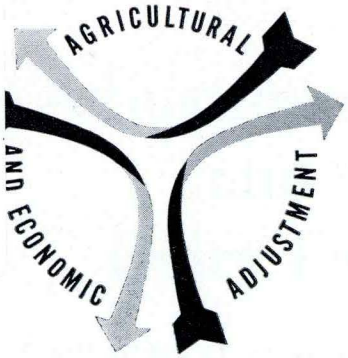

Adjustments to Meet Changes in Prices And to Improve Incomes On Dairy Farms in Northeastern Iowa

(An Application of Programming Methods in Deriving Supply Responses and Imputed Resource Values)

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Adjustments to Meet Changes in Prices and to Improve Incomes on Dairy Farms in Northeastern Iowa[1]

(An Application of Programming Methods in Deriving Supply Responses and Imputed Resource Values)

BY EARL O. HEADY,[2] ROSS V. BAUMANN[3] AND FRANK ORAZEM[4]

Prices of dairy products, particularly those for butter, turned downward in 1952. Costs of producing these products have remained relatively high and are increasing for many farms. Consequently, net returns on midwestern dairy farms have declined. Farmers on dairy and dairy-hog farms are concerned about changes in farming which can be made to meet the unfavorable price-cost relationships.

Major shifts from one enterprise to another often are difficult. They may mean additional expenditures, particularly if the farm is well adapted to a single enterprise. Minor changes and shifts between different enterprises, however, may call for only small new investments, if any. In addition, an individual farm operator often can better his income position by making adjustments which reduce the unit cost of production – changes which will enable him to produce more product with the same resources, if not the same amount of product with fewer resources.

OBJECTIVES

This study focuses on adjustments for dairy farms in northeastern Iowa to meet decreases in the price for milk and the current cost-price squeeze in general. Milk, though important, typically ranks in second or third place as a source of income in northeastern Iowa. Hogs are a larger source of income on the majority of farms, while cattle feeding contributes more than dairying on a considerable number of farms. Hence, an analysis of dairy farms in the area requires an analysis of the complete farm organization. In analyzing the extent to which reorganization of practices and enterprises can offset declines in prices by stabilizing income at recent levels, the specific objectives of this study are:

1. To develop optimum organizations for typical farms with different labor and capital resources under present crop and livestock practices with projected prices and with 20-percent-lower prices for milk.

2. To develop optimum organizations under both levels of prices when improved practices are used on livestock but the cropping program is left the same.

3. To develop optimum organizations under both levels of prices when improved practices are used for both crops and livestock.

4. To examine the opportunities for increasing net income by changing the resource structure of the farm.

5. To estimate the marginal value productivity of resources which limit farm plans.

6. To determine price ranges (normative supply responses) over which particular enterprise combinations are stable.

FARM SITUATION STUDIED

The farm situation selected for study is located in Grand Meadow Township, Clayton County. It is in the Tama-Downs soil association group, [5] which also predominates in the adjoining counties of Allamakee, Winneshiek, Fayette, Dubuque, Jackson, Jones and Clinton. [6] Since modal farm size in this area is in the range of 150 to 170 acres, a 160-acre farm was chosen for the analysis which follows.

Mean crop acreages and livestock numbers for 160-acre farms in Grand Meadow Township are shown in table 1. These averages provide the present organization from which alternative plans are considered. The initial organization provides the basis for the amount and form of capital existing on the farm. The machinery and supplies indicated represent part of the existing stock of capital. The rest is represented by the buildings, land and livestock. In the analysis which follows, it is assumed that the capital in existing live-

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[5] Bernard J. Bowlen and Earl O. Heady. Optimum combinations of competitive crops at particular locations. Iowa Agr. Exp. Sta. Res. Bul. 426. 1955. p. 377.

[6] H. R. Meldrum and others. Guide to fertilizer use. Iowa Coop. Ext. Serv. Pamphlet 193. 1953. p. 10.

TABLE 1. ORGANIZATION FOR 160-ACRE FARMS AND CROP YIELDS IN GRAND MEADOW TOWNSHIP, CLAYTON COUNTY, 1949-53.[a]

Crop or land use	Amount (acres)	Yield per acre (bu. or ton)	Production (bu. or ton)	Livestock	Number
Corn	43	64.5	2,773	Dairy animals[b]	18
Oats	32	40.2	1,288	Spring litters of pigs	15.3
Hay	28	2.0	56	Fall litters of pigs	5.5
Plowable pasture	13	1.6[c]	21[c]	Hens	132
Permanent pasture	30	1.0[c]	30[c]		
Roads, lots, buildings, woods and waste	14	...	...		

[a] U. S. Dept. Commerce. United States Census of Agriculture. Vol 1. Part 9. 1950. p. 47. Iowa Dept. Agr. and U. S. Dept. Agr., cooperating. Iowa census of agriculture—crop and other farm statistics of Grand Meadow Township, Clayton County, Iowa. 1949-53.
[b] Includes dairy cows and heifers 2 years old or over kept for milk.
[c] Pasture yields are in tons of hay equivalent.

stock and supplies can be converted to forms allowing reorganization and reinvestment for new plans, but that the capital in buildings, land and machinery must be retained in the existing form. The farm is considered to be owner-operated.

Alternative Enterprises and Production Techniques

Two categories of production techniques are considered: (1) average techniques of livestock production to represent the types of practices commonly used on farms in the area and (2) above-average techniques of production which are economically advantageous, even with lower milk prices, for farmers with sufficient capital. [7]

Crops have been separated into different categories of rotations and fertilization levels which represent different soil management practices. All the rotation-fertilizer enterprises are included in the linear programming procedure when improvement in crop opportunities is considered. In this way the cropping program which is best suited in a given farm resource situation will be determined. Not all rotations which provide higher corn yields can be classed as economically advantageous for all farmers. A rotation with intensive grain production and with little or no fertilizer may return maximum profit for a farmer with limited funds; a rotation with more meadow and fertilizer may be superior for a farmer with sufficient capital and an ample supply of family labor.

LIVESTOCK ENTERPRISES

The livestock enterprises considered in this study include dairy enterprises representing several management practices, spring and fall pig enterprises also representing several techniques and a poultry enterprise. A description of the different livestock activities follows.

Milk produced under average production practices. This activity includes dairy practices currently found in the area. The feeding, breeding, sanitation and other techniques of dairy management are assumed to be those for the average dairy herd of the area. For this activity, a cow weighing 1,200 pounds produces 6,285 pounds of 3.5 percent fat-corrected milk. The cow's yearly feeding ration consists of 27 bushels of corn equivalent, 160 pounds of protein supplement and 8,700 pounds of hay equivalent (including hay, silage and pasture).[8]

Milk produced under above-average production practices. This activity includes the use of proven sires and more careful selection than usual of dairy cows for productive capacity. It also includes better sanitation than average and the feeding of concentrates to individual cows according to the level of milk production. Cows weighing 1,200 pounds produce 9,500 pounds of 3.5 percent fat-corrected milk each. With above-average production practices, the yearly ration includes 54 bushels of corn equivalent, 280 pounds of protein supplement and 8,720 pounds of hay equivalent.

Cows are replaced every 5 years for both of the previous activities. The replacement stock per cow per year consists of 0.239 of a 2-year-old heifer, 0.278 of a 1-year-old heifer and 0.314 of a calf.[9] The feed requirements of the replacement stock per cow include 2,800 pounds of hay and 15.5 bushels of corn equivalent.[10] Annual sales per cow, besides milk, include 32 pounds of veal calf, 78 pounds of heifer, 156 pounds of cull cow sold for beef and 85 pounds of the cow sold for dairy purposes. Cash expenditures per cow and associated replacement stock are summarized in table 2. The annual labor requirements per cow and associated replacement stock with average and above-average production practices are estimated at 116 and 131 hours, respectively.[11]

Pork produced with average production practices for spring pigs.[12] This activity includes pigs farrowed

[7] The data used for determining the feeding rations and the milk output for the two categories of production practices for the dairy enterprise are given in table A-5 in the Appendix.

[8] Dairy Herd Improvement Association records for Clayton County for the years 1951-53 were examined and used for determining the rations fed to dairy cows and their corresponding milk output. Three pounds of silage are assumed to be equivalent to 1 pound of hay, 2 bushels of oats to 1 bushel of corn and each month of pasture is assumed to be equivalent to 750 pounds of hay. The weight of the cow and the quality of pasture were considered in estimating the value of pasture in terms of hay.

[9] John Ingels and C. Y. Cannon. The mortality of calves in the Iowa State University dairy herd. Amer. Soc. Anim. Prod. Proc. 1936: 223-228.

[10] U. S. Dept. Agr. Feeding, care and management of young dairy stock. Farmers' Bul. 1723. 1940. p. 31. H. Morrison. Feeds and feeding. 21st ed. Morrison Publishing Co., New York. 1950. pp. 720-767.

[11] Cunningham, L. C. Cost of raising dairy heifers in New York, N. Y. (Ithaca) Agr. Exp. Sta. Res. Bul. 807. 1944. p. 10. Niels Rorholm and others. Farm labor and farm costs. Univ. of Minnesota and U. S. Dept. Agr., cooperating. Report No. 217. 1954. (Mimeo.)

[12] Iowa Coop. Ext. Serv. Iowa farm record summary. Area 4. 1948-1954. (Mimeo.); Iowa Agr. Exp. Sta. and U. S. Dept. Agr. Appraisal of agricultural productive capacity in Iowa. 1946. p. 35. (Mimeo.); Midwest farm handbook. 3rd ed. Iowa State University Press. Ames, Iowa. 1954. p. 29; Karl A. Vary. Economics of grassland farming. Mich. Agr. Exp. Sta. Spec. Bul. 391. 1954; U. S. Dept. Agr. Better feeding of livestock. Farmers' Bul. 2052. 1952; Earl O. Heady and others. Heading for greater hog profits. Iowa Farm Science. 42, No. 9: 3-5. 1954; L. Harding, R. N. Weigle and H. S. Wann. Hogs, one- and two-litter systems compared. Ind. Agr. Exp. Sta. Bul. 565. 1951.

TABLE 2. ANNUAL CASH EXPENDITURES PER COW AND ASSOCIATED REPLACEMENT STOCK WITH AVERAGE AND ABOVE-AVERAGE PRODUCTION PRACTICES.[a]

	Average dairy enterprise	Above-average dairy enterprise
Special equipment[b]	$ 0.49	$ 0.88
Buildings and fences (repair)	6.45	8.61
Miscellaneous cash expenditures[c]	4.88	9.07
Artificial insemination	6.25	6.25
Protein and mineral supplement	8.91	14.46
Total	26.98	39.27

[a] R. K. Buck, J. A. Hopkins and C. C. Malone. An economic study of the dairy enterprise in northeastern Iowa. Iowa Agr. Exp. Sta. Res. Bul. 278. pp. 857-858; Earl O. Heady and Russell O. Olson. Substitution relationships, resource requirements and income variability in the utilization of forage crops. Iowa Agr. Exp. Sta. Res. Bul. 390. pp. 931-933. The costs are adjusted by the index of prices paid by farmers for supplies to the 1954 cost and price level.

[b] It includes use of a milking machine, cream separator, water heater, cans and other miscellaneous equipment.

[c] It includes power, insurance, taxes, veterinary expenses and other incidentals.

in March and April with 6.7 pigs weaned per litter. The amount of pork sold per litter, including 300 pounds of sow, is 1,507 pounds. A 5-percent post-weaning death loss is assumed. Feed requirements include 114.5 bushels of corn, 1.1 tons of hay equivalent (pasture) and 527 pounds of protein supplement per litter. Feed requirements for hogs marketed include a proportionate amount of feed consumed by pigs which die before marketing.

Pork produced with above-average production practices for spring pigs. This activity includes pigs farrowed in March with 7.4 pigs weaned per litter. The amount of pork marketed per litter is 1,721.6 pounds, including 300 pounds of sow. Post-weaning death loss is estimated to be 3 percent. Feed consumed per litter includes 97 bushels of corn, 0.93 tons of hay equivalent and 794 pounds of protein supplement.

Pork produced with average production practices for fall pigs. Pigs are farrowed in August and/or September. The number of pigs weaned per litter is 6.6. A 5-percent post-weaning death loss is subtracted. The amount of pork marketed per litter is 1,468 pounds, including 300 pounds of sow. Pigs are fed in drylot and consume 124.5 bushels of corn and 587 pounds of protein supplement per litter.

