wilfred Candler, Linear Programming Methods (Ames, Iowa: The Iowa State University Press, 1958).

production.

All relationships studied are the result of limiting the value of assets used as collateral to borrow capital and thus capital is the limiting resource in this study. Net working and net fixed capital are used as collateral for feed purchases, crop enterprises and the purchase of feeder calves or yearling steers. Beef cows are purchased with collateral from either net working or net fixed capital while land purchases require net fixed capital as security.

Results are from eight levels of borrowed capital. The levels studied have been obtained by parametric programming and represent capital levels at which there is a change in farm organization and income. Income and organization between these levels is relatively unchanged.

A year is divided into four-month periods and labor requirements for both crop and livestock enterprises are specified for each period. In addition the period of April through October is divided into two-week sub-periods and labor requirements are specified for crops during these sub-periods.

An adjustment in labor available is made for field conditions too wet for field work. This adjustment reduces the days per period when field work can be done, based upon the probability of rainfall occurring during the period[4].

Typical cropping enterprises for this region are included as alternatives. These are soybeans, wheat, barley, grain sorghum, corn, corn silage and alfalfa. Soybeans and wheat are considered as cash crops whereas barley,

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4/ Dean L. Bark and A. M. Feyerherm, "Probabilities of Sequences of Wet and Dry Days in Kansas." Technical Bulletin 139a, Agricultural Experiment Station, Kansas State University, Manhattan, 1964.

grain sorghum and corn can be either sold or fed. Alfalfa and corn silage are used for feed only.

Both cow herd and noncow herd beef systems are considered. A 2 percent death loss is assumed for all systems. In addition, it is assumed that a cow adds only .75 calf, after adjustment for death loss, replacements and cows that do not calve. Cow herd systems include selling calves at weaning time, wintering, production of creep fed calves, wintering and grazing calves, deferred systems and production of fat calves. Noncow herd systems include those previously mentioned, excluding weaning calves and creep fed calves. In addition, grazing and feeding yearlings and fattening of yearlings are included. Purchase of calves for the fattening systems and steers for the full feeding or grazing and feeding programs is permitted during any month. Mixed systems or heifer systems are excluded.

It is assumed that cows will calve in early spring so calves can be weaned in the fall and sold or used in one of the other beef systems. Cows used in the creep fed system calve in December, with the finished calf to be sold in December or January of the following year.

All calves in the beef programs are assumed to meet USDA good standards and those sold from the finishing programs are assumed to grade choice. Feeder calves for the fattening systems weigh 400 pounds and are sold weighing 950 pounds. Approximately 240 days are required to achieve these gains, representing 2.29 pounds gain a day. Yearlings purchased for fattening weigh 600 pounds fed for 180 days and are sold at 1000 pounds.

Two wintering systems are considered, both starting with 400 pound calves. In one case calves are fed to gain 150 pounds and in the other 250 pounds. In either case calves are sold in late March or early April. The

wintering and grazing system begins with 400 pound calves which are sold in August off grass weighing 750 pounds.

In the deferred system 400 pound calves are purchased in late October, wintered on roughage and some grain until April when they are turned on grass. These calves are taken from pasture in August, fattened in the drylot and sold in November weighing 1000 pounds. In the grazing and feeding system, calves are purchased in April weighing 600 pounds, on grass until August, then placed in the drylot on full feed and sold about 7 months later weighing 1000 pounds.

Sources of Coefficients

Monthly cattle prices[5] used in the beef enterprise budgets are an average of 1955-1964 monthly cattle prices at the Kansas City market. Based on discussion with livestock marketing Economists, this ten year period is a complete price cycle for all classes of livestock considered. A statistical estimation of price cycles was not made.

Data on returns per acre and other input-output relationships for crop enterprise budgets are estimated using Farm Management Association summary records for this region, based on 1960-1964 yields and prices. This shorter time period was chosen rather than the 1955-1964 period used for beef prices because during the late 1950's government price support measures and acreage control programs were modified causing considerable changes in grain prices. In estimating grain prices, it was considered preferable to use a period when the supply and demand relationships were not so greatly affected by changes

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5/ United States Dept. of Agriculture, "Livestock Meat Wool Market News." Livestock Division, Consumer Marketing Service, 1955-1964.

in government policy.[6]

Rations are not specified for beef systems; instead the animals nutritional needs are based on recommended[7] levels of dry matter, total digestible nutrients and digestible protein. In fattening rations an additional constraint is added requiring that a specific portion of the total digestible nutrients must be supplied by grain. Thus, the animal's nutritional requirements are met at minimum cost.

