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Survey of management practices used by Brazilian dairy farmers and recommendations provided by 43 dairy cattle nutritionists

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Abstract: This work aimed to survey management practices used by dairy farmers and to report nutritional recommendations adopted by 43 dairy cattle nutritionists in Brazil. The web-based survey consisted of 80 questions. Almost 50% of the participants had clients that produce <1000 kg of milk daily and 48.8% had clients who own fewer than 100 dairy cows. Corn was the primary source of grain (97.4%), and 43.9% of the nutritionists included from 41% to 50% concentrate in lactation diets. The mean roughage inclusion in lactation diets was 50.5% and 79% of the nutritionists reported corn silage as the primary roughage source. Average crude protein and rumen-degradable protein concentrations recommended by the nutritionists for lactation diets were 15.7% and 9%, respectively. Average Ca and P concentrations recommended for lactation diets were 0.70% and 0.41%, respectively. The major health problem reported by 83.9% of the nutritionists was mastitis. The present survey provides an overview of management practices adopted by dairy farmers and nutritional recommendations currently applied by dairy cattle nutritionists in Brazil. The most critical points identified were low milk yield, mastitis as the major health problem, lack of proper mixing and delivery of rations, and destination of male calves.

Key words: Brazil, dairy cow, management, nutrition, survey.

Résumé : Ce travail ciblait le sondage des pratiques de gestion utilisées par les producteurs laitiers et le rapport des recommandations nutritionnelles adoptées par quarante-trois nutritionnistes de vaches laitières au Brésil. Le sondage internet comprenait 80 questions. Presque 50 % des participants avaient des clients qui produisaient moins de 1000 kg de lait de façon quotidienne et 48,8 % avaient des clients qui possédaient moins de 100 vaches laitières. Le maïs était la source principale de grain (97,4 %), et 43,9 % des nutritionnistes incluaient de 41 à 50 % de concentré dans les diètes de lactation. La moyenne d'incorporation de fourrage grossier dans les diètes de lactation était de 50,5 % et 79 % des nutritionnistes rapportaient l'ensilage de maïs comme source principale de fourrage grossier. Les concentrations moyennes de protéines brutes et de protéines dégradables dans le rumen recommandées par les nutritionnistes pour les diètes de lactation étaient de 15,7 % et 9 %, respectivement. Les concentrations moyennes de Ca et de P recommandées dans les diètes de lactation étaient de 0,70 % et 0,41 %, respectivement. Le problème principal de santé rapporté par 83,9 % des nutritionnistes était la mastite. Le présent sondage offre un survol des pratiques de gestion adoptées par les producteurs laitiers et des recommandations nutritionnelles actuellement appliquées par les nutritionnistes des vaches laitières au Brésil. Les points les plus critiques identifiés étaient ceux du faible rendement de lait, la mastite comme problème principal de santé, le manque de mélange adéquat et de livraison des rations, et la destination des veaux mâles. [Traduit par la Rédaction]

Mots-clés : Brésil, vache laitière, gestion, nutrition, sondage.

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Introduction

Brazil has the second largest dairy cattle inventory in the world with more than 38.9 million head of cattle in its territory, and it is the fifth largest milk producer with an average of 34.5 billion L of milk per year (ANUALPEC 2015).

Typically, forage-fed animals characterize the beef and dairy cattle industries in Brazil. Surveys involving feedlot cattle nutritionists are frequently cited to describe nutritional and management practices used and to identify possible critical issues in North American and Brazilian operations (Oliveira and Millen 2014; Samuelson et al. 2016). However, for dairy cattle, only some surveys conducted in the USA and Germany reporting specific issues and representing only one state or even specific areas are available (Kellogg et al. 2001; Kehoe et al. 2007; Heuwieser et al. 2009). To date, no surveys included interviews with dairy cattle nutritionists about their practices and recommendations to characterize the Brazilian dairy industry as a whole. Conducted previously with feedlot cattle nutritionists, such surveys are important to provide a current snapshot of the dairy cattle system in the country, describe nutritional management and identify possible critical issues in operations to improve diets and management, as well as facilitate industry-oriented research in areas that need further study.

Given the need for this type of information on the dairy cattle industry in Brazil, the objectives of this study were to (1) provide an overview of current management practices used by Brazilian dairy farmers, (2) describe the current nutritional recommendations adopted by dairy nutritionists in Brazil, and (3) identify the most critical points for the improvement of dairy cattle systems.

Materials and Methods

Animal Care and Use Committee Approval was not obtained for this study because no animals were used. Moreover, according to Article 1, the sole paragraph from "Resolução 510/16 — Conselho Nacional de Saúde" of the Ministry of Health, it is not necessary to submit a project to the Ethics Committee when interviewed participants are not identified and the survey has public access.

The authors of this study created a contact information list containing either telephone numbers or email addresses of dairy cattle nutritionists based on information provided by nutrition companies, dairy farmers, and professional associations. One-hundred and forty-eight consulting dairy cattle nutritionists were invited to participate in this survey. These professionals were identified to represent typical dairy cattle feeding practices in different areas of Brazil and were contacted by either email or telephone regarding their participation in this survey. One-hundred nutritionists did not return our request to participate, leaving 48 who agreed to participate and 43 who ultimately completed the survey. The participating nutritionists collectively advised 960 dairy farms across Brazil, and on average, each nutritionist assisted 26.7 ± 14.3 clients. None of these farms was considered a dual-purpose farm.

This survey was conducted using methods similar to those employed by Vasconcelos and Galyean (2007), Millen et al. (2009), Oliveira and Millen (2014), and Samuelson et al. (2016), which included a web-based survey tool (http://www.surveymonkey.com). The 48 nutritionists who agreed to participate received preliminary instructions about completing the survey, and each participant was assigned an identification number. The participants were guaranteed anonymity and were asked to complete the survey as soon as possible. All 43 consultants completed the survey within 1 mo (between 15 Feb. 2015 and 15 Mar. 2015). Based on the survey questions, nutritionists provided information from either a range or average for their clients.

The 80 questions were divided into several categories, including description of participating dairy cattle nutritionists ($n = 7$); description of dairy operations serviced by those nutritionists ($n = 8$); milk quality parameters and processing methods ($n = 5$); reproductive management, selection criteria, and animal trading ($n = 9$); calf management ($n = 13$); dairy cow lactation diets ($n = 15$); energy units and methods for fiber analysis ($n = 3$); mixers (equipment used to mix the rations) and feeding management information ($n = 7$); protein and fat recommendations for lactation diets ($n = 8$); prepartum management recommendations ($n = 3$); and major problems faced by dairy cattle nutritionists ($n = 2$).

All data were tabulated using an Excel spreadsheet (Microsoft, Redmond, WA, USA) as previously described (Vasconcelos and Galyean 2007; Millen et al. 2009; Oliveira and Millen 2014; Samuelson et al. 2016). When appropriate, the number of responses, mean, minimum value, maximum value, and mode were calculated. In addition, some of the results, when appropriate, were expressed as a percentage.

