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Herd Routines and Veterinary Advice Related to Drying-Off and the Dry Period of Dairy Cows

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Abstract: Bovine mastitis at calving or early lactation is often associated with intra-mammary bacterial infections (IMI) at drying-off (DO) or during the dry period (DP). The IMI risk is associated with management routines at the herd, but knowledge on how farmers and veterinarians comply with national recommendations is scarce, as is their attitudes to the importance of such routines. Therefore, the main aims of this study were to collect information on farmer routines and attitudes, and on veterinary advice and attitudes to DO and DP. Associations between routines and advice, and demographic herd and veterinary variables were also studied. Web-based questionnaires were sent to 2472 dairy farmers and 517 veterinarians. The answers were summarized descriptively, and associations with demographics were evaluated using univariable regression models. The response rate was 14% for farmers and 25% for veterinarians. Routines and advice were in line with recommendations at the time of the study in many, but not all, areas of questioning. Significant associations between herd routines or veterinary advice and demographic variables were also found. Milking system and post-graduate training were the variables associated with the largest number of farmer and veterinary answers, respectively. In conclusion, the results indicate a need for more education on good routines during DO and DP. It was also clear that the national recommendations valid at the time of the study were in need of revision.

Keywords: mastitis; drying-off; dry period; dairy cows; management; Sweden

Citation: Persson Waller, K.; Landin, H.; Nyman, A.-K. Herd Routines and Veterinary Advice Related to Drying-Off and the Dry Period of Dairy Cows. *Dairy* **2022**, *3*, 377–399. https://doi.org/10.3390/dairy3020029

Academic Editors: Burim Ametaj and Sven Dänicke

Received: 18 February 2022
Accepted: 9 May 2022
Published: 1 June 2022

1. Introduction

Mastitis in dairy cows is often observed at calving or during the first weeks of lactation, and the dominating reason is bacterial intra-mammary infections (IMI) that may have occurred already at drying-off or during the dry period. In line with this, management routines during these periods have been associated with IMI and mastitis after calving, as reviewed, e.g., by [1–3]. For example, as high milk production at drying-off is a risk factor for IMI, it may be important to adjust the feeding and/or use prolonged milking intervals for a limited period before the dry period to reduce milk production. Moreover, the length of the dry period, hygiene in the close environment of the dry cows, and stress are other risk factors for IMI and mastitis. Recommendations on routines at drying-off and during the dry period have been available for dairy farmers from the main Swedish advisory organization Växa (former Swedish Dairy Organization, Stockholm, Sweden) for many years. Likewise, recommendations are also available in other countries, e.g., [4–6]. The recommendations vary in content, but all contain some advice on feeding and on reductions in daily milk yield.

To our knowledge, only a limited number of studies on routines used by commercial dairy farmers at drying-off and during the dry period have been published [7–10] and none of those were carried out in Sweden. Therefore, the compliance of Swedish farmers with the national recommendations is not known. In addition, we do not know if advice given by field veterinarians working with dairy cattle comply with the recommendations. In addition, the attitudes of farmers and veterinarians to the importance of drying-off and the dry period for animal health and production are not known. A recent publication of ours on routines and advice on dry-cow therapy and the use of internal teat sealants indicated a need for more education and an update of existing recommendations [11].

Therefore, the main objectives were to collect data on herd routines and farmer attitudes as well as on advice and attitudes of veterinarians regarding drying-off and the dry period using web-based questionnaires. Associations between routines and advice, and demographic variables of herds and veterinarians, respectively, were also studied. The long-term goal was to investigate the need for additional information and a revision of recommendations.

2. Materials and Methods

A detailed description of the study design was given in a recent publication [11]. In short, two web-based questionnaires, one for farmers and one for veterinarians, were produced. They included sections with questions about demographics to be answered by the farmer regarding the herd (number of cows per herd, conventional or organic production, average annual milk production per cow, average estimated bulk milk somatic cell count (SCC), milking system, region), or by the veterinarians regarding themselves (year of veterinary degree, country of veterinary degree, gender, post-graduate training in bovine diseases, number of years in cattle practice, number of mastitis cases/month, region). In other parts, questions on drying-off, dry cow therapy with antibiotics, treatment with internal teat sealants, and the dry period were included. In addition, the farmers received questions on housing systems for cows in different stages of lactation. The results from the questions on dry cow therapy with antibiotics and treatment with internal teat sealants were presented by Persson Waller et al. [11]. In the questionnaires, drying-off was defined as the period at the end of lactation when the cow is prepared (via feeding, prolonged milking interval and other management routines) before complete cessation of milking, and the dry period was defined as the period between the last milking of the lactation and calving. The questionnaires were sent by e-mail to 2472 farmers and 517 veterinarians with cattle practice in the end of 2019/beginning of 2020 (late autumn/early winter). These farmers represented 75% of all Swedish dairy farmers at the time.

In summary, the national recommendations for drying-off and the dry period available at the time of the study were: the length of the dry period should be 6–9 weeks (preferably 7 weeks); when necessary, adjustment of the feeding should start approximately 10 weeks before estimated calving, aiming at reducing milk production to a daily milk yield of 15–25 kg at the start of drying-off; the drying-off period should start approximately 7–9 weeks before estimated calving by giving the cow a drying-off ration (i.e., no concentrates, 4 kg DM silage, and free access to straw, mineral feed and water) for approximately one week; at the start of drying-off, the cow should be moved to a separate section of the stable and be milked with a milking interval of 36–48 h 1–3 times (during a maximum 4–5 days), according to a scheme based on daily milk yield at the start of drying-off, with the aim of a daily milk yield of no more than 10–15 kg at the last milking; control of the udder and teat dipping/spraying should be performed morning and evening for 14 days from the start of drying-off; the dry cows should preferably be placed in a stable separate from the lactating cows or, if this is not possible, in a separate section of the same stable as the lactating cows; the bedding should always be dry and clean; the dry cows should be provided with feed of good quality including vitamins and minerals; and stress, e.g., due to overcrowding and regrouping, should be avoided.

Data editing and statistical analyses were performed as described by Persson Waller et al. [11]. In short, the categories of the variables region and bulk milk SCC were adjusted to ensure a sufficient number of herds or veterinarians per category. Descriptive summaries of the answers were performed. Within each group (herds, veterinarians), associations between the answers and herd or veterinary variables were evaluated using univariable logistic and multinomial regression models when questions had enough observations per outcome and answer category. In the statistical models, the answers to the questions were treated as outcomes and the demographic variables as explanatory variables. Due to the large number of univariable analyses, multivariable analyses were not performed.

3. Results

As stated by Persson Waller et al. [11], the response rates of the questionnaires were 14% (340 of 2472) for farmers and 25% (130 of 517) for veterinarians. Below, descriptive results are presented followed by results from the statistical analyses when relevant.

3.1. Herd and Veterinary Variables

Descriptive data on herd and veterinary variables were given by Persson Waller et al. [11]. Most of the participating herds were located in west Sweden (27%) or in Småland and the islands (21%), had conventional production (80%) and used insulated free-stall buildings for housing dairy cows (50%). The most common milking system was the automatic milking system (AMS; 42%) and the average number of cows per herd and year was 116 (median 78). An annual herd milk production of 9000 to 11,000 kg ECM (58%) and an annual average bulk milk SCC below 200,000 cells/mL (66%) was most common.

