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AN ANALYSIS OF IRRIGATION FARMING in the Oakes-LaMoure Project Area

Report of the "MIP" Interdisciplinary Research Team
North Dakota Agricultural Experiment Station
North Dakota State University
of Agriculture and Applied Science
Fargo, North Dakota
in cooperation with
Bureau of Reclamation
United States Department of the Interior
Washington, D.C.
and
Garrison Conservancy District
Carrington, North Dakota

AGRICULTURAL EXPERIMENT STATION
NORTH DAKOTA STATE UNIVERSITY
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FOREWORD

This bulletin reports on the work of the Marketing Irrigation Production research team charged with the responsibility of evaluating the production and market potential of agricultural production from the Garrison Diversion Irrigation Project. It covers the Oakes-LaMoure irrigation area.

The study examines the influence of irrigating 270 acres of a 760 acre model farm in the Oakes-LaMoure Irrigation Area. An analysis is included for normal and optimum managerial ability and of high and low available water capacity soils. The analysis was further divided into a total crop farm and a crop and livestock farm with the inclusion and exclusion of selected specialty crops and livestock enterprises. The influence of producing irrigated potatoes, sugarbeets, or muskmelons; renting additional irrigated land; or hiring labor was limited to model farms with optimum management on both soil textural groups. The purpose of this bulletin is to identify profit maximizing irrigated and dryland cropping patterns with and without livestock alternatives and/or specialty crops. The cost and returns of specific crops are not reported in this publication.

These results can provide guidance to both private irrigators and irrigators from the Garrison Diversion Irrigation Project in the Oakes-LaMoure irrigation area. The analysis in this study employs numerous historic base period values and, therefore, should not be used to evaluate current period cost and returns for irrigated or dryland enterprises. The study emphasis is directed toward estimates of long-run profit maximizing farm plans in the irrigation areas.

This report is a cooperative effort of the MIP research team with Mr. Harvey Vreugdenhil acting as senior author. The members of the MIP team are:

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United States Bureau of Reclamation
The Garrison Conservancy District

The financial support of these agencies has increased the effort expended for research of irrigated agriculture in North Dakota. The added funding has made it possible for the Experiment Station to utilize additional resources in studying ways of using North Dakota's water resources more efficiently.

INTRODUCTION

The **M**arketing **I**rrigation **P**roduction (MIP) interdisciplinary research team was formed to determine the best combination of irrigated crops, dryland crops, and livestock enterprises and to evaluate the market potential of agricultural production from the Garrison Diversion Irrigation Project. The MIP team consists of research scientists from Agricultural Economics, Agronomy, Animal Science, Horticulture, and Soils departments at North Dakota State University.

The Garrison Diversion Irrigation Project was divided into three general areas: North, Central, and South. The criteria for dividing the district into three areas were length of growing season, amount of rainfall, current farming practices, and present and potential markets. The Northern area, composed of the Souris Loop and Karlsruhe irrigation areas as shown in Figure 1, contains approximately 116,000 acres in parts of Bottineau and McHenry counties. The 74,670 Central area includes all land in the Lincoln Valley, New Rockford, and Warwick-McVille irrigation areas, covering parts of Sheridan, Eddy, Benson, and Nelson counties. The Southern area, composed of the LaMoure, East Oakes, and West Oakes irrigation areas, encompasses 59,330 acres in parts of Stutsman, LaMoure, Dickey, Sargent, and Ransom counties.

The Oakes-LaMoure area covered in this report is the first irrigation area scheduled to receive water from the Garrison Diversion Irrigation Project. Subsequent reports will cover the other irrigation areas.

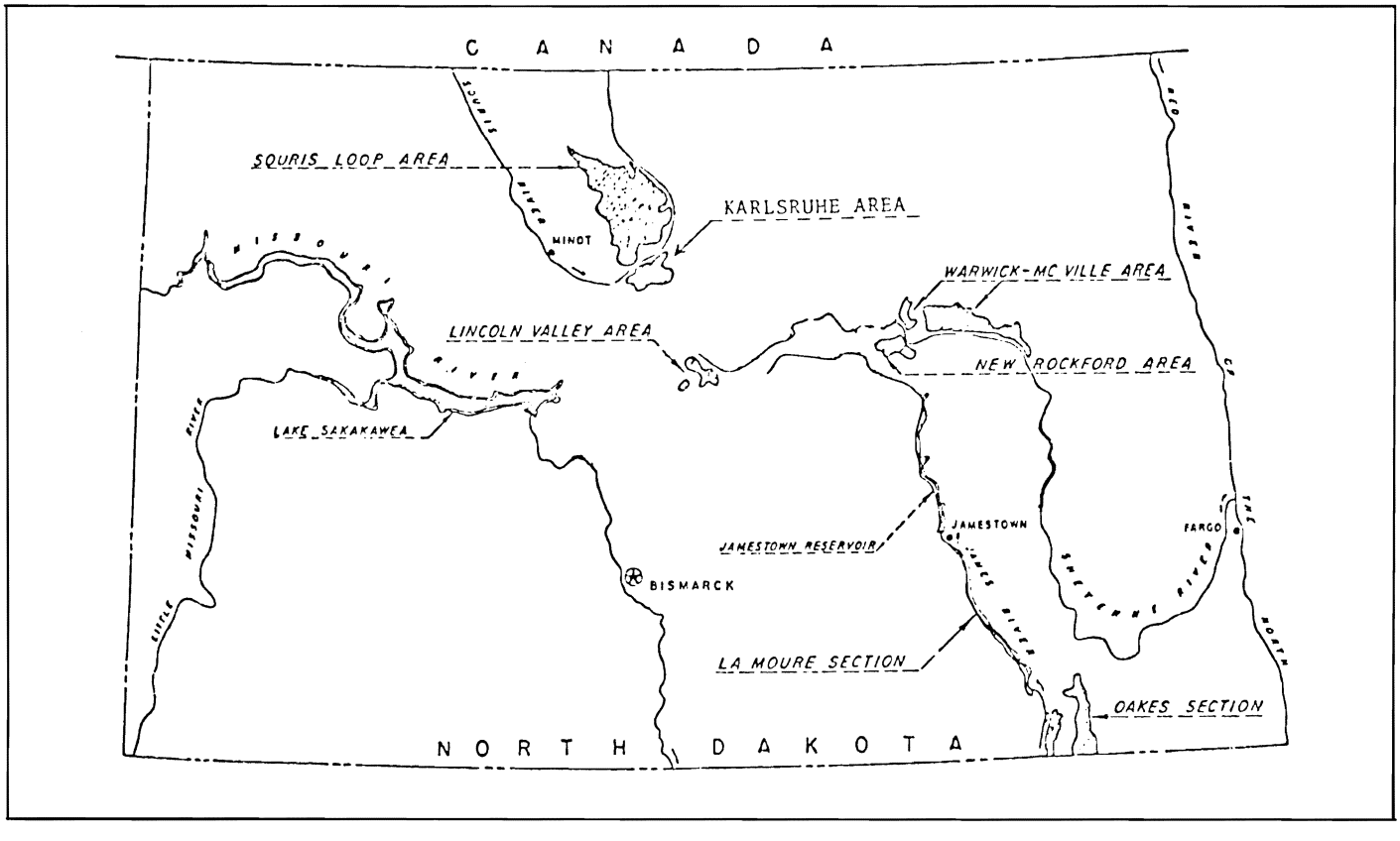

Figure 1. Initial Irrigation Areas of the Garrison Irrigation Project

Description of the Oakes-LaMoure Irrigation Area

The Oakes-LaMoure irrigation area is in parts of Stutsman, LaMoure, Dickey, Sargent, and Ransom counties (Figure 1). The LaMoure section of the area, located along the James River and the lower portion of its tributary, Seven Mile Coulee, extends from the Jamestown vicinity to the confluence of the James River and Bear Creek near Oakes, North Dakota. The West Oakes portion of the area extends southward to the North Dakota-South Dakota border. The East Oakes irrigation unit is mainly in the western part of Sargent County but a small portion of the unit extends into southwestern Ransom County. The Oakes-LaMoure irrigation area contains 59,330 acres of land irrigable by the sprinkler method, with 3,063 acres classified as Class 1 land; 18,548 acres as Class 2; and 37,719 acres as Class 3 according to Bureau of Reclamation standards. Much of the Class 1 land has soils comparable to those described in this report as "high available water capacity soils" and much of the Class 3 land has soils similar to those described as "low available water capacity soils."[1]

Most of the soils tentatively scheduled for irrigation in the LaMoure section are on terraces of the James River and Seven Mile Coulee, and on footslopes adjacent to the steep valley side slopes of the James River Valley. A large proportion of the terrace soils have 10 to 20 inches of medium-textured or moderately coarse-textured material over coarse sand and gravel. Deep, medium-textured to moderately fine-textured soils are on some of the lower terraces. The soils on footslope positions are developed mainly on medium-textured sediments washed from the valley side slopes. At present, drainability probably will preclude irrigation of a large acreage of medium-textured to moderately fine-textured soils on the low terraces and bottomland adjacent to the river channel.

The East and West Oakes units are part of the Glacial Lake Dakota Basin. Both units are nearly level to undulating; hummocky areas occur where the sandy materials have been reworked by wind. An established surface drainage pattern is lacking and numerous large sloughs and depressions occur throughout the area. The water table underlying much of the Lake Dakota Basin is within 10 feet of the surface.

The soils in the west portion of the Oakes section are developed mainly on coarse and moderately coarse-textured sediments. In general, the East Oakes unit is dominated by soils on coarse-textured and medium-textured materials. Both units, however, include soils with a wide range in texture and other properties.[2]

The Irrigated Model Farm

A model farm was developed as a tool to determine the most profitable method to integrate irrigation into a farm plan. The model farm does not represent a particular farm but was considered representative of a typical farm in the Oakes-LaMoure irrigation area. Data from a 1972 survey of farmers within the Oakes irrigation area, together with a consideration of existing laws, prescribed production practices, and a measure of judgment, were combined to determine the model farm characteristics.

The model farm consists of 1,040 acres of which 760 acres are cropland, 230 acres are native pasture, and 50 acres are farmstead and wasteland. Two center pivot irrigation systems are used to irrigate 270 of the 760 cropland acres. Machinery requirements for the model farm are based on the average inventory for farms of a similar size.

Family labor is provided by the farm operator and his school age children. A full-time hired man is employed. Additional seasonal labor is hired as needed for harvesting potatoes and sugarbeets when these crops were produced.

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[1] Available water is the portion of water in a soil which can be absorbed by plant roots. Available water capacity is the capacity of a soil to store water for plant use. In the Oakes-LaMoure area, **high available water capacity** soils are mainly medium-textured to moderately fine-textured (loam, silt loam, or silty clay loam) through the rooting zone and capable of storing more than 9 inches of plant available water within a 5 foot vertical section of soil (USDA-SCS standards). Soils with **moderate available water capacity** are moderately coarse-textured (fine sandy loam or sandy loam) and have plant available water storage capacities of 6 to 9 inches within a 5 foot section of soil. Soils with **low available water capacity** are coarse-textured (loamy fine sand or loamy sand) throughout the rooting zone or soils with loam or sandy loam over sand and gravel at shallow depths. These soils have less than 6 inches of water storage capacity to a depth of 5 feet. Available water capacity is important from the standpoint of the amount of irrigation water which can be applied at one time and the frequency of application required.

[2] Additional information on the soils of the area can be found in the following publications: Patterson, D. D., **et al.**, "Soil Survey Report County General Soil Map, North Dakota," North Dakota Agricultural Experiment Station Bulletin 473, 1968; Larson, W. E., **et al.**, "Soil Survey Sargent County, North Dakota," USDA-SCS and North Dakota Agricultural Experiment Station, U.S. Government Printing Office, Washington, D.C., 1964; Thompson, D. G., and M. D. Sweeney, "Soil Survey LaMoure County and Parts of James River Valley, North Dakota," USDA-SCS and North Dakota Agricultural Experiment Station, U.S. Government Printing Office, Washington, D.C., 1971.

Two model farms with identical resource constraints were developed for each of the two soil textural groups—coarse-textured and medium-textured soils. The two soil textural groups were used because of 1) the relationship between soil texture and available water capacity; 2) the predominance of these textural groups in the area; and 3) the differences in management requirements and crop yields between coarse-textured and medium-textured soils, particularly under dryland conditions.

Normal and optimum management levels were assumed for each model farm. Crop yields under normal management reflect the skills of beginning irrigators or irrigators whose management practices limit production. Optimum management represents the "know-how" of experienced irrigators and the application of known technology. The difference between the two management levels is in the selection, timeliness, and performance of production practices which are reflected in crop yields.

