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Economics of Scale in Dairying: An Exploration of Comparative models of Stanchion and Loose Housing Systems

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ECONOMICS OF SCALE IN DAIRYING--AN EXPLORATION OF COMPARATIVE MODELS OF STANCHION AND LOOSE HOUSING SYSTEMS

BY

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This thesis is approved as a creditable, independent investigation by a candidate for the degree, Master of Science, and is acceptable as meeting the thesis requirements for this degree, but without implying that the conclusions reached by the candidate are necessarily the conclusions of the major department.

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WJS

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CHAPTER I

INTRODUCTION

The trend toward greater substitution of machines for labor to increase output per man and decrease costs of operation has proceeded rapidly in many phases of agriculture.

Commercial production of poultry, both broilers and layers, has moved almost completely into confinement housing. This move has allowed the mechanization of feed processing and distribution. Beef cattle are being fattened to a large extent in drylot, where feed handling can be accomplished by the use of machines instead of hand labor. Hogs too, are now being confined in many of the larger production operations.

"Dairy cows have probably been handled under conditions of partial or complete confinement longer than any of the livestock mentioned above; yet manual methods still predominate, particularly in the distribution of feed."[1]

The pressure toward specialization in agriculture has raised many questions concerning the future of the dairy industry in South Dakota. Several states, including Florida, Arizona, Texas and California, have highly specialized dairy operations. California has

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[1]Van Arsdall, Ray N., Economic Aspects of Mechanization of Feeding on Dairy Farms, U.S.D.A., Agricultural Research Service, Farm Economics Research Division, Urbana, Illinois, June 15, 1959, p. 4.

many herds in the 300-500 cow size and, "in a number of the leading market milk counties such as Los Angeles, Orange, San Diego, Santa Clara and Martin, the average-sized dairy herd is more than 100 cows. No other state has such concentrations of dairy cows in large commercial dairies."[2]

Specialization of the dairy industry has been attempted in Iowa, Wisconsin and Kansas. Fashion Farm at Meservey, Iowa, was the first organization to keep unusually large numbers of dairy cows in one group under one management in the upper North Central area. This organization has since been dissolved because of various reasons. Drainage and manure removal were factors that caused severe problems during specific seasonal periods. Other factors included low production per cow, health problems, poor physical plant layout and difficulty in securing and retaining help. Specialization in the dairy industry, at least with herds exceeding 200-300 milking cows, has been primarily limited to "cow pools" in states adjacent to South Dakota. "Even though 'cow pools' may be only a passing phase or symptom, the trend toward larger milking operations will undoubtedly continue."[3]

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[2]Shultis, Arthur and G. E. Gordon, California Dairy Farm Management Circular #417, California Agricultural Experimental Station, Extension Service, University of California, November, 1952, p. 5.

[3]Evans, T. A., Development of Large Dairy Operations, Nebraska Farm and Ranch Economics, #138, August, 1959.

Since dairying is one of the major agricultural industries in South Dakota, it is imperative that the industry continue to adjust to new developments and economic change if it is to grow or even maintain its relative position.

Many changes have occurred in dairying in South Dakota during the past 20 years although the relative cash income from dairy products compared to other farm commodities has remained about the same. This is evidenced by comparisons of percentages of cash farm income from dairying compared with other farm commodities and livestock products (See Table 1).

Table 1. Cash Farm Income from Dairy Products as Per Cent of Total Cash Farm Income, South Dakota, 5 year Averages and 1959 and 1960

1946-1950 Average	1951-1955 Average	1956-1960 Average	1959	1960
5.6	5.5	5.8	5.7	5.8

Source: South Dakota Agriculture, South Dakota Crop and Livestock Reporting Service, 1961, Sioux Falls, South Dakota, p. 76.

While the percentage of cash farm income from dairy products is not a large percentage of the total cash farm income in South Dakota, dairy farming accounts for the fourth largest cash income relative to all grain commodities and livestock products. Only cattle and calves, hogs and corn have higher cash farm incomes in South Dakota.

Developments in the distribution of fluid milk have made a substantial change in the marketing structure in the state. Prior to

1947 large quantities of Grade A milk were shipped into the state. Shipments of whole milk rose from 92 million pounds in 1945 to 750 million in 1961. Of the amount shipped in 1961, 150 million pounds were used for fluid consumption.

Numbers of farms selling whole milk in South Dakota increased 71 percent while the number of farms selling cream decreased 50 percent during the past ten years. Although this substantial change has taken place, "South Dakota is one of the few states that disposed of as much as 40 percent of its total milk supply as farm-skimmed cream in 1961."[4]

While dairying in South Dakota is not a specialized area of agriculture as in some parts of the nation, many technological advances have been made. Management and feeding practices have generally improved as has the use of superior dairy sires. The number of cows bred artificially has increased 1,279 percent from 1950 to 1960. The use of coolers, both can and bulk, have increased greatly during the past ten years with bulk coolers alone increasing from 0 to 1500 during this period.

South Dakota continues to experience a loss in numbers of milk cows. While the decline in the number of milk cows has been approximately 25 percent during the ten year period 1951-1960, milk production

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[4]Unpublished Thesis, Dairy Product Demand Projections to 1975: Their Impact on South Dakota's Dairy Industry, Norman Kallemeyn, 1963, p. 4.

has held relatively stable at from 1.30 to 1.45 million pounds of milk per year. (Table 2)

Table 2. South Dakota Milk and Butterfat Production

Year	Milk cows on farms (thousand)	Milk prod. per cow (lbs.)	Bft. prod. per cow (lbs.)	Total Production Milk (lbs.) (thousand pounds)	Total Production Bft. (lbs.) (thousand pounds)
1951	323	4300	161	1389	52
1952	311	4170	156	1297	49
1953	314	4360	159	1369	50
1954	309	4400	161	1360	50
1955	302	4530	161	1368	49
1956	299	4720	168	1411	50
1957	293	4900	173	1436	52
1958	275	5190	179	1427	52
1959	259	5610	196	1453	51
1960	248	5620	202	1394	50

Source: South Dakota Agriculture, 1955 and 1961, South Dakota Crop and Livestock Reporting Service, Sioux Falls, South Dakota, pp. 41 and 72.

Increased emphasis on the large, specialized dairy operation may be one way of expanding this industry in South Dakota. Also more of the roughage and grains produced in the state can be consumed locally.

Review of Literature

Most evaluative reports and papers dealing with the cost of producing milk in the upper North Central area are based on diversified farming operations or of the "cow pool" type operation. Likewise, most of the information available on larger herds is based on the loose

housing method of handling the milking herd. Data are not available on housing a large herd in stanchion or comfort-stall type housing for the upper North Central area.

Recent studies reveal that many of the problems associated with large scale dairy operations evolve from organizational and operating procedures. The factors that should receive the major emphasis when planning a large scale dairy operation are "planned buildings, work simplification and an integrated system. These factors are all important and to omit one may loose the effectiveness of the others."[5]

Some of the management factors that are regarded as potential problem areas and where a high degree of consideration should be placed in the planning stages include drainage and manure removal. In Southern climates, these problems are not present in near the degree they are in the Northern part of the United States. The use of stanchion barns and hard surfaced lots would be considered as methods of reducing these problems. Fly control would also be greatly reduced with the stanchion barn system. While various studies have been made regarding labor requirements for stanchion barns versus loose housing, very little evidence is available using a completely mechanized feeding and manure handling operation. The use of such equipment and the stockpiling of a complete dairy ration to be automatically fed to the cows could greatly reduce the labor requirements in stanchion barns.

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[5]Van Arsdall, op. cit., p. 5.

"Not only is good equipment available, but it costs relatively less than in the past. Cost relationships favor replacing labor with mechanical equipment now more than ever before."[6]

Another factor causing difficulty in large scale operations is the labor management problem. While it may be conceded that total labor requirements may be slightly greater for stanchion barns, "the management input (decision making and production practices) had less effect on labor requirements in the stanchion barns than in milking parlors."[7] It is possible that many of the problems in labor management could be reduced by the use of a herdsman for a specific group of 100 cows. Under such an arrangement, the herdsman would be responsible for the herd, milk the cows and provide for maximum returns by the use of an incentive plan. According to John E. Kadler and Arthur K. House in a report No Magic Size for a Dairy Herd, "the most efficient managers would make the most profit with over 70 cows."[8] In a similar study conducted in the Los Angeles milkshed, labor efficiency was increased when "each milker milks approximately 90 cows per day."[9]

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[6]Ibid., p. 5.

[7]Hawkins, Dean H. and Robert C. Suter, Dairy Cattle Rates of Resource Use for Budgeting Enterprise Costs and Returns, Purdue University, Agricultural Experiment Station, Lafayette, Indiana, February, 1962, p. 5.

[8]Kadler, John E., and Arthur K. House, No Magic Size for a Dairy Herd, Economic and Marketing Information for Indiana Farmers, June 30, 1962, p. 1.

[9]Nosker, Dean and J. L. Albright, Los Angeles County, Worlds Largest Milk Factory, Hoards Dairyman, February 10, 1961, p. 144.

Purpose of Study

The purpose of this study was to provide South Dakota Dairy producers and others interested in establishing large scale dairy operations with a more complete set of guide lines that will help them to determine the profitableness of expanding existing or establishing new dairy producing units. This was done by analyzing and comparing the costs of producing milk in 80-140 cow existing dairy farms in South Dakota with the estimated costs and returns for large scale model dairies of 480, 960, 1,440 and 1,920 cows involving both the stanchion barn and loose housing systems.

It is hoped that many management problems, encountered by existing or previous "cow pools" can either be eliminated or greatly reduced in future large scale dairy operations. There are undoubtedly specific advantages and disadvantages to each system but it is not the purpose of this study to evaluate all the advantages and disadvantages in determining the feasibility of one or the other system.

Objectives

Objectives of the study were: (1) to determine representative costs of producing milk in 80-140 cow herds in South Dakota by a survey, (2) to determine the economies of scale of producing milk by establishing model systems, using both stanchion and loose housing, and (3) to determine the profitability of such a dairy system in South Dakota.

Procedure

To derive the representative costs of producing milk in larger herds in South Dakota, a survey of dairy herds with 80-140 cows was made. Data and information used in the computation of costs and returns, were obtained by personal interviews with a sample of the large dairy owners in eastern and western South Dakota. The information derived from this survey was used as a benchmark for costs and returns of milk production.

One model utilized stanchion barns for housing with the cows milked in a milking parlor. One man would be responsible for each barn holding 100 cows but feeding and manure handling, which would be completely mechanized, would be performed by other workers.

The loose housing model would be somewhat similar to existing loose housing dairy operations, only much larger in size. The number of cows per herdsman would be the same in each model and cows would be milked in a milking parlor as in the stanchion barn system.

The assignment of a herdsman for each 100 cows permits more individual care of the cows. The larger number of cows handled per man, compared to existing dairy herds would be offset by mechanized feeding and manure handling and related chores performed by other personnel.

Information provided in this study provided the basis to determine the economic profitability of operating large scale dairy operations as described in the hypothetical models.

No attempt was made to investigate sources of financing the model operations nor of marketing the dairy products. It was assumed that both adequate financing and a market were available.

CHAPTER II

COSTS AND RETURNS OF SURVEYED DAIRY FARMS

Method of Selecting Dairy Farms Surveyed

According to the 1959 census data, 25 dairy farms had 75 or more milk cows in South Dakota. Of these, 19 herds had 75 to 99 cows and 5 herds had 100 or more cows. This was almost double the number of dairy farms with 75 milk cows or more indicated by the 1954 census data.[10]

To aid in selecting a sample for this study, all dairy operations with 80 or more cows were screened from the 1961 South Dakota Annual DHIA Report. Seven dairy farms listed in the report had 80 milk cows or more in South Dakota. From this list of seven dairy farms, Hollis Hall, Assistant Extension Dairyman, selected six whom he considered would have adequate records to provide necessary cost and return information.

Method of Collecting and Calculating Data

Information for each farm included in this survey was obtained in a personal interview with the dairy farm operator. Six dairy farms were visited and results obtained from four. All dairymen interviewed provided additional material by mail.

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[10]U. S. Bureau of the Census, U. S. Census of Agriculture, 1959, Vol. 1, Counties, Part 19, South Dakota, U. S. Government Printing Office, Washington 25, D. C., 1961.

Very few dairymen, as well as other types of farmers, keep permanent or complete financial and production records. In order to obtain as complete information as possible, visits were scheduled immediately after the first of the year when the dairyman was compiling his costs and returns for income tax purposes. While this helped to obtain some of the data, for some purposes estimates were required as the dairyman did not keep or use records for certain phases of his operation. The following explanation describes how each unit of production cost was charged and computed.

Milk Production Costs

Only the inputs directly utilized by the dairy enterprise are included in this study. If feed was grown on the dairy farm it was valued at the market price to the dairy enterprise and the labor, investment and other costs in growing the feed were ignored.

Some cost figures were taken directly in dollar amounts as reported by the dairyman for use in the analysis. In other cases, the physical amount of a factor was obtained in the survey and the charge for the input was determined either by opportunity cost or replacement value. All dairy farms surveyed were typical loose housing systems. The average number of cows in the surveyed herds was 108.

Actual average production per cow was calculated to be 10,632 pounds of milk and the average expense per cow and replacement was $493.38. Average cost to produce 100 pounds of milk was computed to

be $4.64 with approximately 90 percent of the milk production cost attributed to feed, labor and investment expenses.

Feed Cost

Feed accounted for approximately 54 percent of the cost of producing milk in the herds surveyed in South Dakota. The major portion of the feed cost was contributed by roughage.

With feed accounting for 54 percent of the cost of producing milk, this factor deserves major attention in making cost analysis decisions. Money can be saved by comparing costs of various feed combinations as the relative prices of feeds change, the least expensive feed mixture may change. Seasonal availability and quality of dairy feeds change and need to be studied to determine least cost feed mixtures. Seasonal purchasing versus stable year around purchasing must also be considered to determine whether the cost of credit and storage offset the gain in price per unit of feed product.

Labor Cost

The cost of labor contributed about 14 percent to the total production cost. Labor cost includes all labor attributable to the dairy enterprise.

Since the dairies included in the survey were highly specialized, labor allocation was assigned relatively easily. Allowances for privileges, such as housing, milk, meat and eggs and others are included in the cost of labor. Family or operator's labor was computed on

prevailing wage rates. It was assumed that family labor just replaced labor that could be hired at the prevailing wage rate in the area. Monthly wage rates varied considerably from eastern to western South Dakota.

No charge was made in the cost summary for time spent in managing the dairy business. Returns to management are considered in the cost and return summary.

Investment Cost

Investment cost includes depreciation on buildings and equipment and interest on investment. Taxes and insurance are also considered as an investment cost but due to the method of obtaining cost data were included in miscellaneous costs.

The amount of investment attributed to milk production was obtained in the personal interview. The investment value for each item was the dairyman's estimate of its replacement cost. Investment items include the dairy herd, land, buildings and improvements and machinery and equipment. Interest on investment was charged at 6 percent of the investment. (Table 3)

Table 3. Average Investment per Dairy and per Cow and Replacement, Surveyed Dairy Herds, South Dakota, 1962

Type of investment	Average per dairy farm	Average per cow and replacement
Dairy herd	$ 50,509.50	$ 468.76
Land	1,205.00	11.18
Buildings and improvements	36,638.00	340.02
Equipment	22,364.00	207.56
Total investment	$110,716.50	$1,027.52

Depreciation on buildings and equipment was calculated on the estimated replacement value divided by the farmer's estimated length of life for each specific item. As a general rule, buildings and improvements were depreciated on a 20-year schedule and equipment and machinery on a 10-year schedule.

Livestock depreciation was calculated as the net change in the value of the herd, including the milking herd, bulls and young female stock being raised, from the beginning to the ending inventory. The method used was: "(value of all livestock at the beginning of the year plus cost of all purchases) minus (value of all livestock at the end of the year plus the amount received from all sales) equals net change in value for the year."[11]

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[11]Greene, R. E. L., R. H. Walker and D. L. Brooke, Summary of Costs and Returns for Wholesale Dairy Farms, Tampa Bay Milk Marketing Area, Florida, 1959, Department of Ag. Econ. Florida Agricultural Experiment Stations, Gainesville, Florida, 1960, pp. 14-150.

This method gives a depreciation expense based on the actual turnover and loss experienced in the year under consideration.

Included in this method, during the year were cattle losses due to death, as they were figured in the beginning inventory or purchases but not in the ending inventory.

