RESEARCH BULLETIN 958 DECEMBER 1963

Maximizing Income By Expanding the Dairy Enterprise On Northeastern Ohio Farms

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Maximizing Income by Expanding the Dairy Enterprise on Northeastern Ohio Farms

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INTRODUCTION AND PROBLEM

The dairy cow has been basic to the agricultural economy of Ohio for several decades. Sale of dairy products comprised 21 percent of cash farm receipts and totaled 210 million dollars in 1960. Dairying was the most important source of farm income in 45 of Ohio's 88 counties and ranked second in another 18 counties.[2] Eight of the top ten dairy income counties were found in northeastern Ohio.[3]

This area is the most heavily populated part of the state and provides a ready market for a large volume of dairy products. However, population and industrial pressures offer agriculture severe competition for the use of land. Farmers find it difficult, if not impossible, to purchase additional land for agricultural purposes and when land is available, the price is high.

Soils in the area resulted from a mixing of the residual sandstone and shales, typical of eastern Ohio, with the glaciated limestone soils of western Ohio. These soils are moderately high in productivity and moisture holding capacity, have a gently rolling topography, and respond well to applications of lime, fertilizer, and the build-up of organic matter. Contour strip cropping and the production of meadow crops are desirable conservation practices on soil areas subject to erosion.

Northeastern Ohio was settled early in the development of the state and dairying was established as the major agricultural activity. The influence of the Connecticut Western Reserve "yankee farmer" is still evidenced on farms in this area today.

Many northeastern Ohio farm families are experiencing problems of rising resource costs, technological change, and vigorous competition.

[1]Acknowledgment: R. H. Baker and J. R. Tompkin of the Department of Agricultural Economics and Rural Sociology helped in the development of the linear programming matrix; W. J. Brakel, Department of Dairy Science; and J. H. Cline, Department of Animal Science, assisted with the establishment of livestock feed nutrient requirements and T. W. Hildebrandt of the Numerical Computation Laboratory assisted in the use of computational equipment.

[2]Smith, M. G.; McCormick, F. B.; Dockum, R. C.; Krock, L.; Kendall, J. R.; and Houghton, E. E.; Ohio Farm Income 1960; Departmental Series A. E. 325; Department of Agricultural Economics and Rural Sociology; The Ohio State University, October 1961.

[3]The counties were: Ashland, Ashtabula, Holmes, Lorain, Medina, Stark, Trumbull, and Wayne.

As a result, incomes are threatened and adjustments in the operation and organization of the farm business are necessary if the family income is to be maintained or improved. Many technological changes result in smaller net income margins per unit of production. Consequently, to maintain or improve income in the face of reduced margins, either the same number of units must be produced at a lower cost or more units must be produced for sale by the farm family.

Two primary ways available to the family for improving income were considered in this study. One was to produce more milk per cow and/or greater crop yields per acre which requires a more intensive use of the available farm land and facilities. The other route was more extensive in that the same labor force must handle more land, facilities, and cows.

Farm income can be increased by either route only if more output is achieved per unit of input. Managerial and risk responsibilities increase as more intensive production methods are employed and larger sums of money are invested. Such problems may be characterized by labor shortages, excessive rain, drought, livestock health, etc.

OBJECTIVES

The purpose of this study was to select the organization that will maximize farm income with the resources available on a typical northeastern Ohio dairy farm. A second objective was to consider the effects that selected changes in resource availability would have on income. Changes in forage handling methods and milking facilities were of particular interest because of the important influence they exert within the farm business organization.

REVIEW OF LITERATURE

Several researchers have attempted to study the effects that selected forage handling systems and organization of resources have on farm income.

Smith (4), in a Wisconsin study, investigated five selected systems of handling the meadow crops that would permit greater quantities of forage to be fed. Rotations and feeding systems were varied and the net profit from each was determined. He concluded that Wisconsin dairy farmers could profitably produce and feed larger quantities of forage than was usually practiced. The most profitable program included feeding corn silage, ensiling the first crop of hay, and preserving and feeding the remaining meadow crops as field cured hay.

Linear programming was used by Armstrong *et al.* (1) to develop an optimum dairy farm organization for a west-central Ohio dairy farm with three levels of available capital.

When the amount of capital available for the acquisition of land was relatively more abundant than the labor supply, a rotation of corn-corn-corn-small grain-meadow was selected. Conventional grazing of meadows was practiced and all of the harvested forage was fed as hay. Capital was used to acquire land for cash-grain production. The rotation was modified to corn-corn-small grain-meadow-meadow when the availability of capital was restricted. Hay was field conditioned, chopped, and barn dried; and pastures were rotationally grazed. When capital was restricted further, a rotation of corn-small grain-meadow-meadow-meadow was selected and rotational grazing of meadows was practiced. In all situations, as many high producing cows (12,500 pounds of milk) were kept as could be cared for and still effectively utilize the available capital. Cow numbers varied from 35 to 40 head, plus the necessary replacements.

Hoglund and Harrison (2) compared selected intensive grazing systems on Michigan dairy farms. Both field grazing (rotational) and strip grazing (rationed) yielded more net income than conventional grazing methods. Green chop was found to be no more profitable than a conventional grazing system.

Shaudys *et al.* (3) found that a green chop system increased the carrying capacity of a pasture 40 percent over conventional grazing under actual farm conditions and that milk production would have to be increased 350 to 400 pounds of milk per acre of pasture to offset this added cost. Rotational grazing increased carrying capacity 25 percent over a conventional grazing system and would require an increase of 100 pounds of milk per acre to offset the added cost.