6/ Bias can be introduced into the results by estimating prices using the 1955-1964 period for livestock and 1960-1964 period for grains. This occurs if there is a price trend in either or both livestock or grains. A study of price trends for beef cattle was not available, and it was beyond the scope of this study to estimate beef cattle price trends of cycles. Relying on the judgement of some livestock marketing Economists, omitting price adjustment for trend and using a simple average of prices during the 1955-1964 period would not seriously affect the results and conclusions.

7/ Frank B. Morrison, Feeds & Feeding, Abridged (Ithaca, New York: The Morrison Publishing Co., 1954); Nutritional Research Council, "Nutrient Requirements of Beef Cattle," National Academy of Sciences, Publication 1137, 1963.

CHAPTER III

THE ANALYSIS

Income and Organizational Changes

Effects of Capital Increases on Income

Changes in capital have a great influence on income and optimum organization. Profitable organizational changes are in quantity and use of cropland, quantity of grass, labor, feed purchases and beef enterprises. Income, as used in this analysis, is gross income minus variable costs of production.

In all cases considered, additional capital use increases income. Increases in income, however occur at a slower rate than corresponding changes in capital. As capital is increased from $11,690 to $84,489, an increase of 622.7 percent, income increases from $9,941 to $42,354, an increase of 326.0 percent. Diminishing marginal returns to capital are due to the increased scarcity of other resources as more operating capital is made available.

When $11,690 of capital is borrowed, income per dollar of borrowed capital is $.85. At a level of $12,400 of capital, income is $1.17 for each dollar borrowed. This is the highest average return to capital borrowed. As capital is increased beyond $12,400, income per dollar of capital borrowed decreases to $.50 for $84,489. The elasticity of production is greater than one for capital levels of $12,400 and under, indicating that more capital should be used if it is available.

Table 3. AVERAGE AND MARGINAL CHANGES IN INCOME AT VARIOUS CAPITAL INPUT LEVELS

	Capital level							
	1	2	3	4	5	6	7	8
Capital borrowed ($)	11,690	12,400	15,869	18,229	22,956	29,438	70,423	84,489
Gross income minus variable costs ($)	9,941	14,499	16,723	17,641	19,346	21,628	37,174	42,354
Average income/$ of capital input	.85	1.17	1.05	.97	.84	.73	.53	.50
Increase in income from previous capital level ($)	9,941	4,558	2,224	918	1,705	2,282	15,546	5,180
Increase in operating capital from previous capital level ($)	11,690	710	3,469	2,360	4,727	6,482	40,985	14,066
Marginal returns to borrowed capital ($)	.85	6.42	.64	.39	.36	.35	.38	.37
Total assets to debt ratio as compared to the average farm in this region	4.92	4.64	3.62	3.15	2.50	1.95	.82	.68

Marginal returns to capital exceed the cost of an additional unit of capital at all levels of capital borrowed. At a level of $11,690, a marginal return of $.85 is realized. The marginal return increases to $6.42 when capital is increased to $12,400. Beyond $12,400 capital marginal returns began to decline. (Table 3).

Effects of Capital Increases on Land Use

Capital variations cause wide fluctuations in the total land acreage used. (Table 4). The representative farm has 524 acres of grass and 369 acres of cropland, however, in no case was the 893 acres of available land utilized. The greatest fluctuations occur in the acreage of grass used. These changes in pasture requirements are due to changes in the type of beef enterprise. At a capital level of $11,690, 222.9 acres of grass are used, but decreases to only 23.3 acres when $12,400 are borrowed. At higher capital levels, grass usage becomes relatively stable fluctuating between 469.4 and 524.0 acres. At capital inputs of $29,438 and above, all available pasture is used. No additional pasture is acquired at any capital level. There is some indication, however, that if capital had been increased beyond $84,489 additional pasture would have been purchased or leased.

The ratio of grass to cropland fluctuates as capital is increased. A ratio of .8 acre of grass per acre of crop is optimal for a capital level of $11,690. This ratio decreases to .1 acre of grass to an acre of cropland when capital is increased to $12,400. Further increases in capital result in an increase in the ratio of grass to cropland with a ratio of 1.7 acres of grass to an acre of cropland being optimal for a capital level of $15,869. This ratio increases to 4.8 acres of grass per acre of cropland