Pork produced with above-average production practices for fall pigs. The average number of pigs per litter when pork is produced with above-average production practices is 7.3. The amount of pork marketed per litter averages 1,693 pounds. This quantity includes 300 pounds of sow and takes into account a 3-percent post-weaning death loss. Feed requirements per litter include 107 bushels of corn and 880 pounds of protein supplement.[13]

The spring pigs differ in feed requirements from fall pigs in that the former are produced on pasture, while the latter are produced in drylot. Other differences in production practices for both spring and fall pigs are reflected in the rations fed, breeding stock selection, pigs saved per litter, death loss and time required for pigs to reach a specified marketing weight. Pigs in all four activities are sold when they reach the weight of 225 pounds. Time required is approximately 127 days from weaning to marketing for pigs under average production practices and 112 days for pigs under above-average production practices. The yearly cash expenditures for the four hog activities are presented in table 3.

[13] Average hog systems have 12.5 percent protein in the total ration, and above-average hog systems have a ration consisting of 14.8 percent protein.

TABLE 3. ANNUAL CASH EXPENDITURES PER LITTER OF PIGS AT DIFFERENT PRODUCTION EFFICIENCY LEVELS, 1950-54.

	Average production efficiency		Above-average production efficiency	
	Spring litter	Fall litter	Spring litter	Fall litter
Building and equipment	$12.16	$12.16	$13.94	$13.94
Boar charges per litter	2.00	2.00	2.00	2.00
Power, machinery	8.00	8.79	9.02	9.92
Veterinary medicine	6.58	6.00	7.41	6.84
Taxes and insurance	2.19	2.00	2.47	2.25
Protein supplement (soybean oilmeal equiv.)	24.40	27.18	36.76	40.74
Total	55.33	58.13	71.60	75.69

POULTRY ENTERPRISES

The only level of production techniques considered for the poultry enterprise was a small farm laying flock cared for entirely by the farmer's wife. This enterprise is competitive with other farm enterprises for the capital and feed, but not for the operator's labor. (It does not compete with the other enterprises for the nonhousewife labor.) The poultry enterprise considered in this study represents average farm conditions found in northeastern Iowa.[14] The laying flock is replaced annually by purchased chicks. Enough chicks are purchased every year to insure the given number of laying pullets by late summer. The mortality rates for laying hens and chicks are estimated to be 12 and 14 percent, respectively.

Feed requirements for the laying and growing flock on a per-hen basis consist of 92.5 pounds of corn and 43.9 pounds of laying mash. The annual cash expenditure per hen is $0.88, plus the outlays needed for purchases of laying mash. The output per hen includes 16 dozen eggs and 4.3 pounds of meat.

CROP ENTERPRISES

The crop enterprises include four alternative rotations:[15] a corn-corn-oats-meadow (CCOM) rotation, a corn-oats-meadow (COM) rotation, a corn-corn-oats-meadow-meadow (CCOMM) rotation and a corn-oats-meadow-meadow (COMM) rotation. In addition, two levels of fertilization are considered with each rotation: (1) no application of commercial fertilizer and (2) the application of commercial fertilizer at the recommended rate for the crops in these rotations in northeastern Iowa. Hence, there are eight activities or alternatives with respect to the cropping sys-

[14] Iowa Coop. Ext. Service. Iowa demonstration record flocks. Ames, Iowa. 1953. p. 9 (Mimeo.); Minnesota data which were obtained from farmers in southeastern Minnesota, an area close to the area of this study, compare favorably with above data. Minnesota Univ. Institute of Agr. and U. S. Dept. Agr., cooperating. Poultry costs and returns. Report No. 205 and Report No. 212. 1943 .(Mimeo.); J. C. Gilson. Optimum livestock production under varying resource and price cost situations in northeastern Iowa. Unpublished Ph.D. thesis. Iowa State University Library, Ames, Iowa. 1954. p. 171b.

[15] Crop rotations considered as alternatives for the area under study were suggested by John Pesek, Department of Agronomy, Iowa State University, Ames, Iowa and I. L. Christensen, Area Conservationist, Soil Conservation Service, U. S. Dept. of Agr., Elkader, Iowa.

TABLE 4. ESTIMATED AVERAGE YIELDS PER ACRE FOR CORN, OATS AND ALFALFA-BROME HAY IN VARIOUS ROTATIONS AND WITH SPECIFIED TREATMENT OF TAMA SILT LOAM.[a]

Rotation and crops	Unit	Treatment: Unfertilized	Treatment: Fertilized
CCOM			
Corn—1st year	bu.	61	71
Corn—2nd year	bu.	53	64
Oats	bu.	32	42
Hay	tons	2.7	3.5
CCOMM			
Corn—1st year	bu.	64	72
Corn—2nd year	bu.	56	63
Oats	bu.	32	42
Hay—1st year	tons	2.7	3.5
Hay—2nd year	tons	2.5	3.5
COM			
Corn	bu.	62	71
Oats	bu.	35	44
Hay	tons	2.7	3.5
COMM			
Corn	bu.	64	72
Oats	bu.	38	47
Hay—1st year	tons	2.7	3.5
Hay—2nd year	tons	2.5	3.5

[a] Yield estimates were made by John Pesek and others, Department of Agronomy, Iowa State University, Ames, Iowa, and are based on the following assumptions: (1) Cultivating practices are those standard for the area, and they are the same for both fertility levels. (2) Unfertilized treatment includes inadequate lime, less than 1 ton of manure per acre per year and no commercial fertilizer. (3) Fertilizer treatment includes lime as needed, not more than 2 tons of manure per acre per year and application of recommended level of commercial fertilizer.

tem: (1) $CCOM_o$, (2) COM_o, (3) $CCOMM_o$, (4) $COMM_o$, (5) $CCOM_f$, (6) COM_f, (7) $CCOMM_f$ and (8) $COMM_f$, where the zero subscript refers to no fertilization other than manure and the "f" subscript refers to the recommended level of chemical fertilizer. Estimated crop yields for the various rotations with and without fertilizer practices are presented in table 4.

POWER, MACHINERY AND PRACTICE COSTS

The costs of power, machinery and seed which are directly associated with the production of corn, oats and hay are presented in table 5. The cost of terracing for a CCOM rotation was estimated to be $0.76 per acre, which includes the fuel and the use of a two-bottom plow and tractor. One mile of terraces was assumed to protect 12.5 acres of cropland. The cost of fertilizer, when applied, was estimated to be $5.70 per acre of CCOM rotation, $4.46 per acre of CCOMM rotation, $3.31 per acre of COM rotation and $2.37 per acre of COMM rotation.

Prices Used

Two price situations are used to determine optimum plans for the various resource situations: (1)

TABLE 5. VARIABLE COSTS FOR POWER, MACHINERY AND SEED FOR PRODUCTION OF 1 ACRE OF CORN, OATS AND HAY, 1950-54.[a]

Item	Corn	Oats	Hay
Power[b]	$4.96	$2.76	$3.02
Machinery, repair and upkeep	5.20	2.62	5.85
Seed	1.54[c]	3.07[d]	6.32[e]

[a] Rorholm. op. cit. pp. 4-12; Illinois University. Tractor costs by drawbar horse power rating and hours during 1952 in Sangamon area. AE 2969. 1953. (Mimeo.) Costs were adjusted to the 1950-54 price level by the indexes of farm supplies and farm machinery.
[b] Sixty-five percent of the power cost was spent for fuel, oil and grease; 35 percent for repairs and labor. The cost of running a tractor was estimated at $0.56 per hour. These are based on the Nebraska tractor tests (average drawbar horsepower 18.8) and adjusted to the 1950-54 level of cost by the index of farm supplies.
[c] Eight pounds of hybrid seed corn.
[d] Two-and-eight-tenths bushels of seed oats.
[e] Seed mixture includes 5 pounds of alfalfa, 4 pounds of red clover and 5 pounds of bromegrass.

TABLE 6. PRICES RECEIVED BY FARMERS 1950-54 (AVERAGE), 1955 AND PROJECTED FOR 1960, AND AVERAGE PRICES PAID BY FARMERS 1950-54, IOWA.

	Unit	1950-54	1955	Projected 1960
Corn	bu.	$ 1.44	$ 1.33	$ 1.33
Oats	bu.	0.76	0.64	0.72
Hay, all baled	ton	16.86	16.73	15.93
Milk (grade B)	cwt.	2.69	2.68	2.68[a]
Eggs	doz.	0.33	0.27	0.352
Poultry	lb.	0.17	0.15	0.216
Sows, choice	cwt.	17.92	14.10	16.29
Barrow and gilts (200-240 lbs.)				
March-April	cwt.	19.40	16.80	17.98
Sept.-Oct.	cwt.	19.85	15.20	18.05
Cows, cutter and canner	cwt.	13.74	11.46	10.55
Heifers, commercial, all weights	cwt.	21.18	19.74	18.56
Vealers, commercial and good	cwt.	24.74	22.92	20.71
Nitrogen	lb.	0.15	0.15	0.15
Phosphate	lb.	0.10	0.10	0.10
Potash	lb.	0.07	0.07	0.07
Alfalfa seed	cwt.	53.40	53.40	53.40
Red clover seed	cwt.	46.70	46.70	46.70
Bromegrass seed	cwt.	35.50	35.50	35.50
Hybrid seed corn	bu.	10.75	10.75	10.75
Seed oats	bu.	1.81	1.81	1.81
Laying mash	cwt.	4.77	4.77	4.77
Soybean meal	cwt.	4.63	4.63	4.63

[a] Northeastern Iowa. A 20-percent decline in the price of milk would change the price from $2.68 to $2.14 per 100 pounds of milk.

those projected for 1960 and (2) the same set of prices, except that the price of milk was reduced by 20 percent.[16] The reason for using these price situations is to determine the effects of the 20-percent-lower milk price on the optimum organization and income. The procedure in the study is to examine optimum organizations and income levels under the projected 1960 prices and the prevailing prices, then to examine the same situations with a 20-percent decline in milk prices following the steps outlined previously.

The projected level of prices is shown in table 6. Average prices received for the period 1950-54 and 1955 are included in the table to indicate that the 1960 projected prices are at levels similar to those received by farmers in the recent past. The average prices of 1950-54 are used for the costs of production and the prices paid by farmers in Iowa; they are assumed to be the same for all plans considered in this study.

METHOD OF ANALYSIS

Linear programming is used in the analysis. This method allows consideration of alternative patterns of resource allocation to maximize income.

The computational procedure requires that the quantities of the limited resources used by each enterprise be specified. The expansion of any enterprise or combination of enterprises cannot exceed the limitation imposed by the fixed quantity of resources. The resource restrictions imposed on the plans are those indicated by equations 1 through 8.

S refers to land, C refers to annual cash outlays, A_1 refers to labor for competitive enterprises, A_2 refers to labor for the supplementary poultry enterprise, G refers to grain (home raised or purchased), F refers to forage (hay, pasture and silage), L_1 refers to restrictions for spring litters of pigs and L_2 refers to restrictions for fall litters of pigs. In these equations, the

[16] The projected 1960 prices formulated in 1954 were developed solely for the purpose of research studies, and they are not forecasts.

x_j refers to the amount of each enterprise (activity) to be produced, and the a_{ij} refers to the amount of the i-th limitational resource required to produce one unit of the j-th activity.

$$(1)\ S = \sum_{j=1}^{n} a_{1j}x_j \qquad (5)\ G = \sum_{j=1}^{n} a_{5j}x_j$$

$$(2)\ C = \sum_{j=1}^{n} a_{2j}x_j \qquad (6)\ F = \sum_{j=1}^{n} a_{6j}x_j$$

$$(3)\ A_1 = \sum_{j=1}^{n} a_{3j}x_j \qquad (7)\ L_1 = \sum_{j=1}^{n} a_{7j}x_j$$

$$(4)\ A_2 = \sum_{j=1}^{n} a_{4j}x_j \qquad (8)\ L_2 = \sum_{j=1}^{n} a_{8j}x_j$$

Labor available for the supplementary poultry, capacity restrictions imposed on spring and fall litters and land are held constant for all price and resource situations considered. Annual cash outlay is set at several levels to allow examination of optimum plans and income changes for different financial situations (i.e., for farmers who have different financial capital). Labor is set at two levels to allow for the determination of plans for one- and two-man farms. Grain and hay supplies are variable, depending on the cropping plan. For all resources except grain, the total resource requirements for the several activities must be equal to or less than the supply of the particular resource. In the case of grain, resource requirements for the various processes (including grain selling) must equal the supply of grain produced on the farm plus additional purchases. The supply of forage is limited to that produced on the farm.

Resource Structure

The following are specific resource situations or restrictions used in this study. The optimum farm programs have been worked out for each combination of resource restrictions. That is, resources which are available in different quantities (labor, operating capital) have been used in every possible combination with other resources available in one quantity only.

