

Management practices that influence the welfare of calves on small family farms

Renata Relić¹, Jože Starič² and Jožica Ježek²

¹Animal Hygiene and Health Protection, Faculty of Agriculture, University of Belgrade, Belgrade, Serbia and ²Clinic for Reproduction and Large Animals, Veterinary Faculty, University of Ljubljana, Ljubljana, Slovenia

Research Reflection

Cite this article: Relić R, Starič J and Ježek J (2020). Management practices that influence the welfare of calves on small family farms. *Journal of Dairy Research* **87**(S1), 93–98. <https://doi.org/10.1017/S0022029920000539>

Received: 18 October 2019
Revised: 20 March 2020
Accepted: 24 March 2020
First published online: 30 July 2020

Keywords:

Calves; health; management; small farms; welfare

Author for correspondence:

Renata Relić, Email: rrelic@agrif.bg.ac.rs

Abstract

In this Research Reflection we review management practices in small family farms with less than 100 cows. Small farms represent the majority of farms in the EU and the world, and they are of great importance for the economy of a country. On cattle farms, the welfare of calves is of primary importance for the profitability of the herd, and poor management is one of the main factors influencing calf health and survival. Data on the risk factors for calf welfare issues in small-scale farms are limited. For this purpose, the literature data from six world countries were presented and compared, including Serbia and Slovenia where a survey related to the issue was carried out within the COST Action FA1308, DairyCare. Some practices within the following areas in calf management were considered: calving management, care for new-born calves, use of painful procedures, colostrum management, cow–calf separation, calf feeding, weaning, calf housing, and general monitoring. In each of the countries, the health and welfare of calves are threatened by some omissions in rearing practices and the major are related to the new-born calf management, the feeding and watering management, and the application of hygienic measures. Many farmers are well aware of the importance of proper calf rearing; others would need more incentive to improve calf management. Each country should pay attention to the education of farmers about the most common deficiencies in calf management.

Small, family-operated farms represent the most common type of agricultural holdings in the world. Of the 10.8 million farms in the EU in 2013, the vast majority (96.2%) were classified as family farms (Eurostat, 2016). They are responsible for a large share of the world's food production, including milk production, given that the majority of cows are belonging to small-scale family farms (Lowder *et al.*, 2016; FAO, 2010; EFSA, 2015; Fanzo, 2017). These farms produce milk for their own need, but also for the local market (EFSA, 2015; Ergmassen *et al.*, 2018).

The average number of dairy cows per family farm varies between countries, for example, in 2018 in Austria it was 21.6 dairy cows per farm (ZAR, 2019), in Slovenia 17.1 (Sadar *et al.*, 2019) and Serbia 1.3 (RZS, 2019b). The threshold for defining a farm as small also varies depending on the country and its average herd size, and it is not strictly defined. According to Grace *et al.* (2008), a small farm in Croatia has up to 3 cattle but in Bulgaria up to 50 cattle; in the Netherlands and other EU countries the maximum is 75 cows although most countries have herds of above 10 cows (EFSA, 2015). However, in the USA, farms with fewer than 30 dairy cows are considered as very small, with 30 to 99 as small, with 100 to 499 cows as medium size and with 500 or more as large farms (USDA, 2016).

Calves can be regarded as the most sensitive category of animal on cattle farms. In Slovenia, calves represent 30.6% of the cattle population (Sadar *et al.*, 2019) and in Serbia 19.42% (RZS, 2019a). Healthy and thriving calves provide quality and productivity of a herd in the future, therefore calf welfare should be of primary importance for a breeder. Poor management is one of the main factors leading to the outbreak of diseases and deaths of calves but, despite recommendations, farmers continuously use practices that may endanger calf health and welfare (Vasseur *et al.*, 2010a). EFSA (2012) described the main hazards posing a risk to calf welfare in intensive breeding systems. However, the literature data addressed specifically to the risk factors for the occurrence of diseases and welfare issues in small-scale farms are limited and in this short review we show some calf rearing techniques at family farms with less than 100 cows and to point out the common practices that carry a risk to calf health and welfare. With this regard, data published from the surveys carried out in Slovenia and Serbia within the COST Action FA1308 DairyCare have been compared with appropriate data from Austria, USA, Canada and Brazil, as important cattle-breeding countries. It was assumed that there are similarities between neighbouring countries, especially if they have similar geographical location (such as Slovenia and Austria) and/or economic status, and also differences between large and small countries (e.g. Serbia vs. Canada) as well as between countries located on the other continent (e.g. Brasil vs. USA).

© The Author(s), 2020. Published by Cambridge University Press on behalf of Hannah Dairy Research Foundation. This is an Open Access article, distributed under the terms of the Creative Commons Attribution licence (<http://creativecommons.org/licenses/by/4.0/>), which permits unrestricted re-use, distribution, and reproduction in any medium, provided the original work is properly cited.



