Assessment of the Dairy Production Needs of Cattle Owners in Southeastern Sicily

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ABSTRACT

This study was undertaken to investigate research and outreach priorities for Progetto Ibleo (Project Ibleo), a center created in 1990 with tripartite government funding to serve dairy producers in the Hyblean region of Sicily. Data comprised values for production and composition of milk from 1984 to 1989 from 35 herds of Modicana cows on a system based on pasture and that from 69 input-intensive herds of Holstein cows, associated lactation and reproduction measures, and yield and composition of forages from 4 of these farms in 1988. Season had a large effect on the neutral detergent fiber and crude protein composition of forages, production and composition of milk, and predicted yield of fresh Ragusano cheese manufactured from the milk of these cows. The poorest forage quality and the poorest cow performance were observed in summer and fall months (May to October). Lactation curves that were flat, without a discernible peak, or convex were observed for both systems, especially for cows calving in spring and in the dry summer seasons (March to July). These abnormalities, signifying substantial sacrifices in production potential, probably had a complex etiology that stemmed from low nutrient intake and high neutral detergent fiber and low crude protein composition of the grazed and preserved forages. Research and outreach priorities to support the Hyblean dairy industry should include chemical evaluation of forages and other feedstuffs, low moisture ensiling of high quality winter forages, better formulation of diets that are dense with nutrients, and the shifting of calving patterns to better exploit high quality winter forages.
(**Key words**: Sicily, Ragusano cheese, Modicana, Holstein)

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INTRODUCTION

The dairy industry in the Hyblean region of Sicily, which mostly consists of the southeastern province of Ragusa, has two production systems. Modest size herds of Modicana cows are generally managed under the traditional system based on pasture. Milk produced by these cows is used to make native Ragusano, provola, and ricotta cheeses. On some of these farms, dairy producers, chiefly those who are mature and experienced, increase the value of the saleable product by artisan manufacture of these unique cheese varieties. Dairy producers on other farms utilize a more input-intensive, specialized system for larger herds of higher producing Holstein cows. For these herds, milk is commercialized for fluid and manufacturing purposes.

Investments in the Hyblean dairy industry are important to private entrepreneurs and to public policy makers because effects resonate economically with shifts in regional incomes, employment, and land use. The dairy cattle population in Ragusa has increased about 25% since 1970, which created more jobs on farms, in the processing of fluid milk, in cheese manufacture, and in dairy product marketing (1). About one-half of the farm land in the province of Ragusa is devoted to cattle production, predominantly dairying. Thus, dairy investment opportunities are important to decision makers and other stakeholders in both the private and public sectors.

In response to the demand of dairy producers for research and outreach (extension education) assistance, especially with the imminent opening of markets, milk quotas per country, and greater competitiveness among producer groups in the European community, a proposal in 1990 led to the establishment of Progetto Ibleo. Progetto lbleo is a dairy research center that focuses on milk production, manufacture and marketing of aged and semi-aged Ragusano cheeses, and farmer outreach programs. This unique venture—possibly a new multistakeholder paradigm for rural and urban cost sharing and