For livestock production, normal management was intended to reflect the current practices while optimum management reflects improved production practices. The difference between the two livestock management levels was reflected in hog weaning rates, the per cent calf and lamb crop for the beef cow and sheep enterprises, and milk production per cow for the dairy enterprises. No differences between management levels were assumed for the livestock feeding enterprises.

Product Prices

Product prices were established to represent normal price relationships. It should be recognized that in any given year, price relationships may differ from normal. These relative prices for the different crop and livestock commodities were based on the average prices during the ten-year period 1963-1972 (Table 1). It was assumed that average prices over this period represented price relationships that could be projected into the future. The base period selected was sufficiently long not to be influenced unduly by cyclical price patterns, yet short enough to reflect recent trends in relative prices. Increases in prices paid by farmers since 1963-1972 were taken into account by increasing product prices by the per cent increase in the index of prices paid by farmers (parity index) between the base period and March, 1974. The prices for all inputs were at 1974 levels.

The prices used do not reflect predictions for a particular year in the future. Inflation is expected to continue, so actual prices of both inputs and products will be higher by the time the Garrison Project water is used on farms. The results of the enterprise analysis would not be changed by increasing both input and product prices by some estimate of the inflation rate.

Market Investigations

No special marketing problems are anticipated for those crop and livestock enterprises already being produced and marketed in the area. However, irrigation does make possible production of certain crops not presently being produced and for which markets would need to be developed.

Two marketing studies were initiated to consider the market potential of specialty crops. A study examining the economic feasibility of operating a sun-cured alfalfa hay pelleting plant was completed. Copies of this study are available from the Department of Agricultural Economics, North Dakota State University, Fargo, North Dakota 58102.

The potato market also was selected for a detailed study in order to get a better perspective on the role of potatoes in the Garrison Diversion Irrigation Project. The study of the fresh and processed potato markets is currently in process.

A study of the long-term market potential of sugarbeet production in North Dakota and western Minnesota was initiated. Considerable expansion of total sugarbeet production may have an impact on the national market for sugar. The study will attempt to measure long-run adjustments that are likely to occur in the national industry and assess the competitive position of sugar production from the Garrison Diversion Irrigation Project on the national market.

Crop and Livestock Enterprises

Crop and livestock production practices and yields are based upon the recommendations and expectations of agronomists, animal scientists, horticulturalists, and soil scientists at North Dakota State University.

Table 1. Estimated Crop and Livestock Selling and Purchase Prices

Crop or Livestock Enterprise	Units	Selling Price	Purchase Price
Corn grain	Bushels	$ 1.75	$ 1.87
Soybeans	Bushels	4.55	
Wheat	Bushels	2.70	
Flax	Bushels	4.70	
Barley	Bushels	1.50	
Millet	Hundredweight	4.15	
Winter rye	Bushels	1.55	
Oats	Bushels	.95	1.07
Grain sorghum	Hundredweight	2.85	
Alfalfa hay	Tons	30.00	
Alfalfa-brome hay	Tons	27.00	
Sunflowers (oil)	Hundredweight	7.90	
Pinto beans	Hundredweight	12.50	
Potatoes (early)	Hundredweight	3.40	
Potatoes (late)	Hundredweight	2.90	
Sugarbeets	Tons	22.50	
Muskmelons	Pound	.10	
Feeder pigs	Hundredweight	70.00	72.50
Slaughter pigs	Hundredweight	35.00	
Steer calf	Hundredweight	55.00	55.74
Heifer calf	Hundredweight	49.00	49.74
Backgrounded steer	Hundredweight	48.00	48.67
Backgrounded heifer	Hundredweight	43.50	44.17
Yearling steer	Hundredweight	46.00	
Yearling heifer	Hundredweight	44.50	
Feeder steer	Hundredweight	46.50	
Sheep	Hundredweight	40.30	
Milk	Hundredweight	7.35	
Hired labor	Hour		3.00
Rented irrigated land	Acre		65.00

Production requirements and yield estimates were made for each selected crop for the two soil textural groups having different available water capacities and for the two operator management levels. Assumptions made when establishing the cultural practices and yield estimates for the various irrigated and dryland crops included:

1. Good quality seed of adapted varieties or hybrids is available.
2. Adequate supplies of fertilizer, herbicides, and insecticides are available.
3. Drainage operations will proceed with irrigation development.
4. Adequate supplies of irrigation water will be available as needed for all crops.
5. The amount of irrigation water required for soils with high and low available water capacity at both management levels is the same since a given amount of water is required to produce a particular type of crop.
6. Crop acreage is limited by the farm equipment needed for timely operation.
7. Peak labor loads are determined from the approximate farm operation dates where combinations of crop and livestock enterprises are employed on the same farm.
8. Natural disasters, such as hail, insects, disease, or frost, were not considered in establishing crop yield estimates.

Types and size of livestock enterprises were based on size of livestock facilities predominant in the area. Costs and returns were calculated for each crop and livestock enterprise using a computer budgeting system which standardized the labor needs and cost for the machinery used. A budget was calculated for each of the following crop and livestock enterprises:

Irrigated Crops	Dryland Crops	Livestock
Hay (alfalfa or alfalfa-brome)	Hay (alfalfa or alfalfa-brome)	Sow with two litters
Corn grain	Corn grain	Finishing feeder pigs
Corn silage	Corn silage	Beef cow herd
Pinto beans	Barley	Backgrounding calves
Early potatoes	Flax	Backgrounding yearlings
Late potatoes	Millet	Finishing steers
Soybeans	Oats	Dairy
Grain sorghum	Oil sunflowers	Sheep
Sugarbeets	Winter rye	
Oil sunflowers	Wheat	
Wheat	Alfalfa-brome pasture	
Alfalfa-brome pasture	Tame grass pasture	
	Native pasture	

All crops were grown in rotation except corn grain, corn silage, and native pasture. Corn could be grown either in rotation or continuously. Continuous corn has slightly higher costs. The per cent of land in certain crops was limited to control disease. Irrigated soybeans, grain sorghum, and corn grain or silage in a rotation were limited to a maximum of 50 per cent of the irrigated land. Pinto beans, potatoes, sugarbeets, and wheat were limited to 33 per cent; and sunflowers to 25 per cent of the total irrigated land. Dryland rotational limitations restricted wheat and corn in rotation up to 50 per cent; and sunflowers, barley, oats, flax, winter rye, and millet up to 33 per cent of the dryland acreage. Additional rotational restrictions may be required if crop disease becomes prevalent in the area. For example, white mold is not very common in the state so far, but can spread, especially under irrigation. Sunflowers and field beans are most susceptible to white mold; and to a lesser extent, sugarbeets, soybeans, and potatoes are susceptible. The carryover effect of herbicides used on the previous year's crop must be considered to avoid crop injury. Volunteer crops may also be a problem, as for example, sugarbeets following sunflowers.

The pig finishing and cattle feeding enterprises were based upon purchased livestock and/or livestock produced on the farm. The size of the swine enterprises was limited to a maximum of 81 sows or 1,269 feeder pigs based on housing limitations.

A planning technique called linear programming was used to study the economic feasibility of alternative crop and livestock enterprises. Relative costs and returns together with land and labor requirements were analyzed for each enterprise to find the combination that would yield the highest net income.

The majority of the discussion in this bulletin deals with normal management on soils with low available water capacity since it was estimated that, initially, normal management will likely account for a high percentage of the irrigators. Also, soils with low available water capacity are predominant in the Oakes-LaMoure irrigation area.

Dryland and Irrigated Farm Production Operations Compared

Irrigation can provide an increased feed supply, stabilized crop production, and provide the opportunity to raise certain specialty crops not feasible under dryland operation. Table 2 provides a comparison of the dryland and irrigated yields for selected crops in the Oakes-LaMoure irrigation area. For example, the irrigated corn grain yield for normal management on soils with low available water capacity increased 250 per cent over the dryland yield. Irrigation permitted a third cutting of alfalfa hay which helps to increase the annual yield per acre.

Production costs of irrigated agriculture also increased due to increased use of fertilizer, seed, herbicides, and other inputs including a $7.40 water charge per acre. For example, the cost of producing an acre of dryland corn grain was $42.60 while the cost for producing an acre of irrigated corn grain was $105.79 or a 148 per cent increase. The yield of corn grain, however, was increased 250 per cent. Irrigation increased operating capital needs 129 per cent while labor use per acre increased approximately 35 per cent.

Crop and Livestock Farm on Low Available Water Capacity Soils

The dryland model farm consisted of 760 cropland acres and 230 acres of native pasture with labor provided by the farmer, two school age children, and a hired man. The profit maximizing dryland farm under normal management produced a net income of $25,600; while for optimum management, the net income was $36,800 [3] (Table 3). The most profitable farm plan had alfalfa hay, corn grain, corn silage, and a small amount of winter rye produced. The livestock enterprises consisted of finishing feeder pigs, feeder cattle, and a small beef cow herd. Farmers with optimum management ability raised their own feeder pigs since they weaned more pigs per litter, while at the normal management level feeder pigs were purchased. It was assumed that the model farm in the Oakes-LaMoure irrigation area would not produce more than 1,269 feeder pigs or 81 sows having two litters per year because of resource limitations. Therefore, the program restricted swine production to these limits. The program provided for backgrounding two-thirds steers and one-third heifers. The heifers were sold as backgrounded yearlings while the steers were finished to a 1,050 pound market weight. Native pasture was not fully utilized by the livestock enterprises since nonpasture using enterprises make better use of available labor. The pasture not utilized by the livestock enterprises was leased out at $3.75 per animal unit month.

The linear programming model attempts to fully utilize all resources of the model farm. Full resource utilization can produce results which may be impractical in an actual farm operation. The profit maximizing farm plan may include a small acreage of a crop or a few head of livestock which could be eliminated with a slight change in net income.

Sometimes the most profitable amount of an enterprise changes with a minor price change. Price sensitivity information helps determine closely competing enterprises which could be substituted without decreasing net income significantly. For example, hay acreage under dryland would increase with a 5 per cent increase in hay price.

[3] Net income is defined as total receipts including inventory changes minus total expenses including depreciation. No charge is made for land or the labor of the farm operator and his family. Also, certain overhead expenses, such as telephone, electricity, and the farm office, have not been included in expenses.

Table 2. Estimated Dryland and Irrigated Yield Comparisons of Some Crops for Oakes-LaMoure Irrigation Area

Crops	Available Soil Water Capacity			
	Low		High	
	Normal Management	Optimum Management	Normal Management	Optimum Management
Corn grain (bushels)				
Irrigated	100.0	140.0	120.0	150.0
Dryland	40.0	55.0	50.0	70.0
Corn silage (tons)				
Irrigated	17.0	23.0	20.0	25.0
Dryland	7.2	10.0	9.0	12.5
Wheat (bushels)				
Irrigated	40.0	56.0	48.0	60.0
Dryland	12.0	16.0	24.0	33.0
Sunflowers (oil) (pounds)				
Irrigated	1,810.0	2,520.0	2,160.0	2,700.0
Dryland	575.0	765.0	825.0	1,100.0
Alfalfa (year of establishment) (tons)				
Irrigated	3.0	4.0	3.5	4.0
Dryland	---	---	---	---
Alfalfa (first year) (tons)				
Irrigated	5.3	6.5	5.8	6.5
Dryland	2.8	3.2	3.2	3.5
Alfalfa (second year) (tons)				
Irrigated	4.8	5.8	5.2	5.8
Dryland	2.5	2.8	2.8	3.1
Alfalfa (third year) (tons)				
Irrigated	4.6	5.5	5.0	5.5
Dryland	2.2	2.5	2.4	2.7
Alfalfa-grass pasture (AUM)				
Irrigated	7.4	9.0	8.0	9.0
Dryland	3.2	4.2	3.5	4.7

Table 3. Crop and Livestock Base Models (Highest Profit Combination of Enterprises), Low Available Water Capacity Soils, Oakes-LaMoure Irrigation Area

	Dryland (760 acres)		Irrigated (270 acres)	
	Normal Management	Optimum Management	Normal Management	Optimum Management
NET INCOME	$25,600	$36,800	$41,600	$65,800
IRRIGATED CROPS (ACRES)				
Alfalfa hay			45(96)*	
Corn grain			135(100)	135(100)
Pinto beans			90	90
Soybeans				45
Total			270	270
DRYLAND CROPS (ACRES)				
Alfalfa hay	344(52)	344(38)	222(30)	222(60)
Corn grain	290(100)	319(100)	159(100)	187(100)
Corn silage	90(100)	61(100)	86(100)	58(100)
Winter rye	36	36	23	23
Total	760	760	490	490
Total cropland acres	760	760	760	760
Native pasture	230(27)	230(50)	230(17)	230(30)
LIVESTOCK (HEAD)				
Sow with two litters		39		39
Purchased feeder pigs	1,269		1,269	
Home-raised feeder pigs		658		658
Beef cow	19	24	a	15
Feeder cattle	430	304	409	315
Dairy				a
FEED PURCHASED (BUSHELS)				
Corn grain	29,583	13,036	20,471	1,960
Oats	83	108	54	70

*( ) indicates per cent of crop utilized as livestock feed with remaining per cent marketed.
[a]A very small size herd was included in the final solution.

