Environment, nutrition, and management practices for far-off, close-up, and fresh cows on Canadian dairy farms—A retrospective descriptive study

Rita Couto Serrenho,^{1*} Christopher Church,² Darren McGee,² and Todd F. Duffield¹

¹Population Medicine, University of Guelph, Guelph, ON, N1G 2W1, Canada

²Elanco Animal Health, Greenfield, IN 46140

ABSTRACT

The complex and interrelated management components of dairy farming are associated with health, production, and profitability of the herd, yet there is limited objective data on current management practices of the far-off, close-up, and fresh periods across Canadian dairy farms. We aimed to describe management practices of Canadian dairy farms by using a pre-existing risk assessment tool and outline potential management opportunities. Upon veterinarians' or producers' request, a transition management risk assessment (The Vital 90, Elanco) was performed by trained observers ($n = 10$) during farm visits ($n = 78$) between August 2014 and March 2018. Most farms were in Ontario ($n = 64$), whereas the remaining were in Alberta ($n = 5$), British Columbia ($n = 4$), Manitoba ($n = 1$), Prince Edward Island ($n = 2$), Newfoundland ($n = 1$), and Saskatchewan ($n = 1$). The study included 79 questions about nutrition, pen management, and cow comfort of the dry (approximate ranges: far-off, -60 to -20 d in milk; close-up, -20 to 0 d in milk) and fresh (0 – 30 d in milk) periods. The herds averaged 125 milking cows, and most had 2 defined dry groups (81%). Freestall (FS; 54%) and straw-bedded loose pack (BP; 81%) were the most common housing systems observed in the far-off and close-up periods, respectively. Heifers and cows were housed together in 56, 80, and 59% of the far-off, close-up, and fresh pens, respectively. A large proportion of the far-off (FS: $>100\%$ stocking density; BP: <9.3 m²/cow; 41%), close-up, and fresh pens (FS: $>80\%$ stocking density; BP: <13.9 m²/cow; 52 and 49%, respectively) were overstocked. Poor water access was observed across all periods (65, 58, and 24% of the far-off, close-up, and fresh, respectively). Only a few farms had proper heat abatement systems in place (absence of properly functioning soakers or fans; $<10\%$ in the

dry and 15% in the fresh periods). Cows were able to sort their ration in 60% of the dry period pens and 31% of the fresh pens. In 73% of the farms, fresh cow health monitoring protocols were not in place. Colostrum cows and sick cows were housed together in 40% of the farms; 59% separated the newborn from the dam within 2 to 12 h of birth with colostrum harvested immediately thereafter. This work describes prevalent management practices in the dry and fresh periods and highlights areas for potential improvement. Future research should focus on the associations between management choices and health performance of dairy farms.

Key words: dairy cow, practices, assessment, transition

INTRODUCTION

A successful lactation relies on excellent transition period management (Jones and Kammel, 2014). Transition period is commonly defined as 3 wk prepartum and postpartum (Grummer, 1995), but it is recognized that the whole dry period influences health and performance of the upcoming lactation (Dann et al., 2006; Abuelo et al., 2021). Assessment of the transition period management can often be challenging given the interrelationships between risk factors and their complexity (Overton and Waldron, 2004; Nydam et al., 2017; Mills et al., 2020). The main goals of transition period management are to maximize nutrient intake and energy availability, control mineral balances, and optimize immunity (Nydam et al., 2017). Dairy producers, farm staff, and agriculture professionals assess different nutritional approaches, grouping strategies, housing facilities, and labor availability to maximize animals' health and welfare and farm efficiency (Jones and Kammel, 2014), which creates unique transition management strategies between farms.

Mills et al. (2020) investigated the perceived barriers for transition period improvement on Canadian dairy farms. In this qualitative study, nutrition and pen management, veterinary involvement, and producer's attitude toward change were defined as the main barriers for transition improvement (Mills et al., 2020). The

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*Corresponding author: rcoutose@uoguelph.ca

best management practices, defined by research and organizational guidelines, are not always the practices observed on-farm, and many reasons could explain the existing gap between research data and on-farm reality. The improvement of transition management and motivation for change are driven by benchmarking (Sumner et al., 2018) and the ability to detect bottlenecks, which are not possible without good record keeping and continuous analysis of herd health and performance (Nydam et al., 2017).

Management and welfare guidelines and best practices for disease prevention are available [e.g., ProAction (Dairy Farmers of Canada, 2021), Code of Practice (National Farm Animal Care Council, 2009)]. However, research data are constantly evolving, and some of the recommendations are not updated regularly. This, along with the lack of information regarding current practices of Canadian dairy farms justifies the importance of describing current the management practices.

By highlighting management opportunities, researchers and dairy consultants will be able to help producers improve transition management practices and herd performance. Standardized management definitions as well as consistent and uniform assessment across herds, will reduce the gap between research data and on-farm practices and help identify the common management flaws during the transition period. Our objectives were to assess current management practices in Canadian dairy farms and provide insight of on-farm management opportunities to improve animal health, and performance of dairy farms.

MATERIALS AND METHODS

This work is reported using the Strengthening the Reporting of Observational Studies in Epidemiology—Veterinary Extension (STROBE-Vet) guidelines (O'Connor et al., 2016).

Farms and Inclusion Criteria

Canadian dairy herds ($n = 78$; 74 Holstein and 4 Jersey farms) were selected based on a convenience sampling method. Farms were included in the study based on pre-existing data and producer's consent to share the data. Most farms were located in Ontario ($n = 64$), whereas the remaining were in Alberta ($n = 5$), British Columbia ($n = 4$), Manitoba ($n = 1$), Prince Edward Island ($n = 2$), Newfoundland ($n = 1$), and Saskatchewan ($n = 1$). Upon veterinarian's, feed advisor's or producer's request, a transition management risk assessment was performed by trained observers ($n = 10$). The majority of the observers were veterinarians ($n = 9$), and each received training from Elanco on

proper use of the risk assessment tool [questionnaire; The Vital 90 Days Analyzer – Dairy Risk Assessment (**Vital 90 dRisk**), Elanco, Greenfield, IN]. Farm visits (one per farm) to fulfill the questionnaire (risk assessment tool) occurred between August 2014 and March 2018.

Risk Assessment Tool

The risk assessment tool, the Vital 90 dRisk was developed by a group of dairy experts and aims to evaluate transition management (from 60 d before until 30 d after parturition). The tool is available as a mobile application (Elanco, 2013) for iPad on AppStore (Apple Inc.). It was created to provide an objective management evaluation. It had as a main goal helping consultants and producers minimize the animal health risk during the transition period. The development of the tool was based on published management research and nutritional recommendations and, in cases of insufficient or unavailable data, on expert opinion risk analysis (Cooke, 1991). The tool includes questions about comfort, nutrition, and pen management of the dry (far-off, approximately -60 to -20 DIM; close-up, approximately -20 to 0 DIM), and fresh (approximately 0 – 30 DIM) periods. Observers filled each survey in real-time while assessing each particular period on-farm. Each period is divided into 3 management areas: feeding management, pen management, and cow comfort. At the completion of each transition management assessment, the Vital 90 dRisk presents the top 8 bottlenecks, scored by an internal weighting system. The observer asked the producer, veterinarian, and feed advisor to discuss the respective 8 topics, and select the top 3 that they would prioritize. The final report would include only the selected 3 topics. The scored weighted system and selection of bottlenecks by farm were not a matter of study in this work.