Most of the responding veterinarians worked in east Sweden (25%), Norrland (18%), or west Sweden (18%). The median year of veterinary graduation was 2005 (variation between 1977 and 2020) and most of the veterinarians had studied in Sweden (81%). The majority of the veterinarians were female (78%) and many (60%) had post-graduate training in cattle diseases. The median number of years in cattle practice was 10–14 years (range 0 to 39 years) and the median number of mastitis cases treated by the veterinarian each month was 4–8 cases (range <1 to >15 cases).

3.2. Questions to Farmers about Housing Systems

Detailed descriptive statistics on the housing system for lactating cows and whether the housing system changed during drying-off and the dry period is given in Supplementary Table S1. In short, 70% of the responding farmers had free-stalls for the lactating cows and 30% had tie-stalls. In most (70%) of the herds with free-stalls, insulated buildings were used. Overall, mats or mattresses were the most common cubicle base, and in almost all (99%) herds bedding was used on top of the mats or matrasses. Wood shavings were most common as bedding, followed by sawdust and chopped straw.

Most of the farmers stated that the same housing system as for lactating cows was used during drying-off (70%) and the dry period (64%). Among those using another system, loose housing in an uninsulated building was the most common in both periods. Overall, the floor base in this area was mostly deep-bedded straw or a cubicle mat. Almost all farmers used some type of bedding, and whole straw or wood shavings were most common.

3.3. Questions to Farmers about Drying-Off

Detailed descriptive statistics on farmer routines at drying-off are presented in Table 1. The results are summarized below.

3.3.1. Written Routines

In most herds (65%), written routines for drying-off were not used. A total of 81 percent of the herds used prolonged milking intervals for ≥75% of these cows. In those herds, it was most common to milk once every second day (44%) for approximately one week (65%).

Table 1. Answers to questions about routines during drying-off of dairy cows given by farmers (n = 340) responding to a web-based questionnaire. Associations between herd variables and answers were investigated by univariable regression models. If significant ($p \leq 0.05$) the herd variables are presented (see Supplementary Table S2 for details).

Questions	Categories	Herd *n* (%)	Significant Herd Variables [1]
Do you have written routines for these cows?			MP, MS, NC
	Yes	117 (35)	
	No	220 (65)	
How many persons take care of these cows?			MP, MS, NC, R
	1	130 (38)	
	2–3	191 (57)	
	>3	17 (5)	
Are these cows milked with prolonged milking interval?			R
	Yes, ≥75% of the cows	272 (81)	
	Yes, <75% of the cows	34 (10)	
	No	31 (9)	
If ≥75% of these cows are milked with prolonged interval, how often are they milked?			BMSCC, MS, NC
	Once per day	73 (24)	
	Once every second day	133 (44)	
	Other or varying interval	99 (32)	
If ≥75% of these cows are milked with prolonged interval, for how long are they milked?			MS
	1 week	195 (65)	
	2 weeks	56 (19)	
	Other	48 (16)	
Do you change the feeding for these cows?			MP
	Yes, for ≥75% of the cows	284 (84)	
	Yes, for <75% of the cows	22 (7)	
	No	31 (9)	
How is the feeding changed (if the herd changes feeding for ≥75% of these cows)?			
Total amount of concentrates			na
	Decreases	278 (98)	
	Not changed	1 (0)	
	Increases	0 (0)	
	Other batch	5 (2)	
Total amount of roughage			MS, NC, R
	Decreases	103 (38)	
	Not changed	134 (49)	
	Increases	10 (4)	
	Other batch	30 (11)	
Amount of straw			MS, NC, R
	Decreases	4 (2)	
	Not changed	76 (31)	
	Increases	152 (63)	
	Other batch	12 (5)	
Amount of hay			NC
	Decreases	29 (14)	
	Not changed	114 (54)	
	Increases	33 (16)	
	Other batch	34 (16)	
Amount of silage			NC, R
	Decreases	151 (59)	
	Not changed	82 (32)	
	Increases	5 (2)	
	Other batch	20 (8)	

Table 1. *Cont.*

Questions	Categories	Herd *n* (%)	Significant Herd Variables [1]
Other roughage	Decreases	52 (28)	MP, NC
	Not changed	83 (44)	
	Increases	18 (10)	
	Other batch	34 (18)	
For how long are the cows given drying-off feed (if the herd changes feeding for ≥75% of these cows)?	1 week	92 (33)	na
	2 weeks	117 (42)	
	3–4 weeks	26 (9)	
	Other	44 (16)	
Do you change water access for these cows?	Yes, for ≥75% of the cows	3 (1)	na
	Yes, for <75% of the cows	1 (0)	
	No	332 (99)	
Do these cows stay in the lactating group?	Yes, ≥75% of the cows	128 (38)	MP, MS, NC, R
	Yes, <75% of the cows	41 (12)	
	No	165 (49)	
Are these cows moved to another building than the lactating cows (herds that do not let these cows stay in the lactating group)?	Yes	81 (49)	ns
	No	84 (51)	
Are these cows within hearing distance of the milking machines (herds that do not let these cows stay in the lactating group)?	Yes	113 (68)	ns
	No	52 (32)	
Are ≥75% of these cows teat dipped/sprayed?	Yes, after each milking	255 (75)	R
	Yes, at specific time points	14 (4)	
	Yes, at the last milking	3 (1)	
	Yes, at other time points	1 (0)	
	No	65 (19)	
Is the udder of ≥75% of these cows examined?	Yes	212 (63)	MP
	No	126 (37)	
How is the udder examined?	Visual inspection	157 (74)	R
	Palpation	190 (90)	MS
	CMT	64 (11)	ns
	Other	23 (5)	na
When is the udder examined	After each milking	128 (60)	na
	Between milkings	46 (22)	
	Both before and after milking	3 (1)	
	Before/in connection with milking	8 (4)	
	Other	27 (13)	
Do you treat these cows with any other substances than teat dip, dry-cow therapy or internal teat sealants?	Yes, homeopathy	5 (1)	na
	Yes, other	7 (2)	
	No	323 (96)	

Table 1. *Cont.*

Questions	Categories	Herd *n* (%)	Significant Herd Variables [1]
			na
Do you think the drying-off routines are important for the udder health of the cows in the beginning of next lactation?	Yes	325 (96)	
	No	3 (1)	
	Do not know	10 (3)	
			na
Do you think the drying-off routines are important for the milk production of the cows in the beginning of next lactation?	Yes	282 (84)	
	No	12 (4)	
	Do not know	42 (12)	
			na
Do you think the drying-off routines are important for the fertility of the cows in the beginning of next lactation?	Yes	134 (40)	
	No	59 (18)	
	Do not know	140 (42)	

[1] ns = not significant; na = not analysed; BMSCC = bulk milk somatic cell count; MP = milk production; MS = milking system; NC = number of cows/herd; R = region.