Irrigated Model Farm

All dryland crops, irrigated crops, and livestock enterprises previously listed, except for potatoes and sugarbeets, were included in the irrigated farm analysis. It was assumed that, initially, market limitations would severely limit potato and sugarbeet production.

The irrigated model farm was the same as the dryland farm except 270 of the cropland acres were irrigated leaving 490 dryland crop acres. The other restrictions on the irrigated model farm were identical to those on the dryland model farm. Irrigating 270 acres increased net income 63 per cent over the dryland situation under normal management and 79 per cent under optimum management (Table 3). The dryland crops only changed in the acreage devoted to each crop. The plan for the irrigated acreage under normal management specified pinto beans to the limit permitted, corn grain and alfalfa hay. With optimum management, the hay is replaced by soybeans and pinto beans to their permitted level.

About two-thirds of the irrigated and dryland crop acres were used to produce livestock feed. The size and type of livestock enterprises influenced the number of acres devoted to corn grain and the amount of corn grain that was purchased for feed. Approximately 96 per cent of the irrigated hay and 30 per cent of the dryland hay

was utilized for feed to support the livestock enterprises under normal management, while 60 per cent of the dryland hay acreage under optimum management was utilized as feed. Only 17 per cent of the available native pasture was utilized under normal management. A small acreage of winter rye was produced to even out the labor load over the year. A 5 per cent increase in the price of hay would increase irrigated hay acreage and decrease pinto beans under normal management.

The livestock enterprises were nearly the same for the dryland and irrigated farm situations with only slight changes in beef cow and feeder cattle numbers. The eight dairy cows under optimum management would not be practical and could be replaced by additional beef cows with little effort on net income. The increase in net income from irrigation can be attributed to increased yields and higher valued irrigated crops since livestock enterprises did not change substantially. It should be noted that purchased feed decreased when irrigation was added to the model, thus increasing the total livestock carrying capacity of the area.

Crop and Livestock Farm on High Available Water Capacity Soils

The dryland model farm under normal management had a net income of $43,100 while the optimum management dryland farm had a net income of $59,200 (Table 4). Net income was over 60 per cent greater on the

Table 4. Crop and Livestock Base Models (Highest Profit Combination of Enterprises), High Available Water Capacity Soils, Oakes-LaMoure Irrigation Area

	Dryland (760 acres)		Irrigated (270 acres)	
	Normal Management	Optimum Management	Normal Management	Optimum Management
NET INCOME	$43,100	$59,200	$63,000	$86,300
IRRIGATED CROPS (ACRES)				
Alfalfa hay			37(100)*	
Corn grain			135(100)	135(100)
Pinto beans			90	90
Soybeans			8	45
Total			270	270
DRYLAND CROPS (ACRES)				
Alfalfa hay	344(43)	236(52)	222(28)	152(82)
Corn grain	317(100)	335(100)	185(100)	201(96)
Corn silage	63(100)	45(100)	60(100)	44(100)
Winter rye	36		23	
Flax		144		93
Total	760	760	490	490
Total cropland acres	760	760	760	760
Native pasture	230(27)	230(9)	230(17)	230
LIVESTOCK (HEAD)				
Sow with two litters		39		39
Home-raised feeder pigs		658		658
Purchased feeder pigs	1,269		1,269	
Beef cow	26		17	
Feeder cattle	419	322	399	367
Dairy		a		
FEED PURCHASED (BUSHELS)				
Corn grain	22,951	7,399	13,312	
Oats	119		76	

*( ) indicates per cent of crop utilized as livestock feed with remaining per cent marketed.
[a]A very small sized herd was included in the final solution.

high available water capacity soils than the low available water capacity soils due to increased productivity. Dryland crops produced on high available water capacity soils were the same as for low available water capacity soils except for the inclusion of flax under optimum management. Flax yields were higher on the more productive soils at higher management levels. Livestock enterprises were similar to those for the other soils textural group. The small dairy herd indicated would not be practical and would either have to be much larger or eliminated.

Irrigating 270 acres increases net income 46 per cent for both management levels. The irrigated crops produced were corn grain, pinto beans, soybeans, and/or hay. Dryland crops produced did not change except for the acreage devoted to each crop. The size of the swine enterprises did not change. The sizes of the feeder cattle and beef cow enterprises were altered slightly when irrigation was added.

All-Crop Farm on Low Available Water Capacity Soils

It is unrealistic to believe all farmers in the Oakes-LaMoure irrigation area will produce livestock so the model farms were analyzed for crop enterprises only. A hired man was not employed since the farmer and his two school age children could provide the necessary labor when only crops are produced.

Land tended to restrict net income when only crops were produced, while labor tended to restrict net income for the livestock enterprises. The reason for higher net income for the model farms with livestock was due to the full utilization of off-season labor and more total labor.

The dryland farm with normal management produced hay, corn grain, sunflowers, and winter rye providing a net income of $4,800 (Table 5). Irrigating 270 of the 760 acres increased net income approximately 223 per cent. Dryland crops produced were similar in both farm situations except in the number of acres devoted to each crop. However, dryland winter rye was not produced when irrigation was added because of the increased acreage of more profitable long season irrigated crops. Irrigated crops were pinto beans, sunflowers, and soybeans, all to the allowable limit, plus some alfalfa hay.

Table 5. Crop Base Models (Highest Profit Combination of Enterprises), Low Available Water Capacity Soils, Oakes-LaMoure Irrigation Area

	Dryland (760 acres)		Irrigated (270 acres)	
	Normal Management	Optimum Management	Normal Management	Optimum Management
NET INCOME	$ 4,800	$12,600	$15,500	$37,300
IRRIGATED CROPS (ACRES)				
Alfalfa hay			68	
Corn grain				68
Pinto beans			90	90
Soybeans			45	45
Sunflowers (oil)			67	67
Total			270	270
DRYLAND CROPS (ACRES)				
Alfalfa hay	235	235	152	152
Corn grain	379	379	245	245
Sunflowers (oil)	51	51	93	93
Winter rye	95	95		
Total	760	760	490	490
Total cropland acres	760	760	760	760
Native pasture	230	230	230	230

The dryland farm with optimum management provided a net income of $12,600. Irrigating 270 acres increased the net income approximately 196 per cent. Changes in the cropping system as a result of adding

irrigation were identical under both management levels except for a substitution of irrigated corn grain for irrigated alfalfa hay with optimum management. The higher net income under optimum management was due to increased yields.

All-Crop Farm on High Available Water Capacity Soils

The dryland model farm with normal management produced a net income of $12,500, while irrigating 270 acres increased net income approximately 198 per cent. With optimum management, the dryland farm's net income was $24,700 and increased about 136 per cent when irrigation was included (Table 6).

Table 6. Crop Base Models (Highest Profit Combination of Enterprises), High Available Water Capacity Soils, Oakes-LaMoure Irrigation Area

	Dryland (760 acres)		Irrigated (270 acres)	
	Normal Management	Optimum Management	Normal Management	Optimum Management
NET INCOME	$12,500	$24,700	$37,200	$58,300
IRRIGATED CROPS (ACRES)				
Corn grain			135	135
Pinto beans			90	90
Soybeans			45	45
Total			270	270
DRYLAND CROPS (ACRES)				
Alfalfa hay	235	235	82	82
Corn grain	379	326	245	245
Sunflowers (oil)	51			
Winter rye	95			
Flax		73		163
Millet		126		
Wheat			163	
Total	760	760	490	490
Total cropland acres	760	760	760	760
Native pasture	230	230	230	230

Dryland crops are mainly alfalfa hay and corn grain plus smaller acreages of sunflowers and winter rye under normal management. Under optimum management, flax and millet replaced sunflowers and winter rye. When irrigation is added, corn grain remains the dominant dryland crop but hay acreage is reduced and wheat (normal management) or flax (optimum management) is also in the plan. Irrigated crops produced were identical under either management level. The maximum acreage of pinto beans and soybeans allowed by rotational considerations is specified in the plan with the remaining acres devoted to corn grain.

Farm Production Alternatives on Low Available Water Capacity Soils

Many farmers in the Oakes-LaMoure irrigation area will not want to produce certain crop and livestock enterprises appearing in the most profitable farm plan. Profit maximizing farm plans excluding certain enterprises are provided in the following sections to provide guidance to these farmers. The influence of adding or eliminating certain crop and/or livestock enterprises is analyzed in this section. Low available water capacity soils under both management levels are included. Similar information for the high available water capacity soils is covered in the next section.

All-Crop Farm Without Pinto Beans and/or Sunflower Alternatives

Normal Management

The all-crop base model includes all crop enterprises except potatoes, sugarbeets, and muskmelons. A discussion of the cropping pattern for the all-crop base model was presented in the previous section where dryland and irrigated operations were compared (Table 5).

No Pinto Beans

Pinto beans were excluded from the model farm because of limited local market outlets. The market is highly volatile as price responds to a relatively small change in supply, as is the case with many specialty crops. Pinto beans, like other specialty crops, require additional capital investment for specialized planting and harvesting equipment.

The elimination of pinto beans as an irrigated crop alternative reduced net income on the model farm 17 per cent compared to the all-crop base model (Table 7). Soybeans replaced pinto beans. Potential disease problems limited the production of sunflowers to once every fourth year or 67 acres. A closely competing irrigated crop was corn grain.

Table 7. Highest Profit Combination of Crop Enterprises With and Without Pinto Beans and/or Sunflowers, Low Available Water Capacity Soils, Normal Management, Oakes-LaMoure Irrigation Area

	All Crop Base Model*	No Pinto Beans	No Pinto Beans or Sunflowers
NET INCOME	$15,500	$12,800	$12,200
IRRIGATED CROPS (ACRES)			
Alfalfa hay	68	68	135
Pinto beans	90		
Soybeans	45	135	135
Sunflowers (oil)	67	67	
Total	270	270	270
DRYLAND CROPS (ACRES)			
Alfalfa hay	152	152	152
Corn grain	245	245	338
Sunflowers (oil)	93	93	
Total	490	490	490
Total cropland acres	760	760	760
Native pasture	230	230	230

*All crop enterprises except potatoes, sugarbeets, and muskmelons were included.

No Sunflowers or Pinto Beans

Net income decreased 21 per cent when no specialty crops were produced on the model farm compared to the all-crop base model (Table 7). Irrigated hay replaced sunflowers and dryland corn grain replaced dryland sunflowers. Crops that could be produced without changing the net income substantially were irrigated corn and dryland wheat.

Optimum Management

Removing pinto beans as a cropping alternative reduced net income 13 per cent compared to the all-crop base model, while removing both pinto beans and sunflowers reduced net income 15 per cent (Table 8).

Table 8. Highest Profit Combination of Crop Enterprises With and Without Pinto Beans and/or Sunflowers, Low Available Water Capacity Soils, Optimum Management, Oakes-LaMoure Irrigation Area

	All Crop Base Model*	No Pinto Beans	No Pinto Beans or Sunflowers
NET INCOME	$37,300	$32,600	$31,700
IRRIGATED CROPS (ACRES)			
Corn grain	68	68	135
Pinto beans	90		
Soybeans	45	135	135
Sunflowers (oil)	67	67	
Total	270	270	270
DRYLAND CROPS (ACRES)			
Alfalfa hay	152	152	152
Corn grain	245	245	338
Sunflowers (oil)	93	93	
Total	490	490	490
Total cropland acres	760	760	760
Native pasture	230	230	230

*All crop enterprises except potatoes, sugarbeets, and muskmelons were included.

Irrigated corn grain acreage increased with the exclusion of the specialty crops. Removing dryland sunflowers as a cropping alternative increased the dryland corn grain acreage. Wheat was a closely competing crop for dryland acres.

Crop and Livestock Farm Without Pinto Bean Alternatives

The farm plan entitled crop and livestock base model considers all crop and livestock enterprises except potatoes, sugarbeets, and muskmelons.

