AN ECONOMIC EVALUATION OF ALTERNATIVE METHODS OF DAIRY HOUSING WHEN DAIRY HERDS ARE EXPANDED

Thesis for the Degree of M. S.

MICHIGAN STATE UNIVERSITY

Charles Binkley Forney

1961

AN ECONOMIC EVALUATION OF ALTERNATIVE METHODS OF DAIRY HOUSING WHEN DAIRY HERDS ARE EXPANDED

By

Charles Hinkley Ferney

AN ABSTRACT

Submitted to the College of Agriculture Michigan State University
of Agriculture and Applied Science in partial
fulfillment of the requirements for
the degree of

MASTER OF SCIENCE

Department of Agricultural Economics

1961

Approved C. Raymond Hoglund

Charles Binkley Forney

ABSTRACT

A study was made of 37 Livingston County dairy farms to determine present technologies in use, future plans for herd expansions, and methods of housing, milking, and feed handling used by these dairymen. These dairymen are presently using stanchion housing.

The dairy farms were divided into three groups: namely, Group I with 30 or less cows, Group II with 31 to 40 cows, and Group III with 41 or more cows per farm. The 14 farms in Group I had an average of 27 cows per farm and expected to expand to 35 cows per farm by 1965. The 12 farmers in Group II averaged 35 cows per farm and planned to expand to 42 cows per farm by 1965. In Group III the 11 farms averaged 46 cows per farm and they planned to have 57 cows per farm by 1965.

Sixty percent of the dairymen had hay conditioners, 46 percent had gutter cleaners, 65 percent baled their hay and 35 percent used chopped hay. Six dairymen used hay dryers to cure their hay. Two used pipe line milkers and one farmer had a milk transfer system. About 84 percent of the dairymen planned to increase the size of their dairy herd in the next five years.

Fifty-four percent of the dairymen planned to continue using stanchion housing in the future. Thirty-five percent planned to use a combination stall barn and loose housing system. Only eleven percent of these dairymen planned to convert their dairy barns into a loose housing and milking parlor system.

Three case farms were selected to use for a budgetary analysis of herd expansion by using alternative methods of housing. Farm A has a 24-stall stanchion barn, farm B has a 40-stall stanchion barn and farm C has an old 36-stall stanchion barn that was obsolete and in need of major repair.

Four plans were budgeted for farm A. A benchmark plan with 24 cows produced a net income of $5,491. If the herd is increased to 48 cows by using a switch barn system as shown in plan 1, net income was reduced $1,790. If the herd was increased to 48 cows by building an addition to the stanchion barn as shown in (plan 2), net income is decreased by $2,333. If the herd is increased to 30 cows by removing the box stalls in the barn and other changes as shown in (plan 3), net income is increased to $6,247. The new investment in this plan can be amortised in three and one-fourth years.

Five budgets were prepared for farm B. The benchmark plan with 44 cows produced $5,748 net income. Plan 1 with 50 cows in a stanchion barn decreased net income by $310. When the herd was increased to 75 cows using stanchion housing (plan 2), net income increased by $324. When the herd was expanded to 60 cows (plan 3) by using a milking parlor, net income decreased by $361. When the herd increased to 100 cows (plan 4) using a loose housing-milking parlor system, net income is increased by $2,053. The new investments in plan 4 can be amortised in six and one-fourth years. If this dairyman would receive $4.50 cwt. for his milk, all four plans would prove profitable and the new investment in plan 4 would be recovered in three and one-half years.

Four budgets were computed for farm C. The benchmark plan with 47 cows produced $5,371 net farm income. Plan 1, with 100 cows using a loose housing-milking parlor system, produced $8,273 net income. Plan 2 is similar to plan 1 except extra grain and hay are purchased and this plan only produced $3,837 net farm income. Plan 3, with 120 cows, resulted in $9,447 net income.

This study showed that increasing the herd size does not necessarily mean that net income increased. The inputs must be used in proper proportions if profits are to be maximized. Cow numbers must be increased in units that fit into increases which each additional man can handle. The net income must increase sufficiently to pay off the new investment in a reasonable period of time.

AN ECONOMIC EVALUATION OF ALTERNATIVE METHODS OF DAIRY HOUSING WHEN DAIRY HERDS ARE EXPANDED

By

Charles Binkley Forney

A THESIS

Submitted to the College of Agriculture Michigan State University
of Agriculture and Applied Science in partial
fulfillment of the requirements for
the degree of

MASTER OF SCIENCE

Department of Agricultural Economics

1961

ACKNOWLEDGMENTS

The author wishes to express his sincere thanks and appreciation to Professor C. Raymond Hoglund for his helpful guidance and encouragement during the course of this study.

Acknowledgment and thanks are given to Elwood Jacobs who assisted in the survey and to Dr. Richard Wheeler who gave helpful suggestions for this study.

The author acknowledges the assistance given by Michigan State University Agricultural Economics Department in awarding him an assistantship, and in providing the environment within which this study was conducted.

The author would like to thank the faculty and graduate students of the Department of Agricultural Economics who readily gave information when needed.

The author also wishes to thank Sandy Rogers for typing the rough draft of the thesis, and JoAnne Miller for typing the final draft.

TABLE OF CONTENTS

LIST OF TABLES

APPENDIX TABLES

CHAPTER I

INTRODUCTION

The trend in dairy farming is toward fewer, but larger, farms with increasing capital investment. According to the 1954 Census of Agriculture,[1] the number of farms in Michigan with dairy cows were reduced from 132,627 in 1944 to 83,212 in 1954. This is a decrease of 30 percent in ten years. Dairy cow numbers were reduced from 951,276 cows in 1944 to 796,635 cows in 1954. This shows a decrease of 16 percent in a ten year period.

A Michigan State University farm accounting report for Area 5 showed the following changes for the period from 1947 to 1959; tillable acres have increased by 41 percent; animal units by 20 percent; machinery investment by 192 percent and total investment per farm by 234 percent. The number of men per farm has remained about constant. This increased efficiency is largely a result of the use of new technology and mechanization. Average farm real estate values per acre in the United States have been increased by 164 percent from July 1942 to July 1956, based on Table C.[2] This was due to competition for land adjoining urban centers, new roads, recreation areas and farm expansion.

---

[1] U. S. Department of Commerce, 1954 Census of Agriculture, Michigan Vol. I, p. 6.

[2] F. F. Elliot, chairman and others, Major Statistical Series of the U. S. Department of Agriculture, Vol. 6; Land Values and Farm Finance, Agriculture Handbook, No. 118, p. 1.

Investment in real estate per farm in Central Michigan, according to Michigan State University accounting farms, has nearly tripled since 1930. The investment in livestock, machinery, equipment, feeds crops and supplies has also tripled and in 1958 was about $24,000.[1]

Herd size and average production per cow in increasing. In 1949, on Michigan farms enrolled in a DHIA testing program, the average size of herd was 17.2 with a production of 8,801 pounds of milk per cow. In 1959, the average herd size was 30.0 cows with an average production of 11,231 pounds per cow.[2] These figures are not entirely comparable because of a change in the sample of dairy farmers cooperating in this testing progress. In Pennsylvania, the average production per cow for all cows in the DHIA testing program in 1949 was 8,809 pounds of milk, with 22.6 cows per herd. By 1959, average milk production per cow increased to 10,352 with 30.4 cows per herd.[3]

The Problem and its Importance

The basic problem facing dairymen today is the price-cost squeeze. The price of land, labor, equipment and supplies has

---

[1]E. B. Hill, Farms in Transition, Paper presented at the Annual Convention of the Michigan Real Estate Assoc., Farm Brokers Section, Mackinac Island, September 1959.

[2]L. A. Johnson and A. J. Thaler, 1959 Michigan Dairy Herd Improvement Records, Cooperative Extension Service, Michigan State University Dairy Department.

[3]Summary of Dairy Herd Improvement Assoc., Records for the year 1959 with data on progress during 49 years of testing, The Pennsylvania State University, Division of Dairy Extension.

increased rapidly in the past 10 to 12 years, while farm product prices have remained constant or have been decreased. For example, in 1946 it took 2,200 pounds of milk to buy an acre of farm land in Michigan. By 1958, 4,300 pounds of milk were required to buy this same acre of land.[1]

As late as 1947, farmers in the Michigan State University farm account project from the dairy and general farming area of South-central Michigan realized a net farm income of about $5,900 per year with a total investment of about $38,000. By 1959, the value of the investment in a similar sample of farms from the same area was estimated to be nearly $80,000, and the net farm income averaged about $6,650.[2]

The cost of most inputs used in the farm business as well as consumer products purchased by the farm family have been increased. Dairymen have gradually expanded their dairy operation in an attempt to maintain or increase their net farm income.

Today many of these farmers have expanded to the maximum capacity of their land and buildings. If they expand further, they must either extend their present dairy barn or build new dairy buildings, and buy or rent more land, or purchase large quantities of feed.

[1] E. B. Hill, Farms in Transition, Mimeograph, Department of Agricultural Economics, Michigan State University, September 17, 1958, p. 5.

[2] Michigan Farm Economics, Department of Agricultural Economics, Michigan State University, Cooperative Extension Service, No. 210, July 1960, p. 1.

New technologies such as bulk tanks, pipe line milkers and milking parlors have added increased pressure on the dairyman to expand herd size to meet the ever rising cost. Some dairymen are undecided as to the size dairy herd they need to pay for these new technologies. Others are uncertain if they should expand with conventional stall barns, build loose housing with a milking parlor, use a combination of the two, or just increase the production within their present farm organization.

It is hoped that this study will help dairymen to analyze their individual situations and to develop detailed plans before they make any radical change in their dairy farm organization.

Objectives and Methods of Study

The purpose of this study is to estimate by comparative budgeting the receipts, expenses, and net income obtained when expanding the scale of operation of dairy farms using different systems of dairy housing. Comparative budgeting, as discussed by Wheeler and Black,[1] make it possible for a farmer or businessman to calculate estimated receipts and expenses from the use of different alternative plans in their business operation. It is less costly to make a mistake with a pencil and piece of paper than to experience failure in an actual farm operation.

The specific objectives were:

---

[1]Richard G. Wheeler and John D. Black, Planning for Successful Dairying in New England, Harvard University Press, Cambridge, 1955, p. 5.

1. To examine the hypothesis that is is more economical to use conventional stanchion housing when making small increases (5 to 20 cows) in herd size starting with a good stanchion barn, than to make investments needed to convert to a loose housing and milking parlor system.
2. To examine the hypothesis that the expansion of herd size does not necessarily result in an increase in net income. There may be a reduction in net income.
3. To examine the hypothesis that loose housing is more economical than conventional housing when substantial increases are made in cow numbers.

These points will be discussed further in Chapter Five.

A study was conducted on 37 dairy farms using stanchion housing in Livingston County. These dairymen were nearly all in DHIA testing and had herds averaging over 10,000 pounds of milk per cow. Present practices and future plans of these dairymen were studied.

Three farms were selected from this group to serve as benchmark farms to budget herd expansion by using alternative methods of housing. The benchmark plan represents the farm organization as it was before planning any expansion. Farm A had 24 cows and 200 acres of land. This farm was budgeted for 48 cows with combination loose housing and stanchion housing, 48 cows in stanchion housing and for 30 cows in stanchion housing.

Farm B had 44 cows and was budgeted for 50 cows in stanchion housing, 75 cows in stanchion housing, 60 cows with a loose housing-milking parlor system, and 100 cows with a loose housing-milking parlor system.

Farm C had 47 cows in a combination stanchion and loose housing system. This farm was budgeted for 100 cows with a loose housing-milking parlor system, growing all the feed needed, for 100 cows on the present 240 acres and buying extra grain and hay, and for 120 cows and renting extra land to grow the feed.

The assumptions used for the budgets on each farm were similar. Although these assumptions may differ from actual figures on specific farms the comparative relationship between the different farm plans should not change.

Details of the budget are discussed in Chapter Seven.

CHAPTER II

TECHNOLOGICAL CHANGE AND ECONOMIC CHOICE

Technological Factors Influencing Size and Specialization

Heady states, "Technological change is one of the more important forces which alter the structure of the agriculture production process."[1]

Many dairy barns in Michigan, Pennsylvania, New York, Wisconsin, and other dairy states have become old and obsolete. These buildings must be remodeled extensively or be replaced before the dairy enterprise can be expanded efficiently. In some cases it is more economical to build a complete new dairy set up rather than try to remodel the old buildings. Pole buildings can be erected at a lower cost than conventional type dairy barns.[2] This, plus the increased labor efficiency, is the main reason why farmers are adopting loose housing. In the Detroit milkshed[3] seven percent of the dairymen are using milking parlor systems.

Since the author is from Pennsylvania and is closely associated with the problems of these dairymen, he has compared Pennsylvania conditions with those in Michigan.

---

[1] Earl O. Heady, Economies of Agricultural Production and Resource Use, Prentice-Hall Inc., Englewood Cliffs, New Jersey, 1952, p. 794.

[2] S. W. Warren, Cost of Building Stall Barns and Pen Barns, Farm Economics, Department of Agricultural Economics, Cornell University, March 1958, Ag. Econ. No. 212, p. 5685.

[3] C. R. Hoglund, Dairy Farming in a Decade of Change, Michigan Farm Economics, Department of Agricultural Economics, No. Michigan State University, 1960.

Pennsylvania dairymen have been slow in accepting this new technology for the following reasons: (1) Most installations in Pennsylvania have resulted from converting old stanchion barns into loose housing and (2) these systems have often been poorly planned, resulting in unsanitary conditions. This is an important reason why most milk inspectors in Pennsylvania do not encourage a system of loose housing.

A third reason why many Pennsylvania dairymen have continued using stanchion barns is that many of their barns are larger and more substantially built than those in Michigan.

Loose housing and milking parlor systems have been replacing the conventional stanchion dairy barn on many farms in Michigan. This method of handling dairy cattle greatly reduces the time and effort needed to care for a dairy herd. Angus and Barr state that, "loose housing saves about 20 percent in terms of labor and 30 percent in terms of travel. Savings are made in milking, feeding, bedding, and cleaning time."[1]

As the scale of farms is increased, there is a tendency toward using more labor-saving equipment in the feeding operation. Silo unloaders and self-feeding feed bunkers are used extensively in these dairy systems. By use of gravity or augers, grain is fed to the cow in the milking parlor. Ralph Culver, Laceyville, Pennsylvania installed an automatic conveyor in the feed manger

---

[1]R. C. Angus and W. L. Barr, An Appraisal of Research Literature Dealing with Loose and Conventional Dairy Cattle Housing; a review, <u>Journal of Dairy Science</u>, April 1955, Vol. XXXVIII, No. 4, p. 401.

of his stanchion barn which he uses to feed silage and chopper hay.[1] With the use of a silo unloader, he feeds silage to the cows in the barn by pushing a button. Chopped hay is moved directly from the mow to the conveyer in the feed bunk. This eliminates the need to carry the hay to the cows. The gutter cleaner and roughage feeder for the 50 cows cost about $3,000.[2]

Many farmers using loose housing systems feed hay in racks built along the side of the hay barn. The hay is thrown directly from the hay storage into the hay racks. Others have special self-feeding hay barns.

Bulk handling of milk has helped to accelerate the rate at which farmers are changing from dairying to other farm enterprises. It has created a pressure on farmers, who remain in the dairy business, to increase their volume of milk to pay for this added investment.

Bulk tanks range in price from about $2,200 for a 300 gallon tank up to $4,300 for an 800 gallon tank.[3] Frequently farmers have increased the size of their herd to help pay for this additional equipment. The bulk tank has eliminated the need to lift heavy milk cans. Also, it has made possible the use of pipe lines to carry

[1]"Automation of a Dairy Farm," <u>The Farm Quarterly</u>, Winter 1960, Vol. 14, No. 4, p. 82.

[2]<u>Ibid.</u>, p. 122.

[3]Earl L. Fuller, <u>Some Labor Efficient Dairy Farm Organizations Designed for Michigan Conditions</u>, Department of Agriculture Economics, Michigan State University, No. 690, 1957.

the milk directly from the milking machine to the tank. This technology saves time and labor in the milking operation. The transition to bulk tank is not complete. In 1960, in the Detroit milkshed, there were 3,360 bulk tanks on dairy farms.[1] Bulk handled milk increased from 9 percent in 1957 to 50 percent three years later. Pennsylvania reports show 6,000[2] bulk tanks on dairy farms, which is about 18 percent of their producers.

Balers, forage choppers, hay conditioners, elevators, heated and unheated air drying systems and hay pelleting machinery are some of the latest machines used in harvesting and handling forage crops. In the past few years, many different sizes and types of hay balers have come on the market. The bale ejector, a device to throw the bale from the baler to the wagon, has reduced hay making to a two-man operation. Special elevators have been developed to carry the bales to the hay mow and random pack them.

The forage harvester can be used as a two or three men haying system. One man can operate the chopper in the field, another man can shuttle the wagon back and forth to the barn, while a third man unloads the forage into a blower or elevator at the barn.

Within the past few years, hay conditioners have become popular with farmers. These machines either crush or crimp the stems of the hay, thus reducing the field drying time 30 to 50

---

[1]C. R. Hoglund, Dairy Farming in a Decade of Change. op. cit.

[2]Estimates by a Pennsylvania State University extension dairy specialist.

percent.[1] This time factor is very important in areas such as Michigan where it is common to have many rainy days in June. From 1949 to 1959 (June 1 to 21 inclusive) there was an average of only 7 days that were good for drying hay.[2]

The barn hay drier helps to improve the quality of hay by allowing storage at about 30 percent moisture. This reduces the field drying time and also helps to prevent leaf loss in the field.

It is possible to cut and store hay in the same day by using a heated-air hay drying system. There are two types of systems in use: (1) the batch hay drying system in which the hay is placed in a specially designed hay drying barn. Heated air is blown through a duct and forced through the baled hay. After the hay is dried, it is removed to a storage barn. (2) The second method is the wagon drying system. Slatted floor wagons are loaded with baled hay in the later afternoon and pulled into a drying shed. A canvas hood is clamped on the top of each wagon and heated air is forced down through the hay. The next morning the hay is dry and can be hauled to the storage barn. If 250 tons of hay were dried annually, it would cost $3.97 per ton when a wagon drying system was used and $4.93 per ton when a batch drying system was used.[3]

---

[1] R. W. Kleis, Hay Crushing, Michigan State University Cooperative Extension Service, Extension Folder F-162, 1953.

[2] W. H. Sheldon, D. E. Wiant, Don Hillman, and S. T. Dexter, Cooperative Extension Service, Early Cut Hay and Mechanical Drying, Michigan State University, Folder F-288, April 1960.

[3] Gerald L. Cole, William E. McDaniel, and William H. Mitchell, Hay Drying Cost and Returns, University of Delaware, Agricultural Experiment Station, Tech. Bul. 334, July 1960.

The latest innovation in forage machinery is a pelleting or wafering machine.[1] This is a device that compresses the hay in the field into a pellet two to four inches in diameter and two to four inches long. If and when this machine is perfected, it will be possible to install mechanical hay feeding systems for livestock. Initial investments at present are high.

Pasture systems as well as forage handling methods have been going through a change in technology. When cows are pastured at the rate of one cow to two or more acres a large percent of the forage is wasted. As cow numbers per farm are increased the dairyman tries to find more efficient ways to utilize the forage. Rotation or field grazing was the first step in this direction and is still used extensively in many areas.