Table 4. INCOME AND ORGANIZATION AT VARIOUS LEVELS OF CAPITAL

	Capital level							
	1	2	3	4	5	6	7	8
Capital borrowed ($)	11,690	12,400	15,869	18,229	22,956	29,438	70,423	84,489
Gross income minus variable costs								
Cash crop ($)	4,675	3,707	2,466	2,318	2,189	1,555	285	27
Beef ($)	5,266	10,792	14,257	15,328	17,157	20,073	36,889	42,327
Total ($)	9,941	14,499	16,723	17,641	19,346	21,628	37,174	42,354
Land used								
Cash crop (acres)	162.3	130.7	88.5	83.6	78.9	55.9	10.0	0.9
Feed grains (acres)	96.6	139.2	175.9	180.5	182.9	193.6	137.8	106.4
Grass (acres)	222.9	23.3	469.4	514.5	473.9	524.0	524.0	524.0
Total (acres)	481.8	293.2	733.8	778.6	735.7	773.5	671.8	631.3
% Total land in grass	46.3	7.9	64.0	66.0	64.4	67.7	78.0	83.0
Purchased beef systems								
Deferred calves (head)			134	122	51			
Graze & feed yearlings (head)				25	84	150	150	150
Full feed Jan.-Aug. (head)	15	91			34	56	174	252
Full feed Aug.-Mar. (head)							187	212
Beef cow systems								
creep (head)	37	4						
Alternative systems[7]	a(1.34) b(3.39)	a(1.34) c(4.13)	a(1.25) d(1.35)	a(2.58) d(2.74)	a(.15) c(3.16)	a(.16) c(3.52)	a(1.39) c(5.07)	a(1.43) c(4.95)
Feed purchased								
Silage (Alfalfa equiv. tons)	93.2		8.1	7.3	5.2	17.9	336.0	450.3
Grain sorghum (bu.)							16,341	22,358
Labor used (hours)	2,319	2,187	2,541	2,551	2,462	2,431	3,834	4,253

1/ a) other fattening, b) deferred, c) winter and full feed, d) graze and full feed; numbers in parenthesis is the reduction in income if one unit, or head, of the system indicated by letter is forced into the organization.

when borrowed capital is $84,489. This compares to the average farm in this area of the Flint Hills which has a ratio of 1.4 acres of grass to an acre of cropland. Results indicate that a greater ratio of grass to cropland is profitable when much capital is used because labor can be used more productively in beef production than in crop production in this region. As this occurs less cropland is utilized.

At all capital levels, less than the 369 acres of cropland available is used. Crop acreage used is relatively stable over a wide range of capital use fluctuating between 258.9 and 249.5 acres for capital up to $29,438. Further increases in capital cause a decline in crop acreage used as increased quantities of labor are needed to complement capital.

Cash crops decrease in importance as a source of income as the use of borrowed capital increases. Percentage of total income from beef production increases as capital use increases. When $11,690 are borrowed, approximately 47 percent of the total income comes from cash crop sales while beef enterprises contribute 53 percent. Revenue from cash crops decrease slowly as capital increases to $29,438, when $1,555 of income is derived from cash crops. As capital is increased beyond this amount income from cash crops becomes negligible, amounting to $285 and $27 at capital inputs of $70,423 and $84,489, respectively. Throughout this range beef income steadily increases and when $84,489 are borrowed almost all of the total income is derived from beef.

Capital increases cause a decrease in the acreage of cash crops. When $11,690 of capital is available 162.3 acres are used for cash crops. Further capital increases cause a decrease in cash crop production until only 0.9 acre is used when capital use is $84,489. As more capital is used to expand

beef production, more of the labor available for crop production is devoted to feed grain production for the beef systems, thus accounting for the decreased emphasis on cash crops.

Acreage devoted to feed grains increases as capital increases. Feed grain production totals 96.6 acres at a capital level of $11,690. Feed grain acreage increases as capital inputs increase until 193.6 acres are used when $29,438 are borrowed. Further capital increases cause a decrease in feed grain acreage with 137.8 and 106.4 acres being used at capital levels of $70,423 and $84,489. At high levels of capital both labor and capital are shifted to the purchase and care of beef rather than being used in crop production indicating that labor is more productive in beef production as capital increases.

Results indicate that cash crops do not have the comparative advantage in this region if sufficient capital is available. The reason is that the marginal value product of capital in crop enterprises decreases faster than the marginal value product of capital for beef enterprises. The amount of capital used per hour of labor in crop production remains relatively stable at all capital inputs. (Table 5). At the lowest level of capital, $2.04 is combined with each hour of labor used for crop production. This figure increases to $2.12 at a capital level of $12,400. As capital borrowed increases from $15,869 to $29,438 each hour of labor for cash crops is combined with $2.25 and $2.27 of capital, respectively. Further increases in capital inputs cause a decrease in the amount of operating capital used per hour of labor in cash crop enterprises. When operating capital is $84,489 only $1.80 of capital is used with each hour of labor.