Westcott (5), in a study developing optimum farm organizations in western Ohio, observed that changes in crop rotation, feeding programs, and herd size were desirable. Adequate cow numbers for full employment of labor and use of resources was more profitable than restricting the herd size to the forage producing capacity of the farm.

METHOD OF STUDY

Problem

Typically, an operator attempting to expand his farm organization must choose between abandoning existing facilities and developing an entirely new organization or modifying the existing facilities in a desirable manner. Usually, the existing facilities have the merit of being paid for, or are of minimal investment cost, whereas the abandonment and construction of an entirely new set of facilities is a costly proposition. However, new facilities offer the possibilities of more efficient use of labor, ease of operation, and prestige.

TABLE 1.—Farm Income by Number of Cows, 48 Northeastern Ohio Dairy Farms, 1959.

Number of Cows	Number of Farms	Farm Income
10-14	4	$2,094
15-19	16	2,616
20-24	15	3,441
25-29	13	4,898
Average	48	$3,448

Source: 48 northeastern Ohio dairy farm records, Ohio Agricultural Extension Service.

The other basic question of major importance to the farm manager is the selection of the most desirable method of securing feed nutrients needed for the dairy herd. Again, several alternatives confront a dairy farm operator.

The basic concern of this study is to determine which of several possible routes for improving income potential through adjustment and/or expansion is the most feasible. Two paramount considerations confronting a northeastern Ohio dairy farm operator are: (1) how can feed nutrients be most economically obtained and (2) how can the needed facilities for milking and housing the dairy herd be developed most effectively.

Farm planning techniques of linear programming and budgeting were used to develop the optimum organization. The basic farm unit was selected as the modal dairy farm on which farm account records had been kept and submitted to the Agricultural Extension Service for summary. Production coefficients were determined for two levels of managerial input as is reflected in production performance.

The Typical Farm

Forty-eight northeastern Ohio dairy farm records were used to define a typical farm production situation as it exists today.[4] Income was found to be related to herd size on these farms. Farmers with 25-29 cow herds reported an average farm income of $4,898 compared with $2,094 by farmers with 10-14 cow herds. The typical or modal farm had 23 cows, 13 replacements, and 154 acres of land, of which 132 acres was owned and 22 acres of land was rented. A rotation of corn-corn-small grain-meadow-meadow was used on 103 acres of cropland and is typical of that found on many farms in the area where erosion control is not a serious problem.

[4]Ohio Farm Account Records; Agricultural Extension Service, The Ohio State University.

TABLE 2.—Capital Investment for a Typical Northeastern Ohio Dairy Farm, 1962 (current valuation).

Item	Investment
Real Estate	$40,000
Milk Cows (23 cows)	7,000
Dairy Replacements	1,000
Machinery and Equipment	7,000
Feed, Supplies, and Operating Capital	3,000
Total	$58,000

With average management the production was reported at 10,000 pounds of milk per cow. With an above-average level of management a production of 12,000 pounds of milk per cow was programmed. Milk sales per cow were programmed at 96 percent of the reported production. Admittedly, this is not an extremely high level of production; but it is considerably above the level of production achieved by many farmers in the area.

Labor availability, as found on the typical or modal farm, consisted of 12 months of operator, 6 months of family, and 3 months of hired labor. A labor calendar was developed to determine the most critical labor demand months. June and October were found to be critical labor months for this type of farm operation and it was determined that if the work load could be handled during these months, it could be handled during the other months of the year (appendix Table 11).

Miscellaneous and maintenance labor requirements were estimated to be 25 percent of the total labor used. A total of 2,917 hours of operator and family labor was available for productive work and up to 100 hours of labor could be hired each month during June, July, and August at $1.25 per hour. Labor was assumed to be unavailable for hire during October. Much of the seasonal hired labor available is furnished by high school boys and this supply is withdrawn during the school year. The total man hours of labor available for productive work is limited to 3,217 hours.

A schedule of prices for items purchased for production and products sold was developed (appendix Table 10). Prices used were selected to be representative of purchased input costs and returns to the farm operator on a typical northeastern Ohio farm during the 1962 year.

Current market value of real estate, facilities, livestock, equipment, feed, and supplies on hand was found to be approximately $58,000 on the typical farm. The program was designed to permit additional increments of capital to be borrowed, up to the point that some other resources, such as labor or feed, became limiting and restricted further expansion of the farm business.

The capital investment and the corresponding fixed investment costs were based on farm account records submitted to the Ohio Agricultural Extension Service for summary. Existing real estate investment was found to be $40,000 on the modal farm. This was comprised of $28,800 for land (current market value) and $11,200 in buildings and improvements. In addition, capital invested in livestock was reported at an inventory value of $8,000, equipment at $7,000, and operating capital was reported at $3,000.

Additional capital available for expansion was assumed at six levels as follows: $5,500; $9,500; $12,800; $15,000; $20,000; and $30,000. Any new investment required in the program for buildings, facilities, livestock, equipment, and operational needs would have to come from this additional capital available.

Included as part of the farm real estate was a 36′ × 72′ dairy barn with 18 stanchions, a gutter cleaner, milking equipment, water heater, bulk tank, washing tanks, and a 12′ × 40′ upright silo.

Management of the farm is reflected in crop yields and livestock performance. Two levels were included in the program. Performance of the modal group of farm record keepers was used as level one and managerial performance indicated by the upper quartile of farm records was considered as level two. Milk produced per cow on management level one farms was programmed at 10,000 pounds and on level two management farms at 12,000 pounds. Acreage and crop yields used in this study for management levels one and two are reported in Table 3.