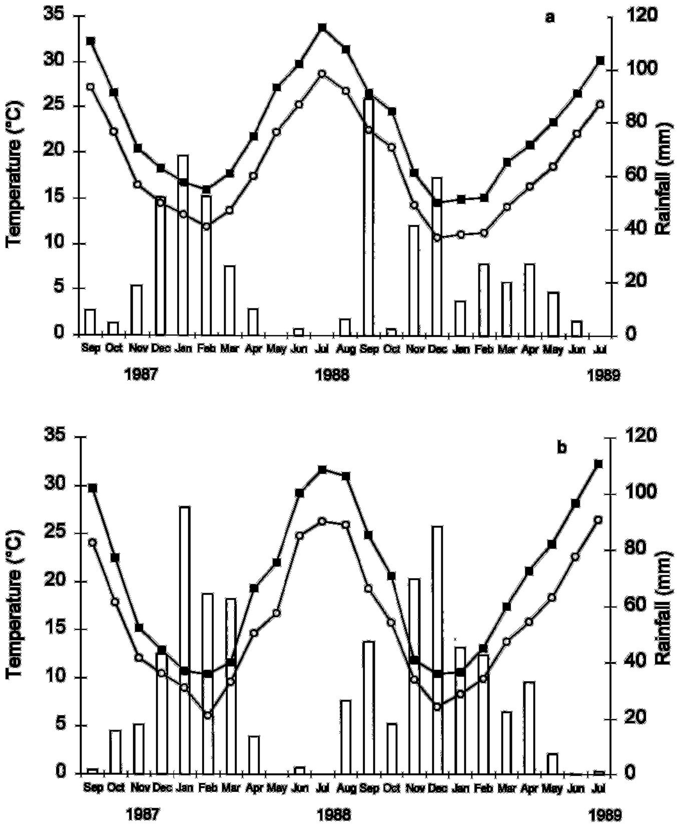

Figure 1. Monthly means for rainfall (bars) and minimum (○) and maximum (■) temperatures in low (a) and high elevations (b) of the Hyblean region from 1987 to 1989.

benefit sharing in agricultural research and outreach programs—was created collaboratively with grant funding from three levels of the public sector (i.e., the provincial and city governments of Ragusa and the regional government of Sicily through the Department of Agriculture and Forestry). Overall objectives of Progetto Ibleo are to improve net economic returns to dairy farmers and to improve the market competitiveness of Ragusano cheeses. Other expected benefits include greater employment opportunities and revenues for both rural and urban communities.

This study was the initial step to determine research, outreach, and management priorities to improve milk production and profits on Hyblean farms and helped formulate Progetto Ibleo. Specific objectives were to establish baseline performance values for production and composition of milk from herds managed under systems based on pasture (Modicana cows) and herds managed under input-intensive systems (Holstein cows), to determine probable forage quality in the region, and to investigate other potentially important factors that are subject to management (i.e., age at first calving, length of dry period, and calving interval).

MATERIALS AND METHODS

Mediterranean Climate, Forage, and Calving Seasons

Rainfall in the hilly Hyblean Mediterranean environment is unequally distributed throughout the year, including a distinct drought for approximately 5 mo (Figure 1), which is similar to many tropical and subtropical regions of the world. Annual mean rainfall is about 700 mm. Temperature trends at low (warmer) and high elevations are inversely associated with rainfall. The mean annual temperature is about 17°C (minimum, ~12°C; maximum, ~21.5°C). The pattern in Figure 1 is characteristic of seasonal variations of the past 30 yr. Obviously dependent on rainfall, the growing season for forages begins in November and lasts through April. Cows calve just prior to and during the forage season (Figure 2). Based on this information, calving seasons for this study were defined as early winter (November and December), late winter (January and February), spring (March and April), summer (May, June, and July), and fall (August, September, and October).

Data and Data Analysis

In 1988, forage samples were obtained to estimate NDF and CP composition and DM availability for grazing or harvest from natural and cultivated

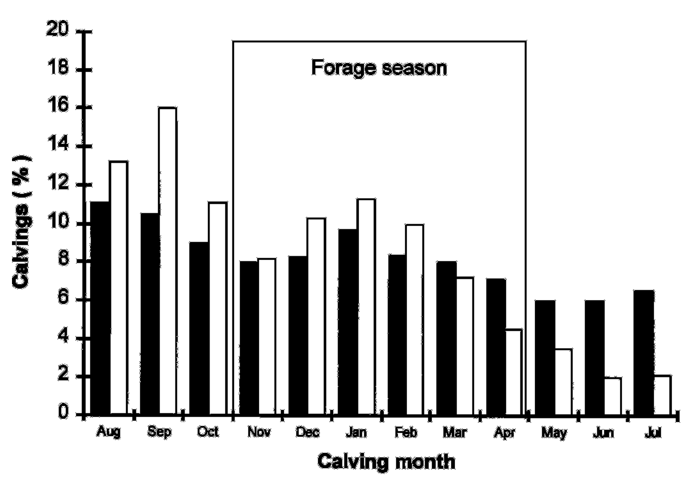

Figure 2. Percentages, by month, of Modicana (□) and Holstein (■) cows calving from 1984 to 1989.