If a net increase for the year occurred, it was listed as an appreciation. All the herds surveyed had an appreciation of $4,400 to $6,500 or an average appreciation of $52.08 per cow. Value of cattle for inventory purposes were estimated by the operator at current replacement animal value. (Table 4)

Table 4. Average Costs per Herd, per Cow and per Hundredweight of Milk Produced, Surveyed Dairy Herds, South Dakota, 1962, Includes Cost of Raising Replacements

Item	Avg. cost per herd	Avg. cost per cow	Avg. cost per cwt. of milk	% of total cost
Interest on investment[a]				
Dairy herd	$ 3,031.00	$ 28.13		
Land	72.25	.67		
Bldgs. and imp.	2,198.25	20.40		
Equipment	1,342.00	12.45		
Subtotal	$ 6,644.50	$ 61.65	.581	12.5
Depreciation[b]				
Bldgs. and imp.	$ 2,005.50	$ 18.61		
Equipment	2,601.50	24.14		
Subtotal	$ 4,607.00	$ 42.75	.402	8.5
Total fixed costs[c]	$11,250.50	$104.40	.983	21.0
Feed	$28,496.00	$264.46	2.493	53.5
Labor[d]	7,212.75	66.94	.631	13.5
Miscellaneous	6,204.57	57.58	.541	12.0
Total variable costs	$41,913.32	$388.98	3.66	79.0
Total costs	$53,163.82	$493.38	4.64	100.0

[a]Interest on investment charged at 6 percent.
[b]Depreciation charged as indicated by dairyman on interview.
[c]Taxes not included in fixed costs, but are included in miscellaneous costs.
[d]Does not include management costs.

Miscellaneous Costs

Included in miscellaneous costs are such items as: milk hauling costs, dairy supplies, veterinary fees and medicine, dues for dairy publications and organizations, gas and repairs pertaining to the dairy enterprise, electricity prorated for the dairy operation and proratio costs of taxes, telephone, insurance, legal and professional services, personal property taxes, social security taxes, trip expenses and others. D.H.I.A. costs were all charged to the dairy operation. Artificial breeding charges are included in miscellaneous costs. Miscellaneous costs account for $57.58 per cow or about 12 percent of the total cost.

Milk Sales and Other Income

Milk sales amounted to an average of $461.59 per cow. Average returns per hundredweight of milk ranged from $4.05 to $4.85 on a yearly basis. Value of milk products used on the farm averaged $4.55 per cow.

All herds had an appreciation in the value of the dairy herd from the beginning inventory until the ending inventory for the year. Average appreciation was $5,611.50 per herd or an average of $52.08 per cow included in the surveyed dairy herds. Total income including appreciation amounted to $518.22 per cow.

A summary of costs and returns of the surveyed dairy farms are shown in Table 5.

Table 5. Summary of Average Income and Costs per Herd, per Cow and per Hundredweight of Milk Produced, Surveyed Dairies, South Dakota, 1962, Includes Cost of Raising Replacements

Item	Avg. income and cost per herd (108 cows)	Avg. income and cost per cow and replacement	Avg. return and cost per cwt. of milk
Milk sales[a]	$49,736.83	$461.59	$4.36
Value of product used[b]	490.01	4.55	4.36
Appreciation of dairy herd[c]	5,611.50	52.08	.49
Total income	55,838.35	518.22	4.85
Total costs for enterprise[d]	46,520.32	431.74	4.05
Net income from investment	9,318.03	86.48	.80
Rate earned on dairy investment	8.4%		
Less interest on investment[e]	6,643.50	61.65	.58
Return to management	2,674.53	24.83	.22
Percent return to management	2.4%		

[a]Milk sales from milk receipts.
[b]Calculated amount of milk used by family and hired help.
[c]Value of all breeding dairy stock at the beginning of the year plus cost of all purchases - value of all breeding dairy stock at the end of the year plus the amount received from all sales of breeding dairy stock - net change in value for the year.
[d]Total costs less interest on investment.
[e]Interest on investment at 6%.

CHAPTER III

MANAGEMENT PROCEDURES FOR HYPOTHETICAL DAIRY SYSTEMS

Probably the most important single factor to consider in operating a highly specialized dairy farm is management. Management requirements increase as farms become larger, more highly mechanized and use greater amounts of invested capital. Routine day-to-day management problems which are easily handled in small herd operations may become limiting factors in large-scale operations.

Feeding, sanitation, labor relations and other management factors may multiply fast when the herd size reaches 500-1000 cows. Even identification of cows becomes an important management procedure in very large herds, but is not considered a management factor at all in relatively small farm herds.

In order to recognize the various problem areas involved in the management process, some guides are given for specific management functions. These guides are suggested and need not be hard and fast rules for all large-scale operations.

Receiving and Identification of Cows

Under the model systems, all new cows and heifers coming into the milking herd would be held in quarantine for a period of not less than six days. While in isolation, the new animals would be routinely checked by a veterinarian. Any unusual symptoms could be checked and diagnosed while in isolation before contact with any of the other cows.

All replacements would either be purchased or raised under contract. If possible, they would be grown under contract as the potential production of the replacement would be known by this method. Calves would be sold at five days of age to a contract grower and repurchased as springing heifers if wanted.

Positive identification of all cows and heifers entering the herd would be essential. A combination tatoo and neck chain would be the preferred identification method.

The use of positive identification would serve as a means to record such data as: date of birth, date purchased, date sold, breeding date, calving date and so forth. The use of neck chains would serve for immediate and easy identification while the tatoo would provide positive identification in case the neck chain broke or the tag would become lost.

A card file or adequate record system would be kept for all cows in the herd. A new card or new entry would be provided for all new incoming cows and heifers. All data such as indicated above and any previous health data would be recorded on the file card.

Production testing records would also be kept but in a separate herd record book. "Standard DHIA testing, making use of central processing, fits large herds especially well."[12]

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[12]Physical Requirements for Large Dairy Herd Operations, Cooperative Extension Service, Iowa State College, Ames, Iowa, January, 1959, p. 4.

Since cows would be fed according to rate of production, the amount of production per cow would have to be available for this purpose.

Feed Requirements

In calculating the feed rations, the following assumptions were made: Average weight of cows is assumed to be 1300 pounds. Average production per cow is 12,000 pounds of 3.75 butterfat milk.

The following ration would be fed as a daily average the year round (See Table 6).

Table 6. Feed Ration Composition and Average Daily Consumption

Type of feed	Lbs./day	D.P.	T.D.N.
Corn silage, well eared	45	.54	8.2
Chopped alfalfa, 25% molasses[13]	15	1.20	7.63
Concentrate mixture[a]	10	1.08	7.54

[a]Ground shelled corn, 600 lbs.; rolled oats, 300 lbs.; soybean meal, 100 lbs.; dicalcium phosphate, 10 lbs.; and salt, 10 lbs.
Source: Morrison, Frank E., "Feeds and Feeding," 21st Ed., The Morrison Publishing Co., Ithaca, New York, 1951, p. 1187.

By using the above feed mixture, long hay feeding could be eliminated and automatic feed handling equipment could be used.

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[13]Personal interview with Orrie Barnes, Barnes Feed Mill, Gayville, South Dakota, regarding use of chopped alfalfa-molasses and price of same, November 29, 1962.

While dry, the cow would receive a complete feed mixture although the concentrate would be reduced to about 5 pounds per cow per day.

Feed Processing and Distribution

The concentrate mixture would be the only feed portion that would require processing. Corn, oats and soybean meal would be purchased in bulk and stored either in or near the feed handling building. The feed mill would be completely automatic and controlled by metering switches. A continuous feed mill capacity of 8 tons per hour should be adequate to handle all the dairy herd sizes considered. Grinding and mixing would be combined in one operation and equipped with metering devices and controls so that measured amounts would be fed into the mill automatically. Adequate holding-bin capacity of the processed concentrate would be provided to store reserve supplies of the concentrate mixture.

Feed would be distributed to storage facilities for both automatic feeding and directly to feed bunks. "Lot feeding is now common to loose housing of dairy cattle, and it is used to some extent for cows milked in stall barns."[14]

Cows milked in the milking parlor would be fed in the milking stalls also to induce the cows to come into the parlor and according to production.

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[14]Van Arsdall, op. cit., p. 9.

The sequence of preparing a load of feed would be as follows: silage would be loaded on a self-unloading wagon to a predetermined amount. The wagon would then be towed into the feed-handling building where a predetermined amount of chopped alfalfa-molasses would be augered unto the silage. The last part of the load would be the concentrate mixture which would also be predetermined and this would be dumped on top of the alfalfa-molasses. The load would then be transferred to the particular pen of cows or the holding silos for storage. Mixing of the entire load would be accomplished by the action of a self-unloading wagon.

The ground and mixed concentrate mixture would be transferred directly to the holding bins near the milking parlor for parlor feeding.

The complete ration mixture would contain an average of 6 pounds of concentrate per cow. When milked in the parlor the cows would be fed additional concentrates according to their production. Considering six pounds concentrate feed in the complete mixture, adequate concentrate should be provided for cows producing 20 to 24 pounds of milk per day. Cows producing greater than 24 pounds of milk per day would be fed according to production on the basis of one pound of concentrate mixture per four pounds of milk produced over the first 24 pounds of milk.

Once a month, cows would be reclassified according to the past month's production record. A color code system would be used which

would eliminate a timely process of determining how much feed each cow would receive.

For example, a cow producing 32 pounds of milk per day should receive 2 pounds of concentrate mixture in the milking parlor. Six pounds received in the complete mixture for the first 24 pounds of milk and 2 pounds for the 8 additional pounds. On the basis of production, various rates would be determined by a colored tag on the neck chain. If a cow was to receive 2 pounds per day, a red tag could indicate 1 pound of feed morning and evening. Other colored tags would be assigned for other rates of feeding. Feed in the milking parlor would be metered out by the use of pull cords.

The use of high moisture corn could be used for this type of operation as once the feed is conveyed to the air-tight storage silos, the feed would remain in the same condition as placed in storage. This factor would not be true of the loose housing system, but an air-tight storage silo could also be used for storage before processing the concentrate mixture. By using a large air-tight silo, the cost of feed could be reduced on certain years by timely purchasing. However, the added cost of the air-tight silo would have to be considered.

Much of the feed could be purchased on a contract basis and delivered as needed. Also attempts would be made to formulize feed in the least-cost combinations.

Dry cows would be fed by a self-unloading wagon by both systems. Dry cows would be fed a minimum of 5 pounds of concentrate mixture per

day except immediately before lactation when the cow would be moved to a maternity pen and hand fed.

Care of Sick and Injured Cows

A veterinary or veterinary staff would be retained for consultative and preventive treatment of the dairy herd. A team of veterinarians would be preferred over a single veterinarian for diagnostic purposes. This would be dependent upon the size of the herd.

All cattle would be inspected monthly for any visual signs of disease. A preventative program such as this would facilitate spotting possible outbreaks of certain diseases. "Very little preventive medicine is practiced in South Dakota but according to practices in California, cost per year is estimated at $12.00 per cow per year."[15] The monthly inspection could also spot possible mineral or vitamin deficiencies which could be corrected before an over-all rundown of the cows would occur. Most health problems could be treated in the stanchion barn unless it was a contagious disease which would indicate isolation. Cows under loose housing would have to be caught in a catch pen for treatment or diagnosis.

All cows having mastitis would be marked so that during the milking process the milk could be transferred to a separate holding container. Injections for treatment of mastitis would be preferred

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[15]Herrick, John B., D.V.M., Should We Try Preventive Medicine, Hoards Dairyman, January 25, 1963, p. 95.

intramuscular instead of in the teats to reduce contamination of the milk as much as possible. Cows with mastitis and/or treated for mastitis would be milked last so that other cows would be less likely to be contaminated.

Milking Routine and Practices

In order to treat each cow on an individual basis, the assignment of a herdsman or milker for each group of 100 cows is considered as an advantage of this plan. The herdsman assigned to each barn or herd of 100 cows would be responsible for the cows in his unit. The milker should have adequate knowledge, proper training and the ability to use routine recommended procedures for milking. Proper let-down along with accepted sanitary practices should be a must in the milking routine.

Four 100-cow herds would use the same milking parlor on a shift basis. Following is a milking shift routine which would utilize milking facilities at maximum capacity, (See Table 7).

Table 7. Milking Parlor Shifts

Barn No.	AM Shift	PM Shift
1	2:00 to 4:30	12:00 to 2:30
2	4:30 to 7:00	2:30 to 5:00
3	7:00 to 9:30	5:00 to 7:30
4	9:30 to 12:00 noon	7:30 to 10:00

Milkers would be required to always milk the cows under their responsibility except on days off when a relief milker would switch shifts. Milkers would get one day off one week and two days off the following week.

Although the same milking machine and facilities would be used for four herds, teat cups would be provided on an individual herd basis. This would allow disinfection of the teat cups between milking shifts.

Manure Handling Procedures

Manure handling is probably one of the most troublesome management problems in a very large herd. Under loose housing conditions in the Southwestern part of the United States, it does not present nearly the problem it does in the North Central area of the United States.

All dry cows would be housed the same as the loose-housed milking herds. A deep pack bedding system would be used in the loafing barns. Mounding manure in the lots would be done twice a week and hauled away at regular intervals. Weather conditions and amounts of manure would determine removal frequency.

Manure would be hauled to a manure stockpile for ultimate delivery to surrounding farms or for sale to other farms. Dehydrating facilities could be considered if a market would be secured to make dehydration practical.

Milking parlors and holding areas would be flushed frequently with a high pressure water hose. This residue would be caught in a large holding basin and pumped out into a large tank wagon at periodic intervals.

Bedding Requirements

Bedding requirements vary with area and type of bedding used. With the large amount of bedding needed for an operation such as this, wood shavings or sawdust was considered.

The amount of bedding required to adequately bed a cow under stanchion and loose housing systems will also vary. According to recent studies conducted on bedding requirements for cows, less bedding is needed than considered in previous trials. Trials in Pennsylvania on both conventional and loose housing systems have determined that about 6 pounds of straw per cow per day will meet the sanitary and comfort needs of the animals for conventional housing and about 9 pounds for loose housing.[16]

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[16]Guffey, J. E., Jr., E. M. Kesler, W. H. Hoover, and C. E. Bruce, Amounts of Straw Required For bedding Cows in Loose and Conventional Housing, Pennsylvania State University, College of Agriculture, Agricultural Experiment Station, University Park, Pennsylvania, December, 1958, p. 2.

Bedding requirements for conventional barns where straw is used, "approximately 6 pounds of straw a day for each adult animal will be required during the winter season."[17]

Cost of shavings or sawdust would also vary according to the area in which a model dairy would be located. For computational purposes, cost of shavings or sawdust was based on the cost of product and transportation from Wadena, Minnesota, to Brookings.[18]

Bedding would be provided for each barn and the barn herdsman would be responsible for bedding milking cows. Dry cows would be bedded by the feeding and cleaning crew.

Heat Detection and Breeding Procedures

While each herdsman would be responsible for the over-all management of his milking herd, heat detection would be the responsibility of the herdsman alone.

By working very closely with his cows, the herdsman or milker would be in a position to observe his cows more closely than if he had other duties such as caring for young stock, feeding calves and so forth. Cows could be observed for heat during milking, in the holding area and during the bedding and barn chore period. "Tests indicate

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[17]Cleaver, Thayer, Harold J. Thompson, and Robert G. Yeck, Stall Barns for Dairy Cattle, Agricultural Bulletin #323, U. S. Department of Agriculture, May, 1954, p. 6.

[18]Interview with Hollis Hall, Assistant Extension Dairyman, and Howard Voelker, Associate Professor of Dairy Husbandry, S.D.S.C., Brookings, South Dakota, December 14, 1962.

that 27 percent of dairy animals in heat will be missed when observed only twice a day. Doubling these checks can boost herd breeding efficiency by 10 to 20 percent."[19]

Cows detected in heat would be marked by an acceptable method and the number of cows and the time to breed would be relayed to the main office building.

The breeding would be performed by one of the crew members who would have been trained in the art of inseminating dairy cattle. Semen could be purchased from an artificial breeding distributor and stored in a nitrogen refrigerator. Insemination cost per cow would average about $4.00 per cow per year.[20]

Labor Requirements and Procedures

Labor requirements would be one of the most important factors to consider for an operation of this type and size. A manager would be in charge of the over-all operation and would be responsible for directing the other personnel.

Since dairy work is considered to be extremely hard work and of long hours, comparable working hours and conditions to other local working conditions should be provided. Proper training, specific job responsibilities, time off on given Sundays, holidays and weekday

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[19]Doane Agricultural Digest, North Central Edition, December 16, 1962, p. 6.