Field grazing is a system in which cows are pastured at the rate of about five cows per acre. The cows are rotated to new plots as more forage is needed. Surplus first-crop pasture is usually harvested as grass silage to be fed later in the season.

Strip grazing is a system of providing fresh grass for the cows by moving an electric fence once or twice daily. This system requires good management to provide the proper amount of forage for the cows. The pasture fields should be located close to the buildings and a water supply.

---

[1] Ralph D. Wennblom and George W. Wormky, Pellets Hay in the Field, Farm Journal, May 1960, p. 43.

A system of green chopping involves chopping forage once or twice daily and hauling it to the dairy cows in dry lot, or in a small pasture lot adjoining the buildings. Both green chopping and strip grazing require good managerial skills to provide top quality forage for the cows at all times. This system requires a tractor and man for 30 to 90 minutes daily to chop and haul the forage to the cows.

Storage feeding is the practice of feeding silage in dry lot year around. A few farmers have adequate storage to feed corn silage year around while others feed corn silage in winter and grass silage during the pasture season. This latter practice makes more efficient use of the silos. Storage feeding has the advantage of providing top quality forage throughout the pasture season since the harvesting can be done in a short period of time when the forage is at the proper maturity. Forage from distant fields can be utilized in a storage feeding program. Cow cleanliness, barn odors, and sanitation may be problems in both green chopping and storage feeding systems.

Hoglund reported the following results in his pasture study:[1] Dairymen following a field-grazing system used nearly one and one-third acres of both first and second crop forage per cow during the pasture season. This included acres of all feed grazed or harvested and fed. A weighted average of both first and second crop forages

---

[1]C. R. Hoglund, Economics of Alternative Pasture Systems, Michigan Agricultural Experiment Station Special Bulletin--1960, pp. 3-5.

used per cow was calculated for all systems. On the basis of using 100 for field-grazing, the requirements for the other systems were 67 percent for green-chopping and 64 percent for storage-feeding.[1]

Individual dairy farmers will need to calculate rather carefully the changes expected in investments, receipts and expenses before adopting a new pasture system. Most dairymen will benefit most, by making improvements in the forage practices and pasture systems they now use. Field or strip grazing will be most profitable for farms with less than 30 cows.[2]

All these new technologies have increased the number of decisions facing the dairyman. It is important that individual dairymen study the alternatives and the expected results before coming to a decision on which technologies to accept and which to reject.

Problems Encountered in Expanding the Dairy Herd

When a dairyman decides to enlarge his enterprise, he is faced with the problem of what to do with his buildings. Each farm is a special case and it takes individual study to determine the best alternative use of the buildings.

Some barns are well built, and even though they may be fifty or more years old they still perform a useful service, if remodeled. Other buildings are so obsolete or in such a poor state of repair

---

[1]C. R. Hoglund, *Ibid*, p. 1.

[2]C. R. Hoglund, *Ibid*, p. 3.

that it is not economical to consider repairs. Most of the old barns were designed for hand methods of feeding and manure removal and are not adapted without major remodeling to modern dairy equipment.

Many old barns can be converted into hay storage or housing for young stock at little additional cost. These barns can often be remodeled into loafing areas for the milking herd, but, usually the area is too small to accommodate the entire herd or the building is of a wrong dimension. If a barn was well designed, in good repair and with adequate size cow stalls, it may be more economical to extend the stanchion barn than to convert the building to a loose housing and milking parlor system. In Pennsylvania, the old "dutch" barns had thick stone walls which made it difficult to convert them to a loafing barn.

The planning of the entire dairy set-up for the larger herd is very important. Farmers too often remodel or add additions to barns with little thought to convenience or cost. These barns frequently are inconvenient, costly to remodel and present an unattractive appearance.

Proper drainage is an important feature in locating the buildings and the concrete yard for a loose housing system. The water should flow freely away from the feeding and loafing areas. The arrangement of the buildings should be such that the cattle are protected from the north and west, with the south side open. The loafing barn and feed storage should be located and designed to permit future expansion. Sixty to seventy square feet per cow is the recommended size of the loafing area, with one hundred square feet per cow of outside concrete areas.

It is essential that storage and feeding space for hay and silage are adequate for the cattle, with provisions for future expansion. Frequently, the old barn can be converted into a hay barn with a hay rack built along the side. The hay can be thrown directly from the barn into the rack. On other farms, it is necessary to construct a special pole hay barn. Straw may be stored at the back or at one end of the loafing shed, or in an old barn.

The concrete area should be as free of obstacles as possible and have proper slope to facilitate frequent scraping. The building should be located to allow a maximum amount of sunlight into the feeding and exercise area, and also to protect the herd from prevailing winds. The silos should be easily accessible for filling. It is essential that the milk room be located near a solid road to facilitate ease in loading the milk.

Farms differ and thus systems must be adapted to each particular situation. Building construction may vary, however, pole construction is the most common type in use.

Within certain limits, capital may be substituted for labor. For example, silo unloaders with mechanical feed bunks, pipe line milkers, gutter cleaners, and elevators can reduce labor requirements. However, there is a point beyond which additional investments in machinery cannot replace human labor.

The farm family with several older children can often operate a farm without regular hired labor, but the children may not be interested in farming and, due to their school activities, their labor contributions are small.

The problem of obtaining dependable farm labor is critical, especially in areas near industrial centers. Dairymen, if they are to compete with industry for laborers, must improve on their work methods. Usually, the good hired hand starts farming for himself after he has worked for a few years. Some farmers in the survey said they preferred to remain as a one-man operation to avoid the problems associated with hired help. Others felt that having a two-man operation gave opportunity for the operator to have alternate weekends off and periods available for vacations. This will become increasingly important in keeping young farm people happily employed in agriculture.

Fuller[1] in his study of efficient dairy farm organizations found that it was difficult to organize a farm business so that a farmer could afford to pay wages comparable to those paid in industry. He found that a dairyman would have to have at least a two-man operation with about 60 cows producing over 10,000 pounds of milk per cow. Labor must be spread over more units by creating a simplified working environment if farm labor is to be competitive with industry. This takes superior management.

A dairyman has three alternatives to obtain the necessary feed supply for the larger herd. He can intensify his farming operation by using higher rates of fertilizer, improve forage harvesting methods, and green chopping to carry more cows per acre.

---

[1] E. I. Fuller, Some Labor Efficient Dairy Farm Organizations, Department of Agricultural Economics, Michigan State University, Ag. Econ. No. 690, July 1957.

Some of the farmers in the survey were using these methods. A second alternative is to buy or rent more land. This can be a very difficult problem in some areas. A third alternative is to buy the extra hay and grain needed to support the herds.

Hoglund[1] considered the effect of buying versus producing feed for a 65 cow dairy herd. For a herd of 65 cows on a 180 acre farm, for which extra feed had to be purchased, he compared renting 62 acres of moderately productive cropland with renting 80 acres of less productive land. The increase in net income over buying the extra feed was nearly $500 in the first case, but only $200 in the second case.

Fuller[2] in budgeting alternative dairy plans, compared a farm of 228 tillable acres and two hired men with one of 456 tillable acres and three hired men, both supporting 120 cows. He found that the latter plan produced $3,082 greater profit.

The end objective in expanding a farm enterprise is to increase net farm income. Farmers too often believe that all they need to do to increase income is to add more cows. For example, if they have 30 cows they believe that by increasing their herd to 60 cows they will double net income. There are many other factors that affect income and expenses. Under some conditions, net income may be reduced as size of the herd is increased.

---

[1] C. R. Hoglund, Economies of Feed Production in South-Central Michigan, Michigan Agricultural Experiment Station, Special Bulletin 420, September 1958, page 27.

[2] E. I. Fuller, op. cit.

A dairyman with 20 to 25 cows can increase his net return $320-$500 by producing excellent rather than poor quality alfalfa grass stands.[1] This is just one of many factors that can help to increase net return to the farmer. Other factors which affect income are feeding, breeding, housing, and fertilization.

As herds become larger, it takes a better manager to keep the kind of records needed in analyzing and operating the farm. It is usually more difficult to note heat periods, to keep accurate breeding records and to handle sick animals than with smaller installations. Diseases, such as brucellosis, tuberculosis, vibriosis, and others can prove costly in a large dairy operation. Every installation should have provisions for isolation of sick cattle.

Feeding operations have become more efficient with the development and use of silo unloaders and mechanical feed bunks. Self feeding hay barns, with gravity grain feeding in the milking parlors, have reduced the time and effort necessary to feed the dairy herd. These new technologies require large capital expenditure and require a large scale of operations to justify their cost.

The availability of capital is a major consideration in changing the scale of operation of the farm business. With the exception of the Farmers Home Administration and the Production

---

[1] C. R. Hoglund, E. J. Benne, L. V. Nelson, and C. F. Huffman, Forage Quality and Protein Feeding of Dairy Cows, Michigan Agricultural Experiment Station, Quarterly Bulletin, Vol. 38, No. 3, page 413, February 1956.

Credit Association, credit is usually limited to about 50-60 percent of the farm assets. This limitation prevents many young farmers from expanding their operation. Large capital requirements in getting established in farming are often so great that a young farmer may be so deep in debt that he cannot obtain additional credit to make major changes in his farm organization.

Usually, the dairyman who is limited in credit, will expand his herd gradually as credit and other conditions permit. For example, he may build a pole shed one year, concrete the outside lot the next year, and at a later date build a milking parlor. This practice involves less financial risk than to undertake a complete change over to loose housing and milking parlor in one step. Expansion, in degrees, also allows time to grow replacement heifers rather than having to buy them. A disadvantage to this type of expansion is that during the transition period labor is not effectively used and there is little gain in net income. One man may be able to handle 30-35 cows, but it requires two men when a farmer expands above this number. It takes about 55 to 60 cows with a loose housing and milking parlor organization to make efficient use of the second man.

The debt repayment plan should be geared to the earning capacity of the farm. If the additional debt cannot be payed off from extra income within about 10-15 years, it is probably wise to reconsider the plan.

"Getting the additional capital needed to start farming is a real problem for young farmers. However, it is more important than gaining 'know-how' and experience; establishing a reputation for being able to earn money and to be a good manager of one's finances. There is scarcely ever a shortage of loan capital for those who have demonstrated their ability to use it effectively."[1]

Inputs in agricultural production such as labor, fertilizer, machinery and all the other production factors should be employed so that:

$$\frac{MPP_{x1}}{P_{x_1}} = \frac{MPP_{x2}}{P_{x_2}} = \frac{MPP_{x3}}{P_{x_3}} = \ldots \frac{MPP_{xn}}{P_{x_n}}$$

"In words, this equation states that the variable inputs are being used in their optimum proportions if the product of the last unit of any input used bears the same relationship to the price of the input as exists for all other variable inputs."[2]

The law of diminishing returns is conceived to hold regardless of the number of variables involved providing some factors are fixed. This means that marginal returns first increase, then decrease, and finally become negative. As long as this law holds, it follows that the optimum proportion can be reached as defined.

---

[1] E. B. Hill, Getting the Necessary Capital to Farm, Mimeograph, Department of Agricultural Economics, Michigan State University.

[2] Bradford and Johnson, op. cit., p. 132.

The optimum amount of product to produce is defined by the following equation:

$$\frac{MVPx_1}{Px_1} = \frac{MVPx_2}{Px_2} = \dots\dots = \frac{MVPx_n}{Px_n} = 1$$

This equation indicates that the use of any input should be expanded as long as its marginal value product is greater than its cost, that the use of an input should be contracted if its marginal value product is less than its cost, and that all inputs are properly used when their respective marginal value products are precisely equal to their costs. In other words, the equation states that additional quantities of anything used in production should be used as long as they pay for themselves and no longer.

The milk inspector is a key man in the dairy enterprise. It is essential that dairymen consider the health rules and regulations regarding the production of milk when planning changes in the dairy operation. In Michigan, milk market inspectors have approved well-managed loose housing systems. In the Philadelphia, Baltimore, Washington, New York, and other Pennsylvania milk markets, the milk inspectors have been hesitant to accept loose housing. They will approve milk from these establishments but do not necessarily recommend them. The author feels that these markets are going through a transition and after more properly planned loose housing and milking parlor systems are in use, the milk inspectors will approve these systems.

Factors Influencing Decision Making

Labor and machinery can be interchanged for many jobs on a farm. The cost and availability of good labor is important in the decision making process. "The core of the managerial principles is the equating of additional costs and additional returns on a condition defining an optimum position."[1]

The goals of the individual family are very important in determining which alternative to select in the operation of the farm. Some operators' aims in life are to have large farm business, while others prefer to have small, efficient family farms which do not depend on regular hired labor. The size of the family and the ages of individuals are important factors in planning the scope of the farm operation.

The financial situation of the farm family is a second factor influencing the decision making process. Many times the operator would like to adopt some new technology but does not have access to the capital or credit needed. Thus he is often forced to use less efficient methods until he can acquire sufficient capital to adopt the technology.

Some individuals believe that it is undesirable to use credit and will not buy anything unless they can pay cash for it. Many of these farmers could increase their income by using credit in their farm operation.

---

[1]Lawrence A. Bradford and Glenn L. Johnson, <u>Farm Management Analysis</u>, John Wiley and Sons, Inc., New York, 1953, p. 31.

For many farmers, capital is the limiting resource in the development of more profitable business. Farmers who thought of such credit only as something to be paid back were obviously partially unaware of doorways to economic progress that might have been opened by its use.[1]

The availability of land is an important factor that influences the farmer's decision to expand the farm operation. Sixty-two percent of the farmers interviewed in this study said they would not consider expanding their herd size unless they had the land available to grow the extra feed required.

Technological changes as well as distance to market, transportation cost, health regulations, and future expectations of the market all affect the decision to enlarge the dairy enterprise.

The bulk tank is an example of a new technology which has been encouraged or forced upon farmers by plant owners. Many farmers have increased their output to pay for the added cost of the bulk tank.

The uncertainty and risks faced by the dairyman affect his decisions. Heady and Jensen[2] list six types of risk and uncertainty. First, price changes are common in agriculture and it is difficult to predict the future prices received for products, as well as future costs of supplies used in production. The longer the time period

---

[1]John E. Lee, Jr. and E. D. Chastain, Problem Recognition in Agriculture ...Managerial Adjustment Opportunities, Agricultural Experiment Station of the Alabama Polytechnic Institute, Bulletin 319, November 1959, p. 23.

[2]Earl O. Heady and Harold R. Jensen, Farm Management Economics, Prentice-Hall, Inc., New York, 1954, p. 516.

involved, the more difficult the prediction. A second type is the uncertainty of yields due to unfavorable weather, storms, and other natural causes. A third type of uncertainty is the changing technology in the agricultural field. Today's new methods and equipment are obsolete tomorrow. New machines which become out-of-date lose their value rapidly. New varieties of crops may prove successful in the research plot but when applied to an individual farm, may not prove successful. A fourth uncertainty involves government policy. It is difficult to predict several years in the future the net effect of price supports, acreage allotments or other governmental policies. A fifth risk involves the uncertainty of the actions of other people. For example, a landlord may decide to sell the farm, or a custom operator may not be able to cut the grain at the proper time. These actions cannot be predicted. A sixth type of risk is the chance of accident, sickness, or death in the family. Some risk can be reduced by insurance, but others must be carried by the farmer. A farm operator, who is free of debt or has savings, can stand adversity which would cause bankruptcy for one who was heavily indebted.

CHAPTER III

ALTERNATE HOUSING, MILKING AND FEEDING SYSTEMS

Housing Alternatives Available

Many changes have occurred in dairy housing in the past few years. These changes have increased the effectiveness of the labor force in milking and feeding cows and in doing other chores. Although research has shown that loose-housing accompanied by a milking parlor system is more efficient, from a labor and investment viewpoint, than conventional stanchion housing, many farmers still prefer stanchion barns. Some farmers in this study believed that cows will not produce as well under loose-housing conditions. Others stated they liked the control possible and the appearance of cows in stanchion barns.

Fifty-four percent of the farmers contacted in this study planned to use stanchion housing if and when they expanded the size of their dairy herds. Hoglund,[1] in his article "Dairy Farming in a Decade of Change," points out that 90 percent of the dairymen shipping milk to the Detroit milkshed are still using stanchion housing. Farmers who have large investments in well-constructed stanchion barns are more likely to continue to use them than farmers whose barns are in poor condition. Thirty-five percent indicated they would use a combination system of housing if they expanded their dairy herd.

---

[1] C. R. Hoglund, "Dairy Farming in a Decade of Change," Michigan Farm Economics, No. 196.

In a combination housing system, part of the herd may be kept in a conventional stanchion barn while the balance of the herd is kept under loose-housing conditions or the whole herd may be kept in a pole barn. All the cows are milked in the stanchion barn. This system permits herd expansion at a minimum housing investment, although, from a labor standpoint, it is not the most efficient system.

Market regulations in Michigan prevent a farmer from having more than twice as many cows as stalls in the milking barn. This regulation has prevented some farmers from further herd expansion under the switch barn plan. In Pennsylvania, some farmers use loose housing, and milk the cows in a row of stanchions located in the end of the barn next to the milk house.

Another advantage of a switch barn dairy system is that roughage can be fed in hay racks and mechanical silage feeding bunks in the feeding lot.

A recent innovation in dairy housing and milking system is a combination of stanchion housing and parlor milking. This system has some advantages of stanchion dairy barns and the labor saving economies of milking parlors. In winter time, this method requires an extra man to untie and tie the cows in the barn before and after milking. In the summer, when labor is critical, this method operates with the same efficiency as a regular milking parlor-loose housing set-up.

One of the disadvantages of this method of handling cows is the high capital investment required. Farmers with large herds in conventional barns may be able to install a milking parlor with pipeline milkers for about the same expense as installing a pipeline milking system in their large dairy barns.

At first glance, a combination stanchion barn and milking parlor system appears to be expensive and inefficient, but there are some important advantages. This system may have application on farms with 80-100 cows and a large stanchion barn in good physical condition.

Typical barns in Michigan are of frame construction and can easily be converted into loafing or hay barns. These buildings are better adapted to loose housing than to conventional stall barn arrangement. Many Michigan stanchion barns are too small to house a larger dairy herd, but they can serve efficiently as calf and hay barns.

The 70 to 100 foot basement-type barns, commonly found in Pennsylvania, have thick stone walls. These buildings are difficult and expensive to remodel for use as loafing barns. They are usually better adapted to stanchion housing.

There is a wide range in the investment in loose housing construction. A Cornell study[1] reports a range in investment from $190 to $1,086 per cow, with an average of $312. This study showed more variation within housing systems than between them. There are many different types of material used in the construction of loose-

[1]S. W. Warren, op. cit., p. 5686.

housing barns. They include pole barns with wood or metal sides, cement block structures, and concrete and steel. The review of dairy housing by Angus and Barr also showed wide ranges in building costs. The larger the herd the lower was the investment per cow for a loose housing system. The milking parlor and equipment was the largest item of investment. A dairyman can increase the number of cows milked in the parlor without adding to the cost of the equipment.

Difference in investments may be due to variations in costs of labor and in the kind and cost of material used. Farmers, who have a farm wood lot and have the ability to work with tools, can often save a large portion of the construction cost by providing part of the material and labor.