In contrast, an hour of labor used for beef production uses $6.61 of

Table 5. INCOME PER HOUR OF LABOR AND CAPITAL PER HOUR OF LABOR USED FOR CASH CROP AND BEEF

	Capital level							
	1	2	3	4	5	6	7	8
Capital borrowed ($)	11,690	12,400	15,869	18,229	22,956	29,423	70,423	84,489
Income/hour of labor ($) Used for cash crop	5.87	6.00	6.27	6.28	6.29	6.27	6.20	5.40
Capital/hour of labor ($) used for cash crops	2.04	2.12	2.25	2.26	2.27	2.26	2.13	1.80
Acres of cash crops	162.3	130.7	88.5	83.6	78.9	55.9	10.0	0.9
Acres of crops for livestock	96.6	139.2	175.9	180.5	182.9	193.6	137.8	106.4
Income/hour of labor used ($) for feed grains & beef	3.46	6.88	6.64	7.02	8.12	9.20	9.74	9.96
Capital/hour of labor used ($) for feed grains & beef	6.61	7.07	6.98	7.97	10.49	13.23	18.56	19.89
Total beef produced	52	95	134	147	169	206	511	614

capital when $11,690 is borrowed, over three times as much as the capital used per hour of labor in crop production at the corresponding capital level. Capital used per hour of labor for beef production increases as capital use increases. At a level of $84,489, beef production uses $19.89 of capital per hour of labor. This is more than eleven times the corresponding value for crop production. The large amount of capital combined with labor in beef production systems shows that cattle production is more capital intensive than crop production. Also, beef systems used at low levels of capital are much less capital intensive than those used at high levels of capital. Thus, under conditions of an extremely limited capital, crop production would be the major or only enterprise, whereas when much capital is available, beef production is the major enterprise.

Table 5 shows the relationships between income per hour of labor used for crop production and the corresponding values for beef production. Income per hour of labor from crop production is $5.87 at the lowest capital level, but increases as capital is increased, reaching a maximum of $6.29 at a capital input of $22,956. As capital inputs continue to increase, income per hour of labor used for cash crop production begins to decrease to a value of $5.40 per hour when the quantity of operating capital is $84,489.

Income per hour of labor used for feed grain and beef production is always higher than that for cash crops at corresponding levels of capital. At a level of $11,690 capital, $6.61 of income is received from each hour of labor used. This is slightly higher than the corresponding $5.87 for cash crops. Income per hour of labor used for beef continues to increase until it reaches a maximum of $9.96 at an input of $84,489 of capital. Thus, labor is much more productive in beef production because it is combined with larger

amounts of capital.

Income per hour of labor and capital per hour of labor do not appear to depend on acreages devoted to crop production. These figures remain almost constant as the crop acreages decline. In contrast, income per hour of labor and capital per hour of labor do increase as the number of cattle produced increases. Part of this increase is due to the use of more capital intensive beef systems as the quantity of capital input increases.

Effects of Capital Increases on Beef Enterprises

Changes in capital inputs have a great influence not only on numbers of cattle produced but also on the type of beef program used. (Table 4). With $11,690 of capital input, 52 head of beef are produced. Thirty-seven are produced on the creep fed calves program and 15 head on the January to August full feeding program. The best alternative system at this capital level is a full feeding program from December to May or July to December with a reduction of net revenue of $1.35 per head if one of these systems is introduced. The second best alternative is the deferred system resulting in an income reduction of $3.39 per head if this system is forced into the organization. An increase in capital to $12,400 results in the use of the same two systems, however, only 4 creep fed calves are produced and 91 calves are full fed. Other full feeding systems are the most competitive alternatives, reducing net revenue by $4.13 if introduced into the organization. With further increases in capital the cow herd system does not appear in any of the optimum organizations.

When $15,869 are borrowed, 134 head of beef are handled by the deferred system. Full feeding systems are still the most competitive alternatives.

The second best alternative is the grazing and feeding program. When $18,229, are borrowed a combination of deferred, and grazing and full feeding yearlings are used for 147 head. The deferred program is dominant with 122 head while 25 head are produced on the grazing and full feeding program. Full feeding systems, and grazing and feeding 400 pound calves are the most competitive alternatives with reduction of income of $2.58 and $2.74 per head, respectively, if introduced into the organization.

Increasing capital to $22,956 results in a combination of deferred, grazing and full feeding yearlings and a January to August full feeding system using 400 pound calves. The deferred system becomes less dominant, with only 51 head. Eighty-four head of yearlings are on the grazing and full feeding program while 34 head are on the January to August full feeding program. At this level other full feeding systems are most competitive with a reduction of net revenue of $.15 followed by a wintering and full feeding program with a reduction of net revenue of $3.16 per head.

When capital is increased to $29,438 the number of cattle on the grazing and full feeding program increases to 150, and 56 head are full fed from January to August. Other full feeding systems, and wintering and full feeding systems are again the best alternatives.

As capital is increased to $70,423, the grazing and feeding system, and a full feeding system is used. Again 150 head are on the grazing and feeding system, however, both the January to August and the August to March full feeding programs are used, having 174 and 187 head, respectively. The best alternatives are other full feeding programs, and wintering and full feeding programs, reducing revenue $1.39 and $5.07 per head, respectively.