Normal Management

Net income decreased 8 per cent when no pinto beans were produced compared to the crop and livestock base model (Table 9). Elimination of irrigated pinto beans increased the irrigated hay acreage. The dryland crops varied slightly with an increase in corn silage acreage and a similar decrease in corn grain acreage requiring additional corn grain purchases. The additional corn silage acreage provided feed for a greater number of feeder cattle. A closely competing irrigated crop was soybeans which could be grown with only a slight decrease in net income.

Table 9. Highest Profit Combination of Crop and Livestock Enterprises With and Without Pinto Beans, Low Available Water Capacity Soils, Normal Management, Oakes-LaMoure Irrigation Area

	Crop and Livestock Base Model*	No Pinto Beans
NET INCOME	$41,600	$38,400
IRRIGATED CROPS (ACRES)		
Alfalfa Hay	45(96)**	135(32)
Corn grain	135(100)	135(100)
Pinto beans	90	
Total	270	270
DRYLAND CROPS (ACRES)		
Alfalfa hay	222(30)	222(30)
Corn grain	159(100)	153(100)
Corn silage	86(100)	92(100)
Winter rye	23	23
Total	490	490
Total cropland acres	760	760
Native pasture	230(17)	230(17)
LIVESTOCK (HEAD)		
Purchased feeder pigs	1,269	1,269
Beef cow	a	a
Feeder cattle	409	437
FEED PURCHASED (BUSHELS)		
Corn grain	20,471	22,010
Oats	54	54

*All crop and livestock enterprises except potatoes, sugarbeets, and muskmelons were included.
**( ) indicates per cent of crop utilized as livestock feed with remaining per cent marketed.
[a]A very small sized herd was included in the final solution.

Optimum Management

Removing pinto beans as a cropping alternative reduced net income 7 per cent compared to the crop and livestock base model (Table 10). Dryland corn silage increased providing the additional feed to increase the size of the feeder cattle enterprise. The two-cow dairy enterprise would be impractical in an actual farm operation and could be deleted with only a minor change in the net income.

Crop and Livestock Farm With Limited Livestock Alternatives

The previous two analyses examined the highest profit combination of cropping alternatives with and without livestock enterprises. Not all farmers will want to produce the kind of livestock specified in the most profitable farm plan, but may not want to eliminate livestock completely. This section deals with the highest profit farm plan when selected livestock enterprises were eliminated.

Normal Management

No Feeder Pigs

Net income decreased 18 per cent when purchased feeder pigs were excluded (Table 11). The enterprise involving a sow with two litters sold as 40-pound feeder pigs replaced the fattening of purchased feeder pigs to

market weight. No changes occurred in the acreage of irrigated crops produced. The dryland crop acreage changed slightly with an increase in corn grain and a decrease in corn silage. The amount of purchased corn grain decreased approximately 13,000 bushels with the removal of the feeder pig enterprise.

Table 10. Highest Profit Combination of Crop and Livestock Enterprises With and Without Pinto Beans, Low Available Water Capacity Soils, Optimum Management, Oakes-LaMoure Irrigation Area

	Crop and Livestock Base Model*	No Pinto Beans
NET INCOME	$65,800	$61,000
IRRIGATED CROPS (ACRES)		
Corn grain	135(100)**	135(100)
Pinto beans	90	
Soybeans	45	135
Total	270	270
DRYLAND CROPS (ACRES)		
Alfalfa hay	222(60)	222(61)
Corn grain	187(100)	184(100)
Corn silage	58(100)	61(100)
Winter rye	23	23
Total	490	490
Total cropland acres	760	760
Native pasture	230(30)	230(24)
LIVESTOCK (HEAD)		
Sow with two litters	39	39
Home-raised feeder pigs	658	658
Beef cow	15	15
Feeder cattle	315	356
Dairy	a	a
FEED PURCHASED (BUSHELS)		
Corn grain	1,960	4,458
Oats	70	70

*All crop and livestock enterprises except potatoes, sugarbeets, and muskmelons were included.
**( ) indicates per cent of crop utilized as livestock feed with remaining per cent marketed.
[a]A very small sized herd was included in the final solution.

No Swine

A 21 per cent reduction in net income occurred if the model farm did not include a swine enterprise of any type. The size of the feeder cattle enterprise increased to replace the swine enterprises. Production of irrigated crops did not change from the previous farm situation, but a shift from dryland corn grain to corn silage was necessary to meet increased forage needs. An increase occurred in the amount of hay used and purchased corn grain to be fed.

Beef Cow and Dairy Only

A beef cow and dairy enterprise reduced net income 46 per cent. The inclusion of a beef cow and dairy herd changed both the irrigated and dryland cropping patterns. Native pasture was fully utilized because of increased grazing requirements. A lower forage requirement and increased pasture requirement shifted dryland crop acres to pasture.

Table 11. Highest Profit Combination of Crop and Livestock Enterprises With Livestock Alternatives, Low Available Water Capacity Soils, Normal Management, Oakes-LaMoure Irrigation Area

	Crop and Livestock Base Model*	No Feeder Pigs	No Swine	Dairy and Beef Cow Only	Beef Cow Only	No Feed Purchased
NET INCOME	$41,600	$34,100	$33,000	$22,400	$13,700	$35,200
IRRIGATED CROPS (ACRES)						
Alfalfa hay	45(96)**	45(77)	45(100)	135(47)	45(100)	
Corn grain	135(100)	135(100)	135(100)			180(100)
Pinto beans	90	90	90	90	90	90
Soybeans				45	45	
Sunflowers (oil)					59	
Pasture					31(100)	
Total	270	270	270	270	270	270
DRYLAND CROPS (ACRES)						
Wheat				37		
Alfalfa hay	222(30)	222(30)	222(46)	222(30)	222(51)	222(76)
Corn grain	159(100)	169(100)	138(100)	123(100)		200(100)
Corn silage	86(100)	76(100)	107(100)	61(100)	128(100)	57(100)
Sunflowers (oil)						
Winter rye	23	23	23			
Oats grain						11(100)
Pasture				31(100)	140(100)	
Total	490	490	490	490	490	490
Total cropland acres	760	760	760	760	760	760
Native pasture	230(17)	230(17)	230(17)	230(100)	230(100)	230(100)
LIVESTOCK (HEAD)						
Sow with two litters		81				
Purchased feeder pigs	1,269					2,269
Beef cow	a	a	a	57	355	56
Feeder cattle	409	365	512			193
Dairy				74		a
FEED PURCHASED (BUSHELS)						
Corn grain	20,471	7,492	16,235			
Oats	54	54	54	255	1,596	

*All crop and livestock enterprises except potatoes, sugarbeets, and muskmelons were included.
**( ) indicates per cent of crop utilized as livestock feed with remaining per cent marketed.
[a]A very small sized herd was included in the final solution.

Beef Cow Only

The beef cow herd is the most common livestock enterprise in North Dakota. The farm plan with the beef cow enterprise produced approximately the same net income as the farm situation that involved no livestock (Table 7). Increased pasture requirements were responsible for the majority of the changes in the cropping patterns.

No Purchased Feed

It is unrealistic to believe all livestock farmers in the Oakes-LaMoure irrigation area will purchase feed so the model farms were analyzed when no feed was purchased. Net income decreased 15 per cent when no feed was purchased (Table 11). The dryland and irrigated cropping patterns changed to increase the acreage devoted to irrigated and dryland corn grain which was utilized as livestock feed. Alfalfa hay utilized by the livestock enterprises also increased. Dryland corn silage decreased with the production of oats grain for the beef cow herd. The size of the feeder cattle enterprise decreased because of feed supply limitations. The size of the feeder pig enterprise did not change. The increased beef cow herd and the inclusion of a dairy herd fully utilized the native pasture.

Optimum Management

Net income for the model farm with optimum management decreased 2 per cent when the home-raised feeder pigs were sold instead of finished to slaughter weight (Table 12). More efficient management saved more pigs per litter and, therefore, it was profitable to produce feeder pigs instead of purchasing them as under normal management. The farm organization changed slightly and the need for purchased corn grain was eliminated when home-raised pigs were sold as feeders.

Removing swine as a livestock alternative increased the size of the feeder cattle enterprise and decreased net income approximately 15 per cent compared to the crop and livestock base model. The only change in the cropping pattern was a shift from corn grain to corn silage to meet increased forage needs. When both the swine and the cattle feeding enterprises were removed as alternatives, additional cash crops were produced. The net income decreased 21 per cent from the crop and livestock base model. The beef cow herd and sheep flock fully utilized the native pasture and required the diversion of 70 acres of cropland to pasture. Other cropping changes were influenced by the need for additional pasture and other forages.

Since under the crop and livestock base model little livestock feed was purchased, net income decreased less than one-half of 1 per cent when no feed was purchased (Table 12). The irrigated cropping pattern did not change. The dryland cropping pattern changed only slightly. The size of the feeder cattle enterprise decreased slightly with a slight increase in the dairy herd.

Other Alternatives

This section analyzes the effect of modifying certain model farm assumptions on net income and enterprise organization. Only optimum management was considered for this section since it was assumed that initially only farmers with relatively high managerial ability would produce sugarbeets, muskmelons, or potatoes; rent additional irrigated land; or hire additional labor.

Other Specialty Crops

Specialty crops, such as muskmelons, potatoes, and sugarbeets, add considerably to net income. Each of these crops has unique marketing problems in addition to a higher capital investment per acre.

Sugarbeet Production

Initially, sugarbeets are not expected to be grown on any appreciable number of irrigated acres in the Oakes-LaMoure irrigation area due to lack of processing plants. The additional capital investment in specialty equipment would be approximately $29,000, or $320 per acre.

Net income increased approximately 12 per cent when sugarbeets were produced on the model farm (Table 13). Ninety acres of sugarbeets replaced an equivalent acreage of corn grain, requiring additional purchased corn grain to support the livestock enterprises. Rotational considerations limited the production of sugarbeets to 90 acres. The acreage of dryland corn grain increased, while corn silage acreage decreased because of a reduction in the size of the feeder cattle enterprise.

Approximately three and one-half hours per acre of additional seasonal labor were employed in the production of sugarbeets. Labor was the most restrictive resource even with the additional seasonal labor hired for sugarbeets.

Table 12. Highest Profit Combination of Crop and Livestock Enterprises With Livestock Alternatives, Low Available Water Capacity Soils, Optimum Management, Oakes-LaMoure Irrigation Area

	Crop and Livestock Base Model*	No Feeder Pigs	No Swine	Dairy and Beef Cow Only	Sheep and Beef Cow Only	No Feed Purchased
NET INCOME	$65,800	$64,500	$55,800	$51,800	$36,500	$65,600
IRRIGATED CROPS (ACRES)						
Corn grain	135(100)**	124(100)	135(100)	30(100)	60	135(100)
Alfalfa hay		11(100)		38(100)	8(100)	
Pinto beans	90	90	90	90	90	90
Soybeans	45	45	45	45	45	45
Sunflowers (oil)				67	67	
Total	270	270	270	270	270	270
DRYLAND CROPS (ACRES)						
Alfalfa hay	222(60)	222(44)	222(79)	222(31)	222(100)	222(56)
Corn grain	187(100)	187(100)	170(100)		165(76)	188(100)
Corn silage	58(100)	58(100)	75(100)	55(100)	33(100)	57(100)
Oats grain						2(100)
Wheat				128		
Winter rye	23	23	23	85		21
Pasture					70(100)	
Total	490	490	490	490	490	490
Total cropland acres	760	760	760	760	760	760
Native pasture	230(30)	230(22)	230(40)	230(100)	230(100)	230(33)
LIVESTOCK (HEAD)						
Sow with two litters	39	81				39
Home-raised feeder pigs	658					658
Beef cow	15	27	15	15	79	27
Feeder cattle	315	345	373			291
Dairy	a	a	a	83		a
Sheep					912	
FEED PURCHASED (BUSHELS)						
Corn grain	1,960			1,430		
Oats	70	70	70	70	356	

*All crop and livestock enterprises except potatoes, sugarbeets, and muskmelons were included.
**( ) indicates per cent of crop utilized as livestock feed with remaining per cent marketed.
[a]A very small sized herd was included in the final solution.