3.3.2. Milking, Feeding and Housing

Over 80% (278 out of 284) of the farmers changed the feeding at drying-off for ≥75% of these cows for one (38%) or two (42%) weeks. Among those 278 farmers, almost all (98%) stated that they decreased the total amount of concentrates, while 49% did not change the total amount of roughage. The type of roughage changed, however, mostly by increasing the amount of straw and decreasing the amount of silage. It was uncommon to change the access to water for the cows.

In 49% (165 out of 334) of the herds, the cows did not remain among the lactating cows during drying-off, and in approximately half of those herds, these cows were moved to another building. However, 68% of the 165 farmers stated that the cows were within hearing distance of the milking machines.

3.3.3. Teat Dipping/Spraying and Examination of the Udder

Teat dipping/spraying during the drying-off period of ≥75% of the cows was performed in approximately 80% of the herd, and in almost all those herds dipping/spraying was carried out after each milking. In approximately two thirds of all herds, the udders of ≥75% of these cows were examined. Among those herds, palpation and visual inspection were the most common routines and 60% of these farmers stated that they examine the udders after each milking.

3.3.4. Impact of Drying-Off Routines on Health and Production

Almost all farmers believed the drying-off routines to be important for udder health (96%) and the milk production (84%) of the cows in the beginning of the next lactation. Their attitudes to the importance of the routines for cow fertility in the next lactation varied markedly and 42% answered that they did not know.

3.4. Associations between Herd Variables and Farmer Routines during Drying-Off

According to Table 1, five of six herd variables (i.e., bulk milk SCC, milk production, milking system, number of cows/herd and region) were significantly associated with the answers given by the farmers. More information on these results is available in Supplementary Table S2. The results, with some examples, are summarized below.

3.4.1. Written Routines

The proportion of herds with written drying-off routines increased with increasing milk production and herd size. Such routines were also more common in herds with a

milking parlour than in herds with AMS or tie-stall milking, and more common in AMS herds than in herds with tie-stall milking.

3.4.2. Milking, Feeding and Housing

To use prolonged milking intervals was more common in Småland and the islands and in south Sweden than in east Sweden or Norrland. More herds with a bulk milk SCC below 200,000 cells/mL used "another" strategy than milking once per day or once every second day, compared with herds with a bulk milk SCC $\geq$ 200,000 cells/mL. In herds with tied-up milking, it was more common to milk once per day than in herds with AMS or a milking parlour, where it was more common to milk cows once every second day. Milking once every second day was more common in herds with $\geq$53 cows than in smaller herds, where it was more common to milk once per day. In herds with tie-stall milking, it was more common to milk cows for 2 weeks compared to herds with a milking parlour, where cows were milked for 1 week or "other" time.

Farmers in herds with a milk production of >11,000 kg ECM/year, more often stated that they "mostly" change the feeding during drying-off than farmers in herds producing 9000 to 11,000 kg ECM/year, where it was more common to "sometimes" change the feeding. It was more common to increase the amount of roughage in herds with rotary milking than in herds with a milking parlour or tied-up milking. It was more common to reduce the amount of silage in herds in west Sweden than in herds in east Sweden, Norrland and north Middle Sweden, and in herds with $\geq$138 cows than in herds with 53–77 cows, where it was more common to leave the amount of silage unchanged.

It was more common to "mostly" or "sometimes/rather often" let the drying-off cows stay in the lactating group in herds producing <9000 kg ECM/year than in herds producing $\geq$9000 kg ECM/year. To let the drying-off cows remain in the lactating herd was more common in herds in Norrland than in herds in Småland and the islands, south Sweden and west Sweden. In herds with tied-up milking, it was more common to "mostly" allow the drying-off cows remain in the lactating group than in herds with AMS, milking parlour or rotary. Moreover, it was more common to allow the cows stay in the lactating group in herds with <138 cows than in herds with $\geq$138 cows.

3.4.3. Teat Dipping/Spraying and Examination of the Udder

It was more common to examine the udder during drying-off in herds producing $\geq$9000 kg ECM/year than in herds producing <9000 kg ECM/year. In herds with tied-up milking it was more common to palpate the udder than in herds with AMS or a milking parlour.

3.5. Questions to Veterinarians about Drying-Off

Detailed descriptive statistics on veterinary advice given to dairy farmers and/or personnel on routines at drying-off are presented in Table 2. The results are summarized below.

3.5.1. Giving Advice

Most of the veterinarians stated that they "sometimes" give advice about drying-off, and one fourth of the veterinarians stated that they "rarely" or "never" give such advice. The main reasons given for not giving advice were low demand from the farmer/personnel and/or too little knowledge on the part of the veterinarian (data not shown).

3.5.2. Milking, Feeding, Hygiene and Moving Cows

Milking and feeding at drying-off were areas considered very important at drying-off by most (79% and 85%, respectively) of the veterinarians, while the corresponding number for water access was 44%.

Table 2. Answers to questions about giving advice regarding drying-off of dairy cows to farmers and personnel given by veterinarians (n = 130) responding to a web-based questionnaire. Associations between veterinary variables and the answers were investigated by univariable regression models. If significant ($p \leq 0.05$) the herd variables are presented (see Supplementary Table S3 for details).

Questions	Categories	Veterinarians *n* (%)	Significant Veterinary Variables [1]
Do you give advice about drying-off?	Yes, often	26 (20)	MC, PT, R, YD
	Yes, sometimes	71 (55)	
	No, never/rarely	33 (25)	
Do you think that the following areas are important at drying-off?			
Milking	Yes, very important	103 (79)	ns
	Yes, rather important	25 (19)	
	No	0 (0)	
	Do not know	2 (2)	
Feeding	Yes, very important	110 (85)	ns
	Yes, rather important	18 (14)	
	No	0 (0)	
	Do not know	2 (2)	
Water access	Yes, very important	57 (44)	ns
	Yes, rather important	38 (30)	
	No	22 (17)	
	Do not know	11 (9)	
Environmental hygiene close to these cows	Yes, very important	117 (91)	na
	Yes, rather important	11 (8)	
	No	1 (1)	
	Do not know	0 (0)	
Removing these cows from the lactating group	Yes, very important	66 (52)	MC
	Yes, rather important	45 (35)	
	No	4 (3)	
	Do not know	13 (10)	
Teat dipping/spraying of these cows	Yes, very important	74 (57)	na
	Yes, rather important	43 (33)	
	No	4 (3)	
	Do not know	8 (6)	
Examination of the udder of these cows	Yes, very important	93 (75)	ns
	Yes, rather important	30 (25)	
	No	1 (1)	
	Do not know	0 (0)	
Do you recommend abrupt cessation of milking?	Yes, always	2 (2)	MC, PT, R
	Yes, under certain conditions	48 (37)	
	No	78 (61)	
Do you recommend prolonged milking intervals?	Yes, always	61 (48)	MC, PT, R
	Yes, under certain conditions	55 (43)	
	No	11 (9)	

