GENERAL MANAGEMENT AND FEEDING STRATEGIES ON WISCONSIN ORGANIC DAIRY FARMS

by

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A thesis submitted in partial fulfillment of

the requirements for the degree of

Master of Science

(Dairy Science)

at the

UNIVERSITY OF WISCONSIN – MADISON

2013

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INTRODUCTION

Organic dairy production continues to flourish in the United States due to increased consumer demand for organic dairy products and farmer interest. However, farm management—specifically feeding strategies for dairy animals—has become increasingly complex for organic dairy producers due to decreased flexibility in feeding programs resulting from regulations tied to organic certification, such as the requirement that organic farmers must feed 100% organic feed and the implementation of a pasture rule. The purpose of this thesis was to describe and evaluate management practices that occurred on surveyed organic farms in 2010, placing particular emphasis on dairy cow feeding strategies utilized within these farms and their influence on milk production and farm profitability. This study results from a larger project titled Strategies of Pasture Supplementation on Organic and Conventional Grazing Dairies: Assessment of Economic, Production, and Environmental Outcomes, in which 133 organic, conventional grazing, and conventional confinement dairy farms in the state of Wisconsin were surveyed regarding general farm characteristics, feeding strategies, grazing practices (if applicable), nutrient management, economic variables, and farm and life satisfaction for the production year of 2010.

This thesis begins with a review of literature (chapter 1) discussing the growth of organic agriculture in the US, organic certification requirements, characteristics of organic dairy farms, and the influence of pasture supplementation. The thesis continues with a general description of the management practices observed on the 70 surveyed organic dairy farms (chapter 2), feeding strategies for lactating dairy cows and their influence on milk production and farm profitability (chapter 3), and management of dry cows on organic farms (chapter 4). The final pages of the thesis (chapter 5) provide a general summary and conclusions regarding feeding management on Wisconsin organic dairy farms.

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CHAPTER 1

Literature Review

Growth and Importance of Organic Dairy Farming

Organic agriculture in the United States has been growing in popularity since the early 1990s (Greene, 2001). Despite the uncertain economic situation of the United States shortly after the turn of the 21st century, the US organic food industry has continued to grow. In 2010, when many other industries had to endure the phrase "flat is the new growth", the organic industry grew at a rate of nearly 8% (Organic Trade Association, 2011). More specifically, the organic dairy industry, the second-largest category of organic products, grew by 9% in 2010, capturing nearly 6% of the total US market for dairy products (Organic Trade Association, 2011).

Wisconsin ranks first in the US for the total number of organic dairy farms, having 22% of the nation's certified organic dairy farms (USDA-NASS, 2012). Milk sales from cows make up the majority of Wisconsin's organic sales, claiming 62% or $82.3 million of total organic sales in Wisconsin (USDA-NASS, 2012).

Organic agriculture has been able to maintain its growth for multiple reasons. Many consumers choose to eat organic foods because they believe that they are safer, having less contamination from herbicides, pesticides, hormones, and genetically modified organisms (GMOs); more nutritious; and produced in a more environmentally-friendly manner (Yiridoe et al., 2005). Many organic producers' reasons for transitioning to organic production align with consumer perceptions. Organic dairy producers believe that by farming organically, they are working more harmoniously with nature and producing a healthier product (Cranfield et al., 2010). The economic incentive of being able to sell organically produced foods at a premium price has also been a reason for farmers to choose organic production methods.

Organic Certification Requirements

In 2002, the United States Department of Agriculture (USDA) National Organic Program (NOP) put into place national standards for organic production (USDA-AMS, 2013). Through third-party certification, these standards regulate all aspects of organic production, from on-farm cultivation and husbandry to processing and product labeling in order to ensure that the organic vision “of using cultural, biological, and mechanical practices to foster cycling of resources, promote ecological balance and conserve biodiversity” is maintained (USDA-AMS, 2013). Upon request by consumers and producers, on June 17, 2010, the USDA-NOP subsequently formalized a pasture rule for organic ruminants ((USDA-AMS, 2010). Organic dairy cattle at least six months of age must receive 30 percent or more of their dry matter intake (DMI) from pasture during the grazing season, which must be at least 120 days long per year, though that does not need to be continuous (USDA-AMS, 2010). Additionally, organic livestock must have access to the outdoors year-round.

All organic livestock feed, including pasture, must be organically produced and only handled by operations certified by NOP. Homegrown feeds must be produced using organically grown seeds, seedlings and other planting stock unless organic varieties for that crop are not commercially available. Crops must be produced as part of a cropping rotation that maintains or improves soil organic matter content, contributes to pest and weed management, manages plant nutrients, and provides erosion control. Crop cultivation practices available to organic farmers include tillage; application of raw and composted animal manures, plant materials, mined substances, and soil amendments listed on the National List of synthetic substances allowed for use in organic crop production; and flaming for weed control (USDA-AMS, 2013).

Organically produced and handled feeds from off-farm sources may be fed, but synthetic feed supplements are not allowed. Some feed additives such as trace minerals and vitamins are allowed but cannot be supplied in amounts above those needed for adequate nutrition and health maintenance for the specific species and stage of life. Animal drugs, including hormones, may not be used to promote growth. Feeds must not contain plastic pellets, urea, manure, antibiotics, or ionophores. For all types and classes of animals on the farm, ruminant livestock producers must record the total feed ration, including descriptions of home-grown and purchased feeds, percent of each feed type (including pasture) in the diet, a list of all supplements and additives, and methods for estimating DM demand and intake (USDA-AMS, 2013).

General Management and Feeding Strategies on Organic Dairy Farms

Though some regional variations exist in US organic dairy farm herd size, (McBride and Green, 2009a), overall the average organic dairy herd is smaller in size (82 cows per herd) than their conventional counterparts (156 cows per herd; Zwald et al., 2004; Sato et al., 2005; Pol and Ruegg, 2007; McBride and Green, 2009b). In 2005, McBride and Green (2009a) found that 45% of US organic dairy herds had less than 50 cows, and 87% of herds had less than 100 cows. They further concluded that the majority (96%) of the herds with less than 50 cows were located in the Midwest (MI, MN, and WI) or Northeast (ME, NY, PA, and VT) while 80% of the largest herds (>200 cows) were located in the West (CA, ID, OR, and WA).

Organic dairy cows are commonly housed and milked in tie stalls (Zwald et al., 2004, Sato et al., 2005) when not on pasture. Average milk production observed on organic farms was approximately 21 kg/cow per day, significantly less than what was produced by conventional cows (24 – 33 kg/cow per day) in the same studies (Zwald et al., 2004; Sato et al., 2005; Pol and Ruegg, 2007). Lower milk production reported on organic farms has been attributed to several factors. Breeds other than the high-producing Holstein breed are more prevalently used on organic farms (Sato et al., 2005; Stiglbauer et al., 2013), and different feeding strategies are employed.

The use of a nutritionist or feeding of mixed feed has not been as common on organic dairy farms compared to conventional dairy farms (Zwald et al., 2005; Stiglbauer et al., 2013). Though the NOP pasture rule had not yet been formalized when these studies occurred, it was observed that organic dairy farms were much more likely to utilize a rotational grazing system than conventional farms (Sato et al., 2005; McBride and Greene, 2009b). Other differences observed between organic and conventional dairy farming related to feeding include less use of soybeans and no use of cottonseed, brewer's byproducts, nor meat and bone meal in organic dairy animal diets (Zwald et al., 2004).

The Role of Rotational Grazing on Dairy Farms

Rotational grazing is increasingly being used as a feeding strategy on dairy farms for many economic, environmental, and social reasons. Oftentimes pasture-based dairying provides dairy producers several economic advantages because of the system's low-input emphasis. Start-up and maintenance costs are usually lower than for confinement operations, since the main capital cost associated with grazing is fencing supplies (Undersander et al., 2002). This advantage makes grazing a more appealing and viable option for beginning dairy farmers to enter into agricultural production. Grazing dairy cattle also decreases the need for stored feeds, reducing the amount of funds required for equipment, seed, fertilizer, labor, and other inputs needed for forage and row crop production. The reduction in inputs by heavily grass-based farms allows for these farms to better handle low milk prices due to lower capital expenses (Patton et al., 2012).

Grazing also has tremendous advantages in environmental stewardship. The maintenance of land in perennial pastures reduces the opportunity for soil erosion by both wind and water. Combining reduced erosion with lower use of pesticides, herbicides, and fertilizers leads to less water pollution from toxic synthetic compounds. Reduced need for tillage activities improves soil structure and increases carbon sequestration. Increased wildlife activity is also observed in both soil (such as earthworms) and above ground ecosystems; residual grass can serve as home to songbirds and wild game (Undersander et al., 2002)

There are also social advantages to pasture-based dairying. Labor can be reduced with appropriately designed grazing systems so that not as much time will be needed for mixing feed and harvesting crops. Furthermore, many producers and consumers enjoy seeing cows grazing on pasture. Additionally, milk produced by grazing cattle has higher levels of desirable fatty acids, such as the cis-9, trans-11 isomer of conjugated linoleic acid, known to inhibit cancer and enhance growth of lean body mass (White et al., 2001).

Not all methods of rotational grazing are equal. The frequency of rotation and order of animal movement can vary from farm to farm and within an operation over the course of a year. Pasture rotation can be as simple as rotating cattle between two paddocks. However, as the number of paddocks increases, shorter grazing periods and longer rest periods result, reducing the opportunity for plants to be overgrazed and providing them with time to regrow, restore energy reserves, and build deeper root systems (Undersander et al., 2002). Recommended grazing rotation practices are based on plant growth rather than a rigid time schedule, to ensure that plant needs for periodic rest are met to maintain pasture sward vigor. Leader-follower rotation is also a pasture management strategy implanted by some dairy graziers. In this system, preferential treatment is given to a group of animals with higher dietary needs, such as all or high-producing lactating cows by allowing them to graze a paddock first (Clark and Kanneganti, 1998). Upon removal of the leading group of animals, animals having less dietary requirements such as late lactation cows, dry cows, or heifers are grazed in the same paddock to utilize the lower quality residual pasture. This practice allows for increased sward use; however in a study by Mayne et al. (1988), an advantage in milk production by the leading high-producing cows was counteracted with a reduction in production by the following low-producing cows. Another management strategy incorporated by some graziers is seasonal calving of the dairy herd. Cows and heifers are calved in spring so they reach peak milk production when pasture growth is heaviest and plants are most nutritious.

Biological Role of Supplementation of Grazing Dairy Cattle

Biological, climatic, and economic factors can prevent complete reliance on pasture for dairy cattle, requiring farmers to find additional feed sources for all or part of the year. Lactating dairy cattle that graze commonly have lower milk production than their confined, TMR-fed counterparts due to insufficient energy intake, (Kolver and

Muller, 1998; Bargo et al., 2003). To reduce the influence of insufficient energy intake and subsequent milk production, graziers commonly provide supplemental feeds to their lactating dairy cattle. Studies regarding supplementation of grazing dairy cattle are extensive, and results vary based on the feedstuff supplemented. It has been well established that supplementation of most feeds increases total DMI, and thus energy intake, allowing for greater milk production (Bargo et al., 2003). However, milk components and other factors are influenced differently depending on the feedstuff supplemented.

Supplementation of concentrates. Numerous studies have been conducted regarding supplementation of concentrates, such as corn, small grains, and commercial mixes, to grazing lactating cows. In their review, Bargo et al. (2003) concluded that supplementation of concentrates up to 10 kg DM/d increased total DMI, milk production, and milk protein concentration in high-producing dairy cattle. However, DMI from pasture and milk fat concentration decreased linearly with supplementation of concentrates (Reis and Combs, 2000). In the review by Bargo et al. (2003), substitution rates (decreases in pasture intake per kilogram of supplemental feed) varied from 0.02 to 0.64 kg of pasture/kg of supplement, depending on the kind of supplement, pasture characteristics such as pasture allowance and forage quality, and animal factors such as genetic merit and production level. Increases in milk production and protein content can be attributed to a more appropriate balance of protein and carbohydrates in the diet, allowing for more efficient utilization of the protein consumed from pasture, particularly lush, leguminous pastures (Reis and Combs, 2000; Bargo et al., 2002a). The decrease in milk fat content is likely due to the acidotic state of the rumen several hours after concentrate feeding, similar to the milk fat depression observed in cows inflicted with subacute rumen acidosis (Reis and Combs, 2000).

Supplementation of protein. Rego et al. (2008) reported that partial replacement of supplemented corn based concentrates with protein-rich soybean meal resulted in an increased milk fat content, but the increased consumption of protein did not lead to greater milk production or milk protein content and led to the need for higher energy expenditure for excretion of excess nitrogen. However, when the partial replacement of supplemented corn with soybeans is combined with supplementation of grass silage, total DMI and milk yield had a tendency to increase (Rego et al., 2008). Murphy et al. (1995) observed no changes in milk yield or component concentrations when supplementing full fat soybeans or soybean meal.

Supplementation of corn silage. Like concentrates, corn silage is often added to the diets of pastured lactating dairy cows to provide energy, and in many cases, can be a fairly substantial part of the diet. However, the supplementation of corn silage in grazing lactating cow diets has more variable results compared to concentrates. Holden et al. (1994) reported that the addition of corn silage at 2.3 kg DM/cow per day to lactating cow diets already containing concentrates at a rate of 1 kg DM of concentrates/ 4 kg of milk had no effect on milk production, milk components, or body weight gain and condition score. However, Valk (1994) observed greater milk yields and smaller decreases in body weight in cows receiving a mixture of freshly cut pasture and maize silage compared to the cows receiving only freshly cut pasture, but this could have been due to a negative influence on DMI in the freshly cut pasture treatment because of a high crude protein concentration. No differences were observed in components or net energy intake, but this could also be influenced by the incorporation of 4 kg DM of concentrates/cow per day. Compared to the previous two corn silage studies, Pérez-Prieto et al. (2011) observed very different results. When grazing low-mass pastures, late-lactation cows supplemented with corn silage and soybeans had significantly greater milk yields and body weights due to increased DM and energy intakes. Milk protein concentration also increased with the addition of supplements, but milk fat concentration remained the same. Experiments in Stockdale (1995) showed that the addition of corn silage to fresh pasture diets resulted in increased milk production until corn silage comprised 30-40% of the diet, in which dietary protein became limiting. However, milk fat content remained the same at all supplementation levels.

Supplementation of grass silage and hay. The supplementation of grass silage decreased pasture DMI and milk protein content but tended to increase milk production when combined with soybean meal (Rego et al., 2008). Supplementation of hay had little influence on production and cow factors. In experiments described in Stockdale (1999), supplementation of hay increased total milk yield, but fat and protein concentrations remained unchanged. However, hay supplementation reduced the cows' decrease in BCS compared to the unsupplemented treatment.

Supplementation of TMR. Supplementation of TMR significantly increased DMI and energy consumption, and thus increased milk production (Kolver and Muller, 1998; Bargo et al., 2002b). Cows supplemented with TMR also had higher milk protein concentrations, body weights, and BCS (Kolver and Muller, 1998; Bargo et al., 2002b). However, the influence of TMR supplementation on milk fat content was more variable.

An increase in milk fat content was observed in Bargo et al., (2002b), but no change was observed in Kolver and Muller (1998).

Economic Influence of Feeding Strategies for Organic Dairy Farms

Soder and Rotz (2001) investigated the economic impact of increased supplementation of grazing dairy cattle. As supplementation increased from 0 to 9 kg of supplement/cow per day, total production costs and income increased, but total income increased more substantially than total costs, leading to an overall increase in net return. However, net return increased at a decreasing rate as explained by the law of diminishing returns. Tozer et al. (2004) also explored the economic impact of supplementation of grazing dairy cattle. At low pasture allowances, the addition of concentrates to lactating cow diets at 1 kg concentrates/4 kg milk produced increased milk income from $4.89 to $7.24/cow per day. At high pasture allowances, milk income increased from $5.66 to $7.34/cow per day with supplementation of concentrates. With the addition of concentrates to the diet, feed expenses increased from $1.59 to $2.72/cow per day and $2.55 to $3.38/cow per d at low and high pasture allowances, respectively. The assumed pasture cost was $0.1205/kg of DM after accounting for the efficiency of harvest. With the addition of concentrates, resulting income over feed costs (IOFC) increased from $3.30 to $3.51/cow per d and $3.10 to $3.96/cow per d at high and low pasture allowances, respectively. However, when considering these profitability measures, one should take note these studies were done in conventional systems and therefore do not reflect organic feed prices.