Land. The land resource includes 160 acres of cropland, permanent pasture and land used for roads, buildings, woods and waste. The amount of land used for pasture and crops was shown in table 1. The cropland may be devoted to different rotations with or without commercial fertilizer. The acres in permanent pasture can be used for grazing only.

Labor. Two labor situations are considered. The first situation is for a one-man farm. Total labor available for competitive enterprises, excluding poultry, includes 260 hours per month for the operator, plus 130 hours per month of family labor in June, July and August. The second situation is for a two-man farm. Total available labor, excluding poultry, includes the labor equivalent of two year-round men, or 520 hours per month throughout the year.

TABLE 7. HOURS OF LABOR AVAILABLE ON ONE- AND TWO-MAN FARMS FOR COMPETITIVE ENTERPRISES AND FOR A SUPPLEMENTARY POULTRY ENTERPRISE.

Month	For competitive enterprises[a]		For supplementary poultry enterprise[b]
	One-man farm	Two-man farm[c]	Both situations
January	260	520	31
February	260	520	28
March	260	520	46.5
April	260	520	45
May	260	520	62
June[d]	390	520	60
July[d]	390	520	62
August[d]	390	520	62
September	260	520	45
October	260	520	46.5
November	260	520	30
December	260	520	31

[a] Crops, dairy and hogs but not poultry.
[b] Wife's labor available for supplementary poultry enterprise only.
[c] Includes operator's labor plus family labor equivalent to one man.
[d] Includes 130 hours per month of family labor in addition to the operator in June, July and August for one-man farm.

The labor supplies can be used for all competing crop and livestock enterprises. In addition, the wife's labor (table 7) was included for a supplementary poultry enterprise for both the one- and two-man farms. Since the poultry enterprise is not competitive for labor, the enterprise cannot use any of the labor listed in columns two and three of table 7.

Annual cash outlays. The four levels of annual cash outlays considered in determining optimum solutions are: $3,000, $4,500, $6,000 and an unlimiting level of annual cash outlays or funds. These funds are used to meet yearly farm expenditures for purchases of concentrates for the livestock, breeding fees, seed, fertilizer, fuel and oil, annual repairs of buildings and fences, veterinary expenditures and other variable expenditures associated with farming operations. Hence, the funds considered are those beyond investment in farm real estate, machinery or livestock. Livestock, for example, could be sold and its proceeds used to meet yearly expenditures. If additional livestock investment is needed, it is assumed that the livestock provides the security for the purchase of the same. This is also true for additional machinery, if needed.

Building space for cattle. No restriction is specified for buildings; building facilities ordinarily are not limitational on 160-acre farms in northeastern Iowa. Even if forage production is increased for producing more livestock, the present building facilities would be sufficient to take care of this expansion. Most farms still have old horse barns which can be remodeled and utilized for housing additional livestock and for storing additional hay.

Hog housing capacity. The size of the hog enterprise for each plan, except as otherwise indicated, is limited to 18 litters of spring pigs and 6 litters of fall pigs. These limits conform to the modal number of spring and fall litters of pigs per farm in the area under study, as indicated by data from the Iowa Crop and Livestock Reporting Service.[17]

[17] Iowa Dept. Agr. and U. S. Dept. Agr., cooperating. Iowa census of agriculture, crop and other farm statistics of Grand Meadow Township, Clayton County, Iowa. 1949-53.

MOST PROFITABLE SYSTEM OF FARMING UNDER PROJECTED PRICES

Optimum profit plans, considering different resource and price situations outlined previously, are now presented.[18] Generally, these plans show that farms with different resource structures require different types and magnitudes of adjustments for increasing income. Plans for a one-man, 160-acre farm are presented first, followed by those for a two-man farm. Two capital levels of $3,000 and $4,500 in annual cash expenditures are used for the one-man farm.

Optimum Plans for a One-Man, 160-Acre Farm With $3,000 for Annual Cash Expenditures

OPTIMUM PROGRAM WITH USUAL CROPPING PROGRAM AND LIVESTOCK PRACTICES

The first empirical step in the study included the determination of the optimum plan on a one-man farm using the farming practices common to the area. The mean cropping system of farms in this group included 43 acres of corn, 32 acres of oats, 41 acres of rotation pasture and 30 acres of permanent meadow. The average amount of feed produced in this cropping system was 3,417 bushels of corn and 107 tons of hay.

Using the preceding cropping system, the optimum livestock system was determined, assuming that the practices or techniques of production used were those typical in the area. The resulting plan (i.e., the one which maximizes profits within the given framework of a cropping program and a set of livestock practices typical in the area) included a combination of 11 dairy cows, 119 spring pigs, 25 fall pigs and no poultry.

In this plan, about twice as much income is obtained from hogs ($5,838) as from the dairy enterprise, including milk, meat and replacement sales ($2,420). Sales of corn contribute $518 to income. Net income is $4,450, after deducting cash expenses and a charge for the depreciation of buildings and machinery. Since this farm situation includes a cropping program with yields and livestock practices common on farms in the area, the programming problem is only that of determining the optimum kinds and numbers of livestock.

This optimum plan, using $3,000 for annual expenditures, does not give an organization of livestock coinciding exactly with that found on the average 160-acre farm in the area. The average farm uses somewhat more capital. (Plans utilizing $4,500 as annual cash expenditures are presented later.) Also, the organization of livestock on the average farm is not necessarily that which maximizes profits. Some farmers have been in the process of adjusting between plans; others may prefer a plan which has less risk even though it offers less profit.

[18] Optimum plans were also determined for 1950-54 average prices. The difference in the 1950-54 and 1960 projected prices was not great enough to affect the allocation of resources among the alternative enterprises considered in this study. The same optimum plans result with either price. Hence, the plans with 1950-54 prices are not presented. This does not mean, however, that prices do not affect allocation of resources. In this case the differences in the price ratios are not large enough to induce changes in the optimum production program.

TABLE 8. OPTIMUM PLANS FOR A ONE-MAN 160-ACRE FARM WITH $3,000 ANNUAL CASH EXPENDITURES, PROJECTED PRICES.

Item	Unit	Usual crop and livestock practices	Improved dairy practices	Improved dairy practices and a flexible crop program	Improved dairy and hog practices and a flexible crop program
		(Plan 1)	(Plan 2)	(Plan 3)	(Plan 4)
Cropland	acres	116	116	116	116
Corn	acres	43	43	58	58
Oats	acres	32	32	29	29
Hay and rotation pasture	acres	41	41	29	29
Permanent pasture	acres	30	30	30	30
Livestock					
Dairy cows	number	11	11	11	11
Spring pigs	number	119	119	119	122
Fall pigs	number	25	19	0	0
Hens	number	0	0	32	0
Receipts					
Dairy enterprises	dollars	2,420	3,409	3,409	3,409
Hogs	dollars	5,838	5,579	4,801	5,193
Poultry	dollars	0	0	210	
Corn sales	dollars	518	290	1,183	1,799
Total receipts	dollars	8,776	9,278	9,603	10,401
Annual cash expend.	dollars	2,950	3,012	3,056	2,952
Depreciation (bldgs. and mach.)	dollars	1,376	1,376	1,376	1,376
Total costs[a]	dollars	4,326	4,388	4,432	4,328
Net farm income[a]	dollars	4,450	4,890	5,171	6,073

[a] Fixed costs such as taxes have not been subtracted since they have no effect on the optimum plan. Net farm profit would be less than net farm income by the amount of the fixed cost.

USE OF IMPROVED DAIRY PRACTICES WITH USUAL CROPPING PROGRAM

Effects on income and organization of using improved dairy practices, while maintaining the usual practices for hogs and crops, are shown in plan 2 of table 8. In the plan which now maximizes profits, the number of fall pigs declines to 19 because of the shortages of capital for expenses and labor. The improved practices for dairying require more of both capital and labor. Hence, fewer fall hogs are raised. The number of cows does not change, but milk production increases because of improved feeding, sanitation and breeding practices in dairy management. Net income increases to $4,890, or by almost 10 percent. This improvement in income results from the simple reorganization of livestock enterprises and does not involve more total resources. (Funds and labor previously devoted to the fall pigs were diverted to the dairy enterprise.)

IMPROVED CROP PRACTICES WITH IMPROVED DAIRY PRACTICES AND USUAL HOG PRACTICES

Thus far, one step has been taken in improving farm organization — namely, improvement in dairy management practices, with the cropping program and other practices remaining constant. We now examine organizational and income changes when improved practices are used for both dairy cows and crops.

The plan presented in plan 3 of table 8, and in more detail in the appendix, is one where alternative rotations and cropping practices were considered by the programming procedure, with the one finally selected being the optimum one when other enterprises also could compete for resources. For this determination, hog production practices remain at the average for the area. This plan is now the one which maximizes net farm income. The program includes a more inten-

sive corn producing rotation — corn-corn-oats-meadow — than is usual in the area. It includes 58 acres of corn and 29 acres of oats, as compared with the average of 43 acres of corn and 32 acres of oats. The livestock organization also changes slightly. Fall pigs drop completely out, and cash sales of corn increase when capital is held fixed at $3,000. The reason for this change is the scarcity of labor. Labor brings higher returns when used for crops, in using a more intense rotation, than for fall pigs. The more intensive rotation requires additional harvest labor in the fall, a time when labor is needed for fall pigs. A few hens now enter the plan since they do not compete for labor, and capital withdrawn from hogs can be used for poultry.

Net income under this plan is $5,171, as compared with $4,890 in the previous case and $4,450 in the initial case.

USE OF IMPROVED DAIRY AND HOG PRACTICES AND A FLEXIBLE CROPPING PROGRAM

The organization and income under a plan allowing improvement in dairy, crop and hog enterprises are indicated in plan 4 of table 8. A few more spring pigs now enter the optimum organization, but the number of dairy cows does not change. More corn is available for sale because of increased feeding efficiency. The corn-corn-oats-meadow rotation remains as the most profitable cropping pattern.

The net income for this plan was $6,073, or $902 greater than when improved hog practices were not considered. Compared with the net income of $4,450 where usual livestock and cropping practices were used, income is increased by 36 percent. Again, the plan does not involve additional resources. The changes represent types of adjustments which individual farmers can profitably make with the resources available to them.

Optimum Plans for a One-Man, 160-Acre Farm With $4,500 for Annual Cash Expenditures

With annual cash expenditures restricted to $3,000, the farm organization did not change much as improved practices were used to increase income. We now examine parallel situations where annual expenditures are at level of $4,500. The procedure followed is the same as that just stated; namely, (1) to compute organization and income under the usual cropping program and livestock practices of the area and (2) to examine the outcome with (a) improvements in dairying only, (b) improvements in both dairying and cropping programs and (c) improvements in dairying, cropping and hog programs. The results are shown in table 9.

TABLE 9. OPTIMUM PLANS FOR A ONE-MAN, 160-ACRE FARM WITH $4,500 ANNUAL CASH EXPENDITURES, PROJECTED PRICES.

Item	Unit	Usual crop and livestock practices	Improved dairy practices, usual hog and crop practices	Improved dairy practices and a flexible cropping program	Improved dairy and hog practices and a flexible cropping program
		(Plan 1)	(Plan 2)	(Plan 3)	(Plan 4)
Cropland	acres	116	116	116	116
Corn	acres	43	43	58	58
Oats	acres	32	32	29	29
Hay and rotation pasture	acres	41	41	29	29
Permanent pasture	acres	30	30	30	30
Livestock					
Dairy cows	number	12	11	9	9
Spring pigs	number	119	119	119	130
Fall pigs	number	13	0	38	40
Hens	number	175	175	175	175
Receipts					
Dairy enterprise	dollars	2,640	3,409	2,789	2,789
Hogs	dollars	5,319	4,801	6,357	7,291
Poultry	dollars	1,148	1,148	1,148	1,148
Corn sales	dollars	408	402	652	845
Total receipts	dollars	9,515	9,760	10,946	12,073
Annual cash expenditures	dollars	3,350	3,312	4,201	4,093
Depreciation (bldgs. and mach.)	dollars	1,376	1,376	1,376	1,376
Total costs[a]	dollars	4,726	4,688	5,577	5,469
Net farm income[a]	dollars	4,789	5,072	5,369	6,604

[a] Fixed costs such as taxes have not been subtracted since they have no effect on the optimum plan. Net farm profit would be less than net farm income by the amount of the fixed cost.

USUAL FARMING PRACTICES

With additional capital available, even though only $3,350 of the $4,500 is used, income is increased from $4,450 to $4,789. The added capital allows for an increase in the number of milk cows, while the number of fall pigs decreases. Also, chickens now come into the farm organization. (These differences are evident from a comparison of plan 1 in table 9 with plan 1 in table 8.)