[20]Interview with Maurice D. Frye, Secretary-Treasurer, Midwest Breeders, Inc., Box 117, Yankton, South Dakota, November 10, 1962.

rotation, adequate pay and proper leadership would all be essential for a successful workforce.

Many of the problems of a large dairy operation should be eliminated by the prescribed herdsman responsibility method. The herdsman would be directly responsible to the manager but would be in charge of his milking herd insofar as milking, bedding, heat detection, feeding and general care.

Day labor would be used where needed for driving self-unloading wagons, for filling storage silos, stacking silage and other seasonal jobs. Since these types of jobs would be of a seasonal character, the use of day labor would be more economical than attempting to spread the work out.

The duties of the relief milkers when not replacing a regular milker would be working in the milking parlor and to fill in where needed in other jobs.

Many functions present in existing dairy herds could be eliminated or altered by a specialized system of this type. "Part of the cost of any method of handling feed remains the same regardless of the amount of feed fed. The importance of these fixed costs increases with mechanization, making size of operation significant in determining the least-cost method of handling feed."[21]

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[21] Van Arsdall, op. cit., p. 7.

CHAPTER IV

SUGGESTED LAYOUT FOR STANCHION BARN SYSTEM

The plans for the stanchion barn layout and for the loose housing system are only suggested plans and are not intended for a specific dairy or site.

The plans were an attempt to provide the kind of facilities for a large dairy to minimize the facilities needed, to standardize the operations as much as possible and to make maximum use of labor and management. The cost analysis provided in Chapter VI should determine to a great extent whether this will be attained.

This study was also an attempt to determine the economy of scale by illustrating four sizes of model dairy layouts. Herds from 480 cows to 1,920 cows with 480 cow increments are illustrated and cost and return analysis compared.

Layout and Requirements for a 480 Cow Dairy Herd

Some of the major types of facilities needed for this layout are: (1) land, (2) stanchion barns, (3) milking facilities, (4) dry cow loafing area and lots, (5) feed handling facilities, (6) feed storage, (7) cow hospital facilities, (8) water facilities, (9) management office, and others as equipment building, (See Figure I).

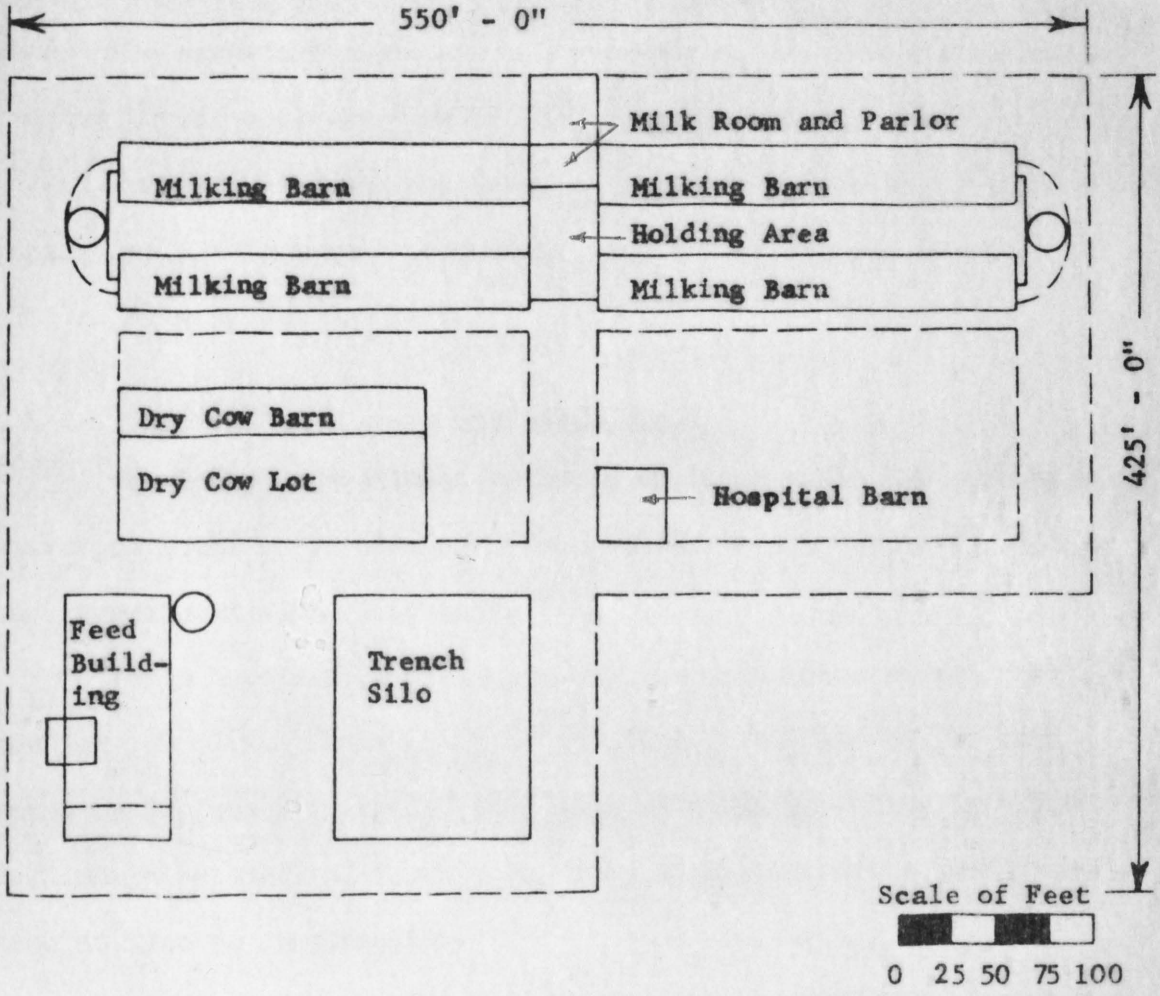

Figure I. Proposed Layout For 480 Cow Dairy Herd - Stanchion Barns

Land

Necessary land area for the 480 cow dairy herd can be accommodated on a lot 425 feet wide by 550 feet deep. However, to provide adequate site space for the largest unit of 1,920 cows, a site approximately 600 feet wide by 850 feet deep would be required. To obtain the necessary depth and width required, in some instances, may require buying a larger plot of land than is needed.

For computational purposes, a tract of land 20 acres in size is considered. This should adequately handle the proposed increase in size of milking and dry herd.

Stanchion Barns

The largest investment in terms of fixed costs for this type operation would be in housing. The stanchion barns would constitute the largest single housing cost.

For a herd of 400 milking cows, four stanchion barns, each housing 100 milking cows would be provided. The size of the barn would be 30 feet wide by 210 feet long with stalls facing in. The barn would be built of frame construction, utilizing the panelized-section type of construction.

Conventional type foundations would be provided and provisions made for mounting a sill on the foundation. Panel sections, prefabricated at a lumber yard or supplier would then be placed on the sill and fastened. Truss rafters would also be prefabricated by the supplier and placed on the wall sections, four foot on centers. Two by

four ribs would be placed perpendicular to the rafter to which metal roof covering would be attached.

The outside and inside covering of the panel sections would be covered with 3/8" C-C grade exterior plywood. Two inch insulation would provide adequate insulation for winter months and also keep temperatures lower in the summer. Windows would be provided every 8 feet to allow adequate light and partial ventilation. Ventilation would be further provided by the use of four thermostatically controlled fans for each barn. The inside ceiling would be a covering of 3/8" C-C grade exterior plywood also, with standard thick insulation. Ventilation slots would be provided in the ceiling area.

The floor surface would be concrete with precast gutters and mangers providing a faster and more economical method of pouring the floor. The floor area between wall and gutter and gutter and manger would be easily concreted as there would be no forming to provide for the gutter or manger.

Metal stall dividers without head gates would be provided. One water bowl for each two cows would be placed on the stall support.

An automatic gutter cleaner would facilitate the manure cleaning chores. An auger system with opposite side feeding would run the length of the barn to auger feed to the mangers. Feed would be supplied from the holding silos, one each for two barns with augers automatically delivering the feed to the auger system from the storage silos.

Milking facilities

Milking facilities would be provided by a double-four milking parlor with an attached milk room for the 400 milking cow herd size.

Cows would be milked in lots of 100 requiring about 2 1/2 hours per shift per lot. This would mean that the milking facilities would be utilized 20 hours per 24-hour day. Milking parlor facilities would also allow for easier and faster milking conditions with this large number of cows.

A holding area large enough for a milking herd would allow the herdsman to let all his cows loose and milk them non-stop. After milking, cows would return to either the holding area or to the stanchion barn.

Four 600 gallon bulk tanks would be provided in the milk house, one for each 100 cow milking herd. A composite milk record could be determined by measuring each tank each day and keeping a daily herd record of milk produced.

Milking units and pipeline facilities would need to be cleaned only once each day. A Cleaned-in-Place unit would provide a labor saving device for cleaning the pipeline and milking equipment. Teat cup units would be furnished for each herd. Each milker would be responsible to clean and service his milker teat cup unit.

Dry Cow Loafing Area and Lot

Adequate space for 80 dry cows would be necessary for replacement cows. Based on a 20 percent replacement of the milking herd, 80 cows would provide the necessary number of replacements.

A loafing barn 30 feet wide and 160 feet long would provide 60 square feet of loafing space per cow. Eight permanent and eight movable maternity pens would be provided in the loafing building for calving by the dry cow herd. A small feed storage bin would provide feed for the calving cows. Water would also be provided to the maternity pens for easy choring facilities.

Wood chips or sawdust would provide bedding for dry cows and for the stanchion barns. Bedding would be spread from a self-unloading wagon each day with manure building up into an accumulative manure pack. Adequate head room would be necessary to allow for 2 1/2 to 3 feet of manure pack. Manure would be hauled from the loafing barns twice a year.

Lot space 50 feet wide and 160 feet long would provide 100 square feet per cow. The lot would be hard surfaced and manure mounded about twice a week.

Cows would be fed daily by the use of a self-unloading wagon into concrete fenceline bunks. The feeding and cleaning crew would be responsible for taking care of the dry cow herd.

Feed Handling Facilities

Feed handling facilities would be centered about a 52 foot wide by 100 foot long clear-span building.

A continuous-flow type grinding and mixing unit would be located in this building with overhead bins for discharge into feed wagons. The mill would have a capacity of approximately 8 tons per hour. A small batch mixer would also be provided to pre-mix minerals and protein supplements.

Holding bins would be provided with 15 ton capacities, one each for protein and oats and two for corn. Another bin with storage capacity of 20 to 25 tons would also be provided for the processed concentrate.

Weighing facilities for metering out batches of processed feed into the self-unloading wagons would be provided. Necessary conveying equipment for transferring feed from storage bins to the grinding area would also be provided.

Bin capacity for processed and unprocessed feed would be approximately 80 tons. This would provide adequate storage capacity for about 30 days.

The barn storage silos would hold about an additional 200 tons of complete feed mixture. Dry cows would be fed from the feed storage and feed handling building each day.

Table 8. Feed Requirements for 480 Cow Dairy Herd

Type of feed		Amount Per day	Per mo.	Per year
Corn silage	lbs.	21,600	648,000	7,254,000
	tons	10 4/5	324	3,627
Chopped alf.-mol.	lbs.	7,200	216,000	2,628,000
	tons	3 3/5	108	1,314
Concentrate	lbs.	4,800	144,000	1,752,000
	tons	2 1/5	72	876
	Total tons	16 3/5	504	5,817

Feed Storage Facilities

The bulk of the feed storage, in terms of processed feed, would be provided by the barn storage silos. The large trench silo would provide storage for about 4/5 of the unprocessed feed.

Enough storage for approximately 60 tons of alfalfa-molasses would be provided as the supplier would undoubtedly not be able to supply a month's needs in one or two days. A silo 20 feet in diameter by 30 feet high would be necessary to store approximately 60 tons of the chopped alfalfa-molasses mixture. A conveyer to the weighing equipment inside the feed processing building would allow a continuous flow of this feed product.

The largest feed storage need would be that of corn silage. A trench silo with concrete floor and concrete side walls would be provided for approximately 4,000 tons of corn silage. A silo 100 feet

wide, 125 feet long and 20 feet deep would provide the necessary capacity. The silo would be constructed so as to be half in and half out of the ground. Excavated soil would be mounded on both sides of the silo to provide support for the concrete walls. Adequate drainage would be necessary to prevent water flowing into the silo.

Silage would be purchased delivered to the silo. The silage would be pushed into the bunker by the use of a track-type tractor with an attached bulldozer blade. Cost of silage delivered to the silo is assumed to be $7.00 per ton for feed cost computations. A hard surfaced apron and approach to the silo would be provided for all-weather use. Silage would be loaded each day for feeding dry cows and every two weeks for filling the storage silos. Silage would be loaded by the use of a silage loader with approximately 30 tons per hour capacity.

Cow Hospital Facilities

Facilities to handle diseased and/or injured cows would be provided by a 36 foot wide and 40 foot long building to isolate animals from the milking and dry herds. This building would provide 12 hospital pens each 9 by 12 feet in size. Additional pens for cows would be provided by the use of movable pens in the dry cow loafing barn. These pens would be used for non-contagious diseases and for injured animals that would not require isolation.

Water and a feed supply would be provided in the hospital building for hand feeding of the sick or injured cows.

Adequate space for necessary medicines and treatment supplies should also be available in the hospital building. A run-around pen 20 feet by 40 feet adjacent to the hospital barn would be used for recuperatory animals. This would be especially useful when weather conditions would allow outside activities for these animals.

Water Facilities

An adequate water supply would be provided to allow approximately 50 gallons of suitable water per cow per day. This would require a water source of approximately 25,000 gallons of water per day.

Water would be piped to the stanchion barn, to the dry cow lot, to the hospital barn, to the milking facilities and to the management office.

The water pressure at the milking parlor would be boosted to provide adequate pressure to flush down the parlor and the holding area.

Since the cost of drilling a well varies widely in different areas, the cost factor is difficult to compute. The cost of a well for this study was based on a 200 feet deep well, complete with pump.[22]

Management Office Space

Space in the feed processing building would be provided for office facilities. A room 12 feet wide by 16 feet long would provide

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[22] U. S. Bureau of Reclamation, unpublished Budget Data E-128.

approximately 200 square feet of floor space for a desk, filing cabinet and counter. Toilet facilities would also be located in this area.

Equipment Storage Facilities

Since the feed processing building has adequate space for expansion, some of the area in this building can be used for storage of equipment.

The drive-through area would be adequate to hold a minimum of two tractors and a self-unloading wagon. The other unloading wagon need not necessarily be housed. The crawler-type tractor could be covered with a tarpaulin as it would be used only at certain seasonal periods. Manure wagons would necessarily be placed at the unloading points of the stanchion barns and would not be housed.

For the 480 cow herd size dairy, no additional equipment housing would be planned.

Layout and Requirements for a 960 Cow Dairy Herd

Stanchion Barns

The same type of stanchion barns would be used for the addition of 400 more milking cows. This would necessitate the addition of four more stanchion barns with capacities of 100 milking cows each.

Since these barns would utilize the existing milk room, the barns would be placed in exactly the same corresponding position, only on the opposite side of the milking parlor, (Figure II).