A few studies investigating costs associated with various feeding programs on US organic dairy farms have occurred. McBride and Greene (2009a) evaluated organic dairy farm feed costs, among other expenditures, by farm size, region, and pasture usage. Smaller farms had less purchased feed costs per unit of milk sold, but larger farms had the advantage in lower homegrown—both harvested and grazed—feed costs ($/unit milk), likely due to the ability to spread capital costs over more units of milk sold. Feed expenses were significantly less on organic dairy farms in the Upper Midwest and Northeast by $1.36 and $1.10/cow per day, respectively, compared to feed expenses on farms in the West; however, farms in the West were much more competitive when feed costs were evaluated on per unit of milk basis. Homegrown harvested feed expenses claimed the majority of Upper Midwestern farms' costs whereas purchased feed costs comprised the bulk of the West's farms' costs. This study also concluded that average feed costs per cow were less on farms that used more homegrown harvested feed and pasture. However, on a per unit of milk basis, feed costs were lower on farms that used less pasture because of their 30% higher milk production per cow (McBride and Green, 2009a).

Hoshide et al. (2011) used the crop and livestock Integrated Farm System Model to evaluate feed costs on organic dairy farms by size as well as feeding programs based on intensity of equipment use. They also concluded that due to economies of scale, larger farms (220 cows per farm) were more economically viable, having higher net farm incomes ($/cow per year) than small (30 cows per farm) and medium (120 cows per farm) farms for all feeding programs evaluated. However, for small and medium farms, the least intense, sod-based stored feeding system was the most economically viable feeding program because it did not require as much capital investment in equipment and storage facilities for corn and small grain crops grown in the more intense feeding programs. The sod-based feeding program also had the advantage in supplying cows with enough protein through the harvested grass and legume forages, whereas the more intense feed programs that incorporated corn in the form of silage and grain required the addition of soybeans to the ration in order to provide enough protein to the cows.

In an experiment by Marston et al. (2011) comparing four mixed rations differing in forage and concentrate type, feed costs ($/cow per day) for grass silage and commodity concentrate diets were found to be numerically lower and IOFC numerically higher than those for the corn silage diets. Milk yield, quality, and composition were the same for all treatments, so the numerically higher income over feed costs ($/cow per day) for the grass silage commodity concentrate diet entirely reflected this treatment's advantage in lower diet cost.

Conclusions

The organic dairy industry is continuing to grow in the US, and Wisconsin's prominent role in this dairy industry makes it a prime and necessary place to study this growing dairy sector. Though organic research is increasing, currently, limited information is available regarding the influence of feeding strategies on organic dairy farms. The incorporation of low-cost pasture into dairy cow diets can have economic as well as other environmental and social advantages, but milk production may suffer compared to non-pastured animals. Thus, when elevated milk prices are available through organic premiums, increasing milk production through supplementation may be more profitable for organic dairy producers despite increased feed costs. The purpose of this thesis is to identify feeding strategies and other management practices on Wisconsin organic dairy farms and evaluate their role in farm productivity and profitability.

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CHAPTER 2

Characterization of Wisconsin Organic Dairy Farm Management Practices

ABSTRACT

The purpose of this study was to characterize certified organic Wisconsin dairy farms, placing particular emphasis on their feeding strategies during the course of 2010. Farms were identified by cross listing two separate directories: the Wisconsin Active Dairy Producers and the Wisconsin Certified Organic Producers. All resulting organic dairy herds from these lists were invited to participate (N=554) in the study. Seventy farms throughout the state were surveyed between January 2011 and January 2012. Total area operated ranged from 17.8 to 775.6 ha, with a mean (±SD) of 123.4 (±133.4). Hectares of pasture ranged from 6.1 to 145.8, with a mean (±SD) of 40.9 (±30.84). Herd size ranged from 12 to 650 cows, with a mean (±SD) of 69.2 (±85.8). The predominant breed varied on the farms, with 57.1, 10.0, and 25.7% of the herds having Holstein, Jersey, and crossbred cows, respectively, as their predominant breed. Milk rolling herd averages varied from 2,356 to 10,285 kg/cow per year, with a mean (±SD) of 6,368 (±1,860). The average grazing season length for study farms in 2010 was 189 (±29.0) days. Eighty-seven, 17.1, and 50.0% of the herds fed concentrates, soybeans, and corn silage, respectively, for at least one month in 2010. As indicated by the ranges and SD presented here, certified organic Wisconsin dairy farms varied widely in farm characteristics, feeding strategies, and animal production. Awareness of these extreme variations should help design Extension programs and agricultural publications better suited to meet the educational needs of this growing dairy sector.

Key words: organic, grazing, supplementation

INTRODUCTION

Organic agriculture has been growing in popularity since the early 1990s. In 2002, the United States Department of Agriculture (USDA) National Organic Program (NOP) put into place national standards for organic production (USDA-AMS, 2013). Upon request by consumers and producers alike, on June 17, 2010, the USDA-NOP subsequently formalized a pasture rule for organic ruminants (USDA-AMS, 2010). Organic dairy cattle at least six months of age must receive 30 percent or more of their DMI from pasture during the grazing season, which must be at least 120 days long (USDA-AMS, 2010).

Feeding management on organic dairy farms has become an increasingly complex task. Compliance with the NOP pasture rule can create challenges for famers when balancing dairy rations. Harsh winters, limited land bases, drought, and many other factors prevent complete reliance on pasture for Wisconsin dairy cattle, requiring farmers to find additional feed sources for all or part of the year. Exorbitant grain prices, limited and expensive harvested forages due to recent droughts, and the requirement that organic dairy farmers must feed 100% organic feeds to their livestock have put extreme constraints on these dairy farmers' supplemental feeding programs.

Wisconsin's prominent role in the nation's organic dairy industry makes it a prime and necessary place to research this growing dairy sector. Furthermore, Wisconsin's organic farms are similar in size and structure to those located in the northeastern part of the U.S., so many conclusions drawn about Wisconsin's organic dairy farms may be applied to those in the Northeast (McBride and Green, 2009). Though research on organic dairy farming in the U.S. is increasing, most studies have focused on comparisons between organic and conventional dairy farming. Few studies have occurred related to only organic dairy farming and described the farm system as a whole. The objective of this study was to characterize organic dairy farms system as a whole system.

MATERIALS AND METHODS

Sampling

Two separate directories, the Wisconsin Active Dairy Producers list, 2009, and the Wisconsin Certified Organic Producers list from the Department of Agriculture Trade and Consumer Protection (DATCP) were referenced to create the list of organic dairy producers from which the sample was drawn. The first directory was a list of the farms in the state that sold milk in 2009. The second directory was a list of all Wisconsin farms that were certified organic, including dairy, meat, and vegetable farms. Names included in both directories were believed to be organic dairy producers in Wisconsin (n=554). All farmers on the resulting list received an invitation to participate in the study through a mailing containing an introductory letter, project summary, description of the project team members, and a pre-stamped postcard to be returned indicating their level of interest in participating in the project. Participants were also offered a $100 honorarium. Farmers who expressed a willingness to participate were contacted by phone or mail to schedule and then conduct the on-farm, face-to-face survey, by one of the two graduate students on the project or a hired enumerator. A total of 70 organic dairy farms in the state were surveyed between January 2011 and January 2012.

The Survey Tool

The survey was 45 pages long and contained nine sections:

a) Farm Business Structure and Decision Makers
b) People on the Farm
c) Dairy Herd and Management
d) Feed Management
e) Pasture Management
f) Land Management and Cropping Operation
g) Manure and Nutrient Management
h) (removed from survey)
i) Economic Information
j) Assessment of Farm Management and Satisfaction

The first three sections looked at the demographics of the farms—land operated, labor, and characteristics of the dairy herd. Section D, Feed Management, asked farmers to divide their herds into specific feeding groups and assessed each group's intake on a month-by-month basis. The information gathered in this section will be used to measure changes in the herds' rations when the cows are provided access to pasture. Sections E, F, and G provided information on sources of feed and distribution of nutrients. Section H, Farmer-to-Farmer Interactions, was removed from the survey upon deeming its prospective data impertinent to the study. The final two sections of the survey assessed sources of income in addition to farm revenues and the farmers' outlooks on agricultural production.

RESULTS

Farm Locations

The surveyed farms formed a tilted U, with the base of the U constructed by the farms in the southwest part of the state, one arm serving as a branch of farms headed towards the northeast part of the state, and the second arm travelling from the southwest corner of the state to Wisconsin's peninsula (Figure 2.1). The most densely populated areas of organic farms were the southwestern part of Wisconsin or the base of the U and the northern arm, especially in the central part of the state. The U surrounds the Central Sands region, where minimal dairy farming occurs. It also excludes the southeastern corner of Wisconsin, the most populous part of the state, and the northern part of the state, which is mostly forested land.

Land

Total land operated on the surveyed organic dairy farms ranged from 17.8 ha to 786 ha, with the average being 118 ha and the median 85.5 ha, and just over two-thirds of the total land operated was owned (Table 2.1). Based on the means, approximately two-thirds of the land was operated as cropland, although six of the 70 farms did not operate any cropland. All farms had at least several hectares of pasture, with a minimum of 6.1 ha. Farmers owned a greater percentage of their pasture than their cropland, with mean percents owned of 77.5% and 61.1%, respectively. The surveyed farms had an average of 13.3 ha of woodland, some of which were grazed on several farms. Additionally, four farms had some land in the Conservation Reserve Program (data not shown).

Herd Size

The average organic Wisconsin dairy farm studied had 69 cows, but the median farm had only 45 cows (Figure 2.2). The range in herd size stretched from 12 cows to 650 cows, with 60% of the farms having 50 or less cows. Only 12.8% of the farms had more than 100 cows. The number of heifers (all female young stock) followed a similar but slightly lower spread, with an average replacement herd size of 58 heifers, median of 40 heifers, and a range extending from 9 to 600 heifers per farm (Figure 2.2). Additionally, 61.4% of the farms had at least one bull for breeding purposes (data not shown).

Breed

Forty (57.1%), seven (10.0%), and 18 (25.7%) of the herds were predominantly (≥ 50%) Holstein, Jersey, and crossbred, respectively (Figures 2.3). The remaining five (7.1%) herds were either predominantly a different breed or had no predominant breed. Thirteen (18.6%) of the herds had no Holstein cows (Figure 2.4). Sixteen (22.9%) of the herds had no crossbred cows (Figure 2.4). The breeds used most prevalently in the crossbred cows were Holstein, Jersey, Milking Shorthorn, Brown Swiss, and Normande, however, a total of 18 different breeds were mentioned between all of the farms as being represented in the crossbred cows (Figure 2.5).

Seasonal Management

Approximately one-fourth (18) of the farms claimed to be seasonal or bi-seasonal in calving strategy (Table 2.2). Of these 18 farms, seven were completely seasonal, with at least one month in the year when milking ceased. Three seasonal farms reduced to one milking per day as cows neared the end of their lactation. One farm milked once daily when lactating cows were present; another farm milked every 18 hours year-round. All other farms milked twice daily. No farms milked three or more times daily.

Milk Production

The average rolling herd average (RHA) reported by the farmers was 6,368 kg/cow per year, with the minimum and maximum RHA measuring at 2,356 and 10,785 kg/cow per year, respectively (Table 2.2). The average percent fat, percent protein, SCC (1,000 cells/ml) were 3.87%, 2.99%, and 242, respectively (Table 2.2). The maximum average percent fat and protein were 5.14 and 3.79, respectively. The SCC (1,000 cells/ml) ranged from 81.3 to 707. Approximately one-half (50.9%) of the herds utilized Dairy Herd Improvement (DHI) testing.

Reproduction and Culling

Thirty-three percent of the herds used natural service to breed cows, and 73.9% of the herds used artificial insemination (AI) to breed cows (Table 2.2). The same number of herds (37) used natural service and AI to breed heifers. The percentages do not total to 100% for cows nor heifers because some farms used both natural service and AI. As expected, none of the farms used synchronization programs, as this practiced is not approved for use on organic farms. The average age of first calving for heifers was 26.2 months (Table 2.2). The average rate of removal of cows from the herd due to culling and death was 21.9%. The most common reasons given for culling were mastitis, low fertility/reproductive issues, and lameness, which occurred in 70.1, 69.1, and 39.7 percent of herds, respectively (data not shown).

Farm Labor

Though all of the surveyed farms identified themselves as family farms, the percentage of labor completed by family members, both immediate and extended family, differed from farm to farm. On 77% of the farms, at least 85% of the farm chores were completed by family members. However, the percent of farm labor completed by family members varied to as low as 31.3%. The average number of family members helping with the farm chores was 3.7, but this value reached 11 members on one farm. Ten (14.3%) of the farms surveyed were identified as part of an Anabaptist group, such as Amish or Mennonite (data not shown). The average age of the respondents, which were all important decision makers on the farm, was 50.3 years (Table 2.2). Twenty-nine farms had at least one respondent or spouse working off of the farm. The average respondent completed high school and some additional technical or college classes. Sixty-two of the respondents grew up on a dairy farm (Table 2.2).

Feeding

Cow diets varied in complexity and application. Thirty percent of the organic herds housed all of their cows, lactating and dry, together. Only 5.7% of farms had multiple lactating cow groups. The average number of feed ingredients in the lactating cow diet was six, but the range extended from two to 14 ingredients. Eighty-seven, 17.1, and 50.0% of herds fed concentrates, supplemented protein in the form of soybeans or other protein products, and fed corn silage, respectively (Table 2). All but one farmer that fed corn silage fed only homegrown corn silage. Sixty-two percent of farmers that fed concentrates purchased at least some of the concentrates. Thirteen percent of the herds reported not feeding any concentrates; however some of these herds may have received corn grain in the form of corn silage. Eighty and 75.7% of the herds fed dry hay and haylage or baleage, respectively, at some point in time during the year. Over 80% of the herds supplemented salt and minerals, and about one-half (48.6%) of herds offered kelp. Excluding minerals etc., 11.4% of herds supplied only pasture for their lactating cows for at least one month during the year. Twenty-three (32.9%) herds mixed feed for their lactating cows, and all but three of these herds supplied mixed feed for the entire year. Seventy percent of farmers reported that they received nutrition assistance from a feed company representative or nutritionist.

Pasture Management

Botanical composition. Farmers' preferred grasses for pasture were orchardgrass, meadow fescue, and Kentucky bluegrass (Table 2.3). Farmers reported that they liked orchardgrass because of its tonnage, was easy to grow, and persistent. Meadow fescue was preferred because of its palatability, ability to mix well with other species, and persistence. Kentucky bluegrass was a preferred species because it was already in the pastures, sod-forming, and persistent. Preferred legumes were white clover, red clover, and alfalfa, with different beneficial characteristics also cited for each. White clover was preferred because it was palatable, led to good milk production, and was naturally growing on the farm. Red clover was desired for its tonnage, easy establishment, and palatability. Alfalfa was desired for its drought tolerance, tonnage, and palatability. The species that some farmers reported they did not prefer to grow were orchardgrass, perennial ryegrass, and tall fescue. Though liked by some for the reasons above, orchardgrass was disliked by others because they reported it was unpalatable. Tall fescue was also disliked because of its lack of palatability. The legumes in which some farmers expressed dislike were alfalfa and birdsfoot trefoil for their lack of persistence and difficulty of establishment, respectively. The grasses that farmers were the most interested in trying were meadow fescue and sorghum sudangrass for their palatability and ability to increase grass availability, respectively. Based on the benefits that farmers had heard from others, the legumes that they wanted to try were kura clover and birdsfoot trefoil (Table 2.3).

Grazing practices. Twenty-eight percent of herds used a leader-follower system for at least part of the grazing season. Dry cows, heifers, and sometimes horses commonly followed the lactating cows. Length of grazing season ranged from 123 to

257 days, with an average length of 189 (±29.0) days (Table 2.2). Thirty-two percent, 22.9%, 27.1%, and 12.9% of farmers moved their lactating cows more than once a day, daily, every 2-4 days, or less than every four days, respectively. Fifty-three percent of farmers increased the amount of hectares available to lactating cows for grazing as the grazing season progressed. Fifteen (21.7%) of farmers grazed their lactating cows on their hayfields at some point in time during the grazing season. Six (8.7%) of farmers grazed their lactating cows on annual crops (Table 2.2).

Cropping

Two cropping rotations were commonly used by the organic farmers: 1) corn, small grain/new seeding of perennial forage, then three more years of that perennial forage and 2) permanent forage (Figure 2.6). In 2010, 65.2% of farmers grew corn, and the average yield for corn silage was 39,608 tons as fed/ha. Small grains that were commonly used as nurse crops were oats, barley, rye, triticale, peas, or peas mixed with one of the small grains. In 2010, 18.8 and 21.7% of farmers harvested oats and barley as grain, respectively. Other crops grown include soybeans and sorghum sudangrass, which were cultivated by 11.6 and 7.2% of farmers, respectively (data not shown). Twenty-seven percent of the farmers sold some of their crops.

