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Intensive Grazing Seasonal Dairying:

The Mahoning County Dairy Program 1987 - 1991

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THE OHIO STATE UNIVERSITY

OARDC

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Intensive Grazing/Seasonal Dairying: The Mahoning County Dairy Program[1] 1987 - 1991

D.L. Zartman, Editor

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Preface

The optimized use of natural and human resources is important to Ohio's economy. Agriculture commonly employs both of these resources towards the end of generating profit. Where agriculture is involved, so too is the environment. Agriculture that benefits the environment while supporting profitability can bolster local economies on a long term basis.

Thinking of agriculture, in 1986 the Ohio State University Extension agriculture agents of the East District laid down the challenge of finding a way to enhance Appalachian area economies. Their suggestion was to find ways of expanding dairy production for the area. Their basis was recognition of the capacity of the area for forage production while serious limitations to other kinds of farming exist. Dairy cows are excellent converters of forages to readily marketable food products, and the cash flow pattern of a dairy is desirable, so they recommended dairy production.

In response, the team of researchers listed above was assembled to fully explore concepts of dairy farming that would be environmentally sound and profitable for the Appalachian area. Thus, the five-year program established at the Mahoning County Farm was designed to analyze the concepts of intensive grazing and seasonal dairying in the context of Ohio. Little was known about the acceptability of these management concepts in this region, yet they were regarded as a fundamental reason for the highly competitive position of the New Zealand dairy industry. It was logical to begin with these concepts in visualizing a notably enhanced dairy methodology for the United States, especially for Ohio.

The team expresses great appreciation to the Ohio Agricultural Research and Development Center administration for supporting this project. Furthermore, the Ohio State University Extension at various levels of administration was highly interactive and supportive in terms of personnel sharing. To the many dairy industry people who watched the project closely, thanks for the encouragement. A special note of gratitude goes to Dianne Shoemaker, wife of Steve and Extension Agent for Mahoning and Columbiana Counties, for her participation in the project ranging from data interpretation to landscaping of the barn site.

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Chapter 1 Program Description

D.L. Zartman & S.R. Shoemaker

The Concepts

Intensive grazing and seasonal dairying have not been well understood by dairy operators in North America. Yet, these are the fundamentals of dairying in other nations such as New Zealand where milk is produced at very competitive costs. Even though some U.S. dairy operators allow their cattle to be on pasture part-time, the feed acquired there is not regarded as significant to the total ration over the long term. The general pattern is to feed each cow individually with a ration balanced to her particular needs. That is improbable with grazing because the forage intake cannot be measured. Also, the nutritional quality of the pasture changes with varying stages of maturity and climate.

Overlooked in the above pattern are the advantages derived from intensive grazing of forages. These advantages can be both economic and ecological. Emphasis is placed on the intensive aspect of grazing. Through modern fencing technology, it is now relatively easy to partition larger pastures into small segments that provide 12 to 24 hours of forage requirement. Fencing difficulty has been one of the barriers to adoption of intensive grazing in the past. Lately, cost, efficiency, and portability of electrified fencing have become highly acceptable.

Seasonal dairying is a management plan that may enhance seasonal advantages of milk production or milk price (Figure 1.1). The basis of seasonal dairying is a 12-month calving interval with all the cows calving together in a brief time frame, such as eight weeks. Thus, with all cows calving together, ten months later, all cows can be turned dry together resulting in a closure of the milking facility for about seven weeks each year. The basic decision to be made is the choice of season to initiate the lactation period. If the advantages of grazing forages are to be maximized, calving should occur three to four weeks ahead of the onset of the grazing season. Then, every cow will be peaking in production just when the forage is most abundant and also most nutritious. Where land is best used for production of pastures, and when these pastures are to be used to greatest advantage, late winter freshening maximizes the conversion of forages to milk. Intensive grazing accomplishes the best harvesting at least cost.

There are other virtues for seasonal dairying. Most importantly, duties of the manager are arranged sequentially rather than simultaneously. This facilitates greater concentration on execution of management tasks, resulting in better management for the herd. The lifestyle is markedly more versatile for the dairy family and employees. Feed purchasing advantages are possible. Cows can sometimes be culled at better prices, depending on the season chosen. Summer heat slump and fertility problems can be reduced or eliminated under some models of management. Operating costs and housing requirements can also be reduced. The inherent 12-month calving interval may contribute to profitability.

The Program Design

The Mahoning Dairy Program was developed around the two fundamentals of intensive grazing and seasonal dairying. Because of the fragile tendency of the soil in that rolling terrain, it is best suited to forage production rather than tillage agriculture, which suggests the preference of late winter freshening for the Mahoning dairy. Forage management by intensive grazing was chosen for the following expectations:

- avoids the requirement for much machinery
- harvesting can occur in any weather
- machine compaction of soil is reduced
- forage is consumed in much better nutritional state
- manure handling is minimized
- cows are healthier and more vigorous than those kept in confinement (esp. sound feet)

The project site was formerly a beef production unit. An old bank barn with an attached silo and an open-sided shed were available. Forty-two acres (17 hectares) of poor pasture which had not been intensively grazed were included in the project. The pastures were fenced into paddocks of about five acres (two hectares) in size. The daily allocation of pasture was controlled with electrified polywire which was relocated every afternoon for a 24-hour rotation. A milk house was built within the bank barn alongside a six-stanchion milking area. The milking system included three milking machines, a pipeline, and a 600 gal (3,271 L) bulk tank.

To broaden the base of data interpretation, Holstein and Jersey breeds were equally represented in the 30 head of springing heifers assembled to construct the herd. These heifers were generally commercial in value, many resulting from natural service by home bulls. There was plenty of opportunity for genetic improvement during the five-year project.

Because the cows in the first year were all two-year-olds, the herd health was more controlled and

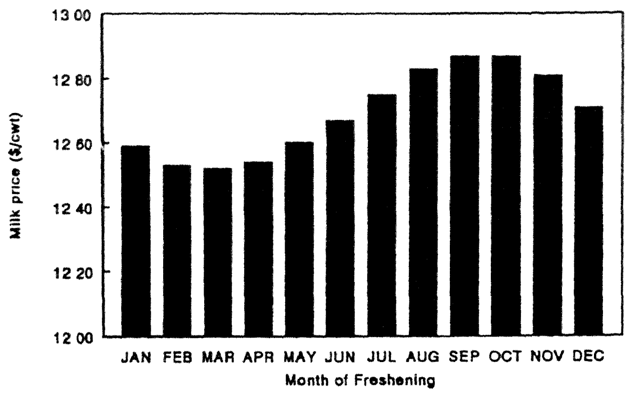

Figure 1.1. *Aggregate milk price earned according to month of freshening. The returns are based on a 305-day lactation with 85% persistence of the lactation curve, representing 1981-87 prices in Federal Order 33.*

the performance of the two breeds was more understandable as the herd aged over the course of the five-year project. Since no yearlings were on site the first year, it was decided to improve half of the pasture not needed by the herd through a minimum tillage alfalfa seeding. That pasture was to be switched for the utilized half during the second year to accomplish the improvement of the other half. However, the intensive grazing effect was so favorable, it was not deemed prudent to invest in the overseeding process the second year. Meanwhile, the residual pesticide levels in certain pastures were monitored closely as reported later in this Bulletin (Chapter 11). Consequently, the alfalfa-incorporated pastures were taken out of the project after one year of use because of the pesticide levels in the soil.

The program was initially for Grade B milk production. There is substantial demand in Ohio for milk to be used in cheese production and the requirements for physical facilities of such a dairy are not as expensive as for Grade A. After three years of Grade B operation, following a relatively minor investment in barn improvements, the dairy was upgraded to Grade A status. This improved the blend price for milk about $1.50/cwt.

Compartmentalization of the program into modules helped define the areas of responsibility of the several scientists on the project. Also, portions of the overall project could thus be extracted and reported separately for various purposes. The modules were:

- Grazing Management
- Seasonal Dairying
- Herd Health
- Reproduction
- Nutrition
- Mastitis Control
- Heifer Management
- Economics
- Milk Production Factors
- Soil Pesticide Management
- Agronomic Features

Program Goals

The dominant goal was to define a new dairy management program for greater profitability in Ohio agriculture while remaining faithful to environmental principles. Service goals were: (1) to develop and evaluate the 24-hour rotation plan for pasture management, (2) to design a nutritional program around grazing, (3) to operate the dairy with a 12-month calving interval at an economically acceptable involuntary culling rate, (4) to evaluate mastitis control under grazing management, and (5) to understand the problems of contaminated soil used for grazing.

Chapter 2
Intensive Grazing

D. L. Zartman & S. R. Shoemaker

Forage Grazing

While more details about the forage features of the Mahoning Project are reported in Chapters 8 and 9, this Chapter is dedicated to discussion of the grazing principles. Excellent treatises on grazing and fencing can be found in books by Murphy (1991) and Smith et al. (1986). Fundamental to the use of pastures, "intensive" implies high stocking rates of cattle for a short period of time on each plot. Time is defined as ranging from 12 hours to three days. Intensive management calls for rotation of cattle to new areas every 12 to 24 h. If the cattle are left in a single area, generally spacious, more than three days, the management is described as extensive.

For dairy cows in production, forage intake is closely correlated with the volume of milk produced. Sustaining high intake levels of consistently high-quality forage is best accomplished by rapid rotation rates of 12 or 24 hours per plot. With non-lactating stock, more relaxed rotations of up to four days can suffice if daily rotation is difficult to do. Extension bulletins available on grazing include those authored by Michigan scientists Bartlett (1991), Moline and Plummer (1991), and Moline et al. (1991). Another important source of grazing information is a bulletin by Emmick and Fox (1993).

Generally, with regard to forage requirements, a farm in the U.S. Midwest will annually support one cow per acre (.4 hectare). The daily plot allowance is variable with plant growth conditions, but in the spring an acre will feed about 50 cows for 24 h. Cows should go to the pasture in the spring as soon as grasses are about six inches (15 cm) high. The frequency of returning to a plot ranges from 14 to 35 days, depending on the climate.

The agronomic principles obeyed with the rapid rotation depend upon using a high stocking rate to cause the avoidance of selective grazing of mixed forage species and the avoidance of grazing new regrowth of forages before roots have been replenished through photosynthetic processes. The effect achieved is uniform competition of all forages for sunlight, space, nutrients, and moisture, while allowing roots to become stronger and deeper. In the process, the soil is stabilized and moisture retention is increased as root expansion opens up the soil. Meanwhile with grazing, soil organisms, worms, and insects rapidly degrade organic matter and manure for rapid recycling for plant growth. Earthworms amplify the moisture holding capacity and aeration of soil when their tunnels are not disturbed by tillage - another attribute of grazing.

Pastures that are intensively grazed as compared to extensively grazed are generally characterized as having a favorable balance of forage species that are variously responsive to climatic changes. The cool season grasses are predominant in the spring and late fall, while legumes such as clovers are more active during the summer. Also, due to greater root strength and depth, such pastures are more drought resistant and more resistant to insect and disease damage. These pastures are permanent, lasting decades, as long as they are intensively managed and soil fertility is maintained.

Because the forage growth rate is largely dependent on moisture and temperature, pastures will regenerate at varying rates during the year. Where the number of cattle is relatively constant, the size of the plot offered for grazing at each rotation must be adjusted to most effectively match the stocking density to the expected daily intake of the cows. This is easily done with portable electrified fencing. Polywire was used at the Mahoning Project to govern the 24-hour allowance of pasture by defining pie-shaped plots of pasture at each rotation. A follow-up back fence is needed to prevent regrazing of new shoots which begin to appear at about four days.

The yearling heifers were generally grazed behind the cows during the second 24 h. The cows were thus only required to top graze the most select 60% of forage because the heifers would clean up the rest of the standing forage. High levels of milk production can best be sustained when the cows have the best feed (top grazing) which encourages robust appetites for the pasture. The heifers were removed from the cycle when drought conditions limited the amount of pasture growth and when one cow was thought to have Johne's disease which could have been transmitted to heifers. During these times, the yearlings were grazed elsewhere. Post-weaning, baby calves were reared for their first year in a small pasture near the barn where they could be fed supplemental grain.

Bloat control was not utilized. Little alfalfa was available and no incidents of bloat were observed. Those pastures where alfalfa had been overseeded, which were used only during the second year, had an abundance of grassy species to temper the bloating effect of the alfalfa.

Economic Factors

Forages have excellent levels of important vitamins while they are in the vegetative state. Cows consuming fresh forages gain the advantage of high intake of such vitamins, particularly vitamins A and E. When forages are machine harvested and preserved, substantial deterioration of vitamins in these forages occurs which leads to expensive supplementation for the herd. Also, the protein supply of fresh forages is retarded by mechanical harvesting and storage processes. In terms of quality factors, the value of the cows' forage ration is thus maximized by grazing.

Mechanical harvesting of forages is expensive in terms of equipment costs. Furthermore, there is an agronomic cost to the soil through compaction when machinery is used. Harvesting losses such as leaf shattering are reduced by grazing. Finally, manure handling costs are reduced substantially in a grazing program since most of the defecation occurs in the fields. This could eliminate the need for a lagoon or other manure storage facilities.

Mechanical harvesting of forages is highly weather dependent. Wet conditions create hazards of greater soil compaction and losses in mass and nutritional quality of crops. Grazing is free of weather constraints during the usual season. Soil compaction by cows during intensive grazing is negligible, even under very wet conditions. The cows are in one plot only a few hours. They are nearly always moving, not trampling in one spot. While walking, they help press seeds into the ground for germination. The grasses are sometimes helped when lightly trodden into the mud, it seems, by helping runners take root. Clovers may be damaged, but they are easily restored by no-till seeding.

Grazing does not totally eliminate the need for mechanical harvesting of forages on a dairy farm. In the spring, plant growth is typically very rapid. Unless more cows can be acquired to increase the stocking density for a few weeks, there will be more feed than the cows can graze. It is important for the grazing plan to not get behind on the forage harvesting such that plants go to maturity. If that happens, feed quality diminishes and the plants do not regrow as rapidly following harvest. Normally, the excess spring pasture must be harvested mechanically at the correct stage of growth to preserve its nutritive value. This preserved feed can be fed during late fall and winter.

A useful analysis of grazing economies in Pennsylvania was reported by Parker et al. (1992), who found the gross margin was $121 per cow higher with intensive grazing compared to a drylot feeding system.

Soil Fertility

The cows spread manure nutrients as they graze. Thus, very practical matching of harvesting and fertilization is accomplished every grazing rotation. Soil nutrients are replenished as they are taken up by the plants. This is a very natural balance. Soil insects, microbes, and worms are fed in the process.

Ecologically speaking, a dairy grazing operation is nearly perfect. Soil nutrients taken up by plants are consumed by cattle which partition them into milk, manure, and sometimes, growth. The manure is returned to the soil right away. Milk and meat leave the farm. In replacement, the cows will receive purchased concentrates along with bedding and supplementary forages for use during the winter months which were derived elsewhere. The net effect is nearly balanced extraction and replenishment of soil nutrients for the farm over the long term without much commercial fertilizer being used.

Soil pH is the most likely condition requiring management with purchased fertilizer. Soil testing is recommended to monitor other nutrients. Commercial plant growth fertilizers will seldom be needed. However, forage micronutrient deficiencies for the cows will probably need correction either through soil fertilization or in the concentrate ration provided for the cows.

Drinking Water

Cows require great volumes of water to produce milk. A common expectation is that a lactating cow will drink about 35 gal (132 L) of water per day during the summer. When cows are grazing, the moisture content of the ration is naturally greater than would be found with drylot rations, but cows still need great amounts of drinking water. It is far better to supply drinking water in the pasture rather than have the cows return to the barn to drink. If they stay in the pasture, they will graze longer. The cows in the Mahoning Project were in the pasture all the time except when they were brought in for milking twice per day. Water was provided for them in the pastures.

Shade

A brief exception to the above statement regarding cows being in the pastures all the time occurred about ten days per year when the heat was overwhelming. On such days, the cows were allowed to come to the shade of the barn at about 10:00 a.m., since they were not interested in grazing at that point. Flies were also more persistent on such days. Shades were not important in the pasture because the cows were generally grazing or resting in a dispersed arrangement in the pastures. It is better to encourage the cows to be dispersed to keep manure more evenly spread and also to avoid excessive trampling of plants. Mastitis is less likely when cows are not lying in one spot which may become contaminated.