Table 2. *Cont.*

Questions	Categories	Veterinarians *n* (%)	Significant Veterinary Variables [1]
If prolonged intervals are recommended, how often should these cows be milked?	Once per day	24 (21)	na
	Once every second day	63 (55)	
	Other	27 (24)	
If prolonged intervals are recommended, for how long do you recommend such milking?	1 week	87 (75)	na
	2 weeks	16 (14)	
	Other	13 (11)	
Which recommendations about the following aspects of feeding during drying-off do you give?			
Total amount of concentrates	Decrease	127 (100)	na
	No change	0 (0)	
	Increase	0 (0)	
Total amount of roughage	Decrease	25 (20)	ns
	No change	80 (63)	
	Increase	21 (17)	
Total amount of straw	Decrease	0 (0)	na
	No change	16 (13)	
	Increase	108 (87)	
Total amount of hay	Decrease	36 (31)	PT
	No change	59 (50)	
	Increase	23 (19)	
Total amount of silage	Decrease	87 (71)	ns
	No change	33 (27)	
	Increase	2 (2)	
For how long do you recommend to give the cows a drying-off diet?	1 week	28 (23)	na
	2 weeks	74 (60)	
	Other	21 (17)	
Do you recommend that these cows are moved from the lactating cows?	Yes	89 (82)	na
	No	9 (8)	
	Other	11 (10)	
How often should these cows be teat dipped/sprayed?	After each milking	93 (79)	na
	At certain time points	13 (11)	
	Other	11 (10)	
Which type of examination of the udders of these cows do you recommend?	Visual inspection	85 (69)	ns
	Palpation	116 (94)	ns
	California Mastitis Test (CMT)	71 (58)	NY, PT, YD
	Other	23 (19)	na
Do you think the routines are important for the udder health of the cows in the beginning of next lactation?	Yes, very important	120 (92)	na
	Yes, rather important	10 (8)	
	No	0 (0)	
	Do not know	0 (0)	

Table 2. *Cont.*

Questions	Categories	Veterinarians *n* (%)	Significant Veterinary Variables [1]
Do you think the routines are important for the milk production of the cows in the beginning of next lactation?	Yes, very important	78 (60)	ns
	Yes, rather important	43 (33)	
	No	0 (0)	
	Do not know	8 (7)	
Do you think the routines are important for the fertility of the cows in the beginning of next lactation?	Yes, very important	34 (26)	NY
	Yes, rather important	49 (30)	
	No	16 (12)	
	Do not know	31 (25)	

[1] ns = not significant; na = not analysed; MC = mastitis cases/month; NY = number of years in cattle practice. PT = post-graduate training; R = region; YD = year of degree.

Among those that thought that milking was very or rather important, almost two thirds (61%) stated that they do not recommend the abrupt cessation of milking. Almost all (91%) respondents stated that they always, or under certain conditions (e.g., high milk production), recommend prolonged milking intervals. It was most common to recommend milking once every second day for 1 week.

All veterinarians who thought that feeding was very or rather important stated that they recommend reducing the total amount of concentrates. Moreover, most of the veterinarians recommended reducing the amount of silage (71%) and increasing the amount of straw (87%), and that a drying-off diet should be given for 2 weeks.

The environmental hygiene close to cows was considered very important for 91% of the veterinarians. In contrast, 52% of the veterinarians thought that moving the cows from the lactating group during drying-off is very important, while 35% thought it is rather important.

3.5.3. Teat Dipping/Spraying and Examination of the Udder

Teat dipping/spraying and examination of the udder during drying-off was considered very important for 57% and 75%, respectively, of the veterinarians. Most (79%) of the veterinarians recommended dipping/spraying after each milking. Almost all (94%) veterinarians recommended palpation of the udder, while visual inspection (69%) and use of the California Mastitis Test (CMT; 58%) were also recommended quite often.

3.5.4. Impact of Drying-Off Routines on Health and Production

Almost all (92%) of the veterinarians thought that the routines at drying-off are very important for the udder health of the cows in the next lactation, and 60% thought they are very important for milk production. The attitudes regarding the importance for cow fertility varied and 25% stated that they do not know if drying-off routines would have an impact on fertility in the next lactation.

3.6. Associations between Veterinary Variables and Advices Given by Veterinarians Regarding Drying-Off

According to Table 2, six of seven veterinary variables (i.e., country of origin, mastitis cases/month, number of years in cattle practice, post-graduate training, region and year of degree) were significantly associated with the answers given by the veterinarians. More information on these results is available in Supplementary Table S3. The results, with some examples, are summarized below.

3.6.1. Giving Advice

It was more common to give advice on drying-off routines among veterinarians with a degree in 1977–1991 than among those with a degree in 2009 or later. Likewise, veterinarians

with post-graduate training appear to give advice more often than veterinarians without such training. The same was valid for veterinarians with more than 8 mastitis cases/month compared to veterinarians with fewer cases. Giving advice was also more common in some regions than in other regions.

3.6.2. Milking, Feeding, Hygiene and Moving Cows

It was more common to recommend abrupt cessation of milking under certain conditions among veterinarians with post-graduate training than among veterinarians without training. It was more common in the latter group to never recommend abrupt cessation. The same difference was found between veterinarians with 4–8 or >15 mastitis cases/month compared to those with <1 case/month. Among veterinarians with post-graduate training, it was more common to always or under certain conditions recommend a prolonged milking interval compared to those without such training. Among veterinarians treating 1–3, 4–8 or 9–15 mastitis cases/month, it was more common to always recommend milking with prolonged intervals than among those with >15 cases/month, where it was more common to recommend such milking under certain conditions. Regional differences among veterinarians in their recommendations on abrupt cessation or prolonged milking intervals were also found.

A larger proportion of veterinarians with post-graduate training stated that they recommend the total amount of hay to remain unchanged than veterinarians without training, who recommended an increase in the amount of hay. In general, veterinarians treating <1 mastitis case/month thought that moving cows at drying-off is less important than veterinarians treating more cases/month.

3.6.3. Teat Dipping/Spraying and Examination of the Udder

It was more common for veterinarians with a degree from 2009 or later to recommend CMT as an assessment of udder health at drying off than veterinarians with a degree from 1977–1991. Moreover, veterinarians without post-graduate training recommended CMT more often than those with training. Likewise, veterinarians with <5 years in cattle practice recommended CMT more often than those with 10–14 or $\geq$20 years in such practice.

3.6.4. Impact of Drying-Off Routines on Health and Production

Overall, it was more common that veterinarians with <10 years of cattle practice stated that the drying-off routines are very important for cow fertility in the next lactation than veterinarians with longer experience of such practice.

3.7. Questions to Farmers about the Dry Period

Detailed descriptive statistics on routines on farmer routines during the dry period are presented in Table 3. The results are summarized below.

3.7.1. Written Routines

For most (72%) of the herds, farmers stated that they do not have written routines for the dry period, and in 68% of the herds, 2–3 persons managed the dry cows.

3.7.2. Dry Period Length, Housing and Moving Cows

The dry period was stated to be equally long for most of the cows in almost all (93%) herds. Among those herds, most (74%) used a dry period of 6–8 weeks, while a longer dry period was used in one fourth of the herds. In seventy percent of the herds, dry cows were not allowed to spend time with lactating cows during whole or part of the dry period. Among those herds, it was most common (58%) for dry cows to be housed in another stable. In 60% of all herds, dry cows were not moved between sections during the dry period. In herds where dry cows were moved, it was mainly carried out once or twice per cow.