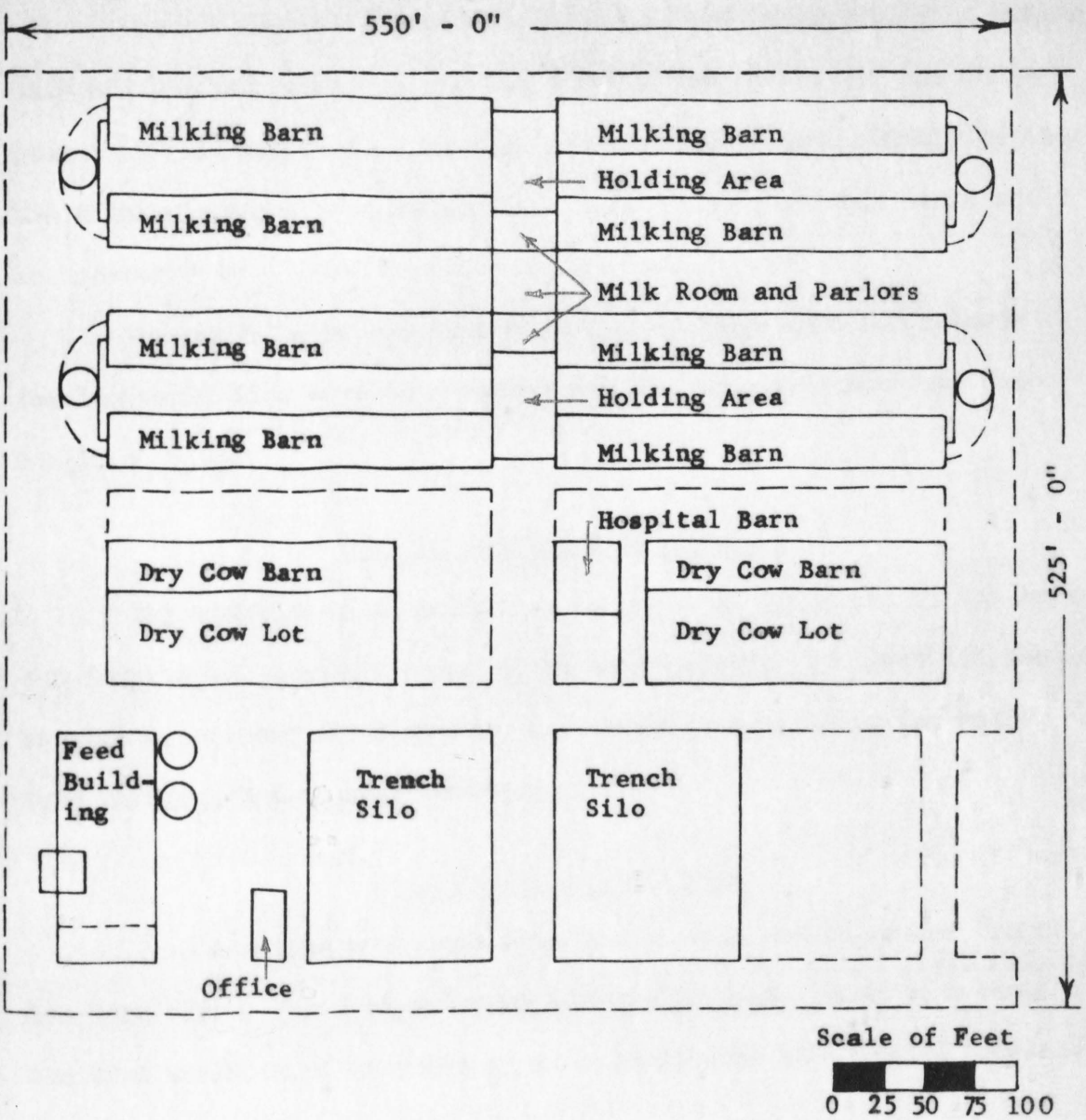

Figure II. Proposed Layout For 960 Cow Dairy Herd - Stanchion Barns

Milking Facilities

The addition of a second double-four herringbone milking parlor unit and holding pen would provide milking facilities for the additional 400 milking cows. The milk house would be used jointly by the two milking parlors simultaneously. Four additional bulk tanks would be necessary to provide adequate milk storage space.

The addition of a bulk concentrate storage unit for metered feeding would also have to be added for the second double four herringbone unit.

Dry Cow Loafing Area and Lots

The addition of a second dry cow unit as explained in the layout for the 480 cow dairy herd would be required. The location should be next to or near the first dry cow facilities to allow for easier feed handling and choring methods.

Feed Handling Facilities

Feed handling would continue by the same method as for the 480 cow herd size. The feed grinding and mixing unit, being of a continuous type would be of adequate size to handle the anticipated increase in the herd size.

Feed holding bins for the 480 cow herd size would also be adequate for this size herd.

Table 9. Feed Requirements for a 960 Cow Dairy Herd

Type of feed		Amount Per day	Per month	Per year
Corn silage	lbs.	43,200	1,296,000	14,508,000
	tons	21 3/8	648	7,254
Chopped alf.-mol.	lbs.	14,400	432,000	5,256,000
	tons	7 1/5	216	2,628
Concentrate	lbs.	9,600	288,000	2,504,000
	tons	4 2/5	144	1,752
	Total tons	33 1/5	1,008	11,634

Feed Storage Facilities

The addition of two more feed storage silos near the stanchion barns would be required. Also another processed feed storage bin with a capacity of approximately 15 tons would be added to increase the reserve concentrate mixture.

A steel bin 20 foot in diameter by 15 foot high would be added to increase the corn storage capacity by approximately 125 tons. The ground alfalfa-molasses storage would be increased to a 20 foot diameter by 50 foot high silo.

Corn silage capacity would be required for approximately 8,000 tons. An additional trench silo of the same capacity as for the 480 cow herd size would be necessary.

Cow Hospital Facilities

Facilities for sick and injured cows should be increased to a building 36 feet wide by 80 feet long with a run-about pen of the same size. Otherwise hospital facilities would be similar to those provided for the 480 cow herd size.

Water Facilities

An adequate water supply to furnish about 50 gallons of water per cow per day as indicated for the 480 cow herd size would again be required. The capacity of the existing water system would be increased or an additional well drilled to provide approximately 50,000 gallons of water daily.

Water would be provided to the additional barns, milking parlor and to the management office.

Management Office

A management office would be provided to allow adequate space for full-time office help. An office building 20 feet wide by 30 feet long, comprising 600 square feet of space should be adequate. Space would be allotted to a general office room, a private office for the manager and toilet facilities.

Equipment Storage Facilities

With the increase of equipment, an equipment shed 30 feet wide by 50 feet long would be provided. Tractors and other motorized equipment would be given storage priority.

Layout and Requirements for 1,440 Cow Dairy Herd

For a herd of 1,440 cows, additional stanchion barns would be necessary to bring the milking barn capacity to 1,200 cows. Twelve stanchion barns would be required (Figure III). A third dry cow unit would be necessary to handle the additional reserve dry cows. The housing facilities as indicated are increased in proportion to the increase in size of herds. However, other facilities and equipment requirements are not proportionate to the increase in size of herds, therefore, economy of scale is evident.

Feed storage facilities would have to be increased to handle the additional number of cows. Two feed storage silos would be required for the processed feed plus additional storage space for unprocessed feed. A 30 foot diameter by 50 foot high silo for chopped alfalfa-molasses would increase the storage of this feed to approximately 230 tons. The silo previously used for alfalfa-molasses storage would be strengthened and used for corn storage. The 20 foot in diameter by 15 foot high steel bin previously used for corn storage would be used for oats storage. Protein storage would be increased by adding another storage bin in the feed handling building. A third trench silo would also be added.

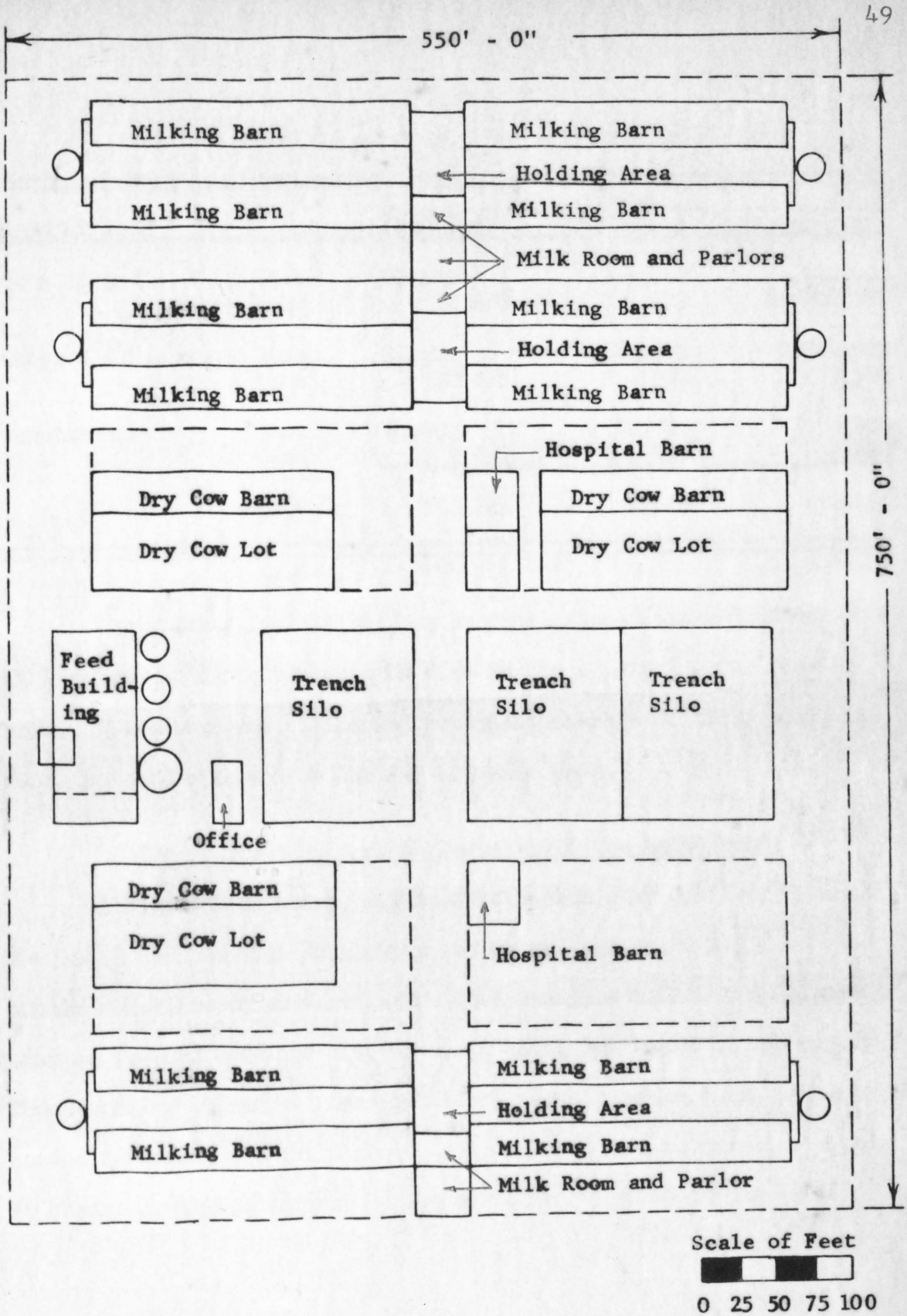

Figure III. Proposed Layout For 1,440 Cow Dairy Herd - Stanchion Barns

Table 10. Feed Requirements for 1,440 Cow Dairy Herd

Type of feed		Amount		
		Per day	Per month	Per year
Corn silage	lbs.	64,800	1,944,000	21,762,000
	tons	32 2/5	972	10,881
Chopped alf.-mol.	lbs.	21,600	648,000	7,884,000
	tons	10 4/5	324	3,942
Concentrate	lbs.	14,400	438,000	5,256,000
	tons	7 1/5	219	2,628
	Total tons	50 2/5	1,515	17,451

The milking facilities, cow hospital facilities and water facilities would be increased in size as the original model for 480 cows. The management office and equipment storage building would remain the same size as for the 960 cow size herd.

Layout and Requirements for a 1,920 Cow Dairy Herd

The stanchion barns, milking facilities, dry cow loafing area and lots, cow hospital facilities and water facilities would be essentially a double 960 cow unit. The feed handling building would be the same as for the previous size of 1,440 cows, but would be nearing its feed handling capacity. Four additional feed storage silos would be needed and the equipment storage building would be increased in size. No change in the management office would be required (Figure IV).

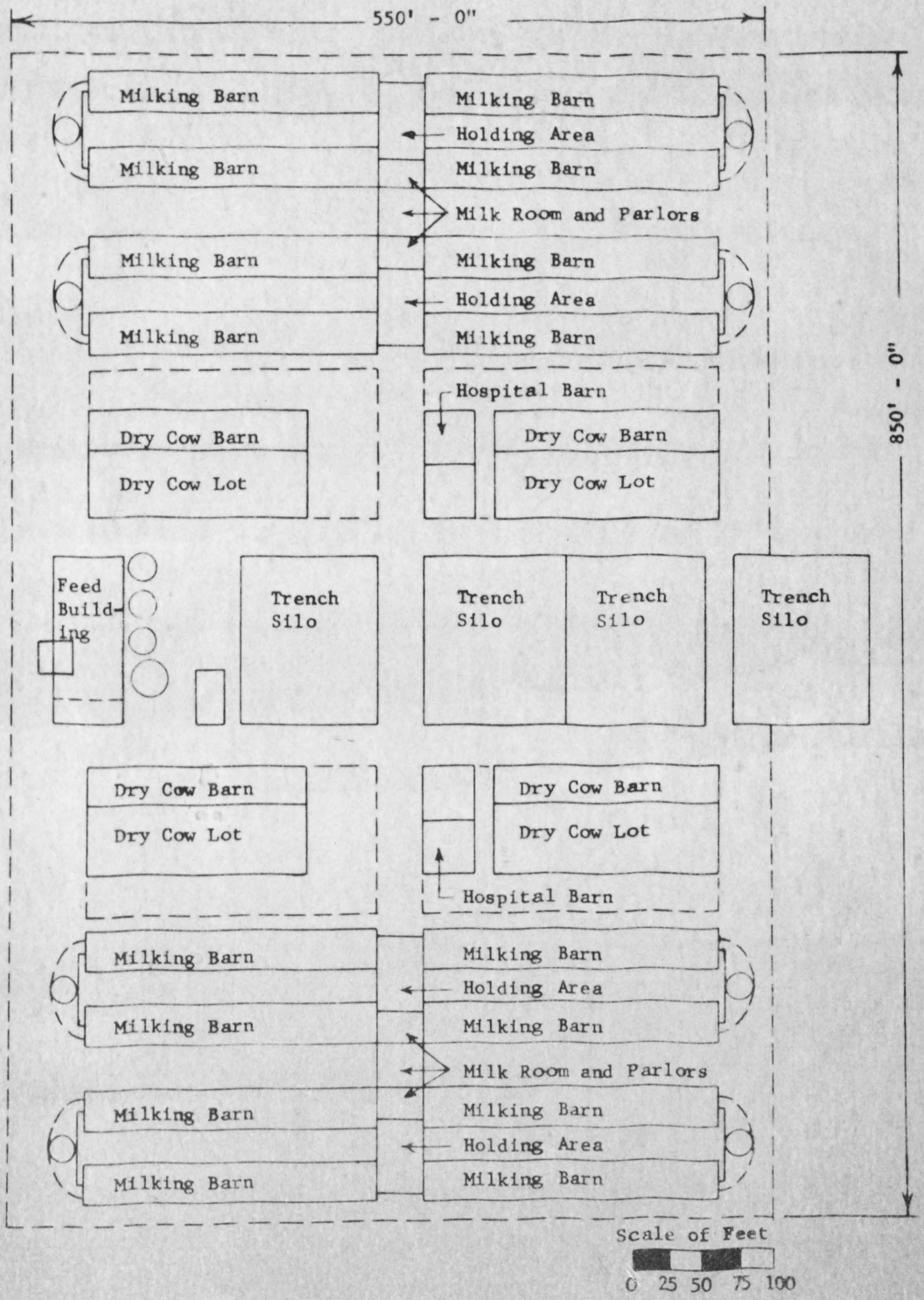

Figure IV. Proposed Layout For 1,920 Cow Dairy Herd - Stanchion Barns

Table 11. Feed Requirements for 1,920 Cow Dairy Herd

Type of feed		Amount		
		Per day	Per month	Per year
Corn silage	lbs.	86,400	2,592,000	29,016,000
	tons	43 1/5	1,296	14,508
Chopped alf.-mol.	lbs.	28,800	864,000	10,512,000
	tons	14 2/5	432	5,256
Concentrate	lbs.	19,200	576,000	7,008,000
	tons	8 4/5	288	3,504
	Total tons	66 2/5	2,016	23,268

An analysis of the costs for the stanchion barn system is shown in Chapter VI.

CHAPTER V

SUGGESTED LAYOUT FOR LOOSE HOUSING SYSTEM

The loose housing layout, resembles a wheel-and-spoke arrangement. Some southwestern dairies use this layout arrangement, but several modifications must be made due to climatic and topographical variations.

The size of the milking herd and the number of dry cows will be exactly the same as illustrated in the chapter on the stanchion barn system.

Amount of feed required will not be indicated in this chapter but can be referred to, if needed, from the previous chapter.

Methods of management will be the same basic procedures as in the stanchion barn system. One dairyman would be responsible for a herd of 100 milking cows. He would milk the cows, observe for heat periods, check any unusual signs or abnormalities of the herd and would be in charge of all husbandry practices.