Chapter 3
Heifer Rearing

B. L. Brockett

Intensive grazing and seasonal dairying provide some unique opportunities as well as challenges in the area of heifer rearing. Intensive grazing allows a very economical method of rearing replacement heifers by reducing feed costs, housing requirements, and labor required to spread manure. It also reduces exposure to internal parasites compared with traditionally pastured heifers. Another major advantage is that, contrary to the practice of housing heifers at another location away from the cows, breeding age heifers integrated into the cow's grazing scheme can be on the home farm and in view of farm workers. This allows for better heat detection and the use of A.I., especially with seasonal dairying where the heifers are all the same age. One disadvantage of heifers grazing behind the cows is exposure to contagious diseases, such as Johne's.

Seasonal dairying requires an aggressive heifer rearing program because heifers must calve at 24 months of age. Such heifers must be well fed because it has long been known that small first-lactation cows give less milk than well-grown cows. The incentive to calve heifers at 24 months, rather than the Ohio average of 28 months, can earn greater returns for enhanced management.

The heifer rearing program at the Mahoning County Farm started new-born calves on colostrum and whole milk for 60 days. Calves were housed in a converted grain storage building which had good natural ventilation. Individual calf stalls were constructed to prevent nose-to-nose contact. To enhance colostrum value, an oral *E. coli* preparation was given at birth for the first two years of the project. During the last three years, cows were vaccinated for *E. coli*. This program and the skill of the herdsman resulted in a 100% heifer calf survival for the five-year project among all born alive.

After weaning at 60 days, calves were moved to an exercise pasture where they were fed free choice a complete calf pellet. During this time, they received vaccinations for brucellosis, BVD and IBR. During late fall and winter, they received a ration of hay and concentrate with an ionophore. During their yearling year, they grazed for 24 hours behind the milking herd and received no concentrate. During dry years when pasture was short, heifers were rotationally grazed on their own pasture or were traditionally grazed and received supplemental feed, depending on what was available. Calves were dewormed once their first year and twice their yearling year. Using this program, Holstein heifers gained an average of 1.45 lb (.66 kg) per day and Jersey heifers gained 1.1 lb (.5 kg) per day.

Before first calving, Holstein heifers averaged 1,138 lb (517.3 kg) in weight and Jersey heifers were 829 lb (376.8 kg). This is slightly less than desirable and can be overcome by feeding supplemental concentrate with an ionophore during the grazing season. The amount of concentrate will vary with pasture quality, but less than 5 lb (2.3 kg) per day is usually sufficient.

Before heifers are grazed behind the milking herd, the herd veterinarian should determine the status of Johne's Disease in the herd. This disease is spread from cows to younger animals through fecal contamination. Only after it is determined that the herd is Johne's free should heifers be allowed to graze behind the cows.

Chapter 4
Herd Health

K. H. Hoblet

Two major areas of herd health, i.e., udder health and the reproductive program, are covered in Chapters 5 and 6 of this Bulletin. This chapter will describe the remainder of the Herd Health program for the Mahoning County Project.

Early concerns at the Mahoning Project were those health problems, e.g., internal parasites, bloat, grass tetany, or infectious foot rot, that might be expected in cattle that are grazing pasture. In a seasonal dairying program, breeding and calving seasons would be expected to resemble somewhat those of a well-managed beef herd. That is, breeding of the entire herd occurred within a short period of time and subsequently all cows in the herd would be at a similar stage of pregnancy. Finally, all calves would be born in a short period of time. Thus, a scenario for introduction of an infectious disease resulting in either an abortion storm or an epidemic of calf disease seemed a real possibility. See Table 4.1 for an overview of the health maintenance program.

Metabolic Diseases

In general, the occurrences of metabolic diseases such as milk fever, ketosis, and retained placenta were at or below the rates expected in well-managed herds. Bloat and grass tetany were not detected during the study.

Infectious Diseases

After site-reared replacements became available in 1989, the herd was maintained as a closed-herd. We believe this was especially important given the nature of the breeding program required in seasonal dairying. Several abortions were detected during the project. As is often the case, although diagnostic efforts were made, a conclusive diagnosis was not achieved. While serologic titers suggested a possibility of leptospirosis in 1988 and IBR-induced abortion in 1990, results were not definitive. The herd vaccination program consisted of modified-live virus vaccines given to heifers at four to six months of age and repeated one month later. Replacement heifers were also calfhood vaccinated against brucellosis. Older animals received inactivated (killed) virus vaccines (IBR-PI3, BVD, bovine respiratory syncytial virus (BSVD)) and pentavalent leptospirosis bacteria every six months. Given present technology, it is probably not realistic to expect complete prevention of losses resulting from the common infectious diseases. However, preventing the entry of new disease agents (CLOSED-HERD) and developing and maintaining herd immunity (PROPER VACCINATION PROGRAM) should allow producers to keep losses at a low level.

Calf Health

Because of the high intensity of calving in the seasonal dairying project, a monoclonal antibody product given orally to calves to prevent Escherichia coli-induced diarrhea was used initially. In later years, this was replaced with a maternal vaccination given to cows during the dry period. Colostrum was fed to all calves. Prior to feeding, the specific gravity of colostrum was measured with a colostrometer. Specific gravity is associated with antibody level in colostrum. An injectable selenium product (Bo-Se®[1]) was given to all heifer calves shortly after birth.

Occasional diarrhea was noted in calves and treatment consisted primarily of supportive therapy such as oral electrolyte fluids. During one spring calving season, scours were noted in virtually every calf. A viral cause such as rotavirus or coronavirus was suspected but not conclusively demonstrated. Prompt electrolyte therapy resulted in reversal of clinical signs, and no death losses were noted as a result of diarrhea. One six-day-old bull calf died suddenly during feeding. Laboratory tests indicated the cause to be acute white muscle disease which led to heart failure. This bull calf had not received a Bo-Se® injection.

Internal Parasites

During their first summer, calves were raised in a small permanent pasture and were dewormed in the autumn. Yearling heifers were grazed behind cows in the intensive system. Yearlings were dewormed in June and July of each season approximating the third and sixth week (eight weeks if Ivermectin®[2] is used) after turnout as recommended by OSU parasitologists. Fecal samples checked at various times had low worm egg counts indicating success in keeping pasture larval counts low. Grazing yearlings behind cows in the intensive grazing system at Mahoning did not appear to result in heavy worm exposure. Controlling internal parasite loads in heifers has been proven to be very beneficial economically in previous research conducted at OSU (Herd, 1983). In addition to adopting OSU research-generated deworming recommenda-

[1] *Source: Schering Plough Animal Health Corp., Kenilworth, NJ 07033.*

[2] *Source: Merck & Co., P.O. Box 2000, Rahway, NJ 07065.*

Table 4.1. Summary of the herd health program, 1990.		
Cows		
	Vaccinations	
		Killed IBR, BVD, PI-3, BRSV and 5-way Leptospirosis bacterin every six months
		Escherichia coli, rotavirus, coronavirus vaccine to dry cows
	Injectable selenium (Mu-Se®)[1]	
		14 days prepartum
		30 days postpartum
	Dry treatment of all quarters of all cows	
Yearling Heifers		
	Vaccinations - same as for cows	
	Pinkeye vaccine in July	
	Dewormed in June and July	
Calves		
	At birth	
		Dip navels
		Colostrum -- after being tested as adequate with colostrometer
		Injectable selenium (Bo-Se®)[1]
	14 days	
		Injectable selenium (Bo-Se®)[1]
	4-6 months of age	
		Brucella vaccination
		Modified-live IBR, BVD, PI-3 and 5-way Leptospirosis bacterin vaccination
		Dewormed
	1 month later	
		Booster modified-live IBR, BVD, PI-3 and 5-way Leptospirosis bacterin

[1] Source: Schering Plough Animal Health Corp., Kenilworth, NJ 07033

tions (Herd and Heider, 1980; Herd et al., 1987), producers should be cautioned to work closely with their veterinarians to monitor worm burdens in heifers. Fecal egg counts in heifers of greater than 100 eggs per gram are generally considered significant.

Johne's Disease

In 1990, one cow with diarrhea was subsequently found positive by fecal culture for the bacterium which causes Johne's disease. A considerable risk of introducing Johne's disease is assumed when establishing a herd or adding purchased replacements. The diagnosis in the Mahoning herd emphasizes the following:

(1) If purchases are necessary, determine, if at all possible, the Johne's disease status of the herd of origin; and

(2) Practice good hygiene in raising replacements, including separation of the calf from its dam at birth.

Subsequently, fecal samples from the entire herd were cultured an additional three times at six-month-intervals, and to date, no more positives have been detected.

Note: For further information regarding prevention and control of Johne's disease, the reader is referred to the Ohio State University Extension bulletin by Hoblet and Shulaw (1988).

Summary

In general, herd health during the Mahoning project was very good. In fact, it was better than might have been expected when a herd is assembled from multiple sources. The experience with the Mahoning herd indicates that disease occurs periodically even in well-managed herds. However as was demonstrated in the Mahoning project, an excellent on-going working arrangement between the dairy producer and the veterinarian can be expected to greatly minimize herd health problems.

Chapter 5
Mastitis Control

K. L. Smith & J. S. Hogan

Summary

The herd experienced a low incidence of new intramammary infections and clinical mastitis during lactation. The positive aspects of mammary health during lactation may be attributed to a low level of exposure to pathogens between milkings and an excellent milking hygiene regime. Cows on intensive grazing programs are generally exposed to fewer environmental mastitis pathogens than conventionally housed cows. The limited use of water and practice of predipping teats in a germicide were means of decreasing pathogen loads at the teat end during milking. Another factor that may account for the low incidence of mastitis was the relatively low milk production per cow in the herd. The risk of mastitis in a herd increases as milk production increases.

In contrast, mammary health at calving was a concern. Both percentage of quarters infected and incidence of clinical mastitis at calving were greater than those anticipated for cows under conventional management practices. Extended dry periods (often 120 days) and calving cows in manure-pack bedded box stalls probably contributed to the high incidence of mastitis at calving. The relative risk of mastitis at calving increases as dry periods extend past 60 days. Manure-packs should be avoided as calving areas because they generally contain extremely high counts of mastitis pathogens.

Control Procedures

Teats were prepared for milking by predipping with an iodophor teat skin sanitizer, allowing the germicide to remain on teats at least 30 seconds, and completely drying predip from teats with individual paper towels. Water was used to wash teats only when mammary glands were excessively dirty. In the rare instances when water was used to prepare teats for milking, teats were washed, dried, predipped, and dried. All teats were dipped in post-milking teat sanitizer after milking machine removal.

At drying-off day, all lactating quarters of each cow were infused with commercially available antibiotics approved by the Food and Drug Administration for use in nonlactating cows. Cows were dried off by abrupt cessation of milking. Subsequently, at the next lactation, most cows calved in a box stall bedded with a manure-pack, because the calving time preceded the grazing season.

The bacteriological status of mammary glands was determined by collecting duplicate quarter foremilk samples within seven days after calving, at drying off, semi-monthly during lactation, and from all quarters of cows showing clinical signs of mastitis.

Mammary Health

Percentage of quarters infected with major pathogens at calving averaged 9% of quarters. The predominant major pathogens isolated from infected glands at calving were environmental streptococci and coliforms. The predominant minor pathogens isolated at calving time were coagulase-negative staphylococci. The percentage of quarters infected at calving with the minor pathogens, coagulase-negative staphylococci, was greater in first-lactation cows (averaged 23% of quarters) than multiparous cows (11% of quarters). Percent quarters infected with all pathogens did not differ from July to December. No contagious mastitis pathogens were isolated from the herd.

The incidence of clinical mastitis was highest within seven days after calving (66% of clinical cases) compared with other stages of lactation. Environmental streptococci were the bacteria most frequently isolated from clinical quarters. Incidence of clinical quarters was greater in multiparous cows than in first-lactation cows, which is contrary to the infection rates reported above.

Herd geometric mean somatic cell counts did not exceed 260,000/ml in any year of the project. Somatic cell counts increased throughout lactation, corresponding with a decrease in milk production. Somatic cell counts did not differ among parity groups.

Chapter 6 Reproduction

D. L. Zartman & S. R. Shoemaker

Lactating Cows

Management of the cow herd in a seasonal dairy is somewhat unique. As was mentioned in Chapter 1, duties on a seasonal dairy are mostly sequential rather than simultaneous. At the Mahoning Project, the cows freshened as a group during an eight-week period. In fact, most of them were clustered within four weeks as a result of high first-service conception rates, averaging 72% for years two through five of the project. The reproductive management was concentrated into a short time period. Subsequently, nearly all the problems associated with parturition and metabolic illnesses of early lactation were also limited to a brief period of time. Breeding problems were handled very efficiently with relatively few veterinarian calls. Heat checking was simplified by the mutual state of reproductive status of the herd. Usually, several cows were in or near estrus at the same time. This tends to enhance reproductive functions in all the cows.

Grazing management promotes successful reproduction as shown in Table 6.1. The cows were outside on good footing for estrous behavior which was assisted by their general vigor resulting from grazing. They were taken to and from pasture twice per day - a pattern leading to group interaction and displays of estrous behavior. The elevated levels of key vitamins such as A and E in high quality pasture may have enhanced reproductive health.

Spring breeding (June) probably is favored by photoperiod extension that improves endocrine gland activity related to ovulation. Yet, as this herd was bred during the months of June and July when heat stress was often severe, reproduction must have been compromised by high ambient temperatures and cow stress.

Pressure on the manager of a seasonal herd derives from the requirement for a 12-month calving interval. Without it, the herd cannot be kept in a seasonal pattern. Of course, low involuntary culling rates are the key to this accomplishment. The 12-month calving interval cannot be economically viable if it requires excessive involuntary culling. Involuntary culling rates for the project were 40, 23, 22, 3, and 12%, respectively, over the five years for an overall average of 20%. Culling during the first year was accelerated by the desire to advance the calving period by more than a month. Late pregnant cows were regarded as involuntary culls.

Tools used to assist estrous behavior observation (heat detection) for breeding decisions included veterinary support weekly through the breeding period, milk progesterone assays, and chalk marking on the rump. Treatment for cows found to have cystic ovaries was selected by the veterinarian according to milk progesterone levels. With problematic cows, milk progesterone levels were tracked to evaluate responsiveness to drug therapy and to assess pregnancy. These strategies recovered several cows that might ordinarily have been lost to infertility.

Reproductive performance for the first year of the project was the poorest overall. The seasonal timing was retarded a month by the difficulty of finding suitable heifers in a rapid initiation of the project with many preparations to be accomplished. The desire to move the freshening period forward led to heavier culling than would ordinarily have been needed. Also, nutritional adjustments were needed as part of the learning process about managing a seasonal, intensively grazed herd. In the first year, cows, all two-year-olds, were quite thin at breeding time. Subsequently, management improved to the advantage of reproduction. A different milk progesterone assay kit was used with improved confidence. Especially during the last two years, the nutritional program was changed with positive results. Cows experienced improved pregnancy rates, they were in heavier body condition as reflected by higher body condition scores, and the lactation curves had better persistence.

During the project, the driest year (1991) and an extremely cool and wet year (1989) occurred. There was also a nearly ideal year for grazing in 1990. Reproduction was best that year. Essentially, the program has worked under all probable conditions and extremes. The Jersey and Holstein cows appeared to be equal in reproductive performance. Since all normal heifer calves were successfully reared, excess replacements were available during the last three years of the project. Increased production culling was then possible.

The comparative advantage of reproduction in 1990 at an excellent 97% pregnancy rate with 84% first-service conception causes the suspicion that the poorer statistics for 1989 and 1991 were related to inadequate nutrition. The weather adversity of those two years forced the feeding of hay along with poor pasture at breeding time. Yet, even then, the reproduction rates were admirable considering the short breeding period and the summertime season.

There was no apparent relationship between production level and reproduction in this herd. Milk production steadily increased each year as the genetic base improved, the herd became more mature and the nutrition program was refined.

The average calving intervals shown were calculated on the Dairy Herd Improvement (DHI) report

Table 6.1. Features of the lactating herd at last test day before annual end-of-year culling[1].

