Improving Large Dairy Herd Management Practices: Review of Regional Project NC-119

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ABSTRACT

Scientists at 17 experiment stations have cooperated in research on several problems of dairy herd management associated with increasing size of herd. Research has been grouped under six major topics: 1) to identify animals and retrieve information; 2) to raise calves and replacements; 3) to manage and feed cows in groups; 4) to measure social and sexual behavior and increase efficiency of reproduction; 5) to develop milking, housing, and waste-handling systems to improve efficiency of labor; and 6) to use computers to make decisions for management. Important results have been contributed in each area through the combined efforts of several scientists, each working on a different aspect of a problem. Results have been documented in nearly 200 scientific and popular reports. Although this project originated in the North Central region, it now involves at least two experiment stations from each of the other regions. This broadens the scope of the research and brings in scientific expertise and management situations from a broad range of environments. Consequently, the results should have application to dairying nationwide.

INTRODUCTION

The shift to larger dairy herds prompted establishment of a regional research project to study changes in herd size and concurrent changes in management systems. The decreasing margin between gross and net income during recent periods of marked inflation forced many dairy farmers out of business, and those remaining have had to find new ways to improve their efficiency. Improved use of labor and ability to make use of technological innovations to spread the investment over more cows were factors in the increase in herd size. The shift to larger herds was accompanied by new problems peculiar to management of larger dairy herds. The shift also created the need to examine old problems in the context of larger herds.

The concept of a coordinated approach to research on problems of large herd management soon spread from the North Central region to other regions, particularly the West and South where herd sizes already were larger. Consequently, this project has become multi-regional in scope. Originated in 1972, the NC-119 project was revised in 1977. The purpose of this report is to bring together in one summary for wide use by extension and industry a review of the progress reached in each of the six original objectives of this project, followed by the new objectives and an outline of proposed research.

PREVIOUS RESEARCH IN NC-119

Identify Animals and Retrieve Information

Use of electronic temperature sensors, either in the ear canal or in the milking machine, for locating sick cows and cows in estrus, has progressed (29). Computer systems have been developed to assist in retrieval of information (16), and new methods of identifying individual animals have been reported (20).
Raise Calves and Replacements

Fermented colostrum for feeding calves was one of the most active areas of research; scientists at six experiment stations cooperated in this work. Research on amounts to feed, rate of dilution, preservatives, and the effect of temperature of fermentation on mastitic milk and colostrum were coordinated through a subcommittee on calf management. The information on rate of dilution and the use of preservatives for colostrum answered many practical questions of feeding fermented colostrum (7, 33, 34, 36, 39, 43, 44). A survey of dairymen using recommended rates for feeding fermented or preserved colostrum showed fewer health problems and lower costs in raising calves (42). Progress has been significant on the use of preservatives (formaldehyde, propionic, formic, and acetic acids) for colostrum when results with normal fermentations are not consistent (34, 37, 43, 44). A subcommittee conducted a survey to determine the areas and extent of research on systems of calf and replacement rearing at experiment stations throughout the U.S. They also developed guidelines for uniform measuring and reporting of data on calf research (28). Calf hutch systems of minimum investment were economically feasible for reducing calf mortality in areas of such temperature extremes as South Dakota and Nebraska in winter and Arizona in summer (7, 35). The practicality of a simplified program of calf rearing has been established. Labor and liquid feed costs can be reduced by once-a-day feeding of colostrum and by early weaning (7). Results of calf research are now being assembled in a total package of recommendations for housing, feeding, and managing calves.

Feed and Manage Cows in Groups

Scientists at seven experiment stations have been evaluating milk production, cow health, and economics of various group feeding and handling systems. Many of these studies are multi-lactational and are still in progress. Highlights of research indicate that corn silage as the sole forage, coupled with high corn grain fed continuously over two or more lactations and dry periods, is unsatisfactory because of lowered production and increased health problems (6). Varying the energy content of complete rations during different stages of lactation appears more satisfactory than feeding one blended ration to the entire herd (1). Scientists at five stations tested the use of three different automated self-feeders. The use of self-feeders benefit dairymen who find grouping their cows difficult but wish to feed additional grain to the cows with highest production (23).