Layout and Requirements for a 480 Cow Dairy Herd

Facilities for the loose housing system will bear several resemblances to that of the stanchion barn system. Where there is no change from the previous system, the reader will be referred to the specific herd size facilities in Chapter IV. There will, however, be specific differences and these will be explained.

The major types of facilities are as follows: (1) land, (2) lots, (3) loafing barns, (4) feed handling facilities, (5) feed storage facilities, (6) cow hospital facilities, (7) milking facilities, (8) water facilities, (9) management office, and others such as equipment shelter (See Figure V).

Land

Based on an assumed expansion for a capacity of four times the original sized dairy, adequate land would be purchased to allow for this growth. A lot approximately 750 feet wide and 800 feet deep would be necessary for the dairy herd size of 480 cows. The site area necessary for 1,920 dairy cows would be approximately 925 feet wide and 1,550 feet deep, which would be approximately 35 acres. To obtain the necessary depth and width in some instances may necessitate the purchase of more acreage than is needed.

Lots

A total of five lots would be needed for the herd of 480 dairy cows. One lot for the dry cows and four lots, each holding 100 cows for the milking herd. Space needs would be "300 to 500 square feet of lot space per cow on a well-drained lot,"[23] with enough hard surfacing to keep the cows dry and clean.

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[23]Physical Requirements for Large Dairy Herd Operations, op. cit. p. 2.

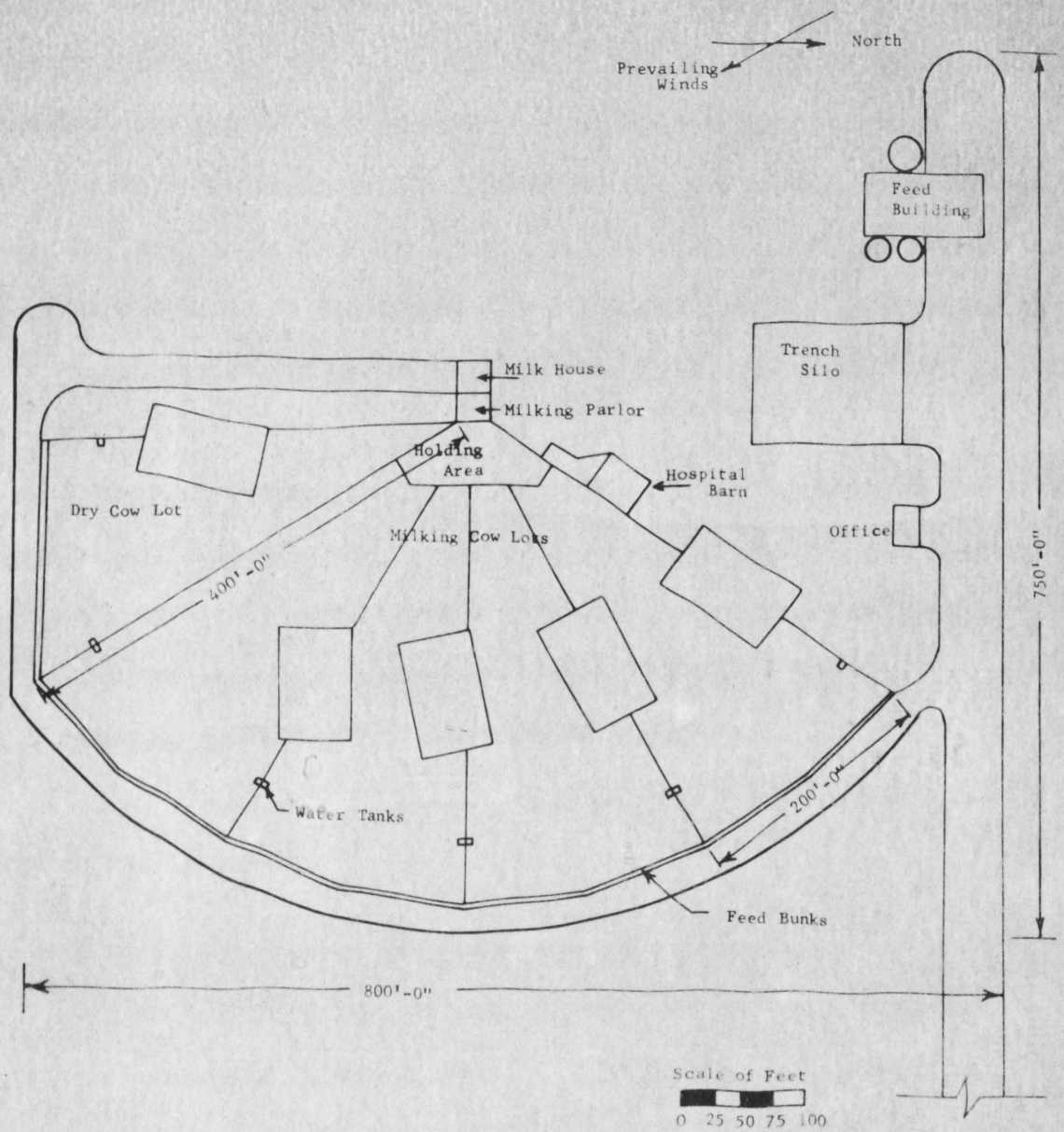

Figure V. Proposed Layout For 480 Cow Dairy Herd - Loose Housing System

The milking cow lots would be pie-shaped, 200 feet wide at the widest end and approximately 325 feet long, which would provide about 300 square feet of lot space per cow. The dry cow lot would have a smaller area but would be occupied by 80 cows instead of 100.

Since drainage and lot conditions are one of the major handicaps to loose housing dairy systems in the midwest, adequate hard surfaced area should be available. To allow for adequate hard surfaced lot space, feeding area, holding area and loafing area, a total of 200 square feet of concrete is assumed.

Hard surfacing, but of bituminous material is provided for a 10 foot runway bordering the concrete bunks on the wide edge of the pie-shaped lots. This would be necessary for all-weather feeding operations.

Drainage would be given special recognition, and would be dependent upon the specific site that would be considered.

The holding area would be enclosed with sliding doors and hard surfaced with a large drainage pool.

Loafing Barns

Five loafing barns, 60 feet by 100 feet would be suggested to give the necessary 60 square feet of loafing space for each cow. The space considered would be more than suggested for the dry cows but with provisions for maternity pens, the space would not be excessive.

The loafing barns could be built of either pole-type construction or of a clear span method. One of the main provisions to consider is to be able to clean out the barn with a tractor loader.

Bedding would be spread by a self-unloading wagon but for very cold periods of the year reserve bedding storage would be provided in the loafing barns.

Feed Handling Facilities

The feed handling facilities would be the same as those suggested for the stanchion barn system. However, the feed handling facilities would be used more extensively on a routine basis, as all the cows in the herd would be fed each day by the fenceline bunk.

Feed Storage Facilities

Storage space, based on the same feeding rates, would have to be materially increased. Space provided by the barn storage silos would have to be compensated by the addition of storage space for unprocessed feed near the feed handling building.

Adequate storage is suggested for approximately a 30 to 60 day reserve. To allow storage for this reserve, the following storage facilities would be necessary: Alfalfa-molasses mixture, a 30 by 50 foot silo which would provide storage for about 320 tons of this material. Corn storage for about 210 tons would be contained in a 20 by 30 foot silo and oats storage for approximately 60 tons would be provided in a 3,300 bushel steel bin. Storage bins in the feed handling building would also have a capacity for approximately 60 tons of unprocessed feed. Included in the bin capacities would be space for handling bulk protein.

Corn silage storage would be handled exactly the same as by the stanchion barn system. For the 480 cow dairy, a trench silo 100 feet wide, 125 feet long and 20 feet deep would store approximately 4,000 tons of corn silage.

Cow Hospital Facilities

Cow hospital facilities would be the same as those suggested for the 480 cow herd size in the stanchion barn system.

Milking Facilities

Milking parlor and milk house would be exactly as described for the 480 cow herd size, however, the holding area would differ in respect to shape and location.

Water Facilities

Capacity of the water system would be the same in this system as in the stanchion system. Water would be available to automatically heated waterers in each lot. Otherwise water would be supplied to counterparts of this system as to the stanchion barn system.

Management Office

The management office would be provided in the feed handling building the same as suggested for the 480 cow herd size stanchion barn system.

Equipment Facilities

Equipment storage facilities should be the same as suggested for the stanchion barn system of the same size.

Layout and Requirements for a 960 Cow Dairy Herd

Essentially a unit identical to the one described for 480 cows would be added to the half-wheel arrangement. The lot facilities, milking parlor and holding area would be identical as previously explained, attached to the opposite side of the milk house (See Figure VI). Four additional milk coolers would be added to the suggested layout to provide adequate milk storage facilities.

Water facilities and hospital facilities would both be doubled to handle the increased size of the herd. Feed storage facilities would be increased but not proportionate to the increase in herd size.

The addition of a management office as indicated for the 960 cow herd size, stanchion barn system, would be suggested.

Layout and Requirements for 1,440 Cow Dairy Herd

In order to facilitate feed handling and manure removal, the placement of additional units should be considered. The addition of a unit like the 480 cow herd size unit would be added adjacent to the feed handling facilities as indicated in Figure VII. An arrangement like this should provide for least distance traveled for feed distribution and for water routing.

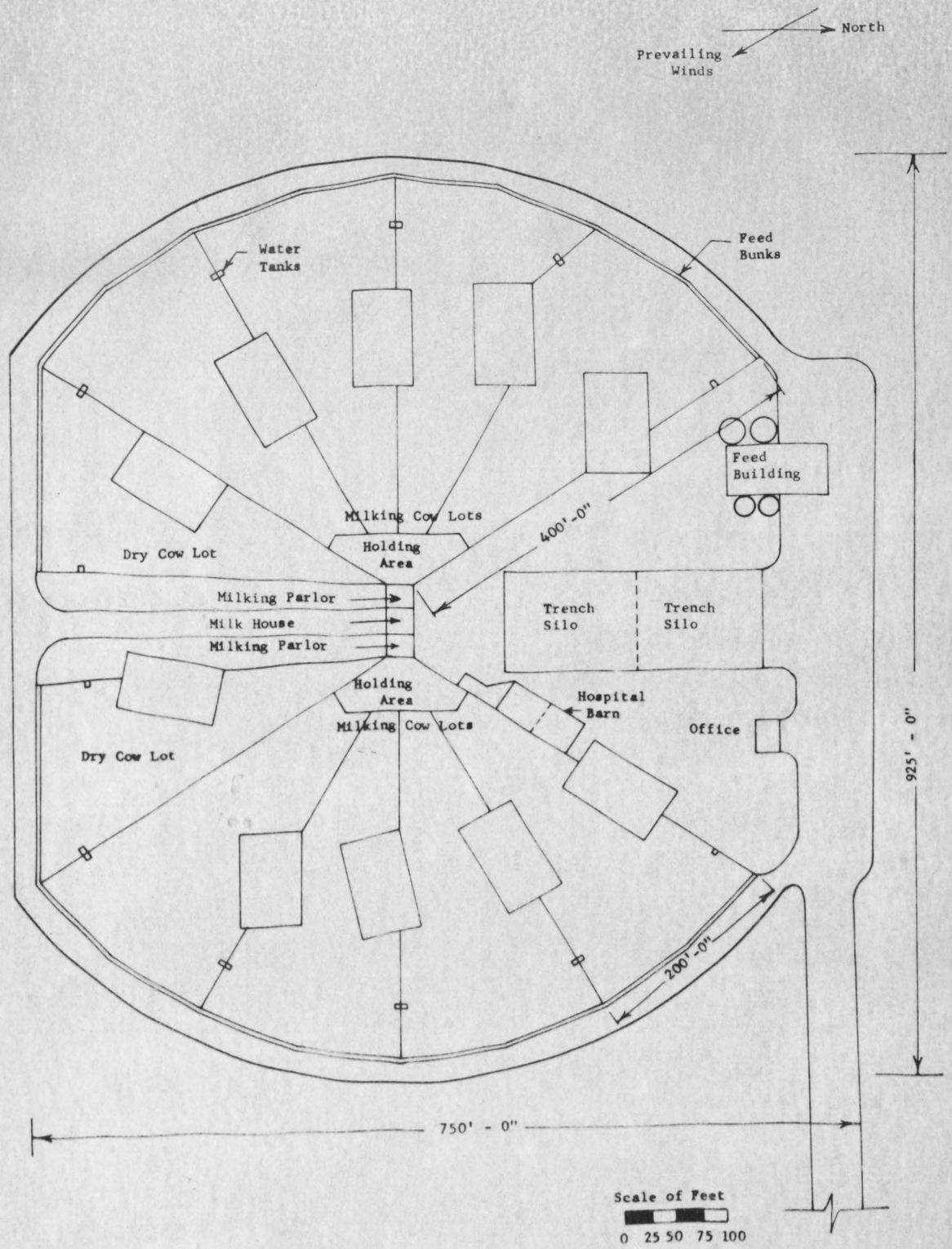

Figure VI. Proposed Layout For 960 Cow Dairy Herd - Loose Housing System

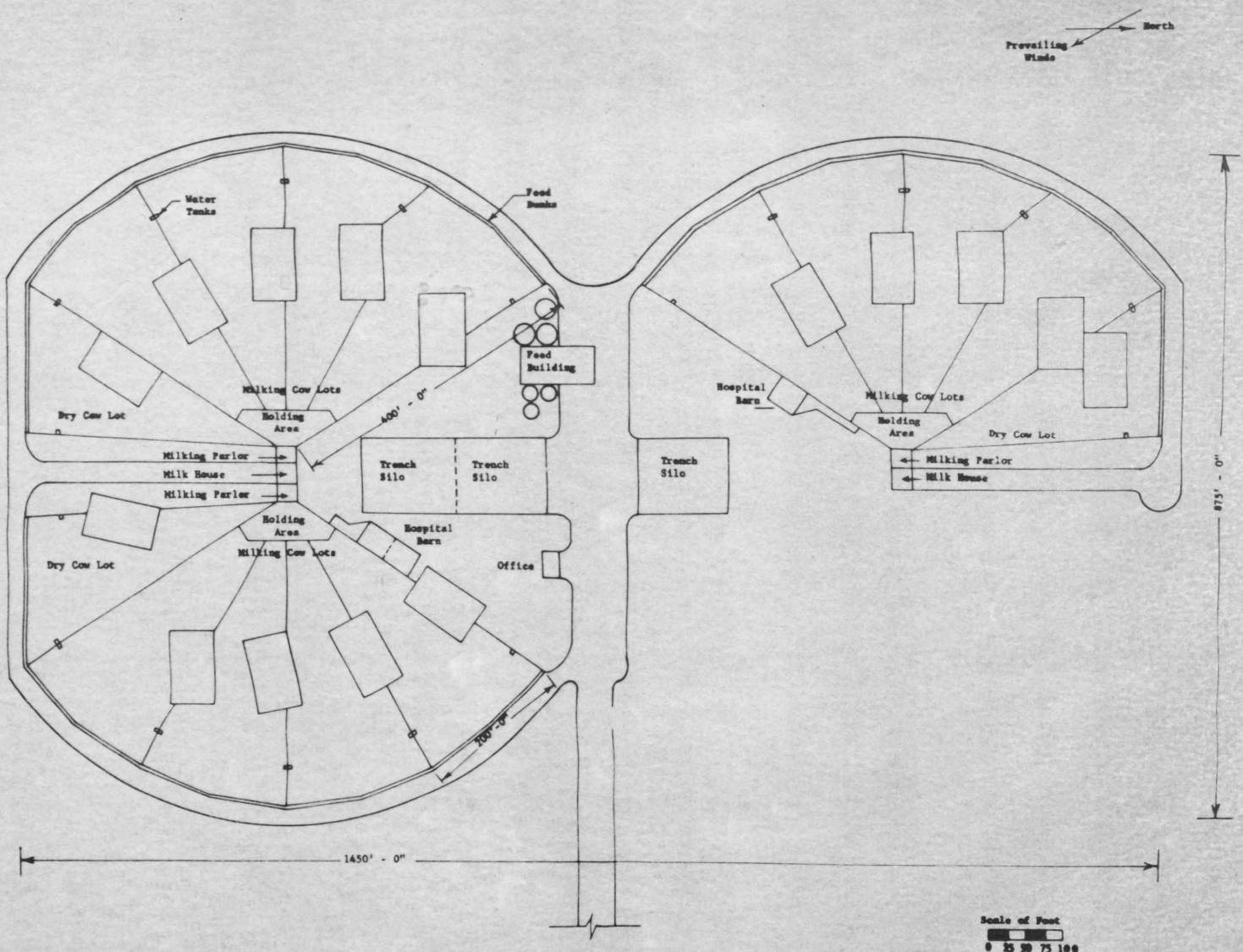

Figure VII. Proposed Layout For 1,440 Cow Dairy Herd - Loose Housing System

Other facilities to increase would be the hospital barn and water facilities. Feed storage would again be increased to handle the increased herd size. By the addition of these facilities, and the suggested facilities as described for the 1,440 cow herd size in the stanchion barn system, the unit would be complete as suggested.