			DHI, 305-day Extended								
Year	Breed	No. Cows	Actual Milk lb	ME Milk lb	1st Serv % pg	Total % pg	No. Serv/ Concept	Last CI	Days Open	DIM 1st Breeding	DIM[2]
1987	Holstein	14	12,162	15,185	29	57	2.17	...	124	56	249
	Jersey	15	9,007	11,378	53	73	1.86	...	79	49	236
	All	29	10,468	13,118	41	66	2.00	...	101	53	243
1988	Holstein	15	15,001	17,540	77	87	1.54	11.9	101	65	262
	Jersey	15	10,809	12,225	75	80	1.33	11.9	75	69	273
	All	30	12,905	14,893	76	83	1.44	11.9	89	67	267
1989	Holstein	18	14,515	16,616	67	83	1.40	12.1	88	68	273
	Jersey	18	11,083	12,203	56	100	1.67	12.4	92	69	282
	All	36	12,799	14,378	61	92	1.55	12.3	90	68	278
1990	Holstein	15	17,020	19,196	86	93	1.14	12.5	94	84	292
	Jersey	17	11,947	13,453	82	100	1.18	12.0	78	74	287
	All	32	14,325	16,110	84	97	1.16	12.2	86	79	289
1991	Holstein	21	17,758	19,906	70	95	1.50	12.3	88	75	291
	Jersey	22	13,028	14,740	65	86	1.75	12.5	93	74	296
	All	43	15,393	17,286	68	91	1.63	12.4	91	74	293

[1] Abbreviations: ME = mature equivalent; serv = services; pg = pregnant; concept = conception; CI = calving interval; and DIM = days in milk.

[2] Extended to last day of production for the last year.

prior to the December culling of late-pregnant cows. Once those cows were removed, the average calving intervals fell to 11.6, 11.9, 12.0, and 12.1 months. Replacement heifers were bred to freshen during the third week of the calving period.

Average days open for 1988 through 1991 was 89, which is consistent with a high pregnancy rate on a 12-month calving interval with low average numbers of services per conception (1.44). With these capabilities, it was not prudent to begin breeding cows before 60 days of lactation unless they were very late in the calving period. Consequently, the average days-in-milk (DIM) at first service was 72. This promotes greater production for a cow through delay of pregnancy and its retarding effect on lactation persistency (Bath et al., 1978; Erb et al., 1952; Schmidt et al., 1974).

The average DIM increased by 50 days from the first to the last years of the project, as the breeding period was pushed forward each year to arrive at the desired calving dates to make the most of the pastures. The herd was turned dry before Christmas as a convenience. Another twelve days of milking could easily have produced a normalized 305 day average lactation length.

Cows that were physically sound and worthy milk producers were bred as many as five times before being given up as beef cull candidates. When such cows became pregnant beyond the ideal eight-week period, they were marketed on the herd turn-dry day as dairy stock. On average, they brought $130 more salvage value than the beef culls.

All cattle, i. e., cows and yearlings, were artificially inseminated (AI). The semen was purchased from a single bull stud. Semen from the young sire group was used exclusively until the last year when the cattle would be leaving the project in pregnant condition.

Heifers

A slight difference in semen selection for heifers compared to the cows lay in the choice of proven calving ease Holstein bulls. Like the cows, all heifers were bred AI even though they were on pasture. This was facilitated by using ovulation synchronization with Norgestomet (Synchromate B®[1]). Thus, pregnancies were tightly clustered in the desired breeding period and the freshening period was subsequently compacted within about four weeks. Typically, each heifer was serviced on signs of standing heat within four days of removing the synchronizing implant from the ear. Heifer reproduction data are presented in Table 6.2. The first service conception rate was 67% over the four years of breeding yearlings. Services per conception averaged 1.36. Over the four years, only one of 60 left the herd not pregnant within three services. Only two required three services for pregnancy. Later, these were sold as springers at a dairy auction because they were due to calve later than acceptable for this herd.

[1] Source: Sanofi Animal Health, Inc., 7101 College Blvd., Suite 610, Overland Park, KS 66210.

Table 6.2. Breeding results for yearling heifers.

Year	Breed		Total	No. Heifers and % Pregnant 1st Service	No. Heifers and % Pregnant
	Jersey	Holstein			
1988	6	8	14	8 (57%)	14 (100%)[1]
1989	6	7	13	7 (54%)	13 (100%)[1]
1990	10	7	17	13 (76%)	17 (100%)
1991	10	6	16	12 (75%)	15 (94%)[2]
Total	32	28	60	40 (67%)	59 (98%)

[1] A single Holstein heifer in each of 1988 and 1989 required a third service for pregnancy.

[2] A Holstein heifer was unsuccessfully serviced four times. She was the only bred yearling in the entire project not to become pregnant with three or fewer services.

Chapter 7 Milk Production Patterns

M. L. Eastridge

In general, it is assumed by researchers and dairy producers that milk yield will be lower for cows on an intensive grazing system compared to a dry-lot system; however, the major economic motivation for implementing an intensive grazing system is to lower input costs. Although milk yield may be lower, the lower input costs are projected to result in a respectable income per animal or land unit. Various indices for profitability can be used to evaluate a dairy enterprise, but "milk sales" is the most significant contributor to the income side of profitability. Milk production patterns observed during the project will be discussed in this chapter.

From the onset of the project, the herd was enrolled in an official test program with the Dairy Herd Improvement Association (DHIA). A standard program was used, not an a.m./p.m. program. Generally speaking, cows were in milk from April through December. Actual DIM for each cow were calculated on each DHI test date, and data were divided into 30-day increments, based on DIM, for graphic purposes. The distribution of cows by age and year of the project is provided in Table 7.1.

Milk yield was considerably lower in 1987 than for other years (Table 7.2) because forage growth got ahead of harvesting schedules and all animals were in their first lactation. The mature equivalent (ME) production was also lower during 1987, probably because of lower than desirable genetic merit of the cows purchased from multiple sources. Milk yields generally increased in 1988 above 1987 levels; however, increases in herd production were stymied by all cows being in their first or second lactation and the limited forage available because of the severe drought. Actually, the adjusted rolling herd average (RHA) milk yield for the Jersey cows decreased in 1988 compared to 1987. This and the lower improvements in other production indices for the Jersey cows in 1988 can be at least partially attributed to the grain feeding program - the 1:4 grain-to-actual milk ratio used for both breeds would favor the Holstein cows.

The RHA milk yields in 1989 increased above 1988 levels, but daily and ME milk yields remained very similar or even slightly decreased. The grain feeding regime in practice and forage quantity and quality during 1988 permitted the cows to become quite thin, which may have affected the performance in 1989.

By 1990 and 1991, milk production had reached levels that had been anticipated at the onset of the project. The performance in these two years can be attributed to better forage quality, changes in grain feeding, and improved animal genetics. The RHA milk production during these two years was also affected by the increase in DIM. The ME milk production for 1991 increased above 1990 levels by 3.7% for Holstein cows and 9.6% for Jersey cows, slightly more than the 2 to 3% annual U.S. average increase in milk yield per cow.

The RHA milk production during 1991 was similar to the 1991 Ohio DHIA averages for milk production (Holstein - 8,537 kg or 18,781 lb; Jersey - 5,707 kg or 12,555 lb). At first glance this may not be apparent because an adjustment must be made for DIM. If you assume a 305-day lactation, the Holstein cows were in milk about 9% fewer days and the Jersey cows were in milk about 8% fewer days than would occur for a typical lactation. Therefore, the following calculations must be made to fairly compare production to the state average:

Holstein: [(7,658 kg/.91)/8,537 kg] x 100
= 98.6% of state average

Jersey: [(5,561 kg/.92)/5,707 kg] x 100
= 106% of state average

Cows typically peaked on the second DHIA test, approximately 60 DIM (Figures 7.1 and 7.2). The Holstein cows essentially peaked at the first DHIA test in 1989 (Figure 7.1), possibly because of the less than desirable body condition discussed earlier. The Jersey cows peaked at the first DHIA test in 1988, perhaps because of the grain feeding regime also discussed earlier. Otherwise, the patterns for the lactation curves were as would be expected for any other herd.

Table 7.1. Parity distribution of lactating animals during the trial.

Breed	Lactation Number	Year 1987	1988	1989	1990	1991
Holstein	1	14	8	8	6	9
	2	-	7	3	4	3
	≥ 3	-	--	7	5	9
Subtotal		14	15	18	15	21
Jersey	1	15	4	6	6	10
	2	--	11	4	5	5
	≥ 3	--	--	8	6	7
Subtotal		15	15	18	17	22
Total		**29**	**30**	**36**	**32**	**43**

Table 7.2. Milk production and milk composition by cows during the trial.

Item[1]	Year 1987	1988	1989	1990	1991
HOLSTEIN					
Milk, lb/d	41.0	52.9	51.6	57.3	60.6
4% FCM, lb/d	37.0	50.3	47.4	52.2	54.7
Milk fat, %	3.42	3.73	3.51	3.47	3.40
Milk protein, %	2.95	3.11	3.12	3.11	3.05
Milk fat/protein	1.16	1.20	1.13	1.12	1.11
Days in milk	243	250	257	274	277
Adj. RHA milk, lb[2]	9,908	10,481	13,860	16,131	16,883
Milk yield, lb/acre[3]	354	299	396	461	482
Adj. RHA fat, lb[2]	335	388	478	558	575
Adj. RHA protein, lb[2]	---	322	428	498	516
305-day ME milk, lb[4]	15,185	17,540	16,616	19,196	19,906
305-day ME fat, lb[4]	514	659	582	666	683
305-day ME 4% FCM, lb[4]	13,779	16,907	15,379	17,659	18,212
JERSEY					
Milk, lb/d	32.4	37.7	38.6	41.2	43.9
4% FCM, lb/d	34.2	40.8	42.1	44.8	46.5
Milk fat, %	4.46	4.66	4.68	4.62	4.47
Milk protein, %	3.50	3.74	3.69	3.70	3.58
Milk fat/protein	1.27	1.25	1.27	1.25	1.25
Days in milk	230	261	266	269	282
Adj. RHA milk, lb[2]	7,824	7,533	10,728	11,585	12,260
Milk yield, lb/acre[3]	279	215	307	331	350
Adj. RHA fat, lb[2]	344	333	498	536	547
Adj. RHA protein, lb[2]	---	276	392	423	437
305-day ME milk, lb[4]	11,378	12,225	12,203	13,453	14,740
305-day ME fat, lb[4]	500	560	571	622	657
305-day ME 4% FCM, lb[4]	12,057	13,330	13,448	14,700	15,756

[1] Kilograms (kg) = lb/2.2.

[2] Adjusted rolling herd average (Adj. RHA) calculated from DHI records by dividing total product yield for months of actual production by the average number of cow days.

[3] Adjusted RHA milk yield divided by acres grazed, assuming 28 acres grazed in 1987 and 35 acres grazed during 1988 through 1991.

[4] The extended 305-day product yield calculated during the last month of production was converted to a mature equivalent (ME) basis.

Percentages of milk fat and protein were slightly lower than for respective breed averages, especially during 1987 and 1991. Of course, this is somewhat expected with pasture systems; however, feeding programs must be continually investigated to help offset such occurrences. Across all years, the average milk fat-to-protein ratio was similar to breed averages (Holstein - 1.14; Jersey - 1.26); however, the milk fat/protein ratio was high in 1988 for the Holstein cows. This occurred because of an increase in milk fat percentage rather than a decrease in milk protein percentage, perhaps in response to lack of energy intake and an increase in mobilization of fat from adipose tissue.

Milk fat and protein percentages by DIM generally followed patterns similar to other herds (Figures 7.3 to 7.6). Graphing milk fat and protein percentages of DHIA herds by month of the year would usually reveal a rather constant milk composition because cows from all stages of lactation would be used to calculate the averages by month. The cows on this project calved within a short time, and therefore, graphing the herd's milk composition by month also reflects the expected changes in milk composition by stage of lactation.

Percentage of milk fat was typically lowest at 120 DIM for Holstein cows (Figure 7.3), corresponding primarily to the month of July when forage quality decreased, forage intake decreased, and grain-to-forage intake increased. Percentages of milk fat for the Jersey cows were somewhat more erratic (Figure 7.4) but were generally lowest during June to August. The percentages of milk fat were particularly low for both breeds during 1987 (first year of project) and 1988 and 1991 (drought years). Milk protein percentages followed patterns similar to those of milk fat, although the magnitude of change was less.

In conclusion, the production patterns for this herd were similar to those of other Ohio herds. However, focus must continue on improving fat and protein production by cows on pasture, especially protein given the current trends in milk pricing programs. The performance of the animals in a pasture system is greatly affected by the quality of available forage and the grain feeding strategy. Although the desire is to maximize the utilization of forage, feeding strategies with the forage and grain must be adjusted as needed when forage production is altered due to environmental effects. This need also gives credence to the fact that using a pasture system does not dismiss the need to test forages.

Actual milk production from a dairy enterprise, organized similarly to the one on this project, should not be the major index for measuring success. Rather than comparing production to typical DHIA averages, use adjustments discussed in this paper. A farmer should use profitability per animal or land unit as the economic principle for success instead of production per animal. However, for new users of an all-pasture forage system, it is suggested to employ a conservative estimate of milk production (about 80% of budgeted amount) for the first year on the system because of the adjustments in management that will occur until more experience is gained.

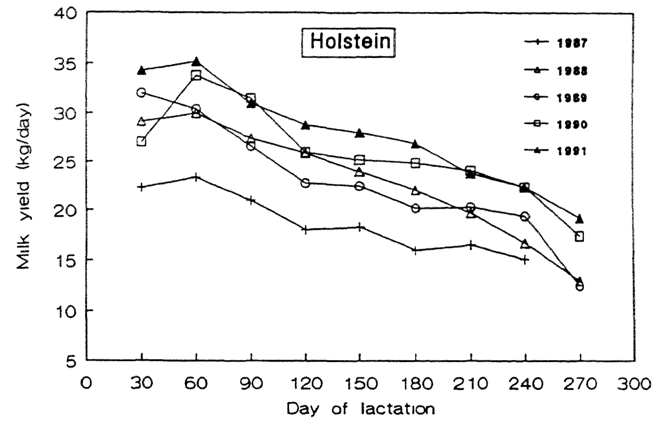

Figure 7.1. Milk production by Holstein cows, 1987-1991.

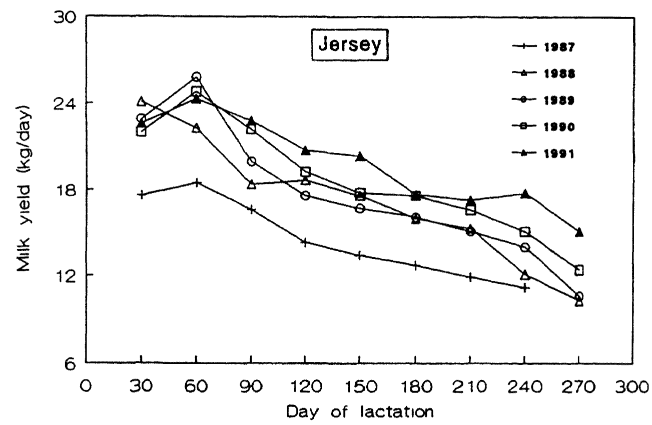

Figure 7.2. Milk production by Jersey cows, 1987-1991.

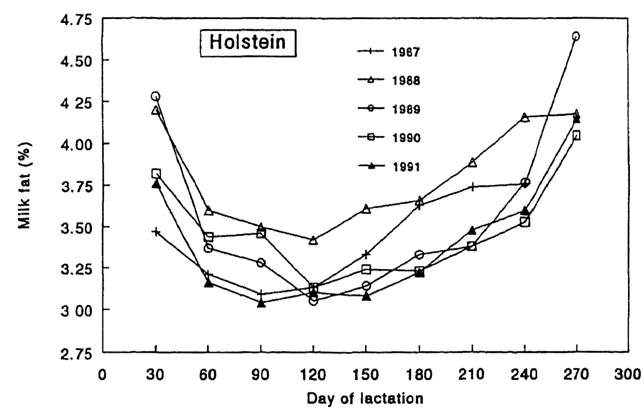

Figure 7.3. Percentage of milk fat within a lactation for Holstein cows, 1987-1991.