Nutrient Management

Four of the 70 farms did not haul manure in 2010 (data not shown). Of the remaining 66 farms, 71.2% of the farms hauled only solid manure and 19.8% of farms hauled both solid and liquid manure. The average longest distance that farmers had to haul manure was 2.94 km. Approximately one-half of farmers hauled manure at least every three days. Seventy-three percent and 33.8% used indoor and outdoor bedded packs, respectively (data not shown).

All but two farmers who raised corn fertilized their upcoming corn crop with dairy manure (data not shown). Additionally, 70.5% of surveyed farms growing corn applied an organic starter fertilizer or soil amendment to their corn crop, which was in the form of pelleted poultry manure for 22.7% of the farms. Fifty-six percent of farmers mechanically applied fertilizer to their pasture. Major reasons for not applying manure to hay ground and pasture were not-wanting to reduce palatability, and in the case of pasture, the cows did the manure application themselves.

DISCUSSION

The location of the organic dairy farms throughout the state was expected. A 2009 survey by DATCP also found Wisconsin organic farms to be concentrated in in the southwest, west central, and north central parts of the state (Figure 2.7; Blazek et al., 2010). Caution has to be used when considering this graph because it incorporates all types of organic farming in the state of Wisconsin. The average land base for Wisconsin organic dairy farms (118 ha) was larger than the average land base for all farms in the state, which was 79 ha (USDA-NASS, 2011). However, the NASS-reported value incorporates small hobby farms in Wisconsin.

The average Wisconsin organic dairy herd size of 69 cows in this study fell within the range found in previous organic studies conducted in Midwestern and Northeastern states, which varied from 51 to 91 cows per herd (Zwald et al. 2004; Sato et al, 2005; Pol and Ruegg, 2007). Greater use of breeds other than Holstein on organic dairy farms was also recorded by Sato et al. (2005) and Stiglbauer et al. (2013). A wider range of rolling herd averages were observed in this study (2,357 – 10,785 kg/cow per year) compared to the range of 5,443 to 9,911 kg/cow per year in Zwald et al. (2004). The average RHA in this study (6,368 kg/cow per year) was larger than the average for Midwestern states in McBride and Green (2009) of 5,991 kg/cow per year. However, McBride and Green (2009) used 2005 data, so improvements in animal genetics and organic farming practices could be contributing to the larger RHA in this study. The percent of farms using AI (73.9%) in this study was in agreement with McBride and Green (2009), in which 77% of Midwestern organic dairy farms reported using AI. However, they reported a slightly larger percentage of farms using DHI (60%) compared to 50% in this study.

The cropping strategies used by Hoshide et al. (2011) in their modeling of Maine organic dairy farm cropping systems were similar to those observed in this study. Production systems entered into their model were continuous perennial sod stands containing alfalfa, and two systems involving corn and or small gains in addition to alfalfa.

CONCLUSIONS

As indicated by the ranges and standard deviations presented in this study, Wisconsin organic dairy farms varied widely in herd performance characteristics, feeding strategies, and general structure. Awareness of these extreme variations should help in design of Extension programs and agricultural publications better suited to meet the educational needs of this dairy sector.

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Table 2.1. Land operated and owned by the surveyed Wisconsin organic dairy farms

	Minimum	Maximum	Median	Mean	SD
Total land operated (ha)	17.8	786	85.5	118	124
Owned, %	0.0	100	69.9	67.0	29.9
Cropland operated (ha)	0.0	640	49.2	77.6	110
Owned, %	0.0	100	70.7	61.1	37.4
Pasture operated (ha)	6.1	146	27.3	40.8	31.4
Owned, %	0.0	100	100	77.5	32.9
Woodland[1] (ha)	0.0	81.0	4.9	13.3	18.6

[1]Only owned woodland was considered in the survey. One farm did not have woodland data.

Table 2.2. General and feeding characteristics of the surveyed organic dairy farms[1]

Trait	%	Minimum	Maximum	Median	Average	SD
GENERAL						
Number of years certified organic	-	0.67	20	5.5	6.76	4.68
Number of years utilizing grazing	-	0.0	55	11.0	14.4	11.2
Number of decision makers	-	1.0	5.0	2.0	2.37	0.95
Age of the respondent (years)	-	23	80	51.5	50.3	12.7
Raised on farm (% of respondents)	88.6	-	-	-	-	-
Relied entirely on family labor (% of farms)	43.9	-	-	-	-	-
DAIRY HERD						
Number of cows	-	12	650	45	69.2	85.8
Number of heifers	-	9	600	40	58.2	78.3
Milk production (kg/cow per year)	-	2,356	10,785	6,606	6,368	1,860
Fat content (%)	-	3.20	5.14	3.79	3.87	0.41
Protein content (%)	-	2.56	3.63	2.95	2.99	0.24
SCC (x1,000 cells/ml)	-	81.3	707	234	242	99.0
Length of dry period (d)	-	35	140	60	62.9	15.8
Calving interval (d)	-	300	608	386	390	37.1
Age of first calving (months)	-	23	36	26	26.2	2.70
Seasonal calving (% of farms)	25.7	-	-	-	-	-
Purchased dairy replacements (% of farms)	10.6	-	-	-	-	-
Used natural service for cows (% of farms)	33.3	-	-	-	-	-
Used AI for cows (% of farms)	73.9	-	-	-	-	-
Used DHIA (% of farms)	50.9	-	-	-	-	-
SUPPLEMENTAL FEEDING						
Fed mixed feed (% of farms)	32.9	-	-	-	-	-
Fed concentrates (% of farms)	87.1	-	-	-	-	-
Fed soybeans (% of farms)	17.1	-	-	-	-	-
Fed corn silage (% of farms)	50.0	-	-	-	-	-
Fed kelp (% of farms)	48.6	-	-	-	-	-

GRAZING PRACTICES						
Used leader-follower system (% of farms)	27.5	-	-	-	-	-
Grazed annual crops (% of farms)	8.7	-	-	-	-	-
Occupancy period (d)	-	0.21	30	1.00	2.25	2.27
Length of grazing season (d)	-	123	257	188	189	29.0

[1]Not all farms had information available for every variable

Table 2.3. Farmers' preferences on pasture plant species

	Reason 1	Reason 2	Reason 3
Preferred grasses and legumes			
Orchardgrass	tonnage	grows well	persistent
Meadow fescue	palatability	mixes well with others	persistent
Kentucky bluegrass	native	sod-forming	persistent
White clover	palatability	milk production	native
Red clover	tonnage	easy to establish	palatable
Alfalfa	drought tolerance	tonnage	palatable
Disliked grasses and legumes			
Orchardgrass	unpalatable		
Perennial ryegrass	uncompetitive		
Tall fescue	unpalatable		
Alfalfa	lack of persistence		
Birdsfoot trefoil	difficult to establish		
Grasses and legumes to try			
Meadow fescue	palatability		
Sorghum sudangrass	increase grass availability		
Kura clover	heard good things		
Birdsfoot trefoil	heard good things		

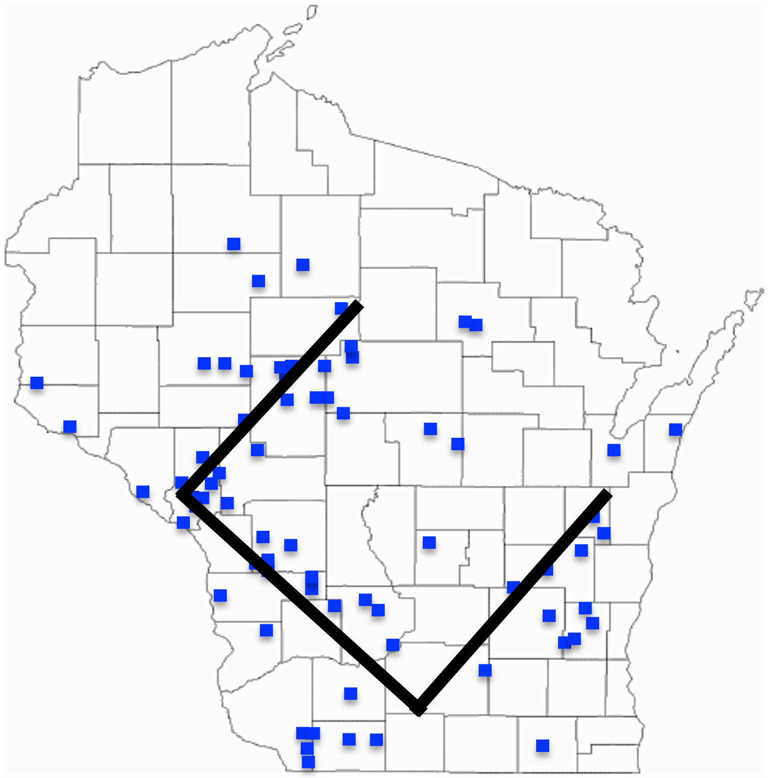

Figure 2.1. The locations of the surveyed Wisconsin organic farms.

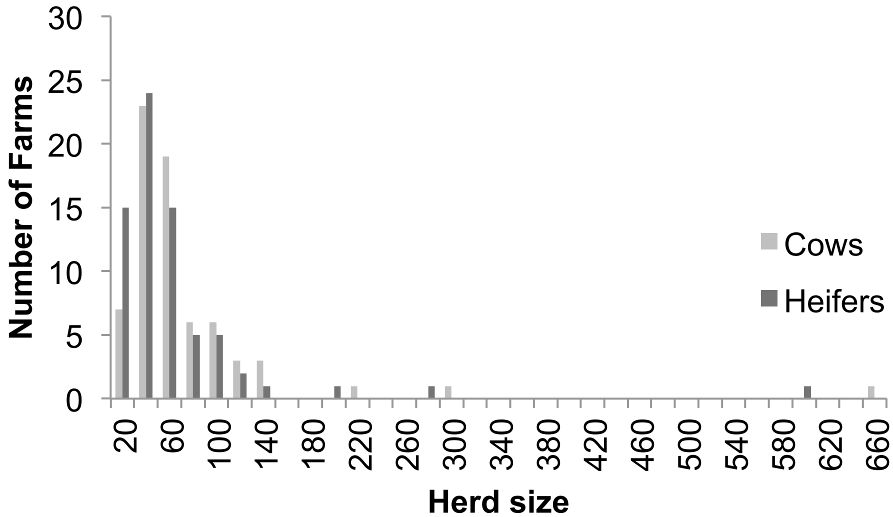

Figure 2.2. Distibution of cow and heifer (all female young stock) herd sizes for the surveyed farms.

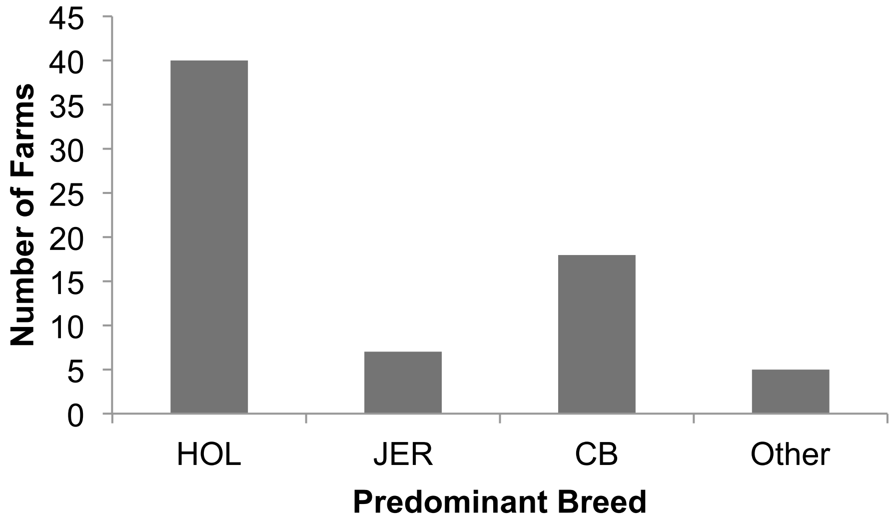

Figure 2.3. Predominant breed (≥ 50% of cows) on the surveyed herds. HOL = Holstein, JER = Jersey, CB = crossbred, and Other = herds having a different predominant breed or no predominant breed.

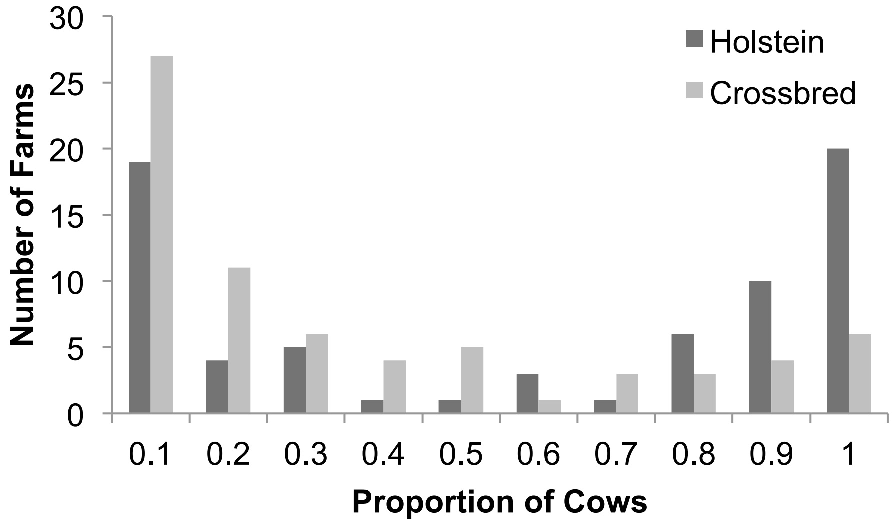

Figure 2.4. Distribution of the farms based on the proportion of Holstein and crossbred cows within each herd.

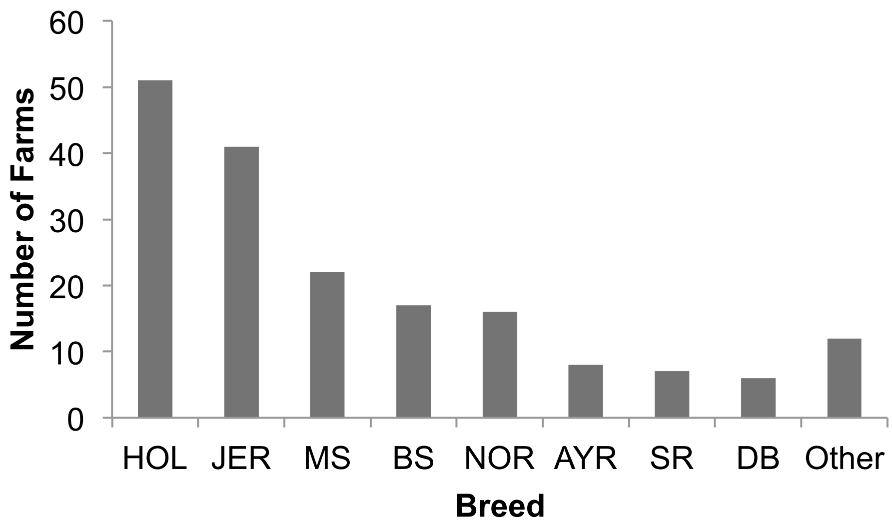

Figure 2.5. Breeds represented in the crossbred cows on the surveyed farms. HOL = Holstein, JER = Jersey, MS = Milking Shorthorn, BS = Brown Swiss, NOR = Normande, AYR = Ayrshire, SR = Swedish Red, DB = Dutch Belted.

