BURLEIGH DODDS SERIES IN AGRICULTURAL SCIENCE

Advances in organic dairy cattle farming

Edited by Dr Mette Vaarst, Aarhus University, Denmark
Dr Stephen Roderick, Duchy College, UK
Dr Lindsay Whistance, Organic Research Centre, UK

E-CHAPTER FROM THIS BOOK

burleigh dodds SCIENCE PUBLISHING

The lives of calves from organic dairy farms

Kerstin Barth, J. H. von Thünen Institute, Federal Research Institute for Rural Areas, Forestry and Fisheries, Germany; Julie Føske Johnsen, Norwegian Veterinary Institute, Norway; Marie Haskell, SRUC, UK; Silvia Ivemeyer, J. H. von Thünen Institute, Federal Research Institute for Rural Areas, Forestry and Fisheries, Germany; and Mette Vaarst, Aarhus University, Denmark

1 Introduction

For many years, the rearing of healthy, vital calves for the future dairy herd has been the major focus for farmers, advisors, and researchers. Evidence of the effects of calf feeding, particularly the concept of metabolic programming (Soberon *et al.*, 2011; reviewed by Hammon *et al.*, 2020), on animal productivity later in life provided the impetus for a more detailed examination of the methods of calf rearing applied in current practice on farms and the potential for improvement. Furthermore, efficient rearing (referring to fast growth without becoming diseased), was seen as an option to reduce the age at first calving and thus to increase economic sustainability, although longevity is not necessarily correlated to a low age at first calving (Krpálková *et al.*, 2014). However, ad libitum liquid feeding, thereby providing milk-fed calves with adequate nutrition, has been demonstrated to improve their development and resilience (e.g. Curtis *et al.*, 2018).

http://dx.doi.org/10.19103/AS.2024.0138.07

Chapter taken from: Vaarst, M., Roderick S. and Whistance L. (ed.), *Advances in organic dairy cattle farming*, pp. 99–130, Burleigh Dodds Science Publishing, Cambridge, UK, 2025, (ISBN: 978 1 80146 538 0; www.bdspublishing.com)

In organic herds, this milk should preferably come from the dam (*Regulation (EU) 2018/848)*, but organic milk powder is also accepted, as it is interpreted as 'natural milk' (e.g. Anon. 2024). Many practices based on research outcomes focused on growth, future production and efficiency of calves that were intended to become dairy cows. Although organic farming and regulation gave some consideration on early contact between dam and calf, group housing and outdoor stay for young calves, the focus on growth and productivity has also been strong in organic dairy herds, where the milking herd and milk production were the main focus.

The organic dairy sector has been strong and successful in many countries, and organic dairy products have generally been one of the main drivers of organic markets in many European countries (Willer *et al.*, 2023). At the farm level, ruminants are good agroecological system partners because they can use all types of grassland and utilize nitrogen fixers such as clover, as well as deliver manure. The positive environmental profile complements the interest in the nutritional benefits and the absence of chemicals in organic dairy products, especially from many families with children (Riefer and Hamm, 2008). However, this emphasis on milk production keeps a strong focus on the dairy cows and those female calves which the farmers intend to include in the dairy herd, as much in organic dairy farming, as in conventional.

According to the organic principle of fairness (IFOAM, 2020), '... animals should be provided with the conditions and opportunities of life that accord with their physiology, natural behaviour and well-being'. This means that all animals should be treated equally well and have the opportunity for a good life, irrespective of species or sex, so already here, a dilemma emerges. The intention in organic farming to combine animal-friendly husbandry with sustainable food production poses some challenges, but on the other hand favors the calves' behavioural repertoire to a comparatively high degree, for example in terms of group housing, space requirements and outdoor access.

However, over the last decade, citizens have also become increasingly aware of practices in animal husbandry, and general concerns about the ethical treatment of farm animals have been raised (Cardoso *et al.*, 2016) that contribute to the erosion of trust in the dairy sector (Cook and von Keyserlingk, 2023). Killing newborn male calves just after birth was one of the practices that highlighted the imbalanced value of milk and calves, as well as the imbalanced view of different "classes" of animals on the farm. One procedure that is also widely applied in organic dairy production is the early separation of cow and calf, which has been increasingly criticized by participants in opinion polls (reviewed by Placzek *et al.*, 2021). Dairy farmers in general have given many good reasons for early separation, mainly with the starting point of the high value of milk versus the low value of calves (especially male calves), in combination with the reduced volume of saleable milk in such systems, because calves are

Published by Burleigh Dodds Science Publishing Limited, 2025.

allowed to consume more milk (Johnsen *et al.*, 2016; Meagher *et al.*, 2019). Another reason given for early cow-calf separation was that it reduced the risk of transmission of infectious diseases between cow and calf, but depending on which infection is in question, it is not always supported by literature as strongly and uniformly, as some assume (Beaver *et al.*, 2019). Organic dairy farmers also referred to practical difficulties with dam-rearing, such as the requirements of housing systems, which for decades have been built only for cows (Bertelsen and Vaarst, 2023). However, as relevant as dairy farmers' arguments for early cow-calf separation are from an economic and practical farming systems point of view, no matter whether they are organic or conventional, studies have shown that citizens confronted with these arguments do not necessarily change their attitudes (Busch *et al.*, 2017). This also applies to other aspects of animal farming, e.g. the use of cages for hens (Weary *et al.*, 2016).

In light of an increasing focus from citizens and farmers on letting calves staying longer with their dams, it is only logical that research on this topic has increased significantly in recent years, addressing not only the fundamentals of animal behaviour and physiology but also increasingly the practical implementation of the procedures, e.g. how to organize cow-calf contact (CCC) systems during the grazing season. However, CCC systems often seem like significant contrasts to an industrialized dairy industry, which also includes some organic dairy farming, and usually focuses on the maximum performance of the dairy cows or the pasture/land used. However, the organic principles as formulated by IFOAM (2020) insist on organic farming meeting more natural needs, e.g. the principles of fairness mentioned above, in combination with the principle of care, which insists that organic farming '*… can enhance efficiency and increase productivity, but this should not be at the risk of jeopardizing health and well-being*'. This could be an explanation for why a reintroduction and reinforcement of contact between cow and calf is given more attention in organic farming.

The pioneers in this field have often been organic farmers, who have developed quite individual approaches for themselves, or farmers in low-input farming systems, where calves are traditionally raised by the milking cows, e.g. with indigenous breeds like Modicana in Sicily (Erikson *et al.*, 2022). An increasing body of knowledge is being developed both in practice and in science, where experiments are conducted to know more about animal behaviour and motivation. It must be expected to help the development of CCC systems a lot, if there is an increasing body of knowledge and experience to build on, also in many different types of circumstances and local conditions.