Layout and Requirements for 1,920 Cow Dairy Herd

The maximum size considered in this study would be two units as suggested for the 960 cow herd size with feed handling facilities between them (See Figure VIII).

Water facilities and cow hospital units would be increased by the amount necessary for a 480 cow herd size. Feed storage facilities would be increased by a like amount as for the preceding herd size. Other facilities and procedure would be the same as described for either in the similar sized operation or in this chapter for the loose housing system.

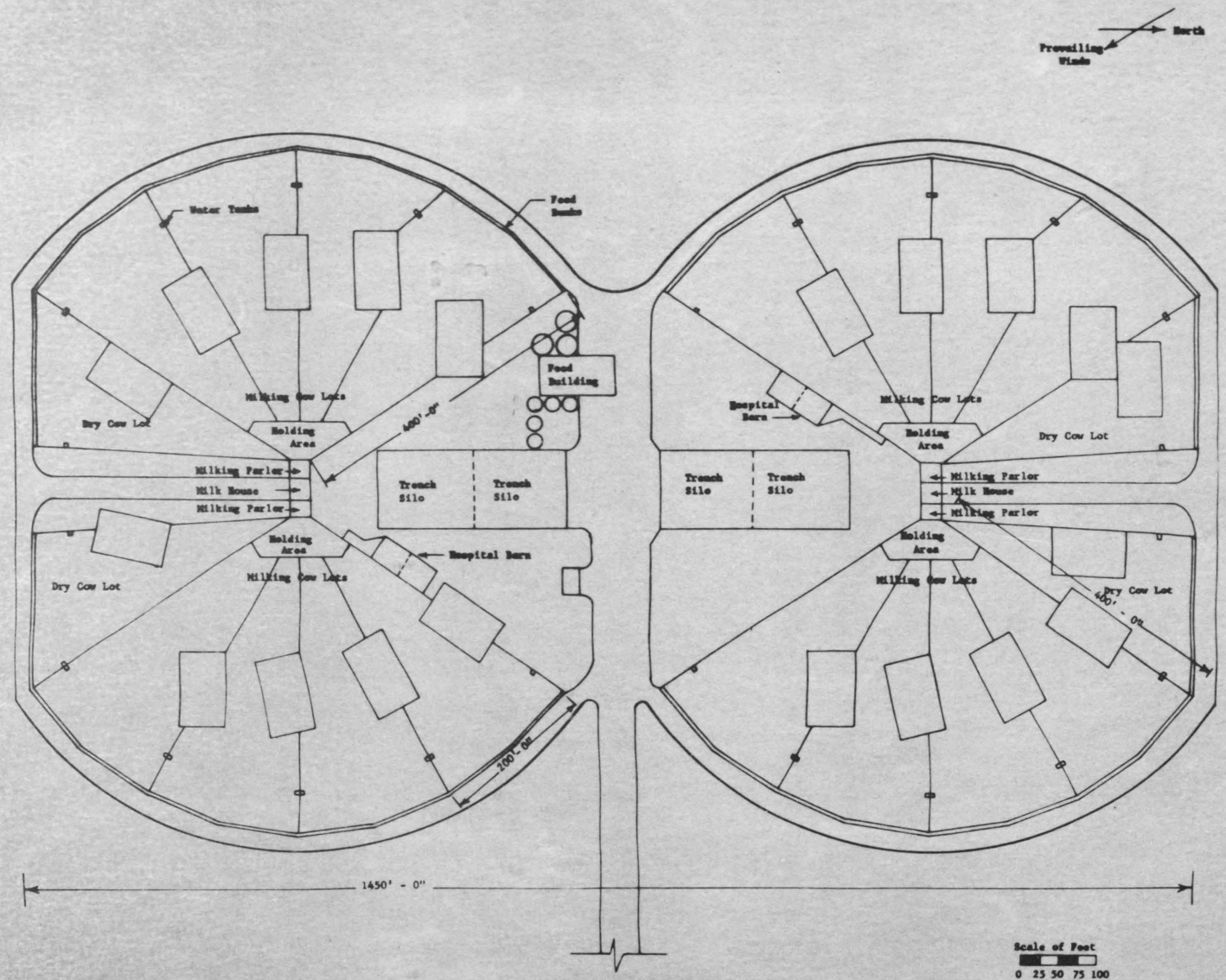

Figure VIII. Proposed Layout For 1,900 Cow Dairy Herd - Loose Housing System

CHAPTER VI

COST AND RETURN ANALYSIS OF SURVEYED DAIRY HERDS AND HYPOTHETICAL DAIRY SYSTEMS

The analysis of costs is a comparison of the cost of production on a per herd, per cow and per hundredweight of milk basis. The comparisons are made of the costs and returns of the large dairy herds surveyed with the eight hypothetical models described.

Investment costs are also compared and are categorized as to the amount allotted to land, buildings, equipment, cow cost, feed cost, labor cost and miscellaneous cost.

In order to clarify some of the inputs costs, definition of the inputs and rates used are indicated. All costs for the hypothetical model dairy systems were determined from rates obtained from current sources[24] and interviews with equipment dealers and building supply companies.

For purposes of this analysis, costs of land, buildings and equipment for the hypothetical dairy systems were divided into fixed and variable costs (see Tables 12 and 13 and Figure IX). Fixed costs include depreciation, interest on investment, taxes and insurance. Depreciation of buildings were calculated on a 20-year basis and

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[24]Helfinstine, Rex, Economic Comparison of Irrigated and Dryland Farming in Central South Dakota, Economics Department, Agricultural Experiment Station, South Dakota State College, Brookings, South Dakota, Preliminary Draft, February, 1963.

Table 12. Fixed and Variable Costs per Year of Land, Buildings and Equipment - 480, 960, 1,440 and 1,920 Cow Dairy Herds - Stanchion Barns

Item	Initial Investment	Fixed cost[a]	Variable cost[b]	Cost per year	Cost per cow/year	Cost per cwt. milk
Land	$ 5,000	$ 288	$ -	$ 288	$ .60	$ .0050
Buildings & improv.	145,669	15,659	6,873	22,532	46.94	.3912
Equipment	50,966	8,709	4,807	13,516	28.16	.2346
480 Cow Total	201,636	24,656	11,680	36,336	75.70	.6308
Land	5,000	288	-	288	.30	.0025
Building & improv.	279,180	30,012	13,380	43,392	45.20	.3767
Equipment	77,048	13,011	8,618	21,629	22.53	.1877
960 Cow Total	361,228	43,311	21,998	65,309	68.03	.5669
Land	5,000	288	-	288	.20	.0017
Buildings & improv.	413,510	44,452	19,877	64,329	44.67	.3723
Equipment	100,011	16,802	12,306	29,108	20.21	.1684
1,440 Cow Total	518,521	61,542	32,183	93,725	65.08	.5424
Land	5,000	288	-	288	.15	.0012
Buildings & improv.	538,420	57,880	26,043	83,923	43.71	.3642
Equipment	120,703	20,216	15,902	36,118	18.81	.1568
1,920 Cow Total	664,123	78,384	41,945	120,329	62.67	.5222

[a]Fixed costs include depreciation, interest on investment, taxes and insurance.
[b]Variable costs include repairs on buildings and equipment, electricity and gasoline.

Table 13. Fixed and Variable Costs per Year of Land, Buildings and Equipment - 480, 960, 1,440 and 1,920 Cow Dairy Herds - Loose Housing System

Item	Initial investment	Fixed cost[a]	Variable cost[b]	Cost per year	Cost per cow/year	Cost per cwt. milk
Land	$ 10,000	$ 575	$ -	$ 575	$ 1.20	$ .0099
Buildings & improv.	128,960	13,863	5,073	18,936	39.45	.3288
Equipment	53,238	9,084	5,286	14,370	29.94	.2494
480 Cow Total	192,198	23,522	10,359	33,881	70.59	.5881
Land	10,000	575	-	575	.60	.0059
Buildings & improv.	235,071	25,270	9,406	34,676	36.12	.3010
Equipment	74,839	12,648	9,306	21,954	22.87	.1905
960 Cow Total	319,910	38,493	18,712	57,205	59.59	.4965
Land	10,000	575	-	575	.40	.0033
Buildings & improv.	336,408	36,164	13,533	49,697	34.51	.2876
Equipment	99,424	16,703	13,447	30,150	20.94	.1744
1,440 Cow Total	445,832	53,442	26,980	80,422	55.85	.4653
Land	10,000	575	-	575	.30	.0025
Buildings & improv.	443,625	47,690	17,865	65,554	34.14	.2845
Equipment	121,675	20,376	17,494	37,871	19.72	.1644
1,920 Cow Total	575,300	68,641	35,359	104,000	54.16	.4514

[a]Fixed costs include depreciation, interest on investment, taxes and insurance.
[b]Variable costs include repairs on buildings and equipment, electricity and gasoline.

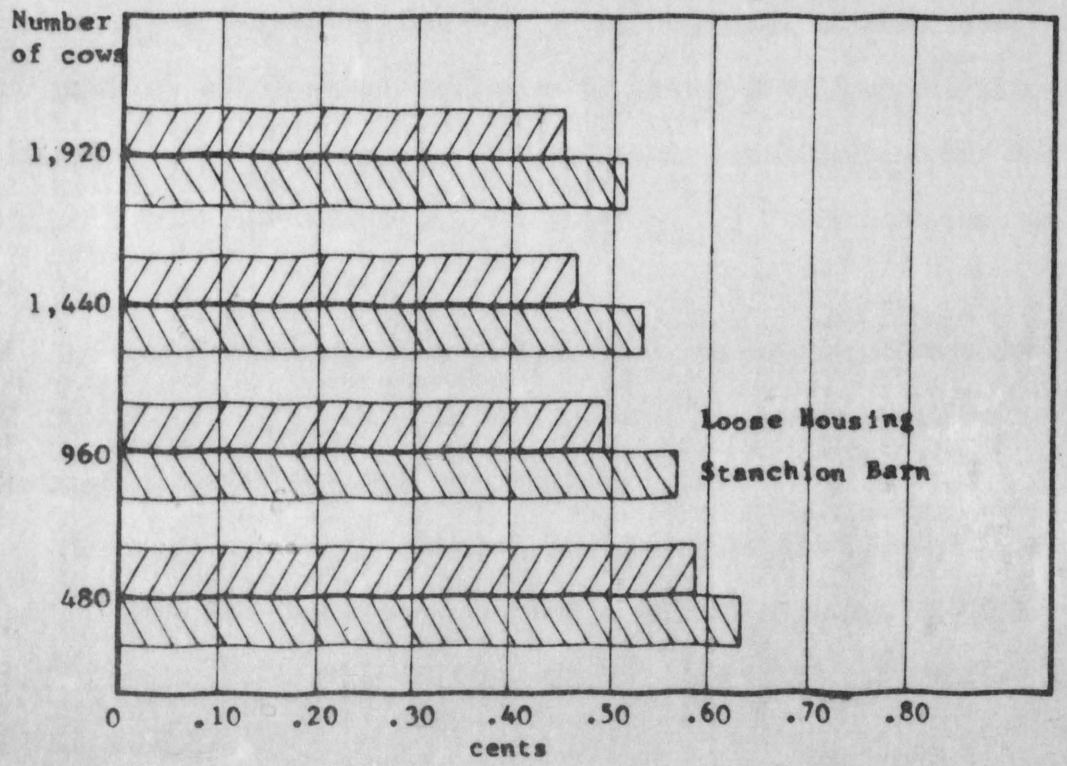

Figure IX. Fixed and Variable Costs of Land, Buildings and Equipment Per Hundred-weight of Milk, Hypothetical Model Dairies

equipment on a 10-year basis. Interest on investment was computed on one-half the investment value, 5 1/2 percent on buildings and improvements and 7 percent on equipment.

Variable costs include items such as electricity, gasoline and repairs. For computational purposes, electricity and gasoline were calculated on the basis of electrical use per animal where data was available and on estimated time-use in the remainder of the cases. Repair cost of buildings was estimated by taking 3 1/2 percent times the original investment cost of the buildings. Machinery repair was estimated in the same manner but 4 percent of the investment cost was used.

Original investment cost of buildings and equipment were derived from Tables 1, 2, and 3 in the Appendix plus correspondence and interviews with machinery and equipment dealers.

Value of land is estimated at $250 per acre for all model dairy systems. Since land value cost is such a small percentage of the over-all investment cost, a differential of $100 per acre would be hardly noticeable.

Feed Cost

Feed cost prices are considered to be estimated long-term prices. In Table 14 below are the commodity prices used for the calculations of feed costs.

Table 14. Feed Prices Used for Calculating Feed Costs

Commodity	Unit	Price
Corn silage[a]	Ton	$ 7.00
Alfalfa-molasses 25%[a]	Ton	32.00
Corn[b]	Bushel	1.00
Oats[b]	Bushel	.55
Soybean meal[c]	Ton	65.00
Salt and mineral[b]	Cwt.	2.60

[a]Silage and alfalfa-molasses delivered to plant.
[b]Price assumptions.
[c]1957-61 5-year average, Minneapolis.

Total feed cost for the model dairies was calculated to be $219.50 per cow which is less than the amount per cow in the existing surveyed herds. However, the amount for actual dairy herds included raising replacements.

Cow Cost

Costs included in cow costs are depreciation, death loss, interest on investment and based on a four year milking life of each cow. Death loss is based on the 3.9 percent average death rate for cows on DHIA production records in South Dakota.[25]

[25]Hall, Hollis, South Dakota 1959 Annual Report, Dairy Herd Improvement Association, Agricultural Extension Service, South Dakota State College, Brookings, South Dakota.

Salvage value is computed on canner and cutter prices, average 1956-60 which was $13.78 per hundredweight.[26]

1,300 lb. cull cow x $13.78 = $179.14
$350.00 purchase price - $179.14 = $180.86
$180.86 ÷ 4 = $45.22 depreciation per year
Death loss of 7.09 per cow
$52.31 depreciation per cow per year.

Interest on cow investment amounted to $10.50 per cow per year as did insurance and taxes. Total cow cost per year including death loss, depreciation, interest on investment, insurance and taxes are calculated to total $73.31 per cow. Since all replacements are purchased, no cost is charged to raising replacements. Replacement purchase price was based on the current market value of dairy cows at time of interviews.

Labor Cost

Labor requirements are computed on the basis of labor needs calculated in Table 6 in the Appendix. Managers salaries are progressive in scale, beginning at $6,000 annually for the 480 cow herd size to $12,000 for the largest herd size. Milkers are considered to earn $350 per month for a 44 hour week. Provisions are also included for each hired worker to take a two weeks' paid vacation and up to two weeks' sick leave per year. Yard workers wages are computed at $300 per month with the same hours and fringe benefits as the milkers.

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[26] Livestock and Meat Statistics, Supplement for 1960 to Statistical Bulletin #230, U. S. Department of Agriculture, Agricultural Marketing Service, Statistical Reporting Service, Economic Research Service, Washington, D. C.

Office help is considered to be female employees with a basic salary of $200 per month.

Day labor for seasonal work is based on a $1.25 per hour wage scale.

Miscellaneous Costs

Included in miscellaneous costs are such items as bedding, breeding fees, veterinary and medicine, office supplies, telephone, lawyer retainer, dues, subscriptions, DHIA costs, cow supplies and interest on operating capital.

The range of miscellaneous costs per cow were $41.20 to $51.16 which was due to differences in amount of bedding used by the loose housing versus stanchion barn system and to the fixed basis of some costs such as lawyer retainer fee, and to some extent telephone expense. The differential of bedding cost of loose housing to stanchion barns was calculated at $6.57 per cow which accounts for most of the variance.

DHIA costs had some economy of scale although of a minor nature. Production record costs were based on South Dakota DHIA testing costs which in most associations is $9.00 for the first 10 cows, plus 25 cents for each additional cow. Also 11 cents per cow for IBM processing.

Miscellaneous costs consisting of breeding fee, veterinary fee, bedding cost and DHIA cost contributed the major portion of this cost.