Results and Discussion

Description of participating dairy cattle nutritionists

When asked about the nature of their professional practice, nutritionists surveyed worked for a corporate feed manufacturing company (44.1%, $n = 19$), as independent consultants (23.3%, $n = 10$), as part of a consulting company (20.9%, $n = 9$), in a university (4.7%, $n = 2$) or research center (4.7%, $n = 2$), and only 2.3% ($n = 1$) worked for a veterinary laboratory. Most nutritionists surveyed ($n = 17$, 39.5%) had worked as nutrition consultants for more than 10 yr, 4.7% ($n = 2$) had been practicing from 8 to 10 yr, 18.6% ($n = 8$) from 5 to 8 yr, 27.9% ($n = 12$) from 2 to 5 yr, and 9.3% ($n = 4$) for 2 yr or less. Among nutritionists surveyed, 68.3% had a Bachelor of Science degree (agronomy, animal science, or veterinary medicine) with

($n = 20$) or without ($n = 8$) continuing education courses. Thirteen nutritionists had graduate degrees, either a PhD ($n = 8$) or a Masters ($n = 5$) degree.

The nutritionists surveyed obtained their degrees in the states of Minas Gerais (28.6%, $n = 12$), São Paulo (26.2%, $n = 11$), Rio Grande do Sul (19%, $n = 8$), Paraná (11.9%, $n = 5$), Santa Catarina (7.1%, $n = 3$), Rio de Janeiro (2.4%, $n = 1$), Goiás (2.4%, $n = 1$), and Espírito Santo (2.4%, $n = 1$).

The main states of the country where the surveyed nutritionists worked were Minas Gerais (44.2%, $n = 19$) and São Paulo (37.2%, $n = 16$). Nutritionists also worked in Rio Grande do Sul (27.9%, $n = 12$), Paraná (27.9%, $n = 12$), Santa Catarina (18.6%, $n = 8$), Goiás (16.3%, $n = 7$), Bahia (14%, $n = 6$), Mato Grosso (11.6%, $n = 5$), Rio de Janeiro (9.3%, $n = 4$), Mato Grosso do Sul (9.3%, $n = 4$), Espírito Santo (7%, $n = 3$), Tocantins (4.7%, $n = 2$), and Pará (4.7%, $n = 2$). Some of the nutritionists surveyed had clients in more than one state, and that explains why the sum of responses exceeds 100%.

The main source of information for nutritional requirements of dairy cattle to formulate diets was the National Research Council (NRC 2001) Dairy Cattle ($n = 22$, 68.8%), followed by The Cornell–Penn–Miner Dairy (CPM-Dairy; $n = 6$, 18.8%), Cornell Net Carbohydrate and Protein System (CNCPS; $n = 3$, 9.4%), and Agricultural Model and Training System (ATMS; $n = 1$, 3.1%). The *Journal of Dairy Science* ($n = 17$, 53.1%; www.adsa.org/Publications/Journal-of-Dairy-Science) was the main source of scientific information used by dairy cattle nutritionists, followed by the *Brazilian Journal of Animal Science* ($n = 4$, 12.5%; www.scielo.br/rbz), Milk Point website ($n = 3$, 9.4%; www.milkpoint.com.br), Balde Branco magazine ($n = 2$, 6.3%; www.baldebranco.com.br), universities ($n = 2$, 6.3%), Leite Integral magazine ($n = 2$, 6.3%; www.revistaleiteintegral.com.br), Hoards Dairyman ($n = 1$, 3.1%; www.hoards.com), and the *Journal of Animal Science* ($n = 1$, 3.1%; academic.oup.com/jas). Kellogg et al. (2001) asked about sources of information to American Holstein producers, and responses included veterinarians, other dairy producers, private consultants, farm magazines, industry representatives, extension personnel, university researchers, and dairy-herd-improvement association supervisors.

Description of dairy operations serviced by nutritionists

When asked about the average daily milk production on dairy farms nutritionists serviced, 46.5% ($n = 20$) of the participants had clients that produce <1000 kg daily, 27.9% ($n = 12$) had clients ranging from 1001 to 3000 kg, and 25.6% ($n = 11$) assisted dairy farms with a capacity of more than 3000 kg daily. The average daily milk production per cow on the dairy farms assisted by the nutritionists surveyed was 17.7 kg (minimum = 9.8 kg, maximum = 35.6 kg and mode = 16 kg). When asked about the average herd size, 48.8% of the nutritionists surveyed ($n = 21$) had clients with fewer than 100 dairy cows, whereas 44.2% ($n = 19$) had clients ranging from 101 to 300 dairy cows and only 7% ($n = 3$) of participants interviewed assisted operations with more than 300 dairy cows on average.

Brazilian dairy cattle systems, in general, consist of small-sized operations with lower milk production per cow [national average of 6 kg^{-1} cow^{-1} d^{-1} (no dual-purpose farms included); ANUALPEC 2015] compared with American dairy herds. Brazil has a dairy industry based on grass-fed cattle, and dairy cows spend most of their lives grazing tropical pastures. As a result, dairy cattle fed exclusively on grazing systems with only mineral supplementation typically have low milk production. For example, Kellogg et al. (2001) interviewed dairy producers who owned high-producing dairy herds and observed that the average daily milk production of Holstein and Jersey herds in American dairy farms was 36.62 and 24.23 kg, respectively. However, the USDA (2018) reported that average milk production considering all American herds was 26.51 kg. The primary breed used by the clients of the nutritionists surveyed in the present study was Holstein ($n = 29$, 69%), followed by Girolando (5/8 Holstein, 3/8 Gir; $n = 13$, 31%). Girolando is a popular breed in Brazil because it is more resistant to heat and parasites than Holstein and more productive than Gir, making this breed an alternative for systems developed for milk production based on forage. Kellogg et al. (2001) also reported the use of Holstein cattle as the primary breed on American dairy farms; however, the second most used breed on American dairy farms was Jersey.

Most production systems assisted by the nutritionists were pasture based and offered cows concentrate (40.5%, $n = 17$) or mineral supplements (16.7%, $n = 7$) in the milking parlor. Some dairies confined animals in dry lots (19%, $n = 8$), free stalls (14.3%, $n = 6$), or loose housings (9.5%, $n = 4$; e.g., compost barns and other facilities with a common lying area with open lounging). Some of the dairy producers do not supplement any concentrate, silage, or by-product because they produce milk based on an extensive system. Because most nutritionists surveyed had clients who produce <1000 kg of milk daily, it was expected that grazing would be the predominant production system. In addition, because Brazil has 2.47 million acres of tropical pasture (ANUALPEC 2015), it is more feasible for dairy farmers to keep cows on pastureland. On the other hand, free stall and loose housing systems are not easily adopted in Brazil because implementation in small dairy herds can be difficult owing to the high costs involved. The use of intensive production systems on some of the dairy farms serviced by the nutritionists surveyed, such as free stall and loose housings, as well as the use of the Holstein breed and its crossbreds, certainly contributed to the increased daily milk production per cow reported in this survey when compared with the national average

Table 1. Quality parameters and milk processing methods adopted by dairy operations in Brazil according to consulting nutritionists surveyed.