Another challenge for organic dairy production is to develop strategies for handling the calves that are not needed for herd replacement. This requires that milk and meat production should both be given value. It is not in accordance with the principles to 'export' a number of the calves from organic farms to

conventional veal or beef farms. All animals born on an organic farm should be given value and the opportunity to live a life of good quality, and it is the responsibility of the sector and surrounding human society to ensure this.

2 Management of calves under organic farming conditions

2.1 Regulations

The regulations for keeping calves in organic farming vary widely across the world, but the supply of natural milk is fixed, although some countries allow organic milk powder as feed for calves. Roughage must be offered even to young calves (e.g. *Regulation (EU) 2018/848*, *NOP eCFR:: 7 CFR 205.239 – Livestock living conditions* 2023). In the EU, maternal milk is encouraged even more than in other regions. However, there are great differences between countries in the regulations on the age at which the animals are required to be kept in groups, as well as when they must have access to pasture. Group housing is mandatory in the EU from the 8th day of life and rearing systems should be based on maximizing grazing time (*Regulation (EU) 2018*). In the USA, however, calves can be confined until they are 6 months old (*NOP eCFR:: 7 CFR 205.239 – Livestock living conditions* 2023).

Furthermore, organic calves are influenced by other legislation, such as welfare regulations which also set rules, and environmental regulations, which influence some farm structures and practices, including the way in which organic regulations are interpreted at the country level. Many countries or regions have specific husbandry regulations or standards for the handling of calves irrespective of whether they are organic or conventional, so that often only additional criteria are included in the regulations for organic farming (Grundin *et al.*, 2019).

2.2 Colostrum and milk feeding

Health promotion and disease prevention are the keystones for the success of organic systems. Ensuring that the cow is strong and healthy and can produce high-quality colostrum, which can be fed to the calf in adequate quantities within the first hours after birth is essential for the immediate protection as well as the further physical development of the newborn calf (reviewed by Hammon *et al.*, 2020).

In the meantime, further studies also show that the transition milk, i.e. the milk produced by the cow in the days after calving, also has an impact on calf growth beyond the period of transition milk feeding (Kargar *et al.*, 2021). The requirement to provide calves with mother's milk, as formulated, e.g. in the EU or Swiss guidelines for organic farming (*Bio Suisse Richtlinien 2023*; Regulation

(EU) 2018/848), could potentially therefore lead to better calf performance if implemented literally, provided that the mother cow produces high-quality colostrum. However, studies concerning the effects of prolonged feeding of milk from their own dams on calves' physiology and health are still lacking, although the increase in dam-calf contact systems offers the option for more comprehensive studies of the subject.

In Europe, organic calves have to be provided with natural milk for at least 90 days (*Regulation (EU) 2018/848*). This period goes far beyond the milk-feeding phase in conventional dairy production today but without reaching the natural weaning age for cattle that starts around 8 months (Reinhardt, 1980). Furthermore, the amount of milk that has to be offered to the calves is not clearly defined, and even on some organic dairy farms, e.g. Norway: Johnsen *et al.* (2021a), Germany: Dachrodt *et al.* (2022), calves are provided with less milk per day than current recommendations prescribe based on scientific studies (reviewed by Khan *et al.*, 2011).

Although the use of larger quantities of high-quality organic milk in the diet of any calf may appear to be economically disadvantageous in the short term, in the long term, it can be expected to have a positive effect on animal health, which will lead to an improvement in environmental sustainability. Milk from healthy cows that does not contain mastitis pathogens (Abb-Schwedler *et al.*, 2014) or drug residues promotes calf intestinal health (Malmuthuge and Le Guan, 2017) while reducing the risk of the development of pathogenic microorganism resistance (Aust *et al.*, 2013). Thus, improving the general health situation in the dairy herd and not using antibiotics and anthelmintics preventively, ensures healthy milk and has a direct impact on calf health and well-being on the farm.

2.3 Roughage feeding and grazing

The calf develops from a monogastric to a ruminant over the first weeks of life. This process should be encouraged and initiated as early as possible, not least because ruminants can, generally live on feed that cannot be consumed by humans, thus contributing to the sustainability of the entire farming and food system (Leiber *et al.*, 2019).

The quality of the roughage must of course meet the calves' needs to support their gut health. Webb *et al.* (2013) showed that straw can cause damage to the abomasum, and recommended feeding other types of roughage to young animals. Calves that follow their dams on grass, are observed to graze at an age of 1 week and show marked grazing behaviour immediately after weaning (Nicolao *et al.*, 2020). Another advantage of calves grazing with their dams is the reduction of parasite pressure on the calves, which have yet to develop immunity to pasture parasites (Constancis *et al.*, 2021, 2022). Older cattle that

have a higher feed intake, simply eat more of the infectious parasite larvae, and since they are immune, they excrete fewer parasite eggs and thereby 'dilute' the infection pressure on the paddock, as discussed by e.g. Nansen *et al.* (1990).

2.4 Birthplace and housing

Before giving birth, cows search for a place where they can calve undisturbed and then establish the bond with their own calf (reviewed by Rørvang *et al.*, 2018). Under semi-natural conditions, cows with their newborn calves do not fully reintegrate into the herd until 1–3 weeks after birth (Reinhardt, 1980). The *Regulation (EU) 2018/848* takes this behaviour into account by allowing individual housing of calves only during the first week of life. However, this specification also allows for complete isolation from conspecifics, as the calves usually have no contact with their dams either.

Single housing for a few days after birth is justified for the purpose of improving animal health, although Chua *et al.* (2002) have shown that at least pair housing at this early stage does not affect it. Nevertheless, early group housing might pose risks for transmission of infection, especially in large or dynamic groups (Pedersen *et al.*, 2009) where younger calves are constantly being introduced, such as in smaller herds when calving is not seasonal.

2.5 Particular constraints in rearing offspring

The principles and guidelines for organic calf rearing do not distinguish between calves intended as replacement for dairy cows, and calves for meat production (male calves, and some female calves). However, organic farming has generally become increasingly large-scale and specialized in many European countries (European Commission, 2023) as well as in the USA (Natzke, 2023), where organic products go into a supermarket-based food system, and where the competition on price is strong. While organic milk has been successful and competitive in the market, the demand for organically produced beef has been lower. Many organic dairy farms are built in similar ways as many non-organic dairy farms, e.g. cubicle housing and milking by robots (Wallenbeck *et al.*, 2019), and although group housed and have more space than many conventional calves, most young organic calves are housed in similar housing systems. Many organic farms are not built to house all the calves for more than a few weeks, and specialized dairy farmers are not experienced in rearing calves to slaughter, or marketing beef meat.

3 Cow-calf contact during the milk-feeding period

In suckler beef systems, the cows rear their calves during the pasture period until weaning and separation, often 4–8 months after birth. In some tropical

and sub-tropical traditional dairy farming systems, dairy cows spend the first days with their calves, and are often still stimulated by the presence of calves as a normal part of the milking routine (Froberg *et al.*, 2007, Eriksson *et al.*, 2022).