pastures in late winter (beginning January 15) and spring and summer (early May only) from four fields on 4 farms. A total of 96 bulk samples representative of the general climatic conditions in Figure 1 was obtained. The composition and plant biomass of these samples were typical of grazing or hay making in these seasons. Native pastures were subsequently found to contain >100 plant species (4, 5) with about 20 dominant species. Dairy producers who manage systems based on pasture gradually shift the forage source, starting in early winter, from hay to pasture and reduce supplemental concentrate. By late February and spring, the diets of Modicana herds do not contain concentrate. Producers who manage Holstein herds on more input-intensive systems utilize cultivated forages supplemented with concentrates. For both systems, producers typically lengthen grazing or forage harvest intervals in spring and summer compared with those in winter to increase the availability of feed biomass for storage. Forage DM per hectare was estimated by drying samples that were obtained from a quadrant. The content of NDF was determined by the method of Van Soest et al. (10), and CP was determined by micro-Kjeldahl analysis. The NDF and CP composition and the corresponding forage DM offered during these seasons were regressed on day of forage season, which began November 1 (d 0), to illustrate probable quality and accumulated forage biomass on Hyblean dairy farms.

Milk production and composition records were obtained from the Sicilian DHI program for cows calving from 1984 to 1989 in the province of Ragusa. Milk production records were available for 4184 lactations from 35 Modicana herds and for 12,946 lactations from 69 Holstein herds. These records also provided data on age at first calving, length of lactation, length of the dry period, and calving interval. Test day milk protein and fat composition data for complete lactations were available for a subset of 443 Modicana and 4271 Holstein cows.

The available data were overlapping, which is to be expected at the start of recording. Nonetheless, the data should accurately characterize the management limitations of the producers of Ragusa. Forage measurements were from typically managed pastures on farms for which cow performance data were available. Cow performance data were available from herds using both production systems of the Ragusa dairy industry.

Production and composition of milk, age at first calving, and length of the dry period were evaluated using a statistical model containing fixed effects for breed (i.e., production system); herd-year; parity (1 or >1); season of calving; two-way interactions of season; breed and parity; and random residual. Length of lactation and calving interval were analyzed with a model that also contained cumulative milk production in the first 100 d of lactation as a covariable to remove partly the effect of production from breed difference. Mean performances presented in Tables 1 and 2 were adjusted for effects in these models. Lactation curves for milk production and fat and protein composition were summarized according to season of calving, parity, and ranges in mean herd production (<3000, 3000 to 3999, and >5000 kg for Modicana herds; <5000, 6000 to 6999, and >8000 kg for Holstein herds) for lactations >100 d using Wood's incomplete gamma function (11, 12).

TABLE 1. Adjusted means for production and composition of milk, length of lactation, length of the dry period, age at first calving, and calving interval by parity in recorded herds of Modicana and Holstein cows in the southeastern Hyblean region of Sicily.

Variable	Modicana		Holstein	
	$\overline{X}$	SD	$\overline{X}$	SD
Milk production, kg				
Parity 1	2885	1042	5216	2014
Parity >1	3122	1222	6032	2268
Overall	3080	1199	5799	2229
Composition, %				
Milk fat	3.7	0.26	3.4	0.21
Protein	3.6	0.15	3.1	0.06
Casein	2.8	0.16	2.6	0.05
Length of lactation, d				
Parity 1	249	67	283	79
Parity >1	246	68	283	80
Overall	246	67	283	80
<8 mo, %	52	. . .	33	. . .
Dry period, d	131	69	90	56
Calving interval, d	392	61	394	63
Age at first calving, %	27.6	>7	28.3	<5
<24 mo	35	. . .	17	. . .
>30 mo	26	. . .	27	. . .

RESULTS AND DISCUSSION

Forage Composition

Figure 3 illustrates the increasing NDF content and the decreasing CP content as the forage growing season in 1988 advanced from early winter (January 15) to early summer (May). Coefficients of determination for the pattern of loss in forage quality were 0.75 for NDF and 0.81 for CP. These responses were in agreement with results of other studies conducted by Progetto Ibleo (2, 3, 6). Forage DM increased per unit of land area, especially in late spring and summer, undoubtedly because of the decisions of dairy producers to accumulate biomass for silage and hay making and, less frequently, for grazing during the dry season.