Item	Mean	Minimum	Maximum	Mode
Clients who receive bonus for milk quality (%; $n = 38$)	67.2	0	100	100
Clients who process milk (%; $n = 41$)	11.2	0	95	0
	No. of responses		**% of responses**	
Primary milk quality parameter required by milk processing plants ($n = 38$)				
Somatic cells count	12		31.6	
Protein content (%)	10		26.3	
Total bacteria count	10		26.3	
Fat content (%)	6		15.8	
Secondary milk quality parameter required by milk processing plants ($n = 41$)				
Fat content (%)	12		29.3	
Protein content (%)	10		24.4	
Somatic cells count	10		24.4	
Total bacteria count	9		22.0	
Primary milk processing method ($n = 16$)				
Cheese	11		68.8	
Pasteurization and packing	4		25.0	
Pasteurization	1		6.3	

(17.7 vs. 6 kg). In addition, dairy farms presenting low milk productivity may not be entirely represented in this survey, as those farmers usually cannot afford a nutritionist.

With respect to milking frequency, 83.7% ($n = 36$) of the nutritionists had clients who milk cows twice daily, and 14% ($n = 6$) reported having clients who milk cows thrice daily, whereas only 2.3% ($n = 1$) had clients who milk cows once a day. Most nutritionists ($n = 22$, 51.2%) reported that the milking interval among their clients ranged from 6 to 8 h, whereas 37.2% ($n = 16$) reported milking interval that ranged from 10 to 12 h, and 9.3% ($n = 4$) had clients whose milking interval was more than 12 h. Only 2.3% ($n = 1$) of the nutritionists had clients who adopted a milking interval ranging from 8 to 10 h. Bar-Peled et al. (1995) and Dahl et al. (2004) observed that the increase of milking frequency from 2 to 3 times daily increased milk production by 10% or more over the first 21 d on milk. This increase was observed in early lactation and throughout the lactation period, as well. However, nutritionists are not recommending an increase of milking frequency from 2 to 3 times nowadays in Brazil because the walking distance to the milking parlor in a pasture-based system may be too long, and no scientific evidence supports the idea that production will increase by 10% when low-producing cows are milked three times daily. In addition, to increase milking frequency, nutritionists should consider nutritional adjustments in the diets to match cows' requirements for greater milk production, as well as the overall operational costs, such as electricity and labor.

Furthermore, most dairy nutritionists surveyed (59.5%, $n = 25$) reported that milk production per cow was measured once a month at the dairy farms they serviced, followed by twice a month (every 15 d; 23.8%, $n = 10$), daily (7.1%, $n = 3$), and once a week (2.4%, $n = 1$). In addition, 7.1% ($n = 3$) of the nutritionists had clients who do not perform any milk production assessments. In general, milk production is determined using a regular scale. Milk production assessment aims to collect data to support overall operational management (Katz et al. 2016). In addition, it is typically used to select the most productive and efficient animals, to form homogeneous groups of animals according to their production, and to match nutritional requirements when high-producing cows receive diets containing more concentrate, which will increase milk production and reduce overall costs (Togashi and Lin 2004; Togashi and Lin 2008). However, for low-producing cows on small grazing operations, the measurement of milk production of individual animals is less important because typically it does not vary much among cows. Shorter intervals between two consecutive milk production assessments allow greater control of animals' production and milk quality. Nevertheless, shortening the interval between two milk production assessments is not always possible because it requires personnel shifts and increases the costs related to labor, which was identified in this study as one of the major challenges faced by nutritionists that prevents putting into practice their nutritional recommendations. In Brazil, no national dairy herd information association is available, and as a result, the lack of trained employees may compromise milk quality and yield.

Milk quality parameters and processing methods

With respect to quality parameters and milk processing methods (Table 1), 67.2% of the clients advised

by the nutritionists surveyed receive some sort of bonus for milk quality. Milk processing plants in Brazil have been encouraging dairy farmers to improve milk quality, and in return, they have been rewarding farmers by paying 3%–8% more per kilogram of milk (Teixeira et al. 2015). Nutritionists reported that the most important milk quality parameters required of their clients by milk processing plants for payment of bonuses were as follows from most to least cited responses: somatic cell count, percentage of protein, total bacteria count, and percentage of fat. However, minimum milk quality standards are defined by each of the milk processing plants because no national reward system has been implemented by the Department of Agriculture in Brazil. In reality, not all milk processing plants reward their clients based on milk quality, instead paying bonuses based on criteria that may range from only one up to all the four quality parameters cited above by the interviewed nutritionists. In addition, 11.2% of dairy producers do not sell the milk to a milk processing plant because they process at the farm. When milk is processed at the farm, the primary milk processing was for cheese, followed by pasteurization and packaging, and only pasteurization.

Reproductive management

About the reproductive management practices adopted on the farms they serviced, 37 nutritionists surveyed reported that 88.1% of their clients use artificial insemination. With respect to annual conception rate (related to all services) at their clients' farms, 40% of the nutritionists ($n = 16$) responded that it ranged from 31% to 40%, 27.5% ($n = 11$) reported from 41% to 50%, and 25% ($n = 10$) answered more than 51%. In addition, 7.5% ($n = 3$) of the nutritionists surveyed reported annual conception rates ranging from 21% to 30%. Based on the average daily milk production per cow (17.7 kg) reported by the nutritionists in this survey, the conception rate should be around 80% according to Nordin et al. (2004). For detection of cows' estrus, 90.7% ($n = 39$) of the nutritionists had clients who use visual observation, 4.7% ($n = 2$) reported that their clients use gomer bulls, 2.3% ($n = 1$) reported that their clients use an estrus alert system (e.g., Kamar and Estrotect), and 2.3% ($n = 1$) reported having clients who use the tail–head marking method. Although most nutritionists' clients use visual observation to detect a cow's estrus, it does not mean that this is the only factor affecting conception rate. Other factors, such as low body condition, heat stress, and lack of nutrients in the diet, may also play an important role in decreasing conception rate (Löf et al. 2006).

On American dairy farms, Kellogg et al. (2001) reported that estrus detection aids were primarily chalk (37.4%), followed by Kamar patches (16.5%), paint (12.2%), and computerized Heat Watch (11.3%). In addition, according to the USDA (2018), only 8.6% of dairy operations in the United States used electronic heat-monitoring systems to detect an estrus. Reproductive efficiency is one of the main factors directly affecting herd productivity (Löf et al. 2006); therefore, the method involving visual observation of estrus is not very efficient, as the chances for human error are greater (Cavestany and Galina 2001), thus compromising artificial insemination, and in turn, reducing both the conception rate and the reproductive efficiency of the herd (At-Taras and Spahr 2001).