To obtain as much milk as possible for human consumption, it has been standard practice that calves in intensive dairy farming are separated from their mothers shortly after birth for more than a century (Schlipf, 1908). This is also the case in organic herds. For example, in Danish organic dairy farming, it was a legal requirement for two decades that a calf should stay with its mother for a minimum of 24 h (which is already short), but from January 2023, this stipulation was removed because it was seen as over-implementation of the EU-regulation. Since then, a calf only needed to stay with the mother for 12 h like in conventional herds, unless the dairy company has agreed with the farmers that they keep a minimum of 24 h (Anonymous, 2023).

As already mentioned, calf-rearing systems allowing calves to have contact with a cow during the milk feeding period, are currently emerging, and research addressing the early separation of the dairy cow and calf is now a spiralling research area globally (Johnsen *et al.*, 2016; Beaver *et al.*, 2019; Meagher *et al.*, 2019).

CCC systems entail that calves have physical contact and behavioural interaction with either their own dam (dam-calf contact) or a foster cow, where the calf is reared by a cow that also rears other (alien) calves (Sirovnik *et al.*, 2020). Reflecting different farmers' resources, aims, values and motivations, multiple different CCC systems exist (Fig. 1), including combinations of the ones mentioned above (e.g. Eriksson *et al.*, 2022; Neave *et al.*, 2022; Johanssen *et al.*, 2023; Bertelsen and Vaarst, 2023).

The time span of CCC usually reflects the pre-weaning period and includes suckling. Although a minimal duration has not yet been clearly determined as part of a definition of what constitutes a CCC system in general, in a first step a contact duration of at least 14 days has been suggested (Sirovnik *et al.*, 2020). In Norway, around 3% of all dairy farmers already practice CCC for a minimum of 14 days (Hansen *et al.*, 2023). In the organic certification for CCC systems in Germany, a minimum contact time of 3 months is defined, based on the minimum requirement for a milk feeding period of 90 days *(EU 2018/848)*.

3.1 Organizing CCC systems

3.1.1 Housing and contact times

The great variety of CCC systems illustrated in Fig. 1, reflects the fact that they were developed directly on farms and available resources have a major influence on the choice of how the CCC systems were organized (Eriksson *et al.*, 2022; Johanssen *et al.*, 2023; Neave *et al.*, 2022). So far, only very few housing systems have been built and developed to house dairy cows with

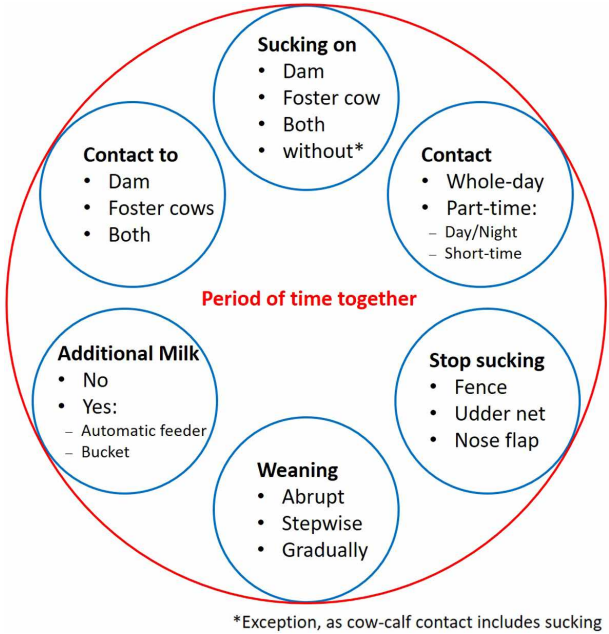

Figure 1 CCC systems are characterized by many different aspects, which are also combined in different ways, resulting in a wide variety of systems. (©Thünen Institute)

calves. Therefore, farmers develop their own CCC system using the buildings and resources available, which will determine the design of the systems.

In general, three main types of dam-calf contact exist: whole-day systems, where calves freely roam around among dairy cows indoors and/or on pasture, and part-time systems that include half-day systems, either over day, or night (Eriksson *et al.*, 2022), or short-time CCC for two or more short periods per day (Sirovnik *et al.*, 2020). The majority of 104 farms with CCC monitored in six European countries, allowed whole-day CCC (48 farms), followed by restricted contact around milking (37 farms), and less often half-day contact (5 farms, Eriksson *et al.,* 2022).

Systems with permanently keeping the calves together with the dams within the group of lactating cows, require barns without slatted alleys (due to differences in minimum slat width by legislation), with enough space and without risk of injuries for the calves. Furthermore, dam-rearing systems require proximity to the milking area, especially when automatic milking systems are used. Separate barns or sections with deep bedding are often used for dams or foster cows if the milking herd barn is not suitable for keeping calves and cows together. Alternatively, there may be a contact area where cows and calves meet only a few times a day.

Space allowance guidelines for CCC systems are not yet well-developed. However, independent of the duration of daily contact allowed between cow and calf, when keeping cows and calves together more space and resources are required, compared to systems designed for cows only. For example, calves need safe lying areas (e.g. a hide), and place for their feed, such as concentrate and hay, and water troughs in their height. If cows and calves can stay in each their own housing system during the majority of the day and meet for some time in a suitable contact area (for suckling and social contact), e.g. in the outdoor yard or a part of the cow stable or in the calf stable, less space is needed. Furthermore, calf creeps providing an area of special feeding and resting, encourage calves to spend time away from the cows, and can make the weaning and separation process easier.

Part-time contact may entail practical benefits related to separate housing of cow and calf. If a system has different 'departments', contact and suckling can be facilitated by allowing cows to visit their calves in a designated area (cow-driven CCC) or calves to visit the cows (calf-driven CCC, Sirovnik *et al.*, 2020). The access to the calves may be facilitated by a mechanical or push-gate or a computer-controlled smart-gate responding to the cows' Radio Frequency Identification ear-tag (Johnsen *et al.,* 2021b, 2021c, Fig. 2). Calf-driven contact may also be facilitated through manually opening gates between the calf and cow pen (Veissier *et al.*, 2013; Johnsen *et al.*, 2015b) or a computer-controlled push gate (Johnsen *et al.*, 2016).

Figure 2 A computer-controlled smart gate controls the access of cows to an area where they can interact with their calves (© Camilla Mellemstrand)

3.1.2 Grazing in CCC systems

Pasture access during the summer is mandatory for organic dairy cows. Therefore, research on CCC systems also includes pasture management with cows and calves together. Mac *et al.* (2023) studied the impact of CCC at pasture in a whole-day contact system. The authors reported that the calves seemed to habituate well to the transient separation from the dams during milking. However, farmers also have expressed legitimate concerns (such as weather conditions and colostrum supply) regarding rearing calves outdoors with dams (Neave *et al.* 2022; Johannsen *et al.*, 2023). Danish farmers, e.g. have found that it requires extra fencing to avoid calves escaping under the typical, single-strand wire fence and out onto nearby roads (Vaarst *et al.*, 2023).