A capital level of $84,489 produced results similar to those of the

previous capital level. The number of cattle on the grazing and full feeding program remains unchanged with an increase in cattle on the full feeding programs. Other full feeding systems, and wintering and full feeding systems are most competitive reducing net revenue by $1.43 and $4.95 per head, respectively.

Results show that cow herd systems are competitive only at low capital levels. In the intermediate capital range the deferred system is dominant. As capital is increased further the deferred system is replaced by a grazing and feeding system. Full feeding systems replace other systems to utilize labor during winter months as more capital becomes available. At high levels of capital, more capital intensive beef enterprises are used and the farm begins to resemble a commercial feed lot. Full feeding systems or some slight variation of them seem to be highly competitive at all levels of capital input. Furthermore, results indicate that a wintering system is not competitive for resource use because a full feeding system requiring the same amount of labor will yield greater returns.

Effects of Capital Increases on Purchased Inputs

Feed purchases vary with changes in organization as the use of capital increases. (Table 4). Sufficient feed grain is produced for all beef programs until $70,423 capital is used and then 16,341 bushels of grain sorghum are purchased. As capital increases to $84,489, 22,358 bushels of grain sorghum are purchased. Additional silage is required at nearly all levels of capital. Large amounts of silage are purchased when capital is most restricted, however, as more capital becomes available purchase of feed declines because more of the cropland used is devoted to feed crops thus less purchased inputs

are needed. At large capital inputs the large numbers of beef produced combined with a decline in use of crop acreage make it necessary to purchase large quantities of silage and grain sorghum.

Effects of Capital Increases on Labor Use

Capital changes also have considerable effect on labor required. Labor usage fluctuates widely as capital borrowed increases from $11,690 to $29,438 as 2,187 and 2,551 hours are used. However, labor requirements do not necessarily increase as capital increases. Instead they seem to depend on organization rather than capital. Operator labor is sufficient to meet all labor requirements for capital levels up to $22,956. As capital borrowed is increased beyond this point additional labor is needed, as 51 hours, 1,146 hours and 1,565 hours of labor are hired at capital inputs of $29,438, $70,423 and $84,489, respectively. On this size farm one man's labor should be sufficient for the optimum organization unless operating capital is extremely plentiful. Greater amounts of capital require organizations which increase labor requirements in excess of the amount provided by the operator. (Table 4).

Results show that a combination of beef systems can utilize labor during all periods of the year. Cash crops and feed grains require large amounts of labor during the months of May through October but relatively small amounts during late fall, winter and early spring. When more capital becomes available labor can be used more efficiently in beef production.

Labor scarcity for crop production is most acute during the latter half of May and July and all of June and October. (Table 6). Shadow prices for June and July labor are an average of the imputed value of labor during both

halves of the month. Values are shown for periods where shadow prices are high. (See Table 2 in the appendix for complete information on shadow prices of labor for all periods.)

Table 6. SHADOW PRICES FOR LABOR AT VARIOUS CAPITAL LEVELS

	Capital Level							
	1	2	3	4	5	6	7	8
Capital ($)	11,690	12,400	15,869	18,229	22,956	29,438	70,423	84,489
Labor Shadow Prices ($ per hour)								
Nov.-Feb.							1.95	1.87
Mar.-June		1.31	3.75	2.90	.83	3.21	5.19	5.14
July-Oct.					1.57	1.56	1.61	1.75
May 15-31				4.75	15.55	9.42	4.08	4.83
June 1-30	5.64	9.31	.89	7.78	2.10	1.29	.68	.46
July 15-31	6.41	22.19	10.71	21.62	9.25	11.40	11.45	9.95
Oct. 1-31	1.71	2.46	13.33	4.75	17.99	14.03	9.85	9.07

Periods of November through February, March through June and July through October specify labor requirements for both crop and livestock production. The subperiods specify labor requirements for crop production only. This division of the labor periods into smaller subperiods was necessary because many crop operations such as planting and harvesting must be completed in a relatively short time and at specific times of the year. The probability of rain, which would hinder field operations, was used to compute the number of hours that would be available for crop production during these subperiods.

When relatively little capital is borrowed, more labor is used for crop

production, thus labor for crop production is scarce. When $11,690 of capital is available the shadow price of labor used for crop production is $5.64 per hour in June and $6.41 per hour in the latter half of July. When $12,400 is borrowed, labor in the latter half of July is worth $22.19 per hour. As more capital is borrowed labor scarcity becomes more acute. When $18,229 is borrowed, labor for crop production is scarce in all subperiods. Shadow prices vary greatly during the same month as the amount of capital borrowed increases. For instance, June labor is worth $9.31 when $12,400 are borrowed and falls to $.89 per hour when $15,869 is available.