Table 13. Effect of Selected Specialty Crops on Highest Profit Combination of Crop and/or Livestock Enterprises, Low Available Water Capacity Soils, Optimum Management, Oakes-LaMoure Irrigation Area

	Crop and Livestock Farm			All-Crop Farm			
	Base Model*	Sugarbeets Added	Potatoes Added	Base Model**	Sugarbeets Added	Potatoes Added	Muskmelons Added
NET INCOME	$ 65,800	$ 73,600	$104,100	$ 37,300	$ 47,400	$ 78,100	$ 60,200
IRRIGATED CROPS (ACRES)							
Corn grain	135(100)***	45(100)	45(100)	68			58
Pinto beans	90	90	90	90	90	90	90
Soybeans	45	45	45	45	45	45	45
Sunflowers (oil)				67	45	45	67
Muskmelons							10
Late potatoes			90			90	
Sugarbeets		90			90		
Total	270	270	270	270	270	270	270
DRYLAND CROPS (ACRES)							
Alfalfa hay	222(60)	222(57)	222(54)	152	152	152	152
Corn grain	187(100)	192(100)	197(100)	245	245	245	245
Corn silage	58(100)	53(100)	48(100)				
Winter rye	23	23	23				
Sunflowers (oil)				93	93	93	93
Total	490	490	490	490	490	490	490
Total cropland acres	760	760	760	760	760	760	760
Native pasture	230(30)	230(35)	230(43)	230	230	230	230
LIVESTOCK (HEAD)							
Sow with two litters	39	39	39				
Home-raised feeder pigs	658	658	658				
Beef cow	15	15	15				
Feeder cattle	315	262	195				
Dairy	a	a	a				
FEED PURCHASED (BUSHELS)							
Corn grain	1,960	11,034	6,685				
Oats	70	70	70				

*All crop and livestock enterprises except potatoes, sugarbeets, and muskmelons were included.
**All crop enterprises except potatoes, sugarbeets, and muskmelons were included.
***( ) indicates per cent of crop utilized as livestock feed with remaining per cent marketed.
[a]A very small sized herd was included in the final solution.

The inclusion of sugarbeets as an irrigated crop enterprise on the all-crop model farm increased net income 27 per cent over the all-crop base model (Table 13). The irrigated crops produced were pinto beans, soybeans, sunflowers, and sugarbeets. The dryland crop acreage did not change from the all-crop base model.

Potato Production

It was assumed, for the purpose of this analysis, that farmers would not produce both sugarbeets and potatoes because of the large capital investment necessary for specialty equipment relative to the size of the model farm. Capital investment for potato equipment was $26,500, or approximately $295 per acre. No storage cost for the potatoes was included in the cost and returns calculations. Potato production increased the model farm's net income approximately 58 per cent compared to the crop and livestock base model (Table 13). Corn grain, pinto beans, late potatoes, and soybeans were produced on the irrigated land. Again, the rotational considerations for potatoes and pinto beans limited production of each of these crops to 90 acres.

The 490 dryland acres consisted of corn grain, corn silage, winter rye, and hay. The size of the feeder pig and beef cow enterprises did not change. The size of the feeder cattle enterprise decreased while the dairy herd increased. Additional seasonal labor (1.2 hours per acre) was hired to plant and harvest potatoes.

Adding potatoes while excluding livestock resulted in a 109 per cent increase in the farm's net income (Table 13). The irrigated crops grown on the model farm were late potatoes, pinto beans, sunflowers, and soybeans. No changes occurred in the acreage of dryland crops.

Muskmelon Production

Muskmelon production is a specialty enterprise that can provide a high return per acre if a market for the product is available. A few acres of muskmelons meet the needs of a relatively large area. It was estimated that one acre of muskmelons would fill the requirements of approximately 2,000 people. Muskmelons also require a substantial amount of labor. One to three acres of muskmelons would be a hand labor enterprise, while a larger operation would require more mechanization, such as a transplanting machine and a plastic mulch laying machine. A limit of ten acres of muskmelons was assumed for this study, which includes only limited mechanization.

Producing muskmelons on ten of the 270 irrigated acres increased the net income approximately 61 per cent compared to the all-crop base model (Table 13). The irrigated cropping pattern changed, with muskmelons replacing the least profitable irrigated crop (corn grain) in this farm plan.

Renting Additional Irrigated Land

One of the basic assumptions of the linear programming model and the model farm was that the farmer was married; therefore, under the Bureau of Reclamation rules, the farmer and his spouse could each own 160 acres of irrigated land or a total of 320 acres. Two center pivots were used to irrigate 270 of the 320 acres of available irrigated land. Not all farmers in the Oakes-LaMoure irrigation area indicated a desire to irrigate their land; therefore, there should be additional irrigated land that could be rented. The profitability of irrigation may encourage some farmers to invest all their resources in irrigation. The following analysis examines the profitability of renting additional irrigated land at a cost of $65 per acre.

Crop and Livestock Farm

All of the irrigated crops produced on the model farm with optimum management increased in acreage (Table 14). Irrigated acreage increased from 270 to 820, increasing net income 41 per cent over the crop and livestock base model. The feeder cattle enterprise decreased while the dairy enterprise was eliminated, providing some of the labor needed for the extra irrigated acres. The dryland cropping pattern also changed drastically because of labor shortage.

All-Crop Farm

Not all farmers in the Oakes-LaMoure irrigation area will produce livestock so the model farm was analyzed for only crop enterprises when additional irrigated land was rented. The labor supply was reduced by eliminating the full-time hired man.

Net income increased approximately 2 per cent over the crop and livestock base model (Table 14). Grain sorghum was produced as a cash crop due to a labor shortage in the spring. An additional 771 irrigated acres were rented. Dryland corn did not appear in the program solution since it was not needed as a livestock feed and was not as profitable as other crops produced. This indicates that renting additional land is another alternative to more fully utilize available labor.

Table 14. Effect of Renting Additional Irrigated Land on Highest Profit Combination of Crop and/or Livestock Enterprises, Low Available Water Capacity Soils, Optimum Management, Oakes-LaMoure Irrigation Area

	Crop and Livestock Base Farm*	Expanded Crop and Livestock Farm	Expanded All-Crop Farm
NET INCOME	$65,800	$92,800	$66,900
IRRIGATED CROPS (ACRES)			
Corn grain	135(100)**	243(77)	10
Pinto beans	90	273	274
Soybeans	45	137	246
Alfalfa hay		160(16)	169
Grain sorghum		7	342
Total	270	820	1,041
DRYLAND CROPS (ACRES)			
Alfalfa hay	222(60)	222(31)	222
Corn grain	187(100)	36	
Corn silage	58(100)	37(100)	
Winter rye	23	163	155
Flax		32	113
Millet			
Total	490	490	490
Total cropland acres	760	1,310	1,531
Native pasture	230(30)	230(22)	230
LIVESTOCK (HEAD)			
Sow with two litters	39	39	
Home-raised feeder pigs	658	658	
Beef cow	15	15	
Feeder cattle	315	224	
Dairy	a		
FEED PURCHASED (BUSHELS)			
Corn grain	1,960		
Oats	70	70	

*All crop and livestock enterprises except potatoes, sugarbeets, and muskmelons were included.
**( ) indicates per cent of crop utilized as livestock feed with remaining per cent marketed.
[a]A very small sized herd was included in the final solution.

Changes in Labor Supply

Labor was one of the major restraints in all of the farm situations that included livestock enterprises. Irrigated land requires additional labor for the irrigation operation and additional field work. Irrigation provides a more stable feed supply for the livestock enterprises and can provide additional feed sources to increase the size of the livestock enterprises. Since not all farmers will want to hire additional labor or can find a full-time hired man, the following analysis will examine the effect of labor supply on the model farm's net income and cropping patterns.

Crop and Livestock Farm

The effect of eliminating the full-time hired man on the model farm with optimum management decreased net income 15 per cent (Table 15). Labor restrictions also eliminated the dairy enterprise and reduced the size of the feeder cattle enterprise. Changes in the cropping patterns for irrigated and dryland crops were required to support the livestock enterprises.

Table 15. Effect of Hired Labor on Highest Profit Combination of Crop and/or Livestock Enterprises, Low Available Water Capacity Soils, Optimum Management, Oakes-LaMoure Irrigation Area

	Crop and Livestock Farm		All-Crop Farm	
	One Hired Man	No Hired Man	One Hired Man*	No Hired Man
NET INCOME	$65,800	$56,000	$66,900	$37,300
IRRIGATED CROPS (ACRES)				
Corn grain	135(100)**	103(99)	10	68
Alfalfa hay		32	169	
Pinto beans	90	90	274	90
Soybeans	45	45	246	45
Sunflowers (oil)				67
Grain sorghum			342	
Total	270	270	1,041	270
DRYLAND CROPS (ACRES)				
Alfalfa hay	222(60)	222(18)	222	152
Corn grain	187(100)	89		245
Corn silage	58(100)	16(100)		
Winter rye	23	163	155	
Sunflowers (oil)				93
Flax			113	
Total	490	490	490	490
Total cropland acres	760	760	1,531	760
Native pasture	230(30)	230(22)	230	230
LIVESTOCK (HEAD)				
Sow with two litters	39	39		
Home-raised feeder pigs	658	658		
Beef cow	15	15		
Feeder cattle	315	95		
Dairy	a			
FEED PURCHASED (BUSHELS)				
Corn grain	1,960			
Oats	70	70		

*Additional irrigated land was rented.

**( ) indicates per cent of crop utilized as livestock feed with remaining per cent marketed.

[a]A very small sized herd was included in the final solution.

All-Crop Farm

Labor was not restrictive on the all-crop farm unless irrigated land was rented since the farmer and his two school age children could provide the necessary labor. A full-time hired man was employed at a salary of $700 per month when additional irrigated acreage was rented. This provided additional off-season labor that could not be fully utilized. The analysis was limited to one full-time hired man since the machinery on the model farm was not sufficient to utilize additional labor.

The combined influence of hiring a full-time hired man and renting additional land can be observed by comparing the two farm situations for the all-crop farm (Table 15). Net income increased 79 per cent when 771 additional irrigated acres were rented and a full-time hired man was employed. The irrigated cropping pattern changed with alfalfa hay and grain sorghum replacing sunflowers. Sunflowers were replaced by winter rye and flax on the dryland acreage. The increased row crop acreage caused a shortage of summer labor, making it economical to produce winter rye because of the different labor periods utilized.

1976 Prices

A comparison of the crop and livestock patterns using long-run price relationships and the January to June, 1976, average prices was made (Table 16). The analysis of 1976 prices should be viewed as a current (1976) estimate because of the fluctuation and cyclical price pattern in the different crop and livestock prices during any given year.

Table 16. Comparison of Long-Run and Current (1976) Prices

Crop or Livestock Enterprise	Units	Long-Run Prices	Current (1976) Prices
Corn grain	Bushels	$ 1.75	$ 2.51
Soybeans	Bushels	4.55	4.62
Wheat	Bushels	2.70	3.87
Flax	Bushels	4.70	5.90
Barley	Bushels	1.50	2.35
Millet	Hundredweight	4.15	5.50
Winter rye	Bushels	1.55	2.33
Oats	Bushels	.95	1.31
Grain sorghum	Hundredweight	2.85	3.95
Alfalfa hay	Tons	30.00	37.00
Alfalfa-brome hay	Tons	27.00	35.00
Sunflowers (oil)	Hundredweight	7.90	10.40
Pinto beans	Hundredweight	12.50	11.40
Potatoes (early)	Hundredweight	3.40	5.14
Potatoes (late)	Hundredweight	2.90	4.64
Sugarbeets	Tons	22.50	20.00
Muskmelons	Pound	.10	.15
Feeder pigs	Hundredweight	70.00	110.50
Slaughter pigs	Hundredweight	35.00	48.60
Steer calf	Hundredweight	55.00	41.45
Heifer calf	Hundredweight	49.00	33.75
Backgrounded steer	Hundredweight	48.00	41.05
Backgrounded heifer	Hundredweight	43.50	34.60
Yearling steer	Hundredweight	46.00	39.45
Yearling heifer	Hundredweight	44.50	36.60
Feeder steer	Hundredweight	46.50	38.10
Sheep	Hundredweight	40.30	52.30
Milk	Hundredweight	7.35	8.60

Normal Management

A comparison of the cropping patterns under current (1976) and long-run price relationships for normal management on low available water capacity soils is presented in Table 17.

Crop and Livestock Farm

The decrease in the livestock prices from the long-run to current (1976) prices decreased the net income for the crop and livestock farm by 44 per cent. Irrigated corn grain was produced under either set of price relationships and was the most stable of all irrigated crops. Irrigated pinto beans were not produced under the current (1976) prices while the acreage of irrigated oil sunflowers increased. Most of the changes in the irrigated cropping patterns were due to specialty crops which tend to have more year-to-year price fluctuation than other crops.