Selection criteria and animal trading

Nutritionists surveyed ($n = 41$) reported that 79.1% of their clients adopt some sort of criteria for animal selection (Table 2). However, nutritionists were not asked how their clients' choice of selection criteria was implemented. Most nutritionists responded that milk production, followed by fertility, breed, abnormal conformation, and udder conformation, were the primary criteria for animal selection. Animal selection is based on artificial insemination, as described in the previous section. However, nutritionists were not asked if the use of different types of semen was based on the cow conformation or production, nor were they asked if artificial insemination was only used for selected cows. In general, selection to increase milk production in dairy cattle can have negative side effects on fertility traits (Windig et al. 2006). However, since daily milk yield per cow on dairy farms serviced by the Brazilian nutritionists surveyed is still low (averaging 17.7 kg) when compared with other countries (ANUALPEC 2015), milk production should still be applied in the future as the main selection criterion.

Most nutritionists surveyed reported that their clients form groups based on milk production, followed by age and lactation stage (Table 2). In general, the objective of animal grouping based on milk production is to match cows' nutritional requirements at different lactation stages. Nevertheless, Phillips and Rind (2001) argued that the absence of interaction among cows in either different lactation stages or different ages may result in decreased milk production. Bach et al. (2006) noted no differences in either dry matter intake (DMI) or milk production when groups of primiparous and multiparous cows were mixed. Although little evidence supports the idea that milk production must be the main criterion for animal group formation, dairy farms in Brazil should keep using this criterion in the future because average milk production per cow still needs to be improved (6 kg per animal per day; ANUALPEC 2015).

Most nutritionists surveyed reported that their clients replace <10% of their herd annually, followed by 10%–20% and more than 20% (Table 2). According to Calus et al. (2015), a decrease in voluntary culling rate, i.e., the percentage of dairy cows in a herd replaced by heifers on a yearly basis leads to an increase in herd productive life, which may negatively affect milk production in the future. In addition, nutritionists indicated

Table 2. Selection criteria and animal trading in dairy cattle operations from Brazil according to consulting nutritionists surveyed.

Item	Mean	Minimum	Maximum	Mode
Percentage of clients who trade animals	49.3	0	100	10
Clients who use some criteria for animal selection (%; $n = 41$)	79.1	0	100	100
	No. of responses		**% of responses**	
Primary criteria used for animal selection by dairy cattle operations ($n = 40$)				
Milk production	32		80.0	
Fertility (reproduction)	4		10.0	
Breed	2		5.0	
Abnormal conformation (stifle and hock joints)	1		2.5	
Udder conformation	1		2.5	
Primary criteria used for group formation ($n = 36$)				
Milk production	34		94.4	
Age (lactation number)	1		2.8	
Lactation stage (early, mid, and late)	1		2.8	
Annual percentage of herd replacement ($n = 40$)				
<10%	20		50.0	
10%–20%	18		45.0	
More than 20%	2		5.0	

that 49.3% of their clients trade their animals with other dairy farmers or at auctions. Trading negotiations involve either the purchase of good-producing cows or sale of poor-producing cows, calves, and heifers. Considering that approximately 50% of that calves are born males, and that 71% of the nutritionists reported that their clients donate or slaughter these calves right after birth (Table 3), we can assume that among those 49.3% of nutritionists' clients who trade animals, most trade dairy calves, heifers, or cows, which would decrease the amount of animals available for herd replacement. This may explain why 95% of the nutritionists surveyed reported that their clients replace <20% of the herd annually.

Calf management

Calf management practices are summarized in Table 3.

Methods of colostrum delivery

Most nutritionists (about 51%) surveyed and reported that their clients used a controlled colostrum delivery with buckets and bottles, or forced ingestion via esophageal feeder ($n = 2$, 4.7%; Table 3). The remaining nutritionists interviewed reported that their clients practiced ad libitum feeding with bottles and buckets and nursing of dams (Table 3). Kehoe et al. (2007) reported that 87% of the clients surveyed in the United States used colostrum-controlled delivery with bottle and that only 2% of the clients let calves nurse the dam. When the supply of colostrum is controlled or fed on an ad libitum basis using bottles or buckets, the intake can be measured. However, when calves consume colostrum directly from the cow, intake cannot be controlled; therefore, the immune status of the calves, as well as the immunoglobulin G (IgG) intake, will be unknown (Pritchett et al. 1991). It should be noted that nutritionists were not asked about the amount of colostrum fed, nor were they asked about the time of colostrum feeding relative to calving.

Colostrum storage

Most nutritionists reported that their clients do not store any colostrum (Table 3), whereas others responded that their clients use frozen colostrum (good colostrum is frozen for future use), and only one nutritionist reported having clients who utilize colostrum silage, i.e., colostrum fermented under anaerobic conditions at temperatures around 22.5 °C (Ferreira et al. 2013). The management and feeding of high-quality colostrum is important to transfer passive immunity (Phipps et al. 2016) because the colostrum contains immunoglobulins, mainly IgG, which, when absorbed, protects calves from infectious disease (Furman-Fratczak et al. 2011). Kehoe et al. (2007) reported that 38% of dairy operations stored frozen colostrum, 22% refrigerated colostrum, 2% used the colostrum silage method (no freezing), and 38% of the dairy operations had no type of colostrum storage. On the other hand, Vasseur et al. (2010) reported that most dairy farms in Quebec, Canada (98.3%) used fresh colostrum, and only 32.2% of farms had stocks of colostrum. It is noteworthy that dairies assessed by Kehoe et al. (2007) and Vasseur et al. (2010) are not similar to Brazilian dairies. Based on these data, colostrum storage might be a way to control its quality and reduce calves' morbidity during their first months of life (Vasseur et al. 2010); however, most clients serviced by the

Table 3. Calf management adopted by dairy operations in Brazil according to consulting nutritionists surveyed.

Item	No. of responses	% of responses
Methods of colostrum delivery		
Controlled with buckets and bottles	22	51.1
Ad libitum with buckets and bottles	13	30.2
Nursing the dam	6	14.0
Forced ingestion (via esophageal feeder)	2	4.7
Colostrum storage		
None	28	65.1
Frozen colostrum	14	32.6
Colostrum silage	1	2.3
Primary method for milk feeding of calves		
Bucket	25	58.1
Bottle	11	25.6
Bucket with nipple	4	9.3
None	3	7.0
Type of milk used to feed calves ($n = 41$)		
Saleable milk	29	70.7
Waste milk	10	24.4
Milk replacer	2	4.9
Daily milk intake per calf		
2–3 L	4	9.3
4–6 L	36	83.7
More than 6 L	3	7.0
Frequency of milk feeding of calves		
Two times daily	41	95.3
Three times daily	2	4.7
Destination of milk containing antibiotic residues ($n = 40$)		
Discarded	21	52.5
Fed to calves	19	47.5
Type of housing for calves ($n = 42$)		
Pens (housed individually)	32	76.2
Group housing	10	23.8
Main criteria for weaning ($n = 42$)		
Age	15	35.7
Live weight	15	35.7
Concentrate intake	12	28.6
Primary roughage source offered to calves		
Hay	15	34.9
Corn silage	13	30.2
Sugarcane bagasse	8	18.6
None	5	11.6
Sugarcane	1	2.3
Haylage	1	2.3
Primary concentrate source offered to calves ($n = 41$)		
Finely ground corn	20	48.8
Total mixed ration	14	34.1
Cracked corm	7	17.1
Destination of male dairy calves ($n = 38$)		
Donation	23	60.5
Slaughter right after birth	4	10.5
Veal	4	10.5
Pastured and sold (about 1 yr old)	3	7.9
Finished on feedlots	3	7.9
Sale	1	2.6

nutritionists interviewed do not store any colostrum. As described earlier, in general, Brazilian dairy cattle systems consist of small-sized operations with lower milk production per cow, which may explain the lack of resources available to freeze colostrum. In addition, no evidence suggests that dairy farms in Brazil without stored colostrum are forced to underfeed calves.