Total Costs per Herd, per Cow and per Hundredweight of Milk

Total costs per cow ranged from $493.38 for the average of the surveyed dairy herds to a low of $461.38 for the largest herd size in loose housing (See Table 15). This is a differential of $32.00 per cow from the existing herd size of 108 cows to the hypothetical herd size of 1,920 cows.

Cost per hundredweight of milk varied from a high of $4.64 to a low of $3.84 (See Figure X). The lowest cost per unit is in loose housing in the 1,920 cow herd size. This is based on the assumption that cows in the hypothetical dairy herds produce 12,000 pounds of milk per cow.

While this amount of milk is greater than the average for the surveyed dairies, 10,632 pounds per cow, the break-even point for each hypothetical model was also calculated (See Table 16). The break-even production point ranged from 10,691 to 9,963. The upper portion of this range is about the same as the average production of the surveyed herds.

The break-even prices per hundredweight, assuming the 12,000 pounds production per cow, were computed including returns from calves sold. The break-even prices ranged from $3.88 to $3.65 per hundredweight on this basis.

The average cost per cow declined nearly proportionate in the stanchion barn system as compared to the loose housing system (See Figure XI).

Table 15. Total Costs per Herd, per Cow and per Hundredweight of Milk, Surveyed Dairy Herds and Hypothetical Dairy Herds

Item	Surveyed dairy herds (108 cows)	Stanchion barn, Number of cows 480	Stanchion barn, Number of cows 960	Stanchion barn, Number of cows 1,440	Stanchion barn, Number of cows 1,920	Loose housing, Number of cows 480	Loose housing, Number of cows 960	Loose housing, Number of cows 1,440	Loose housing, Number of cows 1,920
Yearly cost per herd									
Land	$ 72.25	$ 288	$ 288	$ 288	$ 288	$ 575	$ 575	$ 575	$ 575
Bldgs. & improv.	4,203.75	22,532	43,392	64,329	83,923	18,936	34,676	49,697	65,544
Equipment	3,943.50	13,516	21,629	29,108	36,118	14,370	21,954	30,150	37,871
Subtotal	8,219.50	36,336	65,309	93,725	120,329	33,881	57,205	80,422	104,000
Feed cost	28,496.00	105,368	210,736	316,104	421,472	105,368	210,736	316,104	421,472
Cow cost[a]	3,031.00	35,189	70,378	105,566	140,755	35,189	70,378	105,566	140,755
Labor cost	7,212.75	38,400	70,200	102,076	135,480	34,200	66,900	98,875	127,950
Miscellaneous	6,204.57	21,401	41,592	60,910	79,101	24,555	47,817	70,371	91,716
Total per herd	53,163.82	236,694	458,215	678,381	897,137	233,193	453,036	671,338	885,893
Yearly cost per cow									
Land	.67	.60	.30	.20	.15	1.20	.60	.40	.30
Bldgs. & improv.	39.01	46.94	45.20	44.67	43.71	39.45	36.12	34.51	34.14
Equipment	36.59	28.16	22.53	20.21	18.81	29.94	22.87	20.94	19.72
Subtotal	76.27	75.70	68.03	65.08	62.67	70.59	59.59	55.85	54.16

Table 15 (con't)

Item	Surveyed dairy herds (108 cows)	Stanchion barn, Number of cows: 480	960	1,440	1,920	Loose housing, Number of cows: 480	960	1,440	1,920
				Yearly cost per cow					
Feed cost	264.46	219.50	219.50	219.50	219.50	219.50	219.50	219.50	219.50
Cow cost	28.13	73.31	73.31	73.31	73.31	73.31	73.31	73.31	73.31
Labor cost	66.94	80.00	73.13	70.88	70.56	71.25	69.69	66.58	66.64
Miscellaneous	57.58	44.59	43.33	42.30	41.20	51.16	49.81	48.87	47.77
Total per cow	493.38	493.10	477.30	471.07	467.24	485.81	471.90	464.11	461.38
				Cost per hundredweight of milk					
Cost per cwt. milk[b]	4.64	4.11	3.98	3.93	3.89	4.05	3.93	3.87	3.84

[a]Includes only interest on investment of cow herd and replacements. Insurance, taxes and depreciation are included in miscellaneous costs and raising of replacements.

[b]Assumed production for hypothetical dairy herds is 12,000 pounds of milk per cow. Surveyed dairy herds is actual production.

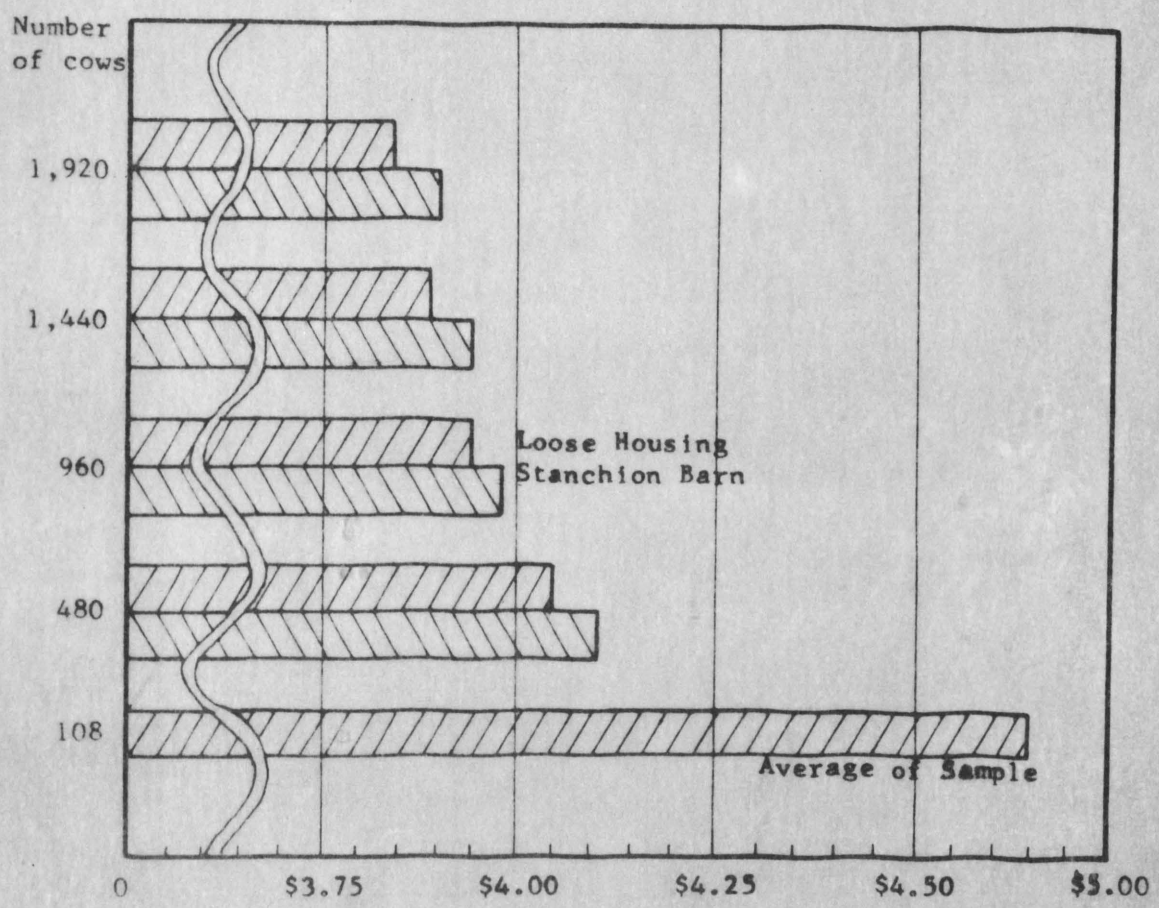

Figure X. Total Cost of Producing Milk Per Hundred-weight, Average of Sample Dairies and 480, 960, 1,440 and 1,920 Cow Hypothetical Model Dairies

Table 16. Return and Cost Comparisons of Surveyed Dairy Herds and Hypothetical Dairy Herds

Returns	Surveyed dairies (108 cows)	Stanchion barn, Number of cows 480	960	1,440	1,920	Loose housing, Number of cows 480	960	1,440	1,920
Milk receipts at $4.36 cwt.	$49,736.38	251,136	502,272	753,408	1,004,544	251,136	502,272	753,408	1,004,544
Other income calves, etc.	490.01	12,960	25,920	38,880	51,840	12,960	25,920	38,880	51,840
Appreciation of dairy herd	5,611.50	-	-	-	-	-	-	-	-
Total income	55,838.35	264,096	528,192	792,288	1,056,384	264,096	528,192	792,288	1,056,384
Gross income per cow	518.22	550	550	550	550	550	550	550	550
Costs:									
Land	72.25	288	288	288	288	575	575	575	575
Bldgs. & imp.	4,203.75	22,532	43,392	64,329	83,923	18,936	34,676	49,697	65,554
Equipment	3,943.50	13,516	21,629	29,108	36,118	14,370	21,954	30,150	37,871
Feed	28,496.00	105,368	210,736	316,104	421,472	105,368	210,736	316,104	421,472
Cows	3,031.00	35,189	70,378	105,566	140,755	35,189	70,378	105,566	140,755
Labor	7,212.75	38,400	70,200	102,076	135,480	34,200	66,900	98,875	127,950
Misc.	6,204.57	21,401	41,592	60,910	79,101	24,555	47,817	70,371	91,716
Total cost	53,163.82	236,694	458,215	678,381	897,137	233,193	453,036	671,338	885,893
Net income	2,674.53	27,402	69,977	113,907	159,247	30,903	75,156	120,950	170,491
Rate of return to management	2.4%	6.96%	9.39%	10.41%	11.12%	8.0%	10.68%	11.84%	12.69%
Break-even point in pounds of milk at $4.36		10,691	10,328	10,186	10,098	10,523	10,234	10,074	9,963
Break-even point in price/cwt. 12,000#/cow		3.88	3.75	3.70	3.67	3.82	3.71	3.66	3.62

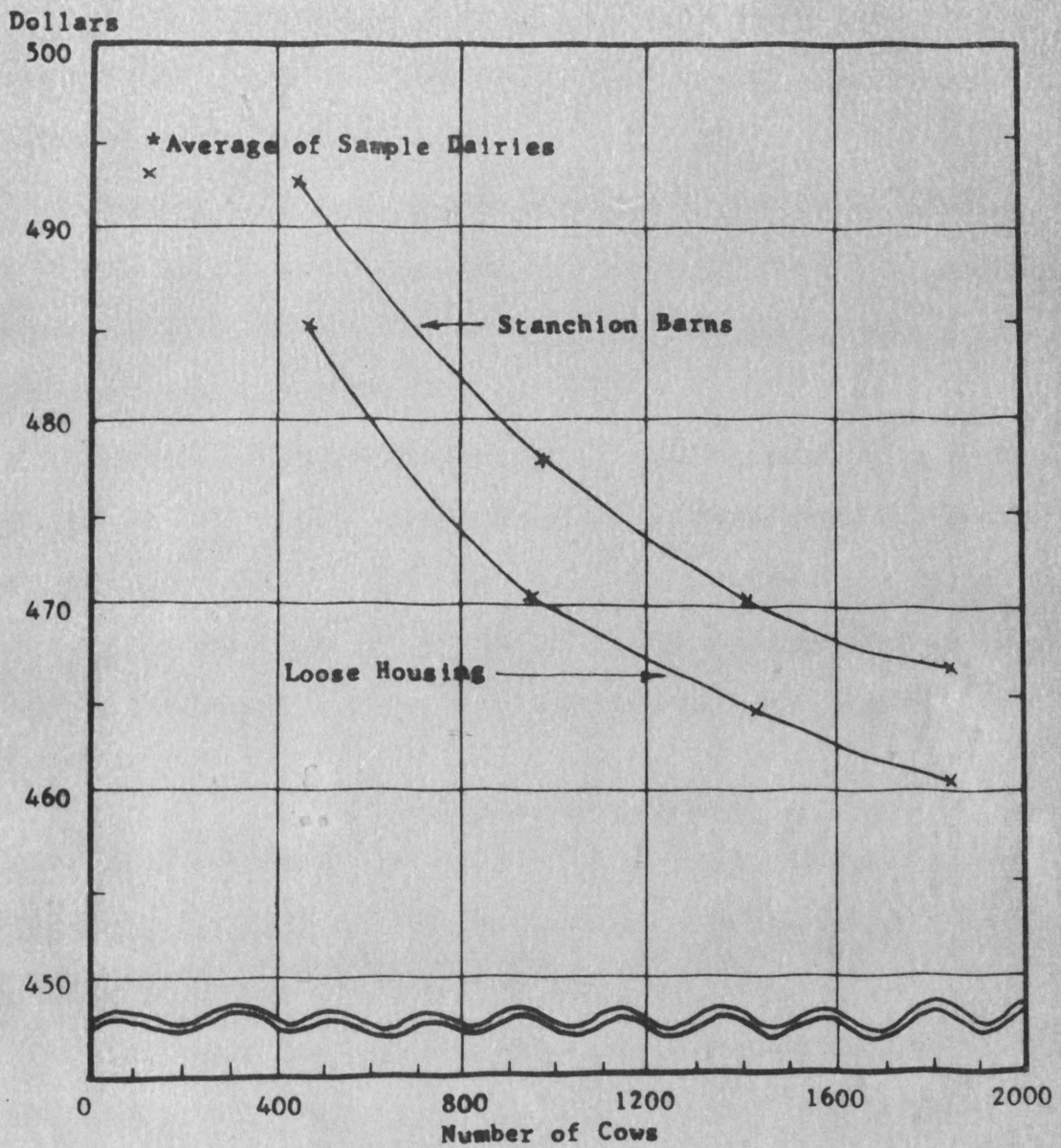

Figure XI. Total Yearly Cost Per Cow, Average of Sample Dairies and 480, 960, 1,440 and 1,920 Cow Hypothetical Model Dairies

Total Investment per Herd and per Cow

Total investment per herd varied from $116,716 per herd for the surveyed dairy herds to a high of $1,432,123 for the largest herd in stanchion barns, (See Table 17).

Per cow investments ranged from $1,083 to a low of $702 for the 1,920 cow herd size in loose housing. The range for the hypothetical models was from $820 for the 480 cow herd, stanchion system, to the $702 previously mentioned.

Average investment differential in the stanchion barn system was $820 to $745 or $75 per cow difference. Loose housing investment per cow varied more from $702 to $800. The investment per cow cost was slightly less than $20 per cow in the 480 cow herd size to slightly over $43 differential at the 1,920 cow herd size (See Figure XII).

Return and Cost Comparison

Total returns to the surveyed dairy systems included sales of milk, appreciation of dairy herd, income from calves or young breeding stock and the value of milk used on the farm.

Total costs included all the costs enumerated in Table 15. The difference of these total sums indicated the net income to the various dairy systems, (See Table 16). The average return to management was computed on the basis of net income divided by the total investment for each dairy system.

Table 17. Analysis of Investment per Herd and per Cow, Surveyed Dairy Herds and Hypothetical Dairy Herds

Item	Surveyed dairy herds (108 cows)	Stanchion housing, Number of cows 480	960	1,440	1,920	Loose housing, Number of cows 480	960	1,440	1,920
Total investment per herd									
Land	$ 1,205.00	5,000	5,000	5,000	5,000	10,000	10,000	10,000	10,000
Bldgs. & improv.	36,638.00	145,669	279,180	413,510	538,420	128,960	235,071	336,408	443,625
Equipment	22,364.00	50,966	77,048	100,011	120,703	53,238	74,839	99,424	121,675
Subtotal	60,207.00	201,636	361,228	518,521	664,123	192,198	319,910	445,832	575,300
Cows	50,509.50[a]	168,000	336,000	504,000	672,000	168,000	336,000	504,000	672,000
Operating capital	6,000.00[b]	24,000	48,000	72,000	96,000	24,000	48,000	72,000	96,000
Total per herd	116,716.50	393,636	745,228	1094,521	1432,123	384,198	703,910	1021,832	1343,300
Total investment per cow									
Land	11.18	10.42	5.21	3.47	2.60	20.83	10.42	6.94	5.21
Bldgs. & improv.	340.02	303.48	290.81	287.16	280.43	268.66	244.87	233.62	233.49
Equipment	207.56	106.18	80.26	69.45	62.87	110.91	77.96	69.04	63.37
Subtotal	558.76	420.08	376.28	360.08	345.90	400.40	333.25	309.60	302.07
Cows	468.76[a]	350.00	350.00	350.00	350.00	350.00	350.00	350.00	350.00
Operating capital	55.55[b]	50.00	50.00	50.00	50.00	50.00	50.00	50.00	50.00
Total per cow	1,083.07	820.08	776.28	760.08	745.90	800.40	733.25	709.60	702.07

[a]Includes raising replacements.
[b]Estimated at one-fourth the amount for the 480 cow herd.