Table 3. Answers to questions about routines during the dry period of dairy cows given by farmers (n = 340) responding to a web-based questionnaire. Associations between herd variables and answers were investigated by univariable regression models. If significant ($p \leq 0.05$) the herd variables are presented (see Supplementary Table S4 for details).

Questions	Categories	Herd *n* (%)	Significant Herd Variables [1]
Do you have written routines for the dry period?	Yes	94 (28)	MS, NC, PS
	No	242 (72)	
How many persons take care of these cows?	1	83 (25)	MS, NC
	2–3	227 (68)	
	>3	26 (8)	
Is the dry period equally long for most (≥75%) of the cows?	Yes	313 (93)	ns
	No	25 (7)	
How long is the dry period (if equally long for most cows)?	<6 weeks	1 (0.3)	ns
	6–8 weeks	231 (74)	
	>8 weeks	74 (24)	
	Other	6 (2)	
Do dry cows spend time with lactating cows?	Yes, ≥75% of the cows	53 (16)	MP, MS, NC
	Yes, <75% of the cows	49 (15)	
	No	233 (70)	
Where are the dry cows if they do not spend time with lactating cows?	In a separate section of the same stable	92 (38)	MS, PS
	In another stable	141 (58)	MS
	Other	10 (4)	na
Are dry cows moved between sections?	Yes, ≥75% of the cows	89 (26)	MP, MS, NC
	Yes, <75% of the cows	46 (14)	
	No	201 (60)	
How many times are the dry cows moved (herds that move ≥75% of the cows)?	1–2 times	82 (92)	na
	>2 times	7 (8)	
Are ≥75% of the dry cows teat dipped/sprayed?	Yes	39 (12)	BMSCC
	No	298 (88)	
Is the udder of ≥75% of the dry cows examined?	Yes	145 (43)	ns
	No	189 (57)	
If the udder of ≥75% of the dry cows is examined how is this done?	Visual inspection	138 (95)	ns
	Palpation	92 (63)	MP, MS
	California Mastitis Test (CMT)	6 (4)	na
Do you use other substances than teat dip, dry-cow therapy or internal teat sealants?	Yes, homeopathy	2 (1)	na
	Yes, other	3 (1)	
	No	331 (98)	
Do you think the dry period is important for the udder health of cows in the beginning of next lactation?	Yes	319 (95)	na
	No	2 (1)	
	Do not know	15 (4)	

Table 3. *Cont.*

Questions	Categories	Herd *n* (%)	Significant Herd Variables [1]
Do you think the dry period is important for the milk production of cows in the beginning of next lactation?	Yes	313 (93)	na
	No	5 (1)	
	Do not know	19 (6)	
Do you think the dry period is important for the fertility of cows in the beginning of next lactation?	Yes	176 (53)	na
	No	35 (10)	
	Do not know	122 (37)	
Do you think the dry period is important for the occurrence of milk fever in cows in the beginning of next lactation?	Yes	188 (56)	na
	No	51 (15)	
	Do not know	95 (28)	
Do you think the dry period is important for the occurrence of inappetence in cows in the beginning of next lactation?	Yes	192 (58)	na
	No	46 (14)	
	Do not know	95 (28)	
Do you think the dry period is important for the health of the calf?	Yes	201 (61)	na
	No	43 (13)	
	Do not know	88 (26)	

[1] ns = not significant; na = not analysed; BMSCC = bulk milk somatic cell count; MP = milk production; MS = milking system; NC = number of cows/herd; PS = production system.

3.7.3. Teat Dipping/Spraying and Examination of the Udder

In most (88%) herds, teat dipping/spraying of dry cows was not used and in 57% of the herds the udders of most cows were not examined during the dry period. In almost all herds that examined the udders this was done by visual inspection and in two thirds of the herds examination was performed by palpation.

3.7.4. Impact of Routines during the Dry Period on Health and Production

Almost all (93–95%) farmers stated that the dry period is important for udder health as well as for milk production of the cow in the coming lactation, while just over half of the farmers thought it is important for cow fertility, occurrence of milk fever or inappetence in cows, and for calf health. Around one fourth of the farmers answered "do not know" for these variables.

3.8. Associations between Herd Variables and Farmer Routines during the Dry Period

According to Table 3, five of six herd variables (i.e., bulk milk SCC, milk production, milking system, number of cows/herd and production system) were significantly associated with the answers given by the farmers. More information on these results is available in Supplementary Table S4. The results, with some examples, are summarized below.

3.8.1. Written Routines

It was more common to have written routines in herds with organic production and in larger herds, but less common in herds with tied-up milking than in herds with other systems.

3.8.2. Dry Period Length, Housing and Moving Cows

It was more common to allow the integration of dry cows with lactating cows in herds with <9000 kg ECM/year than in herds with ≥9000 kg ECM/year, in herds with tied-up milking versus herds with AMS or a milking parlour and in smaller herds versus larger

herds. In organic (versus conventional) herds and in herds with tied-up milking or AMS (versus parlour), it was more common to keep dry cows in a separate section of the same stable as the lactating cows. In herds with higher milk production, in all other milking systems versus tied-up milking, and in herds with the largest number of cows, it was more common to move cows between sections.

3.8.3. Teat Dipping/Spraying and Examination of the Udder

It was more common to perform teat dipping/spraying during the dry period in herds with BMSCC < 200,000 cells/mL than in herds with ≥200,000 cells/mL. Palpation of the udder of dry cows was more often carried out in herds producing 9000–11,000 kg ECM/year than in herds producing >11,000 kg ECM/year. Moreover, herds with tie-stall milking more often performed this routine than herds with a milking parlour.

3.9. Questions to Veterinarians about the Dry Period

Detailed descriptive statistics on veterinary advice given to dairy farmers and/or personnel on routines during the dry period are given in Table 4. The results are summarized below.

3.9.1. Giving Advice

Most of the veterinarians stated that they "sometimes" give advice about drying-off, and one fourth of the veterinarians stated that they "rarely" or "never" give such advice. The main reasons given for not giving advice were low demand from the farmer/personnel and/or too little knowledge on the part of the veterinarian (data not shown).

Table 4. Answers to questions about giving advice regarding the dry period of dairy cows to farmers and personnel given by veterinarians (n = 130) responding to a web-based questionnaire. Associations between veterinary variables and answers were investigated by univariable regression models. If significant ($p \leq 0.05$) the veterinary variables are presented (see Supplementary Table S5 for details).