Stanchion barns are either of one or two-story construction. Construction costs are lower per cow for a one-story than a two-story barn. However, if the cost of insulation, and hay and straw storage space is added, there is little difference in cost between the two type barns.

A United States Department of Agriculture bulletin[1] showed the cost of building a one-story stanchion barn for 20 cows at $425 to $450 per cow. The cost of a 28 to 43-stall two-story barn was $375 to $730 per cow. These cost figures varied greatly due to difference in labor and material expenses.

---

[1]Thayer Cleaver, Harold J. Thompson, and Robert G. Yeck, Stall Barns for Dairy Cattle, U. S. Department of Agriculture Information Bulletin No. 123; May 1954, p. 16.

A 1956 study of building costs conducted by Cornell University[1] showed the cost of building a one and one-half story laminated rafter dairy barn from $233 to $716 per cow. The average cost of the construction, omitting the highest and lowest cost figures, was $404 per cow for an average of 35 cows per barn.

Many studies have been conducted on dairy housing and labor required per cow under various management systems. These studies indicate a wide variation in efficiency between farms.

Day, Anne, and Pond, in a study of the effect of herd size on dairy chore labor in stanchion barns, found increasing efficiency in the use of labor as dairy herds were expanded from 10 to 40 cows. A 10-cow herd required 132 hours labor per cow; a 20-cow herd 94 hours per cow; a 30-cow herd 82 hours per cow and a 40-cow herd 75 hours per cow.[2]

Milk and Milk Handling Systems

Today a dairyman has a choice of several methods of handling milk. He can use a milking parlor with a pipeline milker and bulk tank. In stanchion housing he can carry the milk to the milk house, use a pipeline milker and bulk tank or he can use a milk transfer system.

---

[1]S. W. Warren, "Cost of Building Stall Barns and Pen Barns," _Farm Economics_, Department of Agricultural Economics, New York State College of Agriculture, Cornell University, Ithaca, N. Y., No. 212, March 1958.

[2]L. M. Day, H. J. Anne, and G. A. Pond, _Effect of Herd Size on Dairy Chore Labor_, Minnesota Agricultural Experiment Station, Bulletin No. 449, June 1959, p. 5.

The parlor system of milking has greatly reduced the time and effort needed to milk a herd of dairy cattle. With this system the cow comes to the man rather than having the man go to the cow. There are four basic types of milking parlors in operation: herringbone, walk-through, U side opening, and inline side opening. Nearly all milking parlor systems provide for grain storage overhead. Grain is moved to the cow by gravity or auger systems.

Brown, Snyder, Hoglund and Boyd[1] calculated the distance walked by one man in milking 50 cows. When step-saving practices were used, the operator walked 1,469 feet in the double 5 herringbone; 1,797 feet in the double 3 walk-through; 1,167 feet in the 3-U side opening; and 2,263 feet in the 3-in-line side-opening milking parlors. Dairymen using the herringbone system milked at an average rate of 735 pounds of milk per man hour with cows averaging 33.9 pounds of milk per cow daily. The rate of milking for the other parlor types were 519 pounds per man per hour with cows averaging 33.5 pounds per cow daily.

The study of operations and investments of herringbone milking systems, conducted by Hoglund, Boyd, and Synder,[2] showed that the investment in a double 6 herringbone building, milking room, and milk room equipment varied from $12,000 to $14,000 when all work was

---

[1]B. A. Brown, W. W. Snyder, C. R. Hoglund, and J. S. Boyd, "Labor Requirements for Herringbone and Other Milking Systems," Michigan Agricultural Experiment Station, Quarterly Bulletin, Vol. 41, No. 96, May 1959, p. 916.

[2]C. R. Hoglund, J. S. Boyd, and W. W. Snyder, "Herringbone and Other Milking Systems - Operations and Investments," Michigan Agricultural Experiment Station, Quarterly Bulletin, Vol. 41, No. 3, February 1959, p. 7.

contracted and the building was constructed of concrete block. When the cost of a pole barn, concrete exercise lot, silos, and automatic silage feeding equipment is added to this figure, the total investment is $40,000. A dairyman must milk a larger number of cows to justify this large investment.

Pipeline milking is another new technology that has reduced the labor requirement for milking the dairy herd. Pipelines are almost always used in milking parlor systems, but their acceptance in conventional barns has been slow. High cost of installation is the major reason for this lag.

A study at Cornell University[1] reported the average investment per cow for a pipeline milker for barns ranging from 40 to 49 stalls as $70. The investment in a pipe line for the same size herd using a milking parlor was $34 per cow or only one-half as high. As cow numbers are increased, investments per cow are decreased more rapidly with the milking parlor than with a stall-barn system. The average annual cost of operating a pipe line milker in a milking parlor was $345 per year. Herds, ranging from 50 to 59 cows, were milked in the milking parlor at a cost of $6 per cow. The cost of operation in a stall barn was $710 per year for herds of 50 to 59 cows. Annual cost per cow was $12.[2] These costs included interest, depreciation, cleaning compound, additional electricity, repairs, insurance, strainers and other supplies.

---

[1] B. F. Stantan, Pipeline Milking,-Its Place on Your Farm, Cornell University Extension Bulletin No. 1024, February 1959, p. 8.

[2] B. F. Stantan, op. cit., p. 11.

The Georgia Experiment Station reported, the cost of installing pipeline facilities ranged from approximately $1,800 to $3,000, depending on the size of barn and the make of equipment installed. The labor requirements for milking were about four minutes of labor per cow per day lower for pipeline barns than conventional stanchion barns. No significant difference was found between labor requirements in a milking parlor and a stanchion barn with pipeline facilities. However, milking parlors eliminated much of the stooping and lifting that is still present in stanchion barns with pipeline milking.[1] In this study, the savings in labor figured at $1 per hour would pay for the cost of the pipeline installations in two to four years. It should be noted that this study was made with herds averaging 67 cows per farm that were milked in shifts in 24 to 30 cow stanchion barns. These savings would be different when applied to typical Michigan or Pennsylvania stanchion barns.

In the Cornell study, if labor were valued at $1.25 per hour, 560 hours of labor would have to be saved annually by the pipeline system to make it pay. Alternative uses of the labor saved, ease of milking and quality of the milk must be considered. An increase in herd size may be an important consideration in investment in a pipeline milking system.

---

[1] J. H. Padgett and T. L. Frazier, Economic Analysis of Important Aspects of Dairy Farm Automation, Georgia Agricultural Experiment Station, Bulletin No. 47, November 1957, p. 45.

The cost of cleaning compound and of electricity for heating extra hot water needed amounted to 29 to 35 percent of the annual operating cost of a pipeline system.[1] A number of the farmers interviewed in this study remarked that they would like to have a pipe line, but thought they could not justify the investment.

The transfer system[2] of carrying milk from the cow in a stall barn to the bulk tank shows promise. One farmer in this study had been using a milk transferer and was well satisfied with it. This system is not as convenient as a pipe line, but the initial investment is much lower.

Systems of Feed Handling and Manure Removal

Labor in feeding can be minimized in the loose-housing system by convenient arrangement of storage and use of mechanical feeding equipment. Greater efficiency can be obtained from this equipment by using it year around under a storage feeding program. Some dairymen self-feed silage from trench or bunker silos. This system requires less investment, but creates more management problems than a conventional tower silo system.

Hay can be stored in baled or chopped form. The efficiency of a forage harvester can be improved if it is used to chop silage,

---

[1] B. F. Stanton, op. cit., pp. 9 and 10.

[2] This is a system where the milk is poured into a receiving pail in the barn and pumped from this container through plastic hose to the bulk tank.

hay, and straw. In some installations, a hay barn is constructed in the feed lot. Hay is placed in the barn and either hand or self-fed to the cattle. These hay barns are well adapted for the use of chopped hay and mechanical drying systems. The hay may also be stored in baled form and fed as needed.

Frequently, farmers convert an old dairy barn into a hay barn by building a feeding rack along or directly inside the barn. Hay is thrown directly from the barn into the hay rack. This system works with chopped or baled hay.

The mechanical silage unloader and mechanical feeder have reduced the labor required to feed silage to a dairy herd. A silo unloader and mechanical feeder, for a 20 x 55 foot silo, requires an investment of about $2,900 with a total annual cost of $435.[1] A farmer would have to save over $435 worth of labor to justify the investment in this equipment unless the investment resulted in a greater labor output per man. As more equipment is added to the farm, the scale of business must be increased or the labor force reduced, so that the additional income or savings in costs will pay for the increased investment plus a profit to the operator.

In the larger diameter silos, 20 to 24 feet, it becomes an almost impossible job to hand unload such large silos. It is also quite hazardous to climb a silo once or twice a day.

---

[1]C. R. Hoglund, M. L. Esmay, J. S. Boyd, and W. W. Snyder, "Economics of Tower and Bunker Silos," Michigan Agricultural Experiment Station, Quarterly Bulletin, Vol. 41, No. 2, November 1958, p. 12.

New technologies have developed which reduce the labor required to care for cows in a stanchion barn. The gutter cleaner has reduced the labor needed to care for a dairy herd. A study conducted by the Virginia Agricultural Experiment Station[1] shows an investment cost of $40 per cow. The total annual cost of operating the gutter cleaners ranged from $4.73 per cow for 20 to 30 cow herds, to $2.94 per cow for herds of 44 to 72 cows. The average cost for all farms in the study was $3.73 per cow.

In comparing the costs of removing manure by mechanical compared to hand methods, the researchers concluded that labor would have to receive $1.25 per hour to justify the use of a barn cleaner from an economic standpoint. However, there are other values that must be considered in the purchase of a barn cleaner. This equipment reduces the drudgery of the work thus making it possible to obtain and keep higher quality hired labor.

Manure removal is one of the less desirable and time consuming jobs on a dairy farm. A loose-housing system permits the use of mechanical equipment to perform this job. A tractor, equipped with a hydraulic manure loader, can greatly reduce the time and effort required to remove the manure from a pen barn. In a Wisconsin dairy barn study,[2] using hand methods, eight percent less labor was required for manure removal in a pen barn than in a conventional

---

[1] R. Lee Chambliss Jr., "The Economics of Mechanical Dairy Barn Gutter Cleaners," Virginia Agricultural Experiment Station, Bulletin 506, April 1959, p. 11.

[2] Angus and Barr, op. cit., p. 9.

stall barn. It is important that the loafing area be as free of posts and other obstacles as possible to aid in the ease of removing the manure. In a Michigan study,[1] one man on a tractor equipped with a hydraulic manure loader, and one man with the aid of two tractors and two spreaders were able to clean a 40 x 50 foot barn in less than eight hours.

The advantages of manure removal in a loose-housing system are: (1) the manure is hauled out about twice a year. This eliminates the need of hauling manure daily as is customary in stall barns, (2) the manure contains more plant nutrients because the liquids are absorbed in the bedding, resulting in less loss of nitrogen. Some disadvantages of manure handling in loose-housing barns are: (1) hauling manure may conflict with other spring work, (2) scraping the manure from the concrete area can be a problem in winter under freezing conditions. Too often farmers are lax in keeping the cows bedded and the concrete area clean. This is a major reason why some milk markets do not accept or approve of a loose-housing system of dairying.

Dairymen can choose from several alternative methods of housing dairy cattle. They can use conventional stanchion housing, loose housing with a milking parlor, combination loose housing and stanchion barn, or a stanchion barn with a milking parlor.

Several alternative methods of milk handling are available to the dairymen. They can carry the milk in pails, use a pipe line

---

[1] B. F. Cargill and N. P. Ralston, "Loose Housing for Dairy Cattle in Steel Buildings," Michigan Agricultural Experiment Station, Quarterly Bulletin, Vol. 38, No. 1, 1955, p. 15.

milker or a milk transfer system. If they prefer to use a milking parlor they have a choice of the herringbone, walk-through, U side opening, or in-line side opening milking parlors.

Hay may be fed in bales or chopped form. It may be fed in hay racks along the side of the barn or in special hay barns. Silage may be fed by using a mechanical silage unloader and a mechanical bunk feeder or it can be self-fed from a bunker silo.

Manure may be removed from stanchion barns by mechanical gutter cleaners or in loose-housing by a tractor equipped with a hydraulic manure loader.

A dairyman should study the alternative methods of housing, feeding and milk handling carefully before making a decision as to which systems to use on his farm.

CHAPTER IV

REVIEW OF RESEARCH ON LOOSE AND STANCHION HOUSING

Many studies have dealt with loose housing and milking parlor, and stanchion barn systems. Angus and Barr[1] reviewed approximately 140 references relating to this subject. Most of these studies showed a saving in milking time when using milking parlors compared to stanchion barns.

A study by Jarvesoo, Moser, and Gray[2] showed an average milking time of 3.79 minutes per cow in the milking parlor as compared to 5.57 minutes per cow in the stanchion barn. Washing and setting up the equipment required 2.53 minutes per cow in the loose housing system and 1.58 minutes per cow in the stanchion barn. Carrying milk required .16 minutes per cow in the parlor compared to 1.91 minutes per cow in the stanchion barn. The total milking time required per cow for the milking parlor was 6.48 minutes and 9.06 minutes for the stanchion barn.

A similar study by Baker and Bailey[3] showed 6.6 minutes per cow milking time for both stanchion barns and milking parlors. This study reported .9 minutes per cow in stanchion barns and .8 minutes per cow in pen barns for carrying the milk from the cow to the milk

---

[1] Angus and Barr, *op. cit.*

[2] Elmar Jarvesoo, Roy E. Moser, and Leo R. Gray, *Pen and Stanchion Barns, Daily Chore Time Comparisons*, University of Massachusetts, Agricultural Experiment Station, Bulletin 483, 1955.

[3] R. H. Baker and R. A. Bailey, *Plan Dairy Chores*, Ohio Agricultural Experiment Station Research Bulletin 706, 1952.

house. It took 2.1 minutes per cow in the stanchion barn to care for and clean the milking equipment. This same task consumed 2.7 minutes per cow in the pen barns. According to this study, the complete milking operation took 9.6 minutes per cow in the stanchion barn compared to 10.1 minutes per cow in the milking parlor.

In a Wisconsin milking room study conducted during 1949,[1] less time was required to milk cows in milking parlors than in conventional barns. Twenty to 25 cows were milked per man-hour under varying routines in the several milk rooms.

Research in labor requirements for milking was also conducted by Dodd[2] in England, Bettenany,[3] Cullity,[4] and Scott and Scott[5] in Australia and by Whittleston[6] in New Zealand. These studies report high milking rates and low labor requirements for milking parlors. Brown[7] reported an average milking rate with one operator for the double 4, double 5 and double 6 herringbone milking parlor as 40, 44,

---

[1]S. A. Witzel, Progress in Milking Parlor Research, University of Wisconsin, mimeo., 1951.

[2]F. H. Dodd and A. S. Foot, "Experiments on Milking Technique," Journal Dairy Research, 15:1, 1947.

[3]R. A. Bettenany, "Rate of Milking with Machines," J. Agr. W. Australia, 27:160, 1950.

[4]M. Cullity, "Rate of Milking Machines," J. Agr. W. Australia, 26:99, 1949.

[5]W. I. Scott and D. R. Scott, A Survey of Machine Milking Techniques in N.S.W. New Wales, Dept. of Agri., Division of Dairying, P.C. 50, 1951.

[6]W. G. Whittleston, and C. How, "A Survey of Machine Milking," New Zealand J. Agr., 73:441, 1946.

[7]B. A. Brown, W. W. Snyder, C. R. Hoglund and J. S. Boyd, "Labor Requirements for Herringbone and Other Milking Systems," Quarterly Bulletin, Michigan Exp. Station, Vol. 41, No. 4, May 1959, p. 920.

and 46 cows per man hour, respectively.

A time-travel study of 56 Kentucky dairy barns was conducted by Byers[1] from 1948 to 1952. Dairy chores averaged 120 hours per cow annually in five conventional barns. Sixteen walk-through milking parlor systems averaged 75.2 hours per cow annually. A synthesized routine for conventional barns required 77 hours per cow annually while the walk-through milking parlor required only 51.8 hours.

In a stop-watch study in 1952, Shute[2] found loose housing required 69.4 hours per cow annually, compared to 80.4 hours in conventional barns. All chores except feeding required less time in loose housing. Shute concluded that loose housing took less labor and physical ability.

Angus and Barr[3] conclude that loose housing saves about 20 percent in terms of labor and 30 percent in terms of travel. Savings are made in milking, feeding, bedding, and cleaning time. Savings in cleaning are questionable because some investigators compared manual manure handling methods for conventional barns with mechanical methods in loose housing. Travel savings were indicated for each job except bedding.

Labor was easier, less fatiguing, and took less physical stamina in loose housing with elevated milking rooms. The most general

---

[1] G. B. Byers, _Effect of Work Methods and Building Designs on Building Costs and Labor Efficiency for Dairy Chores_, Kentucky Agricultural Experiment Station, Bulletin 509, 1950.

[2] J. A. Shute, _A Comparison of Dairy Cattle Labor Requirements for Stall and Loose Housing Barns_, University of Minnesota, mimeo., 1952.

[3] Angus and Barr, _op. cit._

comment on working conditions was that loose housing milking rooms were cold.

Daily manure handling was reduced in loose housing, and chore labor, particularly feeding and cleaning, was more flexible, making labor organization easier.

Witzel and Heizer[1] at Wisconsin kept records on milk production for nine years on a stanchion and a loose housing barn. The daily average milk production per cow in the stanchion barn was 38.1 pounds of milk with 3.6 percent fat or 35.8 pounds of milk on a 4 percent fat basis. The loose-housing herd averaged 38.1 pounds of milk with 3.64 fat or 36.1 pounds of milk on a 4 percent fat basis. This study showed that herds produce equally well in warm stanchion barns and in loose-housing barns. There was no observed relationship between low temperature and milk production. High quality milk was produced in both systems. Feed requirements per pound of milk were essentially the same for both barns.

Jarvesoo, Moser and Gray[2] report a total feeding time of 1.55 minutes per cow per day for loose housing barns and 3.22 minutes per cow per day for stanchion barns. This includes feeding hay, silage and grain. Baker and Bailey[3] report a feeding time of 3.1 minutes per cow per day for stanchion barns and 3.0 minutes per cow per day

---

[1] S. A. Witzel and E. E. Heizer, Loose Housing or Stanchion Type Barns, University of Wisconsin Agricultural Experiment Station, Bulletin 503, 1953.

[2] Jarvesoo, Moser, and Gray, op. cit.

[3] Baker and Bailey, op. cit.

for loose-housing barns.

Angus and Barr[1] made the following conclusion: "Feed consumption-milk production research has been carried out by controlled experiments reasonably alike in design. Investigators report that more roughage was consumed by loose-housed herds, but differences were small in terms of TDN. Although some investigators found higher feed efficiencies in loose housing and others found the reverse, the range of results is remarkably narrow. Feed efficiency appears about equal in both systems and thus is apparently not related to barn type. Records showed that low air temperature had very little effect on milk production when cows were clean, dry, free from drafts, and free to exercise."

Differences in bacteriological quality of milk produced in loose and conventional housing were small. Satisfactory quality was obtained in both systems.

A number of these studies were made before the silo unloader, automatic bunk feeders, and herringbone milking parlors had appeared on the scene. With these new technologies, feeding time has been greatly reduced in the loose-housing system.