Activities That Could Be Included in the Dairy Farm Organization

Dairy was the only livestock enterprise considered. However, it was necessary to include the complete farm program in order to reflect the effect each activity would have on the use of the resources available. Particular consideration was given to the handling of the meadow crops because of their importance in this organization and operation of the farm.

Information on prices, production costs, labor inputs, and fertilizer was drawn from other studies pertaining to farms of comparable size and type.

TABLE 3.—Land Use and Crop Yields by Two Levels of Management on a Northeastern Ohio Dairy Farm, 1962.

Land Use	Acres	Management Level 1	Management Level 2
Cropland			
Corn	41	70 bu.	85 bu.
Oats	7	55 bu	65 bu.
Wheat	14	25 bu.	35 bu
Meadow	41	2.5 ton	3.6 ton
Total	103		
Permanent Pasture	14		
Woods, farmstead, and other	37		
Total Land Area	154		

Meadow Crops

Yields of hay, silage, and selected methods of pasturing a dairy herd were included. The nutrient content is influenced by the timeliness of harvesting the meadow crops and the system used. An acre of meadow crop could be harvested in the following ways:

Systems of Harvesting the Meadow Crops

System	Cutting		
	First	Second	Third
a	Hay	Hay	Hay
b	Hay	Hay	Pasture
c	Hay	Pasture	Pasture
d	Silage	Hay	Hay
e	Silage	Hay	Pasture
f	Silage	Pasture	Pasture
g	Pasture	Pasture	Pasture

In addition, the effect of the time of making hay during the season was programmed to permit the differences in nutrient yield, labor, and capital requirements to be taken into account. Digestible nutrient content and palatability decline with delay in time of cutting. Meadow crops cut for hay could be field cured, field conditioned, mow dried, or field conditioned and mow dried. Either baling or chopping could be used. The selection was dependent on the desirability of the method as determined by its effect on net income earned and the resource input required.

Grass-legume silage was another possible method of handling meadow crops. The typical farm in northeastern Ohio was found to have a 12′ × 40′ upright silo with a feeding capacity of 85 tons. It was assumed possible to increase the silage storage capacity if the addition was economically feasible. Both direct-cut and wilting of the forage crops were considered.

Pasture was the other alternative method of harvesting the meadow crops. The possible pasture harvesting methods were (1) conventional grazing, (2) rotational grazing, and (3) green chop.[5] It was possible to use each of the pasturing systems for (1) the full season, (2) after the first crop hay or silage, and (3) after the first and second crops had been harvested. In addition, there were 14 acres of permanent pasture on the typical farm. This pasture land could be improved with fertilizer and lime and either conventional or rotational grazing used.

Dairy

Two levels of milk production (management level one at 10,000 pounds of 3.5 milk and management level two at 12,000 pounds of 3.5 milk) were considered to determine the influence management has on the economic desirability of practices selected.

The necessary nutritional intake of grains and forages within the stomach capacity limits of the dairy cow were used to establish feed requirements. At the two production levels considered, a cow could not ingest the needed nutrients from either all grain or all hay, and some combination was required. The nutritional needs of the cow and her replacement to maintain the herd were developed for the total pounds of total digestible nutrients and digestible protein (appendix Table 12).[6] The herd replacements were assumed to be produced on the farm.

Existing dairy facilities on the farm consisted of an 18-cow faceout stanchion barn with a gutter cleaner, a bulk tank, two milker units, and adequate loafing area for 28 cows. Two expansion possibilities were included in the program. One of these permitted increasing the number of stanchions. The other would permit the present stanchions to be abandoned and to install a double four herringbone parlor and pipeline milker. With the herringbone system, the dairy herd could be increased to the limits imposed by other resources on the farm. It

[5]With conventional grazing the animals are permitted to graze over the entire field for the pasture season; with rotational grazing the meadows are divided into small fields and the cows are periodically rotated over the series of fields as the forage is consumed. With green chop the meadow crop is cut daily and transported to the cows.

[6]Feed inputs were determined as the needs for a 12-month period to satisfy the nutritional requirements of the dairy animals. The feeding ration could be varied during the year in accordance with variations in nutritional needs.

TABLE 4.—Assumed Amounts of Capital Available for Two Levels of Management and for Two Milking Systems for a Northeastern Ohio Dairy Farm, 1962.

Milking System	Added Capital	Level of Management 1	Level of Management 2
Stanchion			
	none	$58,000	——
	$ 5,500	——	$63,500
	9,500	67,500[1]	——
	12,800	——	70,800[2]
Herringbone			
	$15,000	$73,000	$73,000
	20,000	78,000	——
	30,000	88,000[3]	88,000[4]

[1]Only $63,500 of capital was used.
[2]Only $65,711 of capital was used
[3]Only $80,828 of capital was used
[4]Only $80,597 of capital was used

was assumed that the production per cow would not be influenced by either of the systems considered for handling the dairy animals.

Labor requirements per cow were varied with the number of cows in the herd. The planning estimate programmed for a herd of 25 cows was 90 hours per cow for a stanchion barn and was 65 hours per cow for a herringbone facility.

DISCUSSIONS AND FINDINGS

Production takes place only when land, labor, capital, and managerial resource inputs can be combined in some manner. The available resources must be employed at the same level of intensity if maximum farm income is to be realized. Within the farm business organization, the most limiting resource restricts development and may prevent other resources from being utilized effectively. An excess in one type of resource that cannot be utilized effectively because of another resource shortage may return little if any income to the farm business.

The most desirable combination of the available resources was determined for selected farm conditions in this study. Farm organizations were developed to maximize farm income, starting with a typical farm situation found in northeastern Ohio. Modifications in the farm organization through changes in existing resource use and the acquisition of additional resources were considered.

