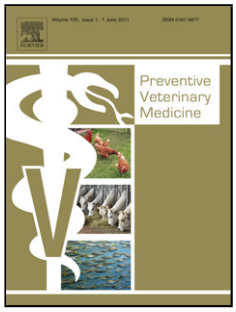

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Lameness on Brazilian pasture based dairies – part 1: farmers' awareness and actions

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Highlights

- Brazilian family farmers were largely unaware of the prevalence of lameness on their farms
- Some farmers considered lameness as a secondary health issue
- High use of antibiotics and low use of analgesics to treat lameness was reported
- The use of measures to prevent lameness in cows was non-existent at the time of the study
- Efforts should focus on farmers' continual education and provision of veterinary support

Abstract

This cross-sectional survey aimed to verify farmers' awareness and knowledge about lameness in grazing dairy cows and to analyze their perspectives and actions intended to control this issue. Farms (n = 44, mean herd size: 42, SD = 11.2) located in southern Brazil were visited twice in 2015. On the first visit the farmers were requested to answer a questionnaire on lameness knowledge (relative importance as a health issue, aetiology, impacts on culling) and management (prevention, treatment and veterinary assistance) on their farms. Farmers were asked to estimate the number of lame cows present on their farms at each visit. All lactating cows on each farm were locomotion scored by a veterinarian to estimate lameness prevalence on both visits. Intra-class correlation coefficients (ICC) were used to test similarity between the veterinarian and farmer estimated lameness prevalence. Mixed-effects linear models were fitted to investigate the associations between veterinarian lameness estimated prevalence and farmers' answers regarding lameness importance and impacts on culling cows at the farms. On average, farmers underestimated lameness prevalence during both visits; however, when assessing only severe lameness, veterinarian and farmer prevalence lameness ratings were very similar on the second visit (ICC 0.8, 95% CI: 0.6-0.9, n = 43, $P < 0.01$). The veterinarian's estimated lameness prevalence was about 10% higher on herds where farmers identified lameness as a primary health issue (40.24%) or as a reason for culling (41.7%) versus farms where the farmer did not recognize lameness as a health concern or reason for culling. Farmers' most reported causes of lameness on their farms were categorized as hoof trauma, inadequate feeding practices associated with acidosis–laminitis, high moisture on walking surfaces, and individual features of cows. Farmers mentioned frequently that they made use of antibiotics and topical hoof products to treat lame cows; they also reported low use of anti-inflammatories/analgesics and hoof trimming as treatment remedies and no one mentioned adoption of regular preventative measures for lameness. Farmers reported having no training on lameness management, and cited an overall lack of veterinary support to control lameness on their farms. The farmers seemed unaware of the extent of lameness on their farms. Interventions aimed at reducing lameness in small scale herds in this region of Brazil should include

a preventative veterinary assistance approach focused, initially, to increase farmers' knowledge and awareness on lameness.

Keywords: Animal welfare; Dairy cows; Quali-quantitative methodology; Smallholder

Introduction

Lameness is a serious issue affecting the global dairy cattle industry (Potterton et al., 2012). Lame cows have reduced health and welfare status, and affected herds have higher production costs derived from treatments and production loss (Bruijnis et al., 2013; Huxley et al., 2012). Recommendations directed towards reducing the impact of lameness at the herd level have been derived from undertaking risk factor analyses (Bicalho and Oikonomou, 2013; Randall et al., 2015). Basic measures such as effectively detecting and treating lame cows early are best practices needed to avoid medical complications and progression of cases (Bicalho and Oikonomou, 2013). Additionally, measures such as providing adequate lying areas (Solano et al., 2016) and dry comfortable standing areas to the cows (Bicalho and Oikonomou, 2013; Huxley et al., 2012), implementation of hoof trimming protocols (Maxwell et al., 2015), or avoiding greater loss of body condition in cows (Newsome et al., 2017a), are recommended management practices intended to limit the emergence of new cases of lameness.