Labor used for both crop and livestock enterprises becomes scarce during March through June with a value of $1.31 per hour when $12,400 are borrowed. When $22,956 are borrowed, labor during July through October becomes scarce and has a value of $1.57. It is not until $70,423 are borrowed that labor during November through March becomes scarce with a similar situation being observed at $84,489. When capital is abundant, labor use is distributed more evenly throughout the year. Productivity of labor during all periods begins to equalize with shadow prices becoming more uniform between periods. This is possible because the abundance of capital allows capital intensive beef enterprises to use labor productively during all periods.

Returns to Factors of Production

Imputed Returns to Capital

Imputed returns or total value product of capital is a measure of the amount of income generated by the capital invested. (Table 7).

Table 7. EFFECT OF QUANTITY OF CAPITAL BORROWED ON IMPUTED RETURNS AND RETURNS PER DOLLAR CAPITAL BORROWED

Capital level	$ Capital borrowed	$ Gross Income less Variable costs	$ Imputed Returns to Capital	% Total Income due to returns to capital	$ Returns per $ capital borrowed
1	11,690	9,941	6,888	69.3	.59
2	12,400	14,499	8,370	57.7	.67
3	15,869	16,723	8,757	52.4	.55
4	18,229	17,641	9,392	53.2	.52
5	22,956	19,346	10,148	52.5	.44
6	29,438	21,628	10,528	48.7	.36
7	70,423	37,174	22,717	61.1	.32
8	84,489	42,354	27,879	65.8	.33

Returns to capital increase with each increase in capital borrowed. As the quantity of capital borrowed increases from $11,690 to $84,489, an increase of 622.7 percent, imputed returns increase from $6,888 to $27,879, an increase of only 304.5 percent. Returns to capital increase proportionately less than increases in the amount of capital borrowed, indicating decreasing productivity of capital. At a level of $11,690, $.59 is the average return for each dollar of capital borrowed. As the quantity of borrowed capital increases to $12,400, an increase of $710, average returns are $.67. This is the highest average return realized. If capital is increased still further, average returns per dollar borrowed decline still further until only $.33 return for each dollar of capital is obtained when the level of operating capital is $84,489.

The above relationships indicate that on the particular farm situation studied here at least $12,400 of operating capital is necessary for rational production, or "stage II," because it is at this capital level that average returns per dollar of capital invested reach a maximum. Below this level, production is in "stage I" or the irrational zone.

When capital is the lowest level shown, returns to capital amount of 69.28 percent of the total income, other factors account for only 30.72 percent, indicating that land and labor are relatively inefficient at low levels of capital. When the quantity of capital borrowed increases to $12,400 returns to capital constitute 57.73 percent of total income while returns to other factors make up 42.27 percent, thus this increase in capital creates greater efficiency in the use of land and labor in the model. As capital is increased from this point to a level of $29,438, returns to capital constitute between 56.36 percent and 48.68 percent of total income while the other factors of production generate between 43.64 percent and 51.32 percent of total income, indicating that land and labor become most efficient in this range. As extremely high levels of capital are reached, the percentage of total income due to capital begins to increase. The productivity of land begins to level off or decline at this point because land becomes less significant for a full feeding program. Although average returns per dollar of capital are low when the quantity of capital borrowed is extremely large, these large quantities even at a low average return enable it to constitute a large proportion of total income.

Imputed Returns to Labor

Returns to labor are an important part of income. (Table 8). As the

Table 8. EFFECT OF QUANTITY OF CAPITAL BORROWED ON IMPUTED RETURNS TO LABOR AND RETURNS PER HOUR OF LABOR USED

	Capital level							
	1	2	3	4	5	6	7	8
Capital input ($)	11,690	12,400	15,869	18,229	22,956	29,438	70,423	84,489
Gross income less variable costs ($)	9,941	14,499	16,723	17,641	19,346	21,628	37,174	42,354
Imputed returns to labor ($)	2,383	6,129	7,966	8,249	9,198	10,082	12,200	12,253
Hours of operators labor used	2,319	2,187	2,541	2,551	2,462	2,380	2,688	2,688
Hours of hired labor used	0	0	0	0	0	51	1,146	1,565
Total hours of labor used	2,319	2,187	2,541	2,551	2,462	2,431	3,834	4,253
% of total income due to labor	24.0	42.3	47.6	46.8	47.5	46.6	32.8	28.9
Average return/hour ($) of labor used	1.03	2.80	3.13	3.23	3.74	4.15	3.18	2.88