An optimum farm organization was developed for each of six selected amounts of additional available capital and for two levels of managerial input. In addition, a stanchion facility and a herringbone loose-housing system were considered at both management levels. The available capital included all of the money that could be obtained and used for adding to the permanent improvements, increasing livestock numbers, and for operating needs.

With several of the programs, something less than the total amount of capital that could be obtained was actually used in the organization. Some other resources became limiting before all of the available additional capital could be profitably utilized in these farm organizations.

The typical farmer (management level one), as determined from the farm account records, had a $58,000 investment. An average debt of $10,000 and an equity of $48,000 was typical on these farms. The available resources were reorganized with the existing available capital. This reorganization would be representative of that possible for a farmer with average management but lacking in ability or willingness to borrow additional capital.

MANAGEMENT LEVEL ONE

Stanchion

Farm income, as reported in the 48 account records with an average of 23 cows, was $3,448 (Table 1).[7] The farm was first reorganized within the capital typically found available ($58,000) to determine if more income could be earned with existing resources. This reorganized operation permitted 23 cows to be kept but yielded $4,665 of farm income (See Table 5).

After reorganization, $1,217 more income was earned than on the average of all 48 farms; $1,224 more than was earned by the 15 farmers with 20 to 24 cows. Most of the increase in farm income resulted from lowered expenditures. The same number of cows (23) was kept in the herd but lower cost sources of available feeds and other inputs were utilized. Several changes were made in the existing farm organization which contributed to this increased income. Prior to reorganization, approximately 12 percent of the feed nutrients produced was fed to livestock other than dairy. As reorganized, other livestock was eliminated and a specialized dairy established. Any feed produced in excess of dairy needs was sold. The same basic rotation and yields were used in both cases but the reorganized operation did not place as much emphasis on maximizing use of pastures as a part of the summer dairy

[7]Farm income equals cash receipts, minus cash expenses, minus depreciation, adjusted for change in inventories. Farm income represents the earnings of the farm firm that are available to pay for the use of family and operator labor, equity capital, and management.

ration. Instead, more supplementary feeds were fed in the form of grain and hay. Harvested forage quality was improved after the reorganization and a lower machine cost was realized. Machine services were hired when the cost of getting the job done was lower than if the machine had been owned and much less machine duplication was involved. For example, some farmers submitting records, maintained both a forage chopper and pick-up baler in the machinery inventory. Silage was not fed under the reorganized program at this level of operation.

When $9,500 of additional capital was assumed to be available for use in the farm business, the herd size was expanded to 28 cows and the farm income earned increased to $5,503. With this amount of additional capital, the availability of labor became limiting, particularly during the month of October, and only $5,500 of the $9,500 additional capital available could be profitably utilized. This brought the total capital invested in the farm business to $63,500.

It made it possible to more fully utilize the available family and operator labor, to employ a different system of handling the meadow crops, and to add 10 stanchions, thus permitting the expansion of the herd to 28 cows.

At the $63,500 capital availability level and with management level one, meadow crops were utilized more intensively than when capital was restricted to $58,000. All of the available first crop meadow (41 acres), was harvested and 16 acres of second and third cutting was harvested as hay. In addition, the second and third meadow crops were rotationally, rather than conventionally, grazed. When capital availability was held to $58,000, only first cutting hay was harvested and a conventional method of grazing meadows was practiced. Adequate nutrients to feed the 28 cows could be produced at less cost using extensive production methods than if more cows were kept. The 14 acres of available permanent pasture was improved and rotationally grazed. More of the available labor was employed and more additional labor was hired during the peak demand periods of June, July, and August than at the $58,000 capital availability level.

Herringbone

A herringbone milking system was considered with average management at capital availability levels of $73,000; $78,000; and at $88,000. The use of a herringbone parlor-loose housing system required that the existing stanchion facilities be abandoned and that a herringbone facility be installed to handle the herd. The cost of converting the existing barn into a loose-housing facility was included,

TABLE 5.—Herd Size, Labor, Feed Inputs, and Farm Income By Selected Level of Capital Investment and Milking Systems for a Northeastern Ohio Dairy Farm with Management Level One, 1962.

Item	Unit	Capital Investment				
		Stanchion		Herringbone Parlor		
		$58,000	$63,500	$73,000	$78,000	$80,828
Milk Cows	No.	23	28	29	37	42
Labor	Hrs.	2465	3000	2473	2900	3217
Feed Per Cow:						
Corn[1]	Bu.	87	78	90	111	103
Hay	Ton	2.2	2.8	2.3	1.6	1.7
Silage (corn)	Ton	—	—	—	—	2.0
Pasture	AUGD[2]	118	129	126	110	80
Farm Income	Dollar	$4,665	$5,503	$4,621	$5,468	$5,717

[1]Corn and cob or equivalent.

[2]Animal unit grazing days per cow.

Note: A five-year rotation of corn-corn-small grain-meadow-meadow was established for the cropland. The total farm area consisted of 154 acres with 103 acres in crops, 14 acres in permanent pasture, and 37 acres in woods, farmstead, and other uses.

Capital was the limiting input at the $73,000 availability level. Family income earned was $4,621 with a herd of 29 cows in milk. Meadow crops were harvested in a pattern similar to that used with the stanchion facility when 28 cows were kept in the herd.

With this system no labor was hired and 2,473 hours of family and operator labor was employed. The farm income earned was greater when the stanchion system was expanded than when a herringbone facility with this level of available capital was installed. This was found to be true, even though the labor required to care for the herd and to conduct the farm operation was considerably less with a herringbone system than for a farmer using a stanchion system.