CAMBRIDGE
UNIVERSITY PRESS

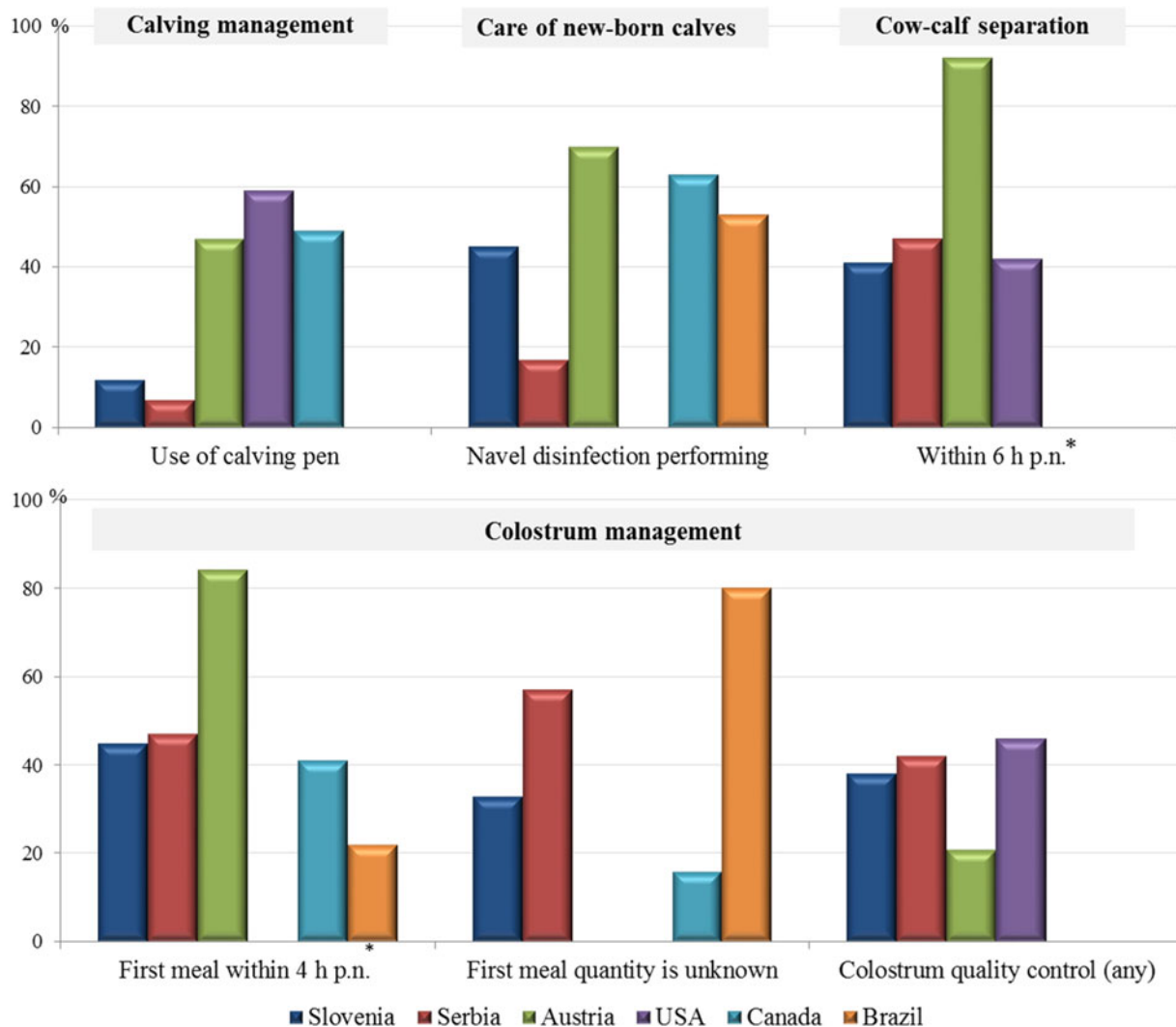


Fig. 1. Some practices regarding calving management, care of new-born calf, colostrum management and cow-calf separation on small farms in different countries. The values (percentages of the farms) are presented as integers from the original data; missing column – no numerical data or data was not found; *p.n. – post-natum. References: Vasseur *et al.* (2010a), Hötzel *et al.* (2014), Klein-Jöbstl *et al.* (2015), Santos and Machado Bittar (2015), USDA (2016), Relić *et al.* (2018).

An overview of calf management practices on small farms

Vasseur *et al.* (2010b) identified critical areas in the rearing: calving management, care of new-born calves, use of painful procedures, colostrum management, cow-calf separation, calf feeding and weaning, calf housing, and general monitoring. Calf health and welfare may be compromised if any of the procedure is not carried out regularly, properly or on time.