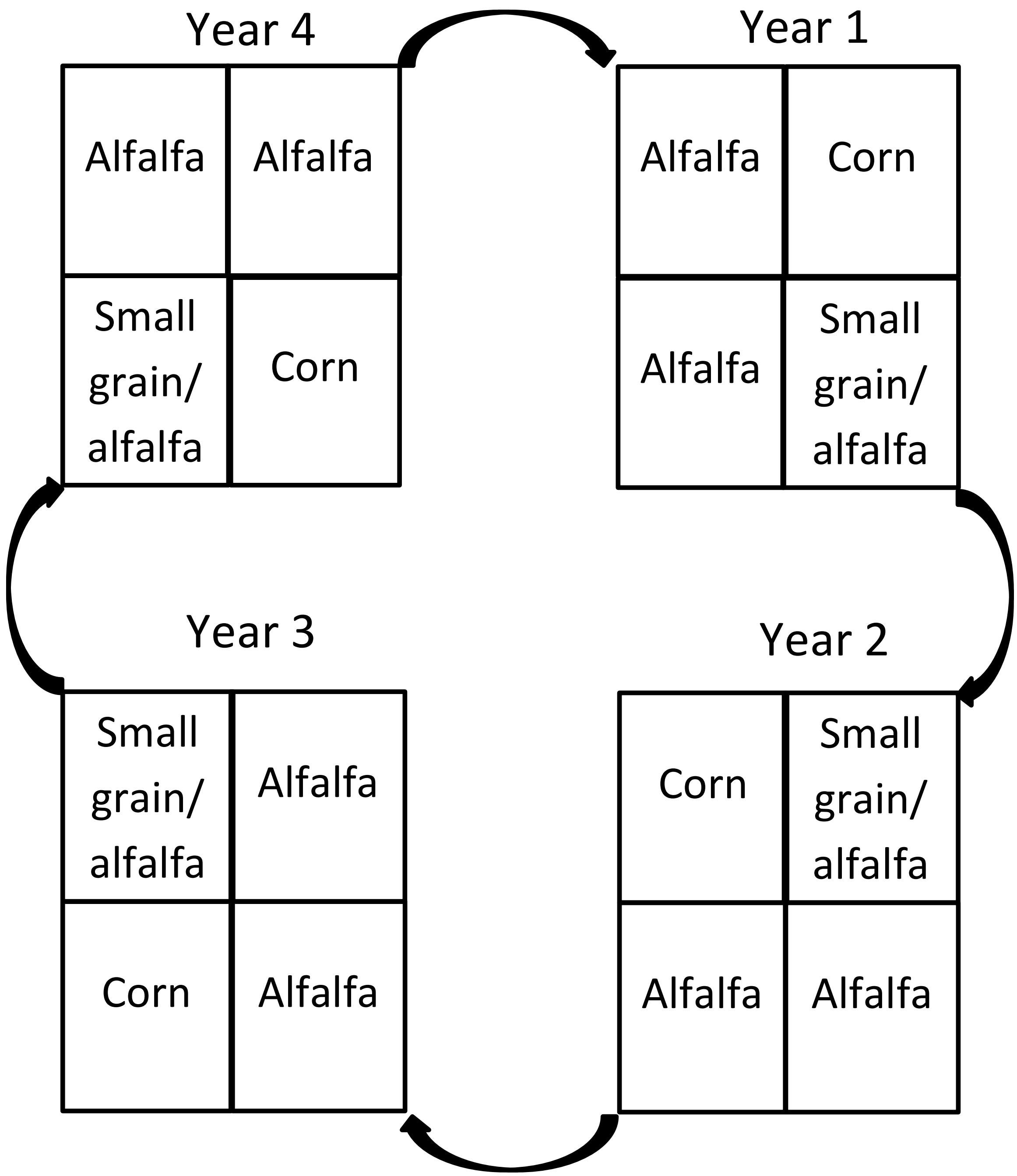

Figure 2.6. Depiction of a four-year crop rotation commonly used on the surveyed farms. By beginning with year 1 and following the upper right-hand corner of each subsequent box, one can see that the crop rotation is Year 1 = corn, Year 2 = small grain/new seeding perennial forage (alfalfa), Year 3 = mature stand of perennial forage (alfalfa), and Year 4 = mature stand of perennial forage (alfalfa).

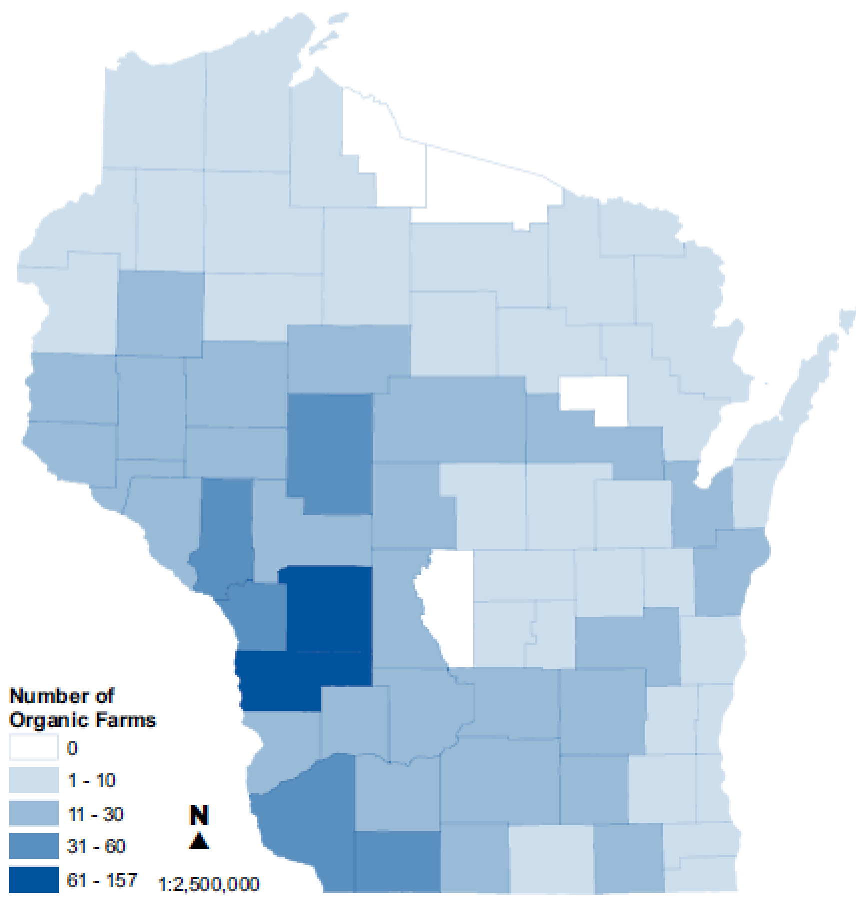

Figure 2. Distribution of certified organic farms in Wisconsin.
Farm locations geocoded from addresses provided by a 2009 Wisconsin DATCP survey of seven organic certifiers. Map by Larry Cutforth.

Figure 2.7. Location of all organic farms in the state of Wisconsin based on a 2009 survey conducted by the Wisconsin Department of Agriculture, Trade, and Consumer Protection.

CHAPTER 3

Feeding Strategies on Wisconsin Organic Dairy Farms and Their Impact on Milk Production and Income Over Feed Costs

ABSTRACT

The purposes of this study were (1) to group and compare certified organic Wisconsin dairy farms based on general farm characteristics and their feeding strategies during the course of 2010 and (2) to evaluate herd milk production and income over feed costs (IOFC). An on-site survey containing sections on farm demographics, feeding, grazing, and economics was conducted on 69 organic dairy farms. A non-hierarchical clustering method using nine variables related to general farm characteristics, feed supplementation, and grazing was applied to partition the farms into clusters. A scree plot was used to determine the most appropriate number of clusters. Milk production was evaluated using reported milk rolling herd averages (RHA). Income over feeds costs was calculated as milk income minus feed expenses. The farms in clusters 1 (n=8) and 3 (n=32), the large and small high-input farms, respectively, supplemented more feed ingredients into their lactating cows' diets and relied more heavily on concentrates. Cows on these farms were predominantly Holstein. Clusters 1 and 3 had the highest RHA (6,878 and 7,457 kg/cow per yr, respectively) and IOFC ($10.17 and $8.59/lactating cow per d, respectively). The farms in cluster 2 (n=5) were completely seasonal, extremely low-input farms, that relied much more heavily on pasture as a source of feed for their cows, with 4 out of the 5 farms having all of their operated land in pasture. Farms in cluster 2 relied on significantly fewer feeds during both the grazing and non-grazing seasons. These farms had the lowest RHA and IOFC at 3,632 kg/cow per yr and $5.76/lactating cow per d, respectively. Cluster 4 (n=24), the semi-seasonal, moderate-input cluster, was third for RHA and IOFC at 5,417 kg/cow per yr and $5.83/lactating cow per d, respectively. Breeds other than Holstein were used more prevalently on farms in clusters 2 and 4, which may have influenced the RHA and IOFC. Results indicate that Wisconsin organic dairy farms differed tremendously in structure and feeding strategies, and farms that supplemented more feed had higher RHA and IOFC. These results can benefit current organic and transition farmers when considering farm management changes needed to meet the current organic pasture rule requirements or dealing with feed supplementation challenges.

Key words: organic, supplementation, income over feed cost, cluster analysis

INTRODUCTION

Feeding management on organic dairy farms has become an increasingly critical and complex task. In the US during 2010, feed costs accounted for approximately one-half of total costs for producing milk (USDA-NASS, 2012). Furthermore, on June 17, 2010, the United States Department of Agriculture National Organic Program finalized a pasture rule for organic ruminants (USDA-AMS, 2010). Organic dairy cattle at least 6 months of age must receive 30% or more of their DMI from pasture during the yearly grazing season, which must be at least 120 days long. Compliance with the pasture rule can create challenges for organic famers when balancing dairy rations. Harsh winters, limited land bases, drought, and many other factors prevent complete reliance on pasture for Wisconsin dairy cattle, requiring farmers to find additional feed sources for all or part of the year. Rising grain prices, limited and expensive harvested forages due to recent droughts (USDA-ERS, 2013), and the requirement that organic dairy herds must feed 100% organic feed to their livestock have put extreme constraints on these dairy farms' supplemental feeding programs (USDA-AMS, 2013).

Wisconsin's prominent role in the nation's organic dairy industry makes it a prime and necessary place to study this growing dairy sector. Wisconsin ranks first in the United States for the total number of organic dairy farms, having 22% of the nation's certified organic dairy farms (USDA-NASS, 2012). Milk sales from dairy cattle make up the majority of Wisconsin's organic sales, representing 62% or $82.3 million of total organic sales in Wisconsin (USDA-NASS, 2012). Because Wisconsin's organic farms are similar in size and structure to those located in the northeastern part of the US, some conclusions drawn about Wisconsin's organic dairy farms could also apply to similar farms in the Northeast (McBride and Green, 2009).

Though research on organic dairy farming in the US is increasing, especially with comparisons to conventional farming (Zwald et al., 2004; Sato et al., 2005; Pol and Ruegg, 2007; Stiglbauer, 2013), few sources delve into organic dairy farming alone. Furthermore, limited studies have reported on feeding management and its role in organic farm system profitability (McBride and Green 2009; Hoshide et al., 2011; Marston et al., 2011). The purposes of this study were (1) to group and compare certified organic Wisconsin dairy farms based on general farm characteristics and their feeding strategies during the 2010 production year and (2) to evaluate herd milk production and income over feed costs (**IOFC**) as a measure of profitability.

MATERIALS AND METHODS

Sampling

To establish the sampling frame, two separate directories, the 2009 Wisconsin Active Dairy Producers list and the Wisconsin Certified Organic Producers list, were obtained from Wisconsin's Department of Trade and Consumer Protection. The first directory included all Wisconsin farms that sold milk in 2009. The second directory was a list of all Wisconsin farms that were certified organic in 2010, which included dairy, meat, and vegetable farms. The two lists were compared to create a list of Wisconsin organic dairy producers, as names that appeared in both directories were believed to be organic dairy cattle producers in Wisconsin (N = 554) . All farmers on the resulting list were invited to participate in the study through a direct mailing that included an introductory letter, project summary, description of the project team members, and a pre-stamped postcard to be returned indicating their level of interest in participating in the project. Farmers were also informed of a $100 honorarium to be received upon completion of the survey. Producers who expressed a willingness to participate were contacted by phone or mail to schedule an on-farm, face-to-face survey. A total of 70 farms were surveyed between January 2011 and January 2012 regarding the 2010 production year.

Survey Protocol

The survey was 45 pages long and contained 98 questions and 46 tables to be completed within 9 general sections. Selected data from 7 sections were used in this study. The first portion of the survey focused on farm demographics—land operated and characteristics of the dairy herd. Additionally, the amount of milk sold, milk price, and component figures were obtained from milk check stubs for each month of 2010. The middle sections of the survey focused on feed supplementation and grazing. Farmers were asked to divide their herds into specific cow feeding groups and assess feed ingredient types and amounts consumed for all groups on a month-by-month basis for 2010. The information gathered in this section was used to measure changes in the farms' strategies of feeding supplementation when the cows were provided access to pasture. The pasture management section of the survey addressed botanical composition of the pastures and grazing management practices. The final portion of the survey assessed cropping strategies, home-grown feed costs and other economic variables. The survey and study protocol were evaluated and qualified as exempt from review by the University of Wisconsin-Madison Education Research and Social and Behavioral Science Institutional Review Board office. The survey instrument was tested on 3 pilot farms before its use for research data collection.

Variable Calculations

Lactating cow DM consumed (kg/cow per day) year-round was approximated based on farmer-reported total amounts of feed consumed during the non-grazing season months. The difference between the approximated total daily DM consumed and the amount of non-pasture feed consumed during the grazing season was assumed to be DM consumed from pasture [pasture DM consumed = total approximated DM consumed – DM consumed from non-pasture feed during the grazing season], as outlined in Gehman et al. (2006) and Rego et al. (2008).

Income over feed cost was used as a measure of each farm's profitability. In this study, income referred specifically to revenue generated from milk sales. Feed costs included expenses related to purchased feeds, homegrown feeds, and a calculated grazing cost for lactating cows only. Specific expenditures factored into the homegrown feed crops and grazing costs included seed, fertilizer, weed and pest control, and irrigation costs. When applicable, custom harvesting and labor, storage, and transportation costs were also included in feed costs. Thus, IOFC was calculated for each month as follows:

IOFC ($/lactating cow per day) = (income from milk sales by month – (non-pasture feed + grazing expenses by month)) / (average number of lactating cows per day by month)]. Milk production was measured by milk rolling herd averages (**RHA**) obtained from DHI records (when available) or reported by the farmers. RHA was used to measure milk production because RHA automatically included milk sold and milk not sold. Substantial amounts of milk may be used for calves on farm rather than sold since there are no certified organic milk replacers. Furthermore, RHA was available for all farms.

Clustering

Nine continuous numerical variables were used to cluster (group) the farms, with three variables from each of the following categories: general farm characteristics, non-pasture feeding practices, and grazing practices (Table 1). Variable selection was based on clustering goals and recommendations outlined in Mooi and Sarstedt (2011) and Weigel and Rekaya (1999). The three general farm variables used were: cows per herd = mean number of cows (lactating and dry combined) each farm had in 2010, percent Holstein = percent of cows within each farm that were Holstein, and milking frequency = weighted mean number of milkings per day (as a proxy to capture seasonal production). The three non-pasture feeding variables used were: cow feeding groups = total number of lactating and dry cow feeding groups on the farm, non-pasture feeds = total number of purchased and non-pasture homegrown feeds incorporated into the lactating cows' diet, and concentrates fed = mean amount of concentrates fed to lactating cows in kilograms DM per cow per day. The three grazing variables used to gauge farmers' incorporation of pasture into their lactating cow feeding program were: land used as pasture = percentage of each farm's operated land primarily used as pasture, occupancy period =

the number of days lactating cows remained in a paddock before being rotated to new pasture, and grazing season length = the 2010 length of grazing season for each farm.

A preliminary analysis identified one farm that had an incomplete dataset and outlying values in three of the nine clustering variables. Data from this farm were excluded from further analysis. Data were standardized by subtracting the means and dividing by the standard deviations. A non-hierarchical (k-means) partitioning method was used to cluster the farms as this method is less affected by outliers (Mooi and Sarstedt, 2011). Based on a preliminary scree plot (R Foundation for Statistical Computing, 2011), the 69 farms analyzed were partitioned into 4 clusters. Various properties of the clusters were then compared using Kruskal-Wallis tests, because the data was not all normally distributed. If the Kruskal-Wallis test for a particular variable indicated significant effect of cluster, pair-wise Wilcoxon rank-sum tests with Bonferroni corrections were used to determine which clusters differed. All statistical analyses were performed using R version 2.14.0 (R Foundation for Statistical Computing, 2011). Statistical significance was set at $P < 0.05$.

RESULTS

Cluster 1

Cluster 1 consisted of 8 farms with a median herd size of 129 cows per farm (Table 1). All 8 farms milked twice daily, year-round, although one farm had the majority of calving occur in March, April, and May. The median percentage of Holstein cows on cluster 1 farms was 90%; the remaining cows were crossbreds (Table 1). In addition to Holstein, breeds represented in the crossbreds included Jersey, Milking

Shorthorn, Brown Swiss, Swedish Red, Normande, Dutch Belted, Linebacks, and Fleckvieh (data not shown).

All 8 farms in cluster 1 penned dry cows separate from lactating cows, and 2 of the farms had multiple feeding groups for lactating cows (Table 1). For the majority of the farms in cluster 1, pasture was estimated as roughly one-third of the lactating cows' diets during the peak grazing season and approximately one-fourth (22.0%) of the farms' operated land was allotted to pasture (Table 1). The majority of the remaining acres were under a crop rotation consisting of 1 to 2 years of an annual crop such as corn or soybeans followed by a new seeding of a perennial forage, usually alfalfa, planted with a small grain nurse crop such as oats or barley. The average perennial forage stand life was approximately 3 years (data not shown).