Capital was again found to be the limiting factor needed at the $78,000 availability input level. With this availability of capital, 37 cows were kept in the herd and a heavy grain ration was fed. All of the first crop of hay and a very small amount of the second and third cutting was harvested as hay. Most of the second and third crop was conventionally grazed. More grain was fed per cow than for any of the other capital situations and more total labor was employed. However, feed nutrients were not fully utilized, and more cows could have been maintained without intensifying production methods.

With $78,000 of capital invested, family income was $847 higher for the herringbone system than when capital was limited to $73,000,

TABLE 6.—Acres of Grain, Silage, Hay and Cropland Pasture by Selected Levels of Capital Investment and Milking Systems for a Northeastern Ohio Dairy Farm with Management Level One, 1962 (with a rotation of corn-corn-small grain-meadow-meadow).

Crop	Capital Investment				
	Stanchion		Herringbone		
	$58,000	$63,500	$73,000	$78,000	$80,828
Corn					
Grain	41	41	41	41	34
Silage	—	—	—	—	7
Wheat	14	14	14	14	14
Oats	7	7	7	7	7
Meadow					
Hay (cutting)					
first	38	41	39	41	41
second	—	16	13	3	15
third	—	16	9	3	15
Pasture					
Rotational graze (crop)					
first	—	—	2	—	—
second	—	25	28	—	—
third	—	25	32	—	—
Conventional graze (crop)					
first	3	—	—	—	—
second	41	—	—	38	26
third	41	—	—	38	26
Total meadow	41	41	41	41	41
Total crops	103	103	103	103	103

but it was $35 less per year than for a 28 cow herd with a stanchion milking system with $63,500 of capital. It is important to note that $14,500 less capital was required for the stanchion system. With the herringbone system one hundred hours less labor was employed and about the same income was earned. However, more cows had to be maintained and $14,500 more capital used.

With the maximum level of capital ($80,828) that could be profitably used, the herd was increased to 42 head of milk cows. The profitable use of capital required that 5 percent return be paid for all of the capital employed. Actually, other resource limitations, in this case availability of labor, limited the use of additional capital to $2,828 above the $78,000 level. Thus, the herringbone system cannot be justified at 42 cows and $17,328 more capital when compared to the stanchion system with 28 cows at the rates of performance programmed.

At this level ($80,828) most of the added capital was used to secure and maintain five additional cows. Further increases in cow

numbers were not possible with the restriction placed on the availability of labor. At this level of operation the feed production and handling methods were quite different than at other levels of operation. One major difference was the introduction of silage. Seven acres of corn was harvested as silage with each cow receiving about 2 tons annually. Slightly less grain and hay were fed per cow. However, a greater acreage of meadow was harvested and less pasture was grazed than when less capital was available. Rotation meadows were conventionally grazed with this system of handling the farm operation. Feed available did not limit the number of cows or farm income.

MANAGEMENT LEVEL TWO

Management level two operators produced higher crop yields and achieved more production per cow at moderate increases in production costs than management level one operators. For example, corn yields on level two farms averaged 85 bushels compared to 70 bushels per acre on management level one farms. Likewise, production per cow at level two was programmed at 12,000 pounds per year compared to 10,000 pounds per year at level one. The 12,000 pound cows utilize feed, labor, and facilities more efficiently than 10,000 pound cows because they use a higher proportion of these inputs for milk production (maintenance remains about the same).

Four levels of capital availabililty were programmed at management level two. An expansion of the existing facilities (a stanchion barn) was programmed at the $63,500 and $70,800 (of which $65,711 was used) levels of capital availability. The abandonment of the existing stanchion facility and the use of a herringbone system on the farm was programmed with $73,000 and $88,000 of available capital for investment and operation of the farm business.

Stanchion

The availability of capital was found to be the most limiting resource at the $63,500 level. Production per cow and crop yields were much higher with management level two than with management level one. Costs of operation and investment in the dairy animals were also slightly higher. The effect of this capital limitation was that only 22 cows were kept in the herd in contrast to 28 cows on a management level one farm, although considerably more farm income was earned ($7,457 compared to $5,503). Although increasing the herd above 22 cows would have been profitable, the imposed capital limitations prevented the farm operator from securing additional cows.

With this level of capital all of the corn was harvested as grain and 2275 bushels of corn were sold. A high proportion of the meadows

TABLE 7.—Herd Size, Labor, Feed Inputs, and Farm Income by Selected Levels of Capital Investment and Milking Systems for a Northeastern Ohio Dairy Farm with Management Level Two, 1962.

Item	Unit	Capital Investment			
		Stanchion		Herringbone	
		$63,500	$65,711	$73,000	$80,597
Milk Cows	No.	22	28	25	41
Labor	Hrs.	2376	3067	2100	3217
Feed Per Cow:					
Corn[1]	Bu.	40	40	45	77
Hay	Ton	4.3	5.3	3.9	3.9
Pasture	AUGD[2]	155	77	139	57
Farm Income	Dollar	$7,457	$8,930	$7,007	$10,226

[1]Corn and cob or equivalent.
[2]Animal unit grazing days per cow.

Note: A five-year rotation of corn-corn-small grain-meadow-meadow was established for the cropland. The farm area consisted of 154 acres with 103 acres in crops, 14 acres in permanent pasture, and 37 acres in woods, farmstead, and other uses.

was harvested in the form of hay and 14 pounds of hay were fed per cow per day to supplement the pasture during the late summer months.

