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ELMER R. KIEHL, *Director*

Cost Minimizing Plans for Various Types of Farms in Northeast Missouri

FRED E. JUSTUS, JR., AND RONALD D. ALEXANDER



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INTRODUCTION

A few decades ago the primary method of increasing net income on an individual farm was the proper application of sound farm production practices. Today, the farmer must not only apply improved farm production practices, but must fit together all practices and production alternatives into an integral plan. This plan must fulfill two conditions: (1) it must fit the resources available on the farm, and (2) it must provide a large enough net income to meet the family's living costs, meet their financial obligations, and permit savings for the future.

The first step in farm planning is a careful appraisal of the land, labor, and capital resources on the farm plus a realistic estimate of the financial needs and wants of the farm family. The financial needs and wants of farm families vary a great deal due to many factors, including the obvious differences in family size, age, health and interests of family members. Nevertheless, each family can arrive at a realistic estimate of the income needed to attain the family goals, and what portion of that must come from the farm business.

To obtain the best combination of enterprises for a farm is not an easy task. On most corn belt farms a large number of production alternatives are open to the farmer. Many farmers have definite preferences as to the types of livestock with which they wish to work, and thus eliminate some enterprises from consideration without careful study of the income possibilities. This preference may be so strong in certain cases that the farmer will consider only one type of farm business. However, even if a farmer decides that he wants a certain type of business there are still many possible production alternatives within each farm type from which to choose the most profitable organization.

Two basic approaches can be used in farm planning. The first approach is profit-maximization, which tries to answer this question: Given the resources

on a farm, what size and combination of enterprises, and combination of available resources will provide the largest net income? The second approach, called cost-minimization, tries to answer the question: What size and combination of enterprises, and what combination of available resources will provide a designated net income at the lowest cost to the farm family? The second approach is particularly applicable where a farmer has a strong preference as to the type of farm business he wishes to operate and where the family is thinking in terms of trying to attain a definite income level. This approach is used to determine how much land, labor, and capital will be needed, and what kind of crops and livestock and how they will have to be produced to provide the needed income.

OBJECTIVE OF THE STUDY

The land, labor and capital resources available to farmers vary greatly from farm to farm, even within a small geographic area. It is obvious, therefore, that the best plan (profit maximizing or cost-minimizing) will also vary from farm to farm. In other words, it is impossible to set up one plan and say that it is the best plan for all farms in the area. But it is possible, and useful, to select typical farm resource situations in an area and determine the best plans for these farms under given assumptions. Determining the best plans for these typical or "model" farms provides farmers and people working with farmers with useful general guides. Obviously, the person planning a specific farm must examine these general guides in terms of how the assumptions and the resources on the model farm compare with those on the individual's farm.

The general purpose of this study was to select typical resource situations in northeast Missouri and through the use of linear programming determine the cost-minimizing plans for different types of farms and for different levels of net income. More specifically, the objective can be stated: To determine by use of linear programming the amount and combination of resources, and the specific crop and livestock enterprises which will produce, at minimum cost, specified levels of net income for four different types of farm businesses, each located on three different typical land resource situations in northeast Missouri.

The four types of farm businesses studied are:

- A. Hog farm.
- B. Dairy farm.
- C. Production of roughage-fed beef cattle.
- D. Production of grain-fed beef cattle.

The three typical land resource situations were:

- A. Level upland farm.
- B. Rolling upland farm.
- C. Bottomland farm.

Each of these types of business and land resource situations will be explained in greater detail later.

INFORMATION ON AREA OF STUDY

This study is based on the land resources found in northeast Missouri. The area is characterized by extensive tracts of level prairie land that is predominantly Putnam silt loam. Putnam silt loam has a heavy clay layer 16 to 20 inches below the surface which causes slow internal drainage. The prairie soils are of medium productivity but respond well to commercial fertilizers. The prairie is occasionally broken by tracts of rolling to hilly terrain which is predominantly Lindley loam. Lindley loam is less productive than the Putnam soils, and often is not suitable for cultivation. The area is bordered on the south and east by fertile Missouri and Mississippi River bottomlands. A number of smaller rivers dissect the area, and along these are relatively narrow bands of fertile bottomland. Soils in the Wabash series are the major bottomland soils.¹ Three model farms were chosen to represent the typical land resources on farms in the area.

The climatic conditions, labor supply, closeness to markets, and transportation facilities of the area are such that a wide variety of crops and livestock commodities can be produced. Presently, most of the farms in the area are general livestock and crop farms with relatively few large, specialized livestock businesses. Many farms have only enough livestock to utilize the production from land not suitable for cropping. But there appear to be no inherent reasons why specialized livestock production can not expand greatly.

A survey of farms in northeast Missouri conducted in 1959 revealed certain patterns of land and labor resources on farms in the area. These resource patterns were used as the basic models in this study.

METHODS OF ANALYSIS

As stated in the objectives, linear programming was the method of analysis used in this study. Three basic quantitative ingredients are necessary in the use of this tool: (1) an objective—in this study to attain designated income levels at least cost, (2) alternative methods of achieving the objective—the alternative crops and livestock activities which can be produced, and (3) resource and other restrictions—the amount and kind of land, labor, and capital available on the model farms. These basic ingredients are presented in the following sections. As literature is voluminous on the specific techniques and the mathematical bases of linear programming descriptions of these are omitted from the present publication.²

¹ For a description of the predominant soil types in the area see *Key for Identifying Soils of Missouri*, Progress Report 12, Missouri Agricultural Experiment Station, October, 1950.

² Among the many references on linear programming techniques are the following. Heady, Earl O. and Wilfred Chandler, *Linear Programming Methods*, Iowa State Press, Ames, Iowa, 1958. Dorfman, R., P. A. Samuelson, and R. Solow, *Linear Programming and Economic Analysis*, McGraw-Hill Book Company, Inc., New York, 1958.

RESOURCES AND RESOURCE USE IN STUDY

Land

The three model farms chosen to represent the typical land resources in the area are:

- A. *Level Upland Farm*—a farm containing all level upland.
- B. *Rolling Upland Farm*—a farm containing 25 percent level upland, 50 percent tillable rolling upland, and 25 percent open pasture (on rolling upland).
- C. *Bottomland Farm*—a farm located along small river containing 50 percent bottomland, 25 percent tillable rolling upland, and 25 percent open pasture (on rolling upland).

The programs were set up so that the amount of land used (purchased) in the minimum-cost solution for each income level and each type of business was determined by the program. In other words, there was not a set acreage in any of the problems. The program, however, had to purchase the designated proportions of the different types of land where more than one type of land was in the model.

Woodland and wasteland were not included in the land resources in these models because of the large variation in the amount of unproductive land on individual farms.

The program could leave land idle that was purchased in a final solution. As the different types of land had to be purchased in a set proportion on the rolling upland and bottomland farms, it was entirely possible that the least-cost solution involved purchasing land that was left idle (say, open pasture land) in order to have the use of the more productive land. This may seem unrealistic, but is logical when it is recognized that farmers actually buy total farm units containing non-productive woods and wasteland in order to get productive land.

The land use and crop yields were determined separately for each of the types of land. These are discussed in a later section on crops.

Land values were estimated by persons familiar with farm real estate prices in the area. Bottomland was valued at \$250 per acre, level upland at \$200, tillable rolling upland at \$150, and open pasture land at \$60 per acre. These values do not include the value of buildings.

Labor

The major portion of the farm earnings available for family living, debt retirement, and savings comes from the use of the family labor and management in the farm business. Therefore the objective of this study was to determine the resources needed to provide designated levels of net income to labor and management. As labor is one of the farm resources, the total amount and seasonal

distribution of labor use in an optimum plan was also determined by the program.

In order to be realistic, however, it was necessary to put some labor supply restrictions into the program. Three levels of labor supply, which represent typical labor situations, were assumed in this study.

Level 1—250 hours of labor available per month. This represents the situation of the operator doing all the work on the farm.

Level 2—250 hours of labor available per month, plus an additional 1100 hours of labor available in the summer months (May—150, June—250, July—250, August—250, September—100, and October—100). This level represents the typical situation where there is family labor available during the summer, evenings and on weekends. The hiring of custom operators or seasonal hired labor on an hourly basis is also a possibility.

Level 3—500 hours of labor available monthly, plus an additional 250 hours monthly during May through October. This represents a 2 man operation with the possibility of hiring up to one additional man during the peak labor requirement months.

In the programming, labor level 1 was used as a restriction until this restriction prohibited reaching a certain income level solution. At this point labor level 2 replaced labor level 1 as a restriction. Similarly, when a certain income level could not be reached under the restrictions of labor level 2 then labor level 3 was put into the program. Thus, it was possible to determine just how large an income could be obtained for each type of farm with each level of labor supply.

Capital

The capital resources needed for the various types of farming and levels of income were computed by the program. Two general classes of capital were determined; land capital and non-land capital. Land capital, that needed to purchase bare land, depended on the acreage of land indicated by the final solution. Non-land capital included buildings, livestock, livestock equipment, feed supplies, machinery, and other production items. Charges for non-land capital use varied among enterprises, depending upon the amount and composition of the total capital needed. The size of each enterprise, of course, was a major factor in the capital requirements.

Buildings are usually considered along with land as real estate. But as building needs are different for each class of livestock and are not required in the same combination with land for all classes of livestock the building capital in this study was handled like operational capital; a per unit building capital requirement was established for each livestock enterprise.

The farm dwelling was not included in the farm investment. This was necessary because of the way the amount of capital was determined in the program.

Machinery and Equipment

In this study "average" machinery and equipment investments for the kind and size of enterprises in the solution were assumed. To get the best possible estimates, an effort was made to charge the machinery and equipment used on the livestock against the individual livestock enterprises and the machinery used on crops against the crop. This was done even for machines used for both livestock and crops. It was decided that \$35 per crop acre was a reasonable estimate of crop machinery investment, regardless of the kinds of crops produced. This fixed estimate has an obvious weakness, but a review of pertinent studies revealed as much variation in machinery investments by crop as among crops.

ACTIVITIES

Crops

All crops commonly grown in the area were considered in this study. Estimated costs, labor requirements, yields, and returns for each crop by land class are presented in Tables 1 and 2.

The price assumptions used for the various crops and livestock products are shown in Table 3. Present prices of inputs were used in calculating the costs of production. In order to conserve space the detailed budgets prepared for each crop are omitted from this publication.³ It should be noted that adequate fertilizer was applied to obtain the stated yields.

In deciding on the crops to be raised on a farm, it is necessary to consider not only the net income that can be derived from the crops but the adaptation of crops to the land. The major, but not the only, concern of adaptation is the matter of soil conservation. To meet this problem, a set of 11 crop rotations was established for use in the programming. In addition, the land could be used in either improved or unimproved permanent pasture.

On land with no erosion problem (level upland and bottomland) the program was allowed to select any rotation regardless of its intensity. Only those rotations feasible from the soil conservation standpoint were placed in the programs on land subject to erosion.

On the rolling upland and bottomland model farms, two or three different types of land occurred on the same model farm. In these cases the program was set up to select rotations for each type of land. The following rotations were used in the study.

³ All input-output data used in this study were based on published sources. Among the most prominent sources of data used are: *Farm Business Planning Guide*, B.F. 6103, Agricultural Extension Service, University of Missouri, 1961. R. G. Johnson and T. R. Nodland, *Land Used in Cattle Feeding*, Station Bulletin 451, Minnesota Institute of Agriculture. Bernard Bowlen and Earl O. Heady, *Optimum Combinations of Competitive Crops*, Research Bulletin 426, Iowa Agricultural Experiment Station, Iowa State University. *Feeder Cattle Guide for 1961-1962*, Illinois Extension Service in Agriculture and Home Economics, University of Illinois.