Social Behavior and Efficiency of Reproduction

Several new approaches to improve efficiency of reproduction have been studied. Concentration of progesterone in the milk at 21 to 23 days after mating looks promising for diagnosis of pregnancy (41). Scientists at three experiment stations have conducted research on breeding early postpartum to reduce calving interval. Detection of estrus in large herds appears to be improved by the use of chin ball markers in surgically altered males. Scientists at three other stations found that pedometers attached to the legs of cows measure increased activity during estrus and provide a potential tool to improve detection of estrus in large herds (25). Artificial control of the time of parturition appears promising to synchronize time of calving with available labor (12, 13, 32). Exercise during the dry period is being studied at two stations as a way to counteract the effect of confinement on retained placentas, udder edema, and other problems of calving (3, 11). Studies are in progress on the effects of early postpartum treatment with hormones and vitamins on reproduction.

Studies on the effects of social behavior of cattle managed in groups are in progress (8, 9, 15, 24, 27, 31). Behavior of cows with limited space at the feed bunk and the effect of the social relationship of the calf with its dam at birth and later in life have been studied. Systematic transfer of cows between groups disrupts the social order of the group but does not appear to affect milk production adversely (2).

Systems of Milking and Efficiency of Labor

Studies on different types of systems for milking, with various degrees of automation in milking parlors and stanchion barns, have been at five stations, with emphasis on efficiency of labor, cost, and cow performance (19). Extensive surveys of time and motion in several types
of milking parlors and stanchion barns are in (4, 5, 10, 14, 30). Automatic detaching units can double through-put in a double-eight herring-bone parlor (14). The results of surveys and computer simulations for efficiency of milking, particularly the appropriate combination of design of parlor, size of parlor, degree of automation, and cost of automation, are important to dairymen who are considering a change of facilities. Research was completed and publications are in preparation on design, effectiveness, and economic efficiencies of milking parlors. Research is continuing on three types of fully automated milking equipment. Scientists at three stations, through a combination of surveys and interviews, are developing guidelines and recommendations for managing the labor force on large dairies.

Computer Assistance in Making Decisions

Research on the use of computers to assist in making decisions helped to develop the technology necessary to assist with feeding programs, dairy farm expansion, and decisions of cow culling and selection (17, 18, 21, 38, 45, 46). One simulation program was developed to determine the effect of rearing rate of calf on the net worth of a dairy herd (26). Another program aids in culling cows on economic merit (40). A computer program for studying the process of management by exception enables the dairyman to find over half of the health problems of dairy cows by examining only 5 to 6% of the herd (22). A 5-yr study was completed on the costs and returns of commercial dairying in the Midwest, and a joint study was begun on the relationships between production factors and economic indexes on large dairies in the Southwest.

JUSTIFICATION FOR CURRENT AND FUTURE NC-119 RESEARCH

The average size of dairy herds on Dairy Herd Improvement (DHI) test has increased from about 30 to 60 cows since 1950. Large herds demand more management skill than small herds. Some dairymen successfully managing herds of 30 to 50 cows fail when herd size is increased. More research is needed on herd management if failures of dairy enterprises are to be reduced. In large dairy herds, cow handling, milking, and feeding systems tend to discourage sufficient attention to individual cows. There is considerable opportunity for improvement of group feeding, record keeping, and for streamlining decisions on culling and breeding. Many opportunities exist for improvements in efficient use of labor.

Methods for detecting estrus in dairy cattle under conditions of large herd are both difficult and time consuming. A system with greater reliability and lower requirements for labor is needed.

Death losses in calves up to 6 mo of age are about 15%. These losses are serious because they represent lost investment and substantially decreased opportunity for selection of herd replacements.

Several additives currently are available to preserve excess colostrum during warm temperatures. However, these are corrosive and may cause problems in handling. Research is needed on other potential preservatives. Environmental conditions are important in rearing calves. Environmentally controlled buildings are gaining in popularity, but maintaining recommended temperature and ventilation is costly and high in use of energy. Exact requirements for temperature and ventilation have not been defined adequately. Comparisons of environmentally controlled buildings with outside calf hutches are needed to determine differences in calf performance and overall cost.