Infobox 1. Examples of cow-calf contact systems, all of them are organic dairy farms, and links to further information is given in section 7.

From Germany (see Barth *et al.*, 2022):

Combined rearing by the dam and foster cows with short-time contact:

The first three weeks after calving, all cows of the 40-strong herd (German Holstein x German Black Pied) stay together with their own calf in a separate area before the calves move into the calf group. In this group, the calves are kept until the 13th to 15th week of life when they are going to be weaned. All cows were milked twice per day, but the udder of cows that are suckling the calves will not be emptied completely. These cows meet the calf group in the cows' lying area while the other cows are milked. Cows and calves (1.3 to 1.8 calves per cow on average) stay together for about 40 minutes to ensure that all calves suckle and receive affection, like social licking. After the suckling udder and teats of the cows as well as the vitality and health of calves are checked before the calves are moved to their own area adjacent to the cows' area. At the end of the suckling period, the calves are allowed to suckle only once per day and then stay in the calves group without being suckled for a few more weeks till they are moved to the youngstock barn. Most of the milk is turned into various dairy products, e.g. raw milk cheese and yogurt, and marketed directly in the own or other farm shops, and on farmer's markets. A large part of the male and female calves that will not be needed for replacement are fattened on the farm also marketed directly.

Dam rearing with whole-day contact

Cow and calf stay together in the calving area for the first five to seven days post calving to establish a strong bond before they join the dairy herd consisting of 60 Holstein cows. The cows are milked two times per day and the calves are allowed to suckle as much as they like till they will be weaned using a nose flap starting at an age of 91 days.

During summer, the calves stay with the herd on pasture for more than four weeks after weaning, in winter they are separated but can get in touch with their dams without the opportunity to suckle. All calves stay at least three months on the farm. Together with four other farms the farm formed a limited liability company, that is a member of a dairy cooperative, and they market their milk under the label 'Four-Seasons-Milk'" with the addition 'Parenty time for our cows'. They are developing their own strategies, such as selling veal, to increase the sales opportunities for calves and meat. That is why they are now used also a dual-purpose breed for cross-breeding.

Rearing by foster cows in a large farm

This is one of the few examples of a CCC system for which a new barn was specially designed. The dairy herd consists of 1500 Holstein cows resulting in 120 calvings per month. The group calving pen has space for five cows and so the calves can also get to know their future foster cows right from birth. After five days the selected foster cows and all calves move into a larger pen where they meet other cows with calves. From the third week onwards, 16 cows with 48 calves were kept in a large pen which has a separate calf area. Till the end of the 3rd month, calves have access to their foster cow group interrupted only for a few hours, during which bedding, veterinary and udder checks of the cows take place. After that the contact times are reduced and the number of calves per cow is increased – one foster cow group suckles two groups of calves till they are 4 months old. Then the cows are moved to another barn where they are milked regularly two times per day in a rotary parlor. The calves stay behind. All calves are reared on the farm and used for replacement or fattening, respectively. The milk and meat are sold through a large organic supermarket.

From Denmark (see video given in section 7)

Two Danish dairy herds with 320 and 150 dairy cows, respectively, initiated their CCC systems in 2020, letting the calves stay with their mothers during the first 2–3 weeks, after which they separated them and let the calves stay with a foster cow, with 2–4 calves per cow. Both of these herds had the initial intention to let calves stay with their mother throughout the 3 months of milk feeding, but left this system, because they had problems with alveolar milk ejection. They experienced that the calves quite quickly calmed down and seemed content in the foster cow environment, so it was 'only' the cow who called for her calf. Some major learning points were the importance of giving enough space indoor to ensure that the calves stayed free of diarrhea, and the advantage of separate the foster cows from the calves gradually by taking them out one by one, which kept the calves more quiet. On the positive side, seeing how calves learned to move around in systems with cows and follow the group on grass was a great pleasure as a farmer and calf carer. The system was calm and easy and both cows and calves stayed indoor during nights and outdoor during days throughout the summers. This was an argument in favor of the foster cow system, because the foster cows did not need milking twice or three times daily (as was the practice in the herd of 320 cows), and therefore was calmer.

3.1.3 Viewing the CCC systems from different perspectives

Vaarst *et al.* (2020) identified four different angles, from which a CCC system could be viewed, based on interviews and a review of research results from France, Norway, The Netherlands and Denmark. The four perspectives were (1) the calf, (2) the cow, (3) the human (the caregiver) and (4) the system (the given and/or development of the structures and practices on the farm). From the interviews, it became clear that different interviewees had different priorities, which guided their choices on how to organize the CCC system. Furthermore, it became obvious that they gave different weight to three different purposes of CCC systems, seen from an animal point of view: (1) nutrition, (2) care and (3) learning. These purposes addressed whether and how a given system could provide nutrition to the calf in a way that satisfied the natural needs, whether it would allow mutual care between the cow and the calf, and finally, whether it could convey learning between cow and calf in ways that prepared the calves for future group and outdoor life. These criteria could guide future efforts to develop and optimize an array of different CCC systems. As an example, if we view the part-time systems described above, some systems will only allow them to meet for the calf to drink milk, which means that cow and calf will not have much opportunity to lay down together (see the example in the infobox 1), and the calf cannot follow the mother to learn from and get to know the system, and the mother cannot defend and care for the calf during the day, when they are in each their system. On the other hand, some of these systems allow for a gradual weaning and separation, which could stimulate the calf to increased solid feed intake and thereby easier weaning.

3.2 Foster cow systems: practices and arguments for and against

Rearing 2–4 calves with a foster cow, who is alien to the calves, is perceived as a practical solution for CCC by some farmers (Bertelsen and Vaarst, 2023). The foster cows are often not part of the milking herd, and may thus be housed together with the calves in a separate barn compartment or on grazing areas during summer, where they stay with the calves 24 h per day. This makes it a more viable and feasible option for many, especially larger dairy farms (see infobox).

A foster cow system needs a process of careful and supervised bonding between the foster cow and the calves that need to be used to suckling. Furthermore, even when this bond is established, it needs constant monitoring to ensure that all calves drink, the cows continue to accept their calves, and that disease, e.g. mastitis or severe diarrhoea, does not occur. Studies show that the foster cows' acceptance, care and nutrition towards the calf is not always consistent (Loberg and Lidfors, 2001), and may lead to large between-calf

variation in growth and affiliative behaviours in such groups (Loberg, 2007; Wieczorreck and Hillmann, 2022).