Research has shown that loose housing requires more bedding than stanchion barns, but there is little agreement as to how much bedding is needed. Estimates range from 100 to 340[2] percent of the conventional barn requirement.

---

[1]Angus and Barr, op. cit.

[2]Angus and Barr, op. cit.

Woodward's[1] study in 1918 reported 8.3 pounds of straw per cow per day for loose housing and 4.9 pounds of straw per day for conventional barns. According to Graves'[2] study, loose housing requires 15-25 pounds of straw per cow per day compared to 8-12 pounds for conventional barns. A study by Brown[3] in Michigan reports 8-15 pounds of straw per cow per day for loose housing and 5-8 pounds for conventional barns.

A Wisconsin[4] study reports 12.3 pounds of straw per cow for loose housing and 7.6 pounds for conventional barns. Byers,[5] in his Kentucky study, reported 9.0 pounds of straw used per cow per day in loose housing and 5.0 pounds per day in stanchion barns. He reported that the location of feed racks and holding areas influenced bedding requirements and recommended locating them so as to minimize travel on bedded areas. Stewart[6] made a survey of 36 loose-housing systems in Missouri in 1950 and concluded that it takes 6-7 pounds of straw per cow per day to provide satisfactory conditions.

---

[1]T. E. Woodward, The Open Shed Compared with the Closed Barn for Dairy Cows, U. S. D. A., Bulletin 763, 1918.

[2]R. R. Graves, J. R. Dawson, and D. V. Kopland, Relative Milk Production of Cows in Pen Barns and Stanchion Barns, U. S. D. A., Circular 763, 1947.

[3]L. H. Brown, B. F. Cargill, and B. R. Bookout, Pen-Type Dairy Barns, Michigan Agricultural Experiment Station, Special Bulletin 363, 1950.

[4]S. A. Witzel and E. E. Heizer, op. cit.

[5]G. B. Byers, op. cit.

[6]R. E. Steward, A Field Study of Practice in Loose Housing of Dairy Cattle in Missouri, Missouri Agricultural Experiment Station, Research Bulletin No. 468, 1950.

Appendix Table D gives a summary of the findings of research on loose and conventional dairy housing chore time. According to these studies, loose housing saves time in milking, feeding, bedding, and cleaning. Loose housing takes 84 percent as much time in milking, 80 percent as much time in feeding, 86 percent as much time in bedding, and 80 percent as much time in cleaning as is used in a conventional stanchion barn.

These studies have brought out numerous advantages and disadvantages of housing systems. Some suggested advantages of stanchion housing are: (1) cows are handled as individuals and so can receive individual attention, (2) cows can be exhibited to advantage in a stall barn, (3) farmers are familiar with handling cows in stall barns, (4) in winter the temperature is more comfortable for the operator to work in a stall barn than in a loose housing system, (5) this system is standardized and accepted by milk sanitarians, (6) less bedding is needed in a stall barn than in a pen barn, (7) boss cows are confined and do not disturb the herd, and (8) cows are confined and thus readily available for the practicing veterinarian.

Some disadvantages of stanchion housing are: (1) the herd size is limited to the number of stalls in the barn, (2) the construction cost of a new barn is high, (3) requires more labor per cow than a milking parlor system, (4) the dairyman must stoop to milk, and (5) the manure must be hauled out in the field daily during the winter.

Some suggested advantages of a loose housing system of dairying are: (1) herd can be handled as a group and can be expanded with little additional cost, (2) cows enjoy pasture comfort throughout the year, (3) the labor required per cow is less than for stanchion barns, (4) milking parlors eliminate stooping and reduce the distance traveled in milking the herd, (5) there are less injuries to udders, hocks and knees, (6) there is more and better preserved manure, (7) farm tractors can be used for feeding and cleaning chores, (8) it is easier to detect the cows heat periods, (9) overall cost of building and equipment can be less, and (10) there is less danger of injury or death in case of a fire.

Some disadvantages of loose housing are: (1) it requires more straw per cow than conventional barns, (2) there is a problem with boss cows, (3) there is a problem with fly control, (4) it is more difficult to handle sick or injured cows, and (5) it takes extra water and a good drainage system to keep the milking parlor clean.

The drainage system in a milking parlor is often poorly designed and a source of trouble as mentioned by several of the dairymen interviewed. Agricultural engineers stress the need for providing for (1) an adequate supply of water, (2) a high water pressure and (3) a properly installed drainage system.

CHAPTER V

PLANS AND PRACTICES OF 37 LIVINGSTON COUNTY DAIRYMEN

The purpose of this survey was to obtain information on the systems of housing, farming practices, and future plans of better-than-average dairymen currently using stanchion housing. An attempt was made to include dairymen with herd production averages of 10,000 to 12,000 pounds of milk. Information found in this study was then used to budget herd expansion for different types of dairy housing using three case farms. On Farm A there is a 24-cow stanchion barn, on Farm B there is a relatively new 40-cow stanchion barn, while on Farm C there is an old 36-stall stanchion barn in poor physical condition. The budgets for these farms will be discussed in detail in Chapter VI.

The following information was acquired in the survey: The size, condition and investment in the farm buildings; the kinds and investments in farm machinery and equipment; the age of the operator and amount of family and hired labor used in the farm operation; the tillable acres, crop yields, and fertilization program; type of pasture system used; the number of milk cows and their production; the time spent daily in barn chores; the number of cows the dairymen expected to have by 1965; the type of housing planned for in future expansion; and what the dairyman felt were the advantages and disadvantages of their own stanchion housing and feeding system.

The 37 dairy farms selected for this study were in Livingston County, in South Central Michigan. The county contains

607[1] dairy farms which produced $2,974,770 worth of dairy products in 1954. Production of milk is the major source of income. Most of the milk is transported to Detroit for processing and sold mostly as Class A.

The farms were selected from the Livingston County D.H.I.A. list with the assistance of the Livingston County Agricultural Agent. The following characteristics were desired in the selection:

1) Dairymen with 20 to 50 cow herds housed in stanchion barns.
2) Young progressive farmers who had good productive herds and would remain in the dairy business for a number of years.
3) Dairymen who were considered successful farmers in their communities.

Future Plans of Dairymen

These 37 dairy farmers were divided into three groups to aid in analyzing the results of the study. Group 1 included 14 farmers with 30 or less cows; Group II was composed of 12 farmers with 31-40 cows; and Group III contained 11 farmers with 41 or more cows. Group 1 averaged 24.6 cows per farm. Dairymen in this group expect to have an average of 34.8 cows by 1965, which is an increase of 41.5 percent.

Dairymen in Group II averaged 35.2 cows per farm with an expected increase of 19.3 percent within five years. The estimated

[1] U. S. Department of Commerce, 1954 Census of Agriculture, Michigan, Vol. 1, pt. 6, p. 62.

herd size for this group by 1965 ranged from 35 to 60 cows per farm with an average of 42 cows.

Group III had an average of 46.1 cows per farm with plans to have 56.3 cows per farm by 1965. This is an increase of 22.1 percent which represents a range in herd size from 40 to 100 cows per farm.

These dairy farms were also divided into three groups according to the degree of change anticipated. There were six farmers or 16.3 percent who planned no changes in their herd size the next five years. Minor changes in herd size (one to five cows per farm) were indicated by 13 dairymen or 35 percent of the group studied. Eighteen dairymen or nearly one-half planned to make major changes in their herd size (over five cows per farm). One of the farmers indicated he may sell out within the next five years.

One dairyman planned to expand his herd to 100 cows; ten planned to expand to 50 to 65 cows, twelve expected to expand to 40 to 49 cows, eleven expected to have 30 to 34 cows and only three dairymen expected to have herds of less than 30 cows by 1965.

Size of Farms

The 14 farms in Group I averaged 150 acres of tillable land per farm with about 38 percent rented. The farms ranged in size from 96 to 260 acres and average 6.1 acres of tillable land per cow. The average farm contained 27.2 acres of pasture which allowed 1.0 acres of pasture or green chopping per cow.

Table 1. Estimated Changes in Dairy Herd Size and Type of Housing in Next Five Years, by Size of Herd, 37 Dairy Farms Surveyed.

Number of Cows	Number of Farms	Average cows per farm			Type of housing planned		
		1960	Expected in 1965	Change	Extend stanchion	Loose housing	Switch herd
		Number	Number	Percent	Percent	Percent	Percent
30 & under	14	24.6	34.8	41.5	53.4	13.3	33.3
31 - 40	12	35.2	42.0	19.3	41.7	16.6	41.7
41 & over	11	46.1	56.3	22.1	54.5	9.1	36.4

Table 2. Tillable Acres, Pasture System Used, Acres of Pasture per Cow for Three Size Groups, 37 Dairy Farms Surveyed.

Number Of Cows	Number Of Farms	Average tillable acres	Number using pasture system			Acres pasture per cow
			Continuous grazing[1]	Field grazing	Green chopping	
30 & under	14	150	7	1	7	1.20
31 - 40	12	241	4	3	4	1.73
41 & over	11	235	4	2	5	1.07
Average	--	209	-	-	-	----

[1] Continuously grazed entire season.

The second group of farms averaged 241 tillable acres per farm of which 19.3 percent was rented. These farms ranged in size from 122 to 420 acres with 6.8 tillable acres per cow. These dairymen averaged 1.7 acres of pasture or green chopping per cow with an average of 45.3 acres per farm devoted to grazing or green chopping.

The eleven farms with 41 or more cows averaged 235 acres per farm of which 22 percent was rented. These farms ranged from 180 to 370 tillable acres per farm which provided an average of 5.1 tillable acres per cow. An average of 48 acres was devoted to pasture or green chopping which allowed an average of 1.1 acres per cow.

These figures indicate that a number of these farms have enough land to expand their herd size without buying or renting additional land. A dairyman should be able to produce the feed for one cow with about four acres of fertile land. Farmers in Groups I and II were using over six acres of land per cow and so should be able to increase their cow numbers by making more intensive use of their land. Most of these farmers were growing wheat as a cash crop. If they eliminated the wheat and increased the corn and hay acreage, it would give them more livestock capacity on the farm. Only eleven of the 31 dairymen who indicated they planned to expand their farm business mentioned that they would need to buy or rent more land. Twenty believed they could handle the additional cows with the present supply of land. Some said they would increase yields by using more fertilizer, others planned to use more intensive pasture management, while several said they would dispose of some other livestock and eliminate the wheat acreage to allow more feed for the dairy herd.

Pasture Systems

During the past few years, there has been an increased trend toward green chopping of forages and hauling it to the cows rather than having the cows harvest the pasture.

In this study, 43.3 percent of the dairymen used green chopping, 40.5 percent used continuous grazing and 16.2 percent used field grazing.

Six of the fourteen farmers in Group I practiced green chopping, seven used continuous grazing and one used field grazing. In Group II five dairymen used green chopping, four used continuous grazing and three used field grazing. Five of the eleven dairymen with 41 or more cows adopted green chopping, four used continuous grazing and two used field grazing. Nearly all the farmers who were using green chopping were well pleased with the practice and other dairymen stated that they plan to adopt it next year.

Labor Supply

Labor is one of the inputs on a farm that can restrict the size of business. Some farmers had a substantial quantity of family labor available for farm work while others must depend primarily on hired labor in the operation of the farm. Some farmers indicated a desire to remain as a one-man operation to avoid the problems

encountered with hired labor. Others planned to have a two-man operation which permitted greater flexibility in planning for vacations and time off during weekends.

The first group averaged 16.6 months of labor per year or 1.4 men per farm. The second group averaged 24.8 months of labor per year or 2.07 men per farm. The farms with 41 or more cows averaged 27 months of labor per farm or 2.25 men per farm. Taking these 37 farms as a group they averaged 1.9 men per farm. This is about the same as for the Michigan State University Farm Account Project.[1]

Cropping Program

When dairymen enlarge their herds, they usually increase the crop acres. The 14 farmers in Group I averaged 32.5 acres of corn for grain, 10.9 acres of corn for silage, 39.2 acres for hay and 35.8 acres of small grain.

The group with 31 to 40 cows averaged 59.9 acres of corn for grain, 19.5 acres for corn silage, 63.5 acres for hay and 55.4 acres of small grain. Those that grew wheat sold it as a cash crop.

The dairymen with over 40 cows averaged 57.6 acres of corn for grain, 19.0 acres of corn for silage, 64 acres of hay, and 53.9 acres of small grain. Most of the small grain grown by this group was oats used as dairy feed. This latter group averaged 5.1 tillable

---

[1] Brown, L. H. and Elwood, M. Farming Today, Michigan State University Cooperative Extension Service Farm Accounting Project, Area 5 report, South Central Michigan, 1960, p. 2.

acres per cow compared to 6.8 tillable acres per cow for Group II. Some of the farmers in the second group sold corn and wheat which helped to increase the number of tillable acres per cow for the farm. In talking with these dairymen, a number remarked that they thought they could improve their crop and pasture yields by using more fertilizer and better pasture management.

Machinery and Equipment Investment

A large amount of capital investment is required for modern farm machinery. In this study the purchase price of the farm machinery was recorded for each farm. There was a wide variation in machinery investment per farm. Several farmers owned forage equipment in partnership with neighbors. This practice helped to reduce their machinery investments. The machinery was divided into three categories: power,[1] forage,[2] and other[3] machinery. The 15 farmers who had 30 or less cows had an average investment of $5,422 in power equipment, $3,578 in forage equipment, and $4,218 in other farm machinery. Investment in power machinery ranged from $1,300 to $11, 220; forage equipment ranged from $2,035 to $7,025; and other equipment ranged from $2,080 to $6,801. Some of the farmers

---

[1] Power equipment included tractors and trucks.

[2] Forage equipment included mowers, hay conditioners, rakes, balers, hay drying fans, forage harvesters, blowers, self-unloading wagons and elevators.

[3] Other equipment included plows, tillage equipment, grain drills, corn planters, combines, corn pickers, manure spreaders, loaders, sprayers, feed grinders, gutter cleaners and dairy equipment.

in this group hired custom machinery for silo filling and grain harvest.

The second group of dairymen had an average investment of $6,464 in power equipment, $4,897 in forage equipment and $5,255 in other machinery.

Their investment in power equipment ranged from $4,700 to $9,000; forage equipment ranged from $2,162 to $8,365; and other machinery ranged from $2,500 to $10,425.

The dairymen who had 41 or more cows had an average investment of $7,617 in power equipment, $6,424 in forage equipment, and $5,996 in other farm machinery. The power machinery investment ranged from $4,800 to $10,000; forage machinery ranged from $1,200 to $9,845; and other machinery ranged from $1,505 to $9,930.

The total power and machinery investment on the 14 farms in Group I was $13,147. The total investment on the 12 farms in Group II was $16,616, while the total investment in the third group was $20,037. The average equipment investment of all 37 farms was $16,620. These figures point out the large amount of capital invested in equipment on a modern dairy farm. A farmer can reduce his operating cost by taking good care of his machinery to extend its useful life. Likewise, careless use of equipment can greatly increase the cost of production on the farm. A number of farmers stated they had difficulty finding a hired man who was careful with machinery and handy around the cows.

Seldom has a new technology been accepted as rapidly by the farmers as has the hay conditioner. In this study, 60 percent of the farmers had hay conditioners and others mentioned that they planned to buy one next year. Forty-seven percent of the farmers in Group I; eighty-two percent in Group II and fifty-five percent of Group III owned hay conditioners.

Forty-six percent of the dairymen in this study had gutter cleaners. Twenty-seven percent in Group I, forty-five percent in Group II, and seventy-three percent in Group III were using this labor saving device. There were eight additional farmers who planned to install gutter cleaners within the next few years. Only three of the dairymen with the larger herds have not installed gutter cleaners. These three indicated that they plan to install a cleaner in the future. On some farms the barn arrangement was not suited for the installation of a barn cleaner.

In this study, sixty-five percent of the farmers used baled hay and thirty-five percent used chopped hay. Sixty percent of the dairymen in Group I used baled hay and forty percent chopped hay; in the middle group, sixty-four percent used baled hay and thirty-six percent used chopped hay; and seventy-three percent in Group III used baled hay and twenty-seven percent used chopped hay. Most of the farmers thought it was more efficient to chop the hay but they disliked handling the chopped hay during the feeding operation. Some thought that a hay drying system was essential to store good quality chopped hay. Only sixteen percent of the farmers in this study used a hay drying system in their barn.

Two dairymen used a pipe line milker, and one used a milk transfer system. Many of the farmers said they thought a pipe line milker would help to reduce the labor required to milk, but the price was too high to justify the equipment. Others said they would put in a milking parlor before they invested in a pipe line in a stanchion barn.

The silo unloader is another labor saving device that is becoming popular with dairy farmers. Only four of the farmers in this study were using silo unloaders but a number are planning to install them in the near future.

The dairymen in this study were mostly young farmers. The average age of those in Group I was 37 with a range in age from 24 to 51. The range in age of the farmers in Group II was 28 to 45 with an average of 38. The average of the farmers with 41 or more cows was 40.4 with a range in age from 23 to 55. In most cases, the younger farmers with large herds used a father-son arrangement.

Milk Production

Not only were these dairymen younger than the average but they had higher producing dairy herds than most Livingston County D.H.I.A. members. The average milk production for Group I was 11,704 pounds of milk with a range in production from 9,044 to 12,994 pounds of milk per cow. Group II averaged 11,629 pounds of milk with a range in production from 8,415 to 15,229 pounds of milk per cow. The average production in Group III was 12,165 pounds of milk with a range in production from 10,202 pounds of milk to 14,200 pounds of milk per cow.

Table 3. Specialized Equipment and Machinery Investment for Three Size Groups, 37 Dairy Farms Surveyed.

Number of Cows	Number using specialized equipment				Machinery investment			
	Hay condi-tioner	Forage chopper	Hay baler	Gutter cleaner	Power	Forage	Other	Total
					----- dollars -----			
30 & under	7	11	6	4	5,422	3,578	4,218	13,149
31 - 40	9	9	6	5	6,464	4,897	5,255	16,616
41 & over	6	10	8	8	7,617	6,424	5,996	20,037

Table 4. Average Milk Production Per Cow, Average Months of Labor Per Farm Per Year and Average Age of Farm Operator by Herd Size, 37 Dairy Farms Surveyed.

Number of of Cows	Number of Farms	Milk production per cow	Average months of labor	Average age of operator
30 & under	14	11,704	16.6	37.0
31 - 40	12	11,629	24.8	38.1
41 & over	11	12,165	27.0	40.4

The Livingston County D.H.I.A. records show an average of 11,229[1] pounds of milk per cow for all cows in the testing program. The number of cows per farm in this study averaged 34.12 cows and 28 head of young stock. Several farmers had more young stock than milk cows. These farmers were raising extra heifers to expand the size of the dairy herd.