IMPROVED DAIRY PRACTICES WITH USUAL HOG AND CROP PRACTICES

The use of improved dairy practices increases the income from dairying (compare plans 1 and 2 of table 9), but the number of dairy cows decreases. The additional labor required for improved management in dairying must come from fall pigs. Since the return for labor used on dairy cows is greater than that used on fall pigs, the latter drop from the organization. Income increases from $4,789 under plan 1 to $5,072 under plan 2 in table 9, or by 6 percent.

USE OF A FLEXIBLE CROPPING SYSTEM WITH IMPROVED DAIRY PRACTICES AND USUAL HOG PRACTICES

With improved rotations and practices also allowed for crops, corn acreage increases from 43 to 58 acres. Oats acreage is decreased from 32 to 29 acres, while hay and rotation pasture acres decrease from 41 to 29 acres (plan 3 of table 9).

Additional changes also take place in livestock numbers. The number of dairy cows decreases from 11 to 9, but the number of fall pigs increases to 38. The effect of using the improved dairying and cropping systems and jointly adjusting the crops and livestock to the optimum plan increases net income by $297 over the previous situation, or by 5.8 percent.

USE OF IMPROVED DAIRY AND HOG PRACTICES AND A FLEXIBLE CROPPING SYSTEM

The use of improved dairy and hog practices along with a flexible cropping program increases income

even more (plan 4). The net income now amounts to $6,604, or an advantage of $235 (as compared with plan 3) from using improved hog practices. As compared with the initial plan when only the usual practices are used, the net income increases from $4,789 to $6,604, or by 37 percent. This increase in returns results from using improved cropping and livestock programs, plus improved practices for both the dairy and hog enterprises.

The use of improved practices and a flexible cropping program causes a shift from dairy to hogs to be profitable. As compared with plan 1 dairy cows drop from 12 to 9. The number of spring pigs increases to 130, and the number of fall pigs increases to 40.

Optimum Plans for a Two-Man Farm With $4,500 for Annual Cash Expenditures

Plans presented in this section are for a two-man farm. Other resources are the same as for plans in the previous section for a one-man farm. Dairying is particularly well adapted to farms where labor is in ample supply but where funds limit the size of other livestock enterprises. Hence, the dairy enterprise becomes of greater importance in the organization of farms with a labor force equivalent to two full-time men. Since $3,000 in annual cash expense does not allow very efficient use of the labor of two men, the first capital level considered is for $4,500 in annual cash expenses.

Plan 1 of table 10 uses the cropping and livestock practices in the area on a two-man farm. Within these practices and resource restrictions, the optimum farm organization includes 15 dairy cows, 119 spring pigs, 19 fall pigs and 175 hens. It provides a net farm income of $5,118.

TABLE 10. OPTIMUM PLANS FOR A TWO-MAN FARM WITH $4,500 ANNUAL CASH EXPENDITURES, PROJECTED PRICES, USUAL AND FLEXIBLE CROPPING PROGRAM AND DIFFERENT LIVESTOCK PRACTICES.

Item	Unit	Usual crop and livestock practices	Improved dairy practices	Improved dairy practices and a flexible crop program	Improved dairy and hog practices and a flexible crop program
		(Plan 1)	(Plan 2)	(Plan 3)	(Plan 4)
Cropland	acres	116	116	116	116
Corn	acres	43	43	48	48
Oats	acres	32	32	24	24
Hay and rotation pastures	acres	41	41	44	44
Permanent pasture	acres	30	30	30	30
Livestock					
Dairy cows	number	15	17	29	29
Spring pigs	number	119	66	119	122
Fall pigs	number	19	40	0	0
Hens	number	175	175	52	78
Receipts					
Dairy enterprise	dollars	3,300	5,268	8,987	8,987
Hogs	dollars	5,579	4,223	4,801	5,268
Poultry	dollars	1,148	1,148	341	512
Corn sales	dollars	74	81	..	..
Total receipts	dollars	10,101	10,720	14,129	14,767
Annual cash expenditures	dollars	3,505	3,533	4,551	4,498
Depreciation (bldgs. and mach.)	dollars	1,478	1,478	1,478	1,478
Corn purchased	dollars	0	0	595	210
Total costs[a]	dollars	4,983	5,011	6,624	6,186
Net farm income[a]	dollars	5,118	5,709	7,505	8,581

[a] Fixed costs such as taxes have not been subtracted since they have no effect on the optimum plan. Net farm profit would be less than net farm income by the amount of the fixed cost.

Improved Dairy Practices, Usual Hog and Cropping Practices

By using improved dairy practices alone (plan 2 compared with plan 1 of table 10), the number of dairy cows increases to 17. Hog numbers drop to 106. The added receipts from milk more than offset the decrease in receipts from hogs, and net income increases by $591 as compared with the previous plan.

Use of Flexible Cropping Practices

The results from the use of flexible cropping practices with improved dairy practices are indicated in plan 3 of table 10. The changes which take place in the cropping pattern are not as great, however, as for the one-man farm. Corn increases to 48 acres, as compared with 43 acres in the initial plan. Oats acreage decreases, and hay and rotation pasture increase. With two men there is more opportunity to have dairy cows, hence more forages are needed.

The greatest changes are in livestock numbers. The number of dairy cows increases to 29 when selection is possible among cropping plans. Hogs increase to 119 spring pigs. Income increases from $5,709 in the previous plan to $7,505. Improving the cropping program is the most important means for augmenting income for a two-man farm with $4,500 of annual cash outlays. This plan is the first one that utilizes all of the $4,500 available for cash expenditures. It is possible that $4,500 is insufficient to allow the most effective use of labor and other fixed resources. This possibility is explored in a later section where plans are based on $6,000 for annual cash outlays.

Use of Improved Dairy and Hog Practices and Flexible Cropping Practices

The use of the improved hog practices, in addition to the improved practices for the dairy and crop enterprises, adds $1,076 (compare plan 4 with plan 3 in table 10) to net income. This improvement in income mainly results from greater efficiency in pork production, which reduces the amount of corn which must be purchased. Also, it allows the addition of a few hogs and laying hens. Otherwise the farm organization remains as in the previous plan.

The Optimum Farm Plan Using $6,000 for Annual Cash Expenditures

The use of improved dairy, crop and hog practices resulted in plans utilizing all of the $4,500 available for annual cash expenditures and increased income. Hence, plans were computed using these improved practices with $6,000 available for annual cash expenditures. The results are given in table 11. Comparisons are made only for cases where flexible cropping opportunities are considered. When improved dairy practices are used (compare plan 3 of table 10 with plan 1 of table 11), the additional $1,500 available for cash expenditures increases farm income by $243. The increase comes from a larger number of hogs, and one less cow which would be kept with the optimum organization. When both dairy and hog practices are improved, income is in-

TABLE 11. OPTIMUM PLANS WHEN USING $6,000 AVAILABLE FOR ANNUAL CASH EXPENDITURES FOR A TWO-MAN FARM WITH FLEXIBLE CROPPING PROGRAM, PROJECTED PRICES.

Item	Unit	Improved dairy practices, usual hog practices	Improved dairy and hog practices
		(Plan 1)	(Plan 2)
Cropland	acres	116	116
Corn	acres	48	49
Oats	acres	25	24
Hay and rotation pasture	acres	43	43
Permanent pasture	acres	30	30
Livestock			
Dairy cows	number	28	28
Spring pigs	number	119	130
Fall pigs	number	38	43
Hens	number	175	175
Receipts			
Dairy enterprise	dollars	8,677	8,677
Hogs	dollars	6,357	7,291
Poultry	dollars	1,148	1,148
Total receipts	dollars	16,182	17,116
Annual cash expenditures	dollars	5,285	5,365
Depreciation (bldgs. and machinery)	dollars	1,478	1,478
Corn purchases	dollars	1,671	1,073
Total costs[a]	dollars	8,434	7,916
Net farm income[a]	dollars	7,748	9,200

[a] Fixed costs such as taxes have not been subtracted since they have no effect on the optimum plan. Net farm profit would be less than net farm income by the amount of the fixed cost.

creased by $619. (Compare plan 4 of table 10 with plan 2 of table 11.) In this case, the income difference also results from the larger number of hogs. As in the previous comparison, one less dairy cow is kept.

EFFECTS OF LOWER PRICES

The foregoing analysis indicates that operators in the area can increase income by using improved farming practices and organizations. While some of the plans presented require more capital than typically is used on farms in the area, these additional funds have a much higher return than going rates of interest. The adjustments outlined, and the income increases associated with them, refer to individual farms. If farmers in aggregate made these changes, output would increase, and the consequent decline in prices might partially cancel the income gains of individual farmers. Even under such circumstances, however, an individual farmer might be better off, in terms of his level of income, in making the adjustments.

In the following section, a study is made of the extent to which dairy farmers in northeastern Iowa might offset a decline in milk prices by improved farm organization. Plans which maximize profits were computed for each of the same farm situations with respect to available capital and management practices when milk prices are 20 percent lower than those used for previous plans.

Plans for a One-Man Farm Would Not Change With a Decrease in the Price for Milk

No change in the farm organization of a one-man farm would be profitable when the price of milk is decreased by only 20 percent (table 12). The consequence would be a lower net farm income, by the amount of the price decrease times the quantity of dairy products sold. This result stems from the particular combination of resources and the fact that labor is particularly limiting. The optimum farm organization under projected prices and improved management practices would still be optimum with milk prices that are 20 percent lower than the projected price for milk.

Improved practices in the dairy or the crop enterprises alone on a one-man farm with $3,000 operating capital would not make up the loss in net income (compared with usual production practices and projected prices) if the price of milk declined by 20 percent. But improved practices in both the dairy and the hog enterprises would more than offset the decrease in income from lower prices. Improvement of practices for both the cropping and the livestock programs would increase net income ($5,513 compared with $4,080 in table 12) by about 35 percent even at the lower price for milk. An operator who has $4,500 instead of $3,000 of operating capital would get about $300 more net income if usual practices were used in both capital situations. If improved, rather than usual, practices were used with $4,500 operating capital, the operator could expect to increase his income by about 40 percent at the lower milk prices. See tables A-3 through A-8 in the appendix for additional data comparing optimum farm organizations under two price levels for farms differing in size, capital and levels of production practices.

TABLE 12. OPTIMUM FARM ORGANIZATION AND NET FARM INCOME UNDER TWO LEVELS OF PRICES FOR MILK ON FARMS DIFFERING IN SIZE, CAPITAL AND LEVELS OF PRODUCTION PRACTICES.

Size, capital and practice level	Organization and net income with projected prices				Organization and net income with 20-percent-lower price of milk			
	Corn	Dairy cows	Hogs	Net farm income	Corn	Dairy cows	Hogs	Net farm income
	(Acres)	(No.)	(No.)	(Dollars)	(Acres)	(No.)	(No.)	(Dollars)
One-man farm								
$3,000 annual cash expenditures								
Usual production practices	43	11	144	4,450	43	11	144	4,080
Improved crop practices	58	11	119	4,879	58	11	119	4,509
Improved dairy and hog practices	43	11	130	5,966	43	11	130	5,406
Improved crop and livestock practices	58	11	112	6,073	58	11	112	5,513
$4,500 annual cash expenditures								
Usual production practices	43	12	132	4,789	43	12	132	4,385
Improved crop practices	58	10	157	5,127	58	10	157	4,790
Improved dairy and hog practices	43	10	158	6,275	43	10	158	5,776
Improved crop and livestock practices	58	9	170	6,604	58	9	170	6,146
Two-man farm								
$4,500 annual cash expenditures								
Usual production practices	43	15	138	5,118	43	15	138	4,613
Improved crop practices	46	30	119	6,510	57	21	157	5,589
Improved dairy and hog practices	43	16	144	7,084	43	16	144	6,269
Improved crop and livestock practices	48	29	122	8,581	51	23	173	7,165

Changes in a Two-Man Farm Plan With a Decline in Milk Price

The situation is somewhat different, however, for a two-man farm. As shown in table 12, some changes should be made in the farm plan for a farm with $4,500 for annual cash expenditures if prices decline. When the typical livestock and cropping practices are used, no changes would be made in the farm organization. Net income would decrease from $5,118 to $4,613 when prices for milk are decreased by 20 percent. But if the cropping program is improved, it would be profitable to increase the acreage of grains and decrease the acreage of hay and rotation pasture, as compared with the use of usual practices and projected prices for milk. The optimum organization would also have 6 more cows and 19 more pigs. When the price of milk declines, the farmer who has plentiful labor and an improved cropping program can afford to increase both dairy and hog production. Net farm income with 20-percent-lower prices for milk would be $5,589, compared with $5,118 with usual production practices and projected prices.