Data Processing and Analysis

The original data set included the following variables: farm name, farm number, observer, date of the farm visit, number of milking cows (continuous), number of dry cows (continuous), number of dry groups (one vs. 2), and far-off, close-up, and fresh period specific questions presented in Tables 1, 2, 3, and 4. The risk assessment tool does not have a classification for a tiestall category for housing facility. In this case, tiestall facilities were entered as freestall (**FS**). From DHI data available for 71 farms at the time of the farm visit, 32% ($n = 23$) milked their cows in tiestall facilities (pipeline), 54% ($n = 38$) in a milking parlor, and 14% ($n = 10$) in an automatic milking system.

The risk assessment tool is structured so that for each variable, there is both a question number (**Q#**) and the written question itself. For the majority of questions, the written answer options represent a designated risk level for the transition period (A, B, or C for the majority of the questions, with A = optimal, B = suboptimal, and C = poor, based on expert opinion; Cooke, 1991).

The data extracted from the risk assessment tool is organized by period (far-off, close-up, and maternity, and fresh period) and housing system within each period. Depending on these responses, the software follows different programming paths – a **Q#** is a unique entry, but the same question might have a different **Q#** depending on the housing system. For example, Q5, Q6, and Q13 represent the same written question “far-off: characterize heat stress abatement” with the same answer options for cows in FS, dry lot, and straw-bedded loose-pack (**BP**) pen, respectively. Thus, when the only difference between repeated questions was the housing type, questions were merged. Merging was not possible when the question was the same, but the answer options differed; in this case, the original questions were kept. Questions with less than 3 entries (and not possible to merge) or with the same entry for all farms were removed. We included 79 questions about comfort, nutrition, and pen management of the dry (far-off and close-up) and fresh periods. All the data cleaning steps are presented in Supplemental Figure S1 (<https://doi.org/10.17632/krn357zs6r.1>; Couto Serrenho, 2021).

Cow comfort data from farms with only one dry cow group, when possible, were repeated in the far-off and close-up questions. Thus, questions relative to far-off and close-up represent the period relative to calving that cows were exposed to. When questions relative to the close-up pen did not apply to farms with one dry group (e.g., pen movements), those entries were only presented in the far-off questions.

To assess the overall stocking density in the far-off and close-up groups, 2 new variables were created. Because stocking density questions had different answers according to housing system, we merged answers based on their classification of management (A, B, or C).

Body condition score of the cows within pen was assessed by the observers (1–5 scale, measured in 0.25-point increments; Ferguson et al., 1994). Ration sortability was assessed visually based on the length of straw and hay particles present. The comfort of cows housed in FS pens were assessed using the size of the stall and the bedding surface offered.

Data cleaning (described above; e.g., deletion of original variables without information), processing (e.g., merging the same question from different programming paths), and analysis (descriptive statistics) were performed using SAS (SAS Institute Inc.) to analyze the prevalence of each response. Descriptive statistics were obtained using the FREQ and MEANS procedures.

RESULTS

The data set included 78 Canadian dairy herds. The herds averaged 125 ± 100 SD milking cows and most had 2 defined dry cow groups (81%). In 90% of the farms, first lactation cows were $\geq 85\%$ of mature weight. Freestall (54%) and BP (81%) pens were the most common housing systems observed in the far-off and close-up periods, respectively (Table 1). Heifers and cows were housed together in 56, 80, and 59% of the far-off, close-up, and fresh pens, respectively (Table 1). This section is organized in order by period of the transition (far-off, close-up, and fresh periods, respectively) and area of management (feeding, pen management, and cow comfort). All questions, respective answer options (optimal, suboptimal, and poor), and results (prevalence) of each section are presented in Tables 2–10.

Table 1. Proportions of housing system and parity grouping during dry (far-off and close-up) and fresh periods of 78 Canadian dairy farms included in a transition cow management descriptive study

Item	Far-off ¹	Close-up ¹	Fresh and maternity ¹
Housing system, % (n)			
Straw-bedded loose pack	41.0 (32)	80.8 (63)	53.9 (42)
Freestall ²	53.9 (42)	18.0 (14)	46.2 (36)
Dry lot or pasture	5.1 (4) ³	1.3 (dry lot = 1)	—
Cows and heifers grouping, %			
Together	55.8	79.5	59.0
Separately	44.2	20.5	41.0

¹Days relative to calving: far-off = from dry-off (~60 d before parturition) until 22 d before parturition; close-up = from 21 d before until parturition; fresh and maternity: first 30 d after parturition.

²Due to nonexistent tiestall option, farms with this type of housing facilities were entered as freestall. From DHI data available for 71 farms at the time of the farm visit, 32% (n = 23) milked their cows in tiestall facilities.

³Dry lot, n = 3; pasture, n = 1.

Table 2. Prevalence of feeding management practices of the far-off dry period on 78 Canadian dairy farms; prevalence results obtained through a risk assessment of the transition where answers A, B, or C, for the majority of the questions correspond to “optimal,” “suboptimal,” and “poor” practices, respectively, according to expert’s knowledge at the time of development of the risk assessment tool)

Question	Answer A	Percent	Answer B	Percent	Answer C	Percent	NA ¹
Feed quality	No evidence of altered fermentation profiles, offensive odors or spoilage in the ration	88.3	Some slight off-odors, mild evidence of spoilage in the ration	10.4	Consistent evidence of altered fermentation profiles, offensive odors and spoilage in the ration	1.3	1 ²
Ration sortability	Chopped forage, well mixed, very few particles >3 in. (7.6 cm) but sufficient effective fiber	39.0	Chopped forage, well mixed, effective fiber but long particles present; moderately sortable	35.1	Poor mixed, nonchopped, lots of long sortable particles or questionable effective fiber/overly processed	26.0	1 ²
Feeding approach	Balanced, ad libitum TMR; if pasture, active monitoring and balancing of pasture access	67.5	Partial TMR or restricted access to TMR; if pasture, inconsistent monitoring and balancing of pasture access	15.6	No TMR; cows have the ability to pick and choose what to eat; poor management of pasture and inadequate balancing	16.9	1 ²
Nutritional philosophy	Low energy, high roughage (0.58–0.62 Mcal of NE _L /lb or 15–17 Mcal of NE _L /d) (5.35–5.72 MJ of NE _L /kg or 63–71 MJ of NE _L /cow) ³	52.0	Moderate energy, high roughage (0.63–0.65 Mcal of NE _L /lb or 18–19 Mcal of NE _L /d) (5.81–6.00 MJ of NE _L /kg or 72–76 MJ of NE _L /cow)	35.1	Excessively high or low energy (<0.58 or >0.66 Mcal of NE _L /lb or <15 or >19 Mcal of NE _L /d) (<5.35 or >6.00 MJ of NE _L /kg or <63 or >76 MJ of NE _L /cow)	13.0	1 ²
Protein level of the ration	>1,000 g of ME	59.7	850–1,000 g of ME	27.4	<850 g of ME	12.9	16 ⁴
Feedbunk access	≥30 in. (≥0.76 m)/cow	80.5	22–29 in. (0.56–0.75 m)/cow	10.4	<22 in. (<0.56 m)/cow	9.1	1 ²
Bunk maintenance	Bunks cleaned daily; if pasture delivered to clean fenceline area	55.8	Bunks usually cleaned regularly but not daily; if pasture, feed often but not always delivered to clean fenceline area	40.3	Bunks not regularly cleaned; moldy feed present; if pasture, feed is delivered to muddy location	3.9	1 ²
Management of stanchions lockups	Cows have prior experience with stanchions; exhibit good utilization; <1 h lockup/d	98.5	Cows have little to no prior experience with stanchions but little to no reluctance to use stanchions; cows are locked for 1–2 h/d	1.5	Cows have no prior experience with stanchions and are reluctant to use them; prolonged locked up (>2 h/d)	—	13 ⁵
Body condition	<10% of cows are ≥4.0 ⁶	62.3	10–25% of cows are ≥4.0	24.7	>25% of cows are ≥4.0	13.0	1 ²
Water access	≥4 in. (≥10.2 cm) linear access/cow; clean water; more than 2 locations in pen ⁷	20.8	2–3.9 in. (5–10 cm) linear access/cow; moderately clean water; more than 2 locations in pen	14.3	<2 in. (<5 cm) linear access/cow; dirty water; only 1 location in pen	64.9%	1 ²

¹NA: Missing frequency or nonapplicable.