quantity of capital borrowed increases the quantity of labor required remains relatively stable for low and intermediate quantities of capital, fluctuating only 364 hours as borrowed capital increases from $11,690 to $29,438. All labor requirements can be met without hiring labor when less than $29,438 is borrowed. Above this level additional labor is hired. When capital reaches $29,438, 51 hours of seasonal labor is required. As the quantity of capital is increased to $70,423, 153 hours of seasonal labor and 993 hours of full time labor is needed. When capital borrowed reaches $84,489, 124 hours of seasonal labor and 1,441 hours of full time labor is required. Only when large amounts of capital are borrowed is it necessary to hire labor to use resources efficiently. If the quantity of capital borrowed is between $12,400 and $29,438 imputed returns to labor account for almost half of total income. In this range the quantity of labor used is relatively constant while capital borrowed has more than doubled. Thus as capital increases, the quantity of labor remains almost constant but its contributions to total income increases, indicating increased labor productivity due to the increased capital.

Average hourly returns to labor increase when sufficient levels of capital are present. At a capital level of $11,690 the average shadow price of labor used is only $1.03 per hour. The hourly returns to labor increase as the quantity of capital borrowed increases until a value of $4.15 per hour is reached with $29,438 borrowed. When $84,489 are borrowed average return per hour for labor is $2.88.

If the criteria is to maximize the returns from labor, at least $29,438 of borrowed capital is needed. At this level the average returns to labor are maximized and began to decrease as more capital is borrowed. This

maximum hourly return represents the beginning of "stage 2" for labor or the rational zone of production. Because returns to labor are of major importance in farming operations it is evident that sufficient capital input must be utilized.

Imputed Returns to Other Factors

Soybean acreage was restricted to 80 acres because it was felt that in most cases a farmer would not have adequate equipment to plant more. Crop rotation problems might also develop if soybean acreage exceeded this limit. When $11,690 are borrowed the total acreage permitted for soybeans is used. A return of $670 is realized from this acreage indicating that an additional acre for soybean production would increase income by $8.38. At all capital levels above $11,690 the restriction on soybean acreage is not effective.

When $29,438 are borrowed all pasture available is used. However, in no case is additional pasture acquired. The shadow price or marginal value product is $1.94, $4.30 and $4.23 for capital levels of $29,438, $70,423 and $84,489, respectively.

CHAPTER IV

SUMMARY

Changes in the quantity of capital affect the income, optimum organization and returns to capital and labor of a beef farm in the Flint Hills. In all cases considered, an increase in capital borrowed increases income. However, income does not increase as fast because land and labor become scarce.

As capital borrowed increased from $11,690 to $84,489, land required for optimum organization was less than the 893 acres available on the representative farm. At low levels of capital, cash crops are an important source of income, accounting for almost half of the total income. Cash crop acreage and income decline steadily until they become negligible at high levels of capital. Feed grain production increases as capital increases because of the increased beef production. As capital borrowed increases both labor and capital are diverted to beef production because labor can be used more productively in the beef enterprises if sufficient capital is available. As these changes occur, more of the feed grain needed is purchased because no labor is required and capital is available to purchase it, thus feed grain acreage also declined.

Labor fluctuates somewhat due to changes in organization at the various capital levels. One man's labor is sufficient for the low and intermediate levels of capital, however, as capital borrowed increases additional labor is required to utilize this capital efficiently. Small amount of seasonal

labor during the summer months is required with large quantities of full time labor being hired. Labor becomes much more productive if sufficient capital is available. Labor during the spring and summer months is scarce at all levels of capital, however it is not until more capital becomes available that all labor available during the winter months is used. The increased availability of capital makes it possible to use full feeding beef systems to utilize labor during all periods of the year.

Pasture usage fluctuates considerably at low levels of capital, however, it stabilizes as operating capital is increased. In general, at low levels of operating capital, labor and capital can be used most productively in crop production. As capital increases a larger percentage of total land in grass becomes profitable. At high levels of capital all available pasture is used. In no case, however, is additional pasture acquired.

Beef cow herds are profitable when relatively little capital is available with creep fed calves being produced. As more capital becomes available cow herd systems are replaced with the deferred system, using purchased stock. Further increases in capital specify a combination of deferred and grazing system of feeding 600 pound yearlings. As capital is increased still further the January to August full feeding system using 400 pound calves in combination with the deferred and grazing and feeding systems is optimal. This combination allows almost full utilization of labor during all months of the year. Further increases in capital specify that a combination of grazing and feeding system, January to August full feeding and an August to March full feeding system replace the deferred system completely.