A recent study indicated a low societal acceptance of foster cow systems (vs. dam-rearing) by consumers (Sirovica *et al.*, 2022). Seen from the animals' point of view, it is an important consideration that foster cow systems still entail dam-calf separation, and hence only partly meet the needs of the calf, and not of the mother-cow. In mother-bonded systems, both cow and calf can perform natural behaviours, and the dam's strong motivation to take care of her own calf is met (Wenker *et al.*, 2020; Constancis *et al.*, 2022), which also is more in accordance with the organic principles of health and fairness (IFOAM, 2020). Thus, it is crucial that future research actually emphasizes these key motivations and behaviours, whilst at the same time accounting for practical and economic feasibility.

3.3 Animal welfare in CCC systems

Cows and calves are highly motivated to be together (Wenker *et al.*, 2020), and the complex bond between cow and calf extends beyond the nutritional relationship (Johnsen *et al*., 2015a). Natural, maternal behaviours resulting from forming a bond with the calf include licking, suckling and reciprocal social behaviours. Allowing for these behaviours follows the IFOAM principles and the organic concept of naturalness (IFOAM, 2020; Lund, 2006). The link between affiliative behaviours and long-term positive affective states in farm animals is established (Boissy *et al.*, 2007). Because natural behaviour and positive affective states are inherent concepts of animal welfare, this rearing method has the potential to advance the welfare of cows and calves in dairy production. Using the four different viewpoints outlined above, the calves may get many of their needs fulfilled in the dam as well as foster cow systems, but seen from the point of view of the cow, in foster cow systems she is still not able to meet her natural needs, being separated from her calf at an early age.

In addition to performing natural behaviour, it is key to animal welfare that the animals stay healthy and don't become diseased or die. Compared to calves kept in individual pens or smaller groups, where feed intake and faecal consistency can be easily observed, monitoring of calves in CCC systems requires a different approach to ensure that all animals are inspected. A recent Norwegian observational study of 39 CCC herds matched with 70 herds not practising CCC found no differences in calf mortality and overall calf morbidity (Johnsen *et al.*, 2022). The study revealed that the relative treatment risk of omphalitis was higher among CCC calves while that of enteric disease tended to be lower for CCC calves. This study indicated that the prevention of diseases in calves is not a valid argument for the early separation of cow and calf. However, some country-specific considerations regarding endemic cattle

diseases (BVD, Johne's disease, etc.) may require different approaches to the implementation of CCC, e.g. whether all cows must be tested before calving and, if positive, contact with the calf may not be possible.

Even though farmers often report that calf disease has been reduced after the introduction of the CCC, especially regarding diarrhoea (e.g. Eriksson *et al.,* 2022), the contact between calf and cow does not necessarily guarantee an adequate calf health status, as found by e.g. Wenker *et al.* (2022) in a controlled study. The majority of CCC studies addressing the relationship between CCC and cow-calf health and diseases have so far been inconclusive (reviewed by Beaver *et al.,* 2019), calling for more research.

3.4 Impacts on milking and milk yield

Performance of dairy cows is often measured through milk yield and milk composition. Time and duration of contact between calf and dam per day affect the amount of saleable machine milk yield during the suckling period (Nicolao *et al.*, 2022) and beyond (Barth, 2020; Churakov *et al.*, 2023). However, in CCC systems the cow yields milk both to the calf (usually not quantified) and to the milking machine. The amount of milk that can be milked by machine is determined by two factors: the amount that the calf has already drunk and the amount that is made available due to alveolar milk ejection (Tančin *et al.*, 1995). The latter is subject to large individual variations, the cause of which is not yet clear and needs further investigation.

Quantifying the performance of cows in CCC systems needs a more nuanced approach than just talking about saleable milk. Brombin *et al.* (2019) argued that one-welfare and sustainability interests could support a transition towards investing more milk in healthy calves through CCC systems and balancing the focus between milk for human consumption and for the calves, maybe in combination with more involvement in dual-purpose breeds. In particular, the extensive use of milk in veal production and the often still very low quantities of milk used in the rearing of female calves need to be addressed. Both are detrimental to the health of the animals concerned and can result in consequential costs that may even outweigh the presumed milk losses in cow contact rearing. Unfortunately, however, there are still no practical surveys that put the reduction in saleable milk in CCC systems into a wider context.

3.5 Gentle weaning and separation

In European farms, the age at weaning in CCC systems reflects the organic standards, which is a minimum 90 days with whole milk. However, it varies considerably from 12 to 30 weeks (Eriksson *et al.*, 2022). In these cases, weaning and separation often happen at the same time, whereas separation from cows

earlier will mean that calves need to learn how to drink milk from buckets or automatic milk feeders.

A major criticism of CCC is the stress caused by the separation of cow and calf after their time together. As most CCC farmers will need to break the cow-calf bond prematurely in order to still obtain enough saleable milk, strong behavioural responses of cow and calf are to be expected at separation if precautions are not taken. These reactions are one reason why some farmers quit CCC after trying it out (Hansen *et al.*, 2023).

Separation from the cow and weaning off milk should be done step by step. Gradual separation and weaning will help to keep the stress for animals and humans as low as possible, to prevent weight losses of calves and milk ejection problems in cows. This might be achieved by gradually reducing the amount of milk for the calf, gradually reducing the contact time between cow and calf, and by implementing a time lag between weaning and separation or vice versa (Schneider *et al.*, 2021).

Encouraging calf nutritional independence seems key to reducing behavioural stress, since calves vocalize in response to the hunger for milk. However, even gradual weaning and separation might cause significant behavioural responses in calves (Vogt *et al.*, 2024). The option of offering calves a different milk source can also be challenging, as relearning drinking from the udder to an artificial teat (automatic feeder or milk bar) takes some time.

Co-creation of new knowledge through investigation of on-farm developed gradual weaning and separation systems needs to be developed, to mitigate adverse effects of separation distress for mother and young. However, given that separation is still premature, we must expect some level of response from both cow and calf, with respect to the cows' motivation to care for the offspring and the calf-filial aspects of the cow-calf bond. Nonetheless, an extended suckling and contact period up to the time of natural weaning (Reinhardt, 1980) could also be an option if cows with good lactation persistence are used, enough resources, like space in barns, are available, and when the extra effort is reflected in the price of milk and meat.

3.6 Case studies: collaborations between research and practice regarding CCC systems

During the early 2000s, research was centred on why there may be benefits of allowing contact between the dairy cow and her calf (Flower and Weary, 2003; Lund, 2006; Newberry and Swanson, 2008). In contrast, several projects around the world now focus on how to implement CCC, on-farm, or in pasture systems. Interestingly, several CCC projects aim to learn about how CCC systems comply with the natural needs of cow and calf. In addition, there is a broad effort to collate farmer experiences with CCC systems, as some farms practice CCC systems already for several decades successfully. As stated by the European

Food Safety Authority (EFSA) Panel on Animal Health and Animal Welfare on request from the European Commission, prolonged CCC in dairy production should increasingly be implemented (Nielsen *et al.*, 2023). Organic farmers are usually pioneers in this respect.