²Farm with far-off on a pasture system. The risk assessment tool sets up different questions and answer options for this system.

³Nutritional philosophy defined based on Daum et al. (2006) and Janovick et al. (2011).

⁴Farms with one dry cow group (n = 15) and 1 pasture-based farm (n = 1).

⁵Farms without lock-up stanchions for close-up cows.

⁶Recommendation based on Duffield and Bagg (2002).

⁷Recommendations based on Smith et al. (2006).

Table 3. Prevalence of pen management practices of the far-off dry period on 78 Canadian dairy farms; prevalence results were obtained through a risk assessment of the transition where A, B, or C, for the majority of the questions, correspond to “optimal,” “suboptimal,” and “poor” practices, respectively, according to expert’s knowledge at the time of development of the risk assessment tool

Question	Answer A	Percent	Answer B	Percent	Answer C	Percent	NA ¹
How often are dry cow pens observed?	Pen is walked daily to detect any problems	95.2	Pen is checked several times per week	3.2	No routine observation of pen other than moving cows	1.6	16 ²
Distribution of d dry	≥90% cows with 40–70 d dry	22.1	75–89% cows with 40–70 d dry	27.3	<75% cows with 40–70 d dry	50.7	1 ³
Group movement patterns of cows	Cows are moved into pens once weekly in groups of 10 or more	44.2	Cows are moved twice weekly; or weekly in groups <10 cows	28.6	Cows are moved daily, are moved individually, or intervals between moves are >7 d	27.3	1 ³

¹NA: Missing frequency or nonapplicable.

²Farms with one dry-cow group (n = 15) and one pasture-based farm (n = 1).

³Farm with far-off on a pasture system. The risk assessment tool sets up different questions and answer options for this system.

Far-off Period

Feeding Management. Most farms (68%) provided a balanced ad libitum TMR, but a restricted TMR access (non-ad libitum) or absence of a TMR (hay and corn silage fed separately) was observed in approximately one-third of the farms (Table 2). More than half of the farms (60%) could improve far-off ration sortability (Table 2) by controlling particle length, amount of effective fiber, and mixture of the ration. Moderate or excessively high or low energy were offered in 35% and 13%, respectively, of the far-off groups; and >50% of the far-off cows had access to low energy (5.35–5.72 MJ of NE_L/kg), high roughage diet (Table 2). Far-off dry cows were offered >1,000 g of MP/d in 60% of the farms. An excessive proportion (>10%) of overconditioned cows (BCS ≥4) were presented in 38% of the farms. Most of the far-off (81%) cow groups had ≥0.76 m/cow (optimal option) of feedbunk access, and bunks were cleaned daily in 56% of those (Table 2). Less than one-fourth of the far-off cow groups, had proper water access (optimal option; defined as ≥10.2 cm/cow linear access with clean water and with waterers in at least 2 locations within the pen (Table 2).

Pen Management. In the majority of the far-off (95%) groups, cows were observed at least once daily (Table 3). In approximately half of far-off groups (51%), more than one-fourth of the cows had dry periods outside of the recommended range (40–70 d); in 44% of the far-off groups, cows were moved once per week in groups of ≥10 cows (Table 3).

Housing and Cow Comfort. In far-off cows housed in FS pens (53.8%), there was opportunity for bedding and comfort improvement in approximately half of the farms (52%); lunge access was obstructed in 36% of the FS pens, and the stall dimensions were not ideal (optimal dimensions: 1.27–1.32 m wide and ≥1.77 m long) in 74% of these farms (Table 4). Overall, stocking density of the far-off period, considering both FS and BP pens, could be improved in 41% of the farms (Table 4). Lack of a proper and functioning heat abatement system was observed in 91% of far-off groups (Table 4). Dead-ends (side of the alley with no exit; one or more) were observed in 27% of the far-off pens (Table 4).

Close-up Period

Feeding Management. In the close-up groups, a partial or restricted access to TMR was observed in 19% of the farms and the absence of a TMR was observed in 15%; 60% of the farms could improve close-up ration sortability (Table 5). “Excessively high or low energy” (>6.1 or <5.5 MJ of NE_L/kg) was offered in 16% of the farms; 38% of the close-up cows were offered low

Table 4. Prevalence of cow-comfort management practices of the far-off dry period on 78 Canadian dairy farms; prevalence results were obtained through a risk assessment of the transition where A, B, or C, for the majority of the questions, correspond to “optimal,” “suboptimal,” and “poor” practices, respectively, according to expert’s knowledge at the time of development of the risk assessment tool

Question	Answer A	Percent	Answer B	Percent	Answer C	Percent	NA ¹
Bedding and comfort ²	Loose, dry bedding with ample cushion; bed space and neck rail placement allow cows to stand squarely in stalls and rest comfortably ≥30 × 30 in. (≥0.76 × 0.76 m) of unobstructed head space for lunge	47.6	Semi-moist bedding or moderate cushion; bed space and neck rail placement allow most cows to stand squarely in stalls and rest comfortably Obstructed head space but side rail permits side lunging	47.6	Very wet bedding or inadequate cushion; bed space or neck rail position does not accommodate cows adequately Obstructed forward and obstructed side lunge space	4.8	36 ³
Lunge access in the freestalls ²	50–52 in. (1.27–1.32 m) wide and ≥70 in. (1.77 m) long <100% stocking density	64.3	45–49 in. (1.14–1.26 m) wide and 65–69 in. (1.65–1.76 m) long 100–120% stocking density	33.3	<45 in. (<1.14 m) wide and <65 in. (<1.65 m) long >120% stocking density	2.4	36 ³
Dimensions of the freestalls ²	Daily grooming; >100 ft ² (9.3 m ²)/cow Properly functioning soakers and fans	26.2	Regular grooming; 75–100 ft ² (7–9.3 m ²)/cow Soaker/misting system or fans present but not both; adequate shade over feedbunk	71.4	Insufficient grooming; <75 ft ² (<7 m ²)/cow	2.4	36 ³
Freestall stocking density ²	No dead-ends; cows have free access 24/7	78.4	One dead-end present; no other limited access within housing	18.9	No/improperly functioning heat abatement	2.7	41 ⁴
Bedding and comfort and stocking density ⁵ Heat abatement	Well maintained and properly installed rubber flooring	37.5	Grooved and maintained flooring	28.1	Two or more dead-ends present; severely restricted access between housing and feeding area	34.4	47 ⁶
Describe access to rest areas or to freestalls		9.1		44.2	Inadequately grooved or slick or uneven flooring	46.8	1 ⁷
Footing and flooring		72.7		22.1		5.2	1 ⁷
Overall stocking density ⁹		24.3		68.9		6.8	4 ⁸
		59.4		23.2		17.4	9

¹NA: Missing frequency or nonapplicable.

²Only applicable for freestall facilities.

³Other facilities than freestall.

⁴Other facilities than freestall (n = 36) and freestall with one dry group (n = 5). Socking density in far-off cows from farms with only one dry group are represented under close-up questions. Representation of those farm in this section was not possible given the different answer options in the far-off and close-up groups.