In addition to the effects of temperature, length of day, water availability, and age of plant regrowth, seasonal changes affected the composition of forage DM, partly because of species substitutions. Different species thrive according to shifts in water availability and temperature in the dynamic pasture ecology of Ragusa. Figure 3 reflects the time trend of the forage season on NDF and CP contents in Sicilian forages. These responses mimic those that are negatively related to feed (energy) intake and the marginal or inadequate forage CP content often encountered in tropical regions (8, 9). The CP content of forages in late spring and early summer were near or below the dietary maintenance requirement of 8%. Late spring and early summer are the typical periods for silage and hay making; therefore, preserved forages that were fed later in the summer and fall seasons when pasture growth was nil had low quality. Consequently, forages containing high NDF and low CP were fed to livestock for most of the year (April to January; ~9 mo); these forages were low in energy and protein. Subsequent field days (i.e., days that producers brought their own forage samples for physical inspection and discussion) showed that producers were anxious to obtain accurate information about chemical composition and the improvement of forage quality.

TABLE 2. Adjusted mean production and composition of milk and predicted yield of fresh Ragusano cheese from milk by season of calving in Modicana and Holstein cows.

Variable	Modicana	Holstein
Milk production, kg		
Early winter[1]	3129	5943
Late winter	2974	5905
Spring	3282	6060
Summer	3064	5556
Fall	3061	5103
Milk fat, %		
Early winter	3.8	3.6
Late winter	3.7	3.4
Spring	3.7	3.4
Summer	3.6	3.4
Fall	3.6	3.4
Milk protein, %		
Early winter	3.6	3.1
Late winter	3.6	3.2
Spring	3.8	3.1
Summer	3.4	3.0
Fall	3.5	3.1
Casein, %		
Early winter	2.8	2.3
Late winter	2.8	2.5
Spring	2.9	2.4
Summer	2.6	2.3
Fall	2.6	2.4
Predicted cheese yield, kg/10 kg		
Early winter	1.11	0.94
Late winter	1.09	0.94
Spring	1.12	0.92
Summer	1.01	0.91
Fall	1.04	0.93

[1]Early winter = November and December; late winter = January and February; spring = March and April; summer = May, June, and July; and fall = August, September, and October.

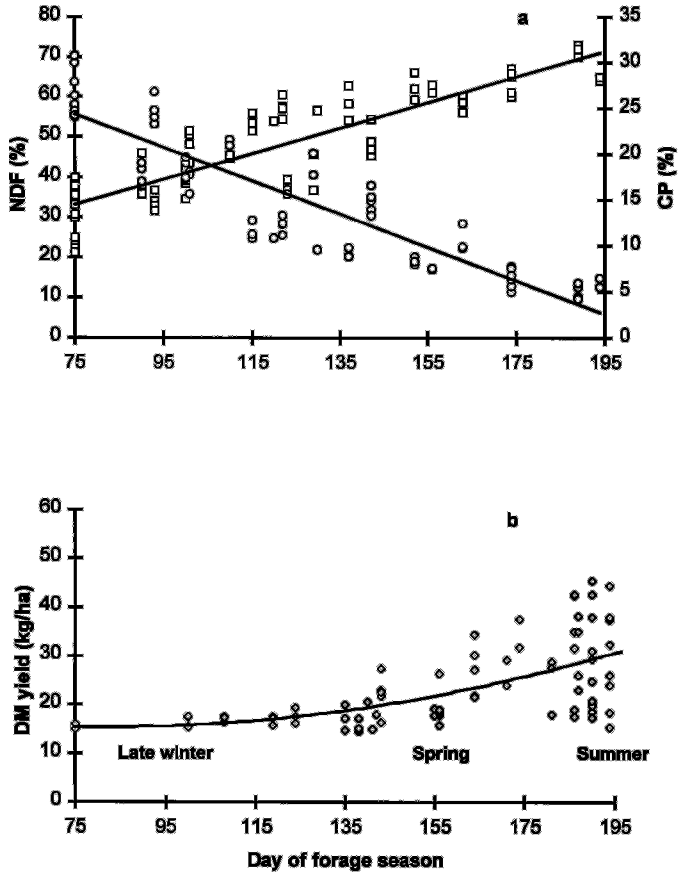

Figure 3. Composition of NDF (□) and CP (○) (a) and available DM (b) of native pasture and cultivated forages in late winter (January and February), spring (March and April), and summer (May, June, and July) seasons in the Hyblean region of Sicily in 1988.