In some countries like Austria, Switzerland and Germany, the majority of farm raising their dairy calves with cows are organic farms, while in France, Sweden and Italy the percentage of organic farms out of the farms practicing CCC is lower: 58%, 42% and 21%, respectively (Eriksson *et al.,* 2022). In Norway, up to 15% of all dairy farmers responded that they planned to implement CCC on their farms in near future (Hansen *et al.,* 2022). As this interest increases, so does the need for recommendations on how to implement CCC in practice on farms, based (a) on experiences and knowledge of farmers, who have already implemented CCC systems, and (b) on results from research projects, several leaflets and extension material have been developed.

3.6.1 Extension material from a survey in different European countries (project 'ProYoungStock') and from a farmer group in Switzerland and South Germany

In the framework of the European CORE Organic Cofund project 'ProYoungStock', more than one hundred farmers practising cow-bonded calf rearing in different European countries were interviewed with standardized closed and open questions regarding their CCC system, their motivation and their experiences with challenges and solutions. One of the main challenges named by the farmers was weaning and separation of cows and calves. Based on the results of the survey, a technical note about the possibilities of gentle and gradual separation and weaning of calves reared in CCC systems has been published (Schneider *et al.*, 2021). Additionally, an existing leaflet based on a farmer-driven process together with FiBL, with general recommendations and several farm examples (with different kinds of CCC systems) in Switzerland and Germany has been translated into several languages and is now available in English, German, French, Italian and Polish (e.g. Spengler Neff *et al.*, 2023). See the list of additional material to read, below.

3.6.2 Cow-bonded calf rearing in dairy farming – a practical guide

In a German EIP project, farmers, scientists and advisors developed a comprehensive guide to provide beginners, experienced farmers, and all those interested in the topic with background knowledge, recommendations and farm examples of possible ways to implement CCC systems on dairy farms (Barth *et al.*, 2022). The guide is based on current scientific as well as experience-based knowledge and an attempt was made to cover all aspects relevant to the

topic from the management of systems to economics, and included several inputs from stakeholder experts. See links and references under additional material to read, below.

3.6.3 Standard development and certification of CCC systems in Germany

In Germany, an initiative of organic dairy farmers together with representatives from research, organic label organizations, and animal protection organizations was started to develop criteria for CCC systems in organic dairy farming, which were published in 2021 (IG kuhgebundene Kälberaufzucht 2022; https://ig-kalbundkuh.de/). The criteria refer to calves from dairy cows and are based on the requirements of the organic label organization. Therefore, criteria such as space allowance, feeding and general husbandry were already regulated and their compliance is checked in the yearly organic certifications according to Regulation (EU) 2018/848.

The main criteria of CCC systems have been defined as follows: (a) calves must be suckled by their own mothers or by foster cows, (b) a minimum period of cow-bound rearing of 90 days on the birth farm (or on a nearby partner farm with foster cows), (c) a maximum of 15% of the born calves (females and males) may leave the farm as breeding or fattening animals after only 4 weeks, (d) weaning and separation of cow and calf must not be done abruptly, but gradually and stepwise for both calf and cow. Besides the criteria, in 2022 a checklist for a certification of CCC systems according to the criteria has been developed, that can be carried out voluntarily within the framework of the organic certification since 2023.

As a next step, a mentoring project has been started in 2023: a group of farmers, experienced in cow-bonded calf rearing, offer a mentoring process to farmers that are interested to convert from artificial to cow-bonded calf rearing. In addition to their own experience, mentoring farmers have access to selected extension material regarding CCC systems that have been compiled by researchers.

3.6.4 Stable school for common social learning on CCC systems in Denmark

In Denmark, a project focusing on mother-bonded calf rearing facilitated a process among farmers to learn together about CCC systems (Vaarst *et al.*, 2019), while establishing and developing them on the participating farms using the so-called Stable School approach (Vaarst *et al.*, 2007). Farms were very different, but still found it interesting to learn from each other: Herd sizes ranged from 7 to 600 cows, the farmers came from 5 different dairy companies, and the CCC systems were a mix of mother-bonded and foster cow systems.

They discussed themes chosen by the host farmer of each meeting, and challenges associated with a CCC system, such as space requirements or pasture access, were often on the agenda. They collectively identified potential solutions for implementing various types of CCC on the participating farms, and collectively gained experience from their own farms as well as from each other. Over time, some of the concerns raised in the beginning, became much smaller, such as vocalization at separation or 'wild calves' because of less direct human contact, others remained challenges, such as the amount of saleable milk, which dramatically decreased in mother-bonded CCC systems. However, this leads to the interesting aspect, how they raised ethical questions to their previous and their emerging systems. Many acknowledged their pleasure and joy in seeing the CCC system work and the calves play or learn from the cows, and the articulation of 'losing milk' because the calf drank a lot, was changed into a discussion on 'how to share the milk'. However, many participants viewed foster cow systems as a more feasible – and sometimes the only possible – option for providing CCC on their farm, both because of the available housing facilities, and because of the issues of calves drinking relatively much milk. One major learning concerning foster cow systems was that it required careful bonding processes, even though the calves often cross suckled, and that the persons taking care of the system, really needed to develop skills in observing calves and cows in such a system. This Stable School experience is described in Vaarst *et al*. (2023) and made it quite clear that socially situated learning through this type of emerging Communities of Practice (CoP) is helpful for farmers, who are interested in developing, implementing and improving CCC systems in different dairy farming contexts.

4 Non-replacement calves born in organic dairy herds

As mentioned above, female calves destined for future replacement animals in the dairy herd are usually kept within the herd. Calves of some specialized dairy breeds often have low economic value and, in some farms and countries, have been killed as newborns. For instance, it is estimated that 15% of male dairy calves were killed on their farm of birth in the UK in the period 2016 to 2018 (CHAWG, 2020), while a survey in Canada suggested that 5% of dairy farmer respondents killed between 1% and 100% of their male calves (Renaud *et al.*, 2017). However, organic regulations, or private agreements, e.g. between shareholders of dairy companies in many countries, actively discourage or prohibit the routine killing of healthy newborn calves (e.g. Denmark: Sector recommendations, 2019; UK: Soil Association, 2023). In other countries such as New Zealand, calves may be transported to slaughterhouses at around one week of age (Boulton *et al.*, 2020), where they are processed for veal, or the hides used for leather goods (Dairy Australia, 2021). These animals are referred

to as 'bobby' or 'bob' calves. Industry representatives and animal welfare groups are also increasingly concerned about the practice of early slaughter of bull calves and likely consumer backlash (Dairy Australia, 2019; GB Dairy Calf Strategy, 2020; Bolton and von Keyserlingk, 2021).

4.1 Rearing calves to leave the birth farm

Studies showed that only about 10–20% of bull calves born on organic dairy farms were raised on these farms (Germany: Ivemeyer *et al.*, 2018; Denmark: Nielsen and Thamsborg, 2002), and the rest is sold to other (mainly conventional) farms or animal dealers. Regarding female calves on conventional farms, it has been estimated that 60–70% of them were needed for replacement (de Vries *et al.*, 2008; Edwards-Callaway *et al.*, 2019). Since improved longevity is an aim for organic farmers, and is achieved on some farms (Ahlman *et al.*, 2011), the proportion of the female calves not required as replacement becomes even larger.