Calving management and care for new-born calves

In calving management, the use of calving pen on small farms differs among the countries. It is very rare in Serbia and Slovenia, and also in Brazil (Fig. 1) where no specific location for calving was identified in most of the farms (Hötzel *et al.*, 2014) or there is a maternity pen outside of the barn (Santos and Machado Bittar, 2015). In many countries including Austria and Canada, a tie-stall housing system is common in small farms (Vasseur *et al.*, 2010a; Klein-Jöbstl *et al.*, 2015). In Slovenia and Serbia, a highly pregnant cow usually stays tied up

at the same place until after parturition (Relić *et al.*, 2018), which represents a lack of comfort for the cow and the risk for a new-born calf to get in contact with manure behind the cow (Vasseur *et al.*, 2010a).

According to the Austrian study, calving pens are more often used on farms with up to 20 cows than on larger farms, 70.5 vs. 30.4% (Klein-Jöbstl *et al.*, 2015). Use of a calving pen minimizes stress and ensures the comfort and hygiene of the cow and the new-born calf (Vasseur *et al.*, 2010a) providing that the pen is regularly cleaned and not used for diseased cows. However, this is often not the case in practice. Only about one-third of small farmers in the USA clean a pen between each calving (USDA, 2016). In Serbia, more than half of farmers claimed they wash the floor of the calving stall/pen by water (mostly cold), and some of them additionally use a detergent or disinfectant (Relić *et al.*, 2017a, 2017b).

Regular surveillance of the calving area is necessary, especially during the night, to ensure assistance at calving if needed and to check if the calf received colostrum within 6 h after birth. On average, farmers in Canada visit the cows that are due to calve

three times during the day and once between evening and morning milkings, and a very small percent used a camera to monitor the calving (Vasseur *et al.*, 2010a). In Brazil, the majority of farmers do not check the maternity pen during the night (Santos and Machado Bittar, 2015).

After birth, calf monitoring is necessary to timely spot the first signs of health problems and changes in behaviour. The majority of farmers in Slovenia and Serbia spent between 15 and 30 min a day for calf surveillance (Relić *et al.*, 2018; Ježek *et al.*, 2019). That may be insufficient even if the number of calves is small.

Navel disinfection is a procedure of great importance for calf health (EFSA, 2012). The fresh navel may represent a portal of entry for pathogens which may cause serious infection and death of the new-born calf (Vasseur *et al.*, 2010a). This procedure is frequently applied by Austrian and Canadian farmers but quite rare in Serbian farms (Fig. 1). In Brazil, it was observed that some farmers treat the navel incorrectly or with an inadequate product (Santos and Machado Bittar, 2015).

Colostrum management

There are several recommendations about time and quantity of colostrum at the first feed but, in general, the sooner calf gets colostrum and the more that is consumed, the better is the transfer of immunoglobulins. Producers should aim to feed all calves within 1 to 2 h after birth and by 6 h at a maximum, considering the efficiency of colostral immunoglobulins' absorption is 50% after parturition, 33% after 8 h and after 24 h there is almost no absorption (Godden, 2008). The calves on small farms get the first colostrum meal most commonly within 4 h in the USA and Austria, and 2 to 3 h after birth in Slovenia, Serbia, and Canada (Fig. 1). In Brazil, if the calving on a small farm was happening during the night, the calf will receive colostrum in the morning (Santos and Machado Bittar, 2015). The quantity of colostrum consumed in the first 12 h after birth should be 10 to 12% of the calf's body weight (Godden, 2008). In Serbian and Brazilian farms calves mostly take colostrum by suckling the dam (Fig. 1), so the quantity of colostrum is not known. If calves are not assisted in feeding in the first hours after birth, there is a very high risk they will be under-supplied with colostrum. Hand-feeding colostrum is often preferred, as this method allows producers to closely monitor the quantity and quality of colostrum consumed (USDA, 2016). At most of the small farms in the USA and Slovenia calves consume up to 2 l and in Austria 2–4 l of colostrum at the first meal (Klein-Jöbstl *et al.*, 2015; USDA, 2016; Ježek *et al.*, 2019). When properly managed, different methods of colostrum delivery can successfully promote calf's health and development (Pempek *et al.*, 2017).

Intake of inadequate or contaminated colostrum has been highlighted as one of the major risks for calf welfare (EFSA, 2012). However, colostrum quality control is not a very common practice on farms (Fig. 1). Most farmers who perform control do not use a colostrometer or refractometer but make a visual assessment based on the appearance of colostrum. It is possible that farmers are not aware of the importance of colostrum quality although they consider colostrum is important for a new-born calf (Ježek *et al.*, 2019).

Cow-calf separation and painful procedures

Immediate separation of the calf from the cow after calving and housing individually in a clean pen is recommended to decrease

the risk of infections, ensure successful colostrum delivery, and reduce potential cow-calf bonding and behavioural distress at later separation (Pempek *et al.*, 2017). From the welfare point of view, maternal care has a positive influence on new-born calf and absorption of colostral immunoglobulin (Aldridge *et al.*, 1992). Furthermore, cow-calf separation is increasingly a topic of public concern worldwide (Busch *et al.*, 2017). Cow-calf separation immediately or within 4–6 h after parturition is done on almost all farms in Austria and on about half the farms in the USA, Serbia, and Slovenia. At about 70% of farms in Canada and Brazil, cow-calf separation is performed within 12 h of birth (Fig. 1).