Although recently a considerable amount of scientific information on lameness control and prevention has become available, not all farmers succeed in achieving low rates of lameness. Thus, the adoption of preventative or therapeutic practices intended to improve the dairy cows' health are also mediated by factors other than the availability of information. Decisions and actions about prevention, treatment and control of cows' health issues like lameness depend on judgment, which is often affected by the farmers' points of view (Horseman et al., 2014). Thus, an important factor that affects the adoption of good practices in some regions is the farmers' understanding of the health issues and therapeutic procedures. For instance, farmers might not adopt effective lameness control measures because they fail to recognize lame cows or view a lame cow as normal, or simply they do not accept that lameness is a problem on their farm (Fabian et al., 2014; Huxley et al., 2012; Leach et al., 2013). Further issues, such as lack of time, labour or skilled labour, unpopularity or difficulty of tasks connected with lameness control, financial costs, deficit of information, and conflicting advice have all been mentioned as potential barriers preventing the implementation of measures to

control lameness on farms (Horseman et al., 2014, 2013; Leach et al., 2013).

In summary, farmers' knowledge, awareness and interest in dealing with lameness can be important factors that modulate their actions concerning lameness control and prevention. Clearly, understanding the farmers' awareness of the problem, the level of knowledge concerning available interventions targeted at reducing lameness and their desire to improve are needed for effective control of lameness on dairy farms.

Therefore, the aims of this study were to verify farmers' awareness and knowledge about lameness in small scale grazing dairy herds and to analyze farmers' perspectives and actions related to lameness management and prevention.

Materials and methods

The procedures of this cross-sectional survey were carried out in accordance with the guidelines of the Ethics Committees on Research on Human (Protocol # PP1237779) and Animals (Protocol # PP00949) of the Federal University of Santa Catarina, Brazil, and the University of British Columbia Animal Care committee (Protocol # A15-0082), Canada. The objectives, methods and specific procedures of the study were explained to all the participant farmers and informed consent was obtained.

Visited farms

Small scale grazing dairy farms (n = 44) distributed amongst 12 municipalities located in the Santa Catarina State of Brazil were visited twice in 2015. The sample of farms was chosen by convenience and potential participants identified by individuals working in the local dairy industry. This research was part of a larger study on lameness (Bran et al., 2018; Costa et al., 2018), transition period diseases (Daros et al., 2017) and stakeholder views of dairy cow health in grazing dairy herds (Olmos et al., submitted). Briefly, inclusion criteria used for recruitment included the following: a) herd size of at least 40 cows at the moment of first visit; b) suitable accessibility to farms from main

urban centers in the region; c) lactating cows kept on pasture for at least 16 hours per day; and d) use of dairy herd records.

Cows' visual locomotion score assessment

All lactating cows in the farms were locomotion scored during two farm visits (January – June and July – October) using a five point visual score. Cows with score 1 or 2 walked with a flat back, no head bob and no noticeable limp. Cows with score 3 had a moderate arched back, asymmetric gait, and a slight limp. Cows with score 4 and 5 had a distinct arched back, asymmetric gait and obvious limp (Flower and Weary, 2006). Cows scored as 1 or 2 were considered non-lame; cows with score ≥3, were considered clinically lame, and cows with score ≥4 as being severely lame. The lead author, a veterinarian trained in locomotion scoring, did all of the locomotion scoring. Cows were observed while leaving the milking parlour as they walked along a flat hard surface.

Interview conducted with the farmers

The farmers were interviewed during the first visit by two of the authors (Bran and Daros) using a predefined questionnaire presented using the Kobotoolbox software (*Kobotoolbox*, 2014) that enabled for the recording of all responses. In addition to the questionnaire that was completed by individuals working on all 44 farms, in-depth semi structured interviews were conducted with 21 farmers and the results of these interviews are presented in a companion paper (Olmos et al. submitted). Farmers' knowledge on lameness and lameness management at the farms (Table 1), data characterizing the farms (farm area, average milk yield, breed of cows), and demographic variables of the families were also collected. During the completion of the questionnaire the presence of the farm manager or equivalent individual who had intimate knowledge of the farm was mandatory; in most cases, all persons working directly with the cows were present during the questionnaire and some answers reflect a consensus based on a discussion among all participants.