Cow Performance in Alternative Production Systems

Table 1 contains means for production and composition of milk, length of lactation, length of the dry period, age at first calving, and calving interval for cows managed under both production systems. The milk production recorded here was similar to the best performances reported in tropical regions where forages also contain high NDF. The milk production of Modicana herds was similar to that of high producing native breeds and their crosses with European dairy breeds in the tropics; the milk production of Holstein herds was similar to that of their counterparts that were also managed under an input-intensive system in the subtropics (7, 8). A short mean lactation length and long dry period signaled important sacrifices in milk sales and net income. One-half of the lactations of Modicana cows and one-third of the lactations of Holstein cows were curtailed before 8 mo. More than one-fourth of primiparous cows of both breeds were >30 mo of age at first calving, which could mean that forage and dietary quality were insufficient for acceptable growth and breeding at an earlier age. Calving intervals, independent of milk production differences, were similar for Modicana and Holstein cows managed under both systems but for different reasons. Producers of Modicana herds managed under systems based on pasture concentrated calvings in the fall prior to the forage season by delaying the breeding of some heifers and cows. Because of this delayed breeding, weanling calves are able to graze pasture, which is why many Modicana cows calve in August and September (Figure 2).

Table 2 shows adjusted means for production and composition of milk and predicted fresh yield of Ragusano cheese, which varied by season of calving ($P < 0.01$). The lowest production, depressed milk composition, and smallest predicted cheese yields were from cows calving in summer and fall when the quality of forages was likely the lowest (Figure 3). At farm gate prices for fresh Ragusano cheese at the current exchange rate (Lire 1550/\$1), this seasonal difference in cheese yield is equivalent to a \$0.06/kg decrease in the price of milk from Modicana herds managed under systems based on pasture and a \$0.02/kg decrease in the price of milk from Holstein herds managed under more input-intensive systems. Sold as fresh cheese, farm gate income is about \$0.055 to \$0.099/kg higher for milk from Modicana herds than for milk from Holstein herds across seasons.

Flat Daily Milk Production

Lactation curves for primiparous and pluriparous Modicana and Holstein cows at different production levels are shown in Figures 4 and 5 for early winter and spring calving seasons. Abnormal curves (flat, without discernible peak, or convex) were observed for cows managed under both systems, especially for cows calving in spring and summer. Early winter and spring seasons illustrate differences in the production of Modicana and Holstein herds for each parity group ($P < 0.01$). Flat or convex lactation curves were dominant, especially in spring and in average or