Disbudding/dehorning is a painful procedure frequently performed in most of the countries observed, except in the USA (Fig. 3). The age of calf when the procedure is performed, the method and the use of analgesia and/or anaesthesia are factors that may affect the calf's welfare. Disbudding should be done in calves less than three weeks of age (NFACC, 2009). In the Czech Republic, calves may be disbudded up to 4 weeks of age without using analgesia or anaesthesia and in older calves dehorning may be done only by veterinarians using analgesia or anaesthesia (Stanek *et al.*, 2014). According to the study in the EU Member States, hot-iron is the most used disbudding method and some kind of medication for pain relief is administered to the animals in less than 30% of farms (Cozzi *et al.*, 2015).

Calf feeding and weaning

In feeding management, calf welfare may be affected by the type of milk used, use of pasteurization and use of waste milk, milk quantity, number of meals and method of milk distribution. Calf age at first access to drinking water, type of access and type of the drinker as well as age at access to a concentrate feed, quantity and number of meals and type and quantity of roughage are all factors also (Vasseur *et al.*, 2010b). Feeding milk to calves *via* nipple (bucket or bottle) is more common practice in the USA and Europe than in Canada (Fig. 2) where the majority of calves drink from buckets. The use of a bottle generally decreased as herd size increased (USDA, 2016). Calves fed from an open pail are unable to perform their natural sucking behaviour, whereas teat-based milking systems provide such opportunity (Vasseur *et al.*, 2010a). Calves suckle milk *via* nipple slower than they drink from the bucket, which enables normal clot formation in the abomasum and prevents gastrointestinal disorders.

Feeding calves with waste milk is a common practice in many countries (Fig. 2), especially on farms with greater milk production (Santos and Machado Bittar, 2015). The milk of treated cows is often used primarily for economic reasons, since it is not suitable for sale but may replace the meal (reduced consumption of healthy milk or milk substitutes). Farmers should be cautious about using waste milk because of the increased risk for transmission of infection and antibiotic residues to calves.

Additionally, hygiene of milk-feeding equipment is important in preventing calf-to-calf disease transmission. The equipment should be cleaned and disinfected between each calf. After each feeding, most small farmers only rinse milk-feeding equipment with water (USDA, 2016).

Water access is an important issue given that on many farms calves do not have *ad libitum* access to water for a long period after birth (Fig. 2). On small farms in the USA, calves have access to water for the first time between day 15 and day 20 (USDA,

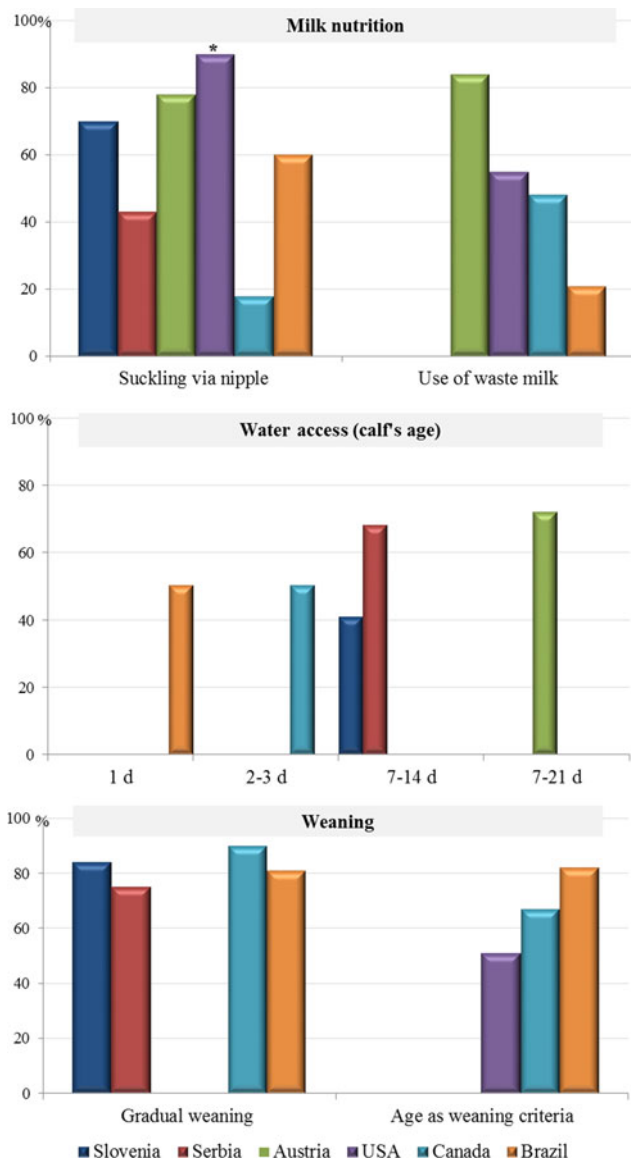


Fig. 2. Some practices regarding feeding and watering, and weaning of calves on small farms in different countries. The values (percentages of the farms) are presented as integers from the original data; missing column – no numerical data or data was not found; *Approximate value according to given data. References: Vasseur *et al.* (2010a), Klein-Jöbstl *et al.* (2015), Santos and Machado Bittar (2015), USDA (2016), Relić *et al.* (2018).