When $2,211 more capital was used ($65,711 compared with $63,500), herd size was increased from 22 to 28 cows and a farm income of $8,930 was earned (Table 7). Only $2,211 of the $7,300 available above the $63,500 level could be profitably employed. This was because all of the available family and hired labor was employed during one of the critical periods. The availability of labor during critical periods limited the size of the farm organization and prevented expansion beyond 28 cows even though the family or other available labor may not be fully employed at other times during the year. All of the available family and hired labor was employed on this farm situation. The same amount of corn was fed per cow as with the $63,500 capital availability situation but more hay and less pasture was fed. Corn was produced in excess of the dairy needs and was sold in both of these capital availability situations.

Increasing cow numbers with the available facilities and labor would require a corresponding decrease in the production and sale of corn. More farm income was earned with 28 cows and producing corn for sale than would have been possible if the herd size were increased. If more cows were kept, corn production suffered and income would have been reduced. Hay was fed throughout the year, indicating a more intensive use of forage nutrients than utilized when capital was slightly more restrictive.

Herringbone

A herringbone milking system was considered for two levels of capital availability. With $73,000 of available capital, 25 head of dairy cows could be carried. The use of the herringbone facility required that the existing stanchions be abandoned. After installing the new herringbone facility, the remaining capital was insufficient to acquire the number of cows required to fully employ available family and operator labor. The herringbone parlor has a "lumpy" capital demand. With this level of capital, only 2,100 of the 2,917 hours of available productive family and operator labor could be employed. Farm income earned was reduced to $7,007 compared with $8,930 with a stanchion milking system. It is significant that $7,289 less capital was required for the stanchion facility than for the herringbone facility. More farm income was realized with the expansion of an existing stanchion system when available capital was restricted to $73,000. At the $73,000 level of available capital about one-third of the rotation meadow area (14 acres) was conventionally grazed. The remainder of the meadow crops was harvested and fed as hay. All of the corn that could be included in the rotation was produced as grain and 45 bushels were fed per cow. The rest of the corn produced was sold as a cash crop.

When $88,000 of capital was assumed available, a farm organization could be developed that would employ most of the available family and hired labor. A herd of 41 milk cows was kept. The same maximum of 100 hours of labor was assumed available for hire during June, July, and August and all of it was hired. It was found that only $80,597 of the $88,000 of available capital was required before labor became restrictive. In this case, labor was the most restrictive input. With $80,597 of capital, the organization that could be developed earned a farm income of $10,226. With this system more grain was fed but less pasture was used and about the same quantity of hay was fed per cow than at the $73,000 capital level. Corn fed per cow was increased to 77 bushels and pasture was reduced to 57 AUGD per cow. The additional corn was used to substitute for pasture. At this level of available capital both hay and grain were fed throughout the entire year.

The use of corn and grass legume silage was considered at both levels of management. In only one of the nine basic farm situations programmed (management level one and $80,828 of capital) was silage selected as the optimal means of producing, harvesting, storing, preserving, and feeding nutrients to the dairy herd. The use of labor and

TABLE 8.—Acres of Grain, Hay, and Cropland Pasture by Selected Levels of Capital Investment and Milking Systems for a Northeastern Ohio Dairy Farm with Management Level Two, 1962 (with a rotation of corn-corn-small grain-meadow-meadow).

Crop	Capital Investment			
	Stanchion		Herringbone	
	$63,500	$65,711	$73,000	$80,597
Corn (grain)	41	41	41	41
Wheat	14	14	14	14
Oats	7	7	7	7
Meadow				
Hay (cutting)				
first	38	41	41	41
second	19	41	27	41
third	—	41	—	41
Pasture				
Rotation graze (crop)				
first	3	—	—	—
second	19	—	—	—
third	19	—	—	—
Conventional graze (crop)				
first	—	—	—	—
second	—	—	14	—
third	—	—	14	—
Total meadow	41	41	41	41
Total crops	103	103	103	103

capital required for handling silage was found to have higher return possibilities elsewhere in the farm business.

INCOME AS RELATED TO AVAILABLE CAPITAL

Some farm families do not have or cannot obtain all of the capital that could be used productively in the farm business. Often the effectiveness of the business organization and its operation is limited by the amount of capital that a farm family is willing to obtain and invest. With the level of managerial ability and land resources given, the other production factors that can affect farm income are the availability and use of capital and labor. Maximum farm income can only be realized when all of the available productive resource inputs are employed to the same level of intensity in the production activities. The return per unit of all resource inputs must be equated if the organization is to permit maximum income to be earned.

In order to determine the effect the acquisition and use of more capital would have on farm income, the increase in farm income was determined after making a charge for the increased labor employed.

This type of an analysis permits an operator to compare the estimated returns with the amount of added capital needed for expanding the dairy herd and enlarging or completely changing the dairy facilities needed. In actual practice, a dairy farm operator is concerned with changes in his combination of resources (input mix) as they affect total or farm income. The possibility of using more labor may be very closely related to the availability of more capital. On many farms the amount of labor that can be employed profitably is limited unless more capital can be obtained and effectively used in the farm business. Thus the division of returns to the additional hours of family labor that could be employed and the added capital used are difficult, if not impossible, to separate with any degree of precision. A comparison of these added returns to labor and capital can be made by costing one of them at a reasonable price and comparing the returns among systems for the use of other resource inputs. In this analysis the added labor used was costed at $1.00 per hour and the residual earnings to capital were compared. Returns to added capital are in addition to (or above the cost of) acquiring capital at 5 percent. A 5 percent interest rate was programmed at the necessary return to obtain capital for use in the farm business. The return above the 5 percent was considered to be available to pay for risks encountered in carrying on the production activity and the return to management.