Data analyses

The farmers' answers were categorized and data analyzed descriptively. Average measure-two-way mixed-effects model intraclass correlations coefficients (ICC 3,1) (Shrout and Fleiss, 1979) were fitted (Gamer et al., 2012) to assess the consistency between the mean lameness prevalence estimated by the veterinarian and the mean prevalence reported by the farmers at the time of each visit.

The prevalence of clinical lameness estimated by the veterinarian in the first and second visit was compared among farms that provided different answers (yes/no) regarding the importance of lameness as a health problem in the farm and the impact of lameness on culling cows. Four univariable mixed-effects linear models were fitted (one model for each category of question regarding lameness importance as a health problem and impacts on culling cows at the farms). The response variable was the average prevalence estimated by the veterinarian in the two visits and the predictor for each model was the farmer response category (No = intercept, Yes = slope). Municipality and farm, nested within municipality, were included as random effects to account for the repeated measurements of prevalence in the farms and also to account for the hierarchical structure of the assessed population. The linear models were fit by restricted maximum likelihood estimation, using the lme4 package (Bates et al., 2015) and P-values were obtained by type II Wald chi-square test (Korner-Nievergelt et al., 2015). Significance was set at $P < 0.05$. The goodness of fit of the regressions was assessed through residual plot analysis and random effects' normality was checked graphically. The associations between lameness prevalence and farmers' answers (lameness estimated prevalence, answers regarding lameness relevance and impacts on culling) were used as a surrogate measure for farmers' awareness of lameness occurrence on their farms. All the statistical analyses were performed using R (R Core Team, 2017).

Results

Description of farms

The average area of farms was 22.3 ha (SD = 11.5) and the mean monthly milk yield per herd was 20306 L (SD = 6162). The mean lactating herd size was 37.6 (SD = 9.2) and 41.9 cows (SD = 11.2) on the first and second visit, respectively. Daily milk yield of individual cows is not commonly recorded on farms within this region. However, when asked on the first visit, farmers estimated that the average daily milk yield per cow was 18.8 L (SD = 3.6). In total, 1633 and 1836 cows were assigned a locomotion score on the first and second visit, respectively. Herds were composed mainly of two breeds (Holstein and Jersey) and their crosses. All visited farms had similar management practices. Briefly, cows were milked twice per day, had access to pasture for most part of the day throughout the year in rotational grazing system and were offered corn silage and concentrate as feed supplement (see also Bran et al., 2018 for full description).

Characterization of the families

Four persons on average (range 2-9) – consisting almost always of family members – worked regularly on the farm. Only 5 out of 44 farms employed non-family workers. The mean age of the farm manager (or equivalent) was 41 years (range 23-60). Most of the farm managers were male (42 out of 44). On average about half the managers reported making decisions regarding milk production collectively with the others working on the farm (24 out of 44 farms) with the management decision on the other farms made by the owner or manager (20 out of 44 farms). The level of education of the family member with the highest level varied across the farms, and was not always the farm manager, with 11 family members having elementary schooling, 22 stated that they had some secondary schooling, and 11 had post-secondary education (mostly animal science, agriculture or business administration). On average the families reported having been engaged in dairy production for approximately 20 years (range 5-35 years).

Farmers' estimated lameness prevalence

On average, the farmers estimated a lower prevalence of lameness on their farms than the

veterinarian (Table 2). Overall there was no agreement between the farmers' and veterinarian estimates of lameness prevalence. The only exception was in the case of severe lameness prevalence, which was similar (ICC 0.8, 95% CI: 0.6-0.9) for the estimates provided by both the trained veterinarian and the farmer on the second visit (Table 2 and Figure 1).

Farmers' suggested causes of lameness in dairy cows

The farmers mentioned different factors as causes of lameness that were grouped into five categories (Table 3). Trauma and conditions that exert excessive stress on the hoof were the most common factors identified as causes of lameness by farmers. This was followed by inadequate feeding practices with farmers frequently mentioning that ruminal acidosis (or giving excessive grain, or silage that promotes acidosis) was the main cause of lameness.