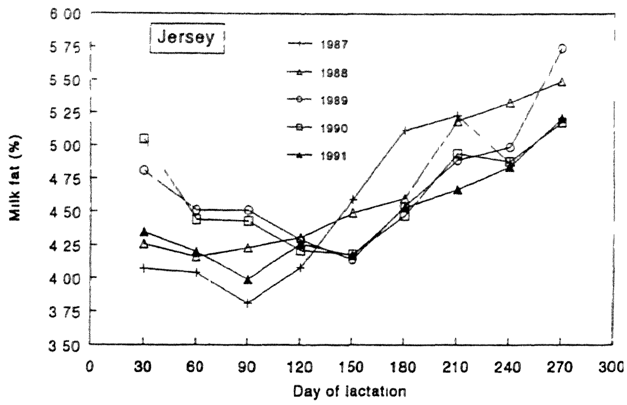

Figure 7.4. *Percentage of milk fat within a lactation for Jersey cows, 1987-1991.*

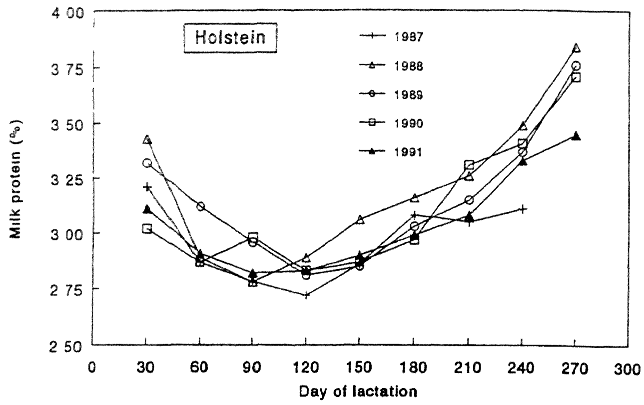

Figure 7.5. *Percentage of milk protein within a lactation for Holstein cows, 1987-1991.*

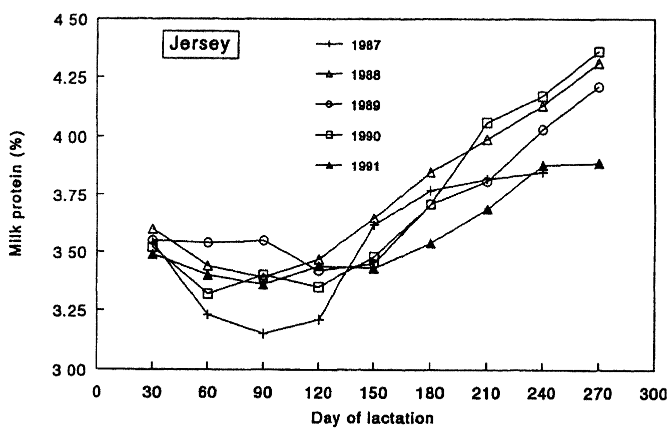

Figure 7.6. *Percentage of milk protein within a lactation for Jersey cows, 1987-1991.*

Chapter 8 Agronomic Summary

R. W. Van Keuren

The soils of the fields used in the study were Canfield and Ravenna silt loams, typical soils of northeast Ohio. Both soils are moderately well drained and occur on nearly level to gently sloping areas in glacial till plains.

At the beginning of the study, the soils had a moderate level of fertility, with an average pH of 6.2, lime test index (LTI) of 67, an available phosphorus level of 46 lb/A, and potassium, 229 lb/A. This level of fertility had been previously maintained by annual fall applications of 300 lb/A of 0-12-46, with lime and additional phosphorus and potassium corrective applications as indicated by annual soil tests. In 1987, potash was applied to all fields at 300 lb per acre; lime was applied in the fall of 1989 at two tons per acre. Soil samples taken at the end of the study indicated that the soil fertility had been maintained at the previous level and were as follows: average pH 6.4, LTI 69, phosphorus 34 lb/A, and potassium 249 lb/A.

For the ten years prior to the study, seven of the ten fields had been used in a beef cow-calf pasture-hay system and were mixed grass-legume stands. Grazing was non-intensive and year-round. The original seeding was a tall fescue-birdsfoot trefoil mixture. During the ensuing ten years, other species, particularly orchardgrass, white clover, and red clover, had encroached strongly into the stand. Orchardgrass was from 30% to over 50% of the stand. Good stands of legume were also present, contributing from 15 to 20% of the sward. The other three fields were in a corn-wheat-alfalfa rotation, followed by four years of meadow, and seeded in 1987 to orchardgrass-alfalfa for the dairy study. In 1989 red clover was no-till drilled into the pastures in August and September to fill in bare spots resulting from dry conditions in 1988. The results of seeding were only fair to poor.

For the first year, 1987, 28 acres, divided into seven fields, were used for grazing and hay production. The three reseeded fields became available for grazing in 1988, increasing the intensively grazed and hayed acreage to 42 acres. A polywire ribbon portable electric fence was used to divide each pasture into an area sufficient for a day of grazing for the herd. The fence was pivoted from one entry point of each field and moved across the field in an arc. The daily paddocks were sized so that the milking herd consumed about 60% of the available forage per day. It took the operator about one-half hour each day to move the fence. The plan was to graze the forage when it reached eight inches in height and graze it down to about two inches. In general, each paddock had about a 30-day recovery period, with 25 days in 1990 because of the above average rainfall. During the late spring-early summer peak growth period, the recovery time was shortened to about 18 days. The grazing management provided forage that averaged about 20% crude protein, except for droughty periods of reduced growth. Heifers followed cows in most of 1988. In 1989 and 1990, heifers followed cows only in spring. In 1990, heifers were given ten of the 42 acres and rotated through it most of the year. In 1991, heifers were moved to other pasture for the entire year.

The grazing season began in mid-April and basically ended in mid-November, with the dates depending on the season, primarily early spring temperature and seasonal moisture. Some fields were harvested as hay for winter feed as large round bales, depending on grazing needs and to utilize surplus forage growth. During dry periods, this hay was also used to supplement the pasture. Fields primarily used as hay were also used as standing fall-saved forage to extend the grazing season.

The grazing periods for each year are shown below. Except for the first year, grazing began in early to mid-April and extended into November and early December. Fall-saved regrowth of hay fields cut for hay was used to extend the grazing period. Weather, particularly moisture, influenced forage production and the length of the grazing season. During periods of limited pasture, the cows were restricted to half-days on pasture with supplemental hay being fed in addition to the concentrates normally being fed. As is typical of the north-central region, occasional dry periods occurred during the grazing season. Below average rainfall occurred in 1988 and unusually high rainfall fell in 1990. Severe drought conditions occurred in 1991 as shown by the need to restrict pasture grazing in mid-summer and during the fall.

Year	Grazing Periods
1987	May 19 - November 24 = full days
1988	April 22 - November 5 = full days;
	November 6 - December 9 = one-half days
1989	April 6 - November 15 = full days
1990	April 16 - October 28 = full days;
	October 29 - November 19 = one-half days
1991	April 3 - August 23 = full days;
	August 24 - November 14, one-half days

The study illustrates the value of forages in a combination grazing and hay system for smaller dairy herds under upper mid-western conditions. A simple daily rotational grazing, using portable electric fence, enabled the operator to provide generally high quality forage for the dairy herd. During the five-year period, the operator had to cope with a range of weather conditions, from normal to unusually wet to unusually dry conditions. Despite this, good milk production was obtained.

Chapter 9 Nutritional Program and Forage Features

W. P. Weiss & W. L. Shockey

The objective of intensively managed grazing is to have high quality forage available to cows through the entire growing season. The nutritional value of forages (forage quality) decreases as plants mature. The concentrations of digestible energy, protein, and vitamins are substantially less in mature plants than in immature plants. For example, cool season grasses harvested in the vegetative stage may contain 18 to 20% crude protein (CP) and .72 to .78 Mcal net energy for lactation (NE_L)/lb. Grasses harvested in the full head stage of maturity usually have 10 to 12% CP and .55 to .60 Mcal NE_L/lb. Milk production is directly proportional to the quality of forage the cows are consuming.

In an intensively managed pasture system, a combination of mechanical harvesting and grazing is used to prevent the forage from becoming overly mature. A strip grazing procedure was used in this project to maintain forage quality. Strip grazing is not only the most intensive form of controlled grazing, but it also provides the highest quality forage to animals when done properly with forages in the vegative growth stages. Cows graze only the tops of the plants and then are moved to the next strip. The top portion of plants contains a large proportion of highly nutritious, immature leaves.

When high quality forage is provided to cows, the need for concentrate is reduced; however, some concentrate is needed to achieve high levels of milk production. Overfeeding concentrate results in reduced consumption of forage, reduced digestibility of the forage, and usually increased costs. Intensively managed pasture provides an exceptional nutritional base which should be complemented by the concentrate.

The pastures at the Mahoning farm were predominantly cool season grasses (mainly tall fescue). Composition (dry basis) of the pasture (averaged over years and months) was 18% CP, 57% neutral detergent fiber (NDF), 30% acid detergent fiber (ADF), and .60 Mcal NE_L/lb. Minerals averaged 2.5% potassium, .8% calcium, .35% phosphorous, and .3% magnesium. Overall, the nutrient profile was about what would be expected for cool season grasses harvested in the vegetative state. Month-to-month and year-to-year variation in composition was substantial. The CP content of the pastures was less than 15% several times over the duration of the project. Milk production generally decreased when cows were consuming poorer quality forage. Because of the variation in nutrient composition, pasture samples should be taken frequently so that the diet can be adjusted appropriately.

Several different concentrate feeding systems were tried during the five-year project. During the first year, Jersey cows were fed concentrate at the rate of 1 lb (0.45 kg) concentrate for every 4 lb (1.8 kg) of 4% fat-corrected milk; Holstein cows were fed at a 1:5 ratio. During the second year of the project, all cows were fed concentrate at a rate of 1 lb (0.45 kg) for every 4 lb (1.8 kg) of actual milk, but all cows were fed at least 10 lb (4.5 kg) of concentrate regardless of milk production. During the third year, the ratio was 1 lb (0.45 kg) of concentrate for every 3.5 lb (1.6 kg) of actual milk with a 10 lb (4.5 kg) minimum. The concentrate feeding strategy changed for the last two years of the project. All cows were fed 17 lb (7.7 kg) of concentrate per day for their entire lactation. The daily concentrate allotment was divided into two equal parts fed at milking.

Because of the severe drought experienced during 1991, supplemental hay had to be provided. The concentrate mix varied over years, but was based on corn grain and soybean meal and was formulated to contain about 15% CP (dry basis) and provide adequate minerals to meet National Research Council (NRC) (1989) recommendations. Strip-grazing usually provides high protein forage to cows; therefore, the concentrate does not need to have a high concentration of CP. Fresh, green forage also contains high concentrations of ß-carotene (a vitamin A precursor) and vitamin E. Grazed cows also are outside in the sunshine, so much less supplemental vitamin D needs to be provided. The concentrate must provide adequate amounts of calcium, magnesium, phosphorous, salt, and trace minerals.

The concentrate compositions used for lactating cows and heifers the final year of the project were as follows:

Lactating Cow Feed. This complete feed was used to supplement the pasture feeding program for lactating Holsteins and Jerseys which all freshened in the spring. During pasture season, cows were fed pasture as the only forage as long as conditions permitted. If pasture growth became inadequate, cows were supplemented with alfalfa hay and/or corn silage. After pasture season, cows were fed alfalfa hay and corn silage. The concentrate was pelleted but need not be. If not pelleted, the grain should contain approximately 2.5% liquid molasses as fed to control dust. This feed was ordered in 3 ton lots. Specifications: 100% dry matter basis.

Minimum 14% crude protein, no non-protein nitrogen (NPN)

Minimum 55% rumen undegradability of protein

Minimum 70% shelled corn

Minimum 6.5% fat - maximum 8%

Minimum 2.5% rumen undegradability of fat

Minimum 1.1% calcium - maximum 1.7% calcium

Minimum 0.5% phosphorus

Minimum 0.55% magnesium

Minimum 0.34% sulfur

Minimum 0.6% potassium

Minimum 0.5 ppm selenium

Maximum 1.7% salt

Minimum 2,000 IU/lb vit A

Minimum 150 IU/lb vit D

Minimum 10 IU/lb vit E

Additional trace minerals met minimum NRC (1989) recommendations.

Supplemental fat sources were limited to soybeans, calcium salts of fatty acids, bleachable fancy tallow, or hydrolyzed animal vegetable blend.

Heifer Feed. Complete feed for replacement heifers from 400-1,300 lbs. Heifers were fed primarily grass hay and possibly some corn silage during the winter. During pasture season, heifers were fed only pasture as long as conditions permitted. This feed was given at the rate of 4-6 lb/day. This feed provided 200 mg of monensin per head/day when fed at 5 lbs. This feed was ordered in 1 ton lots supplied in approximately 100 lb bags. Specifications: 100% dry matter basis.

Minimum 16% crude protein, no NPN

Minimum 70% TDN

Minimum 1% calcium - maximum 1.5% calcium

Minimum .5% phosphorus

Minimum 1% salt

Minimum 10 ppm copper

Minimum .6 ppm selenium

Minimum 3,500 IU/lb vit A

Minimum 400 IU/lb vit D

Minimum 20 IU/lb vit E

Additional trace minerals met NRC (1989) recommendations.

Corn silage from the Mahoning Experiment Station was stored in bags near the cow barn for winter feed. About the end of November, as pastures were no longer growing, grazing was reduced to half-days and silage feeding began. About the middle of December, depending on weather conditions, the cows were taken off pasture to be fed in confinement on silage and medium quality hay. The herd was turned dry about December 22 each year. During the dry period, the cows were fed as usual for confinement dry-cow rations.

Feeding concentrate based on milk production, as was done the first three years, was not the ideal supplementation strategy. All cows in the herd calved in early spring and usually reached peak milk production in early May. Correspondingly, when concentrate feeding was based on milk production, maximum concentrate intake occurred at this time. The quality of cool season grasses is highest during the spring and then declines during the hot summer months. Cows were at their peak production, fed large amounts of concentrate, and forage quality was highest at the same time of the year. The large amount of concentrate offered (many cows received 20 to 22 lb per day) during this time probably reduced consumption and digestibility of the forage. On the other hand, concentrate intake was lowest when forage quality also was low (late summer). This resulted in thin cows. The reason for the 10 lb (4.5 kg) minimum for concentrate offered was to prevent losses in body condition during late lactation. Setting a minimum, however, did not eliminate overfeeding concentrate during the spring.

Feeding a fixed amount of concentrate daily throughout lactation resulted in less concentrate being fed during the spring and more being fed during late summer than when concentrate feeding was based on milk production. Seventeen pounds (7.7 kg) was chosen based on forage quality during the previous years and projected milk production. Another consideration in choosing 17 lb (7.7 kg) was that cows were fed concentrate twice daily (during milking). Conditions within the rumen are adversely affected when more than about 8 lb (3.6 kg) of concentrate are consumed during a single meal. When concentrate is fed only twice daily, 17 lb (7.7 kg) is close to the maximum amount of grain that should be fed.

During each lactation, Holstein cows were fed approximately 4,500 lb (2,045 kg) of concentrate during each of the last two years of the project and 4,000 lb (1,818 kg) of concentrate during each of the first three years of the project. Considering the amount of concentrate fed per lactation, and the overall nutritional quality of the forage, milk production was not exceptionally high. Forage species were probably the cause for the relatively low production. Tall fescue was the predominant species of forage consumed. Most unimproved tall fescue pastures contain an endophytic fungus which is related to poor consumption, decreased digestibility, and reduced production. Forage was not tested for the endophyte, but the probability is high that the pastures were infected. Concentrate feeding cannot overcome all the problems associated with the feeding of endophyte infected tall fescue.

Conclusions

1. Nutrient quality of cool season grasses can be maintained with an intensively managed grazing system.
2. Feeding concentrate based on milk production is not the ideal system with a spring calving, intensive grazing system. Rather, a constant feeding rate throughout lactation is favored.
3. A pasture system based predominantly on tall fescue that probably was infected with endophyte is not conducive to high levels of milk production even when substantial amounts of concentrate are fed.

Chapter 10 Economic Patterns and Labor Utilization

D. P. Miller & G. D. Schnitkey

A seasonal dairying/intensive grazing system has been advanced as an alternative to conventional dairying systems. Compared to conventional systems, a seasonal dairying/intensive grazing system emphasizes reducing capital requirements, thereby allowing easier entry into dairying. Moreover, high milk production is not an overriding objective. Rather, emphasis is placed on lowering feed costs by relying on pasture to provide the animal's forage requirements. Lower capital requirements and lower feed costs then potentially lead to a profitable system.

The Mahoning County Program consisted of a seasonal dairying/intensive grazing system with between 30 and 43 cows and 42 acres of grazed pasture in Northeast Ohio from 1987 through 1991. We used data from this project to address the following question: Can a seasonal dairying/intensive grazing system as structured with the Mahoning Project provide competitive returns to all resources? To address this question, we first highlight production components of a seasonal dairying/intensive grazing system, thereby providing specific criteria for evaluating the system. Then, capital, management, and labor resources used during the project are described. These descriptions serve as the basis for quantifying returns to resources. Following the descriptions, financial reports of the Mahoning Project are analyzed to answer the above question. Based on these analyses, we draw conclusions concerning the commercial applicability of a seasonal dairying/intensive grazing system.