The Land Problem

A problem confronting dairymen who planned to increase the size of their dairy herd was how to obtain the necessary feed for the extra cows. There are five alternatives open to the farmer; (1) he can increase production per acre by using more fertilizer and more intensive pasture management; (2) he can buy more land if it is available; (3) he can rent additional land; (4) he can buy the additional feed needed; and (5) a few dairymen who now sell cash crops can use this acreage for the production of extra feed for the larger dairy herd. The farmers in the survey were asked if they would expand their herd size if they would have to buy the extra feed. Thirty-eight percent of them said they would not hesitate to buy the feed and that this fact would not stop them from enlarging their business. However, 62 percent said they would not increase their cow numbers unless they could buy or rent

[1]1959 Michigan Dairy Herd Improvement Records, Cooperative Extension Service, Michigan State University Dairy Department, p. 3.

additional land to grow the extra feed. This attitude of the dairymen may restrict future herd growth. As was mentioned early in this thesis, farm land is limited and quite often is not available near the home farm at a reasonable price.

Housing

Whenever an increase in cow numbers is anticipated, the problem of housing arises. One of the main objectives of this study was to obtain information on the farmers' dairy housing preferences. Eight of the 14 farmers in Group I planned to extend their stanchion barn if and when they increased cow numbers, two planned to go to loose housing with a milking parlor, and four planned to use a switch herd system.[1]

Six of the dairymen in the 31-40 cow group would extend their stanchion barn, one would use a milking parlor system, and five would use a switch herd system.

In Group III, six planned to extend their stanchion barn, one planned to use a milking parlor system and four planned to use the switch herd plan. When these 37 farmers are taken as a unit, 54 percent would use a stanchion barn, 35 percent a switch barn system and only 11 percent would adopt a loose housing milking parlor system of dairying.

In studying the building arrangements on these farms, it was found that 25 or 67 percent of the dairy barns could be remodeled

---

[1] A switch herd system is the practice of keeping part of the herd in a stanchion barn and the balance of them in a pole shed under loose housing conditions. The cows are milked in the stanchion barn in shifts.

or extended to provide more stanchion space. Seventeen or 33 percent of the barns could not be extended due to the location of other buildings or roads. Eight of the farms had pole sheds which were used to house part of the dairy herd.

Each farmer was asked what he considered the main advantages and disadvantages of his system of housing. Twenty-eight said they preferred stanchion barns because each cow can be treated as an individual. Other advantages mentioned by these farmers were as follows:

(1) more control over the feeding program,

(2) cleaner cows,

(3) more comfortable working temperature,

(4) less bedding required,

(5) more cow comfort,

(6) better control over sick and injured cows,

(7) more desirable herd appearance,

(8) less trouble with cows in heat, and

(9) more production per cow.

The extra labor and milking time required to care for a herd in a conventional barn was the main disadvantage of stanchion barns listed by 28 dairymen. Other disadvantages listed by the farmers were as follows:

(1) inflexibility of increasing herd size,

(2) frequency of udder and leg injuries,

(3) necessity of daily stable cleaning,

(4) lack of exercise for the cows,

(5) necessity of stooping to milk, and

(6) higher cost per cow for housing.

It was evident in talking with these farmers that many of them definitely preferred working with cows in a stall barn. Several dairymen stated that if their barn should be destroyed by storm or fire they would build a pole barn and milking parlor, but it would cost too much to tear out a good stall barn and convert it to a milking parlor system.

This survey shows that most of the dairy farmers are planning to meet the price cost squeeze by increasing the size of their dairy operation. They plan to do this by adopting more intensive farming practices and by using labor saving devices. About half of them plan to continue stanchion housing, 35 percent plan to use a switch barn system and 11 percent plan to adopt a loose housing milking parlor system of dairying.

CHAPTER VI

BUDGETARY ANALYSIS OF CASE STUDIES

The American farmer has been facing a price squeeze for the past 10 years. The prices of inputs used by the farmer have been rising while prices received for agricultural products have declined.

"The index of real income of farm workers, in terms of 1947-49 dollars, declined from 96 in 1950-51 to 84 in 1957. At the same time, the real income of industrial workers increased from 110 to 129."[1] Net income per farm in the United States declined 19 percent from 1951 to 1957.[2] Based on a price index 1910-14 = 100, prices received by Michigan farmers in May 1960 were 241 compared to 270 for May 1947-49. Prices paid by farmers in the United States were 301 in May 1960 compared to 250 for May 1947-49.[3]

This cost-price squeeze has emphasized the importance of improving the organization and operation of farms, and in reducing the inputs needed to produce a unit of output. For example, if a tractor was used on 150 acres instead of 90 acres the machinery

---

[1] Sherman E. Johnson and Kenneth L. Bachman, "Recent Changes in Resource Use and in Farm Incomes," Problems and Policies of American Agriculture, Iowa State University Center for Agricultural Adjustment, Iowa State University Press, 1959, p. 9.

[2] Ibid., p. 10.

[3] Michigan Farm Economics No. 210, Department of Agricultural Economics, Michigan State University, July 1960, page 4.

cost per acre was reduced. There are several possible alternative courses of action which a dairy farmer can take to increase farm income. These are: increase the number of cows on the farm; increase production per cow; or increase the efficiency within the farm unit. Many dairymen are accepting the alternative of increasing the herd size. For example, the average size of Michigan D.H.I.A. herds has increased from 17 cows per farm in 1950 to 30 cows per farm in 1959.[1] A decision to expand creates the additional problem of providing housing for the larger herd. Whenever the number of cows on a farm are increased, the whole farm organization changes. There is a need for more feed, labor and housing. These inputs must be combined in proper proportions if the expansion plan is to prove profitable.

The purpose of this study was to examine the profitability of expanding dairy herds to various sizes when alternative housing methods are used. This was accomplished by computing thirteen farm budgets for three case farms selected from the 37 farms in the survey. These farm represented three different housing situations commonly found on Michigan dairy farms.

Farm A had a twelve year old, two story, 24 stall stanchion dairy barn constructed of cement blocks. This 36 by 70 foot barn had the cows facing out with two large box stalls at the far end of

---

[1] 1959 Michigan Dairy Herd Improvement Records, Cooperative Extension Service, Michigan State University, Dairy Department.

the barn. A gutter cleaner was used to remove the manure. Milk from the 24 cows was carried to a 12 by 16 foot milk house located at the north-west corner of the barn. The barn was in an excellent state of repair.

Farm B had a 36 by 80 feet, 40 stall stanchion barn which was built in 1942. A new 15 by 18 foot cement block milk house was built in 1957. All the buildings were painted and kept in a good state of repair. This farmer was milking 44 cows. Forty were kept in the stanchions in the main barn and four were housed with the young stock. Two 12 by 35 foot silos were used for corn silage. The manure was removed manually by driving the spreader through the barn.

Farm C had an old 36 by 70 foot, 36 stall stanchion barn that was built in 1898 and needed repairs. The barn was dark and the cow stalls were too small for large Holstein cattle. The building was equipped with a gutter cleaner and a pipe line milker. This farmer was milking 47 cows with eleven of them housed in a pole barn. This barn was not suited for expansion or remodeling because of the poor location in relation to other buildings and inadequate drainage.

Bradford and Johnson defined a farm budget as follows: "A farm budget is a written plan for future action, plus the anticipated results. Basically, a budgeting process for a given period converges on two figures. One of these figures is total revenue for the period or situation under consideration. The other figure is total expenses for the same period. When the difference between these two figures is found, it is called net profit or net return, or net loss, depending upon whether net revenues are greater than or less than expenses."[1]

Although budgeting is not an exact science, it does provide a useful tool to compare the profitability of different farm plans. It may be desirable that individual farmers budget alternative plans on the basis of different combinations of expected prices for inputs and outputs.

Assumptions of the Budget

Case farms A and B were assumed to contain 200 tillable acres because this was near the mode of the size of the farms in this study. Farm C was assumed to contain 240 tillable acres. In all but one alternative plan, it was assumed that enough extra land could be rented at a rate of $12 per acre annually to supply the additional feed needed when the dairy herd was expanded.

The farm machinery prices used in this study were the actual prices given by the farmer for the machinery on the case farms. Additional machinery and equipment were added as needed for the expanded enterprise. Machinery depreciation, repairs and insurance were figured at 12-19 percent per year of the original cost. Table K in the Appendix shows the machinery and equipment investment and

---

[1]Bradford and Johnson, op. cit., p. 328-329.

annual cost for each budget.

Table E in the Appendix shows the prices paid[1] for inputs and prices received for outputs. Table F records miscellaneous operation expenses and building construction costs. Milk production for various size herds was shown in Table G.

Wheat and some corn were grown as cash crops on the benchmark farms. The rotation generally followed was corn-corn-oats-hay-hay-hay. Forty pounds of actual nitrogen was applied to corn following corn. The following crop yields per acre were assumed: 67 bushels of shelled corn, 40 bushels of wheat, 60 bushels of oats, 12 ton of corn silage, 7 tons of grass silage for first cutting or 10 ton for the season, and 3.6 tons of alfalfa hay per acre with a hay conditioner and 3.2 tons of hay per acre when a hay conditioner was not used. Pasture was budgeted at the rate of 1.25 acre per cow. Fertilization rates are shown in Table H in the Appendix.

Hired labor was calculated at the rate of $3,000 per year or $300 per month for seasonal help. This rate included the cost of housing, milk and beef for home use.

The milk price for 3.5 percent fat milk was assumed to be $3.80 per hundred net at the farm.

Estimated quantities of forage, grain and protein needed per cow are shown in Table I in the Appendix. It was assumed that

---

[1] James Mulvany and Richard Wheeler, Fact sheet for Michigan Agriculture, Cooperative Extension Service, Michigan State University.

small grains yield one ton of straw per cow and stanchion housing used .8 of a ton per cow per year.

Real estate taxes were assumed to be 1-1/4 percent of the capital investment in land and building because this resulted in a figure comparable to Michigan real estate taxes. Interest on new investment was figures at six percent of one-half of the cost of additional buildings and equipment and six percent of the full cost of purchased cows.

Case Farm A

Farm A consists of two tracts of land with a total of 200 tillable acres. The soil type is of Miami and Conover series, level to gently rolling, well-drained and productive. The soil type of the other two case farms is similar. The buildings on Farm A consist of a 24-stall, gothic roof, stanchion barn, a milk house, a 36 x 50 foot machinery shed, several old chicken houses, corn crib and a grainary. The farm has a 14 x 40 foot silo. The farmer operates the farm with occasional seasonal help and milks 24 cows averaging 11,000 pounds of milk. This farm has a dairy housing situation that is common to many of the smaller dairy farms in Michigan.

This dairyman planned to expand his herd to 40 milk cows in the near future. But like many other dairymen interviewed, he was uncertain as to which system of housing to use.

Four budgets were computed for this farm. A benchmark budget with 24 cows in the stanchion barn; budget one with 48 cows

Table 5. Farm Organization Data for Farms A, B and C.

Item	Unit	Benchmark	Alternate Plans 1	2	3	4
Farm A						
Cows	Number	24	48	48	30	
Tillable land	Acres	200	200	200	200	
Housing		Stanchion	Combination	Stanchion	Stanchion	
Labor hired	Month	4	13.5	13.5	5	
Farm B						
Cows	Number	44	50	75	60	100
Tillable land	Acres	200	214	313	240	402
Housing		Stanchion	Stanchion	Stanchion	Loose	Loose
Labor hired	Month	13.5	14.5	27	14.5	26
Farm C						
Cows	Number	47	100	100	120	
Tillable land	Acres	240	395	240	468	
Housing		Combination	Loose	Loose	Loose	
Hired labor	Month	14.7	30.5	25	39.5	

in a conventional stanchion barn; and plan three with 30 cows in the present stanchion barn with the young stock housed in a pole shed.

Benchmark Plan on Farm A

The cropping system for the benchmark plan included 65 acres of corn for grain, 10 acres of corn silage, 25 acres of oats, 25 acres of wheat, 45 acres of alfalfa-brome grass for hay, and 30 acres of pastures (Table 6). Ten acres of early pasture were harvested as grass silage for supplementary summer feed.

One thousand bushels of wheat and 3,939 bushels of corn were sold as cash crops (Table 7). The cattle are fed a roughage ration of 75 percent hay and 25 percent silage. The silo was filled by custom hired equipment at the rate of $10 per hour. With the exception of silo filling equipment, Farmer A had a full line of farm machinery. His dairy equipment included a 300 gallon bulk tank and a gutter cleaner.

Table 8 shows the estimated receipts and expenses for all four plans. The benchmark plan shows $16,531 receipts, $11,040 expenses and $5,491 net farm income.

Alternate Plan 1 for Farm A

In alternate plan one for Farm A, the herd size was increased from 24 to 48 cows with an assumed production of 10,500 pounds of milk per cow. A pole barn and concrete lot were constructed to handle the added cows. A new silo and silo unloading and feeding equipment

Table 6. Crop Acres and Yields Per Acre Under Alternate Plans, Farm A.

Crop	Unit	Yield	Benchmark	Plan 1	Plan 2	Plan 3
		----------	----------	Acre-	----------	----------
Corn grain	Bu.	67	65	17	17	60
Corn silage	Ton	12	10	35	35	11
Oats[1]	Bu.	60	25	35	35	23
Wheat	Bu.	40	25	-	-	23
Alfalfa hay	Ton	3.2	45	53	53	45
Grass silage	Ton	7	10	15	15	10
Pasture	-	-	30	60	60	38

[1] Straw yield figured at one ton per acre.

Table 7. Total Crop Production Under Alternate Plans, Farm A.

		Benchmark		Plan 1	Plan 2	Plan 3	
Crop	Unit	Total production	Sold	Total production	Total production	Total production	Sold
Corn grain	Bu.	4,355	3,939	1,339	1,339	4,020	3,213
Corn silage	Ton	120	-	420	420	132	-
Oats	Bu.	1,500	-	2,100	2,100	1,380	-
Wheat	Bu.	1,000	1,000	-	-	920	920
Hay	Ton	144	-	191*	191*	162*	-
Grass silage	Ton	70	-	105	105	70	-

*3.6 tons of hay per acre when using hay conditioner.

Table 8. Estimates of Receipts, Expenses, Net Income and Changes in Investments for Benchmark and Alternative Plans, Farm A.

Item	Benchmark	Plan 1	Plan 2	Plan 3
Type of barn	Stanchion	Combination	Stanchion	Stanchion
Number of cows	24	48	48	30
	Dollars	Dollars	Dollars	Dollars
Investments in:				
Buildings	-	5,020	13,840	2,420
Machinery and equipment	-	9,385	8,285	1,050
Additional cows	-	7,200	7,200	1,800
Total additional investment	-	21,605	29,325	5,270
Receipts:				
Milk	10,032	19,152	19,152	12,312
Livestock	960	1,920	1,920	1,200
Wheat	1,600	-	-	1,472
Corn	3,939	-	-	3,213
Total Receipts	16,531	21,072	21,072	18,197
Expenses:				
Buildings (Depreciation, insurance, & repairs)	754	1,061	1,469	906
Machinery (Depreciation, insurance, & repairs)	3,328	4,785	4,700	3,491
Hired labor	1,200	3,450	3,450	1,500
Lime, seed, fertilizer	3,122	3,047	3,047	2,939
Feed purchased	300	879	879	375
Bedding	-	350	308	-
Miscellaneous dairy	600	1,200	1,200	750
Fuel, oil, and grease	692	656	656	648
Custom hire	300	-	-	320
Real estate taxes	504	629	629	509
Electricity and telephone	240	480	480	300
Cash rent	-	-	-	-
Interest on additional investment	-	834	1,096	212
Total Expenses	11,040	17,371	17,914	11,950
Net Income	5,491	3,701	3,158	6,247
Change in net income from benchmark		-1,790	-2,333	+756

were installed. A full time hired man was added to the labor force. Milking was done in the stanchion barn by switching the herd.

The cropping program consisted of 17 acres of corn for grain, 35 acres of corn silage, 35 acres of oats, 53 acres of alfalfa-brome hay and 60 acres of pasture. Fifteen acres of grass silage was made from early surplus pasture to provide supplementary feed during the summer. A 50 percent hay and 50 percent silage forage roughage feeding program was followed.

The changes in investment in buildings consisted of $1,980 for a pole shed, $720 for concrete for the feeding area, and $2,320 for a new 20 x 40 silo.

The change in machinery and equipment included $800 for a hay conditioner, $1,800 for a forage chopper, $400 for a corn attachment for the chopper, $560 for a blower, $800 for self-unloading wagons, $250 for a weed sprayer, $1,300 for a silo unloader, $1,400 for an auger feed bunk system, $250 for additional milking equipment, and $1,825 to trade the 300 gallon bulk tank for a 500 gallon tank. This is a total of $9,385 additional investment in machinery and equipment. Twenty-four cows were purchased at $300 each or $7,200 which together with other new investments totaled $21,600.

Table 8 shows the receipt and expenses for Plan 1. Total receipts amount to $21,072, total expenses amount to $17,371 which resulted in a net income of $3,701. This is a decrease of $1,790 from the benchmark budget. (See Table L in Appendix for more details on additional investments. The increase in receipts is not enough to compensate for the additional capital investment. An increase in the number of cows does not necessarily increase net income.

In analyzing this plan, we find an investment of $2,700 in a silo unloader and auger feeder plus $3,450 for hired labor. The increase in herd size was not large enough to utilize an extra man year around. If a boy was hired part time to help with the milking to replace the hired man, this budget would appear more profitable.

Alternate Plan 2 for Farm A

Alternate plan two for Farm A consisted of expanding the dairy herd to 48 cows and building an addition to the stanchion barn to house the extra 24 cows. The cost of the addition to the barn was $480 per cow or a total of $11,520. The crop acreage and feeding program was identical to Plan 1. The additional machinery investment was the same except there was no silage unloader and auger feeder used in this plan because the cows were fed indoors. Sixteen hundred dollars were spent for an addition to the gutter cleaner. Table 8 shows the additional investment, receipts, expenses and net income. The net farm income on this plan was $3,158, which is $2,333 less than the benchmark budget and about $550 less than for Plan 1. The new investment consisted of $8,285 for machinery and equipment, $11,520 for the addition to the barn, $2,310 for a new 20 x 40 silo and $7,200 for 24 cows. This is similar to Plan 1 in that the additional investments and costs are not offset by the increase in receipts.

Plans 1 and 2 for case Farm A proves the hypothesis that the expansion of herd size does not always result in an increase in net income. In this case there was a loss.

Alternate Plan 3 for Farm A

In alternate Plan 3, two box stalls were removed from the barn and replaced with six cow stalls at a cost of $600. This provided room for 30 milk cows in two rows of stalls. With these facilities the farmer and his wife should be able to handle six extra cows. A pole shed was built at a cost of $1,320 to house the young stock and $500 was spent to enlarge the silo to hold a total of 132 tons of silage. Six cows were purchased at a cost of $1,800. A hay conditioner and weed sprayer were purchased at a cost of $1,050. The cows were fed a 75 percent hay and 25 percent silage roughage ration.

The cropping program consisted of 60 acres of corn for grain, 11 acres of corn silage, 23 acres of oats, 23 acres of wheat, 45 acres of alfalfa-brome grass hay and 38 acres of pasture. Ten acres of early surplus pasture were harvested as silage to be used as supplementary summer feed. Nine hundred and twenty bushels of wheat and 3,213 bushels of corn were sold as cash crops. Milk production was figured at 10,800 pounds per cow. Table 8 shows the additional investments, receipts and expenses. This plan provided a net income of $6,247 which is $756 more than the benchmark budget. This plan showed a positive increase in income because the additional investment required to expand the herd was small. The inputs in this budget were in proper proportion to produce efficiently and the operators labor was utilized more fully during the winter.