Farmers' sources of information

All the farmers reported having no specific lameness training, including no continuing education courses related to lameness prevention or management. However, 20 farmers (45.5%) reported having attended some course or conference during the previous two years where health issues, but not lameness, in dairy cattle were discussed.

Lameness as a health issue or a reason for culling cows

Few farmers ranked lameness as the main health problem of cows on their farms; however, the majority did include it as one of the three most common health issues affecting cows on their farms (Table 4). Two other common health problems identified by the farmers were reproductive failure and mastitis. Many farmers reported lameness as one of the three main reasons for culling cows at their farms (Table 4). We did observe that the farms where farmers identified lameness as either one of the three main health issues, or one of the three common reasons for culling, had higher average predicted lameness prevalence compared to farms where farmers did not list lameness as one

of the main health issues or causes of culling (Table 5).

Veterinary assistance, prevention measures and treatments applied for lameness in the farms

With the exception of one farm, all farmers reported having treated lame cows on their farms. However, no farm kept records of specific treatments nor did they make use of veterinary or professional support to control lameness. Although 24 farmers (55%) reported having a veterinarian visit once a month, 16 farmers (36%) reported only calling a veterinarian for specific health issues, and 4 (9%) reported that they only had a veterinarian visit every 2-3 months. The most common veterinary assistance provided to these farms was in relation to reproduction (17 farms receiving periodical visits, either monthly, or every 2-3 months). Only two farmers mentioned having called a veterinarian to deal with lameness or for hooves' abnormalities in cows.

The main approaches to treatments of lameness described by the respondents are detailed in Table 6. The use of antibiotics to treat lame cows was frequently mentioned. Within this category the use of local and parenteral antibiotics was mentioned by 6 and 24 respondents, respectively, with 3 farmers reporting using both kind of antibiotics at the same time. When asked for the commercial or active principles of antibiotic used, nine respondents mentioned the use of cephalosporins and one reported the use of gentamicin. Only three farmers mentioned having practiced preventative hoof trimming in the past and one reported the use of hoof baths for some cows, but in both cases neither of these practices were routine.

Discussion

Farmers estimated a lower prevalence of lameness compared to the trained veterinarian, with the greatest discrepancy noted on the first visit. The improvement in farmers' estimates (in comparison to the veterinarians) at the second visit may have been due to an increased sensitivity to the issue of lameness, particularly the severe cases which do not require the same degree of training to identify as clinical cases (Fabian et al., 2014). Farmers' underestimation of lameness occurrence is

a barrier to be overcome if lameness is to be addressed (Bennett et al., 2014; Fabian et al., 2014). However, increasing the detection of lame cows is insufficient to fully address the problem, as increased farmer sensitivity to the problem *per se* is also necessary (Leach et al., 2013).

Differences in estimated lameness prevalence between farmers and the trained veterinarian may be simply a matter of the farmers' underestimation of this malady, but it may also be explained, at least to some degree, to differences in what defines a lame cow (Horseman et al., 2014). In cases where failure to recognize lameness is the main problem, the ability to identify lame cows has been reported to increase if the farmers have had previous contact with information, training and some technical orientation about the problem (Leach et al., 2013). The responses to the questionnaire indicated little access to current information about lameness, which may have contributed to the farmers' failure to identify the majority of the lame cows. The large gap between farmers' and veterinarians' estimation of lameness prevalence suggests that efforts focusing on training farmers to identify lame cows (particularly mild lameness) may be a first step to reduce lameness in small scale grazing herds in this region.

Lameness in dairy cows is a clinical sign frequently associated with pain arising by foot infectious diseases or claw horn disruption lesions (CHDL) (Huxley et al., 2012). Some farmers mentioned factors that have been previously associated with higher rates of foot lameness, or conditions that result in greater stress on the cows' feet, such as hoof trauma and excessive moisture on walking surfaces (Cook and Nordlund, 2009; Huxley et al., 2012; Newsome et al., 2017b). However the farmers did not mention diseases associated with lameness, nor did they bring up any of the common CHDL when asked about lameness causes. This provides further evidence that there is low familiarity with technical information regarding lameness in cattle among this group of farmers. Since farmers likely make decisions based on their circumstances and agricultural context (Ritter et al., 2017), farmers' knowledge about factors affecting lameness on their own conditions might be used as a basis for advisers to discuss and motivate the enforcement of actions aimed to control risk factors for lameness.