The trend to larger herds has moved many dairymen to manage cows entirely in drylot. High-producing cows are seldom in the milking parlor for sufficient time to eat enough grain to meet their energy needs for milk production. Consequently, cows often are grouped according to production and fed additional concentrates in the drylot. Mixing roughages and concentrates together in one complete ration is becoming more common; the proportion of concentrates is higher in lots with high-producing cows. Whether all lactating cows in a herd should be fed as a single group to avoid disruption of the social structure resulting from moving cows from one group to another still is controversial.

The mechanization of milking parlors is on the threshold of rapid acceleration. Accompanying this is a need for critical evaluation of design of milking parlors. Mechanization needs to be adopted in an orderly and economic manner, consistent with the needs of dairymen.
Detachers and related equipment for milking machines are being accepted by dairymen as a means of increasing efficiency and reducing labor. The effects of various detachers on either production of milk or health of the udder have not been determined adequately.

Because of increasing environmental concerns, dairymen must devote more resources to collection and disposal of manure. The challenge is to handle animal waste as little as possible, with minimum opportunity for pollution of air, soil, or water and maximum opportunity for efficient use of nitrogen.

Management of dairy cattle is making decisions. In the large dairy herd, the individual cow loses much of her identity and is not observed closely. Research on management by exception is needed if we are to develop methods that accurately will identify cows requiring special attention. Increasing costs and limited availability of labor have led to emphasis on routines that reduce labor. These routines may not lead necessarily to maximum profits. More emphasis is needed on total economic evaluation of all inputs and outputs in various management systems.

This project, although centered in the North Central region, involves at least two experiment stations from each of the other regions. This involvement broadens the scope of research and brings in scientific expertise and dairy management from a broad range of environments. The results from coordinated research over this broad spectrum should have application to dairying nationwide.

**OBJECTIVES**

1) To increase efficiency of producing dairy replacements in large herds. This includes improved efficiency of reproduction and more effective and economical systems of rearing.

2) To improve performance of animals and increase efficiency of labor. This includes social behavior, feeding and handling in groups, and innovative engineering in milking, housing, handling of materials, and disposal of wastes.

3) To develop decision making. This includes modeling systems, identification of animals, retrieval of information, costs of production, income responses, management of personnel, and overall management.

**PROCEDURES**

**Objective 1**

_Estrus Detection_. Different types of pedometers will be adapted for measuring activity of cows. The appropriate location and method of attachment, and a system for protection of the pedometer will be determined. Normal activity will be related to activity during estrus under average environmental conditions and during stress from heat and cold. Subsequently, in field trials, efficiency of reproduction will be determined by pedometers measuring increased activity as compared to conventional methods of detecting estrus (Arizona, SEA-Maryland, and SEA-Utah). Temperature of milk will be measured during milking by insertion of fine-wire thermocouples into each of the four inflations and in the milk line below the claw. Animals with abnormal temperatures will be checked for estrus, mastitis, or other ailments inducing fever (Arizona). A system for detecting motion will be attached to a video tape recorder to observe mounting behavior in yearling heifers (SEA-Maryland).

_Increased Efficiency of Reproduction_. Scientists will work on methods for controlling estrus and ovulation (Illinois, Nebraska, and North Carolina). Systems of breeding heifers for the first time, the possibility of twin ovulations for crossbreeding cull cows with beef bulls, and continued research on collecting, storing, and transferring embryos from genetically superior matings will be studied (North Carolina). Research on progesterone in milk as a test for pregnancy will continue (Illinois). Cows and heifers will be exercised forcibly for 4 to 6 wk before calving to determine the effects of exercise on reproductive performance (SEA-Utah).

_Calf Feeding_. Studies will involve methods of preserving and feeding colostrum and waste milk. Normal, frozen, and fermented colostrum and mastitic milk will be compared, and different feeding rates and dilutions will be evaluated (SEA-Maryland and Nebraska). The effectiveness of various additives not previously used for preserving colostrum and waste milk will be examined (Pennsylvania and Minnesota). A study will clarify the factor(s) responsible for reducing the incidence of scours in calves fed fermented colostrum. Various feed ingredients, starter preparations, and feeding procedures...
will be evaluated for improved intake of starter calves weaned early (Nebraska).