Questions	Categories	Veterinarians *n* (%)	Significant Veterinary Variables [1]
Do you give advice to farmers/personnel?	Yes, often	23 (18)	NY, PT, YD
	Yes, sometimes	71 (55)	
	No, never/rarely	36 (28)	
Do you think that the following areas are important?			
Length of the dry period	Yes, very important	76 (58)	ns
	Yes, rather important	45 (35)	
	No	1 (1)	
	Do not know	8 (6)	
Feeding	Yes, very important	117 (90)	na
	Yes, rather important	9 (7)	
	No	0 (0)	
	Do not know	4 (3)	
Grouping of the cows	Yes, very important	86 (66)	ns
	Yes, rather important	36 (28)	
	No	2 (2)	
	Do not know	6 (5)	
Hygiene close to the cows	Yes, very important	110 (85)	na
	Yes, rather important	16 (12)	
	No	1 (1)	
	Do not know	3 (2)	

Table 4. *Cont.*

Questions	Categories	Veterinarians *n* (%)	Significant Veterinary Variables [1]
Teat dipping/spraying	Yes, very important	40 (31)	PT
	Yes, rather important	37 (28)	
	No	34 (26)	
	Do not know	19 (15)	
Examination of the udder	Yes, very important	69 (53)	PT
	Yes, rather important	49 (38)	
	No	4 (3)	
	Do not know	8 (6)	
If you think the length of the dry period is important, how long should it be?	<6 weeks	3 (3)	na
	6–8 weeks	104 (87)	
	8 weeks	10 (8)	
	Do not know	2 (2)	
If you think grouping of dry cows is important, how should they be grouped?	In a separate section in the same stable as lactating cows	34 (28)	na
	In another stable	71 (58)	
	With the lactating cows	0 (0)	
	Other	17 (14)	
If you think teat dipping/spraying of dry cows is important, when should they be dipped/sprayed?	At fixed time points during the day	21 (31)	na
	During a certain period	39 (58)	
	Other	17 (11)	
If you think examination of the udder of dry cows is important, how should the control be done?	Visual inspection	102 (89)	na
	Palpation	82 (71)	
	California Mastitis Test (CMT)	7 (6)	
	Other	10 (8)	
Do you think the dry period is important for the udder health of cows in the beginning of next lactation?	Yes, very important	114 (88)	na
	Yes, rather important	11 (8)	
	No	0 (0)	
	Do not know	5 (4)	
Do you think the dry period is important for the milk production of cows in the beginning of next lactation?	Yes, very important	106 (82)	na
	Yes, rather important	16 (12)	
	No	0 (0)	
	Do not know	8 (6)	
Do you think the dry period is important for the fertility of cows in the beginning of next lactation?	Yes, very important	66 (51)	na
	Yes, rather important	38 (29)	
	No	6 (5)	
	Do not know	19 (15)	
Do you think the dry period is important for the occurrence of milk fever in cows in the beginning of next lactation?	Yes, very important	104 (80)	na
	Yes, rather important	8 (6)	
	No	4 (3)	
	Do not know	14 (11)	

Table 4. *Cont.*

Questions	Categories	Veterinarians *n* (%)	Significant Veterinary Variables [1]
Do you think the dry period is important for the occurrence of inappetence in cows in the beginning of next lactation?	Yes, very important	102 (78)	na
	Yes, rather important	13 (10)	
	No	1 (1)	
	Do not know	14 (11)	
Do you think the dry period is important for the health of the calf?	Yes, very important	58 (45)	na
	Yes, rather important	45 (35)	
	No	2 (2)	
	Do not know	24 (19)	

[1] ns = not significant; na = not analysed; NY = number of years in cattle practice; PT = post-graduate training; YD = year of degree.

3.9.2. Dry Period Length, Feeding, Grouping of Cows and Hygiene

Feeding and hygiene close to the cows during the dry period were considered very important by most (85–90%) of the veterinarians, while 53–66% thought that length of the dry period, grouping of cows and control of the udder is very important. Almost all (87%) responding veterinarians thought that the dry period should be 6–8 weeks long, and 58% of the veterinarians recommended that the dry cows are placed in another stable than lactating cows.

3.9.3. Teat Dipping/Spraying and Examination of the Udder

Only 31% of the veterinarians thought that teat dipping/spraying is very important during the dry period. Among veterinarians considering teat dipping/spraying important, 58% recommended this during a certain period. Visual inspection and palpation were the most recommended measures for examination of the udders of dry cows.

3.9.4. Impact of Routines during the Dry Period on Health and Production

Almost all (82–88%) veterinarians believed the dry period to be very important for udder health, as well as milk production of cows in the coming lactation. Moreover, around 80% of the veterinarians also believed the dry period to be very important for the occurrence of milk fever and inappetence in newly calved cows, while 45–51% believed it to be important for cow fertility and calf health.

3.10. Associations between Veterinary Variables and Advices Given by Veterinarians Regarding the Dry Period

According to Table 4, three of seven veterinary variables (i.e., number of years in cattle practice, post-graduate training, and year of degree) were significantly associated with the answers given by the veterinarians. More information on these results is given in Supplementary Table S5. The results, with some examples, are summarized below.

3.10.1. Giving Advice

To give advice about the dry period was more common among veterinarians with a degree from 1977–1991 than among those who graduated in 2009 or later, more common among veterinarians with post-graduate training and more common among veterinarians with more years in cattle practice.

3.10.2. Teat Dipping/Spraying and Examination of the Udder

Veterinarians with post-graduate training considered teat dipping/spraying and examination of the udder during the dry period more important than veterinarians without such training.

4. Discussion

A study on routines at drying-off and during the dry period of dairy cows in Swedish commercial herds has not been performed previously and, to our knowledge, this study is the most comprehensive in the area. Studies on some routines have, however, been performed in Finland, Germany, the Netherlands and the UK [7–10]. In addition, a study performed in several European countries reported on some herd routines at drying-off [12]. Moreover, to the best of our knowledge, this is the first report on attitudes of the farmers as well as advice and attitudes of veterinarians with cattle practice on routines during drying-off and the dry period.

4.1. Routines at Drying-Off in Relation to National and International Recommendations

In line with recommendations in other countries [4–6], the Swedish recommendations at the time of the study emphasized the importance of reducing milk production before the dry period by initiating changes in feeding and milking. According to the literature, daily milk production should preferably be no more than 10–15 kg at the last milking before the dry period. The reason for this is to prevent IMI and mastitis, as there is an association between high daily milk production at drying-off and increased risk for milk leakage, slower formation of keratin in the teat canal, increased risk for IMI and the occurrence of mastitis after calving [12–18]. A high milk yield at drying-off can also cause stress and discomfort due to high internal pressure in the udder [19,20]. Even if the results vary somewhat, published studies show that prolonged milking intervals and/or feed restrictions during drying-off can be used to decrease milk production [15–17,20,21]. It is, however, important to avoid reducing the amount of energy too much during drying-off, as this can lead to metabolic disturbances [15,21]. A diet causing hunger is also negative for animal welfare.

The importance of restrictive feeding during drying-off was also high-lighted by participating veterinarians in the present study. Moreover, in line with the recommendations valid at the time of the study, most participating farmers changed the ration for most of the cows, but one-tenth of the farmers did not. Among those that changed the ration, almost all decreased the amounts of concentrates but the changes in amounts of different types of roughage seemed to vary. Some differences between farmer routines and veterinary advice were also observed. For example, one third of the farmers did not change the amounts of straw and silage, which was not in line with the advice given by most of the participating veterinarians. Moreover, the recommendations stated that the drying-off ration should be given for approximately one week, but most veterinarians recommended such feed for two weeks and the farmer routines varied markedly. The results were in line with a Finnish study where most farmers restricted the feeding before drying-off [9]. Changes in the ration was also common in the Netherlands [10], but less common in the UK and German studies [7,8].