If, instead, the operator adopted only improved livestock practices, it would be profitable to increase the cow herd by 2 animals and increase the number of pigs by 6 – 130 spring pigs and 14 fall pigs rather than 119 spring pigs and 19 fall pigs. This would increase net farm income to $1,151 above the level that would be obtained with usual production practices and projected prices.

Net farm income can be increased substantially by improving both crop and livestock production practices, in spite of a decline of 20 percent in the price for milk. Net income can be increased to $7,165, as compared with $5,118 before a decrease in price for milk and improvement of production practices.

Some changes in farm organization would be necessary with the change in prices and the use of improved crop and livestock practices. The acreage of corn would be increased from 43 to 51. Cow numbers would be increased from 15 to 23, and hog numbers would be increased to 173, as compared with 138 produced under usual practices. Thus, if the price of milk declines, a dairy farmer in northeastern Iowa with any of the labor and capital situations studied could still increase net income by improving his production practices and the organization of his farm.

OPTIMUM PLANS AND NORMATIVE SUPPLIES UNDER VARYING PRICES

Two sets of projected prices were used in determining the optimum plans of previous sections. Generally, changes in farm plans would be profitable with a projected decline of 20 percent in milk prices. To allow specification of price ranges over which particular plans are stable, however, further analysis of profitable responses to prices has been made. The procedure used involves a variation in conventional linear programming procedures. Prices are varied, with the results indicating the range of prices for which a particular combination of enterprises is optimum. In effect, the procedure provides a normative supply curve, indicating the amounts of products which should be produced at each price level, if profits are to be maximized. The "supply function" measured is, of course, of a "stair step" nature, because of the restrictions imposed by resources and the linear requirements coefficients.

Responses for Different Situations

The procedure includes varying a particular commodity price, starting from zero, until a new optimum farm plan emerges. Since an infinite number of price and resource combinations might be used in this analysis, only prices of hogs and dairy products were varied. Also, only benchmark situations for above-average management practices on one-man and two-man farms have been considered as a way of keeping the analysis manageable. Prices at which milk or hogs are held constant, while the price of the other product is varied, are $2.68 and $17.98, respectively. Capital level is at approximately $6,000 for all situations analyzed, except the last in which the level is raised to $10,250 along with removal of restrictions on the production of hogs.

ONE-MAN FARM WITH RESTRICTION ON HOG PRODUCTION

Results of varying milk prices upward, with hog prices held constant, are given in table 13. No dairy cows are specified for the farm organization in the programming until milk reaches a price of $0.93. Nine dairy cows, along with 18 spring litters and 6 fall litters of pigs are included in the optimum plan for milk prices ranging from $0.93 to $5.27. At a price above $5.27 per hundredweight for milk, fall hogs begin to decrease, and dairy production begins to increase.

As shown in table 13, the dairy enterprise includes nine cows over the extremely large price range for milk. The fact that dairying comes in at a very low price level results partly from a lack of alternative enterprises to use forage. The plans call for crop rotations which minimize hay production and maximize grain production. Even under this cropping

TABLE 13. OPTIMUM PROGRAMS UNDER VARIABLE MILK PRICES, ONE-MAN FARM (OTHER PRICES FIXED).

Price range	Rotation[a]	Crops	Dairy cows	Hogs	Poultry	Annual cash expenditures	Range of net income
(dollars)		(acres)	(number)	(litters)	(hens)	(dollars)	(dollars)
0.00-0.92	CCOM$_f$	81.2	0	18 spring	175	4,340	4,955
	CCOM$_o$	34.8		6 fall			
0.93-5.27	CCOM$_f$	28.9	9	18 spring	175	4,430	4,955-8,674
	CCOM$_o$	87.1		6 fall			

[a] In the rotations C=corn, O=oats, M=meadow. Rotations subscripts, o=no fertilizer, f=fertilized.

system, there is a large surplus of hay, having little sale value.

Varying hog prices on a one-man farm results in more plans with smaller ranges in prices than when milk prices were varied. In the plans shown in table 14, the milk price is "fixed" at $2.68 per 100 pounds. The supply of spring labor limits cow numbers to 14 when hog prices are below $13.14 per 100 pounds and to 9 when the prices for hogs are increased to $15.53 and the maximum number of hogs comes into the plans.

At a price of $13.14, hogs outcompete dairy cows for spring labor. Capital is not yet limiting. At $14.46, hogs draw capital away from dairy cows and the application of fertilizer. At $15.53 fall hogs also compete for capital and labor and cause more of these resources to be withdrawn from dairying.

Because of the assumed building space restrictions on hogs, a further rise in price above $15.53 does not result in further changes in hog production. The net income of $5,604 given in table 14 is applicable to a price of $15.53. Of course, net income would increase with a further rise in hog prices, even if the farm organization does not change.

TWO-MAN FARM WITH RESTRICTION ON HOG PRODUCTION

Optimum plans in table 15 have been developed for milk prices ranging from $0.00 to $3.12, with hog prices held at the projected price level. Because of the hay produced in the rotation, and with a larger labor and capital supply, 20 dairy cows come into the optimum plan at a milk price of $0.82 per 100 pounds. Because of the larger labor supply, a herd of 20 dairy cows does not require a reduction in hog numbers. At a price of $1.92 for milk, the number of cows increases to 28.

At a price higher than $3.12 for milk, dairy cows increase at the expense of fall pigs. In contrast, the price of milk would need to go above $5.27 on a one-man farm before dairying could outcompete fall pigs (table 13). This difference again results from the greater availability of labor on a two-man farm.

Comparing the results of variable hog prices for a two-man farm with the same procedures as on a one-man farm, the number of dairy cows was 33 with hog prices below $12.96 on a two-man farm (table 16) and 14 with hog prices below $13.14 on a one-man farm (table 14). At a price of $13.03 on a two-man farm and $15.53 on a one-man farm, further changes do not take place because of assumed building restrictions for hogs.

TWO-MAN FARM WITH NO HOG RESTRICTIONS EXCEPT A CAPITAL SUPPLY OF $10,250

Building restrictions limited hogs to 18 spring and 6 fall litters in the foregoing analyses. Some dairy farmers in northeastern Iowa have greater facilities for hog production and more capital than those set as restrictions. Hence, additional analysis has been made with building restrictions removed and capital limitations raised to $10,250. The results are given in table 17.

Hog numbers increase as hog prices rise to $19.52. Seven combinations of hogs and dairy cows occur for hog prices ranging between zero and $19.52. With 36 spring litters, 13 fall litters and 21 dairy cows, labor (2 men) and capital supplies ($10,250) are exhausted, and further changes do not occur. Changes in livestock combinations between the third and fourth and between the fifth and sixth price ranges shown in table 17 are relatively small. Additions to income also are small between these two sets of plans, and many farmers would not care to make these alterations in operations. Also, it is not likely that the designations of small acreages in a rotation will be used because of small fields. The use of a single rotation would not greatly affect the relative amounts of forages and grains produced.

TABLE 14. OPTIMUM PLANS UNDER VARIABLE HOG PRICES, ONE-MAN FARM (OTHER PRICES FIXED).

Price range	Rotation[a]	Crops	Dairy cows	Hogs	Poultry	Annual cash expenditures	Range of net income
(dollars)		(acres)	(number)	(litters)	(hens)	(dollars)	(dollars)
0.00-13.13	CCOM$_f$	116	14	0	175	3,346	5,047
13.14-14.45	CCOM$_f$	116	10	15 spring	175	4,340	5,048-5,329
14.46-15.52	CCOM$_f$	89.6	10	18 spring	175	4,340	5,330-5,603
	CCOM$_o$	26.4					
15.53 and over	CCOM$_f$	26.0	9	18 spring	175	4,340	5,604
	CCOM$_o$	90.0		6 fall			

[a] See table 13 for meaning of letters of rotation.

TABLE 15. OPTIMUM PLANS UNDER VARIABLE MILK PRICES, TWO-MAN FARM (OTHER PRICES FIXED).

Price range	Rotation[a]	Crops	Dairy cows	Hogs	Poultry	Annual cash expenditures	Range of net income
(dollars)		(acres)	(number)	(litters)	(hens)	(dollars)	(dollars)
0.00-0.81	CCOM$_f$	116	0	18 spring	175	4,597	4,921
				6 fall			
0.82-1.91	CCOM$_f$	116	20	18 spring	175	5,378	4,922-7,000
				6 fall			
1.92-3.12	CCOM$_f$	26	28	18 spring	175	6,686	7,001-10,228
	CCOMM$_f$	90		6 fall			
(806 bu. corn purchased)							

[a] See table 13 for meaning of letters of rotation.

TABLE 16. OPTIMUM PLANS UNDER VARIABLE HOG PRICES, TWO-MAN FARM (OTHER PRICES CONSTANT).

Price range	Rotation[a]	Crops	Dairy cows	Hogs	Poultry	Annual cash expenditures	Range of net income
(dollars)		(acres)	(number)	(litters)	(hens)	(dollars)	(dollars)
0.00-12.95	CCOM$_f$	3	33	0	175	4,005	7,351
	CCOMM$_f$	113					
12.96-13.02	CCOM$_f$	16	29	18 spring	175	5,574	7,352-7,368
	CCOMM$_f$	100					
(300 bu. corn purchased)							
13.03 and over	CCOM$_f$	26	28	18 spring	175	6,686	7,369
	CCOMM$_f$	90		6 fall			
(807 bu. corn purchased)							

[a] See table 13 for meaning of letters of rotation.

TABLE 17. VARIABLE HOG PRICES, TWO-MAN FARM WITH HIGHER HOG RESTRICTIONS.

Hog price range	Rotation[a]	Crops	Dairy cows	Hogs	Poultry	Annual cash expenditures	Range of net income
(dollars)		(acres)	(number)	(litters)	(hens)	(dollars)	(dollars)
0.00-12.95	CCOMM$_f$	113	33	0	175	4,005	7,351
	CCOM$_f$	3					
12.96-15.10	CCOMM$_f$	90	26	31 spring	175	7,672	7,352-8,269
	CCOM$_f$	26					
(1,257 bu. corn purchased)							
15.11-15.49	CCOMM$_f$	86	25	36 spring	60	7,947	8,270-8,491
	CCOM$_f$	30					
(1,464 bu. corn purchased)							
15.50-17.44	CCOMM$_f$	83	24	36 spring	0	8,088	8,492-9,549
	CCOM$_f$	33		2 fall			
(1,570 bu. of corn purchased)							
17.45-19.26	CCOMM$_f$	86	24	36 spring	0	8,748	9,550-10,621
	CCOM$_o$	30		5 fall			
(2,066 bu. of corn purchased)							
19.27-19.41	CCOMM$_f$	23	22	36 spring	0	9,918	10,622-10,724
	CCOMM$_o$	93		11 fall			
(2,946 bu. corn purchased)							
19.42-19.52	COMM$_f$	7	21	36 spring	0	10,245	10,725-10,800
	CCOMM$_o$	109		13 fall			
(3,192 bu. of corn purchased)							

[a] See table 13 for meaning of letters of rotation.

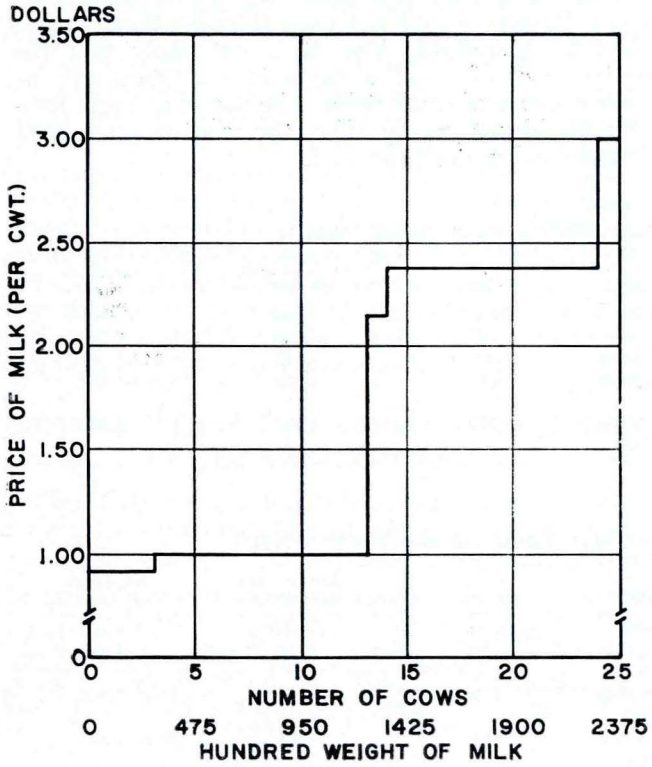

Fig. 1. "Stepped" supply function for milk on two-man farm with other prices constant.