TABLE 1 -- ESTIMATED YIELDS, COSTS AND NET INCOMES PER ACRE FOR CROPS ON THREE LAND CLASSES IN NORTH-EAST MISSOURI*

Crop	Level Upland			Rolling Upland			Bottomland		
	Yield	Cost	Net Income	Yield	Cost	Net Income	Yield	Cost	Net Income
Corn	56.0	\$44.54	\$12.14	45.0	\$41.83	\$3.63	70.0	\$47.29	\$23.40
Soybeans	24.5	38.90	9.92	19.5	36.19	2.87	30.5	41.65	19.37
Wheat	27.5	39.00	10.59	22.0	36.33	3.38	30.5	41.79	13.06
Oats	45.0	32.44	-3.03	36.2	29.60	-6.07	56.5	35.19	1.57
Barley	40.0	33.19	.81	32.0	30.45	-3.25	50.0	35.94	6.56
Silage	10.0	38.47	20.48	8.0	46.83	9.17	12.5	52.29	35.21
Alfalfa	3.0	37.53	16.47	2.4	34.82	8.38	3.7	40.28	27.22
Red Clover	2.3	46.13	22.37	1.8	29.42	6.58	2.7	33.88	10.12
Mixed Meadow	3.0	30.86	14.12	2.0	27.40	6.20	3.0	32.86	22.39
Rotation Pasture	2.6	23.25	3.39	2.6	19.80	1.06	3.0	25.25	6.00
Improved Permanent Pasture	2.0	17.65	6.60	2.0	16.94	7.32	-	-	-
Unimproved Permanent Pasture	-	-	-	1.0	4.82	1.18	-	-	-

*Only a summary of costs is presented here. Detailed cost budgets were prepared on every crop for the production of conditions of each of the three soil types. The major differences in the cost of producing a certain crop on the three soils is the difference in fertilizer applications. These corresponded to estimated yields.

TABLE 2 -- MONTHLY LABOR REQUIREMENTS FOR CROPS IN TERMS OF HOURS PER ACRE

Crop	Total Hours	January	February	March	April	May	June	July	August	September	October	November	December
Corn	7.8	-	-	.40	.40	1.90	1.25	.58	-	.38	1.25	1.25	.39
Corn Silage	15.00	-	-	.20	.50	2.00	1.25	.58	1.47	9.00	-	-	-
Oats	4.00	-	-	1.15	.85	-	-	2.00	-	-	-	-	-
Barley	4.35	-	-	-	-	-	1.20	.80	.80	1.80	-	-	-
Wheat	4.75	-	-	.40	-	-	.80	1.20	.20	1.00	1.40	-	-
Soybeans	6.0	-	-	.20	.30	2.00	1.25	.50	-	.75	1.50	-	-
Alfalfa Hay	16.00	-	-	-	-	3.68	3.43	3.85	2.29	3.25	-	-	-
Rotation Pasture	2.00	-	.50	.75	-	-	-	.75	-	-	-	-	-
Mixed Hay	8.00	-	.50	.75	-	-	-	6.25	.50	-	-	-	-
Clover Stubble	9.00	-	.50	-	-	-	6.50	.80	.60	.60	-	-	-
Clover Hay & Seed	16.50	-	.50	-	-	-	6.50	1.50	6.50	1.50	-	-	-

TABLE 3 -- PRICES ASSUMED IN STUDY

	Unit	Price Per Unit (Dollars)
<u>Crops:</u>		
Corn (Raised)	Bu.	1.00
Corn (Purchase price)	Bu.	1.12
Corn Silage	Ton	7.00
Soybeans	Bu.	2.00
Wheat	Bu.	1.80
Barley	Bu.	.85
Oats	Bu.	.65
Red Clover Hay	Ton	16.00
Alfalfa Hay	Ton	18.00
Mixed Hay	Ton	16.00
Rotation Pasture	Ton-hay equiv.	8.00
<u>Livestock:*</u>		
Milk	Cwt.	3.90
Slaughter Hogs	Cwt.	15.00
Stocker Calf (450#) - sale price	Cwt.	22.00
Steer Calf (450#) - purchase price	Cwt.	23.00
Yearling Steer (600#) - purchase price	Cwt.	22.00
Yearling Steer (650#) - purchase price	Cwt.	21.00
Plain Steer Calf (350#) - purchase price	Cwt.	16.00
Choice Steer (1050-1150#) - sale price	Cwt.	23.00
Plain Steer (700#) - sale price	Cwt.	16.00

*Cattle prices varied to account for time of purchase and sale under different systems of feeding, as well as the quality of cattle fed.

Level Upland Rotations

1. Continuous Corn
2. Continuous Soybeans
3. Corn-Soybeans-Wheat-Red Clover
4. Corn-Oats-Rotation Pasture (2 years)
5. Corn-Oats-Mixed Meadow (2 years)
6. Silage-Barley-Red Clover
7. Corn-Oats-Alfalfa (4 years)
8. Sudan-Soybeans-Wheat-Red Clover (Dairy Programs only)
9. Improved Permanent Pasture

Rolling Upland Rotation

1. Corn-Oats-Red Clover (2 years)
2. Corn-Soybeans-Wheat-Red Clover (2 years)
3. Corn-Oats-Alfalfa (4 years)
4. Soybeans-Barley-Red Clover (2 years)
5. Corn-Oats-Mixed Meadow (2 years)
6. Corn-Oats-Rotation Pasture (2 years)
7. Sudan-Soybeans-Wheat-Red Clover (2 years) (Dairy Programs only)
8. Improved Permanent Pasture
9. Unimproved Permanent Pasture

Bottomland Rotations

All of above rotations were possible.

Livestock

Livestock enterprises selected for programming were those commonly found in Northeast Missouri or those enterprises readily adaptable to conditions of the area. The enterprises put into each program depended upon the type of farm business being analyzed. At least one roughage consuming livestock enterprise was analyzed in every program in order to provide a market for the roughage produced.

The eight livestock enterprises which were analyzed in this study are described briefly below. The detailed input-output data for these enterprises are shown in Tables 4, 5, and 6.

Swine

The only type of swine enterprise considered in this study was the production of slaughter weight hogs. The production or purchase of feeder pigs was not included in this analysis although such pig enterprises are possible alternatives on farms in the area.

The hog enterprise was broken down into three size classes: small, 1 to 15 sows; medium, 16 to 35 sows; large, 36 or more sows. It is assumed that the small herds are handled using equipment less elaborate than central housing, and much hand feeding and individual care is involved. For the larger enterprises the operator uses more labor-saving equipment. Per unit labor requirements were consequently reduced with each step in herd size.

Monthly labor distribution is also affected by the number of sows farrowed. The basic two-litter system of production is employed in this study, but the timing of farrowings is varied with the size of enterprise. In the small herds the sows farrow during two distinct time periods each year. In the larger herds the sows farrow in four or more time periods. For example, 20 sows of a 40 sow herd farrow in late January and early February; the remaining sows farrow in late February and early March. Fall farrowing is handled the same way. This permits using farrowing facilities more efficiently and spreads out the farrowing labor requirements.

The costs and returns were figured on the basis of 7 pigs raised per litter. Some hog producers are able to raise more pigs per litter, but the assumed number is typical for producers over a period of years.

Dairy

For this study the dairy enterprise was divided into 2 size classes: (1) small herds—11 to 40 cows, and (2) large herds—41 or more cows. Separate labor requirements were determined for each of these classes. The small dairy herd is assumed to be large enough to be relatively efficient but lacking in size to take full advantage of the newest, most advanced equipment. It is assumed that the large herds can take full advantage of advanced labor-saving equipment, and thus use less labor per cow.

TABLE 4 -- ANNUAL FEED AND CAPITAL REQUIREMENTS FOR LIVESTOCK ENTERPRISES

Enterprise	Corn Equiv. (bu.)	Hay* Equiv. (tons)	Pasture (Tons of Hay Equiv.)	Capital Requirements**
(Per Unit of Production)				
Swine - Sow and 2 litters (7 pigs/litter, marketed at 225#)	210	-	.5	\$500.00
Dairy - Dairy cow giving 10,000# milk	63	5.5	3.5	840.00
Beef Cow - Stocker Calf Sold at 450#	2	1.5	3.5	290.00
Beef Cow - Calf Fed to 1050#	36	2.5	4.0	455.00
Feeder Cattle, System 1 (Steer Calf 450# , wintered, grazed, fed, sold 1050#)	45	1.25	.75	218.00
Feeder Cattle, System 2 (Yearling Steer 600# , wintered, grazed, fed, sold 1150#)	40	1.25	1.0	239.00
Feeder Cattle, System 3 (Yearling Steer 650# , Short fed to 1150#)	55	.6	.25	184.00
Feeder Cattle, System 4 (Plain Steer Calf 350# , wintered, pastured, sold 700#)	4	.75	1.5	109.00

*Hay and silage requirements, converted to hay equivalent.

**Capital requirements include capital used for livestock (including replacement of breeding stock), feed, equipment and buildings.

TABLE 5 -- SUMMARY OF PER UNIT COSTS AND RETURNS FOR LIVESTOCK ENTERPRISES*

Enterprise	Gross Income	Feed Cost	Vet. Breeding & Similar Costs	Livestock Purchases	Taxes, Ins. Repairs Deprec. & Int. on Cap.	Misc. Costs	Total Costs	Net Returns to Labor & Management
Swine - Sow and 2 litters (7 pigs/litter, marketed at 225#)	\$490.75	\$298.00	\$20.00	\$ --	\$53.88	\$16.03	\$387.91	\$102.84
Dairy - Dairy cow giving 10,000# milk	468.00	223.50	22.00	--	85.19	14.31	345.00	123.00
Beef Cow - Stocker Calf Sold at 450#	97.24	52.00	8.00	--	27.15	1.59	88.74	8.50
Beef Cow - Calf Fed to 1050#	201.32	116.60	8.00	--	43.18	2.23	170.46	30.41
Feeder Cattle, System 1 (Steer Calf 450# , wintered, grazed, fed, sold 1050#)	236.67	85.00	2.00	103.50	21.78	3.55	215.83	20.84
Feeder Cattle System 2 (Yearling Steer 600# , wintered, grazed, fed, sold 1150#)	260.54	83.00	1.00	132.00	23.33	3.91	243.24	17.30
Feeder Cattle System 3 (Yearling Steer 650# , Short fed to 1150#)	249.20	75.00	1.00	136.50	15.94	3.74	231.18	18.02
Feeder Cattle System 4 (Plain Steer Calf 350# , wintered, pastured, sold 700#)	109.20	31.00	2.00	56.00	11.16	1.54	101.70	7.50

*In order to conserve space only a summary of the costs and returns are presented here. Detailed budgets were calculated to account for differences in death loss, capital investments, quality of feed used, and costs and sales of breeding stock.