Most farmers believed that acidosis arising from poor nutrition was the cause of lameness. The idea that a causal relationship exists between rumen acidosis and laminitis in dairy cows and thus is the major cause of lameness has been largely disregarded in the modern literature (Bicalho and Oikonomou, 2013; Danscher et al., 2010; Newsome et al., 2017b). An alternative hypothesis suggesting that the causes of most CHDL and diseases leading to foot lameness are multifactorial is gaining acceptance (Bicalho and Oikonomou, 2013; Newsome et al., 2017b, 2017a). However, it is possible that sources of information, including those brought forward by extension agents and other dairy advisors working in the area, may be historic in nature and thus not represent current knowledge. Equally important to having the correct information available for education is the farmers' desire to incorporate the newest knowledge into the dairy production system. The fact that many of the farmers' exclusively linked acidosis to lameness indicates that, at least to some degree, there are some knowledge gaps either within the advisor or the farmer community, or both. Olmos et al (submitted) provides additional insights following in depth conversations with a subset of the same farmers and their advisors, where it is made clear that at least some of the farmers believe that acidosis (and thus lameness) is alleviated by providing the cows access to a salt buffer feed additive. In summary, it seems that the farmers did not recognize lameness as a sign of pain or discomfort caused by multiple conditions; however, they identified common factors that might be associated with higher occurrence of lameness in herds or cows, but that are not necessarily intervening or causal factors.

The frequent mention of antibiotic use for treating lame cows may suggest a possible suspicion of infectious causes of lameness by the farmers. Foot root and digital dermatitis are infectious diseases that may be common in dairy cows at the region. Previously we described the presence of digital dermatitis on this region (Bran et al., 2018). However, as none of the farmers mentioned any of these diseases on their responses, we can not link the treatments reported by farmers with any specific foot infectious disease.

A lack of understanding of the role of antibiotics in treating disease may also be associated with the frequent mention of these medications to treat lame cows. Conflicting advice or information

given to farmers by different stakeholders such as their veterinarian and feed-store vendors has been mentioned as factors contributing to the misuse of antibiotics in small-scale dairy farms (Redding et al., 2014). Also, given that input vendors are a frequent source of advice for farmers, they may exert a proportionally larger influence on farmers' management decisions compared to others (Castro and Confalonieri, 2005). Thus, the widespread reported use of antibiotics – despite the fact that farmers did not mention infectious causes of lameness as an important issue – may reflect an untargeted approach to treating lameness as a result of misinformation and advising.

The low reported use of analgesics may reflect farmers' unawareness regarding inflammation and pain associated with lameness and the great importance of pain control to preserve the health and welfare of lame cows (Coetzee et al., 2017; Tadich et al., 2013; Weary et al., 2006). Another study surveying the opinions of dairy farmers in the same region to dehorning practices reported that farmers recognize and are concerned by pain in their animals, but this unfortunately rarely reflected in adoption of measures to control it (Cardoso et al., 2016). The recommendations of dairy advisers may also have influenced the decisions of farmers to only make infrequent use of analgesics to control pain associated to lameness. It has been shown that, with regard to other painful situations, extension workers in the region did not recommend medication for pain control (Hötzel and Sneddon, 2013). Advisers may also have different criteria to assess the pain severity in cows (Remnant et al., 2017) and this may affect the recommendations given to the farmers regarding analgesic use. Improving the understanding of the role(s) of advisers may be important, as they may be influential when attempting to advocate for pain mitigation in lame cows on the current farms. This, plus the identification of other barriers preventing effective solutions that control pain (and ultimately lameness), is important as there is need to continue to look for practical, motivational or subjective reasons behind the non-adoption of this basic measure.