⁵Only applicable for straw-bedded loose pack facilities.

⁶Other facilities than straw-bedded loose pack.

⁷Farm with far-off on a pasture system. The risk assessment tool sets up different questions and answer options for this system.

⁸Nonapplicable to dry lot or pasture facilities.

⁹Assessment of stocking density (optimal, suboptimal, poor) considering freestall and straw-bedded loose-pack pens.

energy (5.5–5.8 MJ of NE_L /kg) – high roughage diet (Table 5). In close-up, 50% of the groups were offered <1,200 g of MP. An excessive proportion (>10%) of overconditioned ($BCS \geq 4$) cows were presented in 42% of the farms. Most of the close-up (94%) cow groups had ≥ 0.76 m/cow of feedbunk access (optimal option), and bunks were cleaned daily in 62% of those (Table 5). Less than one-third of the close-up cow groups had proper water access (Table 5). In 15% of the farms, the DCAD of close-up diet was not controlled; in 6% of the farms, a negative DCAD diet was offered and urine pH of the group was assessed weekly to monitor group acidification level. The majority of the farms (78%) offered a diet balanced for minerals of major importance in transition or a negative DCAD diet without consistently monitoring urine pH (Table 5).

Pen Management. In the majority of the close-up (80%) groups, cows were observed at least once daily (Table 6). In the close-up, three-fourths of the groups had 90% of their cows spending between 14 to 28 d in the close-up pen (Table 6). Less than half of the producers moved their close-up cows once per week in groups of 10 or more cows, whereas in 22% of the close-up groups cows were moved daily, individually, or at intervals greater than 7 d (Table 6). If the farm had a separated calving pen (nonexistent in 23 farms), in the majority (63%) of the farms, cows were moved within 6 h of parturition, 9% were moved within 1 d, and approximately one-third of the cows were moved between one and 9 d before the expected calving date or based on parturition signs (Table 6).

Housing and Cow Comfort. Most farms provided a BP pen (81%), whereas 18% were housed in a FS pen (Table 7). In the FS pens, bedding and comfort of close-up cows could be improved in 43% of the farms; lunge access (obstructed head space; $<0.76 \times 0.76$ m) could improve in 36%, and 86% of the stalls had appropriate dimensions (Table 7). In the close-up area, stocking density of FS pens could improve in 36% of the farms (80–100% stocking density), whereas 64% of the farm kept the close-up cows with a stocking density below 80% (Table 7). Close-up cows in BP pens were overstocked in 56% of the farms (<13.9 m²/cow), with 18% having <9.3 m²/cow (Table 7). Overall, close-up cows were overstocked in approximately half of the farms (52%). Lack of a proper and functioning heat abatement system was observed in 91% of close-up groups (Table 7). Dead-ends (one or more) were observed in 22% of the close-up housing facilities (Tables 7).

Fresh Period, Including Maternity

Feeding Management. Fresh cow ration sortability could be improved in 31% of the farms. A balanced

TMR was fed for ad libitum consumption in 77% of the fresh groups, but a partial or restricted access to the TMR was observed in 17%, and the remaining proportion (6%) had no TMR (e.g., hay and corn silage fed separately; Table 8). Energy and critical nutrients were excessive or deficient in 5% of the fresh cow diets; protein level and AA profiles could be improved in 17% of the farms. In most fresh cow pens, there was ≥ 0.76 m/cow available at the feedbunk (87%), and feedbunk was cleaned daily (85%; Table 8). Water access and quality could be improved in 41% of the fresh cow pens (Table 8).

Pen Management. In almost all farms (>95%), cows would spend <1 h locked up for screening purposes and <2 h/d away from the home pen (Table 9). In 27% of the farms, cows were daily monitored with a complete physical exam, in 64% a less rigid daily monitor program was in place with a partial physical exam, and in 9% of the farms, the methods of screening for fresh cow for health issues were not systematically performed. In most of the farms, the newborn was removed from the dam within 2 to 12 h postpartum (59%; Table 9). In 40% of the farms, colostrum cows were housed with hospital cows (Table 9).

Housing and Cow Comfort. In FS pens, stall dimensions could be improved in more than 50% of the farms; more than 80% had appropriate unobstructed head lunge space (Table 10). Bedding and comfort of FS was suboptimal in >62% of the farms; with bedding moist, lack of cushion, or neck rail placement not allowing all cows to rest comfortably (Table 10). Considering both housing systems (FS and BP pens), fresh cows were overstocked in 48% of the farms (FS: >80% stocking density; BP: <13.9 m²/cow). Heat stress abatement strategies could be improved in 85% of the fresh cow facilities and footing and flooring could be improved in half of the facilities (Table 10).

DISCUSSION

This work objectively describes the prevalence of transition cow management practices in Canadian dairy herds. Our results demonstrate that stocking density, water access, heat abatement, and ration sortability are among the biggest opportunities for improvement across far-off, close-up, and fresh cow groups. In our study, the far-off period seems to have the greatest room for improvement versus the close-up and fresh cow periods. When comparing the different transition phases (far-off, close-up, and fresh periods), the far-off and its management implications are the least studied (Nydam et al., 2017) and might partially explain the poorer management practices observed for this group.

Tables 5. Prevalence of feeding management practices of the close-up dry period on 78 Canadian dairy farms; results were obtained through a risk assessment of the transition where A, B, or C, for the majority of the questions, correspond to “optimal,” “suboptimal,” and “poor” practices, respectively, according to expert’s knowledge at the time of development of the risk assessment tool

Question	Answer A	Percent	Answer B	Percent	Answer C	Percent	NA ¹
Feed quality	No evidence of altered fermentation profiles, offensive odors or spoilage in the ration	93.6	Some slight off-odors, mild evidence of spoilage in the ration	6.4	Consistent evidence of altered fermentation profiles, offensive odors and spoilage in the ration	0.0	0
Ration sortability	Chopped forage, well mixed, very few particles >3 in. (7.6 cm) but sufficient effective fiber	39.7	Chopped forage, well mixed, effective fiber but long particles present; moderately sortable	41.0	Poor mixed, nonchopped, lots of long sortable particles or questionable effective fiber/overly processed	19.2	0
Feeding approach	Balanced, ad libitum TMR; if pasture, active monitoring, and balancing of pasture access	65.4	Partial TMR or restricted access to TMR; if pasture, inconsistent monitoring and balancing of pasture access	19.2	No TMR; cows have the ability to pick and choose what to eat; poor management of pasture and inadequate balancing	15.4	0
Nutritional philosophy	Low energy, high roughage (0.60–0.63 Mcal of NE _L /lb or 15–17 Mcal of NE _L /d) (5.5–5.8 MJ of NE _L /kg or 63–71 MJ of NE _L /cow) ²	38.1	Moderate energy, high roughage (0.64–0.66 Mcal of NE _L /lb or 18–19 Mcal of NE _L /d) (5.9–6.1 MJ of NE _L /kg or 72–76 MJ of NE _L /cow) ³	46.0%	Excessively high or low energy (<0.59 or >0.66 Mcal of NE _L /lb or <15 or >19 Mcal of NE _L /d) (<5.5 or >6.1 MJ of NE _L /kg or <63 or >76 MJ of NE _L /cow)	15.9	15 ⁴
Protein level of the ration	>1,200 g of MP	50.0	1,000–1,200 g of MP	38.5	<1,000 g of MP	11.5	0
Feedbunk access	≥30 in. (≥0.76 m)/cow	93.6	22–29 in. (0.56–0.75 m)/cow	5.1	<22 in. (<0.56 m)/cow	1.3	0
Bunk maintenance	Bunks cleaned daily; if pasture delivered to clean fenceline area	61.5	Bunks usually cleaned regularly but not daily; if pasture, feed often but not always delivered to clean fenceline area	34.6	Bunks not regularly cleaned; moldy feed present; if pasture, feed is delivered to muddy location	3.9	0
Management of stanchions lockups	Cows have prior experience with stanchions; exhibit good utilization; <1 h lockup/d	96.9	Cows have little to no prior experience with stanchions but little to no reluctance to use stanchions; cows are locked for 1–2 h/d	3.1	Cows have no prior experience with stanchions and are reluctant to use them; prolonged locked up (>2 h/d)	0.0	13 ⁵
Body condition	<10% of cows are ≥4.0 ⁶	57.7	10–25% of cows are ≥4.0	32.1	>25% of cows are ≥4.0	10.3%	0
Water access	≥4 in. (≥10.2 cm) linear access/cow; clean water; more than 2 locations in pen ⁷	29.5	2–3.9 in. (5–10 cm) linear access/cow; moderately clean water; more than 2 locations in pen	12.8	<2 in. (<5 cm) linear access/cow; dirty water; only 1 location in pen	57.7%	0
Calcium mobilization management	DCAD, TMR, urine pH monitored weekly	6.4	DCAD–urine pH inconsistently monitored; or no DCAD supplements, but major minerals balanced	78.2	No monitoring urine pH but no DCAD; or no DCAD supplements and major minerals not balanced	15.4%	0