TABLE 6 -- MONTHLY LABOR REQUIREMENTS FOR LIVESTOCK ENTERPRISES, PER UNIT OF PRODUCTION

Enterprise	Size	Total Hours	Hours											
			January	February	March	April	May	June	July	August	September	October	November	December
Dairy Cow	11-40	100.0	10.0	10.0	10.0	10.0	7.0	7.0	7.0	7.0	7.0	7.0	8.0	10.0
	41 up	80.0	8.0	8.0	8.0	8.0	5.6	5.5	5.6	5.6	5.6	5.6	6.4	8.0
Sow and Two Litters	1-15	60.0	5.4	6.0	6.0	4.8	4.2	3.6	4.8	6.0	4.8	4.8	4.8	4.8
	16-35	40.0	3.6	4.0	4.0	3.2	2.8	2.4	3.2	4.0	3.2	3.2	3.2	3.2
	36 up	30.0	2.7	3.0	3.0	2.4	1.8	1.8	2.4	3.0	2.7	2.4	2.4	2.4
Beef Cow and Calf	1-15	40.0	4.8	5.2	5.2	4.8	2.4	1.2	1.2	1.2	1.2	3.6	4.4	4.8
	16-35	30.0	3.6	3.9	3.9	3.6	1.8	.9	.9	.9	.9	2.7	3.3	3.6
	36-60	20.0	2.4	2.6	2.6	2.4	1.2	.6	.6	.6	.6	1.8	2.2	2.4
	61 up	15.0	1.8	1.9	1.9	1.8	.9	.5	.4	.5	.4	1.4	1.6	1.8
Long Fed Good to Choice Steer Calf	1-25	22.0	2.0	2.0	2.0	1.7	1.4	1.5	2.4	2.4	2.4	1.0	1.0	2.1
	26-75	13.0	1.2	1.2	1.2	1.0	.9	.9	1.4	1.4	1.3	.6	.6	1.2
Long Fed Good to Choice Yearling Steer	1-25	22.0	2.0	2.0	2.0	1.6	1.6	1.6	2.4	2.4	2.4	1.0	1.0	2.0
	26-75	13.0	1.2	1.2	1.2	1.0	1.0	1.0	1.3	1.4	1.4	.6	.6	1.1
Short Fed Good to Choice Yearling Steer	1-25	18.0	2.6	2.6	2.6	2.6	2.3	-	-	-	-	1.0	2.0	2.3
	26-75	11.0	1.6	1.6	1.6	1.6	1.4	-	-	-	-	.6	1.2	1.4
Wintered and Grazed Common Steer Calf	1-25	11.5	2.0	2.0	2.0	.8	.3	.3	.3	.3	.3	1.0	1.0	1.2
	26-75	6.0	1.0	1.0	1.0	.4	.2	.2	.2	.2	.2	.5	.5	.6
Cow and Calf Fed Out	1-20	46.6	5.1	5.4	5.4	4.9	2.9	2.0	2.7	2.7	2.7	3.5	4.1	5.2
	21-60	29.8	3.3	3.5	3.5	3.2	1.9	1.3	1.7	1.6	1.7	2.2	2.7	3.3
	61 up	23.3	2.6	2.7	2.7	2.5	1.4	1.0	1.4	1.3	1.4	1.7	2.0	2.6

Costs and returns for the dairy enterprise are based on 10,000 pounds of milk production per cow. Grade A dairy production methods and sanitation standards are assumed in the calculations; milk is priced on a Grade A basis. The cost and labor data presented in Tables 6 and 7 include adequate allowances for the dairy replacement stock.

Beef Cow Herd

Two different methods of production utilizing a beef cow herd were studied. The first method of production, designated as *beef cow herd-calf sold*, involves selling calves in the autumn of the year they are born. Calves are sold at a weight of 450 pounds. The second method of production, designated *beef cow herd-calf fed out*, involves keeping the calves on the farm and feeding them until they are ready for slaughter (1050 pounds). The method of feeding these calves after weaning is the same as described below for the long-fed, steer calf feeding enterprise.

Four enterprise size classes are set up in this study: 1-15 cows, 16-35 cows, 36-60 cows, and 61 cows and over. Economies of labor use as related to the size of herd are considered to be relatively large in the beef cow herd enterprise, as many chores require nearly the same amount of labor regardless of the number of animals tended.

The costs and returns of these beef cow herd enterprises were based on a 90 percent calf crop and 16 percent annual cow replacement. It was consequently assumed that 75.6 percent of the calves produced were available for sale or feeding on the farm.

Steer Feeding Enterprises

Farmers follow many different cattle feeding systems. The systems vary in regard to the age, weight, and sex of cattle being fed, the length of time on feed, the kinds of feed being used, and the time of cattle purchase and sale. It was decided, therefore, to select four basically different cattle feeding systems as representative of the systems adaptable to the area. These are described as follows:

System 1: Long-fed, good to choice, steer calves. These steer calves are purchased in October, weighing 425 to 450 pounds. They are placed on stalk fields in October and November to utilize the stalks and grain which still remain as field loss. A limited amount of grain is fed to these calves through the winter and while on pasture during the spring and early summer. They are finished on full feed in dry lot for a period of 60 to 90 days and sold in late September or early October at weights of 1000 to 1050 pounds.

System 2: Long-fed, good to choice yearling steers. These steers are purchased around mid-October, weighing 600 pounds. They are placed on the stalk fields through November, fed a limited amount of grain through the winter and while

on pasture. The steers are finished in dry lot for 30 to 60 days and sold in early September, weighing about 1125 to 1150 pounds.

System 3: Short-fed, good to choice yearling steers. In this system good quality yearling steers weighing around 650 pounds are purchased in mid-October. The animals are placed immediately in dry lot and fed a full grain ration. They are handled this way until marketed in mid-May. By this time they should weigh 1050 to 1075 pounds.

System 4: Plain steer calves. High standard to low good quality, light weight steer calves are purchased in mid-October. These 350 pound calves are fed through the winter to make only moderate growth. They are kept on pasture throughout the spring and summer, and should be sold in mid-October weighing around 650 to 675 pounds. This enterprise is an alternative to the beef cow herd as users of low quality summer and winter roughage. A minimum of grain is fed to these calves.

Labor efficiency increases notably as the size of the feeder cattle enterprise increases, at least within the size range considered relevant on many Missouri farms. Farmstead mechanization and automation are the important factors behind the lower labor requirements on the larger enterprises. To reflect differences in labor needs, three herd sizes were considered for each of the feeder cattle enterprises: Small—1 to 25 head, medium—26 to 75 head, and large—over 75 head.

OTHER ASPECTS OF THE PROGRAMS

Four additional features of the programs should be recognized.

1. The programs were set up to determine the optimum organizations and resource requirements for designated net income levels. It should be understood that net income is defined in this study as the amount of income left to the operator to compensate him for his management and *all* labor employed in the farm business. This corresponds to what is frequently called labor income, although some farm management men define labor income in different ways. The important point to remember is that if the optimum plan involves hiring some labor the cost of that labor must be subtracted from the designated net income level in order to derive the net income available to the farm family. All other cost items have been charged against the business as described previously.
2. In the programs, corn can be purchased for livestock feed on the model farms. Thus, the number of livestock is not limited to the grain raised on the farm. The livestock is charged a higher price for the purchased corn to compensate for transportation and market price differentials. Hay or silage can not be purchased.

3. Grain can be sold from the model farms or fed to the livestock, whichever the program determines gives the greatest income to the entire farm business. Roughage can not be sold from the farm, however. It must be consumed by the livestock or left in the field. This provision was put into the programs because of the poor market for low quality roughage, particularly pasture, other than through livestock on the farm where the roughage is raised.
4. All input-output data used were derived from secondary sources. Some data were directly applicable to the specific situations in Northeast Missouri, other data had to be adjusted to fit area conditions and specific enterprise size and production methods. *The Farm Business Planning Guide* provided much of the basic data, but many references were consulted to obtain the final input-output relationships (see footnote 3).

OPTIMUM PLANS FOR LEVEL UPLAND FARM

The level upland farm is the model farm situation representing the Putnam soil area. The resources were programmed for four dominant types of farm businesses: (1) hog farms, (2) dairy farms, (3) farms specializing in roughage-fed beef cattle, and (4) farms specializing in grain-fed beef cattle. Least-cost plans were determined for net labor income levels of \$3,000 to \$7,000, at \$1,000 intervals, for each type of business using different levels of available labor. Special cases of the above will be discussed as they arise.

Hog Farm

In Table 7 the basic elements of the optimum hog farm plans are presented. The resources needed to attain the given income levels at minimum-cost, the crop rotations and individual crop acreages, the number and kinds of livestock, and the amount of corn purchased in the optimum plans are all shown. Only a summary will be given in the text as the details can be readily examined in the table.

Using only the operator's labor (labor level 1) optimum plans for net income levels up through \$6,000 were determined.⁴ With this limited amount of labor available it was impossible to achieve \$7,000 net income.

It was possible to achieve the \$7,000 net income level with labor level 2 (operator's labor plus 1100 hours of seasonal labor). A higher income level could not have been obtained under this typical farm family situation as the entire labor supply was used in four of the 12 months.

The \$7,000 income level was easily achieved under the conditions of labor level 3. Labor level 3 assumes 500 hours available monthly labor in months January through April, and in November and December, with 750 hours available in the remaining months.

⁴ In order to make the text more readable the term net income will be used in place of labor income.

TABLE 7 -- ENTERPRISE COMBINATIONS AND RESOURCES USED IN THE COST-MINIMIZING SOLUTIONS TO ATTAIN DESIGNATED LABOR INCOMES ON A HOG FARM, LEVEL UPLAND

Item: Net Labor Income Labor Level	\$3,000	\$4,000		\$5,000		\$6,000		\$7,000	
	L.L. 1	L.L. 1	L.L. 2	L.L. 1	L.L. 2	L.L. 1	L.L. 2	L.L. 2	L.L. 3
<u>Resources Used:</u>									
Land (acres)	83	100	110	109	168	96	178	158	193
Capital: Land Capital	16,537	19,858	22,049	21,803	33,588	19,206	35,669	31,789	38,587
Non Land Capital	14,787	22,783	19,716	31,133	24,534	43,474	34,195	50,304	34,503
Total	31,334	42,641	41,755	52,936	58,122	62,680	69,864	82,093	73,090
<u>Annual Labor Used:</u> (hours)	1,497	2,053	2,000	2,109	2,510	2,479	2,624	2,913	2,952
Months Restricted	0	0	0	5th	11th	5th	5, 11th	5, 10, 11th	0
<u>Income Data:</u>									
Total Annual Cost	7,249	11,562	9,665	16,138	12,700	23,248	18,295	28,249	16,914
Net Labor Income	\$3,000	\$4,000	\$4,000	\$5,000	\$5,000	\$6,000	\$6,000	\$7,000	\$7,000
<u>Enterprise:</u>									
Livestock ¹	20	31	27	42	31	57	43	65	47
Hogs				11					
Steers		10							
Crops: (principal ² rotations & acreages thereof)	73 C 10 CORpRp	80 C 20 CORpRp	97 C 12 CORpRp	84 C 25 CORpRp	112 C 42 Sb 15 CORpRp	68 C 28 CORpRp	107 C 53 Sb 19 CORpRp	71 C 67 Sb 17 CORpRp 5 lpp	170 C 23 CORpRp
<u>Acres of Individual Crops:</u> ³									
Corn	74	85	100	90	115	75	110	75	175
Oats	3	5	4	6	4	7	5	4	6
Soybeans	0	0	0	0	41	0	53	66	0
Rot. Pasture	6	10	6	13	8	14	10	8	12
Imp. Perm. Past.	0	0	0	0	0	0	0	5	0
Corn Purchased (bushels)	0	1,620	0	3,600	0	7,960	2,780	9,400	0

¹ Hogs refer to the number of sows which farrow two times per year, Steers refer to steer system 4, common quality steer calves purchased in fall, roughed through the winter, grazed during summer and sold in early fall.

² Number before letter indicates acreage of that rotation. Letters indicate crops as follows: C-Corn, O-Oats, Rp-Rotation Pasture, Sb-Soybeans, lpp-Improved Permanent Pasture.

³ Acreages rounded to nearest whole acre.

The optimum plans vary at each given income level depending upon the labor supply. The plans also vary with the labor supply at different income levels.

Where two different labor supply levels were used at the same income level, more crops, particularly corn, were produced in the optimum plans assuming the larger labor supply. The more restricted labor supply forced the computer to find ways of substituting capital for labor, resulting in a reduction in the acres of crops and more labor devoted to hog production, using purchased corn. If corn buying had not been permitted in this study, it is probable that a net income above \$4,000 could not have been reached using only the operator's labor.

For each labor level, once the labor supply in any single month is fully utilized the general organization of the optimum plan changes and capital is substituted in continually higher proportions for labor.

The optimum size of the hog enterprise varies considerably with the level of income and labor restriction, from a 20 sow herd needed to attain a \$3,000 net income to a 65 sow herd needed to attain a \$7,000 net income (with labor level 2).

It is interesting that even though the beef cow herd enterprises and plain steer calves were activities which could have been in the optimum plans on these hog farms, only in two optimum plans does either of these appear in a significant amount. Plain steer calves are in the optimum plans at the \$4,000 and \$5,000 income levels under labor level 1.

All of the optimum hog farm plans use less than 200 acres of land, with the range being between 83 and 193 acres. The total capital used in the optimum plans ranges between \$31,300 and \$82,100, with non-land capital varying from \$14,800 to \$50,300.