Primary method for milk feeding of calves

Most nutritionists indicated that their clients used bucket, followed by bottle, and then bucket with nipple to feed milk to calves (Table 3). In terms of milk feeding, Li-Feng et al. (2017) reported that there were no significant effects on calves' body weight or average daily gain when different milk feeding methods were compared; however, results were inconclusive in that other studies reported positive effects on calf performance when buckets with nipples were used (de Passille 2001; Jensen 2003). All equipment used for milk feeding should go through proper sanitization. Therefore, each dairy operation may adopt the method that best fits its management.

Milk feeding

Most nutritionists reported the use of saleable milk, followed by waste milk, mainly with antibiotic residuals from mastitis treatment or dry-cow therapy, and milk replacer. In addition, the most common daily milk intake per calf recommended by the nutritionists interviewed was 4–6 L (Table 3). The same recommendation was reported by Vasseur et al. (2010). Rosenberger et al. (2017) fed calves with whole pasteurized milk at 6, 8, 10, or 12 L daily and then reported that higher milk allowances resulted in weight gain advantages before weaning that could persist beyond weaning. Moreover, in terms of frequency of milk feeding of calves, most nutritionists recommended two times daily, followed by three times daily.

Destination of milk containing antibiotic residues

Most nutritionists reported that their clients discard milk containing antibiotic residues, whereas the remainder indicated that their clients use antibiotic-containing milk to feed calves (Table 3). It is well known that milk containing antibiotic residues may cause digestive disorders, such as diarrhea, because antibiotic-sensitive bacteria are killed or suppressed, whereas drug-resistant bacteria multiply, disrupting the intestinal flora (Selim and Cullor 1997), which may negatively affect calves' immunity and performance. It is documented in the literature that calves fed milk containing antibiotic residues might excrete resistant bacteria through their feces [EFSA Panel on Biological Hazards (BIOHAZ) et al. 2017], which might cause serious problems related to antimicrobial resistance. The current regulation in Brazil does not forbid the use of antibiotic-containing milk to feed calves.

Type of housing for calves and main criteria for weaning

A total of 72.6% of nutritionists indicated that their dairy clients housed preweaned calves in individual pens, followed by group housing (Table 3). Nutritionists recommended age, followed by live weight and intake of determined amounts of concentrate feedstuffs as the main criteria for weaning, and they recommended an average age for weaning of calves that ranged from 60 to 80 d ($n = 23$, 53.5%), followed by 81–90 d ($n = 14$, 32.6%), <60 d ($n = 3$, 7%), and more than 90 d ($n = 3$, 7%).

Roughage and concentrate sources offered to calves

Nutritionists reported that hay was the primary roughage source offered to preweaned calves, followed by corn silage, sugarcane bagasse, sugarcane, and haylage (Table 3). Few nutritionists recommended no type of roughage source to calves, resorting only to concentrate feedstuffs. Instead, most nutritionists surveyed reported that finely ground corn was the main concentrate source recommended for calves, followed by a total mixed ration and cracked corn. In studies conducted at American and Canadian dairy farms (Vasseur et al. 2010; USDA 2018), calves also had access to some source of roughage and concentrate before weaning. In addition, according to Suárez et al. (2006), calves consuming concentrates differing in carbohydrate composition had greater rumen development than calves fed only milk replacer.

Destination of male dairy calves

Most nutritionists reported that their clients donate these animals, followed by slaughter right after birth, trade as veal, pasture and sell, finish on feedlots, and sell right after birth (Table 3). Brazilian dairy farmers could add value to male dairy calves by growing and finishing them on feedlots, as typically done in the United States (Samuelson et al. 2016). However, the lack of infrastructure, facilities, and proper equipment and knowledge limits the adoption of a feedlot operation on a dairy farm. Unfortunately, we did not collect data on use of sexed semen.

Dairy cow lactation diets

Commodities

As shown in Table 4, corn was the primary source of grain used in lactation diets ($n = 37$, 97.4%), followed by barley ($n = 1$, 2.6%). In addition, 33 (82.5%) nutritionists reported that the primary grain processing method recommended was finely ground, followed by only cracked ($n = 4$, 10%), high-moisture harvesting and storage ($n = 2$, 5%), and pellets ($n = 1$, 2.5%). Kellogg et al. (2001) also reported that corn was the most common grain source used for high-producing Holstein herds in the United States. Zinn et al. (2002) and Wilkerson et al. (1997) reported that the starch from corn might become more available using such processing methods as steam-flaking or high-moisture harvesting and storage,

Table 4. Commodities and feeding frequency recommended for lactation diets according to the Brazilian consulting nutritionists surveyed.

Item	No. of responses	% of responses
Primary grain used ($n = 38$)		
Corn	37	97.4
Barley	1	2.6
Primary grain processing method ($n = 40$)		
Finely ground	33	82.5
Only cracked	4	10.0
High-moisture harvesting and storage	2	5.0
Pellets	1	2.5
Level of concentrate inclusion in lactation diets (% of DM; $n = 41$)		
<30%	0	0.0
30%–40%	12	29.3
41%–50%	18	43.9
51%–60%	11	26.8
More than 60%	0	0.0
Level of grain inclusion in lactation diets (% of DM; $n = 40$)		
<20%	2	5.0
20%–30%	8	20.0
31%–40%	11	27.5
41%–50%	11	27.5
51%–60%	8	20.0
More than 60%	0	0.0
Type of energy unit used to formulate lactation diets ($n = 37$)		
Total digestible nutrients (TDN)	15	40.5
Nonfiber carbohydrate (NFC)	11	29.7
Net energy for lactation (NE_L)	7	18.9
Metabolizable energy (ME)	4	10.8

Note: DM, dry matter.

rather than dry rolling and fine grinding. Therefore, most dairy operations in Brazil do not adopt processing methods to maximize starch digestion. Because most of the corn fed in Brazil is flint type (Oliveira and Millen 2014), dairy farms could take advantage of more extensive grain processing methods to increase milk yield per cow.