¹NA: Missing frequency or nonapplicable.

²Nutritional philosophy defined based on Dann et al. (2006) and Janovick et al. (2011).

³Nutritional philosophy defined based on McCarthy et al. (2015).

⁴Farms with only one dry cow group.

⁵Farms without lock-up stanchions for close-up cows.

⁶Recommendation based on Duffield and Bagg (2002).

⁷Recommendations based on Smith et al. (2006).

Table 6. Prevalence of pen management practices of the close-up dry period on 78 Canadian dairy farms; results were obtained through a risk assessment of the transition where answers A, B, or C, for the majority of the questions, correspond to “optimal,” “suboptimal,” and “poor” practices, respectively, according to expert’s knowledge at the time of development of the risk assessment tool

Question	Answer A	Percent	Answer B	Percent	Answer C	Percent	NA ¹
How frequently are cows observed?	Pen walked every 2–3 h daily to detect any problems or to move cows	19.2	Pen checked several times per day	79.5	Inconsistent monitoring of close-up pen	1.3	0
Distribution of d in the close-up pen	>90% of cows with 14–28 d	74.6	>85% of cows with 14–28 d	14.3	>15% of cows <10 d or >45 d	11.1	15 ²
Group movement patterns of cows	Cows are moved into pens once weekly in groups of 10 or more	42.3	Cows are moved twice weekly; or weekly in groups <10 cows	35.9	Cows are moved daily; are moved individually, or intervals between moves are >7 d	21.8	0
Time spent in calving pen if separated calving pen	<6 h before calving	63.6	<1 d before calving	9.1	1–9 d before calving	27.3	23 ³

¹NA: Missing frequency or nonapplicable.

²Farms with only one dry cow group.

³Farms without calving pen.

In previous qualitative research, Canadian dairy producers considered the unclear definition of “transition period” as a barrier for management improvement (Mills et al., 2020). The “transition period” is commonly defined as the period between 3 wk before (close-up) up to the first 3 wk after parturition (Grummer, 1995), but many (Dann et al., 2006; Abuelo et al., 2021) highlight the importance of the far-off period for the subsequent lactation. Our study described existing management practices beyond the traditional definition of transition by including management from drying off until approximately 30 DIM (as designed by the developers of the risk assessment tool). The discussion will focus on the greatest opportunities identified from this study for improving nutrition, pen management, and housing environment.

Nutritional Management of the Transition Period

When assessing nutrition management, the focus should be, not only on diet formulation and preparation, but also consider actual intake (Grant and Dann, 2017; DeVries, 2019). In fact, eating behavior is more commonly the limiting factor for DMI than the dietary formulation itself (Grant and Dann, 2017). Producers can optimize DMI by controlling and adapting stocking density, grouping strategies, social interactions, and barn design (Grant and Albright, 2001).

It has been well documented that overcrowding and feedbunk competition compromise natural eating behavior and influence DMI (Albright, 1993; Mentink and Cook, 2006). As cattle increase in girth during pregnancy, the ideal linear bunk space must also increase. Thus, the recommended linear bunk space available per cow is greater in the dry period (minimum of 0.76 m/cow in the transition group, Nordlund et al. (2006)) than mid to late lactation (0.6 m/cow, National Farm Animal Care Council, 2009). Lockup stanchions help ensure the minimal space per cow at the feed bunk; they reduce competition and aggression at the bunk, and increase food access to submissive cows (Krawczel and Grant, 2008; DeVries, 2019). Sova et al. (2013) demonstrated an association between feed bunk length and milk characteristics (group-average milk fat increased by 0.06 percentage points and SSC decreased 13% with a 10 cm/cow increase). In our study, most farms had lockup stanchions in both the dry and in lactating periods. On these farms, cows and heifers were exposed to lockup stanchions before transition, which allows for good utilization of stanchions before the transition period. Although feed bunk access did not seem to be a major concern in our study, pen stocking density was not ideal (worst at the close-up, followed by fresh and

Tables 7. Prevalence of cow-comfort management practices of the close-up dry period on 78 Canadian dairy farms; results were obtained through a risk assessment of the transition where answers A, B, or C, for the majority of the questions correspond to “optimal,” “suboptimal,” and “poor” practices, respectively, according to expert’s knowledge at the time of development of the risk assessment tool

Question	Answer A	Percent	Answer B	Percent	Answer C	Percent	NA ¹
Bedding and comfort ²	Loose, dry bedding with ample cushion; bed space and neck rail placement allow cows to stand squarely in stalls and rest comfortably	57.1	Semi-moist bedding or moderate cushion; bed space and neck rail placement allow most cows to stand squarely in stalls and rest comfortably	35.7	Very wet bedding or inadequate cushion; bed space or neck rail position does not accommodate cows adequately	7.1	64 ³
Lunge access in the freestalls FS	$\geq 30 \times 30$ in. ($\geq 0.76 \times 0.76$ m) of unobstructed head space for lunge	64.3	obstructed head space but side rail permits side lunging	35.7	Obstructed forward and obstructed side lunge space	0.0	64 ³
Dimensions of the freestalls ²	50–52 in. (1.27–1.32 m) wide and ≥ 70 in. (1.77 m) long	14.3	45–49 in. (1.14–1.26 m) wide and 65–69 in. (1.65–1.76 m) long	78.6	<45 in. (<1.14 m) wide and <65 in. (<1.65 m) long	7.1	64 ³
Freestall stocking density ²	<80% stocking density	64.3	80–100% stocking density	35.7	>100% stocking density	0.0	64 ³
Bedding and comfort and stocking density ⁴	Daily grooming; >150 ft ² (13.9 m ²)/cow	44.4	Regular grooming; 100–150 ft ² (9.3–13.9 m ²)/cow	38.1	Insufficient grooming; <100 ft ² (<9.3 m ²)/cow	17.5	15 ⁵
Heat stress abatement	Properly functioning soakers and fans	9.0	Soaker/misting system or fans present but not both; adequate shade over feedbunk	48.7	No/improperly functioning heat abatement	42.3	0
Access to rest areas/stall access	No dead-ends; cows have free access 24/7	78.2	One dead-end present; no other limited access within housing	18.0	Two or more dead-ends present; severely restricted access between housing and feeding area	3.9	0
Footings and flooring	Well maintained and properly installed rubber flooring	35.1	Grooved and maintained flooring	59.7	Inadequately grooved/slick/uneven flooring	5.2	1 ⁶
Overall stocking density ⁷		48.1		37.7		14.3	1

¹NA: Missing frequency or nonapplicable.