Overview of the Seasonal Dairying/Intensive Grazing System

Briefly, a seasonal dairy has all animals freshen within a short period of time each year. As a result, all cows and heifers must be bred within an 8-week window to remain in the herd. Breeding all animals within this time is crucial for the success of a seasonal dairy. During the Mahoning Project, dairy animals were bred during June and July so that freshening occurred during March and April.

Freshening in March matches the forage requirements of dairy animals with forage production from pasture. However, this timing may yield a lower average milk price than received by a conventional dairy or a seasonal dairy freshening at another time (Ford, 1992). Milk prices follow a seasonal pattern. Milk prices tend to be low during spring months, and prices normally rise in late summer until they peak during the winter months. Prices then decline into spring. Because of seasonal milk prices, a seasonal dairy freshening in March must reduce costs to be economically competitive.

In an intensive grazing system, animals are confined to a small area of pasture (or paddock) which is grazed heavily for a short period of time. Then, animals are moved to another paddock while the already grazed paddock regrows. Intensive grazing allows a paddock to be grazed four to six times during a season, depending on pasture characteristics, weather conditions, and livestock stocking rates (see University of Wisconsin-Extension, 1992, for a more complete description of production practices used in intensive grazing). Possible economic benefits from intensive grazing include increased pasture productivity, increased forage quality, and lower reliance on stored forages (Miller and Schnitkey, 1991). Hence, a dairy using intensive grazing should have lower per-cow feed costs relative to a conventional dairy, particularly if lower milk production levels occur.

Seasonal dairying and intensive grazing do not have to be used together. In tandem, the components potentially offer a low investment system. Investments in forage harvesting equipment and storage facilities are reduced by grazing pastures rather than by feeding stored forages. Use of older facilities may further reduce investment.

Given the above discussion, specific criteria for evaluating the seasonal dairying/intensive grazing system are:

1. Per-cow feed costs of this system should be lower than for a conventional dairy,
2. Per-cow fixed costs should be lower than for a conventional dairy, and
3. The system should generate competitive returns to all resources.

Capital Resources

In keeping with the low investment criterion, an old bank barn was remodeled to serve as the dairy facility. Renovation required installing a stanchion milking area, purchasing used milking equipment and a bulk tank, and building a milk house inside the barn. Renovation investment totaled $8,402. In addition, a larger milk tank was purchased in 1989 at a cost of $4,700. Milking and concentrate feeding occurred in a six-place stanchion installation, requiring moving cows in and out of stanchions. The barn had a partially covered feedlot used for loose housing during winter months. An old corn crib near the barn was converted to a calf-raising facility.

Approximately 42 acres of tall fescue-legume pasture were fenced into six large paddocks using electrified high-tensile fence costing $7,402. The majority of the grazing occurred on 23 acres while the remainder was used mostly for hay production. Through the year, all acreage was grazed at some time. The large paddocks were divided into smaller paddocks using electrified polywire. The manager moved this polywire fence while bringing the cows in for the p.m. milking.

At the beginning of the project, 30 bred heifers of average to above average genetic potential were purchased. Half of the heifers were Holstein while the other half were Jersey. These animals and their heifer calves provided the vast majority of the milking animals during the project. Cows culled (eight Holsteins, four Jerseys) at the end of the first year were replaced with transferred or purchased pregnant 2-year-olds since no yearling heifers were present during the first year of the project. Pasture was the only on-farm source of feed for the animals. All other feeds were purchased.

Management Resources

The seasonal dairying/intensive grazing system required a differing management emphasis than a conventional dairy. Specific differences are:

1. Dairy animals must be bred successfully every year during June and early July in order to maintain a 12-month calving interval.
2. All dairy animals freshen during March and early April, causing high labor requirements during this period.
3. Pastures must be properly managed to maintain forage yields and quality. Proper management requires moving dairy animals to differing pasture areas at the proper time.
4. The slack season of end-of-lactation and the subsequent dry period of the herd allowed for labor use opportunities not seen in conventional dairying.

A research team provided long-run management guidance. Steve Shoemaker, herdsman for the project, provided day-to-day management. Mr. Shoemaker had extensive dairy herd management experience prior to the Mahoning Project and proved to be an excellent manager for the project. As reported elsewhere, the breeding (Chapter 6), calving (Chapter 3) and pasture (Chapters 8 and 9) programs were successful.

Labor Resources

Detailed labor use records were maintained by the herdsman during 1987 through 1990. We do not report labor use during 1987 because full production was not maintained. Labor use was not recorded during 1991 because labor use did not vary during the prior three years.

We summarized labor requirements into monthly reports. Labor was provided by the herdsman and by employees of the Ohio Agricultural Research and Development Center (OARDC). Labor provided by OARDC employees was reported as supplemental labor. Both herdsman labor and supplemental labor were divided into three activities:

1. Dairy—labor directly related to the care of dairy animals. Labor for dairy animals was further divided into:
   a. cow labor—labor related to milking, feeding, and caring for milking and dry cows,
   b. heifer labor—labor related to feeding and caring for replacement animals, and
   c. reproduction (repro) labor—labor used for heat detection and breeding.
2. Pasture—labor related to fence moving, pasture care, and pasture maintenance.
3. Miscellaneous (misc)—labor not directly attributable to dairy or pasture activities. Miscellaneous labor was further divided into:
   a. research labor—labor related to research activities which would not be incurred by commercial enterprises, and
   b. other labor—miscellaneous labor not research oriented. Most of this labor was used for barn maintenance.

Labor Use During 1987 Through 1990. An average of 3,037 labor hours were used each year (Table 10.1). The herdsman supplied 91% of the labor while supplemental labor accounted for the remaining 9%. Most supplemental labor was used during January and February when the herdsman was on vacation. During this period, cows were dry and supplemental labor was used to feed cows and haul manure. From February to December, most labor was provided by the herdsman who milked the cows and cared for the calves.

Management of livestock required the most labor, accounting for 2,460 hours or 81% of total labor use. Within this management activity, milking, feeding, and caring for cows required 1,974 hours, 65% of total labor use (Figure 10.1). Heifers required 14% of total labor while reproductive activities required 2%. Activities related to the pasture accounted for 242 hours or 8% of total labor use. Miscellaneous activities accounted for 11% of labor use.

Table 10.1. Herdsman and supplemental labor use per year.

Year	Herdsman	Supplemental Labor	Total
	hours per year		
1988	2,462	360	2,821
1989	2,829	321	3,150
1990	2,923	217	3,140
Average	2,771	299	3,037

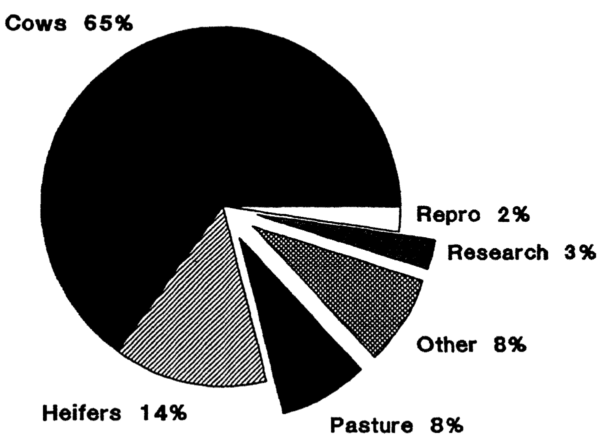

Figure 10.1. Labor distribution by activity, 1988-1990.

Labor use averaged less than 4 hours per day during January and February when cows were dry. Labor use rose dramatically in March and peaked at over 10 hours per day in April through June. During this period, freshening cows and young calves required a great deal of care. Labor use in July through October was fairly stable, averaging between 8.5 and 9 hours per day. During November, labor use increased to 9.6 hours per day because cows were not always on pasture, increasing time spent cleaning the barn. Daily labor use declined to 6.3 hours in December as cows were dried off.

Most of the unevenness in labor use is attributable to cow and heifer activities. When cows were milking, labor use for cow care always exceeded 5 hours per day (Figure 10.3), with the majority of labor use accounted for by milking time. Labor use for heifers was highest in April and May when heifers were young.

Although crucial for the success of a seasonal dairy, reproduction activities did not require a great deal of time. Even in June, when most reproduction activities occurred, average hours for reproduction activities did not exceed an average of 1 hour per day (Figure 10.3).

Summary of Labor Use. Labor use during this project was relatively high and fully employed one person. It was originally thought that this enterprise would allow for possible outside employment. However, labor use was such that only the dry period offered the herdsman any "free" time for vacation or outside employment.

Labor use was very high between April and June when cows were freshening and heifers were young. This period presents a labor bottleneck. Larger herd sizes would require either supplemental labor or a means of reducing labor.

Reductions in labor use most likely would occur by reducing milking time. Modification of the six-stanchion parlor to allow additional automation or for more cows milking at once would reduce milking time. Reducing milking time, however, would likely require investment. Hence, there is a trade-off between labor productivity and investment.

Financial Results

Yearly income statements were prepared using modified costing principles (Frey et al., 1989). These statements provide two measures of income: income before interest and taxes, and cash operating income. Income before interest and taxes measures returns for equity financing, unpaid labor, and unpaid management. Cash operating income measures funds available to make debt principal payments, fund expansion, pay income taxes, and provide for family living.

Income statements were prepared as if the project had been a commercial enterprise assuming that one family owned the cows, managed the herd, and provided all labor. We took this perspective to determine if the project could have been a viable, commercial enterprise. The commercial perspective differed from the actual research arrangement. As the project was structured, the herdsman owned 30 of the cows and he received rental payments for these cows. In addition, the herdsman was provided a salary for operating the enterprise. Expenses for cow rental and herdsman salary were not included in the income statements because a family enterprise would not incur these costs.

We presumed that a family starting this enterprise would rent buildings and land. A rental arrangement was chosen over a purchase arrangement in order to minimize initial investment. As part of the rent, the family was presumed to pay for all building renovations and make a $3,190 yearly payment. About $1,000 of the $3,190 (for rent and taxes) covered property taxes (Table 10.2). If a purchase arrangement had been chosen, rent less property taxes could have serviced debt on a land and building purchase. The $2,190 would have serviced a 20-year amortized loan having a 10% interest rate with a beginning balance of $18,645. Value of the property used in the project was estimated to be between $30,000 and $50,000.

Even without a land and building purchase, an initial investment was still required for building renovation, fencing investment, and cow purchases. At the beginning of the project, building renovations and fencing investment totaled $13,102. Cows would have cost approximately $30,000 (30 cows x $1,000 per cow). Hence, an investment of $43,102 was required. We presumed these investments were equity financed; therefore, no interest costs were included in the income statements. However, the income statements included depreciation on building renovations and fencing investments.

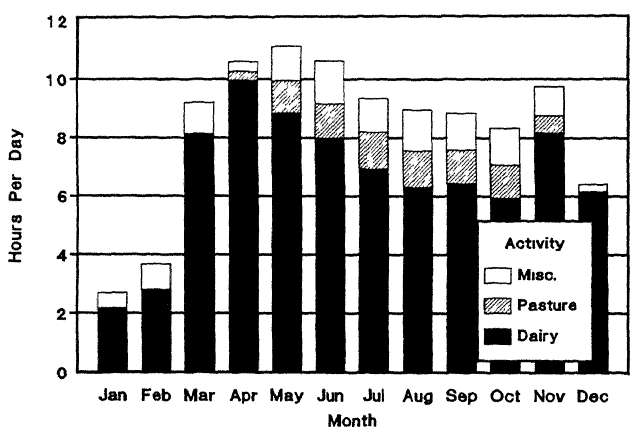

Figure 10.2. Average hours per day by activity and month, 1988-1990.

Most data for income statement preparation came from two sources. The OARDC's accounting office provided yearly reports for 1988 through 1991 listing receipts and disbursements. Receipts and disbursement data were not available for 1987; therefore, an income statement was not prepared for the first year of the project. The herdsman provided ending year inventories of cows, bred heifers, and heifer calves. Data not coming from these two sources are listed in the footnotes (Figure 10.4).

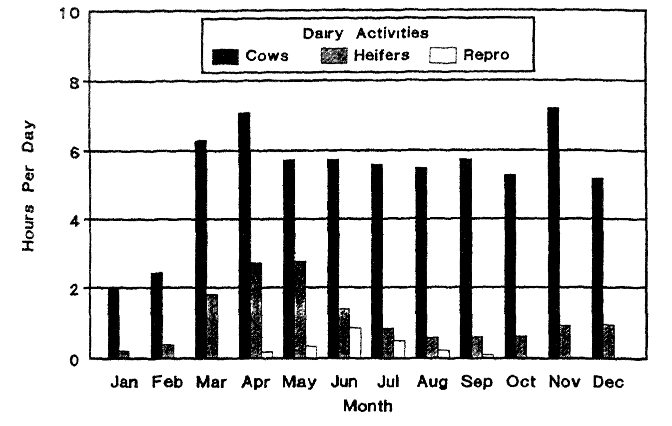

Figure 10.3. Average hours per day by dairy activity and month, 1988-1990.

Income Statements of the Mahoning Dairy Project. In all years, milk sales accounted for over 75% of total revenue. Milk sales steadily increased from a low of $39,998 in 1988 up to a high of $74,866 in 1991 (Table 10.2). Three factors contributed to the increase. First, pounds of milk sold per cow increased over time. Milk sold rose from 10,831 pounds per cow in 1988 to 13,077 pounds in 1991. Second, cow numbers generally increased over time. Cows milked numbered 30, 36, 32, and 43 in 1988 through 1991, respectively. Third, milk prices were substantially lower in 1988 and 1989 than in 1990 and 1991. Milk prices averaged below $13.00 per cwt. in 1988 and 1989 while milk prices were above $13.30 per cwt in 1990 and 1991. Part of the difference in milk prices is explained by a switch from a Grade B to a Grade A dairy in August, 1990.

Yearly average milk prices for 1988 through 1991 were compared to ten-month (March through December) and nine-month (April through December) averages (Table 10.3) to quantify the disadvantage from freshening in March. For these years, ten- and nine-month averages ranged from 97% to 101% of the yearly average, suggesting that the milk price disadvantage is not large. However, this method does not take into account monthly variations in milk volume as seen in a seasonal herd. Price by month is more important under these terms. For example, Figure 1.1 shows the effect of volume with an 85% persistent lactation curve and its effect on aggregate milk price over a ten-month lactation. Not to be forgotten is a great difference in Grade B and Grade A prices which can have a major effect on profitability.

Seasonal production has the effect of exaggerating seasonal milk price effects. The low milk prices characteristic of spring must, therefore, be overcome by substantially reduced costs of production. This leads to the maximum conversion of the best feed to the most milk at least cost through intensive rotational grazing of a herd where all cows are at peak produc-

Table 10.2. Yearly income statements.*[1,2]

	Year			
	1988	1989	1990	1991
Number of cows	30	36	33	43
Total milk sold (lb)	324,919	388,889	390,754	562,318
Actual milk sold per cow (lb)	10,831	10,802	11,841	13,077
Avg milk price per cwt (Grade B, 1988-1990)	$12.31	$12.81	$13.73	$13.31
REVENUE				
Milk sales	$39,998	$49,807	$53,637	$74,866
Bull calf sales	1,220	1,810	1,821	2,355
Total milk and bull calf sales	41,218	51,617	55,458	77,221
Market gains on herd[3]				
Ending inventory	33,050	34,750	37,400	39,850
less beginning inventory	21,450	33,050	34,750	37,400
less purchases	3,850	0	0	0
plus cull cow sales	3,331	6,363	6,321	6,160
Total market gain	11,081	8,063	8,971	8,610
TOTAL REVENUE (Grade A, 1991)	52,299	59,680	64,429	85,831
OPERATING COSTS				
Purchased feed[4]	22,921	29,709	26,910	35,192
Vet. and medicine	2,919	2,843	3,053	3,261
Breeding, milk testing	670	1,343	1,508	1,872
Bedding	919	2,000	1,210	1,920
Misc. and supplies	1,755	3,448	3,848	3,450
Utilities	3,353	4,029	4,300	4,920
Hauling	2,518	2,943	3,019	3,409
Land rent[5]	1,190	1,190	1,190	1,190
Building rent[5]	1,000	1,000	1,000	1,000
Property tax[5]	1,000	1,000	1,000	1,000
Total operating costs	38,245	49,505	47,038	57,214
Depreciation[6]	1,596	2,066	2,066	2,066
TOTAL EXPENSES	39,841	51,571	49,104	59,280
INCOME BEFORE INTEREST AND TAXES[7]	12,458	8,109	15,325	26,551
CASH OPERATING INCOME[8]	2,454	8,475	14,741	26,167

* Superscripted numbers refer to income statement footnotes shown in Figure 10.4.