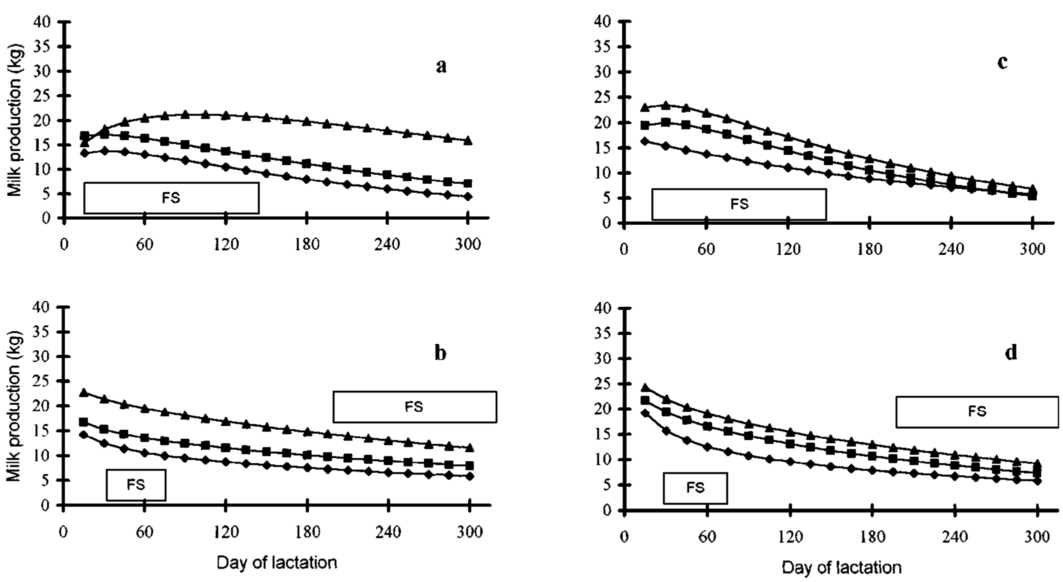

Figure 4. Mean lactation curves for early winter (November and December) calvings of primiparous (a) and pluriparous (c) Modicana cows and for spring (March and April) calvings of primiparous (b) and pluriparous (d) cows with different milk production. Milk production was ≤3000 kg (♦), 3001 to 4000 kg (■), and ≥5000 kg (▲). The x-axis shows the approximate occurrence of the forage season (FS) during lactation.

lower producing cows managed under both systems. These figures show the corresponding forage seasons beginning with the midpoints of each season. Cows calving on December 1 (early winter) encounter better quality forages for grazing than the hay or silage fed to them during the dry period. Conversely, cows calving on April 1 encounter poorer quality forage than that available to them for grazing during the dry period.

A potential cause of flat or otherwise abnormal curves is low nutrient intake from reduced forage availability or forages with a poor composition as indicated by the high NDF and low CP contents in Figure 3. Inadequate body tissue reserves at calving may also cause abnormal lactation responses. Losses in forage quality undoubtedly caused cows to browse rather than practice normal grazing behavior, which also depresses daily intake (8, 9). For cows that may have satisfactory adipose reserves for spring and summer calvings, in addition to dietary limitations on energy intake, homeorrhetic pathways that regulate high peak production are also likely disrupted by the inadequate CP from forage to supplement the energy from catabolized tissues (Figure 3). Thus, chronic nutritional inadequacy, beginning with low forage quality, is a primary detriment to lactation performance and predisposes a delay prior to first calving (i.e., depressed heifer growth) and excessive days dry. Therefore, improved management of forages and herd nutrition should be a priority for integrated research and farmer outreach programs to improve productivity and profit in Hyblean dairy systems.

Changes in milk composition for Modicana and Holstein cows were inversely related to lactation curves at each milk production level. Minimum concentrations were observed near calving, and curvilinearity was lowest for lactations of Modicana cows. These cows produced less milk than did Holstein cows ($P < 0.01$).

Research Priorities and Management Opportunities for the Hyblean Dairy Industry

Table 3 summarizes the baseline diagnosis as a sequence of components—analytical, biological, and management opportunities and technical support. The probable limitations and research priorities to facilitate improved dairy farm productivity and profitability are identified. Effects of season of calving on production and composition of milk and forage quality, the high incidence of curtailed lactations and excessive days dry, and a flat lactation curve signified that nutrient supplies were inadequate to meet requirements. Body tissue reserves were also probably insufficient to achieve normal lactation. Forage quality decreased drastically as the NDF and CP contents declined from late winter to spring and summer. Therefore, the preserved forages subsequently fed in