²Only applicable for freestall facilities.

³Other facilities than freestall.

⁴Only applicable for straw-bedded loose-pack facilities.

⁵Other facilities than straw-bedded loose pack.

⁶Farm with close-up cows on a dry lot facility.

⁷Assessment of stocking density (optimal, suboptimal, poor) considering freestall and straw-bedded loose-pack pens.

Table 8. Prevalence of feeding management practices of the maternity and fresh period (up to 30 DIM) on 78 Canadian dairy farms; results were obtained through a risk assessment of the transition where A, B, or C, for the majority of the questions, correspond to “optimal,” “suboptimal,” and “poor” practices, respectively, according to expert’s knowledge at the time of development of the risk assessment tool

Question	Answer A	Percent	Answer B	Percent	Answer C	Percent	NA ¹
Feed quality	No evidence of altered fermentation profiles, offensive odors or spoilage in the ration	92.3	Some slight off-odors, mild evidence of spoilage in the ration	7.7	Consistent evidence of altered fermentation profiles, offensive odors and spoilage in the ration	0	0
Ration sortability	Chopped forage, well mixed, very few particles >3 in. (7.6 cm) but sufficient effective fiber	69.2	Chopped forage, well mixed, effective fiber but long particles present; moderately sortable	21.8	Poorly mixed, nonchopped, lots of long sortable particles or questionable effective fiber/overly processed	9.0	0
Feeding approach	Balanced, ad libitum TMR; if pasture, active monitoring and balancing of pasture access	76.9	Partial TMR or restricted access to TMR; if pasture, inconsistent monitoring and balancing of pasture access	16.7	No TMR; cows have ability to pick and choose what to eat; poor management of pasture and inadequate balancing	6.4	0
Nutritional philosophy	Carefully balanced for health and productivity	94.9	Deficiencies or excesses of one or more critical nutrients	2.6	Grossly or excessively fermentable carbohydrates or grossly inadequate energy or excessive fiber	2.6	0
Protein level of the ration	MP balance of 95–110%; careful consideration of AA profile	83.3	MP balance of 85–115%; no consideration of AA profile	15.4	MP balance <85% or >115%	1.3	0
Feedbunk access	≥30 in. (≥0.76 m)/cow	87.2	22–29 in. (0.56–0.75 m)/cow	10.3	<22 in. (<0.56 m)/cow	2.6	0
Bunk maintenance	Bunks cleaned daily; if pasture delivered to clean fence line area	84.6	Bunks usually cleaned regularly but not daily; if pasture, feed often but not always delivered to clean fence line area	15.4	Bunks not regularly cleaned; moldy feed present; if pasture, feed is delivered to muddy location	0	0
Body condition	<10% of cows are ≥4.0 ²	93.6	10–25% of cows are ≥4.0	2.6	>25% of cows are ≥4.0	3.9	0
Water access	≥4 in. (≥10.2 cm) linear access/cow; clean water; more than 2 locations in pen ³	59.0	2–3.9 in. (5–10 cm) linear access/cow; moderately clean water; more than 2 locations in pen	16.7	<2 in. (<5 cm) linear access/cow; dirty water; only 1 location in pen	24.4	0

¹NA: Missing frequency or nonapplicable.

²Recommendation based on Duffield and Bagg (2002).

³Recommendations based on Smith et al. (2006).

Table 9. Prevalence of pen management practices of the maternity and fresh period (up to 30 DIM) on 78 Canadian dairy farms; results were obtained through a risk assessment of the transition where answers A, B, or C, for the majority of the questions correspond to “optimal,” “suboptimal,” and “poor” practices, respectively, according to expert’s knowledge at the time of development of the risk assessment tool

Question	Answer A	Percent	Answer B	Percent	Answer C	Percent	NA ¹
Approximate time consumed for screening	<1 h/d spent locked in stanchions	96.2	1–2 h/d spent locked in stanchions	2.6	>2 h/d spent locked in stanchions	1.3	0
Method of screening fresh cows for problems	Rigid daily monitoring and treatment program that includes observing appetite, evaluation of front and rear cow	26.9	Daily but less rigid program consisting of checking one or more prompts (e.g., fever, attitude, milk). Any anomalies prompt exam and assistance	64.1	No routine use of prompts for assistance; no program used to detect sick cows	9.0	0
How are fresh cows handled in the first few days	Colostrum cows separate from sick cows	60.3	Colostrum cows housed with sick cows	39.7	—	—	0
When is the newborn calf removed from the cow	Removed within 2 h of delivery and colostrum is harvested immediately thereafter	37.2	Removed 2–12 h of delivery and colostrum is harvested immediately thereafter	59.0	Inconsistent removal from calving pen; cows often go more than 12 h without milking or movement to fresh pen/fresh ration	3.9	0
Degree of calving trauma	Little or no evidence of tearing/damage to vagina/vulva	84.6	Low occurrence of tearing/damage to vagina/vulva	15.4	Frequent occurrence of cows showing evidence of vaginal/vulval trauma	0	0
How much time are fresh cows away from home pen	<2 h/d spent away from pen	94.9	2–3.5 h/d spent away from pen	3.9	>3.5 h/d spent away from pen	1.3	0

¹NA: Missing frequency or nonapplicable.

Table 10. Prevalence of cow-comfort management practices of the maternity and fresh period (up to 30 DIM) on 78 Canadian dairy farms; results were obtained through a risk assessment of the transition where answers A, B, or C, for the majority of the questions, correspond to “optimal,” “suboptimal,” and “poor” practices, respectively, according to expert’s knowledge at the time of development of the risk assessment tool