[1] We have prepared these income statements from data collected at the Mahoning Dairy Project. Unless otherwise noted, figures are based on actual performance. When preparing these statements, performance is reflected from commercial perspective and not from a research farm perspective. A family is presumed to own all the cows but rents the land and buildings. As part of the rent, the family pays property taxes. Costs of modifications to the buildings are borne by the family.

[2] Income statements are prepared using modified costing principles.

[3] Market gains result from changes in inventories less expenditures for purchases plus revenue from culled animals. All purchased and raised cows are treated similarly so no depreciation is charged on purchased cows. End of year inventory numbers were:

	end of the year				
	1987	1988	1989	1990	1991
Cows	18	23	24	22	30
Bred heifers	—	13	12	17	15
Heifer calves	15	13	17	16	11

Inventory values are based on prices of $900 for cows, $600 for bred heifers, and $350 for calves.

[4] Purchased feed includes silage bagging and feed analysis expenses.

[5] These costs reflect estimates if an individual had rented the barn and land.

[6] Depreciation reflects 1987 barn set-up costs of $8,402, 1987 fencing purchases of $7,402, 1988 equipment purchases of $390, and a 1989 bulk tank purchase of $4,700. Depreciation is calculated using a ten-year life and a straight-line method.

[7] Income before taxes and interest measures profits which provides returns for equity financing, unpaid labor, and unpaid management.

[8] Cash operating income measures funds available to repay debt principal, pay income taxes, and provide for family living expenditures.

***Figure 10.4.** Footnotes of the income statements shown in Table 10.2.*

tion together when the forages are most abundant and nutritious, namely spring.

The second largest contributor to total revenue was market gain (change in inventory value) on the herd, accounting for at least 10% of total revenue in each year (Table 10.2). During 1988, market gain was primarily attributable to an increase in animal numbers during the herd's build-up stage. The herd consisted of 18 cows and 15 heifer calves at the beginning of 1988, while the herd had 23 cows, 13 bred heifers, and 13 heifer calves at the end of 1988 (Figure 10.4). As a result, the ending inventory was worth $11,600 more at the end of the year than at the beginning of the year for 1988. In 1989 through 1991, inventory change accounted for less while cull cow sales accounted for more of the market gain.

Per-cow milk production was relatively low during the Mahoning Project. Reasons for low milk production in order of their importance included:

1. Tall fescue was relatively poor forage, thus limiting nutrient intake and milk production levels (Chapter 9).

2. Seasonal dairying reduced the average number of days cows were in milk during a lactation. Cows in a conventional dairy average over 305 DIM. This seasonal dairy averaged about 270 DIM, about 35 days short of a complete lactation period since drying-off always preceded Christmas day. This could have been alleviated by milking the herd throughout December and into mid-January.

3. A small amount of milk was dumped in March. Often, one or two cows freshened before other cows, resulting in an insufficient quantity of milk for collection.

4. Some milk produced by lactating cows was fed to calves.

Table 10.3. Milk price received by Ohio farmers, Grade A.				
	Year			
	1988	1989	1990	1991
	$ per cwt			
January	12.30	13.70	16.00	12.30
February	12.00	13.40	15.30	12.40
March	11.80	12.80	14.30	12.40
April	11.50	12.50	13.50	11.70
May	11.40	12.30	13.50	11.50
June	11.30	12.40	13.80	11.60
July	11.40	12.50	13.80	11.60
August	11.70	12.90	14.30	12.10
September	12.10	13.60	13.50	13.20
October	12.60	14.40	13.60	13.90
November	13.00	15.20	13.20	14.40
December	13.10	15.90	11.60	14.50
12 month average	12.20	13.47	13.88	12.73
10 month average[1]	11.99	13.45	13.53	12.80
9 month average[2]	12.01	13.52	13.44	12.84

[1] Average from March through December.

[2] Average from April through December

Source: Ohio Agricultural Statistics Service

The second and third reasons will be obstacles for all seasonal dairies, but they can be minimized. Improvement in profitability would be expected by remedying the first and fourth reasons.

The largest expense was purchased feed, accounting for over 50% of total expenses in all years. Year to year variations in costs were highly correlated to cow numbers. The cost of purchased feed was somewhat surprising, given the project's emphasis on reducing feed costs. Because of the size of feed costs, increases in profitability are likely to come from increasing the efficiency of the feeding program.

Income before interest and taxes ranged from a low of $8,109 to a high of $26,551 (Table 10.2). Profitability can be gauged by imputing returns for equity financing, unpaid labor, and unpaid management. The imputed returns represent returns unpaid factors could have generated in alternative uses. Profit is calculated by subtracting imputed returns from income. At a minimum, the $43,000 of equity could have earned 4% interest in a bank savings account, yielding a yearly return of $1,720 ($43,000 equity financing x .04 interest rate). Hourly wages for agricultural workers averaged $6.00 per hour (Ohio Agricultural Statistics Service), giving a labor return of $18,222 per year (3,037 hours per year x $6 per hour). Management charges often are imputed as 5% of gross revenue. These imputed returns result in the following yearly profits:

	1988	1989	1990	1991
Income before interest & taxes	$12,458	$8,109	$15,325	$26,551
- imputed equity return	1,720	1,720	1,720	1,720
- imputed labor return	18,222	18,222	18,222	18,222
- imputed management return	2,615	2,984	3,221	4,292
Profit or loss	-10,099	-14,817	-7,838	2,317

On average, income generated by the project under Grade B management did not cover imputed returns. A positive profit was generated only in 1991 after conversion to Grade A and considerable genetic improvement. In these comparisons, we used conservative rates of return for the resources. Many dairy farms generate above average to exceptional rates of return.

Cash operating income rose steadily over the four years, beginning at $2,454 in 1988 and moving to $26,167 in 1991 (Table 10.2). Since the operation was presumed to have no debt, cash operating income could be used for family living expenditures and income tax payments. During 1988, 1989, and 1990, it is doubtful that the operation would have provided enough funds to sustain family living. In 1991, cash operating income could have provided most of family living expenditures, given a relatively modest lifestyle.

Funds available for family living would have decreased, if a portion of the $43,000 beginning investment was financed. Yearly reductions are given below for differing debt-to-asset ratios, presuming debt was financed using a ten-year, amortized loan having a 10% interest rate:

Debt-to-Asset Ratio	Reduction in Funds for Family Living
0	$ 0
.1	670
.2	1,399
.3	2,099
.4	2,799
.5	3,499

Presence of debt would significantly reduce funds available for family living, particularly in early years of the project.

Dairy Enterprise Returns and Costs. Yearly results reflecting performance on a cow basis also were prepared. These results allowed analysis of the strengths and weaknesses of the seasonal dairy for the given small number of cows in the herd. Moreover, these results not only included cash costs but also included opportunity costs for equity investment, unpaid labor, and unpaid management, thereby giving return above total costs. An enterprise must have positive returns to be viable in the long-run. Most receipt and cost categories in the per cow results equaled their respective categories in the income statement divided by the number of cows. For example, the 1988 per cow milk sales of $1,333 (Table 10.4) equal $39,998 (total milk sales divided by 30, the number of cows milked during 1988). Items not calculated in the above manner are explained in the footnotes (Figure 10.5).

In all years, per-cow returns above total costs for the dairy enterprise were negative (Table 10.4). Hence, the dairy enterprise did not generate the opportunity return of the resources used in the operation.

During the first three years, the dairy enterprise, operated under Grade B terms, immature cows, limited genetics, and a short lactation period, did not cover opportunity costs, and it compared unfavorably to overall U.S. dairy enterprises. For example, residual returns to management and risk for U.S. dairy enterprises were $280 and $178 per cow, respectively, in 1988 and 1989 (USDA, 1991a). Comparable returns for the Mahoning dairy were -$391 in 1988 (-$478 return above total costs + $87 management charge) and -$606 in 1989. Differences in herd sizes are probably important in considering these comparisons.

Potential reasons for poor profitability can be gauged by comparing the 1991 costs of the Mahoning dairy enterprise to costs from a 1991 budget prepared by Ohio State University Extension (1991). The budget chosen for comparison approximates typical costs for a herd producing 13,000 pounds of milk:

Cost Category	1991 Mahoning Project Results	1991 Dairy Budget Estimates
Feed Costs	$993	$952
Variable Costs Other than Feed	$479	$352
Fixed Costs	$835	$1,186
Total Costs	$2,307	$2,490

The Mahoning dairy had approximately the same feed costs, higher other variable costs, and lower fixed costs.

Lower fixed costs indicated that the project was successful in lowering capital inputs. Most of the gain was attributed to equipment and building charges, which averaged $109 per cow in the Mahoning project as compared to $493 in the enterprise budgets.

These gains were partially offset by higher costs for variable items other than feed. The single category having the largest difference was utilities: $114 for the Mahoning project as compared to $54 in the budgets. Thus, increased variable cost control could result in higher profits.

The Mahoning Project's feed costs were roughly equal to figures from the Ohio budget. Although a stated objective of the project was to reduce feed costs, purchased feed costs approached $800 per cow in each year (Table 10.4).

Intensive Grazing Returns and Costs. Per acre intensive grazing results were calculated in a manner similar to per cow dairy results. Returns above total costs for intensive grazing were positive in all years (Table 10.5). Moreover, returns above total costs from intensive grazing were higher than returns from most major grain crops grown in the United States (USDA, 1991b). Hence, intensive grazing compared favorably to other cropping alternatives.

Returns from an intensive grazing enterprise depend on stocking rates. Hence, 1991 results are better than previous years. While stocking rates at 1991 levels can be maintained, dealing with adverse conditions resulting from droughts will become more problematic.

One area where cost could have been reduced was fencing, which accounted for $56 of per acre costs. Individuals involved with the project believed that the initial investment could have been reduced, thereby lowering costs.

Summary of the Financial Results. Following are key points from the financial analysis:

1. As structured, the Mahoning Project did not generate opportunity returns to resources, particularly in the early years of the project while operating as a Grade B dairy. This, however, is typical of research projects. For an intensive grazing/seasonal dairying project to be viable, increases in profitability must occur.
2. Seasonal dairying, as separated from intensive grazing, was unprofitable. Possibilities for increasing profitability center around increasing the efficiency of the feeding program. The final year showed substantial progress in this area, indicating profit potential had been reached.
3. Intensive grazing was profitable.

Table 10.4. Per-cow and replacement dairy returns and costs budget.*[1]

RECEIPTS	Year			
	1988	1989	1990	1991
Milk sales	$1,333	$1,384	$1,625	$1,741
Bull calf sales	41	50	55	55
Cull cow sales	111	117	192	143
Market change[2]	258	47	80	57
TOTAL RECEIPTS	1,743	1,658	1,952	1,996
VARIABLE COSTS				
Purchased feed	764	825	815	818
Pasture charge[3]	175	175	175	175
Total feed costs	939	1,000	990	993
Vet and med	97	79	93	76
Breeding, milk testing	22	37	46	44
Utilities	112	112	130	114
Bedding	31	56	37	45
Misc. and supplies	59	96	117	80
Hauling	84	82	91	79
Interest on operating capital[4]	38	41	41	41
Total other costs	443	503	555	479
TOTAL VARIABLE COSTS	1,382	1,503	1,545	1,472
FIXED COSTS				
Labor charge[5]	532	532	532	532
Interest in insurance on cow[6]	95	89	114	94
Equipment and building charge[7]	125	131	142	109
Management charge[8]	87	83	98	100
TOTAL FIXED COSTS	839	844	886	835
TOTAL COSTS	2,221	2,347	2,431	2,207
RETURN ABOVE VARIABLE COSTS	361	155	407	480
RETURN ABOVE TOTAL COSTS	-478	-689	-479	-355
Receipts per cwt.	16.09	15.35	16.49	15.26
Feed costs per cwt.	8.67	9.26	8.36	7.59
Total variable costs per cwt.	12.76	13.91	13.05	11.26
Total costs per cwt.	21.51	21.73	20.53	17.64

* Superscripted numbers refer to footnotes shown in Figure 10.5.

[1] Most receipt and cost categories in the budgets equal their respective categories in the income statement (Table 10.2) divided by the number of cows. For example, the 1988 per cow milk sales of $1,333 shown in the budget equals $39,998, total milk sales in 1988, divided by 30 (number of cows milked during 1988). Items not calculated in the above manner are explained in the footnotes given below.

The income statements do not include charges for unpaid labor, investment, and management. The budgets include these opportunity charges, thereby reflecting the full economic costs of operating the dairy enterprise. An operation must have positive returns above total costs to be viable in the long run.

[2] Market change equals: (ending inventory - beginning inventory - purchases) / number of cows.

[3] Pasture charge equals 233 cow-days times $.75 per cow day.

[4] Interest charge equals 10% times one-half of the purchased feed costs.

[5] On average, 76 hours were required for each cow in the herd. The labor charge equals 76 hours times $7 per hour.

[6] Interest and insurance equals the average inventory value—(beginning inventory + ending inventory) / 2—times 10.43%. The 10.43% figure reflects a 10% interest charge and a .43% insurance charge.

[7] Building and equipment charge equals: (building rent + property tax + (investment in dairy facilities x .20)) / number of cows. Investment in dairy facilities equals $8,792 in 1988 ($8,402 of barn set-up costs incurred in 1988 plus $390 of equipment purchases in 1988) and $13,492 in other years ($8,792 investment total in 1988 plus $4,700 for a bulk tank purchase in 1989). The .20 factor represents depreciation, interest, repair, and insurance charges equal to .125, .05, .022, and .003, respectively.

[8] Five percent of total receipts.

***Figure 10.5.** Footnotes for the per-cow and replacement results shown in Table 10.4.*

Discussion: Economic Possibilities of Intensive Grazing/Seasonal Dairying Systems

Based on our analyses of labor use and financial results of the Mahoning Project, we arrived at four conclusions:

1. Intensive grazing may be a profitable alternative for some dairy farms.

Intensive grazing may be a means for some dairy farms to increase profitability. Moreover, intensive grazing does not have to be used in conjunction with seasonal dairying. Hence, conventional dairies may use intensive grazing to supplement other forage sources. Generally, dairies with less than 100 cows may be able to profitably use intensive grazing. Budgeting work by Tranel and Frank (1991) support this conclusion.

2. The feed program must be improved before seasonal dairying is a profitable alternative.

The efficiency of the Mahoning project's feeding program could have been increased by having higher quality pastures. Use of higher quality pastures would have reduced feed costs per cwt. of milk by reducing the need for purchased feeds (Chapter 9) and by supporting greater milk production. Given that higher quality pastures are used, a seasonal dairying/intensive grazing system has two diametrically opposed options for increasing efficiency, i.e., low production with commensurately lower feed costs or high production with more efficient feed conversion even though feed costs would increase. In other words, operate without grain feeding which lowers production or feed grain and increase production.

For option one, purchased feed costs could be lowered while accepting low levels of milk production per cow. At the 13,000 lb milk production level per cow maintained during the Mahoning Project, purchased feed costs would have had to be lowered by $400 per cow for the enterprise to be profitable. Reductions in feed costs would have to be even higher if per-cow milk production declined with the feed cost reduction. Whether reductions of this magnitude are possible is not known.

Alternatively, in the second option, emphasis could be placed on achieving greater per-cow milk production levels. For the dairying enterprise to be

Table 10.5. Per-acre intensive grazing results.

	Year			
	1988	1989	1990	1991
RETURNS[1]	228	274	251	327
COSTS				
Seed[2]	4	4	4	4
Fertilizer[3]	10	10	10	10
Machinery and equipment[4]	10	10	10	10
Fence[5]	56	56	56	56
Land[6]	40	40	40	40
Labor[7]	70	70	70	70
Management[8]	11	14	13	16
TOTAL COSTS	201	204	203	206
RETURN ABOVE TOTAL COSTS	27	70	48	121

[1] Return represents the per cow pasture charge in the dairy budget times the number of cows divided by the number of strictly grazed acres (23).

[2] Seed costs are minimal over the life of a well-managed pasture, but some cost needs to be recognized.