2016). A common opinion of cattle breeders worldwide is that suckling calves do not need water because they receive enough fluid *via* milk. Some farmers do not give enough water to the calves even later in their life, sometimes not before weaning. The beginning of the free water access after the first week may be related to starting with the consumption of concentrated feed (Kertz *et al.*, 1984). Provision of drinking water immediately after birth could improve the growth and development of calves pre- and post-weaning, potentially by stimulating rumen development and thus increasing nutrient availability (Wickramasinghe *et al.*, 2019).

Calves will drink more water if they are about to get diarrhoea or some other health issue (Kertz *et al.*, 1984). However, in many farms, diarrhoeic calves have limited access or no access to the water. The owners give them rehydration solution two or more times per day, but it may not cover completely their needs for

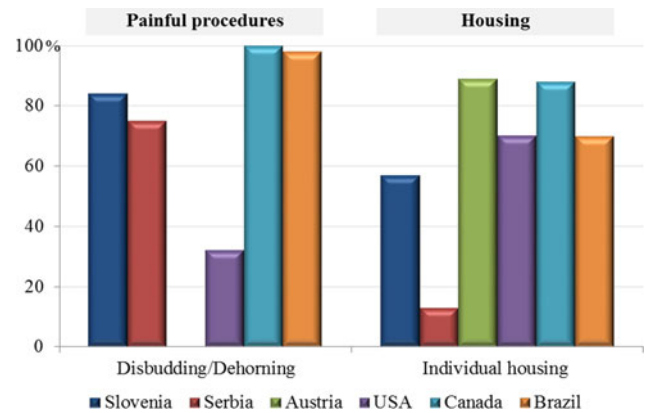


Fig. 3. Some practices regarding painful procedures, and housing of calves on small farms. The values (percentages of the farms) are presented as integers from the original data; missing column – no numerical data or data was not found. References: Vasseur *et al.* (2010a), Klein-Jöbstl *et al.* (2015), Santos and Machado Bittar (2015), USDA (2016), Relić *et al.* (2018), Stojiljković *et al.* (2018), Ježek *et al.* (2019).

the fluid. Calves with diarrhoea lose large amounts of fluid and electrolytes, resulting in dehydration and acidosis. Therefore, in calves suffering from diarrhoea *ad libitum* access to water should be provided. Water quality testing is also a procedure that is not common in small farms. In the USA, cleaning cup/bowl waterers or water tank/troughs is performed at least once per week (USDA, 2016), which is good practice.

Weaning is the first major feeding transition for calves and is particularly stressful for the animal and challenging for the producer. Weaning should be gradual and based on the calf's ability to eat solid feed (Vasseur *et al.*, 2010a; USDA, 2016). Weaning of calves is most frequently performed gradually using age as the weaning criterion (Fig. 2).

Calf housing

The practice in the majority of small farms is to keep calves individually, except in Serbia (Fig. 3), where young calves are most often kept together with adult cattle (Stojiljković *et al.*, 2018). Individual housing is preferred from the perspective of infections and diseases whereas group housing is beneficial regarding its effects on social behaviour (Stanek *et al.*, 2014). In a study by Jensen and Larsen (2014) the type of housing (individual *vs.* pair) did not affect clinical scores and health of the calves. The use of large groups, rather than group housing itself, is responsible for increased calf mortality and morbidity (Svensson and Liberg, 2006).

General aspects of disease prevention and treatment

Calf mortality and morbidity are important indicators of dairy farm health and welfare status (Ortiz-Pelaez *et al.*, 2008). However, breeders often do not keep records on diseases, mortality, or use of medicines, which has been often perceived as an extra workload instead of a necessary part of calf rearing (Hötzel *et al.*, 2014). Without good records, it is difficult to judge the effectiveness of management practices on a long-term basis (Vasseur *et al.*, 2010b). Everywhere in the world, including the countries observed, the most common diseases affecting calves are diarrhoea and respiratory diseases, and also omphalitis

(‘navel-ill’), arthritis (‘joint-ill’) and Trichophytia (‘ringworm’: Lorenz *et al.*, 2011; Moran, 2012; Stojiljković *et al.*, 2018). Klein-Jöbstl *et al.* (2015) found significant relations and interactions between these diseases. The causative agents are microorganisms that can survive long periods in the calf’s environment, meaning that maintaining good hygiene is an essential preventive measure against infectious diseases of calves (Lorenz *et al.*, 2011; Moran, 2012).