Depending on the daily milk yield at the start of drying-off, suggestions on how to perform intermittent milking were also included in the national recommendations valid at the time of the study. According to those recommendations, the number of milkings and the milking intervals (36 or 48 h) vary depending on milk yield, but intermittent milking should preferably not be performed for more than 4–5 days. Here, the results from the questionnaires indicate considerable room for improvement for both farmers and veterinarians, as the alternatives milking once per day and prolonged milking for two weeks were chosen by a substantial number of farmers and veterinarians. In comparison, gradual drying-off was also performed in almost all herds in the Finnish study, but details on milking intervals were not given [9]. To prolong the milking interval before drying-off was also rather common among Dutch farmers [10]. In contrast, most farmers in the other studies on commercial herds [7,8,12] used abrupt cessation of milking. Prolonged milking intervals reduce milk yield by inhibiting milk synthesis when milk remains in the udder. Such downregulation is observed if the interval is longer than 18 h and milk secretion is completely inhibited after 36 h [22]. This, and experiences from previous Swedish

studies [15], is the reason why the Swedish recommendation favours milking intervals of 36–48 h for a varying number of days depending on daily milk yield. Most studies on prolonged milking intervals have, however, compared the effects of abrupt milk cessation and milking once per day for one week, as reviewed by [2].

Another way to reduce milk production in dairy cows is to move the cows to another place during drying-off to make restrictive feeding easier. Moreover, the stress associated with such routine may further reduce milk production [2,15,19]. In line with this, the national recommendation valid at the time of the study suggested that the cows should be moved from the lactating cows to a separate section during drying-off and the results from the present study indicate that almost all veterinarians gave such advice. However, almost 40% of the responding farmers allowed the cows to remain in the lactating group. The reasons for this are not known, but it is possible that practical issues may have made such a routine difficult to perform. Information on performance of this management routine is not available in the other publications on commercial herds. However, the UK guidelines mention regrouping of animals while changing rations [6] and the NMC guidelines state that a change in environment can help to reduce milk production [5].

The use of teat dip or teat spray and the examination of the udder morning and evening for 14 days from the start of drying-off, independent of when milking is performed, was also included in the recommendation valid at the time of the study. Almost all veterinarians participating in the study considered these areas important, but a considerable proportion of the farmers stated that they do not use such routines, indicating room for improvement. Moreover, both farmers and veterinarians used or advised dipping/spraying after milking and not twice per day, which was not in line with the recommendations. Likewise, teat dipping or spraying after drying-off was uncommon among Dutch farmers [10]. Daily examination of the udder after drying-off is also included in the NMC and UK guidelines but they do not mention teat dipping or spraying [4–6].

An interesting observation in the present study was that a substantial proportion of the participating veterinarians stated that they do not give advice on drying-off. The main reasons given for not doing so were that they did not believe there is a demand for such advice, or that they have too little knowledge in the area, indicating a clear need for more education.

4.2. Routines during the Dry Period in Relation to National and International Recommendations

The optimal length of the dry period for health and production has been discussed for a long time, e.g., [23,24]. To our knowledge, there is no consensus, but a dry period of 40–60 days is often recommended [6]. In the present study, most farmers and veterinarians stated that they use or recommend a dry period of 6–8 weeks which also was in line with the national recommendations (6–9 weeks; preferably 7 weeks) valid at the time of the study. However, the fact that one quarter of the farmers used a longer dry period than 8 weeks indicates a need for improvement. Similar results were found in the Finnish study [9]. Although the length of the dry period varied markedly between farmers, the average length was similar also in the UK and German studies [7,8].

To avoid stress and reduce the spread of IMI from lactating to dry cows, the national recommendations at the time of the study stated that the dry cows should be kept separate from the lactating cows, preferably in a separate building. This was also the advice given by most of the veterinarians. However, one third of the participating farmers stated that some or most of the dry cows spend time with lactating cows during whole or parts of the dry period. Why this is so is not known, but practical issues may have been of importance. This question was not included in the other studies.

To further reduce stressful routines, the national recommendations at the time of the study also stated that re-grouping and moving cows should be avoided during the dry period, but almost half of the farmers stated that this is carried out often or rather often. However, it was uncommon to move the cows more than once or twice during the period. In comparison, most herds in the UK study kept dry cows in two groups, far-off and

close-up relative calving, but only around 15% of the farmers tried to keep the dry cows in the same social group as much as possible [8].

As for drying-off, around one third of the responding veterinarians did not give advice on the dry period. The main reasons given for not doing so were that they did not believe there is a demand for such advice, or that they had too little knowledge in the area, indicating a clear need for more education.

4.3. Attitudes to the Importance of Routines at Drying-Off and the Dry Period

Almost all farmers and veterinarians stated that the routines at drying-off and the dry period are important for udder health and milk production in early lactation. Associations between drying-off routines and udder health have been found in several studies. For example, the risk for IMI and mastitis increases with increasing milk production at drying-off [2,12,14,15,18]. Often, such infections manifest as clinical mastitis or high SCC after calving, which also leads to reduced milk production. Studies on associations between dry period routines and udder health have, however, generated varying results. For example, the length of the dry period seems only to have an impact on udder health if it is very short or very long, e.g., [23,24]. However, suboptimal feeding during the dry period may cause negative energy balance and deficiency in vitamins and minerals, which may affect the immune defence around calving and increase the risk for infectious diseases such as mastitis, which in turn affects milk production negatively. Moreover, negative energy balance around calving and in early lactation may also cause ketosis, with negative effects on milk production, e.g., [25].

In contrast, a substantial number of both farmers and veterinarians were uncertain about the importance of routines at drying-off and the dry period for cow fertility in early lactation or did not think they were important. Several studies have, however, shown that mastitis during early lactation has a negative effect on cow fertility [26–28]. Moreover, suboptimal feeding during the dry period may lead to negative energy balance and hypocalcaemia, which are both associated with reproductive disorders and fertility [25,29]. Thus, more knowledge among the target groups is needed in these areas.

Both the farmers and veterinarians received questions on the importance of routines during the dry period for the occurrence of milk fever and inappetence in early lactation, and for the health of the calf. Here, some uncertainties were found in both groups, but especially among farmers indicating a need for more knowledge. Suboptimal feeding during the dry period can increase the risk for hypocalcaemia, and, thus, the occurrence of milk fever [29], as well as the occurrence of negative energy balance leading to ketosis and inappetence in early lactation [25]. Whether there is a link between routines during the dry period and health of the calf is more uncertain, but malnutrition of cows in late pregnancy can have negative effects on the foetus and increase the risk of abortion or premature birth [30]. Other types of stress during gestation, such as heat stress, can also have negative effects on the foetus and calf [31]. Moreover, some studies indicate that the length of the dry period and feeding during dry period can affect the amount and quality of colostrum [32], which, in turn, can have negative effects on calf health.

4.4. Associations between Answers to the Questionnaires and Demographic Variables

Milking system, number of cows per herd, milk production and region were the herd variables associated with the largest number of questions on drying-off and the dry period. In contrast, production type and BMSCC were only associated with a few questions each. Among the veterinarians, post-graduate training, followed by number of mastitis cases/month, number of years in cattle practice, region and year of degree were associated with the largest number of questions. Country of degree and gender were not associated with any of the questions. The herd variables milking system, number of cows per herd, milk production and region are linked to each other, which makes it difficult to assess if one of the variables or a combination of the variables is most important. Unfortunately, performing multivariable analyses to clarify the results was not possible.