Table O in the Appendix shows that this new investment in buildings and equipment can be amortized in about three and one-fourth years. This is the only one of the three plans budgeted for this farm which shows a gain in net income over the benchmark plan. It would take 41 and 53 years respectively to recover the additional investments under Plans 1 and 2.

Case Farm B

Farm B had similar soil type, fertility and drainage as Farm A. The farm is assumed to contain 200 tillable acres. The barn was a two story structure with 40 cow stalls and a new 18 x 20 concrete block milk house. The other buildings consisted of a 34 x 50 foot machinery shed, corn cribs, two silos, 14 x 35 foot, feed room and a heifer shed attached to the main barn. The labor force consisted of the operator and a full time hired man. Although he used some of his father's machinery, it was assumed that he had a full line of equipment to make the budget comparable to the other farm situations. The manure was removed by driving through the barn and hand loading directly into a manure spreader. The milk production on the farm was 10,500 pounds of milk per cow. There were two houses located on the farm. Five plans were budgeted for this farm.

Benchmark Plan for Farm B

The cropping program for the benchmark plan of Farm B consisted of 200 acres containing 26 acres of corn for grain, 20 acres of corn for silage, 24 acres of oats, 13 acres of wheat, 62 acres of hay and 55 acres of pasture, Table 9. Fifteen acres of surplus early pasture were harvested as grass silage to provide supplementary summer feed. Two hundred and eighty-three bushels of corn and 520 bushels of wheat were sold as cash crops, Table 10.

The labor force consisted of the operator, a full time hired man and one and one-half months of seasonal labor.

Except for a combine, the farmer had a full line of farm machinery including forage harvesting equipment. The total farm machinery and equipment investment was $20,860 including dairy equipment valued at $3,760. The grain was custom harvested at the rate of $5.50 per acre.

The livestock enterprise included 44 milk cows with a production of 10,500 pounds of milk per cow per year. Replacement heifers were grown on the farm. A 75 percent hay and 25 percent silage forage program was followed.

The farm buildings were valued at $18,650. Table 11 shows the estimated receipts, expenses, and net farm income for the benchmark and four alternative plans for Farm B. This plan resulted in receipts of $20,441, expenses of $14,693 and a net farm income of $5,748.

Table 9. Crop Acres and Yields Per Acre Under Alternate Plans, Farm B.

Crop	Unit	Yield	Benchmark	Plan 1	Plan 2	Plan 3	Plan 4
		- - - - - - - - - -	- - - - -	-Acre-	- - - - -	- - - - -	- - - - -
Corn grain	Bu.	67	26	20	37	29	51
Corn silage	Ton	12	20	23	34	52	115
Oats	Bu.	60	24	37	42	35	47
Wheat	Bu.	40	13	-	-	-	-
Alfalfa hay	Ton	3.6	62	71	106	58	64
Grass silage[1]	Ton	7	15	20	25	30	30
Pasture	-		55	63	94	75	125

[1]Grass silage was made from surplus early pasture.

Table 10. Total Crop Production Under Alternate Plans, Farm B.

		Benchmark		Plan 1	Plan 2	Plan 3	Plan 4
Crop	Unit	Total production	Sold	Total pro-duction	Total pro-duction	Total pro-duction	Total pro-duction
Corn grain	Bu.	1,742	283	1,340	2,479	1,943	3,417
Corn silage	Ton	240	-	276	408	621	1,380
Oats	Bu.	1,440	-	2,220	2,520	2,100	2,820
Wheat	Bu.	520	520	-	-	-	-
Alfalfa hay	Ton	238	-	255	382	207	230
Grass silage	Ton	109	-	140	175	210	210

Table 11. Estimates of Receipts, Expenses, Net Income and Changes in Investments for Benchmark and Alternative Plans, Farm B.

Item	Benchmark	Plan 1	Plan 2	Plan 3	Plan 4
Type of barn	Stanchion	Stanchion	Stanchion	Loose housing	Loose housing
Number of cows	44	50	75	60	100
	Dollars	Dollars	Dollars	Dollars	Dollars
Investments in:					
Buildings	-	5,500	18,910	14,130	20,650
Machinery and equipment	-	-	2,200	10,200	15,300
Additional cows	-	1,800	9,300	4,800	16,800
Total additional investment	-	7,300	30,410	29,130	52,750
Receipts:					
Milk	17,566	19,950	29,070	23,940	38,000
Livestock	1,760	2,000	3,000	2,400	4,000
Wheat	832	-	-	-	-
Corn	283	-	-	-	-
Total Receipts	20,441	21,950	32,070	26,340	42,000
Expenses:					
Buildings (Depreciation insurance, & repairs)	1,121	1,401	2,088	1,806	2,236
Machinery (Depreciation insurance, & repairs)	3,509	3,509	3,839	4,631	5,618
Hired labor	3,450	3,750	6,900	3,750	6,900
Lime, seed, fertilizer	2,872	3,190	4,443	3,689	5,925
Feed purchased	653	742	1,114	891	1,856
Bedding	224	322	672	795	1,442
Miscellaneous dairy	1,100	1,250	1,875	1,500	2,500
Fuel, oil, and grease	636	681	989	839	1,362
Custom hire	204	204	231	193	259
Real estate taxes	484	522	610	653	750
Electricity and telephone	440	500	690	600	840
Cash rent	-	168	1,356	588	2,424
Interest on additional investment	-	273	1,191	1,018	2,087
Total Expenses	14,693	16,512	25,998	20,953	34,199
Net Income	5,748	5,438	6,072	5,387	7,801
Change in net income from benchmark		- 310	+ 324	- 361	+2,053

Alternate Plan 1 for Farm B

In this plan the dairy herd was expanded from 44 to 50 cows. The cropping program was revised to include 20 acres of corn for grain, 23 acres for corn silage, 37 acres of oats, 71 acres of hay and 63 acres of pasture. Twenty acres of early surplus pasture was harvested as silage for supplementary summer feed. Although 31 additional acres of land were needed to feed this larger herd, the dairymen only needed to rent 14 acres as corn and wheat were no longer grown as cash crops. Another alternative would have been to continue growing wheat as a cash crop, and to rent more land or purchase more feed.

A 75 percent hay and 25 percent silage forage feeding program was followed in this plan.

The machinery investment remained the same as in the bench-mark plan. The 500 gallon bulk tank was large enough to handle the milk from the 50-cow herd providing the production is uniform throughout the year.

The major fixed investment made in this plan was a $5,000 extension to the stanchion barn to house 10 extra cows. Previously, four cows were housed in the calf section of the barn with the cows facing out. By locating the milk house at the side of the barn midway along the two rows of cows, the steps required to carry the milk to the milk house was kept to a minimum. An additional $500 was spent to enlarge the silage holding capacity of the silos and $1,800 was invested in six milk cows. There were increases in the variable cost which can be observed in Table 11.

The labor force consisted of the operator, a full time hired man and two and one-half months of seasonal labor. This expansion required one month more labor than the benchmark plan.

The total new investment in this plan was $7,300. The total receipts were $21,950 with total expenses of $16,512 which resulted in a net income of $5,438. This is $310 less than the benchmark plan. Table 11 shows the change in expenses from the benchmark plan. It would take over 40 years as shown in Table Q in the Appendix to recover the investment.

One factor that must not be over looked in this budget is that a ten-cow stall addition to the barn was built but it only increased the cow numbers by six cows because four cows had been housed with the young stock.

This budget can be used to consider the hypothesis that it is more economical to use conventional stanchion housing when making small increases (5 to 20 cows) in herd size starting with a good stanchion barn, than to make investments needed to convert to a loose housing and milking parlor system. Although this budget does not show an increase in net income, it would be profitable if the income from ten cows was added to the receipts.

If ten cows were added instead of six, the dairyman would gain about $780 more net income. This would produce a net income of $6,218 for this plan or a $470 increase over the benchmark plan. This would give an investment recovery of $915 per year and the added investment would be paid off in about seven and one-half years.

If the fixed expenses necessary to adopt loose housing of $3,750 for building a milking parlor, $3,600 for stalls and milking equipment, $2,900 for silage unloader and bunk feeder, $1,500 for concrete for the feeding area and $3,300 for a pole barn were considered, the net income received under the loose housing system would be less than for the expanded stanchion barn. New investments for equipment and building to expand from 44 to 50 cows with stanchion housing cost $5,500 while under a loose housing system it cost $15,050.

Alternate Plan 2 for Farm B

Alternate Plan 2 for this farm consisted of expanding the dairy herd to 75 milk cows. This would be accomplished by building an addition to the stanchion barn to house 35 more cows. The new investments would total $30,410 which included $16,800 for the new barn, $2,110 for an 18 x 40 silo, $2,200 for dairy equipment, and $9,300 for 31 cows. The change in dairy equipment consisted of trading in the 500 gallon bulk tank for an 800 gallon tank and the purchase of additional milking equipment.

The cropping program included 37 acres of corn for grain, 34 acres of corn for silage, 42 acres of oats, 106 acres of alfalfa-brome grass hay, and 94 acres of pasture. One hundred and seventy-five tons of grass silage were harvested for supplementary summer feed from 25 acres of early pasture. It was necessary to rent 113 acres of land at a cost of $1,356 to provide the feed for the expanded dairy herd.

The hired labor force was expanded to two full time hired men and three months seasonal labor. Total receipts were $32,070 and expenses $25,998 resulting in a net farm income of $6,072. This is about $324 more than the benchmark plan. Details of the receipts and expenses can be seen in Table 11. Although this budget does show an increase in net farm income over the benchmark, some dairy farmers may not consider the increase large enough to justify the expansion. It would take 13-1/2 years to amortize this investment in buildings and equipment from the increased net income.

Alternate Plan 3 for Farm B

In this budget the herd was expanded to 60 cows by constructing a loose housing barn and a double-five herringbone milking parlor system. The change resulted in new investments of $14,130 for buildings, $10,200 for equipment, and $4,800 for 16 cows. The new building investment included $3,960 for a pole barn, $500 to remodel the stanchion barn for use as a calf barn, $1,800 for concrete in the exercise yards, $2,620 for a new 20 x 45 silo, $1,500 to rebuild the two silos into a 20 x 45, and $3,750 for the milking parlor. The change in equipment included $1,100 for stalls and feeding equipment in the milking parlor, $1,400 for a silo unloader, $1,500 for mechanical bunk silage feeder, $2,500 for milking equipment and $3,700 for a 600 gallon bulk tank.

Forty additional acres of land were rented to provide the feed needed for a herd of 60 cows. The cropping program consisted of 29 acres of corn for grain, 52 acres for corn silage, 35 acres of oats, 58 acres of hay and 75 acres of pasture. Two hundred and ten tons of grass silage were harvested from surplus pasture to provide supplementary summer feed. Details of the feed produced can be observed in Table 10.

The labor force was composed of the operator, a full time hired man and two and one-half months of seasonable labor. This was the same quantity of labor needed in Plan 1 when 50 cows were housed in a stanchion barn.

The total receipts amounted to $26,340, total expenses were $20,953, and net farm income was $5,387. This is $361 less than the benchmark plan. This demonstrates a situation where the additional costs are too large for the increase in output. These costs must be spread over a larger output if the plan is to show a profit. Budget four will demonstrate this point.

Table F in the Appendix shows that it would take eleven and one-fourth years to amortize the new investment in buildings and equipment.

Alternate Plan 4 for Farm B

In Plan 4 for Farm B, the dairy herd was expanded to 100 milk cows using a loose housing system. The building expansion included $6,600 for a pole barn, $3,000 for concrete slab, $500 for remodeling the old barn, $4,300 for a 24 x 60 silo, $2,500 to build a 24 x 60 silo from two old silos, and $3,750 for a double five herringbone milking parlor. This totaled $20,650 for new buildings and concrete slab.

Other investments included $16,800 for 56 additional cows and $15,300 for new equipment. These new equipment investments included: $2,800 for a third tractor, $400 for a four-row corn planter, $600 for a four-row cultivator, $5,300 for a 1,000 gallon bulk tank, $1,100 for stalls and feeder in the milking parlor, $2,500 for milking equipment, $1,800 for a silo unloader and $2,000 for an automatic auger silage feeder.

The following cropping program was followed: 51 acres of corn for grain, 115 acres of corn silage, 47 acres of oats, 64 acres of hay and 125 acres of pasture. Two hundred and ten tons of grass silage were harvested from surplus pasture for supplementary summer feed. Total feed was produced on 402 acres of tillable land of which 202 were rented.

The labor used in this budget included the operator, two full time hired men and two months of seasonal help.

Table 11 shows the receipts and expenses involved in this plan. The receipts amounted to $42,000, expenses $34,199, and net farm income $7,801. This is $2,053 more than the benchmark plan. Table P in the Appendix shows that the new investment in buildings and equipment can be amortized in six and one-fourth years.

This plan proves the hypothesis that loose housing is more economical than conventional housing when substantial increases are made in cow numbers.

The Effect of Higher Milk Price on Returns on Investment

The milk price and the rate of production per cow are key factors in determining the profitability of expanding a dairy operation. In central Pennsylvania there is a wide variation in milk price between milk markets. Farmers who ship their milk to the New York market average about $4.00 per hundredweight while a neighboring dairyman sells his milk to a local dairy at about $5.00 per hundredweight.

The four plans for Farm B were recalculated using a milk price of $4.50 per hundredweight instead of $3.80 per hundredweight to show the effect of milk price on net farm income. The benchmark plan, using a milk price of $4.50 per hundredweight, showed a net income of $8,972 which is $3,224 more than the original plan. Plan 1 showed a net income of $9,113 with a gain of $141 over the benchmark plan. Plan 2 had a net income of $11,427 with $2,455 increase over then bachmark. Plan 3 had a net income of $9,797 with an income of $825 over the benchmark. Plan 4 had a net income of $14,801 or $5,829 more than the benchmark plan. Table Q in the Appendix shows the gain in net income over the benchmark plan and the number of years to amortize the added investment in each plan. Plan 1 would require fourteen and one-half years; Plan 2, six years; Plan 3, seven years; and Plan 4 would require three and one-half years to amortize the investment. These figures show that milk price is a very important factor to consider when planning to expand the size of a dairy herd.

Case Farm C

The land on Farm C was more rolling than on the other two case farms. This farmer was operating 230 tillable acres of which 44 were rented. The buildings on this farm included a 36-stall stanchion barn, a 40 x 36 barn used for housing replacement heifers, a 30 x 26 double corn crib and feed room, a 30 x 60 pole barn, a new 20 x 55 silo and a worn out machinery shed. The main barn was poorly lighted, had cow stalls too small for Holstein cows, and showed signs of physical deterioration. This farm was budgeted only for loose housing because the physical condition and location of the barn was not suitable for expanding stanchion housing.

This farmer was milking 47 cows using a pipe line milker in the stanchion barn. Thirty-six of the cows were housed in the stanchion barn and 11 in the pole barn. The 20 x 55 cement stave silo was equipped with a silage unloader and a rotary feeder. This dairyman was planning to expand his herd to 100 cows using a loose housing milking parlor system.

This farmer had a full line of farm and forage equipment including three tractors, silo unloader and feeder, and gutter cleaner. This farm was assumed to have 240 acres of tillable land. Four budgets were prepared, the benchmark budget with 47 cows; a loose housing and milking parlor system with 100 cows; one plan providing for producing all feed needed and the other one with no rented land but purchase of extra feed; and a loose housing milking parlor system with 120 cows and the growing of all feed needed (Table 12).

Benchmark Plan for Farm C

The benchmark plan was assumed to have 240 acres of cropland and 47 milk cows producing 10,500 pounds of milk per cow. A 50 percent hay and 50 percent silage forage feeding program was used.

The cropping program included 26 acres of corn for grain, 34 acres of corn for silage, 20 acres of wheat, 40 acres of oats, 60 acres of hay and 60 acres of pasture. Grass silage was harvested from 15 acres of early surplus pasture for supplementary summer feed.

The machinery investments were the purchase prices given by the farmer. A full line of farm equipment including forage machinery, silo unloader and feeder, gutter cleaner, bulk tank, and pipe line milker cost $29,630.

The receipts totaled $22,589, expenses were $17,218, and net income was $5,371. Details of receipts and expenses can be seen in Table 12.

The labor force was composed of the operator, a full time hired man and two and one-half months of seasonal labor. This farm had a large machinery and equipment investment for the size of business as compared with other farms of similar size in Michigan.

Alternate Plan 1 for Farm C

Using a loose housing milking parlor system, the herd in Plan 1 was expanded to 100 milk cows. A storage feeding system was used to replace pasture.

Table 12. Estimates of Receipts, Expenses, Net Income and Changes in Investments for Benchmark and Alternative Plans, Farm C.

Item	Benchmark	Plan 1	Plan 2	Plan 3
Type of barn	Stanchion	Loose housing	Loose housing	Loose housing
Number of cows	47	100	100	120
	Dollars	Dollars	Dollars	Dollars
Investments in:				
Buildings	-	16,705	16,705	18,825
Machinery and equipment	-	9,875	1,075	12,000
Additional cows	-	15,900	15,900	21,900
Total additional investments	-	42,480	33,680	52,725
Receipts:				
Milk	18,753	38,000	38,000	45,600
Livestock	1,880	4,000	4,000	4,800
Wheat	1,280	-	-	-
Corn	676	-	-	-
Total Receipts	22,589	42,000	42,000	50,400
Expenses:				
Buildings (Depreciation insurance, & repairs)	1,168	2,166	2,166	2,367
Machinery (Depreciation insurance, & repairs)	4,926	5,698	5,104	5,833
Hired labor	3,800	7,350	6,300	10,050
Lime, seed, fertilizer	3,742	5,955	3,621	7,054
Feed purchased	698	1,856	12,394	2,228
Bedding	-	1,260	1,610	1,568
Miscellaneous dairy	1,175	2,500	2,500	3,000
Fuel, oil, and grease	773	1,719	1,176	2,052
Custom hire	-	-	193	-
Real estate taxes	466	784	784	866
Electricity and telephone	470	840	840	960
Cash rent	-	1,860	-	2,736
Interest on additional investment	-	1,739	1,475	2,239
Total Expenses	17,218	33,727	38,163	40,953
Net Income	5,371	8,273	3,837	9,447
Change in net income from benchmark		+2,902	-1,534	+4,076

Table 13. Crop Acres, Yields per Acre and Feed Bought Under Alternate Plans, Farm C.

Crop	Unit	Yield	Benchmark	Plan 1	Plan 2	Feed bought	Plan 3
		- - - - - -	-Acre-	- - - - -			Acre
Corn grain	Bu.	67	26	44	-	3,809	55
Corn silage	Ton	12	34	86	86	-	112
Oats	Bu.	60	40	60	35	-	68
Wheat	Bu.	40	20	-	-	-	-
Alfalfa hay	Ton	3.2	60	118	32	276	140
Grass silage[1]	Ton	7	15	-	-	-	-
Pasture		-	60	-	-	-	-
Storage feeding	Ton	11	-	87	87	-	93

[1]Grass silage is from early surplus pasture.

Table 14. Total Crop Production Under Alternate Plans, Farm C.