Question	Answer A	Percent	Answer B	Percent	Answer C	Percent	NA ¹
Describe lunge access in the freestalls ²	≥30 × 30 in. (≥0.76 × 0.76 m) of unobstructed head space for lunge	81.1%	Obstructed head space but side rail permits side lunging	16.2%	Obstructed forward and obstructed side lunge space	2.7%	41 ³
Management of stanchions lockups	Cows have prior experience with stanchions; exhibit good utilization; <1 h lockup/d	92.9%	Cows have little to no prior experience with stanchions but little to no reluctance to use stanchions; cows are locked for 1–2 h/d	4.3%	Cows have no prior experience with stanchions and are reluctant to use them; prolonged locked up (>2 h/d)	2.9%	8 ⁴
Distance walked/d	Cows walk <1,000 yds/d (<0.5 mile or <914 m) to and from parlor (total distance/d)	98.7%	Cows walk 1,000–2,500 yds/d (0.5–1.4 mile or 914–2,286 m) to and from parlor (total distance/d)	1.3%	Cows walk >2,000 yds/d (>1.4 mile or >2,286 m) to and from parlor (total distance/d)	0%	0
Size of first lactation cows	Weight of 1,250–1,400 lbs (567–635 kg); height of 55–58 in. (1.39–1.47 m); or heifers ≥85% of mature weight	89.7%	Weight of 1,050–1,249 lbs (476–566 kg); height of 52–54 in. (1.32–1.37 m); or heifers 70–85% of mature weight	10.3%	Weight of <1,050 lbs (<476 kg); height of ≤52 in. (≤1.32 m); or heifers <70% of mature weight	0%	0
Dimensions of the freestalls ²	50–52 in. (1.27–1.32 m) wide and ≥70 in. (1.77 m) long	46.0%	45–49 in. (1.14–1.26 m) wide and 65–69 in. (1.65–1.76 m) long	51.4%	<45 in. (<1.14 m) wide and <65 in. (<1.65 m) long	2.7%	41 ³
Bedding and comfort ²	Loose, dry bedding with ample cushion; bed space and neck rail placement allow cows to stand squarely in stalls and rest comfortably	35.1%	Semi-moist bedding or moderate cushion; bed space and neck rail placement allow most cows to stand squarely in stalls and rest comfortably	62.2%	Very wet bedding or inadequate cushion; bed space or neck rail position does not accommodate cows adequately	2.7%	41 ³
Freestall stocking density ²	<80% stocking density	40.5%	80–100% stocking density	54.1	>100% stocking density	5.4	41 ³
Bedding and comfort and stocking density ²	Daily grooming; >150 ft ² (13.9 m ²)/cow	59.5%	Regular grooming; 100–150 ft ² (9.3–13.9 m ²)/cow	31.0	Insufficient grooming; <100 ft ² (<9.3 m ²)/cow	9.5	36 ⁶
Access to rest areas or stall access	No dead-ends; cows have free access 24/7	87.2	One dead-end present; no other limited access within housing	10.3	Two or more dead-ends present; severity restricted access between housing and feeding area	2.6	0
Heat stress abatement	Properly functioning soakers and fans in housing and holding pen	15.4	Soaker/misting system or fans present but not both; holding pen or exit lane cooling present but not optimum; adequate shade over feedbunk	57.7	No/improperly functioning heat abatement	26.9	0
Footing and flooring	Well maintained and properly installed rubber flooring in feeding areas and walkways	50.0	Grooved and maintained flooring in feeding areas and walkways	44.9	Inadequately grooved/slick/uneven flooring in feeding areas and walkways	5.1	0
Overall stocking density ⁷		51.3		41.0		7.7	0

¹NA: Missing frequency or nonapplicable.

²Only applicable for freestall pens.

³Other facilities than freestall for fresh pen and maternity.

⁴Farms without lock-up stanchions for fresh pen and maternity.

⁵Only applicable for straw-bedded loose-pack pens.

⁶Other facilities than straw-bedded loose pack for fresh pen and maternity.

⁷Assessment of stocking density (optimal, suboptimal, poor) considering freestall and straw-bedded loose-pack pens.

far-off periods). This topic is further discussed in the Cow Comfort section.

Ration sortability of the dry period (far-off and close-up) and fresh diets was observed in >50% and 30% of the groups, respectively. Consequences of ration sortability and management strategies are reviewed by Miller-Cushon and DeVries (2017). When cows can choose TMR components (preference for small grain particles in detriment of effect fiber (Miller-Cushon and DeVries, 2017), rumen pH decreases, as well as rumination time, and DMI (Coon et al., 2018). In an overcrowded feed bunk, sorting by dominant cows for more palatable ingredients, leaves mostly long particles for submissive animals (generally, younger and smaller cows) (DeVries, 2019). Overall, sorting alters feeding behavior and DMI (dominant vs. submissive cows) (Olofsson, 1999; DeVries et al., 2005), milk yield and components (fat and protein; Sova et al., 2013; Miller-Cushon and DeVries, 2017; Coon et al., 2018), and health (e.g., greater risk for subacute ruminal acidosis; DeVries et al., 2008). For example, in 22 FS herds (cows with 187 ± 47 DIM; parity of 2.3 ± 0.6), for every 2% increase of long TMR particles sorting (top screen of Penn State Particle Separator; Heinrichs and Kononoff, 2006), milk yield decreased 1 kg/d (Sova et al., 2013).

Water is the most important nutrient for dairy cows and affects the welfare, health, and performance of dairy cows throughout the lactation cycle (Murphy, 1992; NRC, 2001). Yet, we demonstrated that its quality and availability are not ideal (≥ 10.2 cm/cow linear access, clean water, and more than 2 locations in pen) during the dry and fresh periods on the studied farms. Having at least 2 water bowls in the pen was supported by (Andersson, 1987). The author compared drinking frequency of cows ($n = 32$ multiparous cows; 8 cows/bowl) placed in equal pens where waterers were placed closely (0.9 m) versus apart (22 m) and concluded that drinking bouts per cow/day were greater in the latter (7 vs. 8 bouts/d, respectively). It is recommended that the number of water sources in a pen follow the number of social groups (2 water sources per social group; Jones and Kammel, 2017). In groups with less than 100 cows (1 social group), water should be located at least in 2 locations in a pen; in pens with 100 to 200 cows, ideally, the pen will have 4 waterers (Jones and Kammel, 2017). To allow the greatest number of cows to drink at the same time, it is recommended that a minimum of 10 cm (4 in.) per cow be available (Jones and Kammel, 2017). In a literature review regarding water intake, Jensen and Vestergaard (2021) refer to the need for studies assessing the relationship between water availability (waterer length and placement), stocking density, welfare, and productivity to assess current recommendation.

In our study, 15% of the farms did not did not balance close-up diets for major essential minerals or supplement with anionic salts (negative DCAD) in an effort to manage calcium metabolism, and only 6% mentioned using anionic supplements with cow's urine pH monitored weekly. Routine evaluation of urine pH average and variation is critical to control acidification level as well TMR mixing or sorting issues (Charbonneau et al., 2006; Goff, 2008). However, prepartum urine pH assessment can be time consuming, even more so without appropriate facilities to lockup cows. This, in most cases, explains why producers might not use anionic supplementation. The DCAD should first be controlled by balancing minerals (e.g., K, Na, P), followed by anionic supplements [e.g., chloride (Cl^-) can be added] when not possible to achieve the targeted DCAD with the available feed ingredients (Goff, 2008). Despite the extra labor and time needed to control acidification, health and performance benefits of prepartum negative DCAD diets seem to be clear for adult cows (Couto Serrenho et al., 2021a). However, the effects in first lactation cows are still unclear (Lean et al., 2019). The increased time to pregnancy observed in primiparous cows after exposure to a negative DCAD diet (DCAD: -108 vs. $+105$ mEq/kg of DM; Couto Serrenho et al., 2021b) raised questions about the overall benefits of prepartum negative DCAD diets when prepartum heifers and adult cows are housed together. Overall, our data demonstrate that there is opportunity for better adoption of nutritional strategies to manage calcium metabolism.

Pen Management and Grouping Strategies

In our study, most farms had <75% of their cows dry during 40 to 70 d and had 2 dry-cow groups. Although less prevalent for the far-off management area than the close-up and fresh areas, heifers and mature cows were commonly housed together. Separate grouping for heifers and cows might be beneficial because of their different nutritional needs throughout the transition period (far-off, close-up, and lactating; NRC, 2001). In addition, regrouping has been shown to be more stressful for heifers than mature cows; social hierarchy, competition, and previous experience with regrouping help make it less detrimental on older animals (Soonberg et al., 2021). However, group sizes and housing constraints might not allow or justify segregation by age groups or by dry stage (far-off and close-up periods; Jones and Kammel, 2014).

In smaller herds, one dry group might be a more reasonable and economic option. However, a close-up group might still be beneficial to allow targeted supple-

mentation for prepartum cows (e.g., anion or rumen-protected choline supplementation) or potentially for improved rumen adaptation to a lactating cow diet, particularly if no fresh diet exists on the farm.