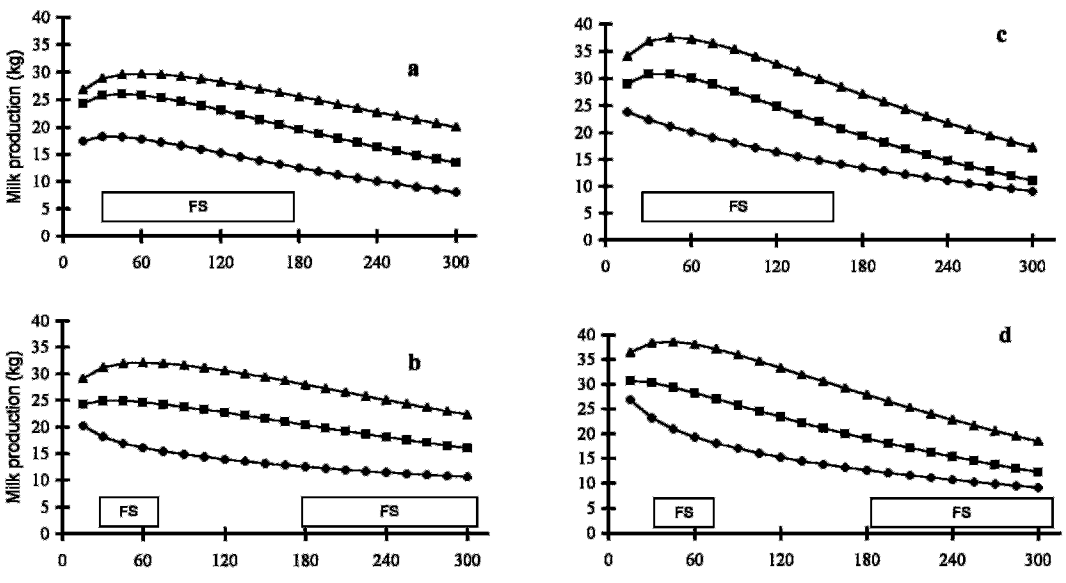

Figure 5. Mean lactation curves for early winter (November and December) calvings of primiparous (a) and pluriparous (c) Holstein cows and for spring (March and April) calvings of primiparous (b) and pluriparous (d) cows with different milk production. Milk production was ≤5000 kg (♦), 6001 to 7000 kg (■), and ≥8000 kg (▲). The x-axis shows the approximate occurrence of the forage season (FS) during lactation.

TABLE 3. Baseline diagnosis of the major technical and dairy herd management priorities to support dairy producers in the Hyblean region of Sicily.

Component	Effect	Response
Analytical	Season of calving Parity Breed High NDF and low CP composition of forages	Flat lactation curves Constrained yield per lactation and per day Curtailed lactations Excessive days dry (>90) Age at first calving ~28 mo Seasonal depression in milk composition and cheese yield
Biological (research needs)	Nutrient availability Dietary intake and balance Body tissue reserves Feed chemical composition Native pasture ecology (species composition) Other forages and feeds	Unmet nutrient requirements Inadequate body condition score Depressed peak daily milk production and lactation persistency Altered milk composition
Management opportunity and technical support	Forage availability Forage quality (composition) Dietary options Increase nutrient density (especially energy) Grouping cows	Choice of management system Grazing and supplementation (low capital) versus confinement (capital intensive) Forage preservation method Dry period (length of lactation) Breed Nutritional recommendations that are profitable, increase peak and lactation yields, improve tissue reserve status, and attenuate milk composition losses

the dry summer and fall (Figure 3) were also poor in quality. Clearly, one investment priority should be to evaluate forages and other feedstuffs chemically for optimal utilization in better formulated diets that are rich in nutrients, regardless of whether the production system relies on seasonal grazing (i.e., Modicana herds) or confinement feeding (i.e., Holstein herds). Improved quality of grazed and preserved forages is necessary, especially in late spring, summer, and fall. To capitalize on superior forage quality in winter and early spring, low moisture silage (haylage) appears to be a worthy option to explore. Cow grouping strategies to improve nutrition and reproduction management portend greater productivity, which must be weighed against the additional capital cost. Substantial cow responses should be expected from these management changes, which are all aimed at the improvement of daily milk production.

CONCLUSIONS

Forage composition showed drastic undesirable changes in NDF and CP contents, similar to tropical ecozones (8, 9), which indicated the cause of the detectable seasonal effect ($P < 0.01$) on production and composition of milk and predicted yield of fresh cheese. Flat and convex lactation curves illustrated substantial sacrifices in production potential and farm income for herds managed under both production systems. These abnormalities probably have a complex etiology that involves 1) low nutrient intake from poor quality grazed and preserved forages, 2) further depression in feed intake because of browsing rather than grazing behavior as forage quality declined, 3) inadequate body tissue reserves at calving, and 4) suboptimal dietary formulations (Table 3). Consequently, research and outreach priorities to improve milk income should include chemical evaluation of forages and other feedstuffs, the production of haylage from high quality winter forages, better formulation of diets that are rich in nutrients, and the shifting of calving patterns to exploit high quality winter forages better. Correspondingly, Progetto Ibleo has implemented a holistic strategy that integrates these management opportunities with standardized technologies for making high quality Ragusano cheeses and with analysis of marketing potentials for these value-added products.

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