Dairy Farm

As most dairy farms today are highly specialized, it was decided that Grade A dairying should be the only livestock enterprise considered of the model dairy farms. Also, to duplicate as nearly as possible actual dairy farming conditions and practices, a sudan grass-soybeans-wheat-red clover rotation was put in the program as an additional alternative rotation.

As many dairy farming operations involve two full time men (father-son partnership, brothers in partnership, etc.), the researchers decided to solve for the maximum net income level possible using labor level 3, instead of stopping at \$7,000 as was done for the other types of farming. Labor level 3 approximates the labor supply of a two-man operation plus additional summer labor.

On hog farms it was possible to attain a \$6,000 net income using only the operator's labor and \$7,000 net income using the operator's labor plus 1100 hours of seasonal labor. Because of the high and regular labor requirements of the dairy enterprise it was impossible to attain anywhere near these net income levels on the model dairy farm. The highest income attained using labor level 1 was \$3,000, and the highest with labor level 2 was \$4,000 (Table 8).

TABLE 8 -- ENTERPRISE COMBINATIONS AND RESOURCES USED IN THE COST-MINIMIZING SOLUTIONS TO ATTAIN DESIGNATED LABOR INCOMES ON A DAIRY FARM, LEVEL UPLAND

Item: Net Labor Income Labor Level	\$3,000		\$4,000		\$5,000	\$6,000	\$7,000	\$8,000	\$9,000 ¹
	L.L. 1	L.L. 2	L.L. 2	L.L. 3	L.L. 3	L.L. 3	L.L. 3	L.L. 3	L.L. 3
Resources Used:									
Land (Acres)	90	94	120	123	156	189	216	246	294
Land Capital	17,757	18,769	24,126	24,694	31,211	37,852	43,172	49,207	58,771
Non-Land Capital	18,626	16,801	23,208	22,979	29,032	35,059	41,459	47,657	55,313
Total	36,383	35,570	47,334	47,673	60,243	72,911	84,631	96,864	114,084
Annual Labor Used: (Hours)	2,369	2,226	3,053	2,991	3,749	4,506	5,325	5,218	6,102
Months Restrictive	6 & 7	0	4	0	0	0	3	0	3, 4 & 6
Income Data:									
Total Annual Cost	5,906	5,334	7,387	7,153	9,087	11,040	13,039	15,013	17,750
Net Labor Income	3,000	3,000	4,000	4,000	5,000	6,000	7,000	8,000	9,000
Enterprises:									
Dairy Cows	18	15	22	21	27	32	39	45	53
Crops (principal ² rotations & acreage thereof)	40 CORpRp 35 SiIBRc 14 COMmMm	60 SudSbWRc 24 COMmMm 8 C	60 SudSbWRc 25 SiIBRc 20 CORpRp 10 C 6 COMmMm	60 SudSbWRc 50 COMmMm 12 CORpRp	74 COMmMm 60 SudSbWRc 22 CORpRp	93 COMmMm 60 SudSbWRc 32 CORpRp	86 COMmMm 60 SudSbWRc 48 CORpRp 22 SiIBRc	93 COMmMm 60 SudSbWRc 60 CORpRp 32 SiIBRc	83 SiIBRc 60 SudSbWRc 54 lpp 36 COMmMm 34 CORpRp 17 C 9 Sb
Acres of Individual Crops:³									
Red Clover	12	15	23	15	15	15	22	26	43
Mixed Meadow	7	12	3	25	37	48	43	46	18
Corn Silage	12	0	8	0	0	0	7	10	28
Barley	12	0	8	0	0	0	7	10	28
Oats	12	7	6	15	24	32	34	40	17
Corn	15	15	17	16	24	32	34	40	34
Rotation Pasture	20	0	10	7	11	17	24	30	18
Sudan	0	15	15	15	15	15	15	15	15
Soybeans	0	15	15	15	15	15	15	15	24
Wheat	0	15	15	15	15	15	15	15	15
Improved Permanent Pasture	0	0	0	0	0	0	0	0	54

¹The dairy programs were solved to determine the highest net income level possible, restricted only by labor.

²Number before letter indicates acreages of that rotation. Letters indicate crops as follows: C-Corn, O-Oats, Rp-Rotation Pasture, Sil-Corn Silage, B-Barley, Rc-Red Clover, Mm-Mixed Meadow, Sud-Sudan Pasture, Sb-Soybeans, W-Wheat, lpp-Improved Permanent Pasture.

³Acreages rounded off to nearest whole acre.

As a \$9,000 net income was attained with labor level 3, the economic logic behind the common two-man dairy operations is supported by the results of this study.

The relatively small number of dairy cows in the solutions at the lower income levels is somewhat surprising, and raises the question as to whether the assumed labor requirements were too high. Although this is possible, the labor requirements used were the ones generally accepted as standards. The more likely explanation is that a dairy farmer works more than 250 hours per month. The profitableness of grain crop production on these level upland soils is also a factor, as crops compete with cows for the available labor. Most dairy specialists believe a dairy farmer should plan for larger herds than indicated here, in order to spread the high fixed costs of modern dairy buildings and equipment.

As expected, the optimum land use program emphasized roughage production. The optimum cropping program varied with the level of net income attained, but all but one plan included 60 acres of the rotation sudan-soybeans-wheat-red clover. This indicates the importance of summer roughage on a dairy farm.

The range in land acreages and capital requirements was greater on the dairy farms than on the hog farms. Land acreage varied from 90 acres at the \$3,000 income level to 294 acres at the \$9,000 income level. Total capital ranged from approximately \$36,400 to \$114,100.

Beef Cattle Farm—Roughage Use Emphasis

Much has been said about the need for Missouri farmers to make greater and more efficient use of grasses and other roughages. It was decided, therefore, to establish one type of farm for analysis on which the livestock enterprises were limited to those which consume primarily roughages. The livestock enterprises put into the program were: (1) beef cow herd—calf sold, (2) beef cow herd—calf fed out, and (3) plain steer calves.

It is obvious from the results in Table 9 that these beef enterprises, which utilize primarily roughages, are not competitive on the level uplands of Northeast Missouri. With the input-output relationships assumed in this study it was impossible, even with the optimum organization, to attain a \$3,000 net income with labor levels 1 or 2. The relative profitableness of grain crops on these level soils and the labor requirements of these beef enterprises in relation to the profits per animal are the main reasons for this result.

Even with labor level 3 (a 2-man operation, plus up to one additional man in the summer months), the highest net income attained was \$5,000. Moreover, the optimum plans under labor level 3 are actually cash grain plans (primarily continuous corn). The beef cow herd enterprise in these plans is only a supplementary enterprise, not a major source of income.

The land and capital requirements for this type of farm are considerably higher than for either the hog or the dairy plans.

TABLE 9 -- ENTERPRISE COMBINATIONS AND RESOURCES USED IN THE COST-MINIMIZING SOLUTIONS TO ATTAIN DESIGNATED LABOR INCOMES ON A ROUGHAGE FEED BEEF CATTLE FARM, LEVEL UPLAND.

Item:	Net Labor Income Labor Level	\$ 3,000 L. L. 3	\$ 4,000 L. L. 3	\$ 5,000 ¹ L. L. 3
<u>Resources Used:</u>				
Land (acres)		250	333	414
Capital: Land Capital		\$49,876	\$66,502	\$82,767
Non-Land Capital		14,751	19,667	28,490
Total		64,627	86,169	111,257
Annual Labor Used (hours)		2,186	2,915	4,059
Months Restricted		0	0	5th
<u>Income Data:</u>				
Total Annual Cost		11,629	15,502	19,476
Net Labor Income		3,000	4,000	5,000
<u>Enterprise:</u>				
Cow with calf fed out ²		6	8	20
Crops (principal ³ rotation & acreage thereof)		240 C 10 CORpRp	319 C 13 CORpRp	315 C 53 CSbWRc 32 CORpRp 14 Sb
<u>Acres of Individual Crops⁴</u>				
Corn		242	322	335
Oats		3	4	8
Rotation Pasture		5	7	16
Soybeans		0	0	27
Wheat		0	0	14
Red Clover		0	0	14

¹Labor restrictions would not permit an income above \$5,000.

²Possible livestock enterprises not entering the final solution are: Beef cows with calves sold as feeders, and common quality steer calves purchased in late fall roughed through the winter and grazed till early fall.

³Numbers before letters indicate acreage of that rotation. Letters indicate crops as follows: C-Corn, O-Oats, Rp-Rotation pasture, Sb-Soybeans, W-Wheat, Rc-Red Clover.

⁴Acreages rounded to nearest whole number.

Beef Cattle Farm—Grain Use Emphasis

Because of the abundance of grain produced in the area, a type of farm was set up emphasizing beef cattle enterprises which utilize considerable amounts of grain in their rations. The three grain consumption beef enterprises put into the programs were: (1) long-fed, good to choice steer calves, (2) long-fed, good to choice yearling steers, and (3) short-fed, good to choice yearling steers. Plain steer calves, primarily a roughage consumption enterprise, were also put into the program. These enterprises were described in detail earlier.

TABLE 10 -- ENTERPRISE COMBINATIONS AND RESOURCES USED IN THE COST-MINIMIZING SOLUTIONS TO ATTAIN DESIGNATED NET LABOR INCOMES ON A GRAIN-FED BEEF CATTLE FARM, LEVEL UPLAND

Item: Net Labor Income Labor Level	\$3,000		\$4,000	\$5,000		\$6,000	\$7,000
	L.L. 1	L.L. 2	L.L. 2	L.L. 2	L.L. 3	L.L. 3	L.L. 3
Resources Used:							
Land (Acres)	134	124	166	230	206	247	288
Land Capital	26,832	24,853	33,291	45,762	41,303	49,402	57,502
Non-Land Capital	21,676	21,655	28,849	39,207	36,449	44,219	51,989
Total	48,508	46,508	62,140	84,969	77,751	93,621	109,491
Annual Labor Used: (Hours)							
Months Restrictive	1,954 5th	1,740 0	2,330 11th	3,219 3rd	2,901 0	3,482 0	4,064 0
Income Data:							
Total Annual Cost	8,234	7,878	10,530	14,607	13,130	15,757	18,383
Net Labor Income	3,000	3,000	4,000	5,000	5,000	6,000	7,000
Enterprises:							
Livestock ¹	35 (S-1) 43 (S-3)	86 (S-3)	3 (S-1) 112 (S-3)	103 (S-1) 36 (S-3)	146 (S-3)	173 (S-3)	210 (S-3)
Crops: (principal ² rotations and acreages thereof):	60 CSbWRc 45 Cont. C 23 CORpRp 7 COMmMm	70 Cont. C 41 CSbWRc 14 CORpRp	90 Cont. C 57 CSbWRc 19 CORpRp	76 Cont. C 60 CSbWRc 56 CORpRp 38 SilBRc	118 Cont. C 60 CSbWRc 22 CORpRp 7 COMmMm	144 Cont. C 60 CSbWRc 26 CORpRp 17 COMmMm	170 Cont. C 60 CSbWRc 30 CORpRp 28 COMmMm
Acres of Individual Crops³							
Corn	68	83	109	105	140	169	200
Oats	7	4	5	14	7	10	14
Soybeans	15	10	14	15	15	15	15
Wheat	15	10	14	15	15	15	15
Barley	0	0	0	13	0	0	0
Corn Silage	0	0	0	13	0	0	0
Red Clover	15	10	14	28	15	15	15
Rotation Pasture	11	7	10	28	10	12	14
Mixed Meadow	3	0	0	0	0	8	14

¹(S-1) Steer system 1, steer calves purchased in fall and fed out; (S-2) Steer system 2, yearling steers purchased in fall and fed out the following late summer and fall; (S-3) Steer system 3, yearling steers purchased in fall and fed out by Mid-May; (S-4) Steer system 4, Common steer calves purchased in late fall roughed through winter and grazed till early fall.

²Number before letters indicates acreages of that rotation. Letters indicate crops as follows: C-Corn, O-Oats, Rp-Rotation Pasture, Mm-Mixed Meadow, Sb-Soybeans, W-Wheat, Rc-Red Clover, Sil-Corn Silage, B-Barley.

³Acreages rounded to nearest whole acre.