The herd was first expanded to 28 cows and such a reorganization of the farm business was found to be desirable. The addition of $5,500 of capital with level one management enabled the farm family to earn $838 more farm income than was possible at the $58,000 level.

Part of this resulted from the employment of 415 hours of labor that was not productively utilized previously. The resulting return to the added investment was $423, or a 7.7 percent rate of return above the assumed 5 percent cost of acquiring the additional capital.

Abandonment of the existing facility and the acquisition of the parlor and related equipment required a sizeable amount of money. It was found that the availability of capital must be sufficient to acquire the facilities needed as well as to obtain more cows before the farm income would equal or exceed that earned when a stanchion facility was used.

The use of a herringbone parlor on the typical farm with level one managerial performance and $15,000 of additional capital actually resulted in a decrease in farm income. Slightly more labor was employed (38 hours) than when the farm was reorganized with the existing available capital but the farm income was reduced by $44.

The income earned was $882 below that realized when $5,500 of added capital was programmed, and the stanchion facility expanded. Unquestionably, if the intent of the operator was to convert to a herringbone facility, without expanding the herd above the number of cows that could be cared for with a stanchion facility, a decrease in farm income would be expected (Table 9).

Farm income earned was $5,717 with a herd of 42 cows for $22,828 of added investment capital with management level one. While this income is $1,052 above the farm income earned after reorganizing existing resources, it was only $214 above the $5,503 earned when keeping the maximum number of cows that could be handled with a stanchion facility. This operation (42 cows and $22,828 added capital) required the use of $17,328 more capital than the 28 cow stanchion system.

Although a return of 2.5 percent was earned above the 5 percent cost of acquiring money, this added earning when compared with the 28 cow stanchion system would not justify the added investment. The investment and managerial risk of using $17,328 of capital and keeping 14 more cows in the herd for an additional net return of $214 is not economically sound. Thus, at this level of managerial input it is concluded that the most feasible expansion possibilities consist of adding to the stanchion facilities and increasing dairy cow numbers to the limit of the labor available. Such an expansion could be accomplished by investing $5,500 of added capital in the farm business and reorganizing resource use. The added capital was used to acquire five additional cows and to expand the facilities and barn space required to handle a herd of 28 cows.

A considerably different situation was found when a higher managerial performance (level two) was programmed (Table 9). The addition of $5,500 of capital permitted a herd of 22 cows to be kept and a farm income of $7,457 to be earned. Farm income was further increased by $1,473 when the herd was expanded to 28 cows. With an additional investment of $7,711 the available labor was fully employed and earned a return of 13.0 percent after the extra available labor employed was costed. Cost of risk and added management must be paid for from this return with the residual as profit. The expansion would be profitable, especially if the farm operator were willing or able to obtain only a limited amount of additional capital.

Shifting to a herringbone parlor with considerably more capital ($15,000) actually resulted in an income reduction of $1,923, as compared to the 28 cow herd and a stanchion facility with level two management. This added amount of capital was not adequate to obtain

TABLE 9.—Investment, Farm Income, and Return to Capital by Selected Levels of Investment and Milking Systems for Two Qualities of Management on a Northeastern Ohio Dairy Farm, 1962.

Total Capital Invested	Number of Cows in the Herd	Added Capital Invested	Farm Income	Added Income	Return to Added Family Labor Used at $1/hr.	Return to Added Capital[1]	
						Amount	Percent
Management Level 1							
Stanchion							
$58,000	23	—	$ 4,665	—	—	—	—
63,500[2]	28	$ 5,500	5,503	$ 838	$415	$ 423	7.7
Herringbone							
$73.000	29	15,000	4,621	–44	38	–82	–.6
78,000	37	20,000	5,468	803	315	488	2.4
80,828[2]	42	22,828	5,717	1,052	482	570	2.5
Management Level 2							
Stanchion							
$63,500	22	5,500	7,457	—	—	—	—
65,711[2]	28	7,711	8,930	1,473	541	932	13 0
Herringbone							
$73,000	25	15,000	7,007	–450	–276	–726	–4.8
80,597[2]	41	22,597	10,226	2,769	541	2228	9.9

[1]Returns to the additional capital employed after 5 percent had been paid for the use of the capital. The indicated return is available for risk and an additional management responsibility incurred.

[2]Labor availability was limiting and would not permit further expansion of the farm business

both the facilities and the cows needed for an efficient operation. However, less labor was required.

The investment of another $7,597, or a total of $22,597 additional capital, did enable the operator to acquire 16 more cows and to earn $3,219 more income than was possible with the 25 cow herringbone system.

The shift from a stanchion to a herringbone system was profitable only if a sufficient number of cows could be acquired to utilize the existing resources and added facilities at a high level of intensity. When the existing stanchion facilities were abandoned and the herringbone system installed for approximately the same number of cows, farm income actually declined. Increasing the herd size to 41 cows and switching to a herringbone facility required $14,886 more capital than the 28 cow stanchion system but permitted the farm family to earn $1,296 more income per year than was possible with the stanchion system. Further expansion could not be accomplished profitably within the restrictions of available labor. Return to the $22,597 of additional capital investment was found to be 9.9 percent after the 5 percent assumed cost of acquiring the capital had been satisfied.