[3] If all forage is harvested as pasture, approximately 80% of nutrients are recycled back on the pasture thereby reducing fertility costs. The $10 charge approximates an annual 100 pounds application of 0-13-43. Costs would increase if a nitrogen application is required.

[4] Some clipping of the pasture may be necessary. This charge represents clipping plus any other necessary machine work.

[5] The fence charge equals the $7,402 investment in fence times .175. The .175 factor represents depreciation, interest, repair, and insurance charges of .125, .05, .022, and .003, respectively.

[6] The land charge equals cash rent for comparable land.

[7] Total labor for the pasture averaged 243 hours per year. The labor charge equals 10 hours times $7 per hour.

[8] The management charge equals 5% of returns.

profitable, per-cow milk production levels would have to increase by 2,730 lb (1,241 kg) giving a per-cow production level of 15,807 lb (7,185 kg), assuming that all other costs remain constant. Production increases would likely have to be higher because feed costs most likely would increase with higher production levels. This option would likely be more feasible than the first option.

3. Herd size must be increased, given that the efficiency of the feed program can be improved.

It's highly unlikely that a 30-cow herd will provide sufficient income for family living. Herd size must be at least in the 40- to 50-cow range. Herd sizes above 70 cows have more potential to be viable than smaller herds.

4. Labor requirements must be reduced, particularly if herd size is to be increased.

Significant labor reductions are possible by changing the milking facilities. For example, a parlor rather than a six-place stanchion facility could have reduced milking time. Such a modification is necessary if more cows are to be milked and additional labor is not obtained.

Summary

Seasonal dairying may appeal to small dairy producers trying to avoid additional investment in buildings or to dairy producers trying to start a firm with limited resources. Seasonal dairying with spring freshening may not be an attractive alternative for the majority of Ohio's current dairy farmers. Critical to success is maintaining low capital resources while obtaining feed efficiency. An efficiently managed intensive grazing system will improve the profitability of many dairy producers. With proper management, a seasonal dairying/intensive grazing system offers some unique opportunities for dairy producers.

Chapter 11
Soil Pesticides

L. B. Willett, A. F. O'Donnell, H. I. Durst & M. M. Kurz

In 1987, a multidisciplinary dairy project was initiated at the Mahoning County Farm in Canfield, Ohio. The principal objectives of this project were to evaluate the feasibility of seasonal and rotational grazing programs in Ohio. Paddocks were established over 42 acres which were subdivided using electrified fencing. Twenty-five percent of this pasture land had a previous history of use as orchards (Figure 11.1). These orchards were managed in typical fashion utilizing a broad range of pesticides which were legally applied at the time of use. At the beginning of this study, there were 33 pesticide formulations, including organochlorine formulations, stored on the Mahoning Farm premises. The latter are extremely stable compounds and, when applied to crops or orchards, persist in the soil and environment for many years.

Early in 1987, a series of soil cores was obtained for pesticide analysis. These cores, in conjunction with aerial photographs, determined the boundaries of the contaminated soils and indicated the concentrations of pesticides present. The organochlorine pesticides detected were heptachlor, lindane, DDT, and its metabolites DDE and DDD. These metabolites are derivatives of the chemical DDT in the soil. Concentrations of heptachlor and lindane were infrequent and near the limit of analytical sensitivity, so these were not included in our continuing studies. The DDT and its breakdown products were primarily within the boundaries of the old orchards, as indicated on the aerial photographs. Drift from the spraying operations or water run-off did contaminate six locations of immediately adjoining pastures with concentrations which were less than .03 µg/g (µg/g = parts per million). Despite the occurrence of plowing of these old orchard sites, the majority of DDT and DDE residues were located near the soil surface. The average concentrations of DDT at the surface and at 14-16 cm of depth were 1.90 + .27 and .41 + .01µg/g, respectively. Concentrations of the residues varied considerably from location to location, with concentrations ranging from none detected to nearly 4 µg/g.

Pesticide formulations which contained the heavy metals lead, arsenic, and copper also were used on these orchard plots. Concentrations of these three metals were detected, not only within the boundaries of the orchard land, but also in adjacent areas which were down-wind and down-slope (Table 11.1). It was clear from these samples that the heavy metals were far more mobile by percolation, run-off, and/or overspray than were the organochlorine pesticides.

At the onset of the dairy project, all cows were sampled to confirm that their milk was free of organochlorine pesticides or other halogenated hydrocarbons such as poly-chlorinated biphenyls. Concentrations of heavy metals were not determined in the cattle.

During the next three years, samples of milk and body fat were collected from these cows to determine whether the organochlorine residues known to be present in the soil would contaminate the livestock intensively grazing these pastures.

Residue determinations during the first year of study clearly pointed out that these soil residues from DDT represented a source of pesticides which would contaminate livestock. The DDE concentration in individual milk fat samples ranged from none detected to .356 µg/g. Residues exceeded .12 µg/g in 11 of the 30 cows. During this year, cows were sampled on days 3, 30, 60, 120, and 180 of lactation which did not necessarily relate to exposures to orchard paddocks.'

During the next two years, the sampling protocol was changed so that the residue uptake by cows could be related to particular paddocks. During year two, each cow had milk samples collected two days after she was removed from a contaminated pasture. In the third year, residues were monitored by milk collected from a pool of all cows at approximately two-day intervals.

Table 11.2 shows the concentrations of DDE in the milk fat of cows before and two days following grazing of the contaminated orchard paddocks. The two-day withdrawal after exposure allowed the milk fat concentration to represent the equilibrium between body fat and milk fat, thus excluding the amount of residue available from recently-eaten forage. This phase of the study clearly showed that all cows were exposed to similar amounts of pesticide residue when on a particular paddock, but it did not explain why those concentrations varied even when cows were placed back on the same paddock.

The concentrations of DDE in the milk fat during the third year are shown in Figure 11.2. These represented the residue concentrations in the pooled milk. The cows were limited from continued access to the most contaminated plots during this year. Residues remained well below regulatory tolerances.

The majority of the scientific literature dealing with the translocation of pesticides in plants suggests that the residues of DDT and its metabolites DDE and DDD do not translocate through the roots to other parts of the plant. However, the concentrations of residue appearing in the cows were sufficiently high that, based on the equation [DDE, $\mu g/g]_{milk\ fat}$ = .28(daily dose)[82], it seemed unlikely that soil consumption was the sole source of residue. When the concentration of

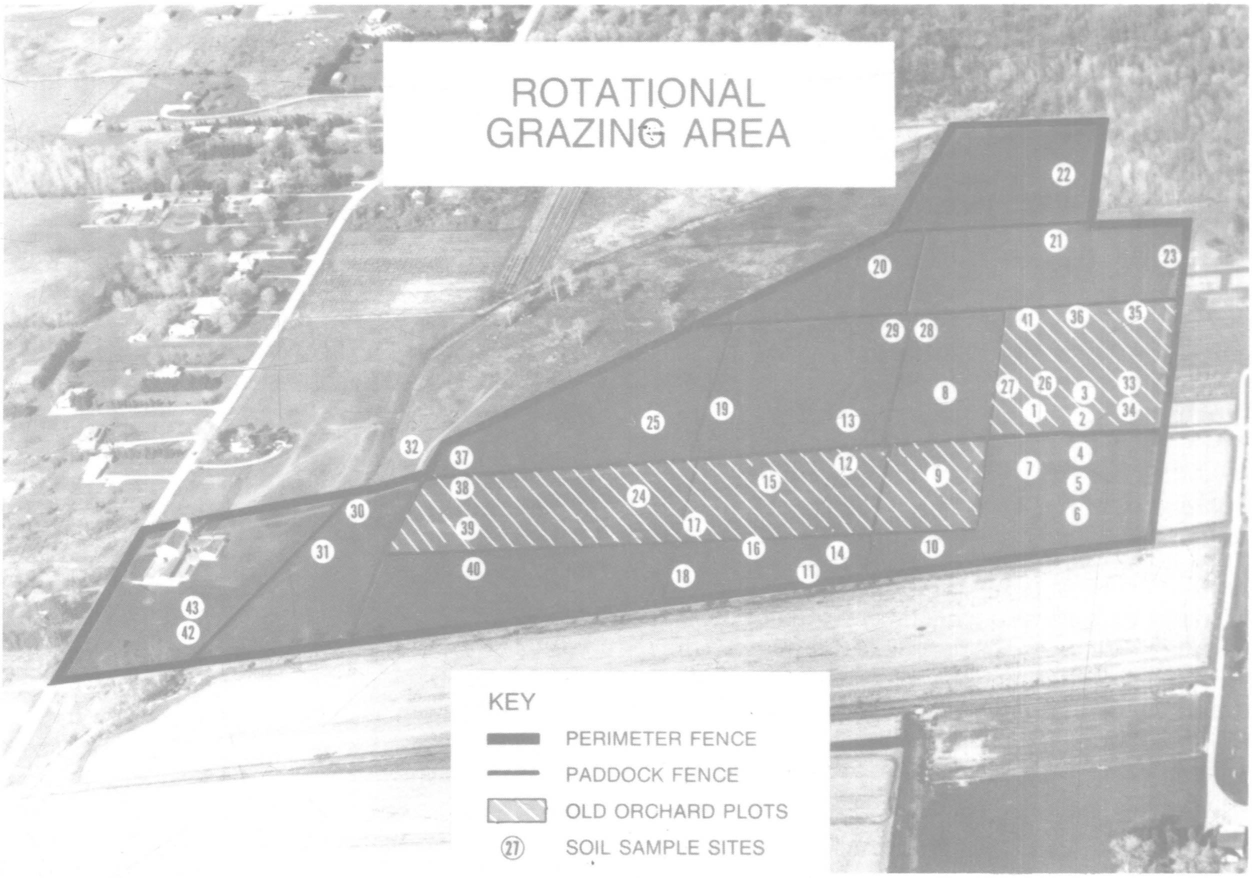

Figure 11.1. An aerial view of the research site showing the pasture paddocks and the area that had previously been used as orchards. Numbers indicate the locations of soil sampling for residue determinations and/or intensive study.

DDE in milk fat reached .3 μg/g, then the cows were consuming approximately 1.1 mg of pesticide per day. Similarly, approximately .28 mg/day would be required to sustain a milk fat concentration of .1 μg/g. If soil was the sole source of pesticides, cows would have had to be consuming between 1 and 2 kg of soil per day - an unlikely possibility. Therefore, grass was suspected to be a carrier medium for the residues from the soil to the cows.

Separate plots (4 m x 4 m) were established in four different areas of the rotational grazing pastures. Three of the four plots were located in old orchard areas. The plots were established based on the concentrations of DDT and DDE in the soil, which were determined the previous years. The fourth plot was located in an area of pasture shown to be free of pesticide residues. Grasses in 1 m^2 sub-plots were harvested at two-, four-, or six-week intervals during an 18-week study. These grasses were extracted differentially to determine the amounts of DDT and DDE residues which adhered to the plant surface and those which were associated with plant tissues.

The results of these studies demonstrated that several important occurrences were taking place on the old orchard plots. The grasses did contain significant concentrations of DDE (Figure 11.3) and only traces of DDT. Residues of the DDT and DDE were not adhering to the outer surfaces of the plant. It previously has been shown that hard rains can cause soil to splash onto plants and become a source of contamination. This was not the case in this study. Concentrations of DDE detected in the grass material related to concentrations of residue in the soil of the respective plots. Residues were not detectable in samples of stems when stems and foliage were separated, suggesting that this material was not moving from the root system through the plant. The most logical conclusion was that the residues were volatilizing from the soil and recondensing on the plant foliage. This mechanism was confirmed when ethylene glycol-treated filter paper traps were suspended 15 cm above the soil surface. As with the grasses, the concentrations found in the filter paper traps were related to the concentrations located in the soil of respective orchard paddocks (Figure 11.4).

If volatilization is the major means of movement of the residues from the soil to the plant materials, then meteorological conditions should influence the transfer. Fortunately, an official semi-automated weather station was located approximately 800 m from the experimental pasture plots. The station provided

Table 11.1. Average concentrations of copper, lead, and arsenic in soils of the orchard areas; in adjacent down-wind and down-slope (Down) pastures; and adjacent up-wind (Up) pastures.

Sample site	Surface (0-2 cm)		Sub-surface (14-16 cm)	
	Mean	SE[1]	Mean	SE[1]
	µg/g			
COPPER				
Orchard	7.87	.93	8.32	.74
Down	8.40	.55	8.71	.54
Up	1.24	.11	1.35	.25
LEAD				
Orchard	2.44	.53	2.44	.57
Down	1.61	.31	.94	.19
Up	.51	.05	.43	.05
ARSENIC				
Orchard	1.02	.26	.99	.30
Down	1.12	.25	.93	.19
Up	.23	.04	.81	.32

[1] SE = standard error.

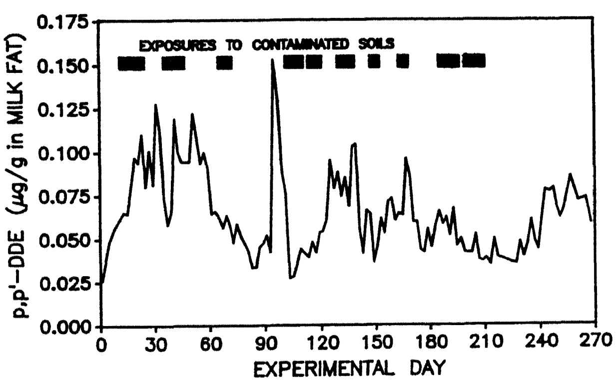

Figure 11.2. Concentration of DDE in pooled milk samples during the 1989 pasture season.

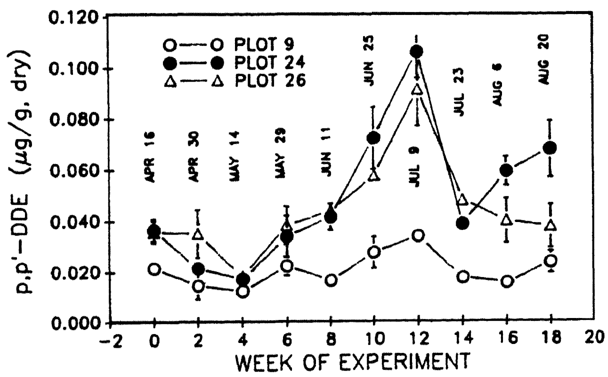

Figure 11.3. Concentrations of DDE in grasses from three old orchard plots.

Table 11.2. Average concentrations of DDE in milk fat of cows before and two days following grazing of orchard paddocks.

Condition	Paddock[1]	Grazing days	DDE[2] Mean	DDE[2] SE[3]
	µg/g			
Day 3, post-partum	NA[4]	NA	.114	.009
Day 30, post-partum	Control	Varied	.088	.014
Exposure 1	8	11	.096	.005
Exposure 2	7	15	.255	.012
Exposure 3	8	7	.121	.007
Exposure 4	8	15	.100	.004
Exposure 5	7	13	.124	.008
End of year	Barn	20	.059	.005

[1] Paddocks 7 and 8 had significant residues of DDT and DDE in the soil. Between exposures, cows were grazed on non-contaminated paddocks.

[2] DDE = chemical derivative of the pesticide, DDT.

[3] SE = standard error.

[4] NA = not applicable.

daily weather information on maximum and minimum air and soil temperatures, wind, precipitation, solar radiation, relative humidity, and water balance. Only daily precipitation was related to the movement of residue. In fact, periods of precipitation were responsible for increases in the DDE content of grass (Figure 11.5). Interestingly enough, periods of rain also were associated with periods of highest residue content in the milk during the second experimental year (Figure 11.6).

The mechanism of volatilization of the pesticides from the orchard soils plus the influence of water content of the soil on volatilization was confirmed in laboratory experiments. In these carefully controlled studies, DDE volatilized from soils taken from the three orchard plot sites. The relationship between soil concentration and the amount detected in laboratory traps was similar to the results of the traps placed on the field plots and residues in grasses. Studies were also conducted where known amounts of DDT and DDE were added to the soil. Only trace quantities of the pesticides volatilized and were detected in the traps when the soils were dry. With the addition of 20% or more of water, DDE was readily volatile.

Other studies have been published that show the water content of the soil was extremely important in order to promote volatilization of pesticides from soil. DDE also has been shown to be eight times more volatile than is DDT. Although there were substantial quantities of DDT in the soil, only DDE appeared in the grasses in significant concentrations. DDT was not identified in the milk of cows but would not be expected to be found, because DDT is rapidly metabolized to DDE in animals.