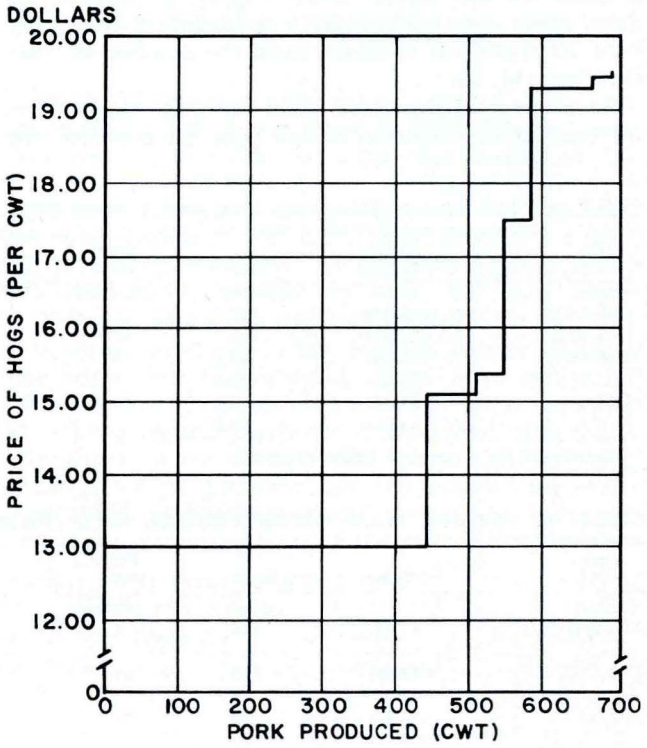

Fig. 2. "Stepped" supply function for pork on two-man farm with other prices constant.

Stepped Nature of Responses

The nature of the "stepped" supply functions is indicated in fig. 1 for milk and fig. 2 for hogs. These functions are for the two-man farm with hog building restrictions removed and capital limitations increased. Figure 2 is based on the data in table 17 and fig. 1 is based on data computed similarly for variable milk prices. While supply functions are not shown for the data presented in other tables, they have the same general "stepped" characteristic of those shown.

The supply functions have horizontal ranges, extending until a particular resource restriction is encountered. They then take a "horizontal jump," defining a price level at which the particular enterprise begins to draw resources from a competing resource. Another horizontal range is then encountered and extends as long as reallocation of a particular resource is taking place. As a point is encountered where another resource is concerned, the supply function takes another jump. The different horizontal phases of the function define the price ranges for which an output of a particular product and a particular plan (i.e., combination of output levels for different enterprises) is stable. Hence, in fig. 1, the output of milk is stable at the level produced by 13 cows for all milk prices ranging between $1 and $2.15 per hundredweight.

Changes in Livestock Organization and Crops

The preceding analyses show that dairying may be the most profitable enterprise even at a low milk price. Since the farm situations analyzed included a considerable amount of forage in all adopted rotations and other cattle or sheep were not included in the programming calculations, dairying may come in the optimum plan at a low price because alternatives do not exist for utilizing forage. In contrast, hogs do not enter the optimum plan until prices are at a relatively high level. Hogs differ from dairy cattle because they use mainly grain. Alternative uses for grain include feeding it to dairy cows and poultry or selling it for cash. Cash sales of hay were not provided because of the relative lack of opportunity to sell hay in the area.

Hence, the "normative supply responses" indicated are those conforming only to the resource restrictions and the alternative enterprises outlined previously. Farmers with other investment opportunities and resouce situations would have other "critical corner points" at which price changes would cause changes in farm organization.

The data in tables 13-17 show an interrelationship between the optimum cropping programs and milk and hog prices. In table 15, for example, the optimum rotation plan changes from $CCOM_f$ to chiefly $CCOMM_f$ as milk prices range from $0.81 to $3.12. In table 15, increasingly higher hog prices cause a shift of capital from part of the fertilizer to the hog enterprise to be profitable. Hence, an increased amount of the rotation goes without fertilizer at the higher hog prices. In table 17, the higher hog prices cause forage-intensive rotations to become profitable so that pasture and hay may be made available for large numbers of dairy cows and increased numbers of hogs. This tendency exists, of course, only because corn can be purchased in meeting grain requirements. With sufficiently high hog prices, it is more profitable to use some of the limited capital for investment in more hogs and purchased corn than in fertilization of all rotated land.

OPPORTUNITIES FOR INCREASING NET INCOME BY CHANGING THE RESOURCE STRUCTURE OF A FARM

Some of the ways individual farmers may offset price declines for milk and increase net incomes have been illustrated by the plans discussed in earlier parts of this report. Striking differences between net incomes appear when farm plans based on a rigid cropping program are compared with plans based on a flexible cropping program. Important differences also exist between plans representing improved livestock practices and those representing practices typically used in the area. Finally, differences in the availability of labor and funds cause large variations in net incomes among plans. It has been emphasized earlier that the productivity of one resource depends on the amount and kind of other resources with which it is combined. Since farmers have different quantities of resources, the plan which is optimum for one farm need not be optimum for another farm.

Values of Resourses in Optimum Plans for One-Man and Two-Man Farms Resulting From Changes in Amounts of Resources

Assigning values to resources is one of the important functions of linear programming. Although the fixed resources have been treated as if they had no price, the problem of pricing enters into the linear programming analysis implicitly.

Tables 18 and 19 show the marginal returns of individual farm resources which are limitational in optimum plans determined for one-man and two-man 160-acre farms. This information suggested changes which should take place in the farm resource structure if incomes are to be improved further.

In general, the resources under consideration are not mobile or easily divisible, especially over relatively short periods of time. Family labor often has no alternative uses during off seasons of the year. Farm acreages cannot be changed readily. Capital, once invested in buildings and machinery, is not easily withdrawn. Nevertheless, the numerical values of the limited farm resources still are of practical importance — particularly in view of long-run opportunities which may exist for making adjustments in the farm resource structure.

Changes in the values of farm resources are associated with changes in the combinations in which they are used. Hence, the value and marginal return of each resource depends upon and is a function of other resources which participate in the production. For example, the optimum plan 1 in appendix table A-8 is based on the following resource restrictions: the availability of $3,000 to meet annual cash expendi-

TABLE 18. MARGINAL RETURNS OF LIMITATIONAL RESOURCES FOR PLANS ON ONE-MAN 160-ACRE FARMS.

Farm plans in table:	Plan	One dollar of operating capital	One acre of cropland	One hour of April labor	Space for one litter of spring pigs	Space for one litter of fall pigs	One hour of Feb. wife's labor
8	1	$0.47	$15.80	$10.90	$ 3.31	$ 0	$ 0
	2	0.43	0	19.39	0	0	0.84
	3	1.00	0	14.86	0	0	0
	4	0.47	18.01	7.96	10.79	0	0
9	1	0	11.57	16.57	25.18	33.01	8.77
	2	0	10.35	18.11	21.26	30.48	8.77
	3	0	10.35	18.11	65.32	69.50	8.77
	4	0	14.56	12.64	40.38	42.57	8.77

TABLE 19. MARGINAL RETURNS OF LIMITATIONAL RESOURCES FOR PLANS ON TWO-MAN 160-ACRE FARMS.

Farm plans in table:	Plan	One dollar of operating capital	One acre of cropland	One acre of permanent pasture	One hour of July labor	Space for one litter of spring pigs	Space for one litter of fall pigs	One hour of Feb. wife's labor
10	1	$0.70	$34.84	$20.58	$ 0	$ 0	$ 0	$ 0
	2	1.38	23.71	19.89	0.89	0	0	0
	3	1.42	26.11	21.03	0.10	0	0	0
	4	0.76	30.04	14.48	0	0	0	0
11	1	0.47	44.03	21.68	0	9.49	0	0
	2	0.47	30.37	19.78	5.32	0.10	0	0

tures, 116 acres of cropland, 30 acres of permanent pasture, year-round family labor equivalent to two men, a capacity of producing 18 litters of spring pigs and 6 litters of fall pigs and a capacity of raising 175 hens taken care of by the farmer's wife. The values and the marginal returns from these resources for this plan are presented in table 19. They are: $0.70 for $1 of annual cash expenditures, $34.84 for 1 acre of cropland and $20.58 for 1 acre of permanent pasture. These values indicate that an additional dollar, an additional acre of cropland or an additional acre of pasture used in this plan would bring a return equivalent to the monetary values indicated.

The shortage of funds in this plan does not permit full utilization of all of the farm resources. Hence, some farm resources are used less than is possible or not at all, and the value of further use of the farm labor or the value of further expansion of hogs is nil as long as the amount of funds remains limited to $3,000. On the other hand, any further expansion of the limited resources – cropland, pasture and the operating funds – would increase net farm income and at the same time make more intensive use of the unemployed or non-limitational farm resources possible.

Farmers who are limited by capital could use credit to assist them in bringing their resources into a balance, thus increasing the returns from their farming operations. The limitation of capital might be generated from at least two broad sources: (a) that imposed by internal capital rationing and (b) that imposed by the external forces. It has been observed that the former type of restriction seems to be the major reason that added capital is not employed, even though returns data and farmers' estimates suggest that the use of added capital is profitable in the aggregate.[19] As long as the market price of any one of the limited resources is less than the productivity of the resources, net income can be increased by increasing the quantity used of this limited resource.

If, on the other hand, the productivity or the contribution of a resource to net income is less than its market price, net income can again be increased by selling or renting out part of that resource or its services. For example, on a one-man 160-acre farm, labor is relatively more limited than land. Hence, the marginal return of farm labor in the plans on a one-man farm is in general greater than that of land. The productivity of 1 acre of cropland on a one-man farm ranges anywhere from zero to $18 per acre. Farmers in these situations would be better off if they sold or rented out part of their land as long as the discounted market price or rent of 1 acre of land exceeds its productivity or contribution to net income. The productivity of land on a two-man farm is greater than on a one-man farm and varies between $20.01 and $55.85. Were the discounted market price or the rent of 1 acre of land less than the productivity of land, it would be profitable for the farmer maximizing net income in this situation either to purchase or rent more land. For most of the plans on a two-man farm, an increase in the size of the farm represents one of the opportunities to improve farm income.

[19] Earl O. Heady and Earl R. Swanson. Resource productivity in Iowa farming with special reference to uncertainty and capital use in southern Iowa. Iowa Agr. Exp. Sta. Res. Bul. 388. 1952. p. 770.

SUMMARY

The general objectives of this study are (1) to determine the effects of a decline in milk prices on the organization of dairy farms and their incomes in northeastern Iowa; (2) to identify adjustments which dairymen can make in their crop and livestock production programs to offset lower milk prices; (3) to provide farm operators and those who counsel them with information to facilitate the process of adjustments on individual farms; and (4) to provide guidance for those who will decide future policies in this area.

The study is concerned with 160-acre farms, the modal size on Tama-Downs soils in northeastern Iowa. Optimum plans are developed for one- and two-man farms with various amounts of operating capital. Both usual and improved practices in crop and livestock production are considered. Linear programming is used as the empirical tool for analyzing production adjustment possibilities for the different farm situations considered in this study. The analysis was made on the basis of 1950-54 price levels projected to 1960 and prices of milk that are 20 percent lower than the projections to 1960. While the results apply to 160-acre farms with given quantities of resources, they also may be indicative of what farmers in other situations could do.

A 20-percent decline in the projected price of milk reduces net farm income of a typical one-man farm by an average of 9.2 percent. To offset this decline in net income from lower prices, an operator of a 160-acre, one-man farm could either improve his cropping program, improve the production practices of his livestock enterprises or reorganize both his cropping and his livestock programs.

Improved practices in the dairy enterprise alone on a one-man farm with $3,000 operating capital would not make up the loss in net income from a price decline of 20 percent for milk. Improved practices in both the dairy and the hog enterprises, however, would more than offset the price decline. Improvement of practices for both the crops and livestock would increase net income by about 24 percent, even at the lower price for milk. A one-man farm with $4,500 operating capital could increase net income from the additional investment by $339 if usual practices were used for both crops and livestock. If improved, rather than usual, practices were used with $4,500 operating capital, income could be increased by about 28 percent, even at the lower milk prices. If the same adjustments were made on a two-man farm with $4,500 operating capital, income would be increased by about 40 percent, even with the lower milk prices. Improved practices on the livestock enterprises alone would increase income by about 22 percent.

Hence, both simple and complex adjustments can be made to meet price declines. The more simple types of adjustments are those which represent changes in practices for a single enterprise. More complex adjustments are those which include both changes in practices for all enterprises and reorganization of enterprises. It appears, however, that typical farmers have the opportunity for making on-farm adjustments which will offset price declines for milk. The extent to which these adjustments can be used to arrest a decline in income, or even to increase income, depends on the operator's managerial abilities and the availability of capital and labor.