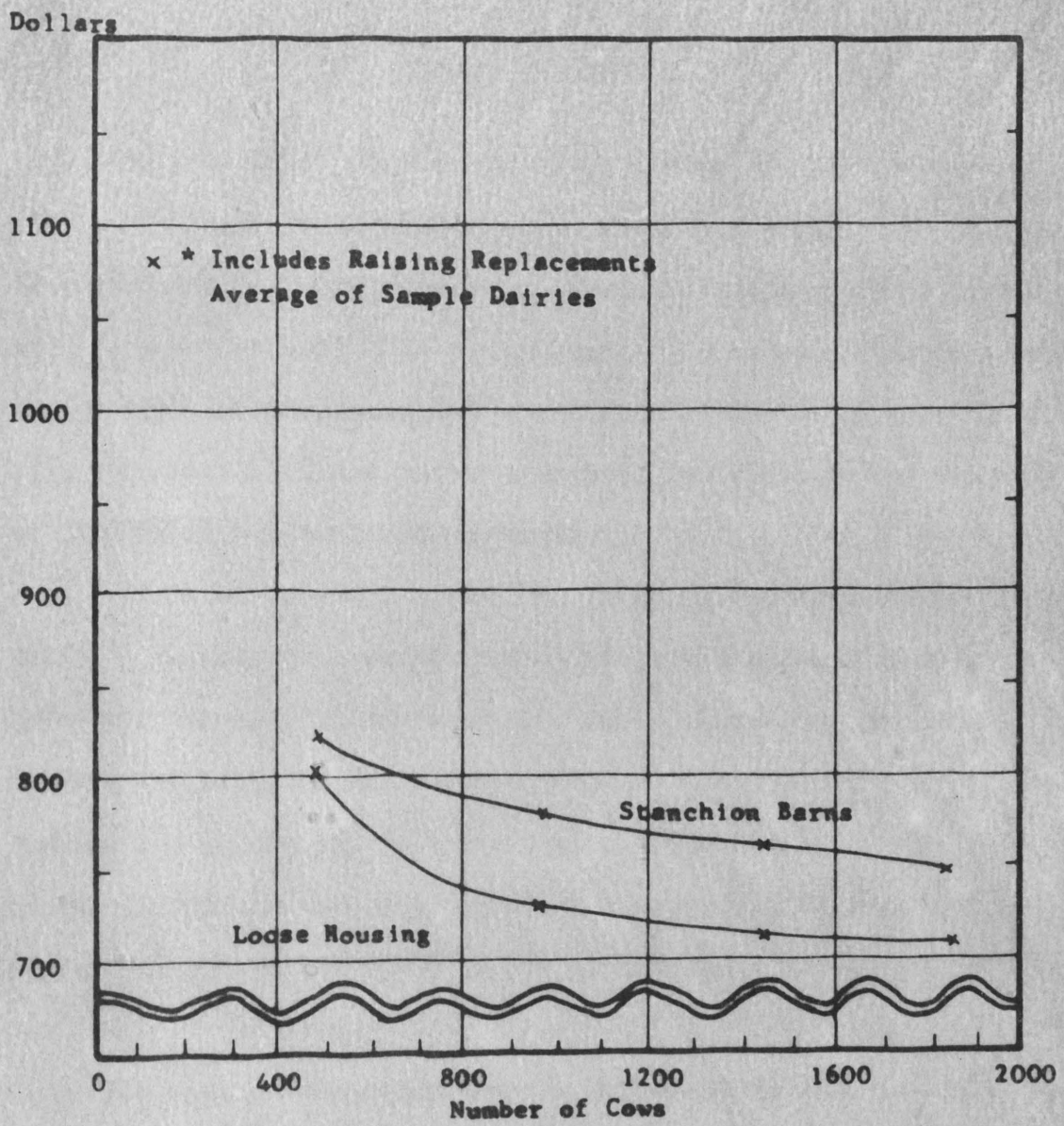

Figure XII. Total Investment Per Cow, Average of Sample Dairies and 480, 960, 1,440 and 1,920 Cow Hypothetical Model Dairies

CHAPTER VII

SUMMARY AND CONCLUSIONS

An average of the four surveyed 80-140 cow dairy herds and eight model dairy systems were analyzed in this study. The three objectives were to: (1) determine representative costs of producing milk in 80-140 cow herds in South Dakota, (2) to determine the economics of scale of producing milk by establishing model systems, using both stanchion and loose housing, and (3) to determine the profitability of such dairy systems in South Dakota.

In order to obtain a realistic cost and return analysis of producing milk in large herds in South Dakota, a sample of four large herds was selected for securing this data. Since few large scale dairies are in operation in South Dakota, this included over 16 percent of the dairies in the state with 80 cows or more in the milking herd. The average number of cows per farm was 108 with an average production per cow of 10,632 pounds of milk which included milk used for family and other purposes.

Average price received per hundredweight of milk was $4.36 for milk sold to the dealers. Income for sale of milk and for family use totaled $466.09 per cow. Appreciation of the dairy herd averaged $52.08 per cow to increase the total income to $518.22 per cow or $4.85 per hundredweight of milk produced.

The average cost per cow and replacement for depreciation, labor, feed and miscellaneous costs was $431.73 or $3.66 per hundredweight. This was contributed by $42.75 per cow for depreciation of buildings and equipment, $264.46 for feed costs, $66.94 for labor and $57.58 for miscellaneous costs. Including a 6 per cent interest on investment of $61.65 made a total cost of $493.38 per cow or $4.64 per hundredweight of milk.

Average capital investment per dairy was $110,716 or an average of $1,027.52 per cow. The value of livestock was about 46 percent while buildings and equipment made up about 53 percent. The remaining one percent was for land attributed to the dairy operation.

Average return to capital and management was $24.83 per cow or approximately 8.5 percent.

Four model dairy systems, each of stanchion and loose housing with herd sizes of 480, 960, 1,440 and 1,920 cows, respectively, were developed to determine the estimated average costs associated with scale of operation. Cost of construction and associated costs were based on present data. A recalculation would be necessary if prices of inputs would change significantly.

The returns of the hypothetical models were based on assumed production per cow and a break-even price per hundredweight of milk, and an assumed price per hundredweight of milk and break-even production per cow.

The importance of having cows that produce at above 11,000 pounds of milk per cow is apparent at the assumed price of $4.36 per hundredweight of milk. The break-even price ranged from $3.62 per hundredweight for the 1,920 cow herd under the loose housing system to $3.88 per hundredweight for the 480 cow herd under the stanchion barn system. In all comparative sized model dairy herds, the break-even price was the lowest for the loose housing system and highest for the stanchion barn housing.

The trend toward larger dairy units would seem justified by the economies associated with scale of the hypothetical model operations. The level of costs per cow, with the exception of feed cost and cow cost, declines as the size of the operation increases.

While costs per cow and per hundredweight of milk produced in the loose housing system are consistently less than for the comparable size stanchion barn system, the differential at the largest size unit is very small. The advantages of year around housing might offset the slight additional cost in terms of comfort of cows and ease of handling during severe climatic conditions.

It appears that all the hypothetical systems as explained would be profitable in South Dakota since the cost of production decreases as size of herd increases. The results of this study showed that the larger the scale of operation, the more definite the cost advantage over the smaller scale model. This cost advantage was due mainly to greater utilization of facilities, equipment and labor.

An advantage other than cost of production with the larger scale units would be the lower milk transportation rates because of decreased milk pick-up costs.

While there are apparently economic advantages of an operation as described, there would also be some disadvantages. Management is a key factor in an operation of the type described and even with a herd of 480 cows, a manager of outstanding quality would be necessary. The level of management cannot be overemphasized in an operation such as indicated by the model dairy systems.

Since many of the factors involved in large milking operations cannot be compared with the usual dairy farm operation, farmers and others should be very cautious in considering a shift to a specialized milking operation. Anyone attempting an operation on a purchased feed basis must know the high levels of production necessary to make a profit from the milking operation alone. One must also be cognizant of the difficulty of paying for the land, buildings and equipment. Once this investment is made, it is difficult to recover unless the dairy herd is maintained for several years.

In conclusion, the relationship between size, cost and level of management is a major consideration for determining how large a dairy herd should be.

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APPENDIX

APPENDIX

Table 1. Capital Outlays: Stanchion Barns and Companion Equipment

Buildings or equipment	Cost per square foot (dollars)
Stanchion barns	
12 to 20 cows	2.50 to 2.75
21 to 36 cows	2.25 to 2.50
37 cows and over	2.00 to 2.25
	Total Cost
Stanchions	26 to 34
Vacuum pumps	140 to 260
Vacuum lines, $3.50 per cow	
Milker units	110 to 150
Pipeline milkers (including milker units)	
32 cows	3,200
36 cows	3,600
Milk coolers (electric)	
4-can (40 gallon)	390 to 480
6-can (60 gallon)	460 to 550
8-can (80 gallon)	525 to 655
10-can (100 gallon)	590 to 710
12-can (120 gallon)	660 to 850
Milk cans	10 to 12
Water heaters	
15 gallon	74 to 80
30 gallon (with pipeline milkers)	100 to 116
Wash tanks, cleaning equipment	25 to 100
Gutter cleaners	
24 cows (196 ft. chain)	1,500
36 cows (240 ft. chain)	1,800
50 cows (280 ft. chain)	2,100

Source: Hawkins, H. Dean, and Robert C. Suter, Dairy Cattle Rates of Resource Use For Budgeting Enterprise Costs and Returns, Research Bulletin #735, February, 1962, Purdue University, Agricultural Experimental Station, Lafayette, Indiana.

Appendix (con't)

Table 2. Capital Outlays: Loafing Barns, Milking Parlors and Companion Equipment

Buildings or equipment	Cost per Square foot (dollars)
Loafing barns	
Remodeled stanchion barns	0.30 to 0.50
New pole barns (not including concrete floor)	1.00 to 1.20
Paved lots (concrete 4 1/2 in. thick)	
(concrete $14 per cu. yd. or .20 per sq. ft.)	0.30 to 0.34
	Total cost
Milking parlor-milk house (including stalls)	
Two-stall walk-thru	2,540 to 2,840
Three-stall walk-thru	3,375 to 3,775
Four-stall walk-thru	3,700 to 4,100
Double 4 herringbone	4,100 to 4,200
Double 5 herringbone	4,500 to 4,600
Double 6 herringbone	4,775 to 4,875
Double 8 herringbone	5,500 to 5,650
Pipeline milkers (including milker units)	
Two units	1,650 to 1,920
Three units	1,880 to 2,450
Four units	2,600 to 2,780
Five units	3,000 to 3,200
Six units	3,300 to 3,500
Eight units	4,200 to 4,450
Bulk tanks	
200 gallon	1,900 to 2,100
300 gallon	2,200 to 2,500
400 gallon	2,600 to 3,050
500 gallon	3,150 to 3,450
600 gallon	3,600 to 4,000
Water heaters	
15 gallon	74 to 80
30 gallon	100 to 116
50 gallon	120 to 140
Wash tanks, cleaning equipment	25 to 100

Table 2. (con't)

Source: Hawkins, H. Dean and Robert C. Suter, Dairy Cattle Rates of Resource Use For Budgeting Enterprise Costs and Returns, Research Bulletin #735, February, 1962, Purdue University, Agricultural Experimental Station, Lafayette, Indiana.

Appendix (con't)

Table 3. Capital Outlays: Feed Storage, Feed Handling and Other Equipment

Buildings and equipment	Cost per ton (dollars)
Hay storage	
Baled hay, 175 cu. ft. per ton (14 ft. to plate requires 12 1/2 sq. ft.)	12.50
Silos, upright	
Concrete stave	
Up to 50 tons	17 to 19
50 to 100 tons	15 to 17
100 to 150 tons	13 to 15
150 to 200 tons	11 to 13
Over 200 tons	9 to 11
Unloader (extra)	1,100 to 1,400
Glass lined, including unloader	
20 x 50, 400 ton	25 to 27
Large diameter	
24 ft. or more	5.00 to 6.00
Silos, horizontal	
Trench	
Up to 200 tons	6.00 to 7.00
200 tons and over	3.00 to 5.00
Bunker	
Up to 200 tons	6.00 to 7.00
200 tons and over	4.00 to 6.00
	Total cost
Feed bunk, automatic feeder	
48 cows	1,200
75 cows	1,875
Ford tractor	2,272
Manure spreaders	
75 bu.	380
115 bu.	625
140 bu.	650
Manure loader	
Hydraulic lift	480 to 520
With double acting cylinder	535 to 600

Table 3. (con't)

Buildings and equipment	Cost per ton (dollars)
	Total cost
Auger wagons	
85 bu.	295
135 bu.	415
Farm wagons	
Running gear, box, tires	264 to 509
Including hydraulic hoist	349 to 609

Source: Hawkins, H. Dean and Robert C. Suter, Dairy Cattle Rates of Resource Use For Budgeting Enterprise Costs and Returns, Research Bulletin #735, February, 1962, Purdue University, Agricultural Experimental Station, Lafayette, Indiana.

Appendix (con't)

Table 4. Basic Labor Data - Stanchion Barn (480 cow herd)

Task and description	Fixed time per week (hours)	Variable time per cow per week (hours)	Total hours per week (hours)
Milking, double-4 herringbone, pipeline, C.I.P.	1.30	.328	136.40
Milking preparation and cleanup	3.73	-	14.92
Feeding milking cows* (completely automatic system)	30 min. per barn per day	-	14.0
Bedding milking herd	1.08	.029	15.88
Manure handling	2.26	.063	34.24
Other routine work	.55	.055	24.20
Feeding dry cows*	30 min. per load	2 loads per day	7.0
General lot cleaning	.39	.069	5.91
Bedding dry cows	1.41	.034	4.13
Irregular tasks (dry cows)	.26	.01	4.26
Breeding chores - artificial (12 cows per week average)	-	.11	1.32
Transferring complete feed from storage to holding silos*	1.93	.117	13.63
Grinding feed (480 cows)	1.18	.009	5.5
			281.39

*Estimated

Source: Fuller, E. I., and H. R. Jensen, "Alternate Dairy Chore Systems in Loose Housing," University of Minnesota, February, 1962, pp. 34, 36 and 37.

Table 5. Basic Labor Data - Loose Housing System (480 cow herd)

Task and description	Fixed time per week (hours)	Variable time per cow per week (hours)	Total hours per week (hours)
Milking, double-4 herringbone, pipeline, C.I.P.	1.30	.328	136.40
Milking preparation and cleanup	3.73	-	14.92
Feeding all cows* (self-unloading wagon)	30 min. per load	6 loads per day	21.0
General cleaning (480 cows) (includes scraping yards and holding pen	.39	.069	35.07
Bedding the herd (480 cows)	1.41	.034	23.37
Irregular tasks (dairy herd)	.26	.01	4.26
Breeding chores - artificial** (12 cows per week average)	-	.5	3.6
Grinding feed (480 cows)	1.18	.009	5.5
Other miscellaneous chores (fence repairs, etc.)	1.51	-	7.55
			251.67

* Estimated.

**Interview with Maurice Frye, Secretary-Treasurer, Midwest Breeders, Inc., Yankton, South Dakota.

Source: Fuller, E. I., and H. R. Jensen, "Alternate Dairy Chore Systems in Loose Housing," University of Minnesota, February, 1962, pp. 34, 36 and 37.

Appendix (con't)

Table 6. Comparative Labor Date - Stanchion and Loose Housing Systems

Size of herd	Stanchion barn		Loose housing system		Men equivalent**	
	Labor hrs. per week	Labor hrs. per year	Labor hrs. per week	Labor hrs. per year	Stanchion	Loose housing
480	281.39	14,632 1,463* 16,095	251.67	13,087 1,308* 14,395	7.62	6.82
960	562.78	29,265 2,926 32,191	503.34	26,174 2,617 28,791	15.25	13.63
1,440	844.17	43,897 4,389 48,286	755.01	39,261 3,926 43,187	22.86	20.45
1,920	1,125.56	58,529 5,852 64,381	1,006.68	52,347 5,234 57,581	30.48	27.26

* 10 percent additional time added for minor duties, coffee breaks, lost time, etc.
**2,112 hours per man per year. Two weeks' vacation, up to two weeks' sick leave, 44 hour work week.