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Appendix Table 1. EFFECT OF QUANTITY BORROWED ON THE SOURCE OF INCOME AND USE OF LABOR

	Capital level							
	1	2	3	4	5	6	7	8
Capital borrowed ($)	11,690	12,400	15,869	18,229	22,956	29,438	70,423	84,489
Gross income minus ($) variable costs	9,941	14,499	16,723	17,641	19,346	21,628	37,174	42,354
% Total income from cash crop	47.02	26.57	14.74	13.14	11.31	7.19	0.77	0.06
% Total income from beef	52.98	73.43	85.26	86.86	88.69	92.81	99.23	99.94
% of total labor used in cash crop production	34.30	28.22	15.47	14.46	14.14	10.20	1.20	.12
% of total labor used for beef production	65.70	71.78	84.53	85.54	85.86	89.80	98.80	99.98

Appendix Table 2. SHADOW PRICES FOR LABOR IN DOLLARS FOR ALL PERIODS WHERE SCARCITY EXISTS

	Capital Input Level							
	1	2	3	4	5	6	7	8
Capital input ($)	11,690	12,400	15,869	18,229	22,956	29,438	70,423	84,489
November - February							1.95	1.87
March - June		1.31	3.75	2.90	.83	3.21	5.19	5.14
July - October					1.57	1.56	1.61	1.75
March - April 15							1.57	1.33
May 15 - 31				4.75	15.55	9.42	4.08	4.83
June 1 - 15	4.48	9.78	1.79	8.95	4.20	2.58	1.37	.93
June 16 - 30	6.80	8.85	10.71	6.62				
July 16 - 31	6.41	22.19	10.71	22.62	9.25	11.40	11.45	9.95
August 16 - 31							1.56	2.25
October 1 - 15		2.36	17.44	7.40	23.60	19.50	13.70	14.57
October 16 - 31	3.42	2.56	9.23	2.11	12.39	8.56	3.00	3.56

EFFECT OF CAPITAL ON INCOME AND ORGANIZATION OF BEEF FARMS IN THE FLINT HILLS OF KANSAS

by

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Because of the economic importance of beef production in the Flint Hills of Kansas it is important to better understand the factors which determine the particular beef system which is best adapted to a given farm in this region. The objective of this study is to analyze the effect on income, organization and returns to factors of production of varying the quantity of operating capital for a representative beef farm in this region. The effect of capital on income, organization and returns to factors of production is considered because beef production is a capital intensive enterprise and thus it is hypothesized that this factor would be of primary importance in determining the type of system which would be most profitable under a given set of circumstances.

A random sample of farms was taken from county assessor's records from the twenty-two counties in the Flint Hills to determine the distribution of farm size and the percentage of farm land in grass to construct a representative farm. A wide range of farm size and grass percentage was found within the region, thus the Flint Hills region was divided into three areas to narrow the range of the distribution. Farms under 160 acres were excluded from the study because a unit this size is considered too limited in capital resources to make the adjustments in farm organization necessary to survive and provide a reasonable amount of farm income.

Data from beef farms in the Farm Management Associations was used to determine the resources for the representative farm. Farms belonging to Farm Management in this region are considerably larger and it is assumed these farms represent above average production efficiency.

Linear programming is used to select an optimum combination of enterprises, subject to the resource limitations on a representative farm for the

middle area of the Flint Hills region. All relationships studied are the result of limiting the amount of capital that can be used as collateral to borrow operating capital. Results are for eight levels of borrowed capital that cause a change in farm organization and income.

Cow herd and noncow herd beef systems are analyzed in the study. Under the cow herd system, calves may be sold when weaned, creep fed, wintered, wintered and grazed, full fed or deferred fed. Noncow herd or purchased steer systems include those previously mentioned, excluding the sale of weaning calves and creep fed calves. Grazing and feeding yearlings or fattening yearling calves are also considered in the noncow herd systems. Crop enterprises considered in the study are soybeans, corn, wheat, barley, grain sorghum, corn silage and alfalfa.

In all cases considered, an increase in capital borrowed increases income. However, income does not increase proportionately because land and labor become scarce as capital is increased.

At low levels of capital, cash crops are an important source of income, accounting for almost half of the total income. As capital use increases, beef production replaces cash crop production as the primary source of income. Feed grain production increases as capital increases because of increased beef production.

Labor requirements fluctuate with various levels due to changes in organization, however, labor provided by one full time man is sufficient for low and intermediate levels of capital, to obtain optimum organization and income. At high levels of capital, additional labor is required. Increasing capital increases labor productivity. Labor during the spring and summer months is scarce at all levels of capital, however, it is not until large

quantities of capital are used that all labor available during the winter months is used.

Beef cow herds are profitable when capital is scarce, with creep fed calves being produced. As more capital becomes available cow herd systems are replaced with the deferred system, using purchased stock. Further increases specify a combination of deferred, and grazing and feeding yearlings. As capital is increased still further a combination of the deferred and a full feeding system is optimal. At the highest level of capital studied a combination of grazing and feeding, and full feeding is specified as optimal.