The beef feeding enterprises, utilizing grain as a major part of their rations, proved to be much more competitive on the level upland farms than did the roughage emphasizing beef programs. A \$3,000 net income was derived using only the operator's labor (labor level 1) and \$5,000 was attained using the operator's labor plus 1100 hours additional seasonal labor. Thus, a reasonable level of income was attained with a typical family labor supply.

TABLE 11 -- LAND RESOURCE RANGES AND COST-MINIMIZING SOLUTIONS WHICH UTILIZE ACREAGES OF LAND WITHIN GIVEN RESOURCE RANGES, LEVEL UPLAND FARMS.

Acreage	Main Enterprise	Income	Cost	Investment	Labor Level	Total Labor (Hrs.)
<u>100 Acres or Less</u>						
83	Hogs	\$3,000	\$ 7,249	\$ 31,334	1	1,497
90	Dairy	3,000	5,906	36,383	1	2,369
94	Dairy	3,000	5,334	35,570	2	2,226
96	Hogs	6,000	23,248	62,680	1	2,479
100	Hogs	4,000	11,562	42,641	1	2,053
<u>101 to 120 Acres</u>						
109	Hogs	5,000	16,138	52,936	1	2,109
110	Hogs	4,000	9,665	41,755	2	2,000
120	Dairy	4,000	7,387	47,334	2	3,053
<u>121 to 160 Acres</u>						
123	Dairy	4,000	7,153	46,673	3	2,991
124	Grain Cattle	3,000	7,878	46,508	2	1,740
134	Grain Cattle	3,000	8,234	48,508	1	1,954
156	Dairy	5,000	9,087	60,243	3	3,749
158	Hogs	7,000	28,249	82,093	2	2,913
<u>161 to 200 Acres</u>						
166	Grain Cattle	4,000	10,530	62,140	2	2,330
168	Hogs	5,000	12,700	58,122	2	2,510
178	Hogs	6,000	18,295	69,864	2	2,624
189	Dairy	6,000	11,040	72,911	3	4,506
193	Hogs	7,000	16,194	73,090	3	2,952
<u>201 to 240 Acres</u>						
206	Grain Cattle	5,000	13,130	77,751	3	2,901
216	Dairy	7,000	13,039	84,631	3	5,325
230	Grain Cattle	5,000	14,607	84,969	2	3,219
<u>241 to 280 Acres</u>						
246	Dairy	8,000	15,013	96,864	3	5,218
247	Grain Cattle	6,000	15,757	93,621	3	3,482
250	Roughage Cattle	3,000	11,629	64,627	3	2,186
<u>Above 280 Acres</u>						
288	Grain Cattle	7,000	18,383	109,491	3	4,064
294	Dairy	9,000	17,750	114,084	3	6,102
333	Roughage Cattle	4,000	15,502	86,169	3	2,915
414	Roughage Cattle	5,000	19,476	111,257	3	4,059

The \$7000 net income level was obtained with labor level 3. Considering that at this income level the labor supply is not entirely used in any month it is likely that somewhat higher income levels could have been reached.

The optimum plans vary with the labor supply and income level. Only two of the three cattle feeding systems are in the optimum plans. The steer calf feeding enterprise was part of lower income level plans, but at the higher income levels the short-fed yearling steer programs prevail.

Except for the crop acreages and numbers of animals involved, all of the optimum plans under labor level 3 were the same. This is as expected as the monthly labor supply was not restrictive at any of the income levels studied.

There is sufficient grain produced on the farm for the cattle at all income levels. This is different from the optimum hog farm plans where considerable amounts of corn are purchased because of the labor restriction. More land and capital is used in these cattle plans than in the hog plans.

A Comparison of Resource Requirements—Level Upland Farms

Often a farmer has a definite acreage of land on which to develop a business. In this case he is interested in studying how much income he can make from different types of businesses with the given land area. In Table 11 the optimum plans (minimum-cost plans) for level upland farms, as determined in this study, are presented in such a way that plans involving acreages within given size ranges can be compared. The table shows what optimum plans use approximately the same acreage, how much income is attained, what annual costs and investment are involved, and how much labor is needed to run the operation. The details of these plans can then be studied by referring back to the specific tables where these optimum plans are presented.

ROLLING UPLAND FARM

The rolling upland farm is described as a farm containing 25 percent level upland, 50 percent tillable rolling upland, and 25 percent non-tillable rolling upland. The livestock alternatives are identical to those in the level upland programs. However, the crop enterprises are designed to fit the soil conditions of this type of land resource.

Hog Farm

Using labor levels 1 or 2 it was possible to attain only a \$4000 income for the optimum hog plans on the rolling upland farm. This is considerably lower than the incomes attainable with these labor supplies on level upland hog farms.

The major reason for the lower incomes was the assumption that 25 percent of all land purchased was non-tillable rolling land and an additional 50 percent of the land had a topography on which row crops could be grown only once every four years. This restriction meant that in order to have 15 acres of corn the program had to purchase at least 40 acres of land. Moreover, at least

TABLE 12 -- ENTERPRISE COMBINATIONS AND RESOURCES USED IN THE COST MINIMIZING SOLUTIONS TO ATTAIN DESIGNATED LABOR INCOMES ON A HOG FARM, ROLLING UPLAND.

Net Labor Income Labor Level	\$ 3,000 1	\$ 3,000 2	\$ 4,000 1	\$ 4,000 3	\$ 5,000 3	\$ 6,000 3	\$ 7,000 3
<u>Resources Used:</u>							
Land (Acres)	183	184	178	245	306	368	459
Land Capital	25,640	25,360	24,864	34,361	42,951	51,540	64,250
Non-Land Capital	29,364	24,000	34,178	30,195	37,687	45,224	55,030
Total	55,004	49,360	59,042	64,556	80,638	96,764	119,280
<u>Annual Labor Used (Hours):</u>	2,244	2,205	2,743	2,939	3,259	3,660	5,008
Months Restrictive	7th	3rd	3rd, 5th & 6th	0	0	0	3rd
Total Annual Cost	9,595	9,495	16,495	12,772	15,962	19,156	22,698
Net Labor Income	3,000	3,000	4,000	4,000	5,000	6,000	7,000
<u>Enterprises:</u>							
Hogs ¹	18	18	33	24	30	36	39
S-4 (Plain steers)	73	67	73	90	112	135	200
<u>Crops (principal rotation and acreages)²</u>							
C, O, Rp, Rp	62	50	0	67	84	101	0
Upp	46	46	45	61	77	92	115
Cont. Corn	46	46	45	62	77	92	115
C, O, Mm, Mm	11	42	5	55	68	83	0
Ipp	0	0	54	0	0	0	57
C, Sb, W, Rc, Rc	0	0	13	0	0	0	0
C, O, Rc, Rc	0	0	0	0	0	0	0
C, O, 4A	18	0	16	0	0	0	67
IDLE	0	0	0	0	0	0	105

Table 12 (Cont'd)

Net Labor Income	\$ 3,000	\$ 3,000	\$ 4,000	\$ 4,000	\$ 5,000	\$ 6,000	\$ 7,000
Labor Level	1	2	1	3	3	3	3
Acres of Individual Crops ³							
Rotation Pasture	32	25	0	33	42	51	0
Unimproved Perm. Pasture	46	46	45	61	77	92	115
Improved Permanent Pasture	0	0	54	0	0	0	57
Mixed Meadow	6	20	2	28	34	41	0
Soybeans	0	0	2	0	0	0	0
Wheat	0	0	2	0	0	0	0
Red Clover	0	0	5	0	0	0	0
Alfalfa	12	0	12	0	0	0	44
Corn	65	70	50	92	115	138	126
Oats	22	23	6	31	36	46	12
IDLE	0	0	0	0	0	0	105
Corn Purchase	0	0	4,500	0	0	0	0

¹Hogs refer to the number of sows which farrow two times per year. Steers refer to the number of common quality steer calves purchased in fall, roughed through the winter, grazed during the summer and sold in early fall.

²Letters indicate crops as follows: C-Corn, O-Oats, Rp-Rotation Pasture, Sb-Soybeans, Ipp-Improved Permanent Pasture, Upp-Unimproved Permanent Pasture, Mm-Mixed Meadow, W-Wheat, Rc-Red Clover, and A-Alfalfa.

³Acreages rounded off to nearest whole acre.

20 acres of this total had to be in roughage production. As taxes and interest on this land adaptable to roughage production must be paid regardless of whether or not the land is actually used, the program must try to find some way to use it. The optimum hog farm plans thus included major roughage consuming livestock enterprises.

This land restriction, and lower corn yields on the rolling upland, caused the optimum hog farm plans to be considerably different from the hog farm plans on level upland. The sizes of the optimum hog enterprises on rolling upland were smaller, much more land was used, somewhat more capital was needed, and a major plain steer calf feeding enterprise was included in every plan.

Continuous corn was produced on all level upland in the optimum plans. Corn was purchased in only one of the optimum plans, the \$4,000 net income level with labor level 1. At that income level the labor supply became very restrictive.

At the \$7000 income level, even labor level 3 becomes restrictive, and major changes occur in the optimum program. To reach this income level the program purchases an additional 91 acres of land in order to have more level corn land. The use of the rolling cropland undergoes dramatic changes. Alfalfa and improved permanent pasture come into the program and, at the same time, 105 acres are left idle. In other words, it is more profitable (with the stated restrictions) to concentrate roughage production on only part of the land and leave some land idle than to use all land, but less intensively. Sixty-five more head of plain steer calves are in the optimum plan at the \$7000 income level than at the \$6000 level.

Dairy Farm

While it was possible to attain a \$3000 net income on the level upland dairy farm with only the operator's labor available, this income level could not be reached on the rolling upland farm. The greater profitableness of grain production on level upland accounts for the difference.

Except for this one difference, the same income levels could be reached with given labor supplies on level upland and rolling upland dairy farms (Table 13). Moreover, there are many similarities in the sizes of enterprises and resources needed for the optimum dairy plans on these two land situations. There are differences, but not nearly so many as described above for the hog farms.

The optimum sizes of dairy herds were virtually the same as on the level upland farms. The sources of roughage for the dairy cattle varied, however. Silage was a major source of roughage in the optimum level upland dairy plans, but hay and pasture were emphasized on the rolling upland dairy plans. Alfalfa hay was not produced in the optimum level upland plans, but was produced in large quantities on the rolling upland plans.

TABLE 13 -- ENTERPRISE COMBINATIONS AND RESOURCES USED IN THE COST MINIMIZING SOLUTIONS TO ATTAIN DESIGNATED LABOR INCOMES ON A DAIRY FARM, ROLLING UPLAND.

Net Labor Income Labor Level	\$ 3,000 2	\$ 4,000 2	\$ 4,000 3	\$ 5,000 3	\$ 6,000 3	\$ 7,000 3	\$ 8,000 3	\$ 9,000 3
Resources Used:								
Land (Acres)	101	145	137	173	209	251	280	316
Land Capital	14,163	20,303	19,190	24,216	29,243	35,174	39,300	44,230
Non-Land Capital	17,283	22,790	23,278	29,274	35,270	41,975	47,260	53,322
Total	31,446	43,093	42,468	53,490	64,513	77,149	86,560	96,552
Annual Labor Used (hours)	2,313	3,014	3,120	3,869	4,738	4,831	5,287	5,985
Months Restricted	0	4th	0	0	0	0	0	7th
Total Annual Cost	4,989	7,042	6,743	8,497	10,251	12,277	13,760	15,653
Net Labor Income	3,000	4,000	4,000	5,000	6,000	7,000	8,000	9,000
Enterprise:								
Dairy Cows	17	22	23	29	35	41	46	52
Crops (Principal rotations & acreage)¹								
C, O, 4A	30	47	43	52	65	80	86	93
C, O, Mm, Mm	20	0	26	35	40	51	56	40
Cont. Corn	6	12	8	10	12	12	15	24
C, Sb, W, Rc	0	24	0	0	0	0	0	0
Upp	25	36	34	43	52	62	70	79
Ipp	20	26	26	33	40	46	53	63
Sil, B, Rc	0	0	0	0	0	0	0	17
Acres of Individual Crops²								
Corn	16	25	21	26	32	38	43	50
Oats	10	6	14	16	20	25	28	25
Alfalfa	20	34	28	37	45	54	58	64
Mixed Meadow	10	0	14	18	20	25	28	20
Soybeans	0	6	0	0	0	0	0	0
Wheat	0	6	0	0	0	0	0	0
Red Clover	0	6	0	0	0	0	0	5
Unimproved Pasture	25	36	34	43	52	62	70	79
Improved Pasture	20	26	26	33	40	46	53	63
Silage	0	0	0	0	0	0	0	5
Barley	0	0	0	0	0	0	0	5

¹ Letters indicate crops as follows: C-Corn, O-Oats, A-Alfalfa, Mm-Mixed Meadow, Sb-Soybeans, W-Wheat, Rc-Red Clover, Upp-Unimproved Permanent Pasture, Ipp-Improved Permanent Pasture, Sil-Silage, B-Barley.