As for the inclusion of concentrate, or nonforage ingredients, in lactation diets [dry matter (DM) basis; Table 4], 29.3% ($n = 12$) of nutritionists recommended from 30% to 40%, 43.9% ($n = 18$) recommended from 41% to 50%, and 26.8% ($n = 11$) reported clients that used from 51% to 60% of concentrate feedstuffs. Moreover, the average recommended level of concentrate inclusion in lactation diets reported by nutritionists in this study was 49.5%. Only two nutritionists (5%) recommended <20% of grain inclusion in lactation diets, whereas eight (20%) reported including from 20% to 30%, 22 (55%) included from 31% to 50%, and eight (20%) recommended from 51% to 60%. Feeding highly fermentable diets to dairy cattle could lead to metabolic disorders, such as acidosis, and impair fiber digestibility (NRC 2001); however, the average recommended concentration of neutral detergent fiber (NDF) in lactation diets recommended by nutritionists was 35.4%, which, according to the NRC (2001), does not represent a risk in terms of acidosis. Therefore, Brazilian dairy operations could benefit from including more concentrate into lactation diets, which would increase milk yield. Still, the cost of concentrate feedstuffs is the most limiting factor, especially for small-sized dairy operations.

Minerals and additives

Only 22 of 43 nutritionists answered the questions on minerals. The average Ca concentration recommended for lactation diets was 0.70% of the DM (minimum = 0.5%, maximum = 1%, and mode = 0.8%). The P concentration recommended for lactation diets was 0.41% of the DM (minimum = 0.3%, maximum = 0.6%, and mode = 0.4%). The Ca and P concentrations reported by our respondents are 13% and 28% greater than the NRC (2001) recommendations of 0.62% and 0.32%, respectively.

Twenty-four of 28 nutritionists who responded to the question on additives reported that ionophores were the primary feed additive used in lactation diets and that the recommended level of ionophore was 15.9 mg kg^{-1} of DM on average (minimum = 10 mg kg^{-1} of DM, maximum = 30 mg kg^{-1} of DM, and mode = 15 mg kg^{-1} of DM). It has been demonstrated that ionophores, lipid-soluble entities that carry ions across a cell

Table 5. Use of concentrate by-product in lactation diets by the Brazilian consulting nutritionists surveyed.

Item	No. of responses	% of responses		
Primary concentrate by-product used in lactation diets ($n = 39$)				
Citrus pulp pellets	20	51.3		
Soybean hulls	8	20.5		
Whole cottonseed with hay	8	20.5		
Brewers' and distillers' grains	1	2.6		
Corn-gluten feed	1	2.6		
Corn germ	1	2.6		
	Mean	**Minimum**	**Maximum**	**Mode**
Percentage of clients who use some sort of by-products in lactation diets ($n = 40$)	88.1	20	100	100
Typical range and maximum inclusion of concentrate by-products in lactation diets (% of DM; $n = 39$)				
Mean (%)	14.7	3.0	33.0	10.0
Maximum (%)	23.6	8.0	60.0	20.0
Typical level of inclusion of primary concentrate products used in lactation diets (% of DM)				
Citrus pulp pellets ($n = 20$)	17.8	8.0	33.0	20.0
Soybean hulls ($n = 8$)	12.3	3.0	25.0	10.0
Whole cottonseed with hay ($n = 8$)	9.1	5.0	15.0	5.0
Brewers' and distillers' grains ($n = 1$)	10.0	10.0	10.0	10.0
Corn-gluten feed ($n = 1$)	10.0	10.0	10.0	10.0
Corn germ ($n = 1$)	30.0	30.0	30.0	30.0

Note: DM, dry matter.

Table 6. Roughage levels and recommended concentrations of fiber by the Brazilian consulting nutritionists surveyed.

Item	No. of responses	Mean	Minimum	Maximum	Mode
Typical range and maximum inclusion of roughage in lactation diets (% of DM)					
Mean (%)	37	50.5	25	85	50
Maximum (%)	36	69.4	50	100	70
Typical level of inclusion of primary roughage sources used in lactation diets (% of DM)					
Corn silage	29	49.2	25	70	50
Pasture	3	66.6	55	85	—
Fresh, chopped sugarcane	3	51.7	45	60	—
Grass silage	2	45.0	40	50	—
Average recommended concentrations of fiber for lactation diets based on preferred fiber analysis method (% of DM)					
Neutral detergent fiber	24	35.4	25	75	30
Physically effective neutral detergent fiber (peNDF)	6	27.0	25	32	25
Acid detergent fiber	2	22.0	19	25	—

Note: DM, dry matter.

membrane, may improve milk yield and reduce ketosis at 30 mg kg^{-1} of DM (McGuffey et al. 2001). However, the question related to ionophores did not address which specific ionophores were used. Sodium bicarbonate ($n = 2$, 7.1%), prebiotics ($n = 1$, 3.6%), and yeasts ($n = 1$, 3.6%) were also cited as the primary feed additive used in lactation diets. Kellogg et al. (2001) observed that sodium bicarbonate (78.8%) was the most commonly used supplement in rations of high-producing cows in the USA, followed by yeast (58.3%), bypass fat (46.2%), and tallow (27.3%).

Concentrate by-products

Table 5 summarizes the use of concentrate by-products in lactation diets. Most clients (88.1%) served by the nutritionists surveyed fed some sort of by-products in lactation diets. The average level of inclusion of concentrate by-products in lactation diets recommended by the nutritionists was 14.7% (minimum = 3%, maximum 33%, and mode = 10%). In addition, when asked about the maximum level of inclusion of concentrate by-products in lactation diets, nutritionists reported that it was 23.6%, on average. According to

recommendations provided by the nutritionists, citrus pulp pellets constituted the primary concentrate by-product included in lactation diets ($n = 20$, 51.3%), followed by soybean hulls ($n = 8$, 20.5%), whole cottonseed with hay ($n = 8$, 20.5%), brewers' and distillers' grains ($n = 1$, 2.6%), corn-gluten feed ($n = 1$, 2.6%), and corn germ ($n = 1$, 2.6%). The level of inclusion of citrus pulp pellets was 17.8% (minimum = 8%, maximum 33%, and mode = 20%). Nutritionists also indicated that soybean hulls and whole cottonseed with hay are widely used at the dairy operations they served with means of 12.3% and 9.1%, respectively. Dairy cattle nutritionists recommend concentrate by-products, such as citrus pulp pellets, soybean hulls and whole cottonseed with hay because, in general, no reduction in milk and protein contents occurs when they are fed (Noftsger et al. 2000; Williams et al. 2017). The by-products described prevent lactate accumulation and help to avoid excessive fermentation in the rumen, resulting in increased total tract digestibility of DM, organic matter, and NDF (Kelzer et al. 2009).