**Calf Housing.** Outside hutches will be compared with housing with environmental controls for their effect on growth, health, intake of feed, economics, efficiency of labor, and use of energy of calves under various climates (Michigan, Nebraska, and Pennsylvania). The growth and health of calves raised in the following environments will be compared: a) raised slatted floors in warm housing, b) floor level stalls in warm housing, c) floor level stalls in cold housing, or d) outside hutches (Wisconsin).

**Raising Heifers.** Feeding trials will relate growth, feed intake, and eating patterns of heifers fed in groups or individually with electronically controlled doors (SEA-Maryland and SEA-Utah). Solids from cattle and poultry manure will be incorporated and tested in complete rations for dairy heifers (SEA-Maryland and North Carolina).

Heifers will be raised in complete confinement from 8 wk of age to calving in an insulated barn in pens with free stalls and either solid or slatted floors. Data will include health, breeding, growth, and intake of dry matter (Wisconsin).

The cost of growing dairy replacements will be compared with that of purchasing replacements on 10 dairies with herd size from 150 to 1200 cows. Milk production during the first lactation will be compared for the two groups (Florida).

**Objective 2**

**Social Behavior.** Space in drylot will be reduced and the effects on behavior and milk production will be measured (Indiana). Social patterns, behavior at feeding, consumption of feed, and growth of heifers with access to feed through doors controlled electronically will be compared to heifers with complete free access to feed. Heifers on each treatment will be housed as a group. Video tape will be used to monitor animal activity (SEA-Utah).

**Systems of Grouping.** Scientists will study three dairy herds in which cows are assigned in three or more groups according to production. A control group of cows assigned at random will be maintained as a single unit in each herd for the total lactation. Factors to be studied are: a) feed cost per kg milk; b) consistency in milk production; c) degree and reason for culling; d) reproduction; and e) disease (Florida). A 145-cow herd will be divided into four groups of equal size. Three of these groups will be stratified according to production; cows will be moved from group to group every 30 days. The fourth group will serve as a control. All cows will be fed a complete ration formulated for 110% of NRC requirements for milk production. The effects of grouping on intake of feed, cost of feed, efficiency of feed utilization, labor, general herd health, space required at feed bunk, production of milk and butterfat, and persistency will be evaluated (Missouri). A questionnaire will be used in a field study of large dairy herds (100 or more milking cows) to study systems of grouping and practices in group feeding and housing (Indiana).

**Systems of Feeding in Groups.** The effect of group assignment, methods of controlling intake, selective feeding of individual cows, and frequency of feeding on milk production, reproductive performance, and health will be studied (SEA-Maryland and Nebraska). Systems analysis will be used to develop guidelines for herd size and production for using grouping and complete rations (New York).

Scientists will measure the production response and behavior of cows fed in groups. Factors include: a) automatic delivery of concentrate-forage mixtures, b) individual electronic transponders for dispensing concentrates, and c) magnet system for dispensing concentrates (Illinois).

Feed gates controlled electronically will be used to compare intake of individual cows with that of cows fed on a group basis (Indiana, North Carolina, and SEA-Utah).

**Systems of Milking.** Equipment and layout of milking parlor for efficient and effective milking will be investigated. Data on time, motion, and cost will be obtained from parlors representing the types of systems and equipment used in dairies with over 100 cows. New equipment for reducing labor, such as automatic preparation of udder, detaching units, and crowd gates in the holding area, will be included (Indiana and Michigan).

The response of cows of different stages of lactation and production to various intervals between milking will be determined. Emphasis will be on both the biological and economic
aspects of frequency of milking. Automatic warm water sprays used premilking and teat dip techniques used postmilking will be evaluated for their effect on letdown and production of milk, and reduction of mastitis (SEA-Maryland).

Productive labor in stanchion barns will be studied in comparative trials by collection of data on time and motion and by computer simulation. Estimates of initial investment costs, annual operating costs, and labor required will be derived to develop alternatives for combinations of layout designs and equipment. In another experiment, scientists will study the effect of elevation of the milk pipeline in a conventional tie-stall barn on milk quality, udder health, adequacy of milking, and milking labor (Minnesota).

Systems of Housing. New approaches to housing dairy cattle in groups will be developed and tested for their application to dairy management and for their effect on animal health and behavior (Illinois). Temperature, relative humidity, and patterns of air movement, will be determined in cold-enclosed and warm-enclosed barns with limited insulation. The effects of animal density and of modifying the environment on milk production, feed consumption, and economic returns will be assessed (Michigan).