For example, milking system was associated with questions on written routines, milking intervals during drying-off, feeding, and keeping drying-off cows or dry cows together with lactating cows during drying-off and the dry period, respectively. Some of these associations can most likely be explained by the fact that the milking system is often influenced by the number of cows per herd. In line with this, written routines were more common in herds with more cows and the number of cows was also associated with feeding, milking interval and keeping cows with lactating cows. In Sweden, the number of cows is also associated with milk production, with higher production in larger herds (Nyman, A.-K., personal communication 2021). Thus, it was not surprising that milk production was associated with the same questions. Herds with more cows may have different goals than smaller herds and may also need a different management structure as more persons, including personnel, often are involved. Such herds also have more possibilities to group cows than smaller herds.

For farmers as well as veterinarians, region was a demographic variable associated with the questions on drying-off. For example, routines used by farmers and advice given by veterinarians regarding prolonged milking intervals differed between regions. Moreover, herd routines regarding feeding, keeping drying-off cows in the lactating group, use of teat dipping/spraying and examination of the udder also differed, as well as the likelihood that the veterinarians gave advice or not. The reasons for these findings are not known but tradition, as well as regional climate, may be of importance.

The BMSCC, reflecting some aspects of udder health at the herd level, was only associated with a few variables. The fact that herds with low BMSCC more often used another strategy than milking once or every second day during drying-off and more often used teat dipping/spraying during the dry period may indicate that these herds are more interested in routines that may prevent mastitis.

As already mentioned, post-graduate training was the veterinary variable associated with the largest number of questions on both drying-off and the dry period. For example, it was more common for veterinarians with training to offer advice about these periods and recommend teat dipping/spraying and udder examination before calving. The differences are likely due to more knowledge and interest among veterinarians with post-graduate training.

Other veterinary variables indicating special interest and experience in diseases in dairy cows are the number of mastitis cases per month and number of years in cattle practice. Moreover, year of veterinary degree may also be associated with those variables. In line with this, all three variables were associated with giving advice on drying-off and the dry period. As expected, this was less common among veterinarians who had graduated relatively recently, worked fewer years in cattle practice and had fewer mastitis cases per month.

4.5. Methodological Considerations

As mentioned in our previous publication [11], the response rate was rather low for both farmers and veterinarians. However, the Finnish study mentioned earlier [9] reported a similar proportion (13%) of farmers responding to their questionnaire. Although web-based questionnaires are very convenient, it is possible that the response rate to such questionnaires is lower than to other types of questionnaires. In comparison, response rates of 49% were found in a study using written questionnaires [7].

It is important to interpret results from questionnaire studies with caution as respondents may be different from the population of interest. As already mentioned in our previous study on other parts of the same questionnaires [11], the geographical spread of the participating farmers was satisfactory. However, the proportion of herds with free-stalls and with AMS was larger among those that answered the questionnaire than among all herds affiliated to the official cow control scheme. Moreover, the responding herds had more cows per herd, higher milk production and lower bulk milk SCC than

the average herd in the national dairy herd recording scheme (Nyman, A.-K., personal communication 2021).

Given that management and conditions for dairy farming vary between countries, as well as between regions within countries, the findings in this study may be of varying validity to farming in other countries.

The risk for type I errors, i.e., to find significant results even though there are no true associations, increases when many risk factors are tested. Thus, the results must be interpreted with care as some of the associations found could be due to chance. To confirm the results, more studies may therefore be needed.

4.6. Revision of Recommendations Valid at the Time of the Study

The results showed that the responding farmers and veterinarians followed the national recommendations valid at the time of the study in many aspects, but several areas where more effort is needed to increase compliance with those recommendations were also identified. Moreover, it was also clear that some areas of those recommendations needed revision. It was also clear that both farmers and veterinarians need more information about management of dairy cows in the drying-off and dry periods. Examples of changes made in the revised recommendations were the addition of definitions of drying-off and the dry period, addition of background and more details, e.g., on feeding, changing the dry period length to 6–8 weeks and incorporating advice on control of udder and teat dipping before calving and advice on how to evaluate the effects of the routines. The new recommendations, in Swedish and English, have been spread to the target groups in various ways and made easily available for everyone at [33]. New recommendations on dry cow therapy with antibiotics [34] and treatment with internal teat sealants at drying-off [35] are also available at the same website.

5. Conclusions

The results indicate that farmer routines and veterinary advice on drying-off and the dry period were in line with many parts of the national recommendations valid at the time of the study. However, a need to improve some of the herd routines and veterinary advice was also identified. Interesting associations between herd routines and herd variables, and between veterinary advice and veterinary variables were also identified. Overall, the results indicate a need for more education on the management of dairy cows during drying-off and the dry period. Moreover, it was also clear that the national recommendations valid at the time of the study needed revision. Therefore, we have put together new recommendations which have been distributed to farmers and veterinarians.

Supplementary Materials: The following supporting information can be downloaded at: https://www.mdpi.com/article/10.3390/dairy3020029/s1, Table S1: Response to questions about housing system of dairy cows during lactation, drying-off and dry period given by farmers (n = 340); Table S2: Significant associations between herd variables and responses to questions about routines during drying-off of dairy cows given by farmers (n = 340); Table S3: Significant associations between veterinary variables and responses to questions about giving advice to farmers and personnel regarding drying-off of dairy cows given by veterinarians (n = 130); Table S4: Significant associations between herd variables and responses to questions about routines during the dry period of dairy cows given by farmers (n = 340); Table S5: Significant associations between veterinary variables and responses to questions about giving advice to farmers and personnel regarding the dry period of dairy cows given by veterinarians (n = 130).

Author Contributions: Conceptualization, K.P.W., H.L. and A.-K.N.; methodology, K.P.W., H.L. and A.-K.N.; software, A.-K.N.; validation, K.P.W., H.L. and A.-K.N.; formal analysis, A.-K.N.; resources, K.P.W.; data curation, A.-K.N.; writing—original draft preparation, K.P.W.; writing—review and editing, K.P.W., H.L. and A.-K.N.; visualization, K.P.W.; supervision, K.P.W.; project administration, K.P.W.; funding acquisition, K.P.W. All authors have read and agreed to the published version of the manuscript.

Funding: This research was funded by the Swedish Board of Agriculture, Jönköping, Sweden, via their fundings scheme "Bekämpande av smittsamma djursjukdomar 2019" [Fighting contagious animal diseases 2019] through the SvarmPat programme.

Institutional Review Board Statement: Ethical review and approval was waived for this study as the study did not require ethical approvement according to Swedish legislation (2003:460, 3–5§) as explained by the Swedish Ethical Review Authority, Uppsala, Sweden.

Informed Consent Statement: Participant consent was waived due to the questionnaires being anonymous. Information about anonymity and that the questionnaires were voluntary was given on the first page of the questionnaires. Thus, by answering the questionnaire the participants consented to enroll in the study.

Data Availability Statement: The datasets generated and analyzed during this study are available upon reasonable request. The data are not publicly available as routines for such publication has not yet been finalized by the National Veterinary Institute.

Conflicts of Interest: The authors declare no conflict of interest.

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