² Acreages rounded to nearest whole acre.

Somewhat more land was needed in the optimum rolling upland dairy plans,, but the differences were surprisingly small. The largest difference at any specific income level was 35 acres.

Less total capital was needed for the optimum rolling than for the level upland plans. This was due to the lower per acre value of the rolling upland. The operational capital needs were approximately the same.

Beef Cattle Farm—Roughage Use Emphasis

It was impossible to obtain even a \$3000 net income on the rolling upland farm with either labor level 1 or labor level 2 when the emphasis was on roughage consuming beef cattle. Only a \$5000 net income could be obtained with labor level 3. These income results are the same as the results obtained for the same type of farm business on level upland. But the optimum plans are a great deal different.

The optimum plans on level upland when these enterprises were analyzed are cash grain operations with only supplemental beef enterprises. On rolling upland, the optimum plans involve major beef enterprises. The program, beef cow herd-calves fed out, showed clear income superiority to the beef cow herd-calves sold in these plans. At the \$5000 income level plain steer calves were in the plan as a major enterprise, because of monthly labor restrictions.

The cropping program, as expected, emphasized roughage production. One surprise was that not all of the level upland was in continuous corn at the \$4000 and \$5000 income levels. This was partly due to the monthly labor restrictions.

The land and capital requirements for these optimum plans are very high, both in relation to the other types of farm businesses on the same land, and the same type of business on level upland (assuming it should be called the same type). The totals of 670 acres of land and \$158,000 capital to attain a \$5000 net income clearly illustrate the need for careful consideration before starting this type of business in Northeast Missouri.

Beef Cattle Farm—Grain Use Emphasis

Perhaps the biggest surprise of the entire study was the inability of the beef cattle-grain use emphasis plan to attain high income levels on the rolling upland farm. The program could not even reach the \$3000 net income level with the operator's labor. Moreover, a \$5000 net income was the highest attainable with labor level 3 (two-man operation plus seasonal labor). On the level upland farm a \$7000 income was obtained.

The land composition restriction was a major difference in the results obtained between the level and rolling upland farms. Crop yields and land costs also affected the results. But the major reason why higher net incomes could not be obtained was associated with the labor requirements of the cattle feeding enterprises. The fact that three different rotations were brought into the optimum plans on the tillable rolling upland was evidence that a complex cropping program was necessary in order to meet the monthly labor restrictions. While

TABLE 14 -- ENTERPRISE COMBINATIONS AND RESOURCES USED IN THE COST MINIMIZING SOLUTIONS TO ATTAIN DESIGNATED LABOR INCOMES ON A ROUGHAGE FED BEEF CATTLE FARM, ROLLING UPLAND

Net Labor Income Labor Level	\$ 3,000 3	\$ 4,000 3	\$ 5,000 3
<u>Resources Used:</u>			
Land (Acres)	340	453	670
Land Capital	47,547	63,394	93,600
Non-Land Capital	39,790	54,160	64,620
Total	87,437	117,554	158,220
<u>Annual Labor</u> (Hours)	4,215	5,112	6,370
Months Restrictive	0	5th	3, 5, 7, & 9th
Total Annual Cost	13,594	18,173	24,193
Net Labor Income	3,000	4,000	5,000
<u>Enterprises:</u>			
<u>Livestock</u>			
Beef Cows (Calves Fed Out)	63	87	56
Plain Steer Calves	0	0	189
<u>Principial Rotation</u> ²			
Upp	85	113	167
Ipp	48	69	165
C, O, 4A	122	158	128
C, Sb, W, Rc	0	27	60
C, O, Mm, Mm	0	0	40
Cont. Corn	85	86	110
<u>Acres of Individual Crops</u> ³			
Unimproved Permanent Pasture	85	113	167
Improved Permanent Pasture	48	69	165
Corn	107	120	157
Oats	20	26	32
Alfalfa	80	104	84
Soybeans	0	7	15
Wheat	0	7	15
Red Clover	0	7	15
Mixed Meadow	0	0	20

¹Common steer calves purchased in late fall roughed through winter and grazed till early next fall.

²Letters indicate crops as follows: Upp--Unimproved Permanent Pasture, Ipp--Improved Permanent Pasture, C, O, 4A--Corn, Oats, 4 years Alfalfa, C,Sb,W,Rc--Corn, Soybeans, Wheat, Red Clover, C,O,Mm,Mm--Corn, Oats, 2 years Mixed Meadow, Cont. Corn--Continuous Corn.

³Acreage rounded to nearest whole number.

generally accepted labor requirements were used for these beef enterprises, it is apparent that greater labor efficiency than was assumed would have to be obtained to achieve high incomes from beef enterprises on this kind of land.

As with the level upland beef plans, the good to choice steer calf feeding system is an important enterprise at the lower income levels, but is replaced at

TABLE 15 -- ENTERPRISE COMBINATIONS AND RESOURCES USED IN THE COST MINIMIZING SOLUTIONS TO ATTAIN DESIGNATED LABOR INCOMES ON A GRAIN FED STEER FARM, ROLLING UPLAND

	\$ 3,000	\$ 4,000	\$ 5,000
Net Labor Income			
Labor Level	2	2	3
Resources Used:			
Land (Acres)	186	250	380
Land Capital	26,035	34,710	53,270
Non-Land Capital	26,205	35,390	50,980
Total	52,240	70,100	104,250
Annual Labor (Hours)	2,099	2,886	4,194
Months Restrictive	0	7th	3rd
Total Annual Cost	8,989	12,097	16,950
Net Labor Income	3,000	4,000	5,000
Enterprises:			
Livestock ¹ S-1	90	114	0
S-2	0	0	0
S-3	0	0	145
S-4	0	15	10
Principal Rotations²			
Upp	46	62	95
C,O,Rp,Rp	10	36	70
C,O,Mm,Mm	65	32	110
C,O,4A	18	56	10
Cont. Corn	47	63	95
Acres of Individual Crops³			
Unimproved Permanent Pasture	46	62	95
Corn	67	89	141
Oats	23	26	47
Rotation Pasture	5	18	35
Mixed Meadow	33	16	55
Alfalfa	12	38	7

¹(S-1) Steer system 1, steer calves purchased in fall and fed out; (S-2) Steer system 2, yearling steer purchased and fed out by mid summer; (S-3) Steer system 3, yearling steers purchased in fall and fed out; (S-4) Steer system 4, common steer calves purchased in late fall roughed through winter and grazed until early fall.

²Letters indicate crops as follows: C-Corn, O-Oats, Rp-Rotation Pasture, Mm-Mixed Meadow, A-Alfalfa, Upp-Unimproved Permanent Pasture.

³Acresages rounded off to nearest whole acre.

the higher income levels by the yearling steers—short fed enterprise. The competition for labor between crops and cattle in the spring and summer months is the main reason for this shift. It is interesting to note that plain steer calves, utilizing roughages almost entirely, enter the optimum plans at the \$4000 and \$5000 level.

The land and capital requirements of this type of business are considerably higher than on the level upland. For example 206 acres of land are needed to

attain a \$5000 net income on the level upland whereas the optimum solution for this income level includes 380 acres in the rolling upland plan.

A Comparison of Resource Requirements

Optimum rolling upland plans are listed in Table 16 by the acreage of land involved. This permits comparison of different types of plans using approximately the same acreages of land.

TABLE 16 -- LAND RESOURCE RANGES AND COST-MINIMIZING SOLUTIONS WHICH UTILIZE ACREAGES OF LAND WITHIN THESE RESOURCE RANGES, ROLLING UPLAND FARMS

Acreage	Main Enterprise	Income	Cost	Investment	Labor Level	Total Labor
<u>120 Acres or Less</u>						
101	Dairy	\$3,000	4,989	31,446	2	2,313
<u>121 to 160 Acres</u>						
137	Dairy	4,000	6,743	42,468	3	3,130
145	Dairy	4,000	7,042	43,093	2	3,014
<u>161 to 200 Acres</u>						
173	Dairy	5,000	8,497	53,490	3	3,869
178	Hogs	4,000	16,495	59,042	1	2,742
183	Hogs	3,000	9,595	55,004	1	2,244
184	Hogs	3,000	9,495	49,360	2	2,205
186	Grain Cattle	3,000	8,989	52,240	2	2,099
<u>201 to 240 Acres</u>						
209	Dairy	6,000	10,251	64,513	3	4,738
<u>241 to 280 Acres</u>						
245	Hogs	4,000	12,772	64,556	3	2,939
250	Grain Cattle	4,000	12,097	70,100	2	2,886
251	Dairy	7,000	12,277	77,149	3	4,831
280	Dairy	8,000	13,760	86,560	3	5,287
<u>281 to 320 Acres</u>						
306	Hogs	5,000	15,962	80,638	3	3,259
316	Dairy	9,000	15,653	97,552	3	5,985
<u>Over 320 Acres</u>						
340	Roughage Cattle	3,000	13,594	87,437	3	4,215
368	Hogs	6,000	19,156	96,764	3	3,660
380	Grain Cattle	5,000	16,950	104,250	3	4,194
453	Roughage Cattle	4,000	18,173	117,554	3	5,112
459	Hogs	7,000	22,698	119,280	3	5,008
670	Roughage Cattle	5,000	24,193	158,220	3	6,370

BOTTOMLAND COMBINATION FARMS

This model farm represents farms located along the small rivers in Northeast Missouri. As such farms typically have rolling upland along with bottomland the model set up in this study is made up of 50 percent tillable bottomland, 25 percent tillable rolling upland, and 25 percent rolling non-tillable pasture land. For the bottomland farms along the Missouri and Mississippi rivers this model farm is not typical.

Hog Farm

The programming results strongly reflect the applicability of a hog business for this type of land resource situation. The abundance of grain produced on the productive bottomland makes grain consuming livestock enterprises natural complements to the cropping systems.

With one exception, the same net incomes were obtained with given labor supplies on bottomland hog farms as on level upland hog farms. The exception was that only \$5000, as compared with \$6000 on the level upland, could be attained with just the operator's labor. Higher maximum incomes were obtained at given labor supply levels than on the rolling upland hog farms.

The optimum hog farm plans are notably different from those on either the level upland or the rolling upland. This is to be expected as the available land source bases are different. The bottomland farm combines the highly productive bottomland which can be used intensively with rolling upland on which roughage production must be emphasized.

The optimum plans contain both hogs and plain steer calves. The optimum sizes of hog enterprises are somewhat smaller than those on the level upland. The plain steer calf enterprise enters the plans to utilize roughage grown on the rolling upland. The steer calf enterprises, while not nearly so large as those in the rolling upland farms, are important in all plans.

The bottomland was cropped intensively in all optimum plans, the cropping system being comprised of continuous corn, and some continuous soybeans in one plan. One interesting aspect of the optimum plans was that a high percentage of the tillable upland that was purchased was left idle. The computer found it less costly to purchase this land and leave it idle (in order to get the bottomland that came with it) than to produce crops on it.