INCOME AS RELATED TO IMPROVED MANAGERIAL INPUT

Managerial performance was reflected in production per cow. Farm income was increased from $4,665 to $7,457 (or $2,792) when management was shifted from level one to level two with a stanchion facility and about the same number of cows. One less cow was kept on the level two farm than on the level one (22 as compared to 23) but $5,500 more capital was required. This added capital was used to acquire cows with a 12,000 pound milk production potential. The increase in farm income earned was much greater when production was improved than when the same amount of capital was used to add 5 more 10,000 pound cows to the herd. Using the $5,500 of capital to add 5 more cows (28 compared to 23) at level one management resulted in $838 more farm income. This was $1,954 less (7,457 compared to $5,503) than could be earned by investing the added $5,500 in better cows at management level two. It is also important to note that this added income was earned with about the same labor input. The addition of 5 more cows at management level one required 415 hours of additional labor.

When capital was available to expand the herd until labor became limiting, 42 cows and 41 cows were kept at management levels one and two respectively. The capital investment was only slightly higher for level one than for level two. However, the returns to the additional

capital invested on the management level two farm was quadruple (9.9 percent compared to 2.5 percent) that earned on the management level one farm.

The herringbone facility under these farm conditions can be justified only if both the herd size and level of performance can be increased. Increasing the number of cows in the herd at level one management (10,000 pounds of milk) could not be justified. Likewise, a higher level of production (12,000 pounds of milk) with the same number of cows resulted in a reduction of income earned. Only when both cow numbers and production were increased was the herringbone facility found to be profitable.

SUMMARY AND CONCLUSIONS

Northeastern Ohio has been a dairy area since the land was first cleared. Today, many dairy farmers in the area are confronted with increasing land values and production costs. In order to maintain a satisfactory level of income many farmers have, and are, seeking ways of expanding their farm business operation.

Several possible methods were developed for expanding an existing or modal farm organization. The modal farm situation was selected to be representative of a large number of family owned and operated dairy farms that presently exist in the northeastern Ohio counties. Two levels of managerial performance and several levels of capital availability were assumed. Existing farm resources were programmed. A fixed rotation of corn-corn-small grain-meadow-meadow with several methods of handling the forage crops were considered as possible means of producing and feeding nutrients. In addition, two possible ways of caring for the dairy cows were considered: 1) use the existing or an expanded stanchion facility or 2) abandon the existing stanchion facility and install a herringbone parlor.

General conclusions of the study are: 1) It would be most profitable to expand the existing stanchion facility and add cows to the limit of available labor with level one (10,000 pounds of milk per cow) managerial input; 2) With level one management an intensive system of handling the forage crops (more forage and less grain) was included in the ration; 3) The added income earned by abandoning the stanchion system, installing a herringbone parlor, and adding the maximum number of cows with level one management did not justify the added risk and responsibility; 4) When level two management inputs (12,000 pounds of milk per cow) were assumed, the herringbone facilities and the addition of a sufficient number of cows maximized income; 5)

Labor and capital could generally be utilized more effectively under these conditions and at the assumed levels of production by harvesting and feeding nutrients in the form of grain, hay, and pasture rather than as silage. The use of labor and the cost of the added nutrients that could be preserved as silage were found to have better alternatives elsewhere in the farm business. It must be remembered, however, that a good quality hay was produced and the quantity made could be handled with the available labor force; and 6) In general, it was found that both an increase in herd production and number of cows were needed before the additional capital investment required for a herringbone facility could be justified. Unless the availablity of capital was sufficient to utilize the facility and other farm resources at a high level of intensity, it was found more profitable to expand within the limits of the existing facilities found on the farm. Even with level two management the rate of return on added capital invested was greater with an expansion of a stanchion facility than for a herringbone system.

APPENDIX

TABLE 10.—Sale and Purchase Prices for a Typical Northeastern Ohio Dairy Farm, 1962.

Item	Unit	Price	
		Sale	Purchase
Corn	bu.	$ 1.00	$ 1.10
Oats	bu	.60	.66
Wheat	bu	1.75	——
Hay	ton	20.00	23.00
Milk	cwt.	4.00[1]	——
Cull cows	cwt	16.00	——
Bull calves	head	10.00	——
Fertilizer 5-20-20	ton		74.00
Fertilizer 0-20-20	ton		60.00
Lime (spread)	ton		5.80

[1]Net at the farm after hauling

TABLE 11.—Availability and Use of Labor by Months on A Typical Northeastern Ohio Farm, 1962 (to the nearest man equivalent hour).

Month	Source				Use		
	Operator	Other Family	Hired	Total	Production	Maintenance	Total
January	215	75	—	290	215	75	290
February	215	75	—	290	215	75	290
March	215	95	—	310	229	81	310
April	260	95	—	355	263	92	355
May	260	95	—	355	263	92	355
June	260	125	100	485	385	100	485
July	260	125	100	485	385	100	485
August	235	96	100	431	344	87	431
September	235	96	—	331	244	87	331
October	235	96	—	331	244	87	331
November	215	75	—	290	215	75	290
December	215	75	—	290	215	75	290
Total	2820	1123	300	4243	3217	1026	4243

TABLE 12.—Pounds of TDN and DP Required for a 1200 Pound Dairy Cow and Replacement Annually on a Northeastern Ohio Dairy Farm.

Animal	Pounds of 3.5 Milk			
	10,000		12,000	
	TDN	DP	TDN	DP
Cow				
Maintenance	3,565	277	3,565	277
Milk production	3,150	460	3,780	552
Gestation	551	45	551	45
Total	7,266	782	7,896	874
Heifer[1]	1,015	91	1,015	91
Calves[2]	575	70	575	70
Total	1,590	161	1,590	161
Total Cow and Replacement	8,856	943	9,486	1,035

[1]One 800 pound heifer every fourth year.
[2]One 300 pound heifer calf every fourth year
Source: Morrison, Frank B , Feeds and Feeding, The Morrison Publishing Company, Ithaca, New York.

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