The average pasture turn-in date for the farms in cluster 1 was April 19 (Table 2). During the grazing season, the lactating cows had access to pasture for an average of 16.9 hr/d. On 6 of the farms, lactating cows had access to pasture all day except for milking time. On the other 2 farms, lactating cows had access to pasture for only one-half of the day. The median number of days lactating cows were in a paddock before being rotated to new pasture was 1.25 d (Table 1). One-half of the farms utilized a leader-follower system to manage pasture, in which heifers or dry cows followed the lactating cows (Table 2). Five of the 8 farms increased the amount of pasture available to their lactating cows to accommodate for slow pasture growth in the latter part of the grazing season. The remaining 3 farms rotated their cows systematically with no regard for pasture regrowth. Pasture not grazed during the spring was harvested as hay. The average last date grazed on farms in cluster 1 was November 7 (Table 2), leading to a median grazing season length of 203 d (Table 1).

Six of the 8 farms in cluster 1 offered a TMR or partial mixed ration throughout the entire year (Table 2). The remaining 2 farms did not offer mixed feed at all. The amount of concentrates consumed remained fairly consistent during the year (Figure 1), with a median value of 5.7 kg DM/lactating cow per d (Table 1). For all 8 farms, the concentrates included corn as dried ground or shelled corn, high moisture shelled corn, or snaplage (corn cob plus leaf) (data not shown). Additionally, 3 farmers fed small grains. All of the farmers grew most or all of their own corn and small grains except for 1 farmer, who purchased all of both. For 5 of the 8 farms, the concentrates included soybeans (Table 2); however, 2 of the 5 farmers only fed soybeans during the non-grazing season. Three of the farmers grew their own soybeans, 1 farm purchased 42% of its soybeans, and the fifth farm purchased all of its soybeans (data not shown). All 8 farms supplemented mineral, 6 of the farms supplemented salt, 4 of the farms supplemented kelp, 3 of the farms supplemented vitamins, and 3 of the farms supplemented sodium bicarbonate (Table 2). Six and 7 of the farms supplemented hay and corn silage, respectively. Levels of supplemented hay and corn silage remained fairly consistent throughout the entire year at approximately 1.96 and 2.71 kg DM/cow per day, respectively (Figure 1). The diet ingredient that changed the most with the onset of the grazing season was haylage. During the peak grazing season, the average amount of haylage supplemented dropped to 3.19 kg DM/cow per d, less than one-third the amount fed during the winter.

Cluster 1 had the highest IOFC for all months except March and July (Figure 2d). The months with the highest IOFC were January and December. Though cluster 1 had the highest average IOFC compared with the other clusters, it was second for RHA at 6,878 kg/cow per year (Table 1). Cows in cluster 1 produced milk with an average yearly percent fat and protein of 3.90% and 3.05%, respectively (Figure 3). The components remained fairly consistent throughout the entire year except for a slight decrease mid-summer. The average SCC was 248,000 cells/ml.

Cluster 2

At the other end of the spectrum in relation to cluster 1 was cluster 2, which consisted of five seasonal, low-input farms. All five farms in cluster 2 were completely seasonal—defined in this study as having at least 1 month (February) in which the farms did not have any lactating cows. The calving window for all five farms was in the spring and occurred between the months of March and June. Three of the five farms milked their cows twice daily for all months in which they had lactating cows. The fourth farm milked its herd twice daily for the first part of the lactation and once daily for the last 2 months of the lactation. The remaining farm utilized once daily milking for the entire lactation.

The median herd size for the farms in cluster 2 was less than one-half the median herd size for farms in cluster 1(50 vs. 129 cows, respectively; Table 1). Only 1 of the 5 farms had purebred Holstein cows, and that was only 12% of the adult herd; the remaining cows were crossbreds. The breeds used by the other farms as purebreds, in crossbreds, or as both were Jersey, Milking Shorthorn, Normande, Brown Swiss, Ayrshire, and New Zealand Fresian (data not shown). Holstein genetics were also present in some of the crossbreds.

Having all of the cows in the same stage of lactation at the same time allowed for all cows to be managed as one group (Table 1). Unlike the herds in cluster 1, during the grazing season, pasture was the primary feedstuff for the herds in cluster 2 (Figure 1). Four of the five farms managed all of their operated land as permanent pasture (Table 1). The acres that were not in pasture on the fifth farm were seeded with a legume-grass mixture for hay. The average grazing start date for the farms in cluster 2 was April 26 (Table 2). During the grazing season, the cows on cluster 2 farms had access to pasture for an average of 21.6 hr/d—all day except for milking time. Three of the farms rotated cows to new pasture twice daily and 2 of the farms rotated cows to new pasture once daily. Two of the farms implemented a leader-follower system for at least part of the grazing season, in which heifers immediately grazed the paddock that the cows were on previously (Table 2). As the grazing season progressed and plant regrowth slowed, the farmers lengthened their pasture rest periods from 21.9 d in the spring to 32.8 d in late summer by increasing the hectares of pasture available to their cows for grazing (data not shown). Pasture not grazed during the spring was harvested as hay. The average last date grazed for farms in cluster 2 was November 28 (Table 2), for an average grazing season length of 216 d (Table 1).

Four of the five farms offered concentrates to lactating cows during the grazing season at rates that mimicked a lactation curve (Figure 1). The average amount of concentrates fed peaked in March 3.74 kg DM/cow per d, but decreased to 1.31 kg DM/cow per d in December. The yearly median amount of concentrates fed to lactating cows for farms in cluster 2 was 2.7 kg/cow per d, less than half the amount of concentrates fed on the farms in cluster 1 (Table 1). Salt, trace minerals, kelp, or a combination of these were supplemented year-round as free choice or as part of grain mixes on 4 of the 5 farms (Table 2). None of the cluster 2 farms supplemented forages during the peak grazing season (Figure 1). The only forage supplemented once pasture became sparse and winter arrived was legume-grass hay (Figure 1). Four of the five farms grew all of their hay; the remaining farm purchased supplemented hay. All five farms in cluster 2 housed their cows on indoor or outdoor bedded packs. Three of the farms did not haul manure in 2010 (data not shown).

The median RHA was 3,509 kg/cow per yr (Table 1). The average yearly percent fat, percent protein, and SCC were 4.11%, 3.32%, and 386,000 cells/ml, respectively. The percent fat was the lowest in July (3.78%) and highest in January (6.48%) (Figure 3). The percent protein was the lowest in April (2.89%) and highest in January (4.37%). Milk sold peaked in the summer months, with an average of 13.6 kg/cow per d for May, June, and July (Figure 2d). The IOFC also followed the lactation curve, with the highest monthly average IOFC occurring in June ($6.06/cow per d).

Cluster 3

The farms in cluster 3 (n=32) were similar in feeding management strategies to those in cluster 1 but herd sizes were much smaller with a median herd size of 41 cows per farm (Table 1). In the majority (93.6%) of the farms, cows calved year-round; however one farm was completely seasonal, in which all of the cows were dry for the month of November, and a second farm was bi-seasonal with distinct spring and fall calving seasons. When lactating cows were present, all farms milked twice daily (Table

1). The percent of Holstein cows on cluster 3 farms was very similar to that of cluster 1, with a median of 89%. Other purebred cows on the farms were of Jersey and Lineback breeds. The remaining cows were crossbreds containing a mixture of Holstein, Jersey, Milking Shorthorn, Brown Swiss, Angus, Guernsey, Swedish Red, Normande, Dutch Belted, Montbeliarde, Lineback, Danish Red, Fresian, or Norwegian Red genetics (data not shown).

There was some variation in grouping of cows in cluster 3. One-fourth of the farms penned all cows together, 23 farms separated lactating and dry cows, and one farm not only separated lactating and dry cows but further split the lactating cows into 2 groups. The farms in cluster 3 managed approximately one-third of their land as pasture (Table 1), with a majority of the remaining acres managed in a crop rotation consisting of 1 to 2 years of corn followed by a new seeding of perennial forage, usually alfalfa, planted with a small grain nurse crop such as oats or barley. The average perennial forage stand life was approximately 3 years (data not shown).

The average pasture turn-in date for farms in cluster 3 was May 1 (Table 2). During the grazing season, the lactating cows had access to pasture for an average of 19.2 hr/d. On 90.6% of the farms, lactating cows had access to pasture all day except for milking time. On the remaining farms, lactating cows had access to pasture for only one-half of the day. For farms that rotated lactating cows among pastures, the median occupancy period in a pasture was 2 d (Table 1). Three farms (9.4%) did not rotate their cows among pastures. On six farms (18.8%), dry cows or heifers were pastured on the same paddocks after the lactating cows. As the grazing season progressed, approximately one-third of the farms increased the hectares of pasture available to their lactating cows to handle the late-season slow pasture growth. The remaining two-thirds of the farms rotated cows with no adjustment due to grass availability. Pasture not grazed during the spring was harvested as hay. The last date grazed for farms in cluster 3 was October 21 (Table 2), for an average grazing season length of 173 d (Table 1).

Forty-one percent of the farms offered mixed feed for at least part of the year (Table 2). The amount of concentrates and corn silage consumed remained fairly consistent throughout the entire year, averaging 3.12 and 1.95 kg DM/cow per d (Figure 1). All but 1 farm fed concentrates, which included soybeans for one-fourth of the farms (Table 2). Approximately one-half of the farms purchased concentrates. All but one farm grew all of their own corn silage. All but one farm fed salt, mineral, or both (Table 2). Forty-seven percent of the farms fed kelp. The diet ingredients that changed the most with the onset of the grazing season were hay and haylage in cluster 3, while usually only haylage was replaced with pasture on the farms in cluster 1 (Figure 1). During the peak grazing season, the average amount of hay and haylage supplemented by cluster 3 farms dropped to 3.4% and 15.0% of the diet DM, more than a 50% decrease from the non-grazing season for both ingredients.

Cluster 3 farms had the highest RHA at 7,457 kg/cow per year (Table 1), and they had second highest IOFC for all months except March and July when they ranked highest (Figure 2) despite having the highest feed expenses (Figure 2c; Table 3.3; Table 3.4; Table 3.5). Farms in cluster 3 had lowest milk fat and protein contents, with an average yearly percent fat of 3.71% and percent protein of 2.89%, respectively. Milk components remained fairly consistent throughout the entire year except for a slight drop during summer (Figure 3). The average SCC was 251,000 cells/ml.

Cluster 4

Farms in cluster 4 (n=24) were similar in size to farms in clusters 2 and 3, having a median herd size of 43 cows per herd. The farms in cluster 4 utilized a much more pasture-based feeding strategy than clusters 1 and 3 but were not as seasonal or low-input as cluster 2. Though 10 of the 24 herds exhibited some seasonality, only 1 herd was completely seasonal, having no lactating cows during the month of February. Two of the farms reduced the number of milkings from twice daily to once daily at some point during the year. During the remainder of the year when lactating cows were present, twice daily milking was used. Similar to cluster 2 farms, breeds other than Holstein were predominant on most cluster 4 farms, with a median percent Holstein of 6.0% for the cluster. One-half of the farms milked other purebreds, and all but 2 farms had at least one crossbred cow. The breeds represented in the crossbreds were similar to those in Cluster 3.

Ten of the cluster 4 farms penned all of their cows together. The remaining 14 farms separated lactating and dry cows. Approximately one-half of the farms' land was managed as pasture, while crop production strategies varied considerably. Approximately one-fourth of the farms utilized the cropping rotation described in cluster 3 (corn, small grain, perennial forage), one-fourth of the farms maintained their cropland in permanent pasture, and the remaining one-half of the farms had no structured crop rotation.

The average pasture turn-in date for the farms in cluster 4 was April 22 (Table 2). Cows had access to pasture for an average of 21.0 hr/d—all day except for milking time. As in cluster 2, the occupancy period in a pasture was 0.5 d (Table 1). Approximately one-third of the farms utilized a leader-follower system to manage pasture in which dry cows and heifers or horses followed the lactating cows (Table 2). Fourteen of the 24 farms increased the hectares of pasture available to their cows as the grazing season progressed, while 10 of the farms utilized the same rotation schedule for their cows independent of grass availability. Pasture not grazed during the spring was harvested as hay. The average last date on pasture for lactating cows on the farms in cluster 4 was November 8 (Table 2), for a median grazing season length of 199 d (Table 1).

Three of the farms offered mixed feed for at least part of the year (Table 2). The amount of supplemented concentrates remained fairly consistent at 1.9 kg/lactating cow per d (Table 1). Seven of the farms did not feed concentrates to their lactating cows except for what was included in the corn silage. Of the 17 farms that offered concentrates, five fed only corn and 13 fed a mixture of grains or only a small grain (data not shown). Two-thirds of the farms that fed concentrates purchased some or all of their concentrates. Only one farm supplemented soybeans (Table 2). Nine of the farms fed corn silage during the non-grazing season, but only one farm used corn silage during the grazing season. Twenty and 19 farms offered hay and haylage, respectively (Table 2). For most farms, stored forage was replaced almost entirely with pasture during the grazing season (Figure 1).

Cluster 4 ranked third for both IOFC and RHA at $5.92/lactating cow per d and 5,388 kg/cow per yr, respectively (Table 1). Milk components dropped slightly during the summer, but the SCC increased (Figure 3). The average SCC was 224,000 cells/ml.

DISCUSSION

Determining Pasture Intake

Determining the proportion of the diet during the grazing season that was from pasture was a challenge in this study. Several animal- and pasture-based techniques (sward-clipping and estimation of fecal production using chromium oxide or alkane markers combined with diet digestibility) have been established for measuring total and pasture DMI for grazing cows (Bargo et al., 2003). However, because pasture and animal material sampling were not a part of the current study, determination of DMI and the proportion of pasture in DMI were limited to using farmer reported data. But, prediction equations are available to estimate data. In their brief review on methods and equations for estimating DMI in grazing cows, Bargo et al. (2003) concluded that NRC (2001) equation 1-2 [$DMI = (0.372 \times FCM + 0.0968 \times BW^{0.75}) \times (1\text{-}e^{[-0.192 \times (WOL + 3.67)]})$] was sufficient for calculating DMI for grazing cows and had the advantage of requiring only animal factors compared to the other equations evaluated (Caird and Holmes, 1986; Vazquez and Smith, 2000). Thus, approximating DMI using NRC (2001) equation 1-2 was explored as a way to test our assumption that DMI in the grazing season was similar to DMI during the non-grazing season months of the year. Figure 4 shows the comparison of the two methods for calculating DMI for each cluster. The following limitations of the survey data regarding the variables required by NRC equation 1-2 ultimately warranted the calculation of year-round daily total DMI to be based on the total daily supplemented DM during the non-grazing season. In order to secure fat corrected milk values for each month of 2010, milk not sold to the dairy plant had to be approximated and added accordingly to milk sold for each month to get total kg of milk produced. Additionally, only one average body weight value was available for each farm, so the same body weight value had to be used in each month's DMI calculation.

Week of lactation values were also not available, so that term (1-e$^{[-0.192 \text{ x } (\text{WOL} + 3.67)]}$) was assumed to be 1. This assumption was considered sufficient for this comparison since a herd average DMI (kg/lactating cow per day) was sought, and this fact implied an average week of lactation greater than 20 weeks, which would be reasonable for continuously calving herds having at least a 12 month calving interval. Moreover, using NRC (2001) equation 1-2 to account for energy for walking to pasture would have required another set of additional assumptions. Lastly, farms that did not have monthly milk data available were not able to have a DMI calculated using NRC (2001) equation 1-2, reducing the number of farms included in the NRC (2001) equation 1-2 estimation of DMI.

Though approximating total DMI based on total DM from supplemented feed during the non-grazing season was useful for determining the proportion of each feed ingredient in the average lactating cow diet for each cluster, it had several limitations in this study. If farmers did not account for wasted supplemented feed, then total DMI was overestimated. On the other hand, by using the daily non-grazing DMI for spring calving herds (cluster 2), grazing season (thus peak lactation) DMI was underestimated since it was determined using non-grazing season (late lactation) DMI values.

The limitations of the two methods for determining total DMI are likely the cause for the observed differences in DMI (~2 kg/cow per d) for the two methods discussed, suspecting that the DMI based on supplementation was an overestimation and DMI based on NRC (2001) equation 1-2 was an underestimation of actual DMI for clusters 1, 3, and 4 (Figure 4). The differences in estimation of DMI for cluster 2 are likely due to several reasons. By assuming the average week of lactation was ≥ 20, DMI based on NRC

(2001) equation 1-2 may be overestimated for the first several months of spring due to the cows being in the early stages of lactation. However, because approximating DMI based on supplementation likely underestimated daily DMI for cluster 2, it is assumed for this cluster, as well as the other 3 clusters for the reasons mentioned above, that the actual DMI of the cows lies somewhere between the resulting values for the two methods. Even so, because the goal of the study was to determine major differences in feeding strategies between organic farms and their relationship to milk production and IOFC rather than specific values for these variables, it was concluded that approximating DMI based on non-grazing season supplemented DM was adequate for and most accurately portrayed cluster feeding strategy differences based on survey data in this study.