Utilizing the aforementioned equation for the quantity of DDE in the milk fat and the daily dose, the amounts of residue in the grasses accounted appropriately for the amount of residue in the milk fat. Utilizing the herd used for the intensive grazing study, the following calculations can be made. The average body weight of the cows was 550 kg with an assumed daily dry matter intake of 3% of body weight or 16.5 kg. Of that, 6.55 kg were from grain supplement. The remaining 9.95 kg of dry matter intake consisted of grass. Utilizing the aforementioned predictive equation for residue excretion in milk fat, the cows with .3 µg/g in milk fat were consuming approximately 1.1 mg/day. That amount of residue was easily obtainable with cows consuming 9.95 kg of dry matter from grass that contained .11 mg/kg of DDE. Following periods of precipitation, that amount of residue was found in the harvested grass (Figure 11.5). Concentrations of .02 to .04 mg/kg in the grass would easily support concentrations of DDE in milk fat of .1 µg/g. When considering potential contamination of livestock by organochlorine pesticides from soil sources, it is extremely important to account for concentrations in the soil and the effect of precipitation, which can influence the rate and amount of

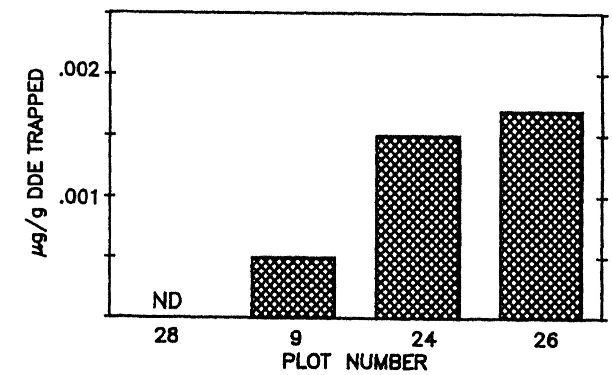

Figure 11.4. Filter paper/ethylene glycol traps were suspended 15 cm above the soil for 14 days. Plots 9, 24, and 26 were within the old orchard plots while plot 28 was a control. See Figure 11.1 for plot locations.

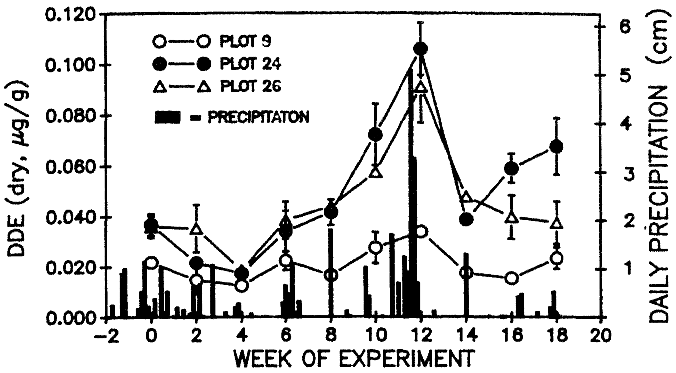

Figure 11.5. The relationship between the concentration of DDE in the grass and occurrences of precipitation.

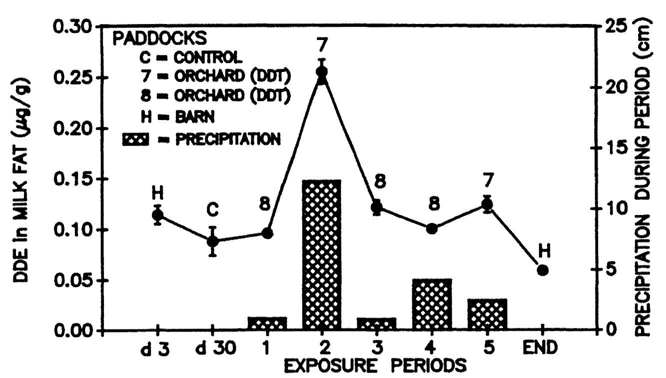

Figure 11.6. The relationship between the average concentration of DDE in milk fat and the total precipitation while cows were on an individual paddock. Cows were rotated among uncontaminated and old orchard paddocks 7 and 8.

volatilization. Additional studies will be helpful to define precisely this relationship.

Contamination of livestock feed with residues from past agricultural practices has often been inconsistent. Feed harvested during one year or season has been relatively free of residue while, at other times, unacceptable residues are present. The serendipity of these experimental plots in close proximity to an official weather station has provided a major key to understanding the role of precipitation in the transfer of organochlorine pesticides from soil to cows via forage. This understanding may play a major role in the management of land that previously had been exposed to residual pesticides so that pesticide residues can be excluded from the human food chain.

Acknowledgements

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Chapter 12
Summary

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D. L. Zartman

Abstract

A 30 cow herd (50% Holstein, 50% Jersey) was established in a Grade B market in 1987 to determine if a seasonal milking/intensive grazing concept was feasible for Ohio dairy farms. This herd expanded to 43 head under Grade A conditions by the fifth year of the project. Spring calving was chosen to efficiently utilize intensively managed pasture forage supplies. Cows calved in March and April and were dried off in late December. Over the five years, the 60- to 71-day calving period was moved 50 days earlier in the spring. A variety of breeding technologies was used to maintain the 12-month calving interval including milk progesterone assays, ovarian palpation, prostaglandin treatments, synchronization of heifers, hormone implants and crayon rump markers. All cows were bred artificially. Over the five years of the project, culling rates for reproduction were 40, 23, 22, 3, and 12%, respectively (Table 12.1). Calving intervals were 11.6, 11.9, 12.0, and 12.1 months in years two through five.

As shown in Table 10.2, projected net income figures before interest and taxes were $12,458, $8,109, $15,325, and $26,551 in years two through five, respectively. By comparing data in Table 10.4, it is apparent that total fixed costs of production were 27 to 30% below those used in conventional simulated Ohio dairy budgets (Ohio Dairy Enterprise Budgets, 1991). In the fifth year (1991), total cost of producing milk was $17.64 per cwt. Although fixed costs were reduced, total costs need to be reduced even more for seasonal spring dairying to be enthusiastically received on dairy farms in Ohio.

Introduction

Eastern Ohio is characterized by shallow soils and hilly terrain with many areas having shale layers close to the surface. These areas are not suitable for extensive cultivation but will support the production of permanent pasture. One method of harvesting the forage produced is by using intensive grazing management with dairy cattle similar to the New Zealand style of milk production. To see if this style of dairy management was suitable to Ohio, a demonstration was set up at the Mahoning County Farm, a branch station of the Ohio Agricultural Research and Development Center, incorporating the concepts of intensive grazing management and seasonal milking.

Project Setup

In 1987, a herd of 15 Holstein and 15 Jersey springing heifers was brought to the farm. The heifers were due to freshen from April through June. An existing beef cow facility was converted to dairy purposes by building within a bank-barn a small milkhouse and a minimum-investment flatbarn consisting of six headlocks installed at an existing feedbunk, and a pipeline to accommodate the use of three milking machines. The only other investment made was the installation of high tensile fence around and across 42 acres (17 hectares) of existing tall fescue pasture.

Milking

The herd was milked twice-a-day. Cows were prepared for milking without being washed unless they were excessively dirty, which seldom occurred while they were on pasture. Their teats were predipped, dried after 30 seconds, milked and post-dipped with an iodine based teat dip. No water was used to clean up the milking area. The floor was simply scraped clean after milking and a bit of lime was

Table 12.1. Mahoning project reproduction statistics.

	1987	1988	1989	1990	1991
Calving period	4-14 thru 6-16	3-15 thru 5-17	2-27 thru 5-7	3-1 thru 4-29	2-25 thru 5-19
Breeding-cows	6-16 thru 9-27	6-16 thru 8-11	5-27 thru 8-11	5-28 thru 8-11	5-15 thru 8-10
Breeding-Heifers	None	Implant, 6-24	Implant, 5-31	Implant, 6-3	Implant, 5-21
Dry date	12-21	12-20	12-20	12-20	12-23
% Cows culled	40%	23%	22%	25%	19%
% Culled for reproduction	40%	23%	22%	3%	12%

spread if necessary. The dairy was set up as Grade B, and milk was sold on a cheese yield basis until August of year four when minimal changes were made to upgrade the facilities. Thereafter, milk was sold as Grade A to gain a substantial price enhancement of about $1.50 / cwt. Net income figures for the last year are notably better as a result.

Cows to be kept were milked until late December when, after the last milking, they were treated with a commercial dry cow antibiotic. Cull cows and cows pregnant too late to remain in the herd were taken to an auction market that day. Feed was limited to poor quality hay for a few days to aid in the drying off process. Production levels can be comparable to those of traditionally managed herds, if cows are milked to an average lactation length of 305 days.

Freshening

Most cows were freshened in temporary box stalls. They immediately joined the milking string which received a ration of alfalfa hay, corn silage, and concentrate mix until pasture was available in April.

Calf and Heifer Care

All female calves were kept and raised for replacements. An existing grain storage building was converted for calf rearing at a cost of approximately $200 for materials. After weaning, calves were grouped together and put out on pasture. When pasture was plentiful, yearling heifers grazed after the cows. When pasture was in short supply, heifers grazed pastures that were not used for the milking herd.

Breeding

Impregnating cows and replacement heifers in a timely way was elementary for their retention in this project. Cattle received MuSe®[1] injections two to four weeks prepartum and again 30 days before breeding. Once calving began, frequent herd checks were conducted by a veterinarian to discover and correct noncycling cows as soon as possible. Uterine infections and cystic ovaries were treated as quickly as they were discovered. Technologies used to enhance the breeding program included milk progesterone tests, prostaglandin treatments, hormonal implants, tailhead chalking, and frequent observation. During the breeding period, veterinary checks were conducted weekly. Since production increased dramatically in the last years of the project, it is apparent that quality genetics pay off in this system just as they do in conventional management.

[1] *Source: Schering Plough Animal Health Corp., Kenilworth, NJ 07033.*

Nutrition

During the pasture season, cows normally received minimal supplemental grain (mostly corn) and no forages other than the pasture they consumed. However, during several periods of drought, dried hay was fed to supplement the depleted pasture inventories. Cows were fed grain during milking. With grain feeding limited to twice per day, it was determined that a maximum of 17 lb (7.7 kg) could be fed per cow per day without disturbing rumen function. The novel discovery is that 17 lb (7.7 kg) of concentrate should be fed to each cow every day of lactation, irrespective of milk produced, for a spring calving herd using intensive grazing. Maintaining sufficient body condition on the cows was a continual challenge. Protein content of the pasture ranged from 15 to 23%. Therefore, the primary function of the grain mix was to supply energy, minerals, and rumen undegradable protein.

Grazing

Cows were turned out to pasture in the spring when growth reached a height of 4 inches (10 cm). This usually occurred by the first week of April. At the beginning of the project, pastures consisted of 42 acres (17 hectares) of primarily tall fescue with a sparse presence of birdsfoot trefoil. The area was divided into eight, five-acre (two-hectare) paddocks with high-tensile fence. Three of the paddocks were also renovated with an alfalfa / grass mixture. Early in the project, abundant clover appeared in the pastures along with other grass species.

Cows were moved to fresh pasture every 24 hours. Divisions were made within the permanent paddocks using portable polywire fencing technology. Drinking water was taken to each paddock using a tank mounted on a wagon from which water flowed by gravity to a stock tank with a float during years one to four. Above ground plastic pipe was laid along the fenceline and tapped off into each paddock to supply drinking water during year five. This was an inexpensive, labor-saving initiative that should have been implemented in the first year.

Soil Pesticides

Soil residues of pesticides, especially DDT and DDT derivatives, render pastures unusable by food producing animals. The pesticides volatilize during high-moisture conditions and recondense on plant foliage.

Key Results

In 1990, U.S. average net cash farm income for dairy farms selling between $40,000 and $100,000 of products (Mahoning project sold $61,779 of milk and cattle) was $19,740 (USDA, ERS, 1992). The project in 1990 (Grade B most of the year) had a net cash profit of $14,741. Switching to Grade A and adding 10 cows increased net cash profit to $26,167 for 1991 in spite of a severe drought.

Returns above total costs per acre from intensive grazing were higher than returns from most major grain crops grown in the United States.

The seasonal milking and intensive grazing scenario can work for Ohio producers. A totally different life style can be chosen by dairy farmers who adopt this program. With the intensively managed reproduction program in the Mahoning Project, calving intervals were maintained at 11.6, 11.9, 12.0, and 12.1 months in years two through five. In years one through three, culling rates of 40, 23, and 22% were based almost solely on reproduction. In years four and five, 3 and 12% of cows were culled for reproduction causes, while the remaining 22 and 7% culled were removed for production reasons.

Considering the entire herd, production (DHI estimates) increased each year, from 11,651 lb (5,296 kg) per cow in year one to 16,095 lb (7,316 kg) per cow in year five. Production patterns by breed are shown in Figures 12.1 and 12.2. Returns above variable costs were $361, $155, $407, and $480 per cow in years two through five, with year five reflecting the Grade A advantage. Returns above total costs per cow were -$478, -$689, -$479, and -$355 in years two through five. This compares favorably with Ohio dairy herd budgets (Ohio Dairy Enterprise Budgets, 1991) which estimate return above variable costs of $444 and return above total costs of -$753 per cow for a 15,000 lb (6,818 kg) production level for a large breed on a 100% hay ration. This comparison is representative of the national average of 14,867 lb (6,758 kg) of milk per cow for 1991. Total fixed costs of $835 per cow in year five are 27 to 30% lower than the $1,141 to $1,197 per cow in a conventional enterprise.

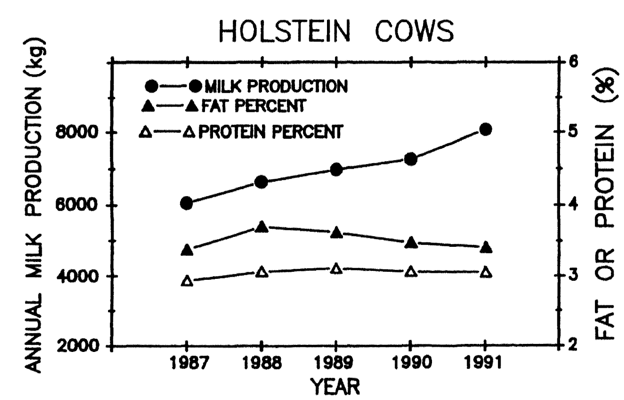

Figure 12.1. Holstein production trends for milk, milk fat percentage and protein percentage by year.

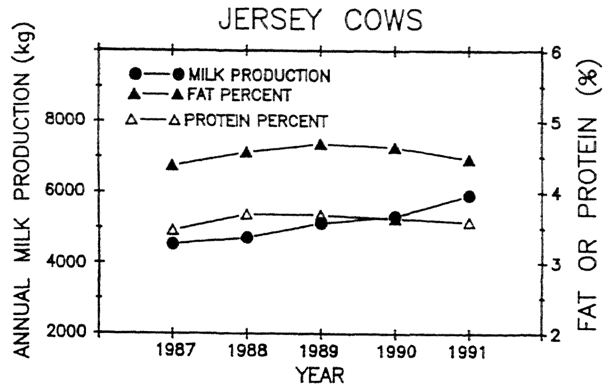

Figure 12.2. Jersey production trends for milk, milk fat percentage and protein percentage by year.

Further Research Needed

The question regarding economics of concentrate feeding in a grazing-based system remains. A valid analysis of zero grain feeding in comparison to various concentrate-feeding strategies in the United States milk market is needed. Where the recommendation from the Mahoning Project is a constant 17 lb (7.7 kg) split into two feedings per day, what rate should be used if cows were fed three or more times per day?

Should seasonally managed herds use three-times-a-day milking for the first part of the lactation period and drop off to once-a-day milking in the latter part of the lactation period? The opportunities for testing new management schemes abound with a seasonal herd. Herd health programs need to be fine-tuned.

What about reproduction management? The requirement of a 12-month calving interval is unforgiving of poor reproduction results. What veterinary support is needed? What management methods work best and what is affordable?

Choice of forage species for various soils and climates is a subject of great interest. Every expert seems to have a different opinion on this subject.

Detoxification of soil contaminated with pesticides looms as a seemingly insurmountable problem. What is the best way of managing such land?

Regarding seasonal dairying and intensive grazing, do various regions of the country have different optimum seasons for the initiation of lactation? Should the milk pricing system of the United States be modified to encourage and support more efficient systems regionally? How will the milk processing industry be affected as seasonal herds present variations in milk component percentages that are related to stage of lactation?

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