The acreages used in the optimum plans were somewhat higher than for the level upland hog farms, but not nearly so large as for the rolling upland hog farms. The one major exception to the prevailing land use pattern was at the \$7000 income level using labor level 2. As the available labor supply was nearly utilized, the computer found that the least costly way to move from \$6000 net income to \$7000 was to buy an additional 123 acres of land and produce 50 of soybeans on the bottomland. Other shifts in land use also took place at the \$7000 level because of the monthly labor restrictions, with one of the net results being that 84 acres of tillable upland was left idle.

TABLE 17 -- ENTERPRISE COMBINATIONS AND RESOURCES USED IN THE COST MINIMIZING SOLUTIONS TO ATTAIN DESIGNATED LABOR INCOMES ON A HOG FARM, SMALL RIVER BOTTOMS

Net Labor Income Labor Level	\$ 3,000 1	\$ 4,000 1	\$ 5,000 1	\$ 5,000 2	\$ 6,000 2	\$ 7,000 2	\$ 7,000 3
<u>Resources Used:</u>							
Land (Acres)	105	140	161	175	210	333	245
Land Capital	18,668	24,890	28,652	31,113	37,336	59,984	43,558
Non-Land Capital	13,075	17,433	23,351	21,791	26,149	30,497	30,507
Total	31,743	42,323	52,003	52,904	63,485	90,481	74,065
<u>Annual Labor Used (Hours):</u>							
Months Restrictive	1,308 0	1,743 0	2,255 5th	1,806 0	2,168 0	2,730 11th	2,528 0
<u>Income Data:</u>							
Total Annual Cost	6,276	8,368	10,600	10,460	12,552	15,629	14,644
Net Labor Income	3,000	4,000	5,000	5,000	6,000	7,000	7,000
<u>Enterprises:</u>							
Livestock ¹ Hogs	18	24	28	29	35	34	41
S-4 (Plain Steer Calves)	12	16	39	20	24	45	28
<u>Crop (principal rotations & acreage)²</u>							
Unimproved Pasture	26	35	40	44	53	84	62
Cont. Corn	53	70	80	88	106	95	123
Cont. Soybeans	0	0	0	0	0	50	0
C, O, Mm, Mm	3	5	19	5	6	0	8
C, Sb, W, Rc	0	0	0	0	0	20	0
Imp. Pasture	0	0	22	0	0	0	0
IDLE	23	30	0	38	45	84	52
<u>Acres of Individual Crops³</u>							
Unimproved Pasture	26	35	40	44	53	84	62
Corn	54	72	85	88	106	100	125
Oats	0	0	4	2	2	0	2
Mixed Meadow	2	3	10	3	4	0	4
Improved Perm. Pasture	0	0	22	0	0	0	0
Soybeans	0	0	0	0	0	55	0
Wheat	0	0	0	0	0	5	0
Red Clover	0	0	0	0	0	5	0
IDLE	23	30	0	38	45	84	52

¹ Hogs refer to the number of sows which farrow two times per year; Steers refer to steer system 4, common steer calves purchased in fall, roughed through winter, grazed during summer, and sold in early fall.

² Letters indicate crops as follows: C-Corn, O-Oats, Mm-Mixed Meadow, Disp-Land Not Used, Sb-Soybeans, W-Wheat, Rc-Red Clover.

³ Acreages rounded to nearest whole acre.

The capital requirements for the optimum plans were basically not much higher than for the level upland hog farms. The value of larger acreages was partially offset by the fact that no corn was purchased on the bottomland hog farms.

Dairy Farm

As with the dairy businesses on the other types of land, optimum dairy plans for bottomland resource situation were determined to the highest income level obtainable. Because of the productive bottomland, higher income levels were reached for each labor level than was possible on either the level upland or the rolling upland. For example, with labor level 3 an \$11,000 net income was obtained, whereas \$9000 was the highest possible on the other types of land.

The optimum bottomland dairy plans are interesting. The productive bottomland made it possible to obtain the given income levels with smaller dairy herds than on the level or rolling upland farms. These herds at the lower income levels are smaller than generally recommended as the size necessary to justify the capital required for dairy buildings and equipment.

The cropping programs in the optimum plans were complex in that at least three different rotations exist in each plan. Furthermore, the land use varied considerably with the income levels and the labor levels. The emphasis of the bottomland cropping system was on roughage production rather than cash grain production in many of the optimum plans. In the optimum hog and beef plans the bottomland was used almost entirely in continuous corn. Evidently the assumed roughage yields on the bottomland were high enough to make roughage production competitive when the labor supply was not restrictive and roughage was converted efficiently into milk.

Whenever labor became restrictive, however, the cropping system shifted toward cash grain production on the bottomland. This can be noted at the highest income level attainable for each labor supply. The extreme example of this occurred at the \$11,000 income level, where there was a major shift toward cash grain production. The number of dairy cows was reduced to 38 and 144 acres of land were added. The acreage of continuous corn was increased from 42 to 115, 30 acres of soybeans were added to the cropping system and 100 acres of tillable upland were left idle.

A comparison of the resources needed to obtain comparable net incomes on level upland, rolling upland, and bottomland dairy farms reveals that less land and capital were needed on the bottomland farm than on the other two land types.

Beef Cattle Farm—Roughage Use Emphasis

The bottomland resource model was also programmed to determine if and how beef enterprises which utilize primarily roughages would fit into a business on this kind of land.

TABLE 18 -- ENTERPRISE COMBINATIONS AND RESOURCES USED IN THE COST MINIMIZING SOLUTIONS TO ATTAIN DESIGNATED LABOR INCOMES ON A DAIRY FARM, SMALL RIVER BOTTOM

Net Labor Income Labor Level	\$3,000 1	\$4,000 1	\$4,000 2	\$5,000 2	\$5,000 3	\$6,000 2	\$6,000 3	\$7,000 3	\$8,000 3	\$9,000 3	\$10,000 3	\$11,000 ¹ 3
Resources Used:												
Land (Acres)	87	140	116	163	145	287	174	202	231	269	376	520
Land Capital	15,408	24,935	20,545	28,997	25,680	50,950	30,817	35,953	41,089	47,722	66,794	92,235
Non-Land Capital	15,792	20,119	21,057	22,877	26,320	25,580	31,585	36,848	42,113	44,038	45,141	46,939
Total	31,200	45,054	41,602	51,874	52,000	76,530	62,402	72,801	83,202	91,760	111,935	138,174
Annual Labor Used: (Hours)	2,055	2,556	2,741	3,015	3,426	3,472	4,111	4,796	5,481	5,859	5,990	6,261
Months Restrictive	0	6 & 7	0	3 & 4	0	3 & 11	0	0	0	4 & 5	3 & 4	3,5 & 11
Total Annual Cost	4,569	6,651	6,092	7,870	7,615	11,228	9,137	10,660	12,148	13,789	16,490	20,130
Net Labor Income	3,000	4,000	4,000	5,000	5,000	6,000	6,000	7,000	8,000	9,000	10,000	11,000
Enterprises:												
Dairy Cows ¹	16	20	21	21	27	21	32	37	43	43	42	38
Crops (Principal rotations & acreages)²												
22 Ipp		21 Ipp	29 Ipp	24 Ipp	36 Ipp	72 Upp	43 Ipp	51 Ipp	58 Ipp	62 Ipp	35 Ipp	130 Upp
22 Upp		35 Upp	29 Upp	41 Upp	36 Upp	22 CORcRc	43 Upp	51 Upp	58 Upp	67 Upp	94 Upp	30 COMmMm
18 CO4A		25 Cont. C	23 CO4A	12 COMmMm	28 CO4A	46 Cont. C	36 CO4A	41 CO4A	41 CO4A	40 COMmMm	12 COMmMm	115 Cont. C
20 COMmMm		24 SiIBRc	27 COMmMm	20 CORc	35 COMmMm	32 Cont. B	40 COMmMm	47 COMmMm	54 COMmMm	41 CO4A	42 Cont. C	30 Cont. B
5 CORcRc		20 COMmMm	8 CORc	60 CSbWRc	10 CORc	60 CSbWRc	12 CORc	12 CORc	14 CORc	60 CSbWRc	86 CORc	60 CSbWRc
		14 Idle		6 Idle		6 CORc				47 Idle	60 CSbWRc	50 CORc
						49 Idle					47 Idle	100 Idle
Acres of Individual Crops³												
Improved Perm. Pasture	22	21	29	24	36	0	43	51	58	62	35	0
Unimproved Perm. Pasture	22	35	29	41	36	72	43	51	58	67	94	130
Corn	9	30	12	25	16	68	20	22	28	31	88	154
Oats	8	6	12	9	16	7	20	22	28	16	32	24
Alfalfa	12	0	16	0	20	0	24	28	28	28	0	0
Mixed Meadow	10	10	14	6	18	0	20	24	26	20	6	16
Red Clover	4	8	4	22	3	28	4	4	5	15	44	32
Silage	0	8	0	0	0	0	0	0	0	0	0	2
Barley	0	8	0	0	0	0	0	0	0	0	0	2
Wheat	0	0	0	15	0	15	0	0	0	15	15	15
Soybeans	0	0	0	15	0	48	0	0	0	15	15	45
Disposal	0	14	0	6	0	49	0	0	0	0	47	100

¹Dairy programs were solved to determine the highest net income level possible restricted only by labor.

²Number before letter indicates acreages of that rotation. Letters indicate crops as follows: Ipp-Improved Permanent Pasture, Upp-Unimproved Permanent Pasture, C-Corn, O-Oats, A-Alfalfa, Mm-Mixed Meadow, Rc-Red Clover, SiI-Corn Silage, B-Barley, Disp-Land not in use, Sb-Soybeans, W-Wheat.

³Acreages rounded to nearest whole acre.

TABLE 19 -- ENTERPRISE COMBINATIONS AND RESOURCES USED IN THE COST MINIMIZING SOLUTIONS TO ATTAIN DESIGNATED LABOR INCOMES ON A ROUGHAGE FED BEEF CATTLE FARM, SMALL RIVER BOTTOM.

Net Labor Income Labor Level	\$3,000 1	\$4,000 1	\$4,000 2	\$5,000 2	\$5,000 3	\$6,000 3	\$7,000 3
Resources Used:							
Land (Acres)	220	305	294	375	366	438	510
Land Capital	39,145	54,105	52,135	66,525	64,971	78,809	96,052
Non-Land Capital	15,668	21,762	20,728	25,712	25,365	29,998	34,635
Total	54,813	75,867	72,863	92,237	90,336	107,807	125,287
Annual Labor Used: (Hours)	1,690	2,328	2,246	2,697	2,775	3,306	3,837
Months Restrictive	0	5, 6 & 10	0	11h	0	0	0
Income Data:							
Total Annual Cost	7,987	11,027	10,720	13,480	13,420	15,938	18,630
Net Labor Income	3,000	4,000	4,000	5,000	5,000	6,000	7,000
Enterprises:							
Livestock ¹	86	121	113	134	133	153	172
S-4 (plain steer calves)							
Crops (Principal rotations and acreages) ²	55 IPP 55 Upp 62 Cont. C 48 CSbWRc	76 Ipp 76 Upp 100 Cont. C 12 CSbWRc 9 COMmMm 32 CORc	74 IPP 74 Upp 89 Cont. C 60 CSbWRc	77 Ipp 94 Upp 95 Cont. C 60 CSbWRc 17 COMmMm 32 Cont. B	78 Ipp 92 Upp 124 Cont. C 60 CSbWRc 12 COMmMm	86 Ipp 109 Upp 159 Cont. C 60 CSbWRc 24 COMmMm	93 Ipp 125 Upp 196 Cont. C 60 CSbWRc 36 COMmMm
Acres of Individual Crops³							
Corn	74	116	104	114	142	180	219
Oats	0	13	0	4	3	6	10
Red Clover	12	13	15	15	15	15	15
Improved Perm. Pasture	55	76	71	77	78	86	93
Unimproved Perm. Pasture	55	76	74	94	92	109	125
Soybeans	12	3	15	48	15	15	15
Wheat	12	3	15	15	15	15	15
Mixed Meadow	0	5	0	8	6	12	18

¹S-4 refers to steer system 4, Common steer calves purchased in fall, roughed through the winter, grazed during summer and sold in early fall. Enterprise possibilities not entering the final solution are cows with calves sold as feeders and cows with calves fed out.