The appliance of sanitary measures on family farms is commonly selective and insufficient (Klein-Jöbstl *et al.*, 2015; USDA, 2016; Relić *et al.*, 2017b; Stojiljković *et al.*, 2018; Ježek *et al.*, 2019). In Slovenia and Serbia, the most frequently fly and/or rodent control was applied, the least frequently farmers practiced quarantine for newly purchased animals and disinfection barriers for vehicles and visitors (Relić *et al.*, 2017b; Ježek *et al.*, 2019). Farmers show poor knowledge about certain disease, which may be related to their low ability to recognize the problem related to disease prevention (Relić *et al.*, 2018). Problems may also arise about the assistance and the treatment of animals. In Slovenia and Serbia, the assistance at calving is always provided by one-third of farmers; in the case of dystocia, about 15% of farmers promptly call a veterinarian, but the rest first try to do something by themselves (Relić *et al.*, 2018). In Serbian farms, the most common reason to call a veterinarian for a calf with diarrhoea was ‘if the situation does not improve in a few days’ and for a calf with respiratory disease ‘when it is detected that the calf has difficulty breathing’ (Stojiljković *et al.*, 2018). In all the mentioned cases, the veterinary help may come too late and may be less efficient.

Factors influencing calf management on small farms

The term ‘stockmanship’ implies to the way animals are handled, the quality of their daily management and health care, and how well problems other than diseases are recognized and solved (Waiblinger and Spooler, 2007). Good practices should apply to all farms, although a significant difference in management exists between small and large farms including both conventional and organic cattle farms (Klein-Jöbstl *et al.*, 2015; USDA, 2016; Pempek *et al.*, 2017). The quality of stockmanship is influenced by the personality, attitude, and behaviour of the farmer (Hemsworth and Coleman, 1998). Attitudes can be modified through experience and education (Kılıç and Bozkurt, 2013), and behaviour of people who are dealing with animals is mostly influenced by the level of empathy, economic stability, and pragmatism (Relić *et al.*, 2019). Small farmers vary from middle-class family businesses to subsistence farmers and ‘hobby’ farmers. In developing countries, they can be among the economically most disadvantaged and vulnerable groups, somewhere on the verge of surviving (Grace *et al.*, 2008). Therefore, it is not always possible to expect they will be able to convey all the recommended measures in calf rearing. In this regard, financial reasons often make the farmer hesitate to call the vet for help, even in countries with a high standard of living. Furthermore, some farmers find local veterinarians as insufficiently competent in herd health management, with low knowledge about effective measures, as described by Svensson *et al.* (2018). Moreover, family farmers manage their herd the way they learned from their ancestors and often have difficulty in adopting new knowledge and technologies. Hötzel *et al.* (2014) identified in their study three major issues regarding the choice of calf management practices: (1) claims of labour, time or economic cost involved in a given

practice; (2) a practice considered as tradition and, (3) perceptions regarding benefits or costs of the practice to the animal. ‘Reducing labour’ or ‘saving time’ farmers presented as reasons to choose or prefer the type of calf housing, feeding milk from a bucket, choice of age for dehorning and to separate the calf from the dam soon after birth. A tradition was a reason for giving a certain quantity of milk to the calf, for rearing calves individually, for separating the calves at birth from the dam, and for deciding to castrate or dehorn calves. Perceived positive effects on calf health and growth explained the choice of housing, bottle feeding and the quantity of milk, which farmers considered as ‘adequate’ for a calf. Farmers found advantage in individual housing because there is no occurrence of cross-suckling. In a study by Pempek *et al.* (2017), USA producers from different operation types largely disagreed on the benefits and risks of cow–calf separation, colostrum management, and vaccination for respiratory disease. These authors emphasized the need for additional research to gain a better understanding of producers’ attitudes that might affect decisions related to the implementation of key calf management practices.

Conclusion

In each of the countries considered here, the health and welfare of calves are threatened by some omissions in rearing practices with the major threats being related to the new-born calf management, the feeding and watering management and the application of hygienic measures. Regarding performing certain procedures, the use of a calving pen is rare in Slovenia and Serbia unlike other countries studied. Serbia markedly differs regarding the use of navel disinfection, which represent a great risk for calf health in this country. Austria stands out from the others by the percentage of farms where calves are separated from the cow within 6 h after birth. Slovenia, Serbia, and Canada are similar in the percentage of farms where calves receive the first colostrum meal within 4 h of birth. Colostrum quality control is rarely performed on small farms in all countries studied, and most often it is based only on visual assessment. Disbudding/ dehorning is most often performed in Canada and Brazil. Individual housing of calves is very common on small farms, with the exception of Serbia. Gradual weaning and feeding waste milk to calves are common practice, as well as feeding milk to calves *via* nipple, the exception being Canada. In many countries, calves have no water access in the first days or even weeks, a situation which is not acceptable especially in calves suffering from diarrhoea. Regardless of the country and its economic status, farmers’ decisions on performing some practice is influenced, essentially, by financial aspects and his sense of the necessity of a certain measure. Many farmers are well aware of the importance of proper calf rearing, but others would need more incentive to improve calf management. Positive experiences through education may change the attitudes and traditional beliefs of farmers and direct them to adopt better rearing practices.