Almost all farmers reported treating lame cows in the recent past, although they appeared to be more aware of severe than moderate cases of lameness, which may imply that they prioritize the treatment of severe lame cows. This approach might be insufficient to control lameness in the herds

since severe lame cows have lower probability of recovery after treatment (Miguel-Pacheco et al., 2017), notwithstanding the welfare impairment on these cows. Additionally, a surprisingly large number of the farmers failed to routinely request veterinary assistance when dealing with lameness cases which may indicate that the treatments for lame cows on these farms may be partially driven by advisers others than veterinarians, which might influence the application of untargeted measures to treat and prevent lameness in cows. Enforcement of preventive measures may be required in order to reduce the impacts of lameness on health, productivity and welfare of the cows. Thus, not just giving adequate treatment to the affected individuals, but reducing the causes of health issues should be a priority when taking a preventive health approach (Rose, 2001). A structured program aimed to control lameness in the assessed population should contemplate measures directed at identifying and treating both mild and severe lame cows, as well as preventing and controlling lameness at the population level.

Most farmers seemed to be aware that lameness is a common issue affecting the health and the culling rate of their cows, a finding that seems coherent with the higher occurrence of lameness observed on farms that reported that lameness was a challenge. However, they did not seem aware of the scope of the problem, given that they underestimated the number of lame cows present on their farms. Thus, the farmers may consider lameness as a secondary problem, thereby placing a priority on other health issues (i.e., reproductive failure and mastitis). Therefore, many of the farmers' efforts are presumably targeted towards the issues that they prioritize, resulting in fewer efforts and resources available to control lameness. A first step needed when addressing this malady is that farmers must acknowledge the existence of the problem and accept the responsibility of taking actions (Ritter et al., 2017). Hence, ignoring the existence of the problem may result in farmers avoiding the adoption of actions intended to reduce the negative impacts of lameness in the herds.

Farmers' adoption of recommended practices to prevent and control health issues in dairy cows is a complex process mediated by the comprehension of the problem by farmers, but also influenced by multiple factors such as socio-economic conditions or the influence of social referents

like advisors, veterinarians, or other farmers (Ritter et al., 2017). Thus, it seems that there are no simple protocols to deal with this issue; nevertheless, some general recommendations to overcome barriers associated with low adoption of practices intended to prevent lameness have been proposed previously. Providing information to farmers about lameness occurrence (Chapinal et al., 2014), risk factors, and the main measures needed to prevent lameness is important to motivate changes directed to control the problem (Whay et al., 2012). Also, training the farmers to recognize and timely treat the mildly lame cows has been suggested as a main measure for controlling lameness (Green et al., 2010). It is also crucial to engage the farmers in the process of planning preventive measures for lameness to ensure their application and success in reducing lameness. Interventions that promote engagement of farmers with assistance of facilitators seem to be effective in the generation of control strategies for lameness (Chapinal et al., 2014; Whay et al., 2012). Thus, providing the farmers access to proper technical information on lameness in dairy cows and promoting the adoption of programs and strategies focusing on reducing lameness, as well as ensuring that correct advice is given are important measures that should help reduce the impact of lameness in this region.

Conclusion

The farmers in the assessed population seemed unaware of the actual occurrence of lameness on their farms and the relevance of the problem in relation to other health related issues (e.g., mastitis or reproductive failure). The knowledge regarding lameness aetiology was minimal and restricted to farmers' empirical observations, with an almost complete absence of any technical training or advising from specialists on the issue, despite apparent routine contact with veterinarians and other advisors. Possibly as a consequence, the strategies of lameness management were mainly focused on treating individual cases, whereas measures directed to prevent or control this disease at the population level were neglected.

Conflicts of interest

We have no conflicts of interest to declare associated to this publication.

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Appendix Supplementary data

Supplementary data associated with this article can be found at https://data.mendeley.com/datasets/59fwj9y247/draft?a=ca3e194c-d05a-4cab-9b25-d8bf0682e752.

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Table 1. Questionnaire conducted with farmers in 44 small scale grazing dairy farms located in the south of Brazil and visited in 2015.