Roughage sources and levels

The mean roughage inclusion recommended by nutritionists in lactation diets was 50.5% (minimum = 25%, maximum 85%, and mode = 50%; Table 6). In addition, nutritionists reported that the maximum level of roughage inclusion recommended in lactation diets was 69.4% (minimum = 50%, maximum 100%, and mode = 70%; Table 6). Corn silage was the primary roughage source utilized in lactation diets ($n = 30$, 79%), followed by pasture ($n = 3$, 7.9%), sugarcane ($n = 3$, 7.9%), and grass silage ($n = 2$, 5.3%). Kellogg et al. (2001) showed that 91% of the operations in the United States also used corn silage as the primary source of roughage. Nutritionists answered that the recommended level of inclusion of corn silage in lactation diets was 49.2% (DM basis), whereas the recommended inclusion level of fresh, chopped sugarcane was 51.7% (DM basis; Table 6). Corn silage is one of the most widely used and studied roughage feeds for dairy cows (NRC 2001).

Energy units and methods for fiber analysis

When asked about the type of energy unit used to formulate lactation diets (Table 4), 40.5% ($n = 15$) of the nutritionists reported total digestible nutrient (TDN), 29.7% ($n = 11$) used nonfiber carbohydrate (NFC), 18.9% ($n = 7$) used net energy for lactation (NE_L), and 10.8% ($n = 4$) reported the use of metabolizable energy (ME). The TDN was also the energy unit most recommended by feedlot cattle nutritionists in a survey conducted by Millen et al. (2009) and Oliveira and Millen (2014). According to the NRC (2001), the NE_L provides more accurate values for energy available than TDN; however, in Brazil, information on NE_L is scarce for most feedstuffs used to formulate lactation diets. The NRC and CPM-Dairy software programs, which are used by most nutritionists surveyed to formulate diets, calculate diet NE_L; however, labs in Brazil, where samples of diets and feedstuffs are sent for chemical analysis, usually report energy units as TDN.

With respect to the preferred method of fiber analysis, 76.3% ($n = 29$) of the nutritionists preferred NDF, whereas the physically effective NDF was cited by 18.4% ($n = 7$) participants, and 5.3% ($n = 2$) nutritionists preferred acid detergent fiber (ADF). In addition, average recommended concentrations of NDF, physically effective NDF, and ADF were 35.4%, 27%, and 22%, respectively (Table 6). The average concentrations of NDF and ADF recommended by the Brazilian nutritionists surveyed exceed the minimum level (25% and 17%, respectively) recommended by the NRC (2001), which means that fiber inclusion levels might be decreased and concentrate co-product levels of inclusion might be increased if proper feeding management is adopted to avoid milk fat depression. Moreover, as the energy content of lactation diets becomes higher, methods of fiber analysis, such as physically effective NDF, as determined via the Penn State Particle Separator (Heinrichs and Kononoff 1996), may become more popular among dairy cattle nutritionists to monitor the risk of digestive disorders.

Mixers and feeding management information

Information about mixers and feeding management information is shown in Table 7. Nutritionists reported that 39.1% of their clients do not use any type of mixer, 32.6% used truck-mounted mixers (trucks used to mix and delivery the rations), 15.9% used only delivery trucks, and 12.5% used stationary mixers and delivery trucks. Typically, when only delivery trucks are utilized, the final mixing is made manually in the feed bunks right after delivery of the ration. When asked about the methods of feed delivery, nutritionists indicated that 52.6% of their clients used programmed delivery per pen based on feed bunk scores, indicating that the amount of feed offered per pen is known and controlled daily, whereas 47.4% of the clients adopted the continuous delivery system in which kilograms offered per pen are not controlled. The facts that approximately 40% of nutritionists' clients did not use any type of mixer and about 47% did not control the amount of feed offered to cows may, together, be related to the 46.5% ($n = 20$) of the participants with clients producing <1000 kg of milk daily, indicating that small-sized, low milk production dairy farms may need to invest in equipment and technology to increase production. In addition, the average mixing time for lactation diets was 9 min (mode = 10 min), and the DM content of lactation diets recommended by nutritionists was 45.3% (mode = 45%).

Nutritionists were asked about the feeding frequency used at the dairy operations serviced (Table 7), and 70.7% ($n = 29$) reported that their clients feed cows two times daily, 24.4% ($n = 10$) responded three times daily, 2.4% ($n = 1$) reported having clients who feed cows only once a day, and 2.4% ($n = 1$) answered that their clients

Table 7. Mixers and feeding management information provided by the Brazilian consulting nutritionists surveyed.

Item	No. of respondents	Mean
Mixers		
Clients who do not use any mixer (%)	32	39.1
Clients who use truck-mounted mixers (%)	36	32.6
Clients who use only delivery trucks (%)	29	15.9
Clients who use stationary mixer/delivery truck (%)	31	12.5
Feed delivery		
Clients who use programmed delivery per pen (%)	28	52.6
Clients who use continuous delivery (%)	28	47.4

	No. of responses	**% of responses**
Feeding frequency for lactation diets ($n = 41$)		
One time daily	1	2.4
Two times daily	29	70.7
Three times daily	10	24.4
More than three times daily	1	2.4
Bunk management ($n = 37$)		
1.0%–3.0% orts	12	32.4
3.0%–5.0% orts	19	51.4
5.0%–10.0% orts	1	2.7
Clean-bunk management	3	8.1
Do not use any bunk management	2	5.4

	Mean	**Minimum**	**Maximum**	**Mode**
Daily feeding interval (h; $n = 34$)	8.3	4.0	24.0	8.0
Average mixing time for lactation diets (min; $n = 34$)	9.0	0	30	10
Dry matter content for lactation diets (%; $n = 33$)	45.3	20	82	45

feed more than three times daily. When cows are on pasture, it is noteworthy that feed is delivered in the milking parlor. Moreover, the daily feeding interval averaged 8.3 h (mode = 8 h). Although feeding frequency seems to affect sorting (DeVries et al. 2005), milk yield and milk composition are unaffected (Hart et al. 2014). Thus, the ideal feeding frequency must be defined based on operational cost and logistical management of the farm.

With respect to bunk management, most nutritionists ($n = 19$, 51.4%) recommended leaving bunks within a range from 3% to 5% of orts and 32.4% ($n = 12$) from 1% to 3% of orts, while 8.1% ($n = 3$) recommended clean-bunk management, and 5.4% ($n = 2$) recommended no bunk management at all. Only 2.7% ($n = 1$) of nutritionists recommended leaving a range from 5% to 10% of orts (Table 7). Most nutritionists (54.1%) recommend bunks with 3% orts or more, and this may have been influenced by those 40% of nutritionists' clients who did not use any type of mixer, as well as the 47% who did not control the amount of feed offered to cows, which leads nutritionists in a more conservative direction with respect to bunk management to ensure that cows will not run out of feed.

Therefore, any recommendation to increase milk production based on greater levels of concentrate inclusion should be made carefully because it is desirable that dairy operations own the proper equipment for mixing diets, as well as delivering feed to the cows.