The most common practice in most European countries is that calves born on organic dairy farms are sold at 2–4 weeks of age into the veal or dairy-beef supply chains, when markets allow this. In countries such as France, the Netherlands and Italy, the majority of all calves are reared for veal (Sans and de Fontguyon, 2009). This is also the case in the United States (Renaud *et al.*, 2017; Creutzinger *et al.*, 2021). Most bull calves from organic farms in Germany (Ivemeyer *et al.*, 2018) and Switzerland (Rell *et al.*, 2020, 2022) go into conventional veal or beef production systems.

White veal is produced from calves that are fed a predominantly milk-based diet with small amounts of roughage, to keep the meat pale. They will normally be individually housed, to restrict movement and thereby muscle development, and they will be slaughtered at 20–26 weeks of age. Nielsen *et al.* (2023) point to insufficient space, individual housing and restriction of iron and fibre in the diet as severe welfare issues associated with white veal production. Rosé veal can be defined as meat from dairy calves below the age of 12 months, which have received a varied diet including roughage (Skelhorn *et al.*, 2020; RSPCA, 2023). Rosé veal is the most commonly reared in the UK where white veal is not consumed.

There is a risk that calves which are intended to leave the birth farms will be given lower priority, compared to the calves which are intended to stay on the farm and are perceived as high value future milking cows. These non-replacement calves may receive poorer quality care on the dairy farm of origin, such as not being fed the same amount and quality of colostrum, receiving inferior quality feed and less attention and care compared to the animals that are meant to stay on the farm (Renaud *et al.*, 2017). It is also possible that less or no bonds are established between caregivers and calves, since the caregivers know that the calves will leave the farm within weeks.

Published by Burleigh Dodds Science Publishing Limited, 2025.

4.2 Transport and mixing of young calves

A number of studies have shown that there are significant welfare challenges associated with early transportation including higher mortality, dehydration and fatigue (Boulton *et al.*, 2020; Roadknight *et al.*, 2021; England *et al.*, 2023; Marcato *et al.*, 2022). These practices are very likely to result in poor welfare, health and growth outcomes, when these calves are moved on to other farms for rearing, and they need more antibiotic treatments, than if they had stayed in the birth farm (Sandelin et al., 2021). It is a well-established fact that mixing of young calves from many herds, gives them a high risk of making them diseased, leading to high antibiotic use (Pardon *et al.*, 2012), because they come from widely different herds and backgrounds (Santman-Berends *et al.*, 2018), increasing social stress and disease risk. To ensure that all these calves receive good standards of care and housing, the calves must provide an economic return to the farmer (Reiber *et al.*, 2020).

4.3 The life of calves seen from an organic principles' viewpoint

There is a strong conflict with organic principles in the practices of early separation from the dam as well as the sale to conventional farms of calves that are not intended to remain on the dairy farm. As stated in the introduction, letting the animals meet their natural needs is explicitly mentioned in the fairness principle, but violated through the early separation from the dam (also leaving the natural needs of the dam unfulfilled), as well as the potentially early transport and mixing with others, being fed with unnatural diets and living short lives under potentially stressful conditions. This way of handling the young calves are also in conflict with the Health principle, which states that '*Health is the wholeness and integrity of living systems. It is not simply the absence of illness, but the maintenance of physical, mental, social and ecological well-being. Immunity, resilience and regeneration are key characteristics of health*' (IFOAM, 2020). Furthermore, it is argued that all animals born under organic conditions should be allowed to live under these conditions during their entire lifetime.

4.4 What are potential solutions?

4.4.1 Prolonged lactation

Reducing the number of calves born each year will reduce the number that need to be reared. Increasing the length of the cow's lactation increases the calving interval and thus reduces the number of calves born overall. Increasing the length of lactation is somewhat controversial as the period of late lactation, when milk yield is relatively low, is extended, which may have negative economic consequences for farmers. A review of the topic by van Knegsel *et al.* (2022)

concluded that while farmers were concerned about a reduction in overall milk yield, a reduction in yield was not always observed, and depended on the age of the cow and the length of the dry period. Additionally, there are many positive outcomes of extended lactations for cow health and fertility (van Knegsel *et al.*, 2022), suggesting that it could also be a good option for organic dairy systems. However, this approach may not be appropriate for cows producing lower yields due to the risk of over-conditioning at the end of the lactation, which increases the risk of dystocia and related diseases in the subsequent lactation (Roche *et al.*, 2009). Furthermore, it could be feasible on farms aiming at a high grazing performance to have spring calvings. This may conflict with the aim of prolonged lactations as annual calvings are then required.

4.4.2 Focus on pasture-based milk and meat

Pasture-based dairy farming, calf rearing and fattening of young animals, using less or no concentrate feed, should be further developed as it has the potential to combine better animal welfare (e.g. Simon *et al.*, 2023) with less greenhouse gas emissions (Murphy *et al.*, 2017) and thus to meet societal expectations for environmentally sound and more animal-friendly meat production. Using grassland to produce high-quality food is highly consistent with the principle of ecology (IFOAM, 2020) aiming for low input and efficient use of resources. Furthermore, consumers show preferences for pasture-raised products (Stampa *et al.*, 2020), which presents opportunities for value-added marketing.

4.4.3 Support rearing the calves from dairy farms for high-value organic beef

At a systemic level, the balance between milk and meat focus on dairy farms, and between beef cattle and calves born on dairy farms and reared as dairy beef, should be reconsidered. The rearing of calves from dairy farms should be prioritized, seen from a life-cycle and environmental perspective (Tichenor *et al.*, 2017). Comparisons of meat quality suggest that dairy beef is as high quality as beef meat (Foraker *et al.*, 2022), and Bonny *et al.* (2016) showed that the eating quality of some of the muscle groups from pure dairy breeds (e.g. Holstein Friesians) was superior to that of pure beef breeds or crosses. It requires a collective effort to find solutions, as e.g. suggested by Proudfoot *et al.* (2022), and since many studies on dairy beef have been conducted under non-organic and non-European conditions, more efforts should be made specifically to solve these challenges at the systemic level for European organic dairy farming, as it is not acceptable that organic calves are not given more value. It would be an attractive development strategy for the organic dairy sector to exploit the options for producing high-value organic beef, preferably on the birth

farm. Currently, this happens in some cases, where non-replacement calves are reared on the birth farm until they are of saleable age, instead of suffering from transport and regrouping stress, which can result in high rates of mortality.