Table 17. Comparison of Cropping Patterns With Current (1976) and Long-Term Price Relationships, Low Available Water Capacity Soils, Normal Management, Oakes-LaMoure Irrigation Area

	Crop and Livestock Farm		All-Crop Farm	
	Long-Run Prices	Current (1976) Prices	Long-Run Prices	Current (1976) Prices
NET INCOME	$41,600	$23,200	$15,500	$18,200
IRRIGATED CROPS (ACRES)				
Alfalfa hay	45(96)*	68(70)	68	
Corn grain	135(100)	135(79)		270
Pinto beans	90		90	
Soybeans			45	
Sunflowers (oil)		67	67	
Total	270	270	270	270
DRYLAND CROPS (ACRES)				
Alfalfa hay	222(30)	222(10)	152	152
Corn grain	159(100)		245	245
Corn silage	86(100)	47(100)		
Winter rye	23			
Sunflowers (oil)			93	93
Wheat		221		
Total	490	490	490	490
Total cropland acres	760	760	760	760
Native pasture	230(17)	230(70)	230	230
LIVESTOCK (HEAD)				
Sow with two litters		45		
Home-raised feeder pigs		575		
Purchased feeder pigs	1,269			
Beef cows	a	a		
Feeder cattle	409			
Dairy		57		
FEED PURCHASED (BUSHELS)				
Corn grain	20,471			
Oats	54	54		

*( ) indicates per cent of crop utilized as livestock feed with remaining per cent marketed.
[a]A very small sized herd was included in the final solution.

Hay was the most stable dryland crop produced under either set of price relationships. Corn silage was produced under both current (1976) and long-run prices, but acreage was influenced by type and size of the livestock enterprises. Dryland wheat was produced under current (1976) prices instead of winter rye and corn. The type and size of the livestock enterprises and the shortage of labor when livestock were produced probably influenced the dryland cropping patterns more than the difference in the price relationships.

Livestock enterprises were influenced by changes in the current (1976) and long-run price relationships. The swine enterprises (sow with two litters annually and finishing feeder pigs) were moderately affected by the price changes. The feeder pigs were home-raised rather than purchased under current (1976) prices under normal management. The feeder cattle enterprise was replaced by a dairy enterprise under 1976 prices because of the change in profitability of feeder cattle in relation to dairy.

All-Crop Farm

Net income under current (1976) prices for the all-crop farm increased 17 per cent compared to the long-run price relationships (Table 17). Irrigated corn grain was the most profitable crop under current (1976) prices and was the only irrigated crop produced under current (1976) prices. The dryland cropping pattern did not change.

Optimum Management

Net income increased 1 per cent under current (1976) prices (Table 18). Corn grain and sunflowers accounted for the majority of the irrigated acreage. The dryland cropping pattern changed drastically, with wheat replacing corn grain and winter rye. The native pasture was fully utilized by the dairy herd and sheep flock. Feeder pigs were sold at a market weight of 40 pounds instead of being finished to slaughter weight under current (1976) prices. The beef cow herd and feeder cattle enterprises were replaced by a dairy herd and a sheep flock. The only major change on the all-crop farm under current (1976) prices was the production of corn grain replacing pinto beans, soybeans, and sunflowers.

Table 18. Comparison of Cropping Patterns With Short- and Long-Run Price Relationships, Low Available Water Capacity Soils, Optimum Management, Oakes-LaMoure Irrigation Area

	Crop and Livestock Farm		All-Crop Farm	
	Long-Run Prices	Current (1976) Prices	Long-Run Prices	Current (1976) Prices
NET INCOME	$65,800	$66,400	$37,300	$44,600
IRRIGATED CROPS (ACRES)				
Corn grain	135(100)*	196(27)	68	270
Pinto beans	90		90	
Soybeans	45		45	
Sunflowers (oil)		67	67	
Alfalfa hay		7(100)		
Total	270	270	270	270
DRYLAND CROPS (ACRES)				
Alfalfa hay	222(60)	152(89)	152	152
Corn grain	187(100)		245	245
Corn silage	58(100)	25(100)		
Winter rye	23			
Sunflowers (oil)		68	93	93
Wheat		245		
Total	490	490	490	490
Total cropland acres	760	760	760	760
Native pasture	230(30)	230(100)	230	230
LIVESTOCK (HEAD)				
Sow with two litters	39	81		
Home-raised feeder pigs	658			
Beef cow	15			
Feeder cattle	315			
Dairy	a	37		
Sheep		328		
FEED PURCHASED (BUSHELS)				
Corn grain	1,960			
Oats	70			

*( ) indicates per cent of crop utilized as livestock feed with remaining per cent marketed.
[a]A very small sized herd was included in the final solution.

Farm Production Alternatives on High Available Water Capacity Soils

This section analyzes the effect that adding or eliminating certain crop and/or livestock enterprises have on the cropping pattern and net income on soils with high available water capacity. Readers are referred to the previous section for a more detailed explanation of why certain crop and/or livestock enterprises were added or eliminated from the analysis.

All-Crop Farm Without Pinto Bean Alternative

The all-crop base model includes all crop enterprises except potatoes, sugarbeets, and muskmelons. A discussion of the cropping patterns for the all-crop base model was presented in an earlier section where dryland and irrigation operations were compared (see page 18).

Normal Management

Removing pinto beans as a cropping alternative reduced net income 12 per cent compared to the all-crop base model. Soybeans replaced pinto beans in the irrigated crop rotations (Table 19). The dryland cropping pattern did not change. Both irrigated and dryland sunflowers were closely competing crops, although they were not grown in the profit maximizing farm plan.

Optimum Management

Removing pinto beans as a cropping alternative decreased net income 10 per cent compared to the all-crop base model (Table 20). Closely competing crops that could be grown with only a slight decrease in net income were irrigated and dryland sunflowers and dryland wheat.

Table 19. Highest Profit Combination of Crop Enterprises With and Without Pinto Beans, High Available Water Capacity Soils, Normal Management, Oakes-LaMoure Irrigation Area

	All-Crop Base Model*	No Pinto Beans
NET INCOME	$37,200	$32,900
IRRIGATED CROPS (ACRES)		
Corn grain	135	135
Pinto beans	90	
Soybeans	45	135
Total	270	270
DRYLAND CROPS (ACRES)		
Alfalfa hay	82	82
Corn grain	245	245
Wheat	163	163
Total	490	490
Total cropland acres	760	760
Native pasture	230	230

*All crop enterprises except potatoes, sugarbeets, and muskmelons were included.

Table 20. Highest Profit Combination of Crop Enterprises With and Without Pinto Beans, High Available Water Capacity Soils, Optimum Management, Oakes-LaMoure Irrigation Area

	All-Crop Base Model*	No Pinto Beans
NET INCOME	$58,300	$52,300
IRRIGATED CROPS (ACRES)		
Corn grain	135	135
Pinto beans	90	
Soybeans	45	135
Total	270	270
DRYLAND CROPS (ACRES)		
Alfalfa hay	82	82
Corn grain	245	245
Flax	163	163
Total	490	490
Total cropland acres	760	760
Native pasture	230	230

*All crop enterprises except potatoes, sugarbeets, and muskmelons were included.

Crop and Livestock Farm Without Pinto Bean Alternative

The farm plan entitled crop and livestock base model considers all crop enterprises except potatoes, sugarbeets, and muskmelons with all livestock enterprises remaining as alternatives in this section. Not all farmers will want to produce the crop and livestock enterprises appearing in the crop and livestock base model. This section can provide guidance to these farmers.

Normal Management

Eliminating pinto beans as an irrigated enterprise reduced net income by approximately 7 per cent (Table 21). Soybean acreage increased, replacing pinto beans. The acreage of dryland crops did not change, but the size of the livestock enterprise (feeder cattle) increased slightly.

Optimum Management

Removing pinto beans as a cropping alternative reduced net income approximately 7 per cent (Table 22). Irrigated soybean acreage increased replacing pinto beans. The dryland cropping pattern changed slightly to accommodate a small increase in the size of the feeder cattle enterprise. Feeder pigs, sold at 40 pounds instead of being fattened to slaughter weight, and a dairy herd were closely competitive livestock enterprises.

Crop and Livestock Farm With Limited Livestock Alternatives

The previous analyses examined the highest profit combination with and without livestock. This section deals with the highest profit farm plan when selected livestock enterprises were eliminated, since not all farmers will want to produce the livestock specified in the most profitable farm plan.

Table 21. Highest Profit Combination of Crop and Livestock Enterprises With and Without Pinto Beans, High Available Water Capacity Soils, Normal Management, Oakes-LaMoure Irrigation Area

	Crop and Livestock Base Model*	No Pinto Beans
NET INCOME	$63,000	$58,800
IRRIGATED CROPS (ACRES)		
Alfalfa hay	37(100)**	37(100)
Corn grain	135(100)	135(100)
Pinto beans	90	
Soybeans	8	98
Total	270	270
DRYLAND CROPS (ACRES)		
Alfalfa hay	222(28)	222(28)
Corn grain	185(100)	185(100)
Corn silage	60(100)	60(100)
Winter rye	23	23
Total	490	490
Total cropland acres	760	760
Native pasture	230(17)	230(17)
LIVESTOCK (HEAD)		
Purchased feeder pigs	1,269	1,269
Beef cow	17	17
Feeder cattle	399	402
FEED PURCHASED (BUSHELS)		
Corn grain	13,312	13,506
Oats	76	76

*All crop and livestock enterprises except potatoes, sugarbeets, and muskmelons were included.
**( ) indicates per cent of crop utilized as livestock feed with remaining per cent marketed.

Normal Management

Net income for the model farm with normal management was reduced 12, 14, and 34 per cent, respectively, compared to the crop and livestock base model by eliminating enterprises in the following sequence: 1) feeder pigs, 2) swine, and 3) swine and feeder cattle (Table 23). Changes occurred in the irrigated and dryland cropping patterns to compensate for the necessary increase and/or decrease in livestock feed supplemented by purchased livestock feed. The livestock enterprise fully utilized the native pasture available and required additional pasture at the expense of the dryland crop acreage. Income loss from the changes in cropping patterns and the shift of cropland to pasture was not offset by income from the livestock enterprises.

Table 22. Highest Profit Combination of Crop and Livestock Enterprises With and Without Pinto Beans, High Available Water Capacity Soils, Optimum Management, Oakes-LaMoure Irrigation Area

	Crop and Livestock Base Model*	No Pinto Beans
NET INCOME	$86,300	$80,600
IRRIGATED CROPS (ACRES)		
Corn grain	135(100)**	135(100)
Pinto beans	90	
Soybeans	45	135
Total	270	270
DRYLAND CROPS (ACRES)		
Alfalfa hay	152(82)	152(81)
Corn grain	201(96)	200(97)
Corn silage	44(100)	45(100)
Flax	93	93
Total	490	490
Total cropland acres	760	760
Native pasture	230	230
LIVESTOCK (HEAD)		
Sow with two litters	39	39
Home-raised feeder pigs	658	658
Feeder cattle	367	370

*All crop and livestock enterprises except potatoes, sugarbeets, and muskmelons were included.
**( ) indicates per cent of crop utilized as livestock feed with remaining per cent marketed.

Compared to the crop and livestock base model, the net income decreased 3 per cent when no livestock feed was purchased (Table 23). Irrigated and dryland corn grain acreage increased substantially to provide additional livestock feed that was previously purchased. The size of the feeder cattle enterprise decreased. The beef cow herd increased with dryland oats grain being produced to provide needed feed supplies. A small dairy enterprise also was included, but would logically be eliminated because of its uneconomic size.

Optimum Management

Net income decreased 2, 11, and 16 per cent, respectively, by eliminating enterprises in the following sequence: 1) feeder pigs, 2) swine, and 3) swine and feeder cattle compared to the crop and livestock base model (Table 24). Both irrigated and dryland cropping patterns were influenced by the need for livestock feed. More acres of forages and pasture were required when the swine enterprises were excluded as a livestock alternative because the beef cow and sheep enterprises required additional pasture.

Other Alternatives

This section analyzes the effects on net income and enterprise organization of modifying certain model farm assumptions. Only optimum management was considered for these options. The results will provide guidance to the farmer who wishes to consider producing muskmelons, potatoes, or sugarbeets; rent additional irrigated land; or hire additional labor.