Protein and fat recommendations for lactation diets

The protein and fat recommendations for lactation diets are summarized in Table 8. The average crude protein concentration recommended by the nutritionists was 15.7% (mode = 15%). When asked if they formulated diets for rumen-degradable protein (RDP), 70.6% ($n = 25$) of the nutritionists answered "yes". In addition, the recommended average concentration of RDP in lactation diets was 9% (mode = 10%). The average urea concentration recommended by nutritionists interviewed was 0.7% (mode = 0.5%). Finally, all nutritionists interviewed ($n = 33$, 100%) reported the use of soybean meal as the primary protein source in lactation diets. The average crude protein concentration of 15.7% recommended by the nutritionists exceeded by 0.2% and 1.6% the NRC (2001) recommendations for cows of large breeds in early- and mid-lactation stages, respectively. However, the level of 9% RDP recommended by the nutritionists surveyed is lower than the 11.3% and 10.4% recommended by the NRC (2001) for cows of large breeds in early- and mid-lactation stages, respectively.

The average dietary fat concentration recommended by the nutritionists surveyed was 3.5% (mode = 4%; Table 8). In addition, the maximum dietary fat

Table 8. Protein and fat recommendations for lactation diets used by the Brazilian consulting nutritionists surveyed.

Item	Mean	Minimum	Maximum	Mode
Recommended level of crude protein (% of DM; $n = 33$)	15.7	12.0	22.0	15.0
RDP recommended for lactation diets (% of DM; $n = 34$)	9.0	5.5	12.0	10.0
Recommended level of urea (% of DM; $n = 20$)	0.7	0.2	1.1	0.5
Recommended dietary fat (% of DM; $n = 37$)	3.5	1.0	5.5	4.0
Typical level of inclusion of main sources of fat used in lactation diets (% of DM)				
Whole cottonseed with lint ($n = 19$)	16.5	9.0	21.0	18.0
Rumen-protected fat ($n = 10$)	3.4	1.0	5.5	3.5
Soybean grain ($n = 5$)	3.4	3.0	4.0	—
Primary protein source used in lactation diets ($n = 33$)	**No. of responses**		**% of responses**	
Soybean meal	33		100	
Main source of fat in lactation diets ($n = 33$)				
Whole cottonseed	18		54.5	
Rumen-protected fat	10		30.3	
Soybean grain	5		15.2	

Note: RDP, rumen-degradable protein; DM, dry matter.

concentration recommended was 5.4% (minimum = 3%, maximum = 7.5%, and mode = 6%). The main source of fat in lactation diets was whole cottonseed with lint (high in protein, fat, fiber, and energy; $n = 18$, 54.5%), followed by rumen-protected fat ($n = 10$, 30.3%) and soybean grain ($n = 5$, 15.2). The level of inclusion of whole cottonseed with lint in lactation diets was 16.5% (DM basis), whereas the inclusion level of both rumen-protected fat and soybean grain was 3.4% (DM basis; Table 8). The greater use of whole cottonseed with lint is a result of its low cost when compared with other sources of fat and also because it is a source of fiber and protein as well. According to NRC (2001), fat is typically fed to increase the energy density of the diet, but fat supplementation has other potential benefits such as increased absorption of fat-soluble nutrients and reduced dustiness of feed. However, milk-yield response to supplemental fat may be influenced by several factors, including basal diet, stage of lactation, energy balance, fat composition, and amount of supplemental fat.

Prepartum management recommendations

Nutritionists reported that 81.2% of their clients use some sort of prepartum nutritional management (minimum = 20%, maximum = 100%, and mode = 100%). Most nutritionists surveyed ($n = 17$, 53.1%) recommended the use of a total mixed ration with a negative dietary cation–anion balance, followed by pasture and concentrate containing a negative dietary cation–anion balance ($n = 5$, 15.6%), pasture and concentrate ($n = 4$, 12.5%), total mixed ration containing low Ca and high Mg ($n = 3$, 9.4%), only pasture ($n = 2$, 6.3%), and only corn silage and concentrate ($n = 1$, 3.1%). On average, prepartum nutritional management started 28.1 d before calving (minimum = 15 d, maximum = 60 d, and mode = 30 d), according to nutritionists' recommendations. Leno et al. (2017) reported that older cows had the greatest response to the negative dietary cation–anion balance and had decreased prevalence of hypocalcemia after calving, resulting in improved plasma Ca status in the immediate postpartum period and increased DMI and milk production in the 3 wk after parturition.

Major problems reported by the nutritionists

The major health problem faced by nutritionists' clients was mastitis ($n = 26$, 83.9%), followed by acidosis ($n = 3$, 9.7%), hoof problems ($n = 1$, 3.2%), and retained placenta ($n = 1$, 3.2%). Heuwieser et al. (2009) conducted a mail survey in Germany and reported that the most common health problems in large herds were retained placenta, milk fever, and left displacement of abomasum. Boldyreva (2014) reported that mastitis was among the major health problems faced by a dairy herd in Europe and North American countries. However, in Brazil, dairy farms are characterized by reduced productivity (ANUALPEC 2015); this contributes to a lack of trained employees and specialized services, which, in turn, results in incorrect adoption of sanitization procedures and management during cow milking and then leads to health problems, such as mastitis. Indeed, the lack of trained employees may be a main contributor to mastitis becoming a huge health issue in Brazilian dairy cattle operations because the main cause of mastitis is, in fact, related to the absence of hygienic procedures to control it (Bradley 2002).

In an open-ended question, nutritionists ($n = 30$) were asked about the most challenging issue to put in practice their nutritional recommendations, and 46.7% ($n = 14$) of the participants identified the lack of trained employees as the most challenging issue, 23.3% ($n = 7$) reported financial resources, 20% ($n = 6$) indicated administrative problems, 3.3% ($n = 1$) reported the culture and

traditionalism of the farmers, 3.3% (n = 1) reported roughage annual planning, and 3.3% (n = 1) indicated equipment availability and precision to do the task they were designed for, such as forage chopping.

Conclusions

The present survey provides an overview of management practices adopted by dairy farmers and nutritional recommendations currently applied by dairy cattle nutritionists in Brazil. This overview reveals a broad spectrum of dairy production systems in Brazil. Generally, the Brazilian system of milk production is characterized by dairy operations that own 100 cows or less. Here, the grazing system predominates, and most cow herds produce <1000 kg of milk daily. As a result, most dairy farmers in Brazil may need to invest in equipment and employee training, which seems to be one of the primary obstacles to improving starch utilization in lactation diets, reducing the incidence of mastitis, and increasing milk production. Overall, the variation among responses provided by the 43 nutritionists surveyed was large, which reflects the differences in the educational background of these consultants and the type of production systems they serviced. The most critical points identified by this survey was low milk yield, incidence of mastitis as the major health problem, lack of proper mixing and delivery of rations, and destination of male calves. The design of production systems that include making the use of male calves more profitable to dairy farmers should be further investigated. This survey of nutritional and management practices adopted by dairy cattle nutritionists should aid in the development of research for the dairy industry in Brazil and similar tropical climates, as well as identify critical points for planning strategies for future improvements.

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