Herd Size

The median and spread of herd sizes observed in this study are comparable to other Midwestern studies. In their study comparing production and management practices on Wisconsin conventional and organic dairy farms, Sato et al. (2005) recorded an average organic herd size of 51 cows, similar to the median herd size of 45 cows observed in this study. In a study on organic dairy farming in the US, McBride and Greene (2009) found a similar spread of herd sizes; with 12.2% of the herds they surveyed in the upper Midwest (MI, MN, and WI) and 3.2% of the herds surveyed in the Northeast (ME, NY, PA, and VT) having at least 100 cows per farm. Likewise, cluster 1 (11.6% of the sampled farms) had a median herd size of 129 cows.

The larger median herd size of cluster 1 could be contributing to the higher IOFC for this cluster due to economies of scale. Even though the farms in cluster 1 supplemented the most feed ingredients, they had the least amount of feed expenses

($/cow per d) for most months in 2010. This advantage is particularly noticeable when comparing clusters 1 and 3. Clusters 1 and 3 were similar in feeding management, breed, and milk production, but cluster 1 had a numerical advantage in IOFC. The ability to distribute capital investment in equipment and storage facilities for homegrown feeds across more animals is likely a contributing factor to cluster 1's higher IOFC. Similarly, in their simulations on the effects of stored feed cropping systems and farm size on Maine organic dairy farm profitability, Hoshide et al. found that long run average total costs and thus net farm income per cow increased with farm size in all simulated feed production systems.

Breed

It is not surprising that only 2 clusters' farms were predominantly Holstein, as breeds other than Holstein are frequently used by graziers because of their advantages in higher milk components, heat tolerance, utilization of grass, and fertility (Barrett et al., 2005; Paine and Gildersleeve, 2011; Smith et al, 2013). Crossbreeding in particular is used for its advantage in reproductive efficiency, especially if the farm wants to employ seasonal calving (Auldist et al., 2007). However, despite these advantages, Holstein-based clusters 1 and 3 resulted in higher RHA and IOFC. The larger sums of milk produced by Holstein cows led to more milk sold per cow, contributing to the higher IOFC for these farms.

Grazing

Though not yet required by the surveyed farms because the pasture rule did not have to be met until June 10, 2011, for farms already certified organic, all 4 clusters appeared to meet the pasture rule requirements of 30% DMI from pasture for at least 120 d (Figure 1) (USDA, 2010). However, the increased reliance on pasture had its advantages and disadvantages. Feed expenses during the grazing season months were among the lowest for all 4 clusters (Figure 2), which is in agreement with the idea that many graziers turn to pasture-based dairying for its reduced input costs (Clark and Kanneganti, 1998). Increases in milk sold per cow were observed in all 4 clusters following the onset of the grazing season, which can be attributed to the nutritious and abundant state of pasture during the spring as well as cows reaching peak lactation for seasonally oriented herds in clusters 2 and 4. However, it is well documented that primary reliance of grazed forage for lactating cow diets may result in overall reduced milk production compared to cows relying on stored feed diets, particularly TMR, due to inadequate provision of energy in the diet (Leaver, 1985; Kolver and Muller, 1998; Bargo et al., 2003).

Rotating lactating cows more frequently to allow for more uniform pasture intake and prevent cows from immediately grazing pasture regrowth (Undersander et al., 2002), is a strategy pasture-based farms such as those in clusters 2 and 4 have implemented to improve their production and management. Implementing a leader-follower system was another grazing strategy that some of the farmers utilized. Mayne et al. (1988) observed that implementation of leader-follower grazing resulted in better utilization of available herbage and a 26% increase in milk production of high-producing cows in their leader-follower treatment compared to high-producing cows in their control treatment.

Feed Supplementation

Feed supplementation has also been a strategy used to improve milk production on pasture-based dairies. The higher percentage of supplemented feed used for lactating cows' diets in clusters 1 and 3 during the grazing season could be attributed to their use of the Holstein breed, which have a higher milk production response to concentrate feeding (White et al., 2002). Furthermore in agreement with this study's findings, Bargo et al. (2002) concluded that the pasture plus partial mixed feed treatment, similar to the lactating cow diets of clusters 1 and 3, resulted in higher milk production than the pasture plus concentrate treatments, which were similar to many of the lactating cow diets of clusters 2 and 4. However, compared to no-grain pasture diets, Bargo et al. (2003) concluded that milk production increases linearly with the addition of concentrates up to 10 kg of concentrates.

The larger number of feed ingredients in the diets containing corn silage for clusters 1, 3, and 4 was not surprising. Hoshide et al. (2011) argued that perennial, sod-based diets provided ample amounts of protein to lactating cows if they were harvested at appropriate times. However, diets that incorporated several corn products in the form of grain and silage need to also include protein-rich ingredients to reach an adequate level of dietary crude protein concentration. This was apparent in our study for which 62.5% of the farms in cluster 1 supplemented soybeans and no farms in cluster 2 fed soybeans (Table 2).

Milk Production and IOFC

The summer decreases in percent fat and percent protein and peak in SCC are apparent nationally (USDA, 2013). The high milk component values for January for cluster 2 could be attributed to several factors including breed, stage of lactation, number of milkings per day, and feeding strategies. A reduction in milk yield late in lactation or a decrease in the number of milkings per day leads to production of a more concentrated milk (Stelwagen et al., 2013). Furthermore, milk produced by cows not consuming pasture has a higher fat concentration than milk produced by cows on pasture (Bargo et al., 2003). The larger reported RHA and calculated IOFC for clusters 1 and 3 are likely due to breed and supplementation levels. Using the Integrated Farm System Model, Hoshide et al. (2011) also found the larger, heavily-supplemented organic farms to be more profitable, with net farm incomes at least $2.47/cow per d more than that of small, perennial sod-based farms, even though breed and milk production (6,531 kg/cow per yr) were kept constant across all treatments.

The economic climate of dairy farming in Wisconsin was not favorable during the time frame surveyed. Milk prices received by some farmers were not true representations of organic premiums, and a number of the organic farmers reported that they lost their organic buyers in 2010, and milk was sold to conventional processors. If they were fortunate enough to find another organic buyer, they were placed in a probation period until the fall months. During probation, these farms received a milk price somewhere in between the conventional price and common organic premium prices, which may partially explain higher IOFC in the latter part of the year (Figure 2). Additionally, some organic farmers were placed on a quota system during the latter half of 2009 and the first part of 2010, and those who exceeded their allotted quota received conventional prices for any milk sold above quota. The increase in IOFC towards the end of 2010 could be due to increased price premiums implemented by some co-ops during the winter as an incentive for farmers to increase their milk production during winter shortages and reduce their milk production during spring surpluses.

Differences between farms within cluster were also investigated concerning IOFC. It has been concluded that no one factor in IOFC is the determinant for farm profitability. In most cases, the most profitable farms within each cluster did not sell the most milk per cow, receive the best pay price, or incur the least expenses for feed, but had an ideal blend of all factors. In cluster 1, the two farms with the largest IOFC ranked second and third for the most milk sold (kg/cow per day), ranked first and seventh for milk price ($/kg), had the lowest feed expenses ($/cow per day). Of the farms in which IOFC could be measured for cluster 3, the three farms with the largest IOFC also sold the most milk per cow, received only a moderate milk price ($/kg), but varied widely for feed expenses ($/cow per day) compared to their other cluster members. Of the farms in which IOFC could be measured for cluster 4, 2 of the top 3 farms were in the top 3 for milk sold (kg/cow per day), all 3 of the top 3 farms were in the top half for milk price received ($/kg), but varied widely for feed expenses ($/cow per day) compared to their other cluster members.

CONCLUSIONS

Wisconsin's organic dairy farms differ significantly in size, feeding management, productivity, and profitability as measured with IOFC. The heavily-supplemented farms appeared to be most profitable based on IOFC and had larger reported RHA compared to farms with more of a grass-based diet. However, research evaluating other farm costs needs to be conducted before assessing profitability at the whole-farm level.

ACKNOWLEDGEMENTS

This research was supported by Organic Agriculture Research and Extension Initiative Competitive Grant no. 2010-51300-20534 from the USDA National Institute of Food and Agriculture.

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Table 3.1. Cluster and total sample medians (interquartile ranges) for the clustering and evaluated variables

	Cluster 1 (n=8)		Cluster 2 (n=5)		Cluster 3 (n=32)		Cluster 4 (n=24)		Total (n=69)	
Variables	mdn[1]	(iqr)[1]	mdn	(iqr)	mdn	(iqr)	mdn	(iqr)	mdn	(iqr)
Clustering										
Cows per herd	129^{a}	(56)	50^{b}	(35)	41^{b}	(14)	43^{b}	(51)	45	(41)
Percent Holstein[2]	90^{a}	(14)	0.0^{b}	(0.0)	89^{a}	(25)	6.0^{b}	(22)	71	(89)
Milking frequency[3]	2.0^{a}	(0.0)	1.5^{b}	(0.43)	2.0^{a}	(0.0)	2.0^{a}	(0.0)	2.0	(0.0)
Cow feeding groups[4]	2.0^{a}	(0.25)	1.0^{b}	(0.00)	2.0^{a}	(1.0)	2.0^{b}	(1.0)	2.0	(1.0)
Supplemented feeds[5]	8.0^{a}	(2.3)	2.0^{c}	(2.0)	6.0^{ab}	(2.0)	6.0^{b}	(1.3)	6.0	(2.0)
Concentrates fed[6]	5.7^{a}	(2.8)	2.7^{ab}	(2.7)	4.2^{a}	(1.4)	1.9^{b}	(2.6)	3.6	(2.6)
Land used as pasture (%)	22^{c}	(20)	100^{a}	(0.0)	31^{c}	(14)	49^{b}	(28)	36	(24)
Occupancy period[7] (d)	1.25^{a}	(1.25)	0.50^{b}	(0.50)	2.00^{a}	(3.25)	0.50^{b}	(0.50)	1.00	(2.00)
Grazing season length (d)	203^{a}	(21)	216^{a}	(24)	176^{b}	(36)	199^{b}	(25)	189	(39)
Evaluated										
RHA[8] (kg/cow per yr)	6,878^{a}	(1,038)	3,632^{c}	(783)	7,457^{a}	(1,754)	5,417^{b}	(1,760)	6,583	(2,520)
IOFC[9] ($/cow per d)	10.17^{a}	(2.99)	5.76^{ab}	(1.62)	8.59^{a}	(4.68)	5.92^{b}	(2.47)	7.73	(4.01)

[1]mdn = median, iqr = interquartile range
[2]Percent of cows within each farm that were Holstein
[3]Weighted mean number of milkings per day
[4]Total number of cow feeding groups on the farm
[5]Total number of non-pasture feeds incorporated into the farm's lactating cow diet
[6]Mean amount of concentrates fed to lactating cows (kg/cow per d)
[7]Number of days lactating cows remained in a paddock before being rotated to new pasture
[8]Milk rolling herd average (RHA)
[9]Milk income over feed costs (IOFC) for lactating cows for January through November, 2010. Note: Cluster 2 (n = 4), Cluster 3 (n = 27), Cluster 4 (n = 20)
[abc]Kruskal-Wallis test ($P \leq 0.05$). Medians within a row not sharing a common superscript are statistically different based on Wilcoxon test with Bonferroni correction ($P < 0.05$).

Table 3.2. Grazing and feed supplementation characteristics of the 4 clusters

	Cluster 1	Cluster 2	Cluster 3	Cluster 4
Grazing characteristics				
Grazing season start date	19-Apr	26-Apr	1-May	22-Apr
Grazing season finish date	7-Nov	28-Nov	21-Oct	8-Nov
Access to pasture (hr/d)	16.9	21.6	19.2	21.0
Used leader/follower system (% of farms)	50	40	19.4	29.2
Feed supplementation characteristics				
Used a nutritionist/feed company representative (% of farms)	100	40	81	50
Fed mixed feed (% of farms)	75	0	41	13
Percent of farms that supplemented:				
Concentrates	100	80	97	71
Soybeans	63	0	25	4
Corn silage	88	0	44	38
Haylage	100	0	22	79
Hay	75	100	25	83
Kelp	50	40	47	54

Table 3.3. Feed costs ($/lactating cow per day) by feed type for each cluster and the total sample for each month of 2010

Month[1]	JAN	FEB[2]	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
						CONCENTRATES						
Cluster 1	0.54	0.54	0.50	0.50	0.42	0.42	0.42	0.42	0.42	0.45	0.49	0.52
Cluster 2	0.47	NA	1.58	1.47	1.27	1.15	1.15	1.15	1.15	0.95	0.87	0.95
Cluster 3	0.97	0.97	0.97	0.96	0.81	0.79	0.73	0.74	0.74	0.78	0.86	0.97
Cluster 4	0.54	0.54	0.56	0.57	0.54	0.52	0.52	0.52	0.56	0.58	0.59	0.53
All Farms	0.74	0.75	0.79	0.79	0.69	0.66	0.64	0.64	0.66	0.68	0.71	0.74
						FORAGES						
Cluster 1	0.51	0.51	0.51	0.44	0.22	0.18	0.18	0.18	0.18	0.30	0.39	0.51
Cluster 2	0.34	NA	0.37	0.28	0.02	0.00	0.00	0.00	0.00	0.02	0.06	0.20
Cluster 3	0.71	0.71	0.71	0.68	0.31	0.24	0.25	0.26	0.29	0.47	0.70	0.71
Cluster 4	0.94	0.93	0.98	0.90	0.12	0.02	0.06	0.05	0.11	0.31	0.80	0.91
All Farms	0.75	0.77	0.77	0.70	0.21	0.14	0.16	0.16	0.20	0.37	0.66	0.75
						VITAMINS AND MINERALS						
Cluster 1	0.68	0.68	0.68	0.68	0.66	0.66	0.64	0.65	0.65	0.65	0.68	0.68
Cluster 2	0.15	NA	0.07	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.31
Cluster 3	0.37	0.37	0.37	0.37	0.36	0.36	0.36	0.36	0.36	0.37	0.38	0.38
Cluster 4	0.25	0.25	0.25	0.23	0.21	0.21	0.21	0.21	0.21	0.21	0.24	0.24
All Farms	0.36	0.37	0.35	0.35	0.34	0.34	0.34	0.34	0.34	0.34	0.36	0.36
						GRAZING						
Cluster 1	0.00	0.00	0.00	0.00	0.02	0.02	0.02	0.02	0.02	0.01	0.00	0.00
Cluster 2	0.00	NA	0.00	0.00	0.10	0.14	0.15	0.15	0.15	0.10	0.06	0.00
Cluster 3	0.00	0.00	0.00	0.00	0.29	0.39	0.40	0.41	0.39	0.23	0.01	0.00
Cluster 4	0.00	0.00	0.00	0.04	0.25	0.23	0.23	0.24	0.24	0.23	0.09	0.02
All Farms	0.00	0.00	0.00	0.01	0.23	0.27	0.27	0.28	0.27	0.20	0.04	0.01

[1]JAN = January, FEB = February, MAR = March, APR = April, JUN = June, JUL = July, AUG = August, SEP = September, OCT = October, NOV = November, DEC = December

[2]The missing values (NA) in February for Cluster 2 indicate that there were no lactating cows on any of that cluster's farms during that month.