Acknowledgements. This article is based upon work from COST Action FA1308 DairyCare, supported by COST (European Cooperation in Science and Technology, <http://www.cost.eu>). COST is a funding agency for research and innovation networks. COST Actions help connect research initiatives across Europe and enable scientists to grow their ideas by sharing them with their peers. This boosts their research, career and innovation. In particular, the authors would like to acknowledge EU COST for funding a Short Term Scientific Mission to Dr Renata Relić, which enabled the realization of this study.

References

- Aldridge B, Garry F and Adams R (1992) Role of colostral transfer in neonatal calf management. Failure of acquisition of passive immunity. *Compendium on Continuing Education for the Practising Veterinarian* **14**, 265–270.
- Busch G, Weary DM, Spiller A and von Keyserlingk MAG (2017) American and German attitudes towards cow–calf separation on dairy farms. *PLoS ONE* **12**, e0174013.
- Cozzi G, Gottardo F, Brscic M, Contiero B, Irrgang N, Knierim U, Pentelescu O, Windig JJ, Mirabito L, Kling Eveillard F, Dockes AC, Veisier I, Velarde A, Fuentes C, Dalmau A and Winckler C (2015) Dehorning of cattle in the EU Member States: a quantitative survey of the current practices. *Livestock Science* **179**, 4–11.
- EFSA Panel on Animal Health and Welfare (AHAW) (2012) Scientific opinion on the welfare of cattle kept for beef production and the welfare in intensive calf farming systems. *EFSA Journal* **10**, 2669.
- EFSA Panel on Animal Health and Welfare (AHAW) and Sihvonen LH (2015) Scientific opinion on the assessment of dairy cow welfare in small-scale farming systems. *EFSA Journal* **13**, 4137.
- Ermgassen EKJ, Alcántara MP, Balmford A, Barioni L, Neto FB, Bettarello MMF, Brito G, Carrero GC, Florence E AS, Garcia E, Gonçalves ET, Luz CT, Mallman G M, Strassburg BBN, Valentim JF and Latawiec A (2018) Results from on-the-ground efforts to promote sustainable cattle ranching in the Brazilian Amazon. *Sustainability* **10**, 1301.
- Eurostat (2016) Agriculture statistics–family farming in the EU. Available at https://ec.europa.eu/eurostat/statistics-explained/index.php/Agriculture_statistics_-_family_farming_in_the_EU#Structural_profile_of_farms_-_analysis_for_the_EU-28.
- Fanzo J (2017) From big to small: the significance of smallholder farms in the global food system. *The Lancet Planetary Health* **1**, e15–e16.
- FAO (2010) Dairy farm numbers world wide. In Hemme T and Otte J (eds), pp. 24–25 *Status of and Prospects for Smallholder Milk Production – A Global Perspective*. FAO, Rome.
- Godden S (2008) Colostrum management for dairy calves. *Veterinary Clinics of North America: Food Animal Practice* **24**, 19–39.
- Grace D, Jost C, Macgregor-Skinner G and Mariner JC (2008) Participation of small farmers in Animal health programmes. *Conf. OIE*, pp. 19–34.
- Hemsworth PH and Coleman GJ (1998) *Human-Livestock Interactions: The Stockperson and the Productivity of Intensively Farmed Animals*. Wallingford, UK: CAB International.
- Hötzel MJ, Longo C, Balcao LF, Cardoso CS and Costa JHC (2014) A survey of management practices that influence performance and welfare of dairy calves reared in southern Brazil. *PLoS ONE* **9**, e114995.
- Jensen MB and Larsen LE (2014) Effect of level of social contact on dairy calf behavior and health. *Journal of Dairy Science* **97**, 5035–5044.
- Ježek J, Grabnar P, Beci B, Klinkon M, Nemec M, Hodnik JJ and Starič J (2019) Management practices affecting calves welfare on farms in Slovenia. *Acta Universitatis Agriculturae et Silviculturae Mendelianae Brunensis* **67**, 1147–1152.
- Kertz AF, Ruettzel LF and Mahoney JH (1984) Ad libitum water intake by neonatal calves and its relationship to calf starter intake, weight gain, faeces score, and season. *Journal of Dairy Science* **67**, 2964–2969.
- Kılıç İ and Bozkurt Z (2013) The relationship between farmers' perceptions and animal welfare standards in sheep farms. *Asian-Australasian Journal of Animal Sciences* **26**, 1329–1338.
- Klein-Jöbstl D, Arnholdt T, Sturmlechner F, Iwersen M and Drillich M (2015) Results of an online questionnaire to survey calf management practices on dairy cattle breeding farms in Austria and to estimate differences in disease incidences depending on farm structure and management practices. *Acta Veterinaria Scandinavica* **57**, 44.
- Lorenz I, Mee JF, Earley B and More SJ (2011) Calf health from birth to weaning. I. General aspects of disease prevention. *Irish Veterinary Journal* **64**, 10.