Table 23. Highest Profit Combination of Crop and Livestock Enterprises With Livestock Alternatives, High Available Water Capacity Soils, Normal Management, Oakes-LaMoure Irrigation Area

	Crop and Livestock Base Model*	No Feeder Pigs	No Swine	Dairy and Beef Cow Only	Beef Cow Only	No Feed Purchased
NET INCOME	$63,000	$55,700	$54,300	$41,800	$33,400	$61,000
IRRIGATED CROPS (ACRES)						
Alfalfa hay	37(100)**	29(100)	45(100)	118(40)		
Corn grain	135(100)	135(100)	135(100)	17(100)	126	180(100)
Pinto beans	90	90	90	90	90	90
Soybeans	8	16		45	45	
Pasture					9(100)	
Total	270	270	270	270	270	270
DRYLAND CROPS (ACRES)						
Alfalfa hay	222(28)	222(28)	222(34)	222(28)	175(100)	222(74)
Corn grain	185(100)	192(100)	169(100)	62(100)	93	216(100)
Corn silage	60(100)	53(100)	76(100)	49(100)	152(100)	48(100)
Wheat				157		
Winter rye	23	23	23			
Oats						4(100)
Pasture					70(100)	
Total	490	490	490	490	490	490
Total cropland acres	760	760	760	760	760	760
Native pasture	230(17)	230(17)	230(17)	230(71)	230(100)	230(50)
LIVESTOCK (HEAD)						
Sow with two litters		81				
Purchased feeder pigs	1,269					1,269
Beef cow	17	17	17	17	346	46
Feeder cattle	399	352	505			298
Dairy				82		a
FEED PURCHASED (BUSHELS)						
Corn grain	13,312	184	9,227			
Oats	76	76	76	76	1,556	

*All crop and livestock enterprises except potatoes, sugarbeets, and muskmelons were included.
**( ) indicates per cent of crop utilized as livestock feed with remaining per cent marketed.
[a]A very small sized herd was included in the final solution.

Table 24. Highest Profit Combination of Crop and Livestock Enterprises With Livestock Alternatives, High Available Water Capacity, Optimum Management, Oakes-LaMoure Irrigation Area

	Crop and Livestock Base Model*	No Feeder Pigs	No Swine	No Swine or Cattle Feeding	Sheep and Beef Cow Only	No Feed Purchased
NET INCOME	$86,300	$84,800	$76,400	$72,400	$56,500	$86,300
IRRIGATED CROPS (ACRES)						
Alfalfa hay				32(100)**		
Corn grain	135(100)	135(63)	135(100)	89(41)	135(20)	135(100)
Pinto beans	90	90	90	90	90	90
Soybeans	45	45	45	45	45	45
Sunflowers (oil)				14		
Total	270	270	270	270	270	270
DRYLAND CROPS (ACRES)						
Alfalfa hay	152(82)	152(75)	159(100)	152(45)	164(100)	152(82)
Corn grain	201(96)	203(100)	187(100)		182	201(96)
Corn silage	44(100)	42(100)	58(100)	38(100)	63(100)	44(100)
Flax	93	93	86	163	11	93
Wheat						
Pasture					70(100)	
Total	490	490	490	490	490	490
Total cropland acres	760	760	760	760	760	760
Native pasture	230	230	230(5)	230(53)	230(100)	230
LIVESTOCK (HEAD)						
Sow with two litters	39	81				39
Home-raised feeder pigs	658					658
Beef cow			a		171	
Feeder cattle	367	344	468			367
Dairy			a	81		
Sheep					579	
FEED PURCHASED (BUSHELS)						
Oats			10		770	

*All crop and livestock enterprises except potatoes, sugarbeets, and muskmelons were included.
**( ) indicates per cent of crop utilized as livestock feed with remaining per cent marketed.
[a]A very small sized herd was included in the final solution.

Specialty Crops

Specialty crops, such as muskmelons, potatoes, and sugarbeets, add considerably to net income. Each of the crops has unique marketing problems in addition to a higher capital investment per acre.

Sugarbeet production increased the model farm's net income 12 per cent and producing potatoes increased net income 50 per cent compared to the crop and livestock base model (Table 25). The same dryland crops were produced but some changes in the number of acres of the respective crops occurred. When potatoes or sugarbeets were produced, a few acres of native pasture were utilized for a small dairy herd which would be impractical in an actual farm operation and could be eliminated with only a slight change in net income.

Production of sugarbeets or potatoes on the all-crop model farm increased net income 20 and 78 per cent, respectively, compared to the all-crop base model (Table 25). The dryland cropping pattern did not change from the all-crop base model, so the increase in net income can be attributed to the inclusion of irrigated specialty crops.

Net income increased 23 per cent when muskmelons were produced on 10 acres of irrigated land (Table 25). The irrigated cropping pattern changes, with muskmelons replacing the least profitable irrigated crop (corn grain) in the farm plan.

Renting Additional Land

The following analysis examines the profitability of renting additional irrigated land at a cost of $65 per acre. Net income for the crop and livestock model farm increased 49 per cent when 803 additional irrigated acres were rented (Table 26). Labor shortages caused a drastic change in the pattern of dryland crops produced. No dryland corn grain or corn silage was produced. The dryland acreage of flax increased 70 acres and 139 acres of winter rye were produced. The size of the feeder cattle enterprise decreased, providing labor for additional irrigated land.

Net income for the all-crop farm increased 20 per cent when rental of irrigated land was considered in the analysis. An additional 835 irrigated acres were rented at $65 per acre, changing the irrigated and dryland cropping patterns. Irrigated hay and grain sorghum were produced on the rented irrigated acres. Winter rye and millet were produced on dryland acreages because of the shortage of labor.

Table 25. Effect of Selected Specialty Crops on Highest Profit Combination of Crop and/or Livestock Enterprises, High Available Water Capacity Soils, Optimum Management, Oakes-LaMoure Irrigation Area

	Crop and Livestock Farm			All-Crop Farm			
	Base Model*	Sugarbeets Added	Potatoes Added	Base Model**	Sugarbeets Added	Potatoes Added	Muskmelons Added
NET INCOME	$ 86,300	$ 96,400	$129,600	$ 58,300	$ 70,200	$103,700	$ 71,500
IRRIGATED CROPS (ACRES)							
Corn grain	135(100)***	90(100)	90(100)	135	45	45	125
Pinto beans	90	90	90	90	90	90	90
Soybeans	45			45	45	45	45
Muskmelons							10
Late potatoes			90			90	
Sugarbeets		90			90		
Total	270	270	270	270	270	270	270
DRYLAND CROPS (ACRES)							
Alfalfa hay	152(82)	152(75)	152(72)	82	82	82	82
Corn grain	201(96)	204(100)	206(100)	245	245	245	245
Corn silage	44(100)	41(100)	39(100)				
Flax	93	93	93	163	163	163	163
Total	490	490	490	490	490	490	490
Total cropland acres	760	760	760	760	760	760	760
Native pasture	230	230(3)	230(7)	230	230	230	230
LIVESTOCK (HEAD)							
Sow with two litters	39	39	39				
Home-raised feeder pigs	658	658	658				
Feeder cattle	367	323	280				
Dairy		a	a				
FEED PURCHASED (BUSHELS)							
Corn grain		2,899					

*All crop and livestock enterprises except potatoes, sugarbeets, and muskmelons were included.
**All crop enterprises except potatoes, sugarbeets, and muskmelons were included.
***( ) indicates per cent of crop utilized as livestock feed with remaining per cent marketed.
[a]A very small sized herd was included in the final solution.

Table 26. Effect of Renting Additional Irrigated Land on Highest Profit Combination of Crop and/or Livestock Enterprises, High Available Water Capacity Soils, Optimum Management, Oakes-LaMoure Irrigation Area

	Crop and Livestock Base Model*	Expanded Crop and Livestock Farm	Expanded All-Crop Farm
NET INCOME	$ 86,300	$129,000	$103,300
IRRIGATED CROPS (ACRES)			
Corn grain	135(100)**	341(38)	331
Pinto beans	90	273	274
Soybeans	45	9	
Alfalfa hay		152	159
Grain sorghum		288	341
Corn silage		10(100)	
Total	270	1,073	1,105
DRYLAND CROPS (ACRES)			
Alfalfa hay	152(82)	188(31)	152
Corn grain	201(96)		
Corn silage	44(100)		
Flax	93	163	163
Winter rye		139	129
Millet			46
Total	490	490	490
Total cropland acres	760	1,563	1,595
Native pasture	230	230(11)	230
LIVESTOCK (HEAD)			
Sow with two litters	39	39	
Home-raised feeder pigs	658	658	
Feeder cattle	367	169	
Beef cow		a	
FEED PURCHASED (BUSHELS)			
Oats		51	

*All crop and livestock enterprises except potatoes, sugarbeets, and muskmelons were included.
**( ) indicates per cent of crop utilized as livestock feed with remaining per cent marketed.
[a]A very small sized herd was included in the final solution.

Changes in Labor Supply

Net income decreased 14 per cent when no hired labor was available (Table 27). The irrigated cropping pattern did not change, but the feeder cattle enterprise decreased in size, reducing the dryland corn silage acreage necessary for livestock feed. Dryland corn grain acreage also decreased while winter rye was produced because of labor restrictions.

The combined influence of hiring a full-time hired man and renting additional irrigated land can be observed by comparing the all-crop farm situations (Table 27). Net income increased approximately 77 per cent when 835 additional irrigated acres were rented and a full-time hired man was employed. The irrigated cropping pattern changed with soybeans replaced by alfalfa hay and grain sorghum. The dryland acreage changed with corn grain replaced by winter rye and millet. The increased row crop acreage influenced the production of alfalfa hay, millet, and winter rye.

Table 27. Effect of Hired Labor on Highest Profit Combination of Crop and/or Livestock Enterprises, High Available Water Capacity Soils, Optimum Management, Oakes-LaMoure Irrigation Area

	Crop and Livestock Farm		All-Crop Farm	
	One Hired Man	No Hired Man	One Hired Man*	No Hired Man
NET INCOME	$ 86,300	$ 74,200	$103,300	$ 58,300
IRRIGATED CROPS (ACRES)				
Alfalfa hay			159	
Corn grain	135(100)**	135(68)	331	135
Pinto beans	90	90	274	90
Soybeans	45	45		45
Grain sorghum			341	
Total	270	270	1,105	270
DRYLAND CROPS (ACRES)				
Alfalfa hay	152(82)	152(19)	152	82
Corn grain	201(96)	75		245
Corn silage	44(100)	11(100)		
Flax	93	123	163	163
Millet			46	
Winter rye		129	129	
Total	490	490	490	490
Total cropland acres	760	760	1,595	760
Native pasture	230	230	230	230
LIVESTOCK (HEAD)				
Sow with two litters	39	39		
Home-raised feeder pigs	658	658		
Feeder cattle	367	89		

*All crop and livestock enterprises except potatoes, sugarbeets, and muskmelons were included.
**( ) indicates per cent of crop utilized as livestock feed with remaining per cent marketed.

1976 Prices

Under the current (1976) prices, irrigated corn grain acreage increased (Table 28). Irrigated sunflowers were produced to the rotational limit of 67 acres. Wheat was produced on one-half of the dryland acreage. The swine enterprise changed from purchasing to raising their own feeder pigs that were fattened to market weight. The beef cow and feeder cattle enterprise were replaced by a dairy enterprise because of increased profitability of milk under the current (1976) price relationship.

Table 28. Comparison of Cropping Patterns With Short- and Long-Run Price Relationships, High Available Water Capacity Soils, Normal Management, Oakes-LaMoure Irrigation Area

	Crop and Livestock Farm		All-Crop Farm	
	Long-Run Prices	Current (1976) Prices	Long-Run Prices	Current (1976) Prices
NET INCOME	$63,000	$54,800	$37,200	$49,100
IRRIGATED CROPS (ACRES)				
Alfalfa hay	37(100)*	38(100)		
Corn grain	135(100)	165(50)	135	270
Pinto beans	90		90	
Soybeans	8		45	
Sunflowers (oil)		67		
Total	270	270	270	270
DRYLAND CROPS (ACRES)				
Alfalfa hay	222(28)	81	82	82
Corn grain	185(100)	137	245	245
Corn silage	60(100)	27(100)		
Winter rye	23			
Wheat		245	163	163
Total	490	490	490	490
Total cropland acres	760	760	760	760
Native pasture	230(17)	230(29)	230	230
LIVESTOCK (HEAD)				
Sow with two litters		45		
Home-raised feeder pigs		575		
Purchased feeder pigs	1,269			
Beef cows	17			
Feeder cattle	399			
Dairy		44		
FEED PURCHASED (BUSHELS)				
Corn grain	13,312			
Oats	76			

*( ) indicates per cent of crop utilized as livestock feed with remaining per cent marketed.

The major difference in the cropping pattern on the all-crop farm was the production of continuous corn grain on the irrigated land under the current (1976) price relationship.

The cropping pattern on irrigated land included corn grain and sunflowers under current (1976) prices and optimum management (Table 29). The dryland cropping pattern changed, with wheat and barley replacing corn grain and flax. The feeder cattle enterprise was replaced by a dairy herd and a sheep flock.

The irrigated and dryland cropping pattern both changed for the all-crop farm. Only irrigated corn grain was produced under the current (1976) prices, with dryland wheat replacing flax and half of the alfalfa hay acreage.