Handling of Bedding and Waste. Large herds with cows housed in groups require a new approach to providing bedding materials. Bedding alternatives (plastic mats, rubber mats, carpets, and wood waste products) will be field tested in free-stall housing with different types of surfaces (clay, concrete, and metal). These alternatives will be evaluated for effectiveness in terms of cow use, bedding requirements, durability, labor requirements, and acceptance by cows, dairymen and milk sanitarians (Indiana, South Dakota, and Wisconsin). Systems for dewatering, storage, and disposal of animal waste will be developed and studied for use in large dairy herds and for their effect on animal health and behavior (Illinois).

Objective 3

Identification of Animals. The technology is now available, and at least one commercial company is developing implantable devices for electronic identification of animals. As soon as such equipment becomes available, scientists at several stations will research how to use electronic devices automatically to record animal identification, body temperature, and milk weight and to transfer this information to a computer for use in management.

Management by Exception. Management by exception detects those animals that are not performing normally. Equipment to collect information and computer systems for analysis for management will be designed and developed (SEA-Illinois). Approximately 4000 lactations with daily milk weights and clinical information will be used in a study of management by exception. Several criteria based on daily variation in milk yield will be compared in efforts to identify cows needing special attention (Wisconsin).

Guides for Culling. A guide for culling, developed from management information from DHIA, will include estimated producing ability and estimated transmitting ability of cows and their replacements, udder health scores, expected calving interval, and number and probable quality of available replacements (Minnesota). Guides for culling based on projected net income per day for some future period will consider age, stage of lactation, reproductive status, and estimated breeding value for milk (Ohio). A whole-farm simulator will be used to determine the rates of increase in net worth, milk yield, and breeding value under various criteria for culling, such as estimated breeding value, estimated producing ability, and predictive economic index (Wisconsin).

Management of Economics. Several stations will study different aspects of costs and returns from large dairy herds. Guidelines will be developed for determining costs of production and income from labor for small vs. large dairy farms. The income response of large dairy herds to various resources, strategies, and technological innovations will be determined (Indiana). Farm account and DHI production records will be used to determine the effect of various combinations of resources, levels of output, and costs on income and financial solvency. Survey data will be used to determine liquidity, financial stability, and gains in net worth. Farm accounts and survey data will be used to determine procedures to be followed before and during herd expansion to minimize decreased production, increased problems in herd
health, and insufficient cash flow which normally occur during the 3 yr after herd expansion (Michigan). A computer modeling approach will be used to determine the effect of variable cow performance on net income. Expected economic returns will be determined for changes in each of the following performance traits: milk production, length of herd life, age at first calving, mature size, days open, and composition of milk (Ohio).

Management of Personnel. Management of personnel on 10 large dairies having good management practices will be studied. Practices to be considered include: a) techniques presently being used; b) background of manager; c) type of personnel records and job descriptions; d) motivation programs; e) employee turnover; f) attitude of employees; g) incentive programs; and h) degree of organization. After this study, a survey will be made of about 100 dairies, each with 300 or more milking cows, to determine the status of labor practices in use (Florida). Various aspects of human performance, behavior, and personality traits as they affect milk yield from dairy animals will be studied (Indiana).

Computer Aids for Making Decisions. Planning guides and models for making decisions will be developed at several experiment stations. Automatic recording of data, electronic identification, and computer modeling will be tested as new practices for dairy herd management (Illinois). Studies will be made to assist dairy farmers in the planning, financing, construction, and use of new facilities in herds expanding slowly because of limited financial resources. A simulation model leading to needed answers regarding animal inventory, labor and feed requirements, farm income and expenses, and capital commitments will be developed (Minnesota).

Planning and control programs for feed inventory will include storage requirements, cropping programs, and feeding programs for dairy farms of different sizes and land productivity. Dairymen will be able to implement full use of land resources, add more stability and regularity to the feeding program, and buy feed at a more opportune time (Minnesota). Rules for mastitis treatment of dry cows will be developed on the basis of the joint frequency distribution of udder infection and somatic cell count in bucket milk (Wisconsin).

REFERENCES


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