Variable prices were used in the programming analysis to determine the price range over which particular enterprise combinations appear stable. In general, prices for hogs and dairy products can range widely before a new plan is required to maximize profits.

For example, on a one-man farm with above-average management, with hog prices constant at $17.98, the optimum plan does not include dairying until the milk price reaches $0.92 per hundredweight. A plan with 9 dairy cows is stable for all prices between $0.92 and $5.27 for milk. The hog enterprise includes 18 spring litters and 6 fall litters for these two price ranges for milk.

When the milk price is held constant at $2.68 and hog prices are varied, a plan with no hogs and 14 cows is stable for all prices between zero and $13.13 for hogs. Fifteen spring litters and 10 cows are included in the optimum plan for hog prices between $13.13 and $14.45. Eighteen spring litters, 6 fall litters and 10 dairy cows are included for hog prices ranging between $14.45 and $15.52. These "stair step" supply characteristics exist because of the fixed resource supplies and linear coefficients used in the linear programming.

Marginal value productivities were computed for scarce resources on one-man and two-man farms. These quantities indicated that farms operating with limited resources could, under efficient management practices, use more resources for a profitable expansion of their business operations.

The types of adjustments outlined in this study can reduce the per-unit cost of producing milk and increase the value productivity of resources on individual farms. The adjustments would be profitable to the individual farmers who make them. If all or a majority of farmers make similar adjustments, however, the mass effect might be to reduce prices further. Thus, the immediate solution to a cost-price squeeze for a few farmers might not be the best solution for farmers as a whole.

APPENDIX

TABLE A-1. RESOURCE REQUIREMENTS FOR EACH UNIT OF OUTPUT FROM DIFFERENT LIVESTOCK ENTERPRISES.

Output units[a]	Average enterprises				Above-average enterprises		
	Dairy	Spring pigs	Fall pigs	Poultry	Dairy	Spring pigs	Fall pigs
	100 lbs. milk	100 lbs. pork	100 lbs. pork	16 doz. eggs	100 lbs. milk	100 lbs. pork	100 lbs. pork
Resources:							
Annual cash outlay	0.42927	3.77	4.053	2.97	0.41337	4.25	4.57
Corn equivalent, lbs.	37.39	425	475	92.5	41.000	315	353
Hay equivalent, lbs.	182.97	146	....	....	122.00	108	
Part of litter	....	0.06812	0.06812	....	....	0.05807	0.05907
Labor hours							
January	0.19761	0.13629	0.21805	0.1596	0.14495	0.11931	0.18907
February	0.19761	0.13629	0.17084	0.1596	0.14495	0.11931	0.14814
March	0.18711	0.16390	0.15736	0.1722	0.13800	0.14347	0.13644
April	0.18186	0.17251	0.12143	0.2058	0.13453	0.15102	0.10526
May	0.14240	0.15700	0.10565	0.3171	0.10684	0.13743	0.09161
June	0.11615	0.14320	0.11689	0.2205	0.08947	0.12535	0.10136
July	0.11615	0.14320	0.11240	0.1722	0.08947	0.12535	0.09746
August	0.12140	0.14320	0.18433	0.1596	0.09295	0.12535	0.15983
September	0.11615	0.13629	0.29223	0.1533	0.08947	0.11931	0.25340
October	0.14240	0.13629	0.27884	0.1218	0.10684	0.11931	0.24170
November	0.15815	0.13457	0.24503	0.1365	0.11726	0.11780	0.21246
December	0.16866	0.12250	0.24503	0.1218	0.12421	0.10723	0.21246

[a] For the composition of various output units see earlier section on "Output Units."

TABLE A-2. RESOURCE REQUIREMENTS FOR DIFFERENT ROTATIONS ON THE BASIS OF 1 ACRE.[a]

	Unfertilized rotations				Fertilized rotations			
	C-C-O-M	C-C-O-M-M	C-O-M	C-O-M-M	C-C-O-M	C-C-O-M-M	C-O-M	C-O-M-M
Annual cash outlay[b] ($)	12.99	13.08	12.64	13.57	19.78	18.83	17.06	17.42
Labor, hours								
January	...	...	...	....	....	....	....	....
February	...	...	...	....	....	....	....	....
March	0.105	0.084	0.104	0.105	0.10	0.084	0.140	0.105
April	0.75	0.600	0.68	0.51	0.75	0.600	0.68	0.51
May	0.88	0.704	0.5867	0.44	0.88	0.704	0.5867	0.44
June	1.3075	1.676	1.397	1.835	1.307	1.676	1.397	1.835
July	1.7975	2.0685	2.103	2.365	1.7975	2.0685	2.103	2.365
August	0.6075	0.528	1.44	0.660	0.6075	0.528	1.44	0.660
September	0.1925	0.260	0.216	0.265	0.1925	0.260	0.216	0.265
October	0.680	0.544	0.453	0.340	0.680	0.544	0.453	0.340
November	0.720	0.572	0.48	0.360	0.720	0.572	0.48	0.360
December	0.20	0.160	0.133	0.10	0.20	0.160	0.133	0.10

[a] A rotation acre is 1 acre which consists of all the crops included in the rotation. The crops take up their proper proportion of that acre.

[b] The annual cash outlay includes expenditures for power (fuel, oil and grease), machinery, seed and terracing and fertilizer expenditures where applicable.

TABLE A-3. OPTIMUM PLANS FOR A ONE-MAN FARM WITH $3,000 ANNUAL CASH EXPENDITURES, SPECIFIED PRICE LEVELS, USUAL CROPPING PROGRAM AND DIFFERENT LIVESTOCK PRACTICES.

	Unit	Projected prices			Milk prices 20 percent lower		
		Usual dairy and hog practices	Improved dairy practices	Improved dairy and hog practices	Usual dairy and hog practices	Improved dairy practices	Improved dairy and hog practices
Plan		1	2	3	4	5	6
Total land	acres	160	160	160	160	160	160
Total cropland	acres	116	116	116	116	116	116
Corn	acres	43	43	43	43	43	43
Oats	acres	32	32	32	32	32	32
Hay and rotation pasture	acres	41	41	41	41	41	41
Permanent pasture	acres	30	30	30	30	30	30
Crop production:							
Corn equivalent	bu.	3,417	3,417	3,417	3,417	3,417	3,417
Hay equivalent	tons	107	107	107	107	107	107
Livestock:							
Dairy cows	no.	11	11	11	11	11	11
Spring pigs	no.	119	119	130	119	119	130
Fall pigs	no.	25	19	0	25	19	0
Hens	no.	0	0	53	0	0	53
Corn fed to:							
Dairy cattle	bu.	467	764	764	467	764	764
Hogs	bu.	2,559	2,435	1,746	2,559	2,435	1,746
Poultry	bu.	0	0	88	0	0	88
Hay equivalent fed to:							
Dairy cattle	tons	64	64	64	64	64	64
Hogs	tons	20	20	17	20	20	17
Receipts:							
Corn	dollars	518	290	1,086	518	290	1,086
Dairy enterprise	dollars	2,420	3,409	3,409	2,050	2,849	2,849
Hogs	dollars	5,838	5,579	5,499	5,838	5,579	5,499
Poultry	dollars	0	0	348	0	0	348
Annual cash expenditures	dollars	2,950	3,012	3,000	2,950	3,012	3,000
Depreciation (bldg. & mach.)	dollars	1,376	1,376	1,376	1,376	1,376	1,376
Net farm income	dollars	4,450	4,890	5,966	4,080	4,330	5,406

TABLE A-4. OPTIMUM PLANS FOR A ONE-MAN FARM WITH $3,000 ANNUAL CASH EXPENDITURES, SPECIFIED PRICE LEVELS, FLEXIBLE CROPPING PROGRAM AND DIFFERENT LIVESTOCK PRACTICES.

		Projected prices			Milk prices 20 percent lower		
	Unit	Usual dairy and hog practices	Improved dairy practices	Improved dairy and hog practices	Usual dairy and hog practices	Improved dairy practices	Improved dairy and hog practices
Plan		1	2	3	4	5	6
Total land	acres	160	160	160	160	160	160
Total cropland	acres	116	116	116	116	116	116
Corn	acres	58	58	58	58	58	58
Oats	acres	29	29	29	29	29	29
Hay and rotation pasture	acres	29	29	29	29	29	29
Permanent pasture	acres	30	30	30	30	30	30
Crop production:							
Corn equivalent	bu.	3,770	3,770	3,770	3,770	3,770	3,770
Hay equivalent	tons	102	102	102	102	102	102
Livestock:							
Dairy cows	no.	11	11	11	11	11	11
Spring pigs	no.	119	119	112	119	119	112
Fall pigs	no.	0	0	0	0	0	0
Hens	no.	58	32	0	58	32	0
Corn fed to:							
Dairy cattle	bu.	467	764	764	467	764	764
Hogs	bu.	2,061	2,061	1,649	2,061	2,061	1,649
Poultry	bu.	96	53	0	96	53	0
Hay equivalent fed to:							
Dairy cattle	tons	64	64	64	64	64	64
Hogs	tons	20	20	16	20	20	16
Receipts:							
Corn	dollars	1,652	1,183	1,799	1,652	1,183	1,799
Dairy enterprise	dollars	2,420	3,409	3,409	2,050	2,849	2,849
Hogs	dollars	4,801	4,801	5,193	4,801	4,801	5,193
Poultry	dollars	380	210	0	380	210	0
Annual cash expenditures	dollars	2,998	3,056	2,952	2,998	3,056	2,952
Depreciation (bldg. & mach.)	dollars	1,376	1,376	1,376	1,376	1,376	1,376
Net farm income	dollars	4,879	5,171	6,073	4,509	4,611	5,513

TABLE A-5. OPTIMUM PLANS FOR A ONE-MAN FARM WITH $4,500 ANNUAL CASH EXPENDITURES, SPECIFIED PRICE LEVELS, USUAL CROPPING PROGRAM AND DIFFERENT LIVESTOCK PRACTICES.

		Projected prices			Milk prices 20 percent lower		
	Unit	Usual dairy and hog practices	Improved dairy practices	Improved dairy and hog practices	Usual dairy and hog practices	Improved dairy practices	Improved dairy and hog practices
Plan		1	2	3	4	5	6
Total land	acres	160	160	160	160	160	160
Total cropland	acres	116	116	116	116	116	116
Corn	acres	43	43	43	43	43	43
Oats	acres	32	32	32	32	32	32
Hay and rotation pasture	acres	41	41	41	41	41	41
Permanent pasture	acres	30	30	30	30	30	30
Crop production:							
Corn equivalent	bu.	3,417	3,417	3,417	3,417	3,417	3,417
Hay equivalent	tons	107	107	107	107	107	107
Livestock:							
Dairy cows	no.	12	11	10	12	11	10
Spring pigs	no.	119	119	130	119	119	130
Fall pigs	no.	13	0	28	13	0	28
Hens	no.	175	175	175	175	175	175
Corn fed to:							
Dairy cattle	bu.	510	764	695	510	764	695
Hogs	bu.	2,310	2,061	2,174	2,310	2,061	2,174
Poultry	bu.	289	289	289	289	289	289
Hay equivalent fed to:							
Dairy cattle	tons	69	64	58	69	64	58
Hogs	tons	20	20	17	20	20	17
Receipts:							
Corn	dollars	408	402	343	408	402	343
Dairy enterprises	dollars	2,640	3,409	3,099	2,236	2,849	2,590
Hogs	dollars	5,319	4,801	6,694	5,319	4,801	6,694
Poultry	dollars	1,148	1,148	1,148	1,148	1,148	1,148
Annual cash expenditures	dollars	3,350	3,312	3,633	3,350	3,312	3,633
Depreciation (bldg. & mach.)	dollars	1,376	1,376	1,376	1,376	1,376	1,376
Net farm income	dollars	4,789	5,072	6,275	4,385	4,512	5,766

TABLE A-6. OPTIMUM PLANS FOR A ONE-MAN FARM WITH $4,500 ANNUAL CASH EXPENDITURES, SPECIFIED PRICE LEVELS, FLEXIBLE CROPPING PROGRAM AND DIFFERENT LIVESTOCK PRACTICES.