Table 29. Comparison of Cropping Patterns With Short- and Long-Run Price Relationships, High Available Water Capacity Soils, Optimum Management, Oakes-LaMoure Irrigation Area

	Crop and Livestock Farm		All-Crop Farm	
	Long-Run Prices	Current (1976) Prices	Long-Run Prices	Current (1976) Prices
NET INCOME	$86,300	$96,900	$58,300	$75,500
IRRIGATED CROPS (ACRES)				
Corn grain	135(100)*	203(24)	135	270
Pinto beans	90		90	
Soybeans	45		45	
Sunflowers (oil)		67		
Total	270	270	270	270
DRYLAND CROPS (ACRES)				
Alfalfa hay	152(82)	127(100)	82	41
Corn grain	201(96)		245	245
Corn silage	44(100)	19(100)		
Flax	93		163	
Wheat		245		204
Barley		99		
Total	490	490	490	490
Total cropland acres	760	760	760	760
Native pasture	230	230(65)	230	230
LIVESTOCK (HEAD)				
Sow with two litters	39	81		
Home-raised feeder pigs	658			
Feeder cattle	367			
Dairy		39		
Sheep		279		

*( ) indicates per cent of crop utilized as livestock feed with remaining per cent marketed.

Farm Enterprise Summary

The purpose of the study was to determine the highest profit combination of irrigated crops, dryland crops, and livestock enterprises from the Oakes-LaMoure section of the Garrison Diversion Irrigation Project. A 1,040-acre model farm was developed containing 760 acres of cropland, 230 acres of native pasture, and 50 acres of farmstead and wasteland. Two center pivot irrigation systems were used to irrigate 270 acres. Labor was provided by the farmer, two school age children, and a full-time hired man. Product prices were established to represent normal commodity price relationships that are considered to be relevant for the long-term planning involved in the Garrison Diversion Irrigation Project. A total of 19 irrigated and 26 dryland crop activities and 23 livestock activities were included as alternatives to determine the types of crop and livestock enterprises that provided the highest net income. The analysis included both normal and optimum management levels and soils with high and low available water capacity. Major emphasis was placed on farms dominated by soils with low available water capacity and operated at the normal management level since this situation is most common in the area.

Table 30 provides a summary of net incomes for the different crop and livestock alternatives. Differences in net income between management levels are due largely to increased productivity of crop and livestock enterprises because of additional management skills. Profit maximizing farm plans with inclusion and exclusion of specialty crops are provided for guidance to interested farmers. Potatoes, sugarbeets, muskmelons, pinto beans, and oil sunflowers are considered specialty crops in this bulletin. Some of the reasons for excluding specialty crops from the farm plan were: 1) the limited number of processing plants presently available for handling specialty crops, 2) the price effect of additional production on the market, and 3) the additional capital investment for specialized equipment. Specialty crops (potatoes, sugarbeets, and muskmelons) do add considerably to the income, but sugarbeets are a contract crop not available to early irrigators while pinto bean and potato markets also may be somewhat limited.

Profit maximizing farm plans without livestock enterprises were analyzed since not all farmers will want to produce livestock. Higher net incomes for model farms with livestock are due to full utilization of off-season labor. Profit maximizing farm plans for different livestock alternatives were analyzed to provide guidance to farmers. The influence of renting additional irrigated land at $65 per acre and/or changing the labor supply was analyzed to determine their effect on crop and livestock production patterns and resulting net income. The crop and livestock enterprises that entered the profit maximizing farm plans are discussed below.

Irrigated Crop Enterprises

Irrigated crop enterprises entering the profit maximization farm plan were influenced by commodity prices, costs of production, feed grain and forage requirements for the livestock enterprises, specialty crops produced, and availability of labor.

Corn Grain

Corn grain was the most consistent crop produced under irrigation. It was included in the cropping pattern when livestock were included and the specialty crops of potatoes and sugarbeets were excluded as alternatives. Although feed could be purchased for livestock, irrigated corn grain was used to meet a large portion of the feed requirements of the livestock enterprises. Corn grain also was included in the majority of the farm plans even when livestock alternatives were deleted.

Hay

Hay is a combination of alfalfa-brome or straight alfalfa produced under a number of different rotations with or without a nurse crop. Irrigated hay was a profit maximizing land use under both management levels for both soil textural groups. The type and size of the livestock enterprises influenced the amount of irrigated hay produced. Irrigated hay production for cash sale came into the farm plan under normal management on soils with low available water capacity when livestock enterprises were excluded.

Table 30. Net Income Summary For Crop and Livestock Alternatives, Base Model Farm, 270 Acres Irrigated, 490 Acres Dryland, Oakes-LaMoure Irrigation Area

	Available Soil Water Capacity			
	Low		High	
	Normal Management	Optimum Management	Normal Management	Optimum Management
ALL CROP FARM WITH SPECIALTY CROP ALTERNATIVES				
Dryland farm	$ 4,800	$ 12,600	$ 12,500	$ 24,700
All crop base model	15,500	37,300	37,200	58,300
No pinto beans	12,800	32,600	32,900	52,300
No sunflowers or pinto beans	12,200	31,700	32,900	52,300
Sugarbeets added		47,400		70,200
Potatoes added		78,100		103,700
Muskmelons added		60,200		71,500
CROP AND LIVESTOCK FARMS WITH SPECIALTY CROP ALTERNATIVES				
Dryland farm	25,600	36,800	43,100	59,200
Crop and livestock base model	41,600	65,800	63,000	86,300
No pinto beans or sunflowers	38,400	61,000	58,800	80,600
Sugarbeets added		73,600		96,400
Potatoes added		104,100		129,600
CROP AND LIVESTOCK FARM WITH LIVESTOCK ALTERNATIVES				
No feeder pigs	34,100	64,500	55,700	84,800
No swine	33,000	55,800	54,300	76,400
No swine or cattle feeding	22,400	51,800	41,800	72,400
Beef cow and sheep only	13,700	36,500	33,400	56,500
Sheep only				
RENTING ADDITIONAL LAND				
Crop and livestock farm		92,800		129,000
All-crop farm		66,900		103,300
HIRING ADDITIONAL LABOR				
Crop and livestock farm				
No hired man		56,000		74,200
One hired man		65,800		86,300
All-crop farm				
No hired man		37,300		58,300
One hired man		66,900		103,300

Soybeans

Soybeans were profitable under both management levels and on both soil groups when no livestock were produced. No soybeans were included with livestock production except with a dairy and/or beef cow herd and normal management on soils with low available water capacity. Soybean acreage for the other combinations of management levels and soil textural groups was influenced by the size and type of livestock enterprises. The model farm with optimum management on soils with low available water capacity produced soybeans even when the high profit specialty crops were included in the cropping pattern with the livestock alternatives.

Pinto Beans

Pinto beans were profitable under both management levels on both soil textural groups. Rotational considerations permitted pinto beans to be produced on only one-third of the irrigated land. Pinto bean acreage was not influenced by livestock enterprises or a shortage of farm labor.

Sunflowers

Sunflowers were profitable under both management levels on soils with low available water capacity when other specialty crops or livestock enterprises were not included. Sunflower production was restricted to once every four years because of rotational considerations.

Potatoes

Early and late harvested potatoes were both included as an enterprise alternative. Early potatoes produced a lower yield but were assumed to receive a $.50 per hundredweight premium. Farm plans including late potatoes were the most profitable in all the farm situations. Rotational considerations limited potatoes to one-third of the irrigated acres. Late potatoes were produced under both management levels and soil textural groups.

Sugarbeets

Sugarbeet production was not influenced by the size or type of livestock enterprise. Sugarbeets were second to potatoes in profitability under both management levels and soil textural groups. Only one-third of the irrigated land was allowed to be used for sugarbeets because of rotational considerations. Sugarbeet production in the Oakes-LaMoure irrigation area is not presently feasible because of the lack of a processing plant in the area.

Muskmelons

Muskmelons can provide a substantial increase in net income. Muskmelons require a relatively high capital investment and a large seasonal labor force. It is estimated that one acre of muskmelons will fill the requirements of approximately 2,000 people. A few acres of melons meet the needs of a relatively large market area, thereby severely limiting the extent of this enterprise.

Other Irrigated Crops

Alfalfa-brome pasture, corn silage, grain sorghum, and wheat were profitable crops only under special circumstances. Wheat production was the only irrigated enterprise not included in any cropping pattern under long-run prices. Alfalfa-brome pasture was utilized only under normal management when livestock grazing requirements could not be satisfied by the native and dryland pastures. Both grain sorghum and corn silage were produced when additional irrigated acres were rented or additional labor was hired under optimum management.

Dryland Crop Enterprises

Dryland cropping patterns were influenced by the irrigated crops produced, especially those used for livestock feed, size, and type of livestock enterprises and availability of farm labor.

Hay

Dryland hay was a combination of alfalfa-brome or straight alfalfa established with a variety of small grains as a nurse crop. Hay was profitable with all management and soil combinations. The number of acres in the farm plan was influenced by the size of the livestock enterprises and availability of farm labor.

Corn Grain

Corn production usually accounted for at least one-half the dryland acres even when no livestock were included. An increase in the size of forage consuming livestock enterprises usually shifted corn acreage from grain to silage.

Corn Silage

Corn silage production was directly related to the size and type of livestock enterprise. Corn silage was used as a major feed source for many of the livestock enterprises with only a very limited use of the corn-hay ration. An increase in the size of the beef enterprises increased corn silage acreage.

Sunflowers

Sunflower production became a competitive crop on soils with low available water capacity when livestock alternatives were deleted. When livestock were produced, the dryland acres were used to produce corn silage for livestock feed and a lack of available spring labor excluded sunflower production in favor of dryland winter rye.

Flax

Dryland flax was profitable with optimum management on soils with high available water capacity.

Winter Rye

Labor shortage influenced winter rye production. Winter rye production increased as labor became restrictive because of the different labor periods utilized for planting and harvest. A small acreage of winter rye was produced in most farm situations.

Wheat

Some wheat was included on the model farm with normal management on high available water capacity soils when livestock enterprises were deleted. The additional available labor permitted wheat production. Wheat was included in the farm plan when swine and cattle feeding enterprises were deleted from the model farm.

Dryland Pasture, Millet, Oats, and Barley

Dryland barley and oats were not produced on the model farm. Dryland millet was produced when no hired labor was employed or when additional irrigated land was rented on the all-crop farm. Dryland cropland was diverted to pasture when grazing requirements for livestock enterprises exceeded the carrying capacity of native pasture.

Native Pasture

Utilization of native pasture was directly related to livestock enterprises and availability of farm labor. Native pasture was fully utilized only when the beef cow and dairy herd and/or sheep flock were substituted for the feeder cattle enterprise. In most farm situations, native pasture was only partially utilized with the remaining acreage leased out.

Livestock Enterprises

Livestock enterprises, entering the profit maximizing farm plans, were influenced by the availability of labor and the irrigated and dryland crop enterprises providing livestock feed.

Sow With Two Litters

One of the most profitable livestock enterprises was a sow farrowing two litters of pigs per year. The pigs could either be sold as feeders or finished to slaughter weight. Farmers with optimum managerial ability raised their own feeder pigs because more pigs were weaned per litter than with normal management. The model farm with either management level produced pigs sold as feeders if finishing to slaughter weight was not included as an alternative.

Feeder Pigs

The feeder pig enterprise involved either an enterprise to feed home-raised pigs or purchased feeder pigs to slaughter weight. The model farm with either management level included finishing feeder pigs in the farm plan. Only the method of obtaining feeder pigs varied. Home-raised feeder pigs were produced on the model farm with optimum management, while purchased feeder pigs were fed under normal management. The maximum size of the swine enterprises was based on resource limitations. No other livestock enterprise would have been included in any of the farm situations if the swine enterprise had not been limited.

Feeder Cattle

This enterprise could utilize home-raised calves, purchased calves and/or purchased yearlings with the steers finished to a market weight of 1,050 pounds. Both steers and heifers were backgrounded, with the heifers sold as yearlings and the steers finished to a market weight. The size of the enterprise was directly influenced by availability of labor and feed. Feeder cattle were second to hogs in return to labor.

Beef Cow

A small beef cow herd was included in most farm situations except under optimum management on soils with high available water capacity. Low returns to labor limited the size of the beef cow herd.

Dairy

A dairy herd was included on the model farm with optimum management on soils with high available water capacity. Dairy partially replaced the feeder cattle enterprise when additional labor was available. Dairy, when analyzed under current (1976) prices, became more competitive.

Sheep

Sheep could not compete for the farm resources when swine or a cattle feeding enterprise was included. Sheep were competitive under optimum management when the beef cow herd was the only livestock enterprise considered.

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