- Lowder SK, Skoet J and Raney R (2016) The number, size, and distribution of farms, smallholder farms, and family farms worldwide. *World Development* **87**, 16–29.
- Moran J (2012) *Rearing Young Stock on Tropical Dairy Farms in Asia*. CSIRO Publishing: Clayton, Australia.
- NFACC (2009) *Code of Practice for the Care and Handling of Dairy Cattle*. Lacombe, Alberta, Canada: National Farm Animal Council.
- Ortiz-Pelaez A, Pritchard DG, Pfeiffer DU, Jones E, Honeyman P and Mawdsley JJ (2008) Calf mortality as a welfare indicator on British cattle farms. *Veterinary Journal* **176**, 177–181.
- Pempek JA, Schuenemann GM, Holder E and Habing GG (2017) Dairy calf management – A comparison of practices and producer attitudes among conventional and organic herds. *Journal of Dairy Science* **100**, 8310–8321.
- Relić R, Savić M, Beckei ZS, Kučević D, Starič J and Ježek J (2017a) Watering practices at small-scale farms of ruminants. *The International Symposium on Animal Science (ISAS) 2017, Proceedings*. 5–10th June 2017, Herceg Novi, Montenegro, pp. 296–301.
- Relić R, Mičić N and Ježek J (2017b) Implementation of hygienic-sanitary measures on small rural farms. *The XXVIII Conference 'Disinfection, Disinsection, Deratisation – One World One Health', with international participation, Proceedings*. 25–28th May 2017, Ečka, Serbia, pp. 121–126. (in Serbian).
- Relić R, Starič J and Ježek J (2018) Calves' health and welfare issues in small-scale farms. *Fifth DairyCare conference, Book of Abstracts*. 19–20th March 2018, Thessaloniki, Greece, p. 61.
- Relić R, Đermanović V and Perišić P (2019) Different views on animal welfare: has something changed? *The International Symposium on animal science (ISAS) 2019, Proceedings*. 3rd–8th Jun 2019 Herceg Novi, Montenegro, pp. 175–180.
- RZS (2019a) Statistical Yearbook of the Republic of Serbia. Available at <https://www.stat.gov.rs/en-US/publikacije/publication/?p=12102>.
- RZS (2019b) Farms by size of dairy herd. Statistical Office of the Republic of Serbia. Available at <http://data.stat.gov.rs/Home/Result/130002040701?languageCode=en-US&displayMode=table>.
- Sadar M, Jenko J, Jeretina J, Logar B, Opara A, Perpar T and Podgoršek P (2019) Results of Dairy and Beef Recording, Slovenia 2018. Centralna podatkovna zbirka GOVEDO, Kmetijski inštitut Slovenije. Available at <http://www.govedo.si>.
- Santos G and Machado Bittar CM (2015) A survey of dairy calf management practices in some producing regions in Brazil. *Revista Brasileira de Zootecnia* **44**, 361–370.
- Stanek S, Zink V, Doležal O and Štolc L (2014) Survey of preweaning dairy calf-rearing practices in Czech dairy herds. *Journal of Dairy Science* **97**, 3973–3981.
- Stojiljković N, Mičić N, Gogić M, Živković V, Cekić B, Ježek J and Relić R (2018) Rearing conditions and health status of calves on small rural farms. *Biotechnology in Animal Husbandry* **34**, 419–432.
- Svensson C and Liberg P (2006) The effect of group size on health and growth rate of Swedish dairy calves housed in pens with automatic milk feeders. *Preventive Veterinary Medicine* **73**, 43–53.
- Svensson C, Alvåsen K, Eldh AC, Frössling J and Lomander H (2018) Veterinary herd health management – experience among farmers and farm managers in Swedish dairy production. *Preventive Veterinary Medicine* **155**, 45–52.
- USDA (2016) Dairy 2014: Health and Management Practices on U.S. Dairy Operations, 2014. USDA–APHIS–VS–CEAH–NAHMS, Fort Collins, CO.
- Vasseur E, Borderas F, Cue RI, Lefebvre D, Pellerin D, Rushen J, Wade KM and de Passille AM (2010a) A survey of dairy calf management practices in Canada that affect animal welfare. *Journal of Dairy Science* **93**, 1307–1315.
- Vasseur E, Rushen J, de Passillé AM, Lefebvre D and Pellerin D (2010b) An advisory tool to improve management practices affecting calf and heifer welfare on dairy farms. *Journal of Dairy Science* **93**, 4414–4426.
- Waiblinger S and Spoolder H (2007) Quality of stockpersonship. In Velarde A and Geers R (eds), *On Farm Monitoring of Pig Welfare*. Wageningen: Wageningen Academic Publishers, pp. 159–166.
- Wickramasinghe HKJP, Kramer AJ and Appahamy JADRN (2019) Drinking water intake of newborn dairy calves and its effects on feed intake, growth performance, health status, and nutrient digestibility. *Journal of Dairy Science* **102**, 377–387.
- ZAR (2019) Cattle breeding in Austria 2018. Available at <http://en.zar.at/Downloads/annual-reports.html>.