Cow-calf separation is a controversial topic within the dairy industry and the different options generate controversy among researchers, producers, consultants, and consumers. Most farms (59%) included in our study removed the calf from the dam within 2 to 12 h after birth. Among the advantages of early cow-calf separation is the minimization of stress caused by separation (Weary and Chua, 2000), avoiding exposure of the newborn to the dam's environment to reduce the risk of infectious diseases (Marcé et al., 2011), and increasing the amount of saleable milk (otherwise consumed by the calf; Wagenaar and Langhout, 2007). However, in a systematic review, Beaver et al. (2019) reported a lack of evidence regarding better calf health (scour, pneumonia, or successful passive transfer of IgG) or lower risk of Johne's disease with early cow-calf separation. Most dairy consumers do not support early cow-calf separation (Boogaard et al., 2011; Busch et al., 2017), and keeping cow and calf together for longer periods has shown some health benefits for the cow (udder and uterine health) and calf (greater average daily gain and fewer diarrhea treatments; Weary and Chua, 2000; Krohn, 2001; Meagher et al., 2019). More research is required to fully evaluate the relative merits of both management practices.

Housing and Cow Comfort

It is well recognized that housing and overall management are as important as the dietary composition for cow's well-being and herd health and performance (Krawczel and Grant, 2008; DeVries, 2019). In terms of facilities, our results suggest that heat abatement strategies, cow comfort, and stocking density can all be better addressed on farms.

Heat stress continues to affect the dairy industry and reduces well-being, production, and reproductive performance (Polsky and von Keyserlingk, 2017). In a literature review, Polsky and von Keyserlingk (2017) addressed the detrimental effects of elevated environmental temperatures on affective states, behavior, biological function, and health. Heat abatement strategies help to mitigate the effect of the environmental conditions on transition dairy cows' health, production, and reproductive performance (Becker and Stone, 2020). Among different options, Correa-Calderon et al. (2004) concluded that combined fans and sprinklers provide a more effective heat stress control (reduction of body temperature and heart rate). In our study, a lack of proper heat stress abatement strategies (absence of

properly functioning soakers, fans, or both) was observed in all groups, but the far-off seems to be the most affected period.

Stocking density can be assessed by feed bunk length, the surface of the lying area, or the ratio of cows to stalls (FS barn; De Vries et al., 2016). Overstocking is associated with lameness severity (King et al., 2016), reduction of DMI (especially in submissive cows; DeVries, 2019), milk yield (Bach et al., 2008), fertility (Scheffers et al., 2010), and overall production efficiency (De Vries et al., 2016).

Maximizing utilization of the facilities without compromising welfare, health, and productivity is the overall goal to achieve better economic performance (De Vries et al., 2016). The optimal stocking density varies along the lactation cycle and is sensitive to milk prices and observed milk losses (De Vries et al., 2016). In our study, the ideal stocking density for close-up and fresh groups was set at <100% for far-off and at <80% for close-up periods. Increased prepartum stocking density is associated with more subclinical ketosis in the first week of lactation (Goldhawk et al., 2009) and milk production is reduced. In fact, in first lactation animals, for each 10% stocking density increase above the 80% in the close-up period was observed a 0.7 kg/d milk yield reduction (Oetzel et al., 2007). When commingling, heifers are more affected than older cows (De Vries et al., 2016). This might be explained by the fact that heifer are smaller and more likely submissive than older cows (Silva et al., 2014). Thus, when mature cows and heifers are housed together it is recommended that the stocking density does not surpass 80% stall occupancy in the prepartum period (Oetzel et al., 2007). Silva et al. (2014) did not observe detrimental effects on health, production, or reproductive performance when evaluating 80% versus 100% stocking density in prepartum pens (FS) in Jersey cows segregated by parity (nulliparous cows, $n = 154$; parous cows, $n = 184$). Optimal stocking density for the prepartum period might vary depending on, for example, grouping strategies, breed, and feedbunk space available. Although transition cows need more space (DeVries, 2019), mid- to late-lactation cows in FS pens can be stocked up to 120% without compromising natural behavior and welfare (Krawczel and Grant, 2009).

The introduction of a new animal to the group is a stressful event for both the cows in the existing group and the new cows, especially in submissive animals (Lamb, 1976; Nydam et al., 2017). Although moving cows between pens is an inevitable and necessary management practice, stress events and magnitude caused by adapting the social hierarchy should be avoided as much as possible. Thus, the number of pen movements should be kept at a bare minimum (Lamb, 1976) and

cows should be moved in groups of 3 to 5 cows, which is thought to cause less stress than moving cows individually (Cook and Nordlund, 2004).

When designing pen movement, grouping, and housing, it is a common mistake to consider the average number of calvings rather than extremes when defining the size of the pens. Jones and Kammel (2014) recommended building the pens considering the pen space needed for 90% of the year (small adjustments can be made for the remaining 10% of the time) or, when no data are available, design it to accommodate 140% of the average number of calvings per week. When the facilities do not account for the fluctuating number of calvings over time, producers tend to sacrifice space for far-off cows to provide more space for close-up cows or vice versa. This may lead to overcrowding of far-off cows and late movements from the far-off to the close-up pen. In this case, close-up cows, instead of being exposed to the close-up diet and environment for at least 2 wk before parturition, have their stressors occurring closer to the beginning of lactation.

Final Considerations and Limitations of the Study

The participating farms were selected based on a convenience sample through requests by the herd veterinarian. Both poor (often initiated by the veterinarian) and exceptionally managed (often initiated by the producer) farms were the most likely to request a risk assessment on their farms. Although we cannot eliminate the presence of selection bias in our study, the presence of an equal chance of better versus lesser management helps balance our sample population. Most farms were located in Ontario, thus extrapolation of the results to a larger geographic area should be made with caution. Some degree of selection bias should also be considered because farms were only included if the owner allowed the use of their data. Considering that the risk assessment tool was performed by independent consultants and that the producer wanted a true evaluation of their management, we do not expect significant information bias.

The fact that, in the risk assessment tool, tiestall farms were entered as FS facilities (absence of the tiestall option in the risk assessment tool) might have contributed to a lack of detail regarding this particular housing system prevalent in Ontario and Quebec provinces (Agriculture and Agri-Food Canada, 2020).

The results of this study indicate that there is opportunity to improve management throughout the dry and fresh periods. Among the 3 areas studied (far-off, close-up, and fresh periods), the far-off group parameters showed the most room for improvement. Although we have identified the most common flaws of transition

cow management, dairy consultants need to consider that on each farm, identification of management opportunities and priorities should arise from a complete and thorough transition period assessment. The risk assessment tool used in this study was designed based on both published literature and expert opinion. Due to the lack of field trials assessing welfare, health, production, and economic outcomes from each management practice, the definition of “optimal” or “suboptimal” should be interpreted with caution. Transition management is farm-specific and deserves a unique approach considering herd characteristics, facilities, economics, and producer’s beliefs and motivations with the final aim of setting new goals and promoting change.

Future research should consider an assessment of the effect of these management practices on health and performance at the herd and individual cow levels. Demonstrating direct effects of management practices on disease, milk yield, or both would provide greater evidence of the link between management, performance, and economics and would help to define management priorities on a dairy farm.

CONCLUSIONS

The use of objective tools to assess transition cow management on-farm helps to facilitate in identifying the areas with the greatest overall opportunity for improvement. Among those highlighted in this study include stocking density, water access and availability, heat abatement strategies, and sorting of the rations across far-off, close-up, and fresh periods. This work brings awareness to some areas of opportunity in transition cow management practices, which can help dairy veterinarians, consultants, and producers assess transition management of dairy farms and define transition management bottlenecks. Future research should evaluate the effect of management practices on individual and overall herd performance.

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ORCID

Rita Couto Serrenho <https://orcid.org/0000-0002-7956-7039>

Todd F. Duffield <https://orcid.org/0000-0001-6035-4669>