Questions relating to demographics
1. How many persons work regularly on your farm working either full time or part time that either work directly with the animals or in any other processes related to milk production, such as forage production, feeding, chasing and milking the cows and cleaning facilities?
2. What age is the farm manager or equivalent person in charge of making decisions?
3. What is the highest educational level of all individuals identified in question 1 (i.e. elementary, secondary or post-secondary school)?
4. How long has each family worked in the dairy industry?
Questions focused on farmers' knowledge and actions related to lameness control and prevention
1. What are the three main health problems of milking cows in your farm? (please rank by order of importance)
2. What are the three most common reasons for culling cows on your farm? (including voluntary and involuntary causes; please rank by order of importance)
3. Have you ever treated lame cows on your farm?[1] If yes, then, please describe how you managed and treated these cows[2].
4. Do you usually practice preventative hoof trimming on cows?
5. Do you use routine preventative footbaths?
6. What are the main causes of lameness on your farm? [3]

7. Have you participated in any continuing education events related to animal health on the last two years? If yes, please describe the topic of the course.

8. Do you have veterinary support? If yes, then:

    a) how frequent does the veterinarian visit the farm?

    b) what are the main health issues that the veterinarian deals with when visiting your farm?

9. How many lactating lame cows are there on our farm today?[4]

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[1] We did not ask farmers to define lameness before or after asking the questions on that issue; instead, we asked them to respond to the question of whether they knew what lameness was and all answered yes.

[2] The use of treatment records, when available, was used to verify responses and the specific name of the medications or protocols mentioned by the farmer.

[3] When farmers reported that lameness was uncommon at the farm (hence, risk factors would be absent at the farm), the question was phrased as: what are the main causes of lameness in dairy cows on herds similar to your farm productive conditions?

[4] This question was phrased each time the veterinarian assessed locomotion of the cows and was used to estimate a farmers' reported prevalence. At the first visit, the interviewees were asked to provide an estimate of how many cows were lame on their farm; this question was repeated on the second visit but was presented directly to the farm manager at the time of milking.

Table 2. Associations between severe lameness prevalence estimates provided by a trained veterinarian and those provided by farmers when asked the percentage of lame cows on their farms. Farms (n = 44) were small scale grazing dairies visited twice in 2015 in the south of Brazil.

Visit	Mean (SD) herd lameness estimated prevalence (%)		ICC[1]	95% confidence interval		P-value[4]
	Veterinarian[2]	Farmers		Lower	Upper	
First	Severe: 14.4 (13.0)	6.5 (5.3)	0.2	-0.5	0.6	0.23
Second[3]	Severe: 4.8 (5.0)	3.8 (3.7)	0.8	0.6	0.9	< 0.01

[1] Average measure-two-way mixed-effects model intraclass correlations coefficients (ICC) for assessing the consistency between the mean lameness prevalence estimated by all the farmers and the veterinarian.

[2] Severe lameness: locomotion score ≥4. The within-herd lameness prevalence estimated by the veterinarian was previously reported in Bran et al., 2018.

[3] n = 43 (one farmer response was missing).

[4] Significance was set at P<0.05; P-value testing if the correlation between the farmer and veterinarian estimate is different from zero.

Table 3. Farmers' suggested causes of lameness in 44 small scale grazing dairy farms located in the south of Brazil and visited in 2015.

Farmers' suggested cause of lameness	n (%)[1]
Trauma	31 (70.5)
Rocky/stony ground	27 (61.4)
Mobility issues[2]	7 (15.9)
Hard floors	1 (2.3)
Inadequate feeding practices	26 (59.1)
Ruminal acidosis	11 (25)
Excessive feeding of grain to cows	8 (18.2)
Excessive feeding of silage to cows	6 (13.6)
Low supply of minerals to cows	3 (6.8)
Environmental causes[3]	23 (52.3)
Individual features of cows	7 (15.9)
Age (older cows)	4 (9.1)
Overweight	1 (2.3)
Inappropriate body conformation	1 (2.3)
Low body condition score	1 (2.3)
Hoof infection	1 (2.3)
Other causes	4 (9.1)

[1] Number of farmers who reported and percentage: categories are summarized per number of respondents and subcategories are expressed as number of responses (some farmers mentioned

multiple subcategories).