		Projected prices			Milk prices 20 percent lower		
	Unit	Usual dairy and hog practices	Improved dairy practices	Improved dairy and hog practices	Usual dairy and hog practices	Improved dairy practices	Improved dairy and hog practices
Plan		1	2	3	4	5	6
Total land	acres	160	160	160	160	160	160
Total cropland	acres	116	116	116	116	116	116
Corn	acres	58	58	58	58	58	58
Oats	acres	29	29	29	29	29	29
Hay and rotation pasture	acres	29	29	29	29	29	29
Permanent pasture	acres	30	30	30	30	30	30
Crop production:							
Corn equivalent	bu.	4,302	4,214	3,939	4,302	4,214	3,939
Hay equivalent	tons	124	118	113	124	118	113
Livestock:							
Dairy cows	no.	10	9	9	10	9	9
Spring pigs	no.	119	119	130	119	119	130
Fall pigs	no.	38	38	40	38	38	40
Hens	no.	175	175	175	175	175	175
Corn fed to:							
Dairy cattle	bu.	425	625	625	425	625	625
Hogs	bu.	2,808	2,808	2,388	2,808	2,808	2,388
Poultry	bu.	289	289	289	289	289	289
Hay equivalent fed to:							
Dairy cattle	tons	58	52	52	58	52	52
Hogs	tons	20	20	17	20	20	17
Receipts:							
Corn	dollars	1,034	652	845	1,034	652	845
Dairy enterprise	dollars	2,200	2,789	2,789	1,863	2,331	2,331
Hogs	dollars	6,357	6,357	7,291	6,357	6,357	7,291
Poultry	dollars	1,148	1,148	1,148	1,148	1,148	1,148
Annual cash expenditures	dollars	4,236	4,201	4,093	4,236	4,201	4,093
Depreciation (bldg. & mach.)	dollars	1,376	1,376	1,376	1,376	1,376	1,376
Net farm income	dollars	5,127	5,369	6,604	4,790	4,911	6,146

TABLE A-7. OPTIMUM PLANS FOR A TWO-MAN FARM WITH $3,000 ANNUAL CASH EXPENDITURES, SPECIFIED PRICE LEVELS, USUAL CROPPING PROGRAM AND DIFFERENT LIVESTOCK PRACTICES.

		Projected prices			Milk prices 20 percent lower		
	Unit	Usual dairy and hog practices	Improved dairy practices	Improved dairy and hog practices	Usual dairy and hog practices	Improved dairy practices	Improved dairy and hog practices
Plan		1	2	3	4	5	6
Total land	acres	160	160	160	160	160	160
Total cropland	acres	116	116	116	116	116	116
Corn	acres	43	43	43	43	43	43
Oats	acres	32	32	32	32	32	32
Hay and rotation pasture	acres	41	41	41	41	41	41
Permanent pasture	acres	30	30	30	30	30	30
Crop production:							
Corn equivalent	bu.	3,417	3,417	3,417	3,417	3,417	3,417
Hay equivalent	tons	107	107	107	107	107	107
Livestock:							
Dairy cows	no.	15	16	18	15	16	16
Spring pigs	no.	119	66	43	119	66	101
Fall pigs	no.	19	38	43	19	38	0
Hens	no.	0	0	45	0	0	67
Corn fed to:							
Dairy cattle	bu.	637	1,112	1,251	637	1,112	1,112
Hogs	bu.	2,435	1,892	1,224	2,435	1,892	1,358
Poultry	bu.	0	0	74	0	0	111
Hay equivalent fed to:							
Dairy cattle	tons	87	93	103	87	93	93
Hogs	tons	20	11	4	20	11	13
Receipts:							
Corn	dollars	459	548	1,152	459	548	1,109
Dairy enterprise	dollars	3,300	4,958	5,578	2,795	4,144	4,144
Hogs	dollars	5,579	4,223	3,625	5,579	4,223	4,277
Poultry	dollars	0	0	295	0	0	440
Annual cash expenditures	dollars	2,985	2,974	3,001	2,985	2,974	3,000
Depreciation (bldg. & mach).	dollars	1,478	1,478	1,478	1,478	1,478	1,478
Net farm income	dollars	4,875	5,277	6,171	4,370	4,463	5,492

TABLE A-8. OPTIMUM PLANS FOR A TWO-MAN FARM WITH $3,000 ANNUAL CASH EXPENDITURES, SPECIFIED PRICE LEVELS, FLEXIBLE CROPPING PROGRAM AND DIFFERENT LIVESTOCK PRACTICES.

		Projected prices			Milk prices 20 percent lower		
	Unit	Usual dairy and hog practices	Improved dairy practices	Improved dairy and hog practices	Usual dairy and hog practices	Improved dairy practices	Improved dairy and hog practices
Plan		1	2	3	4	5	6
Total land	acres	160	160	160	160	160	160
Total cropland	acres	116	116	116	116	116	116
Corn	acres	57	40	40	57	51	58
Oats	acres	28	26	26	28	25	29
Hay and rotation pasture	acres	31	50	50	31	40	29
Permanent pasture	acres	30	30	30	30	30	30
Crop production:							
Corn equivalent	bu.	3,752	3,070	3,111	3,752	3,678	3,770
Hay equivalent	tons	118	184	182	118	160	118
Livestock:							
Dairy cows	no.	17	32	31	17	28	19
Spring pigs	no.	122	0	7	122	0	72
Fall pigs	no.	0	0	0	0	0	0
Hens	no.	0	0	0	0	0	51
Corn fed to:							
Dairy cattle	bu.	722	2,224	2,155	722	1,946	1,320
Hogs	bu.	1,946	0	97	1,946	0	970
Poultry	bu.	0	0	0	0	0	84
Hay equivalent fed to:							
Dairy cattle	tons	98	184	179	98	160	109
Hogs	tons	19	0	1	19	1	9
Receipts:							
Corn	dollars	1,437	1,122	1,134	1,437	2,297	1,851
Dairy enterprise	dollars	3,740	9,916	9,607	3,166	7,251	4,920
Hogs	dollars	4,535	0	305	4,535	0	3,055
Poultry	dollars	0	0	0	0	0	335
Annual cash expenditures	dollars	3,007	3,015	3,005	3,007	3,021	2,998
Depreciation (bldg. & mach.)	dollars	1,478	1,478	1,478	1,478	1,478	1,478
Net farm income	dollars	5,227	6,545	6,563	4,653	5,049	5,685

TABLE A-9. OPTIMUM PLANS FOR A TWO-MAN FARM WITH $4,500 ANNUAL CASH EXPENDITURES, SPECIFIED PRICE LEVELS, USUAL CROPPING PROGRAM AND DIFFERENT LIVESTOCK PRACTICES.

		Projected prices			Milk prices 20 percent lower		
	Unit	Usual dairy and hog practices	Improved dairy practices	Improved dairy and hog practices	Usual dairy and hog practices	Improved dairy practices	Improved dairy and hog practices
Plan		1	2	3	4	5	6
Total land	acres	160	160	160	160	160	160
Total cropland	acres	116	116	116	116	116	116
Corn	acres	43	43	43	43	43	43
Oats	acres	32	32	32	32	32	32
Hay and rotation pasture	acres	41	41	41	41	41	41
Permanent pasture	acres	30	30	30	30	30	30
Crop production:							
Corn equivalent	bu.	3,417	3,417	3,417	3,417	3,417	3,417
Hay equivalent	tons	107	107	107	107	107	107
Livestock:							
Dairy cows	no.	15	17	16	15	17	16
Spring hogs	no.	119	66	130	119	66	130
Fall hogs	no.	19	40	14	19	40	14
Hens	no.	175	175	175	175	175	175
Corn fed to:							
Dairy cattle	bu.	637	1,181	1,112	637	1,181	1,112
Hogs	bu.	2,434	1,892	1,960	2,434	1,892	1,960
Poultry	bu.	289	289	289	289	289	289
Hay equivalent fed to:							
Dairy cattle	tons	87	98	92	87	98	92
Hogs	tons	20	9	16	20	9	16
Receipts:							
Corn	dollars	74	81	74	74	81	74
Dairy enterprise	dollars	3,300	5,268	4,958	2,795	4,402	4,143
Hogs	dollars	5,579	4,223	6,096	5,579	4,223	6,096
Poultry	dollars	1,148	1,148	1,148	1,148	1,148	1,148
Annual cash expenditures	dollars	3,505	3,533	3,714	3,505	3,533	3,714
Depreciation (bldg. & mach.)	dollars	1,478	1,478	1,478	1,478	1,478	1,478
Net farm income	dollars	5,118	5,709	7,084	4,613	4,843	6,269

TABLE A-10. OPTIMUM PLANS FOR A TWO-MAN FARM WITH $4,500 ANNUAL CASH EXPENDITURES, SPECIFIED PRICE LEVELS, FLEXIBLE CROPPING PROGRAM AND DIFFERENT LIVESTOCK PRACTICES.

	Unit	Projected prices			Milk prices 20 percent lower		
		Usual dairy and hog practices	Improved dairy practices	Improved dairy and hog practices	Usual dairy and hog practices	Improved dairy practices	Improved dairy and hog practices
Plan		1	2	3	4	5	6
Total land	acres	160	160	160	160	160	160
Total cropland	acres	116	116	116	116	116	116
Corn	acres	46.4	47.6	47.6	56.6	48	51.1
Oats	acres	23.2	23.8	23.8	23.8	24	27.6
Hay and rotation pasture	acres	46.4	44.6	44.6	31.1	44	37.3
Permanent pasture	acres	30	30	30	30	30	30
Crop production:							
Corn equivalent	bu.	3,619	3,713	3,635	4,435	3,744	3,690
Hay equivalent	tons	192	186	182	140	183	150
Livestock:							
Dairy cows	no.	30	29	29	21	28	23
Spring hogs	no.	119	119	122	119	119	130
Fall hogs	no.	0	0	0	38	19	43
Hens	no.	163	52	78	94	0	66
Corn fed to:							
Dairy cattle	bu.	1,275	2,015	2,015	892	1,946	1,598
Hogs	bu.	2,061	2,061	1,649	2,808	2,434	2,388
Poultry	bu.	269	86	129	155	0	109
Hay equivalent fed to:							
Dairy cattle	tons	172	166	166	120	161	133
Hogs	tons	20	20	16	20	20	17
Receipts:							
Corn	dollars	18	-595	-210	769	-843	-538
Dairy enterprise	dollars	6,599	8,987	8,987	3,912	7,251	5,956
Hogs	dollars	4,801	4,801	5,263	6,357	5,579	7,291
Poultry	dollars	1,070	341	512	617	0	433
Annual cash expenditures	dollars	4,500	4,551	4,498	4,588	4,541	4,499
Depreciation (bldg. & mach.)	dollars	1,478	1,478	1,478	1,478	1,478	1,478
Net farm income	dollars	6,510	7,505	8,581	5,589	5,968	7,165

TABLE A-11. OPTIMUM PLANS FOR A TWO-MAN FARM WITH $6,000 ANNUAL CASH EXPENDITURES, SPECIFIED PRICE LEVELS, FLEXIBLE CROPPING PROGRAM AND DIFFERENT LIVESTOCK PRACTICES.

	Unit	Projected prices			Milk prices 20 percent lower		
		Usual dairy and hog practices	Improved dairy practices	Improved dairy and hog practices	Usual dairy and hog practices	Improved dairy practices	Improved dairy and hog practices
Plan		1	2	3	4	5	6
Total land	acres	160	160	160	160	160	160
Total cropland	acres	116	116	116	116	116	116
Corn	acres	46.4	48	48.9	46.4	48	48.9
Oats	acres	23.2	25	24.4	23.2	25	24.4
Hay and rotation pasture	acres	46.4	43	42.7	46.4	43	42.7
Permanent pasture	acres	30	30	30	30	30	30
Crop production:							
Corn equivalent	bu.	3,619	3,783	3,814	3,619	3,783	3,814
Hay equivalent	tons	192	181	179	192	181	179
Livestock:							
Dairy cows	no.	30	28	28	30	28	28
Spring hogs	no.	119	119	130	119	119	130
Fall hogs	no.	38	38	43	38	38	43
Hens	no.	175	175	175	175	175	175
Corn fed to:							
Dairy cattle	bu.	1,275	1,946	1,946	1,275	1,946	1,946
Hogs	bu.	2,808	2,808	2,388	2,808	2,808	2,388
Poultry	bu.	289	289	289	289	289	289
Hay equivalent fed to:							
Dairy cattle	tons	172	161	161	172	161	161
Hogs	tons	20	20	17	20	20	17
Receipts:							
Corn	dollars	-998	-1,671	-1,073	-998	-1,671	-1,073
Dairy enterprise	dollars	6,599	8,677	8,677	5,589	7,251	7,251
Hogs	dollars	6,357	6,357	7,291	6,357	6,357	7,291
Poultry	dollars	1,148	1,148	1,148	1,148	1,148	1,148
Annual cash expenditures	dollars	4,975	5,285	5,365	4,975	5,285	5,365
Depreciation (bldg. & mach.)	dollars	1,478	1,478	1,478	1,478	1,478	1,478
Net farm income	dollars	6,653	7,748	9,200	5,643	6,322	7,774

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