²Numbers before letters indicate acreage of that rotation. Letters indicate crops as follows: Ipp-Improved Permanent Pasture, Upp-Unimproved Permanent Pasture, C-Corn, Sb-Soybeans, W-Wheat, Rc-Red Clover, Mm-Mixed Meadow.

³Acreages rounded to nearest whole acre.

Much higher income levels were obtained from this program than were obtained on level upland or rolling upland when high roughage consumption beef enterprises were studied. For example, it was impossible on the level or rolling uplands to even attain a \$3000 net income with labor levels 1 or 2, but in the optimum bottomland plan a \$4000 net income was reached with labor level 1 and \$5000 with labor level 2. A \$7000 net income was reached with labor level 3.

The optimum plans put major emphasis on cash grain production. The bottomland was devoted almost entirely to corn, soybeans and wheat. This accounts for the higher levels of income.

While grain crops provided the major source of income, a plain steer calf enterprise was an important part of each plan. These cattle performed the function of utilizing profitably the roughage produced on the rolling upland part of the farm. Evidently the plain steer calves performed this function effectively as they used all of the rolling upland. Some of the tillable upland was in crop rotation at higher income levels, but most of this land went into improved permanent pasture.

The beef cow herd enterprises were alternatives put into these programs, but were not part of any optimum plans.

Much smaller amounts of land, capital, and labor were needed to attain given income levels for these optimum plans than were needed on the level upland and rolling upland farms with the same beef enterprises involved.

Beef Cattle Farm—Grain Use Emphasis

Beef enterprises which utilize considerable quantities of grain fit quite well on the model bottomland farm. Higher income levels were obtained for this type of business at all three levels of labor supply than were possible on the level upland rolling upland farms. For example, a \$7000 net income was reached with the operator's labor plus 1100 hours of seasonal labor. Only \$5000 was attained with this labor supply on the level upland farm, and \$4000 on the rolling upland farm (Table 20).

The highly productive bottomland, which provided an abundance of grain for the cattle and large quantities of grain for cash sales, was the major reason for the higher incomes attained. However, the profitableness of beef cattle enterprises under the conditions of this model was also evident.

All purchased land was used in the optimum plans. The untillable rolling upland was kept in unimproved permanent pasture, and tillable rolling upland, in all but one plan, was in a rotation of corn, oats, and two years of mixed meadow.

In the optimum plans most of the bottomland was in continuous corn, but nearly all plans included a small acreage of bottomland in less intensive rotation. This was necessary to spread the seasonal labor requirements.

The livestock system in these plans was complex. In all plans there were at least two beef enterprises, and in two optimum plans there were three. Usual-

TABLE 20 -- ENTERPRISE COMBINATIONS AND RESOURCES USED IN THE COST MINIMIZING SOLUTIONS TO ATTAIN DESIGNATED LABOR INCOMES ON A GRAIN FED BEEF CATTLE FARM, SMALL RIVER BOTTOM

Net Labor Income Labor Level	\$3,000 1	\$4,000 1,	\$4,000 2	\$5,000 2	\$5,000 3	\$6,000 2	\$6,000 3	\$7,000 2	\$7,000 3
Resources Used:									
Land (Acres)	116	153	155	192	193	243	232	293	270
Land Capital	20,590	27,227	27,453	34,065	34,316	43,186	41,180	52,052	48,043
Non-Land Capital	19,707	25,898	26,275	32,425	32,844	36,725	39,413	42,760	45,982
Total	40,297	53,125	53,728	66,490	67,160	79,911	80,593	94,812	94,025
Annual Labor Used (Hours):									
Months Restrictive	1,500 0	1,946 5th	2,098 0	2,507 3rd	2,501 0	2,928 3rd	3,000 0	3,352 3rd, 7th	3,500 0
Total Annual Cost	6,346	8,480	8,461	10,597	10,576	12,849	12,692	15,225	14,807
Net Labor Income	3,000	4,000	4,000	5,000	5,000	6,000	6,000	7,000	7,000
Enterprises:									
Livestock ¹	S-3,78 S-4, 9	S-1,30 S-3,73 S-4, 2	S-3,104 S-4, 12	S-1,33 S-3,96 S-4, 4	S-3,130 S-4, 15	S-1,84 S-3,52	S-3,156 S-4, 18	S-1,143 S-3, 9	S-3,182 S-4, 22
Crop (Principal rotations & acreages) ²	29 COMmMm 6 CORc 29 Upp 52 Cont. C	38 COMmMm 17 CORc 38 Upp 60 Cont. C	39 COMmMm 8 CORc 39 Upp 69 Cont. C	48 COMmMm 20 CORc 48 Upp 76 Cont. C	48 COMmMm 10 CSbWRc 48 Upp 87 Cont. C	56 COMmMm 5 Ipp 61 Upp 68 Cont. C 53 CSbWRc	58 COMmMm 12 CSbWRc 58 Upp 104 Cont. C	52 COMmMm 21 Ipp 73 Upp 57 Cont. C 60 CSbWRc 30 CORc	68 COMmMm 14 CSbWRc 68 Upp 120 Cont. C
Acres of Individual Crops³									
Corn	61	75	81	94	100	96	121	95	140
Oats	9	15	12	18	14	14	14	23	16
Red Clover	2	5	3	8	3	13	3	25	4
Mixed Meadow	15	20	20	24	24	28	30	26	34
Unimproved Perm. Pasture	29	38	39	48	48	61	58	73	68
Soybeans	0	0	0	0	2	13	3	15	4
Wheat	0	0	0	0	2	13	3	15	4
Improved Perm. Pasture	0	0	0	0	0	5	0	21	0

¹(S-1) Steer system 1, Steer calves purchased and fed out; (S-2) Steer system 2, Yearling steers purchased in fall and fed out the following late summer and fall; (S-3) Steer system 3, Yearling steers purchased in fall and fed out by Mid-May; (S-4) Steer system 4, Common steer calves purchased in late fall, roughed through winter and grazed till early fall.

²Number before letter indicates acreages of that rotation. Letters indicate crops as follows: C-Corn, O-Oats, Mm-Mixed Meadow, Upp-Unimproved Permanent Pasture, Rc-Red Clover, Sb-Soybeans, W-Wheat, Ipp-Improved Permanent Pasture.

³Acreages rounded to nearest whole acre.

ly one of the enterprises was small. Because of the management problems, such as providing two sets of lots, feeders, etc., it is likely that in practice such minor enterprises could justifiably be omitted and the major beef enterprise increased by the number of animals indicated for the minor enterprise.

The beef enterprises in the optimum plans varied with the available labor supply and the income level. At the higher income levels the steer calf long-fed system was the prominent enterprise under conditions of labor level 2. With labor level 3 the steer calf-short-fed system was the major enterprise. It is interesting that plain steer calves, a high roughage consumption enterprise, were in seven of the optimum plans. Usually the number of plain steer calves was small, however.

The land and capital requirements of these optimum beef plans on the bottomland farm were appreciably lower than requirements for beef plans on the other types of land.

A Comparison of Resource Requirements

In Table 21 the optimum plans for the bottomland farm are listed by the acres of land used. As with the other two types of land resources, this table is presented to permit a concise study of major components of the optimum plans having acreage requirements within given acreage ranges. For details of these plans reference should be made back to previous tables in this section.

TABLE 21 -- LAND RESOURCE RANGES AND COST-MINIMIZING SOLUTIONS WHICH UTILIZE ACREAGES OF LAND WITHIN THESE RESOURCE RANGES, BOTTOMLAND FARMS

Acreage	Main Enterprise	Income	Cost	Investment	Labor Level	Total Labor
<u>100 Acres or Less</u>						
87	Dairy	\$3,000	\$ 4,569	\$ 31,200	1	2,055
<u>101 to 120 Acres</u>						
105	Hogs	3,000	6,276	31,743	1	1,308
116	Dairy	4,000	6,092	41,602	2	2,741
116	Grain Cattle	3,000	6,346	40,297	1	1,500
<u>121 to 160 Acres</u>						
140	Dairy	4,000	6,651	45,054	1	2,556
140	Hogs	4,000	8,368	42,323	1	1,743
145	Dairy	5,000	7,615	52,000	3	3,426
153	Grain Cattle	4,000	8,480	53,125	1	1,946
155	Grain Cattle	4,000	8,461	53,728	2	2,098
<u>161 to 200 Acres</u>						
161	Hogs	5,000	10,600	52,003	1	2,255
163	Dairy	5,000	7,870	51,874	2	3,015
174	Dairy	6,000	9,137	62,402	3	4,111
175	Hogs	5,000	10,460	52,904	2	1,806
192	Grain Cattle	5,000	10,597	66,490	2	2,507
<u>201 to 240 Acres</u>						
202	Dairy	7,000	10,660	72,801	3	4,796
210	Hogs	6,000	12,552	63,485	2	2,168
220	Roughage Cattle	3,000	7,987	54,181	1	1,690
231	Dairy	8,000	12,148	83,202	3	5,481
232	Grain Cattle	6,000	12,692	80,593	3	3,000
<u>241 to 280 Acres</u>						
243	Grain Cattle	6,000	12,849	79,911	2	2,928
245	Hogs	7,000	14,644	74,065	3	2,528
269	Dairy	9,000	13,789	91,760	3	5,859
270	Grain Cattle	7,000	14,807	94,025	3	3,500
<u>281 to 320 Acres</u>						
287	Dairy	6,000	11,228	76,530	2	3,472
293	Grain Cattle	7,000	15,225	94,812	2	3,352
294	Roughage Cattle	4,000	10,720	72,863	2	2,246
305	Roughage Cattle	4,000	11,027	75,867	1	2,328
<u>Over 320 Acres</u>						
333	Hogs	7,000	15,629	90,481	2	2,730
366	Roughage Cattle	5,000	13,420	90,336	3	2,775
375	Roughage Cattle	5,000	13,480	92,237	2	2,697
376	Dairy	10,000	16,490	111,935	3	5,990
438	Roughage Cattle	6,000	15,938	107,807	3	3,306
510	Roughage Cattle	7,000	18,630	125,287	3	3,837
520	Dairy	11,000	20,130	138,174	3	6,261

SUMMARY AND CONCLUSIONS

The objective of this research was to select typical resource situations in Northeast Missouri and through the use of linear programming determine the cost-minimizing plans for different types of farm businesses and varying levels of net income. The three typical land resource situations selected for analysis were: (1) *Level Upland Farm*—a farm comprised of all level upland, (2) *Rolling Upland Farm*—a farm comprised of 25 percent level upland, 50 percent tillable rolling upland and 25 percent rolling pasture land, and (3) *Bottomland Farm*—a farm comprised of 50 percent bottomland, 25 percent tillable rolling upland and 25 percent rolling pasture land.

Optimum plans (cost-minimizing plans) were determined for four types of farm business: (1) *Hog Farm Business*, (2) *Dairy Farm Business*, (3) *Beef Farm Business*—with emphasis on roughage-fed cattle, and (4) *Beef Farm Business*—with emphasis on grain-fed cattle. Cost minimizing plans were obtained for each of these types of business located on the three differing land resource situations and for varying net income levels. The basic framework called for determining cost minimizing plans for net income levels from \$3000 to \$7000, at \$1000 intervals. Some deviations from this net income framework were made.

This publication presents the optimum plans obtained. Included in the publication are the amounts and combinations of resources used in each cost-minimizing plan, the specific crop and livestock enterprises involved, and the total annual cost of obtaining each income level.

As the land, labor, and capital resources available to individual farmers in an area vary greatly, it is impossible to establish one farm plan and say that this plan is the best plan for all farms in the area. The purpose of this type of research project is to determine general economic guides regarding the kinds of farm organization which will successfully compete in an area.

These guides, based on typical resource situations, are valuable to persons involved in practical farm planning, but the person involved in planning a specific farm must examine these general guides in terms of how the assumptions and the resources on the typical "model" farm compare with those on the specific individual farm. These general statements apply to the cost-minimizing plans determined in this research project.