[2] e.g., inappropriate paths, rush when chasing the cows to milking, cows walking long distances.

[3] Excessive moisture on paths and floors.

Table 4. Distribution of estimated clinical lameness (locomotion score ≥3) prevalence by gate scoring by a trained veterinarian between answers of farmers to questions about lameness relevance in the farm in 44 small scale grazing dairy farms visited twice in the south of Brazil in 2015.

Farmers' report regarding lameness in their farm	Farmers' answers	Lameness prevalence by visit[1]	
		First	Second
Lameness is the main health problem of milking cows	No (n = 37)	29.71 ± 15.33	33.76 ± 16.26
	Yes (n = 7)	37.90 ± 12.69	41.67 ± 7.50
Lameness is one of the 3 most common health problems affecting milking cows	No (n = 21)	26.37 ± 11.96	28.98 ± 12.18
	Yes (n = 23)	35.25 ± 16.65	40.54 ± 16.23
Lameness is the main reason for culling cows	No (n = 40)	30.42 ± 14.97	34.69 ± 15.82
	Yes (n = 4)	36.99 ± 17.53	38.31 ± 11.83
Lameness is one of the three reasons for culling cows	No (n = 29)	26.43 ± 12.08	30.94 ± 13.09
	Yes (n = 15)	39.88 ± 16.78	42.92 ± 16.93

[1] Mean (± standard deviation) of within-herd lameness prevalence (%) by farmer response category.

Table 5. Associations between answers of farmers to questions about lameness relevance in the farm and estimated clinical lameness (locomotion score ≥3) prevalence by gate scoring by a trained veterinarian on the first and second visit, in 44 small scale grazing dairy farms in the south of Brazil in 2015.

Farmers' report regarding lameness in their farm	Farmers' answers	Estimate[1]	95% confidence interval	P-value	Random effect (SD)[2]	
					Farm	Municipality
Lameness is the main health problem of milking cows	Intercept	31.74	24.93–34.54	0.15	11.91	0
	Yes	8.04	-3.0–19.08			
Lameness is one of the 3 most common health problems affecting milking cows	Intercept	29.78	23.27–36.30	< 0.01	9.64	6.59
	Yes	10.46	3.34–17.58			
Lameness is the main reason for culling cows	Intercept	33.48	28.41–38.55	0.50	11.62	4.14
	Yes	4.83	-9.29–18.95			
Lameness is one of the three reasons for culling cows	Intercept	29.15	24.29–34.01	< 0.01	10.38	2.47
	Yes	12.55	4.78–20.33			

[1] Coefficients were obtained from four univariable mixed-effects linear models (one model was fitted per each category report) comparing each farmer response (No = intercept, Yes = slope) with the average prevalence estimated by the veterinarian in the two visits. P-values were obtained by type II Wald chi-square test.

[2] Municipality (n = 12) and farm, nested within municipality were included as random effects. Standard deviation (SD) of the variation in lameness prevalence around the average lameness prevalence predicted by the model is presented for each level of the random effect.

Table 6. Farmers' reported lameness treatment in dairy cows in 44 small scale grazing farms in the south of Brazil.

Question	Yes n (%)[1]
Treatment of lame cows	43 (97.7)
Use of antibiotics	27 (61.4)
Application of topic products on hooves [2]	18 (40.9)
Use of anti-inflammatories/analgesics	12 (27.3)
Application of hoof trimming for treatment	11 (25)
Diet modifications for treatment	6 (13.6)
Application of foot-baths	4 (9.1)
Use of other measure/medication for treatment	4 (9.1)

[1] Number (n) and percentage of farmers.

[2] Ointments, spray, antiseptics, disinfectants.

Figure 1. Distribution of veterinarian (clinical = locomotion score ≥ 3; severe = locomotion score ≥ 4) and farmer estimated lameness prevalence in 44 small scale grazing farms located in the south of Brazil visited twice. Farmer estimated prevalence in the second visit was obtained from 43 farms.