Crop	Unit	Benchmark		Plan 1	Plan 2		Plan 3
		Total production	Sold	Total production	Total production	Feed bought	Total production
Corn grain	Bu.	1,066	676	2,955	-	3,809	3,685
Corn silage	Ton	408	-	1,032	1,032	-	1,344
Oats	Bu.	2,400	-	3,600	2,100	-	4,080
Wheat	Bu.	800	800	-	-	-	-
Alfalfa hay	Ton	192	-	378	102	276	448
Grass silage	Ton	105	-	-	-	-	-
Storage feeding	Ton	-	-	957	957	-	1,023

The cropping system included 44 acres of corn for grain, 86 acres of corn silage, 60 acres of oats, 118 acres of hay and 87 acres of alfalfa-brome grass for grass silage to be fed during the summer-feeding period. This added a total of 395 acres of which 155 acres were rented at $12 per acre per year. The quantity of crops produced are shown in Table 14.

New building investments were: $4,290 for an addition to the pole barn, $4,300 for a 24 x 60 silo, $3,000 for concrete slab, $500 to remodel the old barn for young stock and $4,215 for a double six herringbone milking parlor.

The new investments in machinery and equipment were: $1,700 for a silo unloader, $1,400 for a roto-feeder, $400 for a manure loader for the tractor, $2,300 to trade in the present 500 gallon bulk milk tank for a 1,000 gallon tank, $2,600 for milking equipment, $1,400 for stalls and $75 for a larger hot water heater. The total investment in building and equipment is $26,580. The investment in 53 additional cows amounted to $15,900 which made the total new investment for this plan $42,480.

The labor force used for this plan includes the operator, two full time hired men, and four and one-half months of seasonal labor. The labor costs amounted to $7,350.

Estimated total receipts were $42,000, expenses $33,727, and net farm income $8,273. The components of receipts and expenses can be observed in Table 12. This resulted in an increase of about $2,902 over the benchmark plan. It would take about five years to amortize the investment of $26,580 at six percent interest.

Alternate Plan 2 for Farm C

This plan was identical to Plan 1 except no extra land was rented. The cropping program was changed to include 86 acres of corn for silage, 35 acres of oats, 87 acres of alfalfa-brome grass for summer storage feeding and 32 acres of hay. Just enough oats was grown to establish new stands of alfalfa to keep the stands productive.

The machinery and equipment investment was the same as that shown for Plan 1 less a tractor, a corn picker, and combine. The labor force is composed of the operator, two full time hired men and one month seasonal labor. This is three and one-half months less labor than is used in Plan 1.

Purchased feed of $12,394 was a major item in this budget. This included $4,190 for 3,809 bushels of corn, $6,348 for 276 tons of hay and $1,856 for about 25 tons of protein.

This budget showed total receipts of $42,000 expenses of $38,163 and a net farm income of $3,837. This plan resulted in a decrease of $1,534 in net income from the benchmark plan. This decrease in income was mainly due to buying grain and extra forage to feed the dairy herd.

Alternate Plan 3 for Farm C

In this budget the herd was expanded to 120 cows by using a pole barn milking parlor system. It was assumed that all feed is grown on the farm. This required 468 acres of tillable land of which 228 acres were rented at $12 per acre.

The new investment over the benchmark plan included $5,610 for an addition to the pole barn, $5,400 for a 30 x 60 cement stave silo, $3,600 for concrete slab, $4,215 for a milking parlor, $2,200 for a silo unloader, $1,800 for a mechanical silage feeder, $4,000 to add a 700 gallon bulk tank, $2,600 for milk equipment, $1,400 for milking parlor equipment, and $21,900 for 73 cows. This adds up to $52,725 additional investment.

The cropping program included 55 acres of corn for grain, 112 acres of corn for silage, 68 acres of oats, 140 acres of hay and 93 acres of alfalfa-brome grass for storage feeding during the summer.

Fifty-one and one-half months of labor per year were supplied by the operator, three full time hired men and three and one-half months of seasonal help.

Milk and livestock sales provided total receipts of $50,400, expenses are $40,953 and net income was $9,447. This was $4,076 higher net income than the benchmark plan and about $1,300 above that for Plan 1. Amortizing this investment at six percent interest, it will take four years to pay back the additional investment in buildings and equipment. This budget utilizes the fixed investment in the milking parlor over a greater output, thus reducing the fixed cost per unit of output.

In Table R in the Appendix is shown the rate of recovery of the additional investment for the alternate budgets for Farm C. If Plan 1 were followed it would be possible to recover the additional investment for dairy structures and equipment in about five years. New investments as outlined for Plan 3 would be amortized in periods of four years. If Plan 2 is followed and large quantities of feed purchased, there is a decrease in net farm income compared to the benchmark plan, thus making it impossible to recover new investments in buildings and equipment in less than 19 years.

Before a farmer makes any major change in herd size he should budget his plan to see if the expected increase in income will pay for added investment in a reasonable period of time.

CHAPTER VII

SUMMARY AND CONCLUSIONS

Summary and Conclusions for Livingston County Dairy Farms

In 1960, a survey of 37 dairy farms in Livingston County was conducted to find out the present farm organization, the size and kind of buildings and equipment in use, and the future plans of the farmers interviewed. The farmers were selected to represent successful dairymen who had from 20 to 50 dairy cows, were using stanchion housing and were expected to farm for at least 10 more years. Most of these farmers were selected from the Livingston County D.H.I.A. list with the aid of the Livingston County Agricultural Agent.

These 37 dairymen were divided into three groups according to herd size. Group I contained 14 dairymen who had 30 or less cows, Group II included 12 farmers with 31 to 40 cows and Group III represented 11 dairymen with 41 or more dairy cows.

These dairymen for the most part were young and planned to remain in the farming profession for a number of years. The average age in Group I was 37; Group II, 38; and Group III, 40. Group I averaged 17 months of labor, Group II averaged 25 months and Group III averaged 27 months of labor per farm per year.

The dairymen in Group I averaged 25 cows per farm and they planned to have 35 by 1965. Those in Group II averaged 35 cows per farm and they planned to have 42 by 1965. The average number of cows in the herds of the dairymen in Group III was 46 and they planned to have 56 by 1965. Only three of the 37 farmers in the study planned to have less than 30 cows by 1965.

Farmers in Group I averaged 150 tillable acres, Group II averaged 241 tillable acres and Group III averaged 234 tillable acres per farm. Only 11 of these farmers said they had to buy more land before their herd could be expanded. Sixty-two percent of these farmers stated they would not expand their herds unless they had the extra land to produce the necessary feed.

Sixty percent of these dairymen were using hay conditioners, 46 percent were using gutter cleaners, 65 percent baled their hay and 35 percent chopped their hay. Only six farms had hay drying systems, two had pipe line milkers and one had a milk transfer system.

When these farmers were asked what systems of dairy housing they planned to use in the future, 54 percent stated they would use stanchion housing, 35 percent planned to use a switch barn system, and 11 percent planned to convert their dairy buildings to a loose housing-milking parlor system.

Of the 14 dairymen in Group I, 53 percent planned to use stanchion housing, 13 percent were considering loose housing with a milking parlor and 33 percent planned to use a switch barn system. In Group II, 42 percent planned to use stanchion housing, 16 percent planned to use loose housing with a milking parlor, and 42 per cent planned to use a switch barn system of housing. In Group III 54 percent planned to use stanchion housing, 9 percent planned to use loose housing and 36 percent planned to use a switch barn system of housing.

The Case Farm Studies

Three farms from the group of 37 surveyed were selected for a budgetary analysis of alternative systems of housing and herd sizes.

Four budgets were figured for Farm A. A benchmark plan with 24 milk cows, a switch herd plan with 48 cows, a stanchion barn housing plan with 48 cows and a 30 cow plan using the present barn with a pole shed for young stock.

Net farm income for the benchmark plan and 24 cows was $5,491. If this farmer doubled the number of cows, added a full-time hired man, milked the cows in two shifts, and made the investments needed for the larger herd size as outlined in Plan 1, net farm income would be reduced by $1,790. Expansion of the present barn to house 48 cows (Plan 2) was even less profitable than Plan 1. Increasing the number of cows from 24 to 30 by converting box stalls to stanchions and building a pole barn to house replacement heifers resulted in a $756 increase in net income. Some dairy farmers can make substantial increases in net income by making small investments in barn interiors and feed storage, and modest changes in the number of cows milked.

Five budgets were prepared for case Farm B. The benchmark plan included 44 cows in a stanchion barn, Plan 1 50 cows in a stanchion barn, Plan 2 75 cows in a stanchion barn, Plan 3 60 cows under a loose housing-milking parlor system and Plan 4 100 cows under a loose housing and milking parlor system of dairying.

Net income for the benchmark plan with 200 acres and 44 cows was $5,748. If the barn was expanded to hold 50 milk cows (Plan 1), the net income would be decreased by $310. However, in this plan, the barn was expanded from 40 to 50 stalls but the number of cows was only increased from 44 to 50 because four cows had been housed in the heifer shed. Expansion of the present barn to hold 75 cows (Plan 2), adding an extra hired man, and adding a new silo resulted in a $324 increase in net farm income. Increasing the herd to 60 cows, building a milking parlor, loafing barn, adding a new silo, silo unloader and feeder (Plan 3) and concreting the feeding area resulted in the loss of $361 in net farm income. If the farm enterprise was expanded to 100 cows by building a milking parlor, adding silos and automatic silage feeding equipment, loafing shed, a concrete feeding area, extra tractor, four-row corn equipment, and an extra hired man the result would be an increase of $2,053 in net farm income. A dairy farmer must make a large increase in herd size to justify the cost of change over from a stanchion to a loose housing-milking parlor system of housing.

Farm 6 was budgeted for four farm plans. The benchmark plan with 47 cows using a switch barn system of housing; Plan 1 with 100 cows using additional rented land, a pole barn and a double six herringbone milking parlor; Plan 2 the same as Plan 1 except extra hay and grain were purchased to supply the feed for the herd in Plan 2; and Plan 3 had 120 cows using a loose housing milking parlor system and renting additional land.

The benchmark plan for Farm C with 240 acres and 47 cows resulted in a net income of $5,371. If this dairyman increased his herd to 100 cows (Plan 1), built a loafing shed, new silo, silo unloader and feeder, concrete feeding area, and a double six herringbone milking parlor, and hired an extra man, the net income would be increased by $2,902. If he followed Plan 1 but bought hay and grain instead of renting extra land to produce all the feed for the herd (Plan 2), net income would be reduced by $1,534. By making the changes necessary to handle 120 cows as shown in Plan 3, the net income would be increased by $4,076.

Implications for Michigan and Pennsylvania Dairymen

The outcome of a budget is dependent on the assumptions. If other assumptions were used the results of these various farm plans would be different. Each farm is different and each dairyman differs as to his management ability. As a result of this each farm must be considered as an individual case when planning for future expansion.

Some farms have extra land to provide feed for the larger herd while others are using all their land under the present plan. In many cases, yields can be increased by using more fertilizer, improved crop management practice and more intensive pasture systems.

Some farms have sound buildings with efficient barn arrangement while others are obsolete and in need of repair or replacement. If a stanchion barn is in poor physical condition and needs to be replaced it is cheaper to build a loose housing milking parlor set up than to build a new stanchion barn. A New York study on dairy housing costs reported $404 per head for a stanchion barn of 35 cows and $312 per head for a loose housing milking parlor installation.

Available labor varies between farm families. Some dairymen may have several teen-age boys who can help to care for a larger dairy herd, while other families must depend on hired labor. Some farms are located close to large industrial centers and must compete with them for labor. These farmers must operate their farm with family labor, pay high cost for hired labor, or add new labor saving equipment to reduce the need for regular hired labor. The age of the operator and the prospects for sones to take over the operation of the farm also help determine the type of investment and prospects for repayment.

The financial condition of the dairymen is an important factor to consider when planning for future expansion. In some cases the farmers' credit may limit his ability to enlarge the farm business.

The important point brought out in this study is that increasing the herd size does not necessarily mean that net income will increase. The inputs must be used in proper proportions if profit is to be maximized. Dairymen often make large investments in new buildings and equipment without increasing the volume of output enough to pay for the added expense.

Dairymen with good stanchion barns may reduce net income by shifting to a loose housing system unless they make rather large increases in herd size. Cow numbers must be increased in units that fit into increases which each additional man can handle.

Appendix Table A. Number of Cows and Number of Dairy Farms in Michigan.[1]

Year	Number of farms with dairy cows	Number of cows
1944	132,627	951,276
1954	83,212	796,635

[1]U. S. Department of Commerce, 1954 Census of Agriculture, Michigan, Vol. 1, Pt. 6.

Appendix Table B. Changes in Investments, Size of Business and Labor Force, Average Per Farm, Michigan Area 5, 1947-1959.[1]

Item	1947	1959	Percentage Change
Total investment	23,854	79,561	233
Machinery investment	3,456	10,091	189
Animal units	46.0	55.2	20
Total acres	215	290	32
Tillable acres	162	228	41
Number of men	1.7	1.8	6

[1]Lauren H. Brown and Everett M. Elwood, Farming Today, Area 5, Michigan State University, Cooperative Extension Service, Ag. Econ. 781, 1960. p. 2.

Appendix Table C. Farm Real Estate: Index Numbers of Average Value[1] per Acre in United States.

Year and month	Index 1912-14 = 100	Index 1947-49 = 100
July 1942	89	53.2
July 1956	235	140.0

[1]F. F. Elliot, Chairman and others, Major Statistical Series of the U. S. Department of Agriculture, Vol. 6; Land Values and Farm Finance, Agriculture Handbook No. 118, pg. 21.

Appendix Table D. Summary of Loose and Conventional Stanchion Housing Chore Time.[1]

Chore job	Comparisons[a]	Average loose housing time relative to conventional barn time	Range High	Range Low
	Number	Percent		
Milking	10	84	97	62
Feeding	9	80	97	41
Bedding	11	86	175	25
Cleaning	10	80	144	45
All dairy chores[b]	14	79	96	61

[1]R. C. Angus and W. L. Barr, "An Appraisal of Research Literature Dealing with Loose and Conventional Dairy Cattle Housing," Journal of Dairy Science, April 1955, Vol. XXXVIII, No. 4, p. 402.

[a]By different investigations of each chore in loose housing and conventional stanchion barns.

[b]Measured from the beginning to the end of dairy chores, including milking, feeding, bedding, and cleaning.

Appendix Table E. Prices Paid for Inputs and Prices Received for Outputs.

Item	Unit	Prices paid	Prices received
Soybean oil meal	Ton	$ 75.00	$ -
Corn	Bushel	1.10	1.00
Alfalfa hay	Ton	23.00	20.00
Straw	Ton	14.00	-
Wheat	Bushel	-	1.60
Calves and cull cows	Per cow	-	40.00
Milk, at net farm 3.5 test	Cwt.	-	3.80
Lime	Ton	5.50	-
Fertilizer (0-20-20)	Ton	68.00	-
(5-20-20)	Ton	75.00	-
(33-0-0)	Ton	90.00	-
Corn seed	Bushel	11.70	-
Oats seed	Bushel	1.50	-
Wheat seed	Bushel	2.75	-
Alfalfa seed	Bushel	31.20	-
Brome grass seed	Bushel	39.00	-
Hired labor, seasonal	Month	300.00	-
Hired labor,[1] regular	Year	3,000.00	-

[1]Includes housing, milk, and a beef.

Appendix Table F. Rates Used in Estimating Miscellaneous Operating Expenses and Construction Costs.

Item	Unit	Cost per unit
Variable expenses		
Fuel, oil, and grease		
Corn for grain	Acre	$ 3.60
Corn for silage	"	4.50
Small grain	"	3.15
Hay, two cuttings	"	3.15
Grass silage, one cutting	"	1.80
Pasture	"	.45
Hauling manure (grazing system)	Cow	2.00
Hauling manure (storage feeding system)	"	3.00
Custom hire		
Combining grain	Acre	5.50
Silage chopper and blower	Hour	10.00
Miscellaneous dairy	Cow	25.00
Electricity and telephone (up to 60 cows)	"	10.00
" " " (61 to 120 cows)	"	6.60
Fixed charges		
Depreciation, repairs and insurance on buildings	Percent	5 to 10
Depreciation, reapirs and insurance on machinery	"	11 to 19
Interest on one-half new investment in buildings and machinery and full investment on cows	"	6
Real estate tax based on value real estate	"	1.25
New construction costs		
Pole barns	Square feet	1.10
Stanchion barns, 20 cows or fewer	Cow	500.00
Stanchion barns, 21 cows or more	"	480.00
Concrete for barnyards	Square feet	.30

Appendix Table G. Estimated Milk Production Per Cow by Size of Herd.

Number of cows	Pounds of milk per cow per year
Less than 25	11,000
26 - 30	10,800
31 - 60	10,500
61 - 75	10,200
76 -120	10,000

Appendix Table H. Inputs of Seed, Fertilizer, and Lime Per Acre Used in Budgets.

Crop	Seeding rate	Lime lbs.	Fertilizer, pounds		
			5-20-20	0-20-20[2]	30-0-0
Corn	10 lbs.	-	200	-	125[1]
Wheat	2 bu.	-	200	-	90
Oats	2 bu.	-	200	-	-
Alfalfa brome mixture[2]	12 lbs.	4,000	-	300	-
Alfalfa hay		-	-	300	-
Grass silage		-	-	300	-
Pasture		-	-	300	-

[1]Used for corn following corn.

[2]Seven pounds of alfalfa and five pounds of brome seed.

Appendix Table I. Estimated Annual Quantities of Forage, Grain and Protein Needed Per Cow Including Replacement Heifers[1] for Period of Barn Feeding.

Feeds	Unit	75% hay 25% silage	50% hay 50% silage	25% hay 75% silage	365 day storage feeding
Alfalfa hay	Tons	5.4	4.0	2.5	4.22
Silage	Tons	4.5	8.6	12.9	18.25
Hay equivalent[1]	Tons	6.9	6.9	6.9	11.0
Grain[2]	Lbs.	3,300	3,300	3,300	3,300
Soybean oil meal	Lbs.	330	396	495	495

[1]Replacement heifers received 50 percent of the forage requirement of the cows. They received 25 percent as silage and 75 percent as hay.

[2]Includes 300 pounds of grain per cow for young stock.

Appendix Table J. Monthly Distribution of Labor in Crop and Livestock Enterprises.[1]

Enterprise	Hours of Labor Per Acre or Per Head Per Month											
	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
Crops												
Corn				2.0	3.0	2.0	0.5			1.5	1.0	
Wheat				0.5			2.0		4.5			
Oats				5.0			2.0					
Corn silage				2.0	3.0	2.0			4.0			
Grass silage (1st cut)				0.3	2.0	4.7						
(2nd cut)				0.2			1.0	1.8				
Alfalfa hay (2 cuttings)				0.5		4.0	2.0	0.5				
Dairy												
Cow, 16-25 cow herd	10	10	10	10	9	6	7	7	8	9	10	11
Cow, over 25 cow herd	10	9	9	9	8	5	6	6	7	8	9	10
Cow, in loose housing	7	6.3	6.3	6.3	5.6	3.5	4.2	4.2	4.9	5.6	6.3	7
Young stock	2.1	1.9	1.9	1.0	0.8	0.6	0.6	0.6	0.6	1.3	1.8	2.5

[1] Adapted from Farm Management Handy-Book compiled by Warren H. Vincent, Agricultural Economics Department, Michigan State University, East Lansing, Michigan, 1954, p. 316.