Table 3.4. Feed costs ($/kg DM) by feed type for each cluster and the total sample for each month of 2010

Month[1]	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
						CONCENTRATES						
Cluster 1	0.084	0.084	0.084	0.084	0.084	0.084	0.084	0.084	0.084	0.084	0.084	0.084
Cluster 2[2]	0.412	NA	0.388	0.394	0.394	0.394	0.394	0.394	0.394	0.394	0.394	0.352
Cluster 3	0.185	0.185	0.185	0.185	0.185	0.181	0.180	0.180	0.180	0.181	0.164	0.185
Cluster 4	0.277	0.277	0.274	0.276	0.284	0.284	0.284	0.284	0.290	0.290	0.286	0.278
All Farms	0.202	0.198	0.209	0.213	0.213	0.211	0.211	0.210	0.213	0.214	0.206	0.208
						CORN SILAGE						
Cluster 1	0.028	0.028	0.028	0.028	0.028	0.028	0.031	0.031	0.031	0.026	0.026	0.026
Cluster 2[2]	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Cluster 3	0.034	0.033	0.033	0.033	0.035	0.037	0.037	0.037	0.040	0.036	0.033	0.033
Cluster 4	0.039	0.040	0.040	0.040	0.022	0.022	0.022	0.050	0.050	0.038	0.039	0.039
All Farms	0.034	0.034	0.034	0.034	0.032	0.033	0.034	0.037	0.038	0.034	0.033	0.033
						HAY						
Cluster 1	0.011	0.011	0.011	0.036	0.036	0.036	0.036	0.036	0.036	0.036	0.011	0.011
Cluster 2[2]	0.030	NA	0.028	0.027	0.022	NA	NA	NA	NA	0.034	0.034	0.020
Cluster 3	0.049	0.049	0.049	0.049	0.059	0.066	0.061	0.061	0.061	0.050	0.050	0.049
Cluster 4	0.106	0.106	0.108	0.113	0.087	0.072	0.079	0.084	0.099	0.084	0.102	0.102
All Farms	0.066	0.068	0.067	0.069	0.062	0.058	0.058	0.058	0.064	0.057	0.065	0.063
						HAYLAGE						
Cluster 1	0.029	0.029	0.029	0.029	0.031	0.015	0.015	0.015	0.015	0.029	0.029	0.029
Cluster 2[2]	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Cluster 3	0.043	0.043	0.043	0.045	0.048	0.038	0.038	0.038	0.053	0.047	0.043	0.043
Cluster 4	0.053	0.054	0.054	0.053	0.022	0.013	0.077	0.044	0.054	0.049	0.048	0.058
All Farms	0.044	0.044	0.044	0.045	0.039	0.030	0.037	0.033	0.045	0.044	0.042	0.046
						VITAMINS AND MINERALS						
Cluster 1	1.371	1.371	1.371	1.371	1.301	1.301	1.273	1.275	1.275	1.275	1.371	1.371
Cluster 2[2]	0.898	NA	1.437	1.254	1.254	1.254	1.254	1.254	1.254	1.254	1.254	1.078
Cluster 3	1.268	1.268	1.270	1.270	1.250	1.230	1.232	1.232	1.233	1.252	1.273	1.272
Cluster 4	1.214	1.214	1.224	1.217	1.258	1.259	1.257	1.253	1.233	1.275	1.289	1.213
All Farms	1.250	1.261	1.268	1.262	1.259	1.251	1.247	1.246	1.239	1.263	1.290	1.253

[1]JAN = January, FEB = February, MAR = March, APR = April, JUN = June, JUL = July, AUG = August, SEP = September, OCT = October, NOV = November, DEC = December

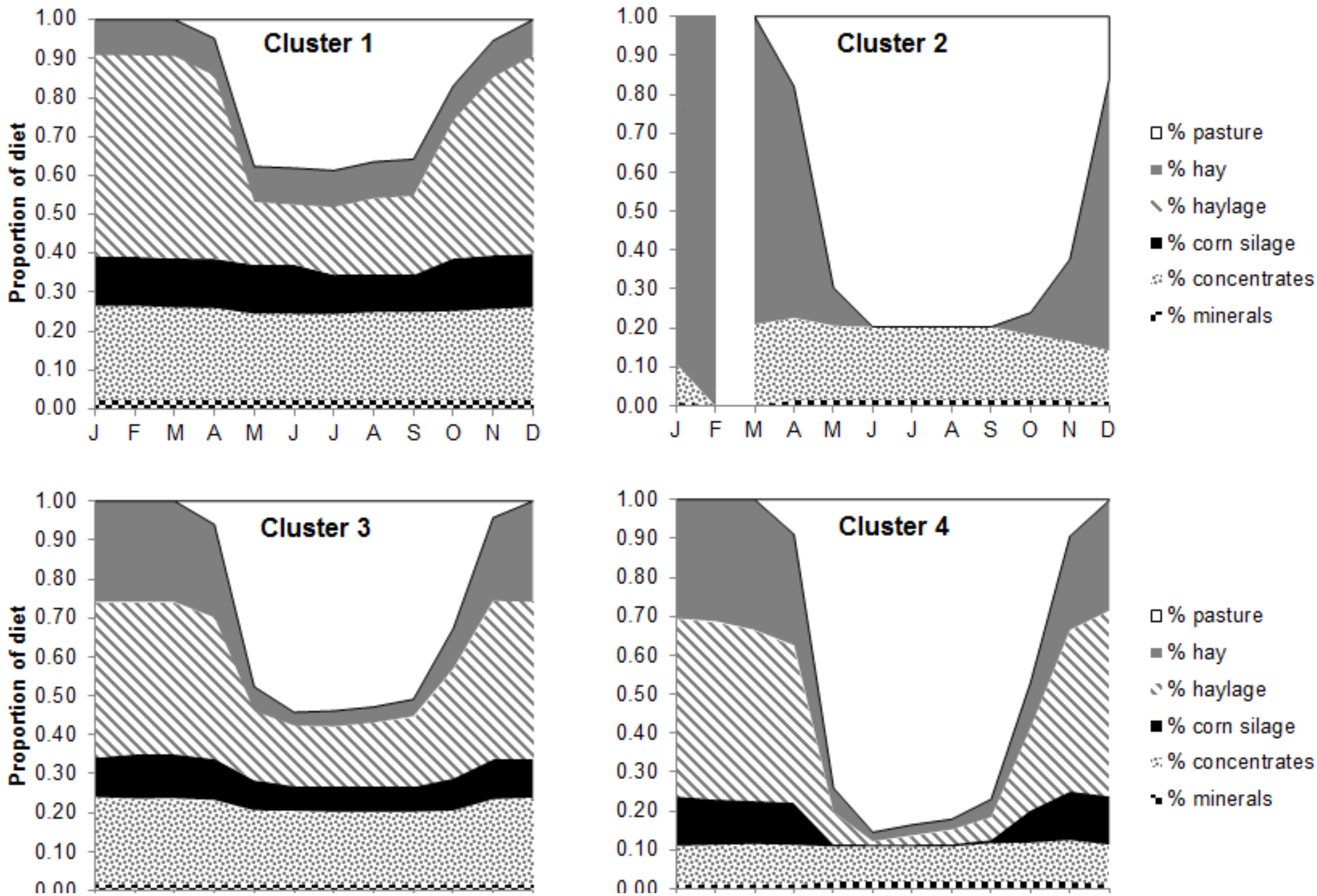
[2]The missing values for Cluster 2 indicate that there were no lactating cows (February) or those feeds were not fed (all other months) on any of that cluster's farms during those months.

Table 3.5. Dry matter fed (kg/lactating cow per day) by feed type for each cluster and the total sample for each month of 2010

Month[1]	JAN	FEB[2]	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
						CONCENTRATES						
Cluster 1	4.98	4.98	4.98	4.98	4.88	4.88	4.88	4.97	4.97	4.98	4.98	4.98
Cluster 2	0.77	NA	3.74	2.80	2.50	2.34	2.34	2.34	2.34	2.03	1.88	1.31
Cluster 3	4.36	4.36	4.36	4.27	3.77	3.75	3.69	3.69	3.69	3.76	4.28	4.36
Cluster 4	1.85	1.85	1.87	1.83	1.64	1.64	1.64	1.64	1.77	1.78	1.95	1.84
All Farms	3.40	3.52	3.52	3.40	3.07	3.04	3.02	3.03	3.08	3.09	3.36	3.36
						CORN SILAGE						
Cluster 1	2.78	2.78	2.78	2.78	2.78	2.78	2.32	2.32	2.32	2.98	2.98	2.98
Cluster 2	0.00	NA	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Cluster 3	2.18	2.52	2.52	2.32	1.66	1.50	1.50	1.50	1.45	1.90	2.26	2.19
Cluster 4	2.42	2.18	2.09	2.00	0.15	0.09	0.09	0.17	0.17	1.53	2.32	2.32
All Farms	2.24	2.43	2.29	2.09	1.14	1.05	1.00	1.02	1.00	1.76	2.20	2.20
						HAY						
Cluster 1	1.94	1.94	1.94	1.99	1.92	1.99	1.99	1.99	1.99	1.89	1.94	1.94
Cluster 2	7.24	NA	13.17	7.32	0.90	0.00	0.00	0.00	0.00	0.61	2.03	7.13
Cluster 3	5.36	5.37	5.36	4.89	1.33	0.70	0.85	0.85	0.91	2.09	4.38	5.36
Cluster 4	5.64	5.69	6.00	5.28	1.26	0.48	0.57	0.52	0.89	2.02	4.33	4.93
All Farms	5.13	5.05	5.53	4.87	1.34	0.72	0.83	0.81	0.96	1.94	3.90	4.91
						HAYLAGE						
Cluster 1	11.58	11.58	11.58	10.51	3.57	3.45	3.91	4.25	4.30	7.99	10.21	11.35
Cluster 2	0.00	NA	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Cluster 3	8.30	8.32	8.30	7.75	3.84	3.19	3.20	3.31	3.52	5.93	8.43	8.39
Cluster 4	8.60	8.39	8.04	7.49	1.48	0.13	0.42	0.57	1.11	3.98	7.62	8.88
All Farms	8.43	8.76	8.23	7.42	2.71	1.93	2.08	2.22	2.52	5.06	7.74	8.42
						VITAMINS AND MINERALS						
Cluster 1	0.46	0.46	0.46	0.46	0.46	0.46	0.45	0.46	0.46	0.46	0.46	0.46
Cluster 2	0.10	NA	0.05	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.11
Cluster 3	0.28	0.28	0.27	0.27	0.27	0.27	0.27	0.27	0.27	0.28	0.28	0.28
Cluster 4	0.20	0.20	0.20	0.19	0.17	0.17	0.17	0.17	0.18	0.17	0.19	0.20
All Farms	0.26	0.27	0.26	0.26	0.25	0.25	0.25	0.25	0.25	0.25	0.26	0.26

[1]JAN = January, FEB = February, MAR = March, APR = April, JUN = June, JUL = July, AUG = August, SEP = September, OCT = October, NOV = November, DEC = December

[2]The missing values in February for Cluster 2 indicate that there were no lactating cows on any of that cluster's farms during that month.


Cluster 1
Cluster 2
Cluster 3
Cluster 4
Proportion of diet
1.00
0.90
0.80
0.70
0.60
0.50
0.40
0.30
0.20
0.10
0.00
J F M A M J J A S O N D
% pasture
% hay
% haylage
% corn silage
% concentrates
% minerals

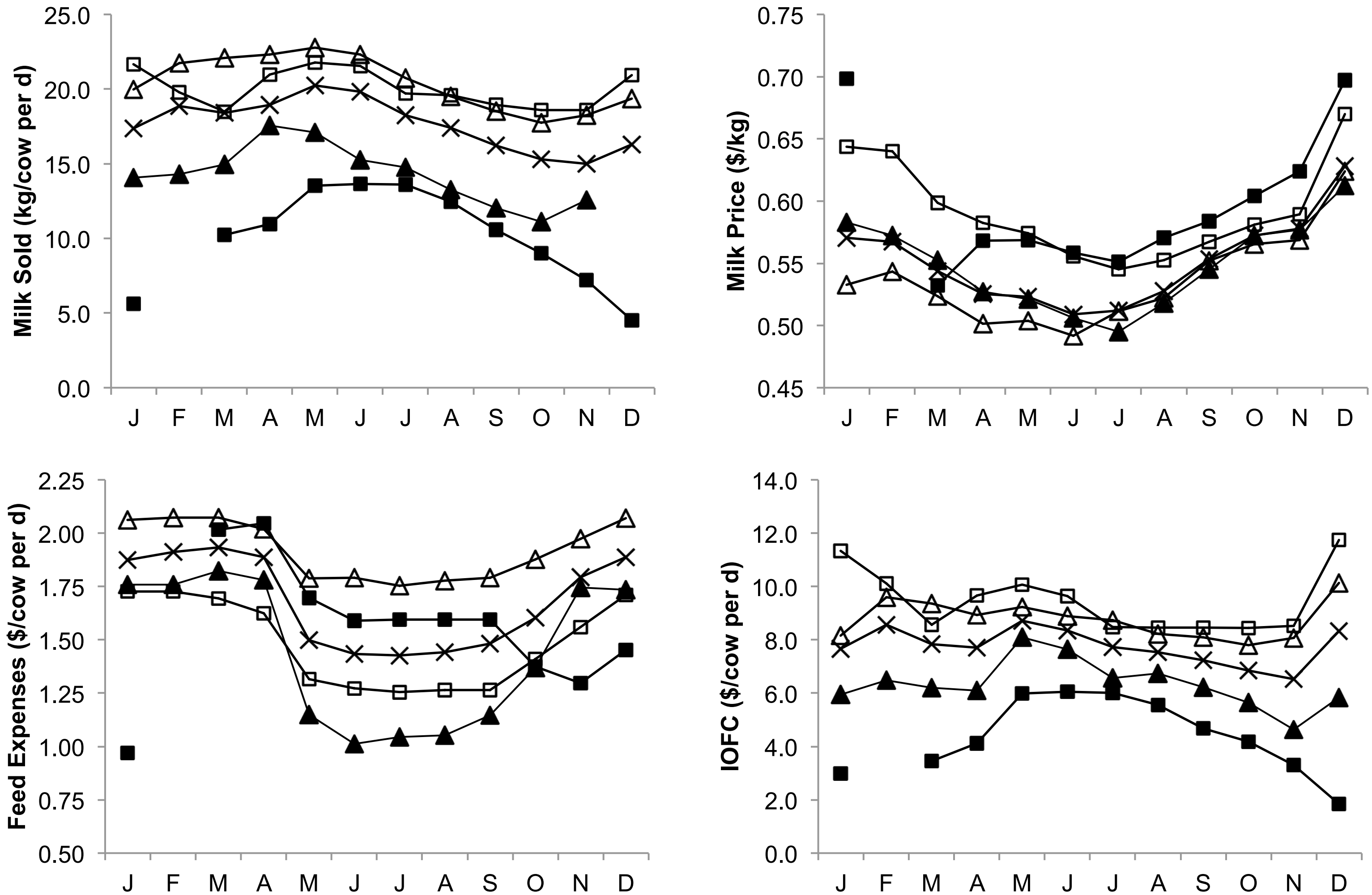


Figure 3.2. (a) Milk sold, (b) milk price, (c) feed expenses, and (d) milk income over feed costs (IOFC) by month of 2010, for the 4 clusters. Note: only approximately one-half of the farms in each cluster had milk data (thus IOFC) available for December 2010. The absence of points in February for cluster 2 indicates that there were no lactating cows during that month on any of that cluster's farms. Cluster 1 = (□), cluster 2 = (■), cluster 3 = (Δ), cluster 4 = (▲), and all farms = (x).

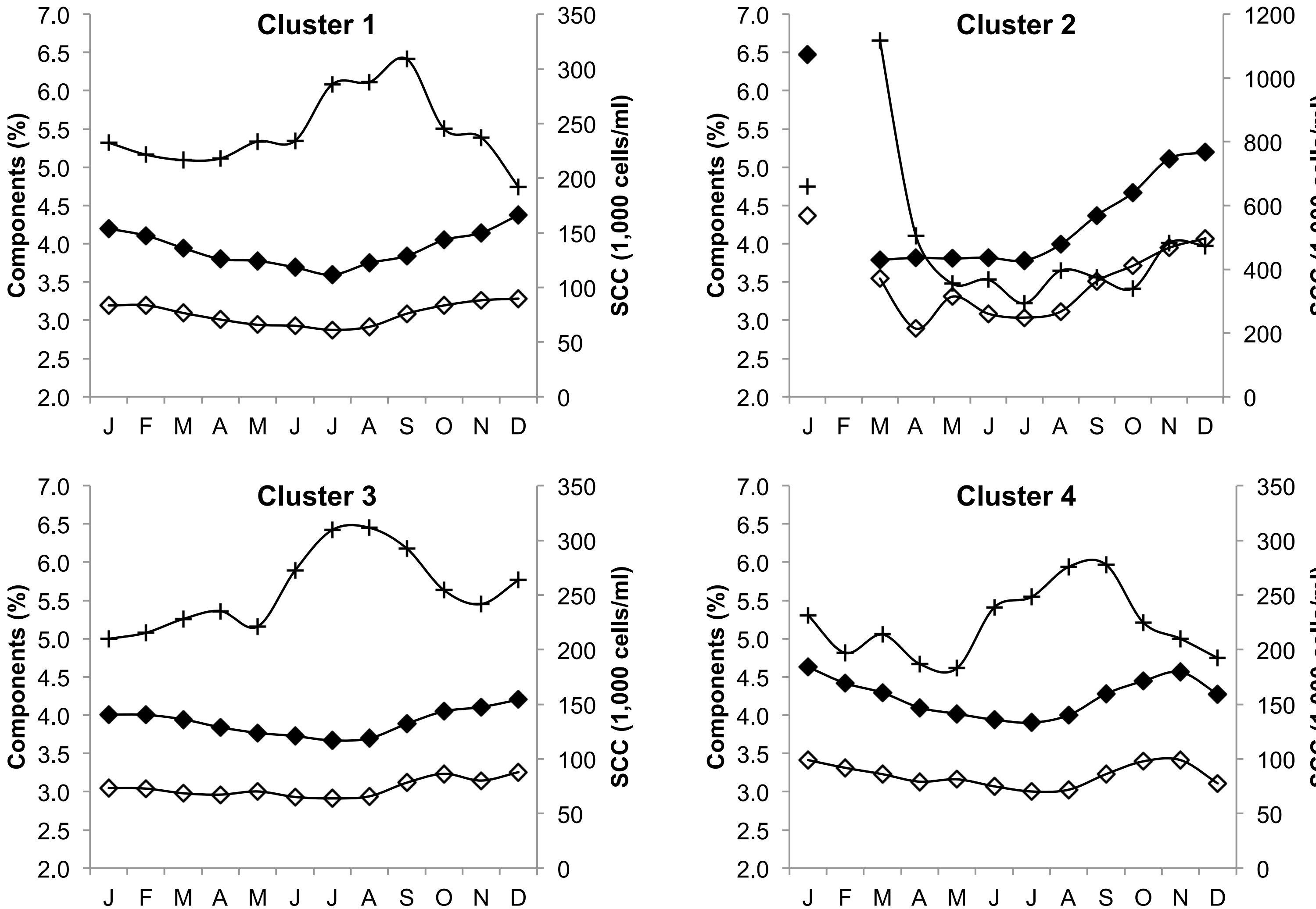


Figure 3.3. Milk component contents (% fat = ♦, % protein = ◊) and SCC (+) for each month of 2010 by cluster. Note: in cluster 2, the missing values in February indicate that there were no lactating cows on any of that cluster's farms during that month, and due to an extreme value, an extended scale was used for SCC.