Appendix Table X. Equipment Investment, Insurance, Depreciation and Repairs Alternative Plans, Farms A, B, and C.

Plans	Power machinery	Forage machinery	Other machinery	Dairy equipment	Total investment	Annual cost
Farm A						
Benchmark	5,300	2,910	7,188	4,375	19,773	3,328
Plan 1	5,300	7,270	10,138	5,925	28,633	4,785
Plan 2	5,300	7,270	7,438	7,525	27,533	4,700
Plan 3	5,300	2,910	7,223	4,375	20,808	3,491
Farm B						
Benchmark	4,800	8,195	4,105	3,760	20,860	3,509
Plan 1	4,800	8,195	4,105	3,760	20,860	3,509
Plan 2	4,800	8,195	4,105	5,960	23,060	3,839
Plan 3	4,800	8,195	4,105	10,200	27,300	4,631
Plan 4	7,600	8,195	4,405	12,700	32,900	5,618
Farm C						
Benchmark	6,400	6,825	9,630	6,775	29,630	4,926
Plan 1	6,400	6,825	12,330	9,450	35,005	5,698
Plan 2	5,200	6,825	9,230	9,450	30,705	5,104
Plan 3	6,400	6,825	13,230	11,150	37,605	5,833

Appendix Table L. Building Investments, Depreciation, Insurance and Repairs Under Alternative Plans, Farm A.

Item	Benchmark			Plan 1		Plan 2		Plan 3	
	Value	Rate	Annual charge	Value	Annual charge	Value	Annual charge	Value	Annual charge
	Dollars	Percent	Dollars	Dollars	Dollars	Dollars	Dollars	Dollars	Dollars
Existing Buildings									
Barn	8,000	5	400	8,000	400	8,000	400	8,000	400
Milk house	300	8	24	300	24	300	24	300	24
Machine shed	1,000	9	90	1,000	90	1,000	90	1,000	90
Other buildings	2,000	9	180	2,000	180	2,000	180	2,000	180
Silo, 14 x 40	1,000	6	60	1,000	60	1,000	60	1,000	60
New Building Investment									
Addition to silo	-	-	-	-	-	-	-	500	30
Pole barn	-	7	-	1,980	132	-	-	1,320	92
Concrete barnyard	-	5	-	720	36	-	-	-	-
Silo, 20 x 40	-	6	-	2,320	139	2,320	139	-	-
Addition to barn	-	5	-	-	-	11,520	576	-	-
Cow stalls	-	5	-	-	-	-	-	600	30
Total	12,300		754	17,320	1,061	26,140	1,469	14,720	906

Appendix Table M. Building Investments, Depreciation, Insurance and Repairs Under Alternative Plans, Farm B.

Item	Benchmark			Plan 1		Plan 2		Plan 3		Plan 4	
	Value	Rate	Annual charge	Value	Annual charge	Value	Annual charge	Value	Annual charge	Value	Annual charge
	Dollars	Percent	- - - - - -	- - - -	- - - -	- - - -	Dollars	- - - -	- - - -	- - - -	- - - -
Existing Buildings											
Barn	12,000	5	600	12,000	600	12,000	600	12,000	600	12,000	600
Milk house	1,000	8	80	1,000	80	1,000	80	-	-	-	-
Other buildings	3,400	9	306	3,400	306	3,400	306	3,400	306	3,400	306
Two silos, 14 x 35	2,250	6	135	2,250	135	2,250	135	-	-	-	-
New Building Investment											
Addition to barn	-	5	-	5,000	250	16,800	840	-	-	-	-
Addition to silo	-	6	-	500	30	-	-	1,500	90	2,500	150
New silo	-	6	-	-	-	2,110	127	2,620	157	4,300	258
Pole barn	-	7	-	-	-	-	-	3,960	277	6,600	462
Concrete barnyard	-	-	-	-	-	-	-	1,800	126	3,000	210
Milking parlor	-	6	-	-	-	-	-	3,750	225	3,750	225
Changing old barn	-	5	-	-	-	-	-	500	25	500	25
Total	18,650		1,121	24,150	1,401	37,560	2,088	29,530	1,806	36,050	2,236

Appendix Table N. Building Investments, Depreciation, Insurance and Repairs Under Alternative Plans, Farm C.

Item	Benchmark			Plan 1		Plan 2		Plan 3	
	Value	Rate	Annual charge	Value	Annual charge	Value	Annual charge	Value	Annual charge
	Dollars	Percent	Dollars	Dollars	Dollars	Dollars	Dollars	Dollars	Dollars
Existing Buildings									
Barn	8,000	5	400	8,000	400	8,000	400	8,000	400
Milk house	600	8	48	-	-	-	-	-	-
Other buildings	6,000	9	540	6,000	540	6,000	540	6,000	540
Silo	3,000	6	180	3,000	180	3,000	180	3,000	180
New Building Investment									
Changing old barn	-	5	-	500	25	500	25	500	25
Concrete barnyard	-	7	-	3,000	210	3,000	210	3,600	252
Pole shed	-	7	-	4,290	300	4,290	300	5,610	393
Milking parlor	-	6	-	4,215	253	4,215	253	4,215	253
New silo	-	6	-	4,300	258	4,300	258	5,400	324
Total	17,600		1,168	33,305	2,166	33,305	2,166	36,325	2,367

Appendix Table O. Rate of Recovering Additional Investments in Dairy Structures and Equipment Under Alternative Plans, Farm A.

Item	Plan 1	Plan 2	Plan 3
Additional investment in dairy structures and equipment	$14,405	$22,125	$3,470
Investment recovered annually with milk at $3.80 cwt.			
(1) gain in net income	-1,820	-2,333	+798
(2) added depreciation charge[1]	1,764	2,087	315
(3) added interest charge[2]	402	664	104
Total	+346	+418	+1,217
Approximate time (years) to recover added investment with six percent interest	41.6	53.0	3-1/4

[1]Depreciation charge on new buildings and new equipment.

[2]Interest charge on one-half the additional investment in dairy structures and equipment at six percent.

Appendix Table P. Rate of Recovering Additional Investments in Dairy Structures and Equipment Under Alternative Plans, Farm B with a Milk Price of $3.80 Cwt.

Item	Plan 1	Plan 2	Plan 3	Plan 4
Additional investment in dairy structures and equipment	$5,500	$21,110	$24,330	$35,950
Investment recovered annually with milk at $3.80 cwt.				
(1) gain in net income	-310	+324	-361	+2,053
(2) added depreciation charge[1]	280	1,297	2,575	3,895
(3) added interest charge[2]	165	633	730	1,079
Total	+135	+2,254	+2,944	+7,027
Total time (years) to recover added investment, with six percent interest and milk at $3.80 per cwt.	Over 40	13-1/2	11-1/4	6-1/4

[1] Depreciation charge on new buildings and new equipment.

[2] Interest charge on one-half additional investment in dairy structures and equipment at six percent.

Appendix Table Q. Receipts, Expenses and Rate of Recovering Additional Investments in Dairy Structures and Equipment Under Alternative Plans, Farm B with a Milk Price of $4.50 Cwt. at the Farm.

Item	Benchmark	Plan 1	Plan 2	Plan 3	Plan 4
Receipts:					
Milk	$20,790	$23,625	$34,425	$28,350	$45,000
Cows	1,760	2,000	3,000	2,400	4,000
Wheat	832	-	-	-	-
Corn	283	-	-	-	-
Total Receipts	$23,665	$25,625	$37,425	$30,750	$49,000
Expenses:	$14,693	$16,512	$25,998	$20,953	$34,199
Net Income	$ 8,972	$ 9,113	$11,427	$ 9,797	$14,801
Investment recovered annually with milk at $4.50 cwt.					
(1) gain in net income	-	141	2,455	825	5,829
(2) added depreciation charge	-	280	1,297	2,575	3,895
(3) added interest charge	-	165	633	730	1,079
Total		586	4,385	4,130	10,803
Approximate time (years) to recover added investment with six percent interest		14-1/4	6	7	3-1/2

Appendix Table R. Rate of Recovering Additional Investments in Dairy Structures and Equipment Under Alternative Plans, Farm C.

Item	Plan 1	Plan 2	Plan 3
Additional investment in dairy structures and equipment	$26,580	$17,780	$30,825
Investment recovered annually with milk at $3.80 cwt.			
(1) gain in net income	+2,902	-1,534	4,075
(2) added depreciation charge[1]	2,535	1,941	3,382
(3) added interest charge[2]	768	533	925
Total	6,205	940	8,382
Approximate time (years) to recover added investment with six percent interest	5	19	4

[1]Depreciation charge on new buildings and new equipment.

[2]Interest charge on one-half added investment in dairy structures and equipment at six percent.

BIBLIOGRAPHY

A. Books

Barlowe, Raleigh, Land Resource Economics, Prentice-Hall, Inc., Englewood Cliffs, New Jersey, 1958.

Bradford, Lawrence A. and Johnson, Glenn L., Farm Management Analysis, John Wiley and Sons, Inc., New York, 1953.

Heady, Earl O., Economics of Agricultural Production and Resource Use, Prentice-Hall Inc., Englewood Cliffs, New Jersey, 1952.

Heady, Earl O. and Jensen, Harold R., Farm Management Economics, Prentice-Hall Inc., New Jersey, 1954.

Johnson, E. Sherman and Bachman, Kenneth L., "Recent Changes in Resource Use and in Farm Incomes," Problems and Policies of American Agriculture, Iowa State University Press, Ames, 1959.

U. S. Bureau of Census, United States Census of Agriculture, 1954.

Wheeler, Richard G. and Black, John D., Planning For Successful Dairying in New England, Harvard University Press, Cambridge, 1955.

B. Bulletins and Reports

Armes, Monroe and others, "Amount of Total Digestible Nutrients and Digestible Protein Produced per Acre in Certain Forage Crops," Pennsylvania Farm and Home Planning Handbook, Compiled by The Pennsylvania State University Farm Management and Home Management Extension Specialists, p. 118.

Baker, R. H. and Bailey, R. A., Plan Dairy Chores, Ohio Agricultural Experiment Station, Research Bulletin 706, 1952.

Brown, B. A., Snyder, W. W., Hoglund, C. R. and Boyd, J. S., "Labor Requirements for Herringbone and Other Milking Systems," Michigan Agricultural Experiment Station Quarterly Bulletin, Vol. 41, No. 4, May 1959.

Brown, L. H., Cargill, B. F. and Bookhout, B. R., Pen-Type Dairy Barns, Michigan Agricultural Experiment Station Special Bulletin 363, 1950.

Brown, L. H., and Elwood, Everett M., Farming Today, Michigan State University Cooperative Extension Service Farm Accounting Project, Area 5 Report, South-central Michigan, 1960.

Byers, G. B., Effect of Work Methods and Building Designs on Building Costs and Labor Efficiency for Dairy Chores, Ky. Agricultural Experiment Station Bulletin 589, 1950.

Cargill, B. F. and Ralston, N. P., "Loose-Housing for Dairy Cattle in Steel Buildings," Michigan Agricultural Experiment Station Quarterly Bulletin, Vol. 38, No. 1, 1955.

Chambliss, R. Lee Jr., The Economics of Mechanical Dairy Barn Gutter Cleaners, Virginia Agricultural Experiment Station Bulletin 506, April 1959.

Cleaver, Thayer, Thompson, Harold J., and Yeck, Robert G., Stall Barns for Dairy Cattle, Agricultural Information Bulletin 123, U. S. Department of Agriculture, May 1954.

Cole, Gerald L., McDaniel, William E. and Mitchell, H. M., Hay Drying Cost and Returns, University of Delaware Agricultural Experiment Station Technical Bulletin 334, July 1960.

Conneman, G. J. and Bratton, C. A., "Heat Driers for Curing Hay," Farm Economics, Cornell University Department of Agricultural Economics, No. 212, March 1958.

Day, L. M., Arne, H. J. and Pond, G. A., Effect of Herd Size on Dairy Chore Labor, Minnesota Agricultural Experiment Station Bulletin 449, June 1959.

Elliot, F. F., Chairman and others, Land Values and Farm Finance, Major Statistical Series of the U. S. Department of Agriculture, Vol. 6, Agricultural Handbook, No. 118.

Fuller, Earl I., Some Labor Efficient Dairy Farm Organizations Designed for Michigan Conditions, Michigan State University Department of Agricultural Economics, Ag. Econ. No. 69, 1957.

Furry, Ronald B., Basic Arrangements of Milking Parlors with Stall Barns, Cornell University Agricultural Engineering Extension Bulletin 341, October 1959.

Furry, Ronald B., Useful Facts and Figures for Dairy Barn Planning, Cornell University Agricultural Engineering Extension Bulletin 317, October 1959.

Graves, R. R., Dawson, J. R., and Kopland, D. V., Relative Milk Production of Cows in Pen Barns and Stanchion Barns, USDA Circular 763, 1947.

Hill, E. B., Farms in Transition, Department of Agricultural Economics, Michigan State University, paper presented at the Annual Convention of the Michigan Real Estate Association, Farm Brokers Section, Mackinaw Island, September 1959.

Hill, E. B., Getting the Necessary Capital to Farm, Department of Agricultural Economics mimeograph, Michigan State University.

Hoglund, C. R., "Dairy Farming in a Decade of Change," Michigan Farm Economics, Department of Agricultural Economics, No. 196, Michigan State University, 1960.

Hoglund, C. R., Benne, E. J., Nelson, L. V., and Huffman, C. F., "Forage Quality and Protein Feeding of Dairy Cows," Michigan Agricultural Experiment Station Quarterly Bulletin, Vol. 38, No. 3, p. 413, February 1956.

Hoglund, C. R., Boyd, J. S., and Synder, W. W., "Herringbone and Other Milking Systems - Operations and Investments," Michigan Agricultural Experiment Station Quarterly Bulletin, Vol. 41, No. 4, May 1959.

Hoglund, C. R., and Harrison, C. M., A Research Report on the Economics of Alternative Pasture Systems, Department of Agricultural Economics mimeograph No. 698, October 1957.

Hoglund, C. R., Esmay, M. L., Boyd, J. S. and Snyder, W. W., "Economics of Tower and Bunker Siles," Michigan Agricultural Experiment Station Quarterly Bulletin, Vol. 41, No. 2, November 1958.

Hoglund, C. R., Soil Conservation in Michigan, Progress and Problems, Michigan Agricultural Experiment Station, Department of Agricultural Economics Special Bulletin 394, January 1955.

Hoglund, C. R., Economics of Feed Production in South-central Michigan, Michigan Agricultural Experiment Station, Special Bulletin 420, September 1958.

Hoglund, C. R., Economics of Alternative Pasture Systems, Michigan Agricultural Experiment Station Special Bulletin, 1960.

Jarvesoo, Elmar, Moser, Roy E., and Gray, Lee R., Pen and Stanchion Barns Daily Chore Time Comparisons, University of Massachusetts, Agricultural Experiment Station, Bulletin 483, 1955.

Johnson, L. A. and Thelen, A. J., 1959 Michigan Dairy Herd Improvement Records, Cooperative Extension Service, Michigan State University Dairy Department.

Kleis, R. W., Hay Crushing, Michigan State University Cooperative Extension Service, Extension Folder F-162, 1953.

Lee, John E. Jr. and Chastain, E. D., Problem Recognition in Agriculture...Managerial Adjustment Opportunities, Agricultural Experiment Station of the Alabama Polytechnic Institute, Bulletin 319, November 1959.

Mulvany, James, Wheeler, Richard, "Prices for Farm Planning in the 1960's," Michigan State University, Department of Agricultural Economics Fact Sheet.

Padgett, J. H. and Frasier, T. L., Economic Analysis of Important Aspects of Dairy Farm Automation, Georgia Agricultural Experiment Station, Bulletin 47, November 1957.

Porterfield, I. D. and others, Choose Comfortable Stalls for Your Dairy Cows, West Virginia Agricultural Experiment Station, Bulletin 410, December 1957.

Scott, W. I. and Scott, D. R., A Survey of Machine Milking Techniques in N.S.W. New Wales, Department of Agriculture, Division of Dairying, P.C. 50, 1951.

Sheldon, W. H., Wiant, D. E., Hillman, Don, and Dexter, S. T., Early Cut Hay and Mechanical Drying, Michigan State University Cooperative Extension Service, Extension Folder F-288, April 1960.

Shute, J. A., A Comparison of Dairy Cattle Labor Requirements for Stall and Loose Housing Barns, University of Minnesota mimeograph, 1952.

Stanton, B. F., Pipeline Milking, Its Place on Your Farm, Cornell University Extension Bulletin 1024, February 1959.

Steward, R. E., A Field Study of Practice in Loose Housing of Dairy Cattle in Missouri, Missouri Agricultural Experiment Station Research Bulletin 468, 1950.

Summary of Dairy Herd Improvement Association Records for 1959 with data on progress during 49 years of testing, The Pennsylvania State University, College of Agriculture, Division of Extension.

Warren, S. W., "Cost of Building Stall Barns and Pen Barns, Farm Economics, Department of Agricultural Economics, Cornell University, Ag. Econ. No. 212, March 1958.

Witzel, S. A. and others, Dairy Cattle Housing, Wisconsin Agricultural Experiment Station, Regional Bulletin 470, Revised October 1950.

Witzel, S. A. and Heizier, E. E., Loose Housing or Stanchion Type Barns, University of Wisconsin Agricultural Experiment Station Bulletin 503, 1953.

Witzel, S. A., Progress in Milking Parlor Research, University of Wisconsin, mimeograph, 1951.

Woodward, T. E., The Open Shed Compared with the Closed Barn for Dairy Cows, USDA Bulletin 763, 1918.

C. Periodicals

Angus, R. C. and Barr, W. L., "An Appraisal of Research Literature Dealing with Loose and Conventional Dairy Cattle Housing," a review, Journal of Dairy Science, April 1955, Vol. XXXVIII, No. 41.

"Automation of a Dairy Farm," The Farm Quarterly, Winter, 1960, Vol. 14, No. 4, p. 82.

Bettenany, R. A., "Rate of Milking with Machines," J. Agr. W. Australia, 27:160, 1950.

Bowen, R., "Why Build a New Barn When You Can Cut Labor in Your Present Barn, Hoard's Dairyman, 96:944, October 1951.

Cullity, M., "Rate of Milking Machines," J. Agr. W. Australia, 26: 99, 1949.

Dodd, F. H. and Foot, A. S., "Experiments on Milking Technique," Journal of Dairy Research, 15:1, 1947.

Fisher, L. R., "Rubber Mattress for Dairy Cattle," Hoard's Dairyman, 100:893, October 1955.

Hoard's Dairyman Round Table, We Prefer a Stanchion Barn and Milking Parlor, Hoard's Dairyman, Vol. 104, No. 23, December 1959.

Hoglund, C. R., "Our Industry Today, Journal of Dairy Science, Vol. XLII, No. 6, June 1951, p. 1104.

McFate, K. L. and Calderwood, D. L., "Save Steps in Your Dairy Barn," Hoard's Dairyman, 99: 737, August 1954.

Wennblom, Ralph D. and Wormky, George W., "Pellets Hay in the Field," Farm Journal, May 1960.

Whittleston, W. G. and How, G., "A Survey of Machine Milking," New Zealand J. Agr., 73:441, 1946.