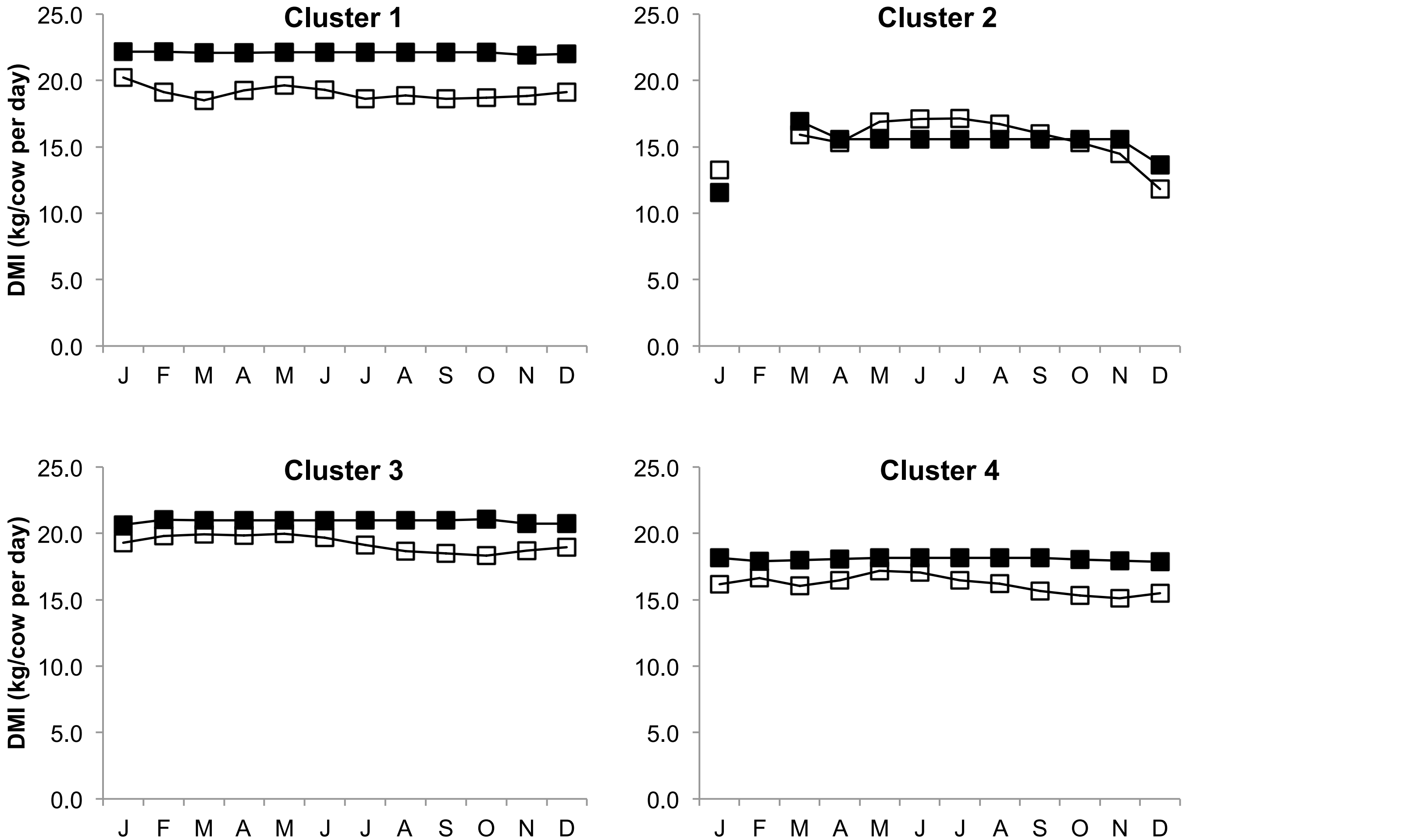


Figure 3.4. Comparison of two methods for calculating dry matter intake (DMI) for each cluster. In method 1 (■), the total daily amount of feed supplemented during the non-grazing season was assumed to be the total daily DMI year-round. Method 2 (□) approximated total DMI using a modified version of NRC (2011) equation 1-2 [DMI = (0.372 x FCM + 0.0968 x BW$^{0.75}$) x (1-e$^{[-0.192 \times (WOL + 3.67)]}$)]. Note: in cluster 2, the missing values in February indicate that there were no lactating cows on any of that cluster's farms during that month.

CHAPTER 4

Dry Cow Feeding Management on Wisconsin Organic Dairy Farms

ABSTRACT

A survey was conducted on 70 organic dairy farms in Wisconsin to identify organic dry cow feeding strategies and evaluate their associated costs over the time span of one year. All but one farm grazed their dry cows during the summer. Ten farms fed mixed feed to their dry cows. Thirty, 28, and 30 farms fed their dry cows concentrates, corn silage, and kelp, respectively, for at least one month of the year. Average total feed costs varied from \$0.61/cow per day in June to \$1.02/cow per day in February.

Key words: dry cow, organic, feed costs

INTRODUCTION

Organic dairying continues to remain as one of the most rapidly growing agricultural sectors in the US. Though an increase in research comparing organic and conventional dairy farms and management of organic lactating cows can be observed in response to this growth, to our knowledge, no studies have been conducted regarding feeding management of organic dry cows. Hence, the purpose of this study was to identify feeding strategies for organic dry cows and evaluate their costs. Our hypothesis was that organic dry cow feeding programs were very pasture-based and that the level of supplementation would be low due to high organic feed prices, maintaining an overall low organic dry cow feed cost.

MATERIALS AND METHODS

All organic dairy farms in the state of Wisconsin (N = 554) were invited to participate in the study through a direct mailing that included a project summary and a pre-stamped postcard to be returned indicating their level of interest in participating in the study. Seventy Wisconsin organic dairy farms were surveyed on-farm, face-to-face, between January 2011 and January 2012. The survey and study protocol were evaluated and qualified as exempt from review by the University of Wisconsin-Madison Education Research and Social and Behavioral Science Institutional Review Board office. The survey instrument was tested on three pilot farms before its use for research data collection.

To evaluate dry cow feeding programs, the survey asked farmers to list all types and amounts of feeds incorporated into their dry cow diets for each month of 2010. To determine the proportion of each feed ingredient in the diet, total DM consumed (kg/cow per day) year-round was approximated based on total amounts of feed consumed during the non-grazing season months. The difference between the approximated total daily DM consumed and the amount of non-pasture feed consumed during the grazing season was assumed to be DM consumed from pasture [pasture DM consumed = total approximated DM consumed – DM consumed from non-pasture feed during the grazing season], as outlined in Gehman et al. (2006) and Rego et al. (2008). Feed expenses were calculated using farmer reported purchased feed costs, grazing expenses, and homegrown feed crop inputs including seed, fertilizer, custom harvest, and storage costs. Means and medians were calculated in Excel.

RESULTS

Herd size on the surveyed organic dairy farms ranged from 12 to 650 cows (lactating and dry) with a median of 45 cows per farm. The number of dry cows on the farms varied from 0 to 105 cows depending on the month. For eight of the 12 months in 2010, the median number of dry cows on the farms was six cows or less. Approximately one-fourth (18) of the farms had at least one month in 2010 in which they did not have any dry cows. Three different methods were used by the organic farmers to group their dry cows. Thirty percent of the surveyed farmers penned all of their cows (lactating and dry) together, 28.6% penned their dry cows by themselves, and 41.4% of the farmers penned their dry cows with bred or other older heifers. No farms had multiple pens (such as far-off and pre-fresh) of dry cows.

All but one farm grazed their dry cows for at least part of the grazing season. Ten of the farms continuously stocked their dry cows. Of the 59 farms that rotationally grazed their dry cows, 12 farms had their dry cows follow the lactating cows under the leader-follower system of pasture management. Forages commonly grazed by dry cows were crop residues and unimproved native pastures low in legumes.

Figure 1 displays the proportion of different feed ingredients in the average dry cow diet for each month in 2010. Ten farms fed mixed feed to their dry cows. Eight of the farms that fed mixed feed to their dry cows fed mixed feed throughout the entire year; the remaining two farms fed mixed feed to their dry cows only during the non-grazing season. The diets were highly forage based. Only 30 of the farms fed concentrates to their dry cows. The average amount of concentrates in a dry cow diet was approximately 0.45 kg/cow per day. Twenty-eight farms fed corn silage to their dry cows; however 19 of those farms fed corn silage to their dry cows only during the non-grazing season. Haylage and grassy hay made up the largest portion of the diet during the winter but were the feeds most commonly replaced by pasture during the grazing season. Four farms did not feed salt, vitamins, or minerals to their dry cows. Thirty farms fed kelp, a harvested seaweed believed to be high in beneficial minerals (Berry and Turk, 1944).

Figure 2 displays total feed expenses and feed expenses by feed type. The least amount of feed expenses were observed during the grazing season due to a dramatic drop in supplemented forage expenses and a slight drop in supplemented concentrate expenses. Mineral costs remained fairly consistent through the duration of the year. Average feed costs varied from $0.61/cow per day in June to $1.05/cow per day in February, which was less than half the state average for a commercial dairy herd ($2.20/cow per day; Giordano et al., 2011).

DISCUSSION

The small herd size of many organic farms can create challenges for farmers desiring to tailor diets to cows in different stages of lactation unless individual feeding options, such as through tie-stalls barns, are available. Smaller farms may only have one or two dry cows at a time, leading farmers to group them with other animals. This reduces the flexibility for farmers to provide feeds specific to dry cows, such as low potassium forages and anionic salts as a preventative diet to reduce incidence of milk fever. However, when able, many of the farms in the current study appeared to employ other feeding strategies to address transition cow metabolic diseases. For example, grass hay was fed rather than alfalfa hay, to reduce the amount of potassium ingested by dry cows, and specific dry cow minerals were fed as well.

CONCLUSIONS

Overall dry cow rations on Wisconsin organic dairy farms were very forage-based and monthly feed expenses varied between approximately $0.60 and $1.00 per cow per day.

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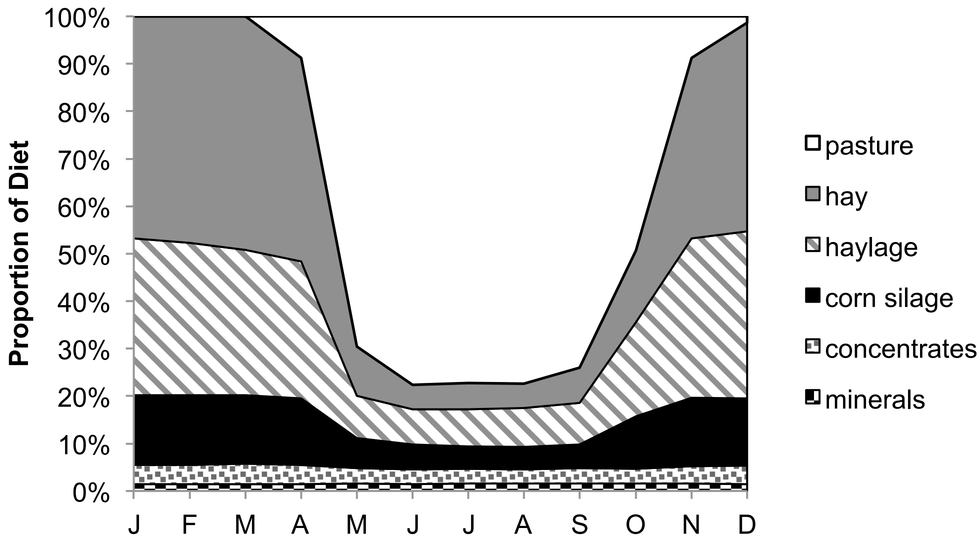

Figure 4.1. Proportion of feeds (on a DM basis) in the average dry cow diet for each month in 2010.

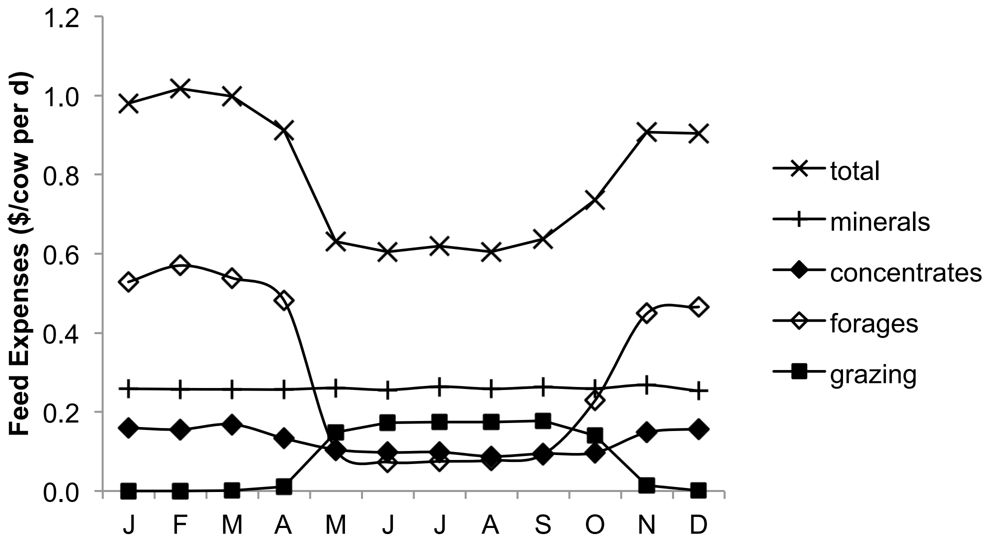

Figure 4.2. Average amount of expenses incurred for each feed type in the average dry cow diet for each month in 2010.

CHAPTER 5

Summary and Conclusions

The goal of this thesis was to describe general management on Wisconsin organic dairy farms and evaluate their feeding strategies. Determination of characteristics of the most profitable feeding systems will aid farmers in decision-making as they address the challenges associated with feeding of organic dairy cattle when formulating rations.

Though four clusters resulted when separating the organic farms based on general management, feed supplementation, and pasture practices, two overall feeding strategies surfaced—heavily supplemented feeding systems and pasture-based feeding systems. Farms relying heavily on non-pasture feed sources were predominantly Holstein in breed and incorporated numerous feed ingredients into their lactating cow diets, even during the grazing season. However, these farms still appeared to meet the requirements set forth in the USDA-NOP pasture rule of a minimum of 30% dry matter intake from pasture during a 120 day grazing season. The farms under this management style had higher milk production and income over feed costs.

The grass-based farms surpassed the pasture rule regulations, and for many of these farms, pasture served as the only forage source during the grazing season. These farms also differed from the heavily supplemented farms in their more frequent use of breeds other than Holstein and seasonal calving management. Milk production was lower on these farms but component concentrations were higher. Income over feed costs was also lower on these farms. Dry cow feeding programs on Wisconsin organic dairy farms were also very pasture-based, resulting in low feed costs per cow.

Pasture supplementation on Wisconsin organic dairy farms appeared to aid in increased milk production and income over feed costs. However, other factors need to be included before assessing whole-farm profitability of these farms.