Sandelin *et al.* (2021) observed a mortality rate of 2.5% among calves on Finnish fattening farms, when the calves were bought as weaned calves, compared to a mortality rate between 4.6 and 5.3% for calves which were bought in as milk-fed calves. This study was based on conventional farming, but is relevant for calves born on organic dairy farms, since far the most organic calves go to conventional veal or fattening farms.

Prices of calves being raised on milk in organic dairy herds are completely out of proportion, compared to current market prices for beef meet. In addition, organic dairy farms do not have facilities or staff to raise calves until slaughter. Furthermore, environmental legislation restricts the possible number of animal units per farm in many European countries, hence rearing of calves will be economically unviable, as shown, for example, in a survey of all Irish dairy farms (Maher *et al.*, 2021).

The British Calf Strategy aims to encourage responsible breeding practices that produce dairy-origin calves that are suitable for the beef supply chain (GB Calf Strategy, 2020). Larger organic dairy farms in particular, often base their breed selection on milk yield. For example, more than 90% of German organic farms with more than 70 cows (milk yield >7000 kg per year) keep Holstein cows (Ivemeyer *et al.*, 2018). Calves from such specialized dairy breeds tend to have lower meat-to-bone ratios at slaughter than calves from beef breeds because of the selection for higher milk yield (Berry, 2021), which is a main challenge when rearing calves from dairy farms, even if crossed with heavier breeds. Some dairy breeds, particularly Jerseys and their crosses, are also slower growing with a smaller mature size (Coleman *et al.*, 2016), which makes them less economically viable to rear as beef animals, and maybe even problematic to deliver to an abattoir, because the equipment is of a standardized size. In addition, the fat of Jersey animals is yellow, which makes the meat unattractive for some consumers (Dunne *et al.*, 2006).

Some have also pointed to the use of sexed semen as a solution, and the use has increased over the last decade. This is allowed in organic farming in Europe according to Regulation (EU) 2018/848, although some organic farmers' organizations, e.g. BioSuisse (2023) in Switzerland or Demeter in many countries, do not allow this and question this in relation to the organic principles. This use of sexed semen has allowed farmers to be selective regarding which of their cows should give birth to the new generations of herd-replacement female calves (de Vries et al., 2008). Although this might facilitate the use of beef-breed semen, and in this way get better prices for calves exported from the farm, but it cannot be a stand-alone strategy, not least because it is still considered conflicting to the organic principles by many.

Published by Burleigh Dodds Science Publishing Limited, 2025.

5 Conclusion

Ensuring that calves are treated in an ethical manner and in accordance with the principles of organic farming has been one of the biggest challenges faced by organic dairy farmers for many years. While on the one hand, it was mostly organic farmers who initially re-introduced the contact between cow and calf on their farms, on the other hand, many organic calves are exported into the conventional veal or beef industry. To change the latter, the expansion of organic fattening and marketing structures and changes on the farms themselves are necessary. Research can support this process by developing holistic approaches that value all calves equally, regardless of their intended use and for reasons of sustainability. The coupling of milk and meat production should become a stronger focus of research. However, the exchange between practice and research is particularly important. Examples in terms of case studies are given to demonstrate how pressing issues have been tackled jointly and fostered development in different settings.

6 Future trends in research

For CCC systems, the effects of CCC on the health of cows and calves will remain in focus. In addition to issues related to individual disease risk, such as the incidence of umbilical infections, those related to the management of infectious diseases, e.g. Johne's disease, will become more important. From the perspective of animal welfare, gentle weaning and separation methods have to be (further) developed. Technical solutions could support this, and the application of methods of so-called precision livestock farming in CCC systems should be explored. However, much of the available knowledge on raising healthy, vigorous calves is based on studies of calves raised on milk replacers and often with no or only social contact with peers. There is a clear knowledge gap regarding the effect of contact with the dam or an alien cow on the development of calves. Although consumers prefer mother-bonded rearing and cows should have the opportunity to live out their natural maternal behaviour, the use of foster cows can be a first step in this direction. However, foster cow, as well as dam-rearing systems, must achieve at least the quality of well-managed artificial calf-rearing methods using bucket or automatic milk feeding.

The high variability of the CCC systems inevitably leads to a large variation and sometimes contradictory results. In order to ensure the comparability of studies and to enable later evaluation in meta-analyses, a group of scientists has already developed initial recommendations on the methodology of studies in this field (de Oliviera *et al.*, 2020, Ferneborg *et al.*, 2020) that should be applied on a broad scale and, of course, further developed.

Published by Burleigh Dodds Science Publishing Limited, 2025.

To improve the situation for calves that will not replace cows of the dairy herds, research should focus on the conditions that will promote the expansion of organic fattening, processing and marketing structures. Structural changes in terms of shared responsibility for environmentally and animal ethically friendly solutions which takes equally care of dairy cows and their calves, should be supported by research e.g. scenario development and economic as well as environmental and agricultural systems research.

In order to strengthen the social acceptance of organic milk and meat production, the effects of the new farming methods on the environment should be studied more closely, in particular, the consequences of increased calf milk intakes in CCC and other rearing systems.

7 Where to look for further information

A good introduction to the topic of CCC is provided by the following reviews:

- Meagher, R.K., Beaver, A., Weary, D.M. and von Keyserlingk, M.A.G. (2019), 'Invited review: a systematic review of the effects of prolonged cow-calf contact on behavior, welfare, and productivity', *J Dairy Sci*, 102(7), 5765–5783.
- Johnsen, J.F., Zipp, K.A., Kälber, T., Passillé, A.M. de, Knierim, U., Barth, K. and Mejdell, C.M. (2016), 'Is rearing calves with the dam a feasible option for dairy farms? –Current and future research', *Appl Anim Behav Sci*, 181, 1–11.

Definitions and recommendations for the design and reporting of investigations can be found here:

- Sirovnik, J., Barth, K., de Oliveira, D., Ferneborg, S., Haskell, M.J., Hillmann, E., Jensen, M.B., Mejdell, C.M., Napolitano, F., Vaarst, M., Verwer, C., Waiblinger, S., Zipp. K. and Johnsen, J.F. (2020), 'Methodological terminology and definitions for research and discussion of cow-calf contact systems', *J Dairy Res*, 87S1, 108–114.
- de Oliveira, D., Barth, K., Haskell, M.J., Hillmann, E., Jensen, M.B., Johnsen, J.F., Mejdell, C.M., Waiblinger, S. and Ferneborg, S. (2020), 'Methodology for experimental and observational animal studies in cow-calf contact systems', *J Dairy Res*, 87S1, 115-121.
- Ferneborg, S., Napolitano, F., Vaarst, M., Mejdell, C.M., Waiblinger, S. and de Oliveira, D. (2020), 'Methodology for studying human attitudes and behaviour to cow–calf contact systems', *J Dairy Res*, 87S1, 122-127.

Instructions for the practical implementation of CCC on the dairy farm:

Published by Burleigh Dodds Science Publishing Limited, 2025.

- Abstract about separation and weaning of calves reared in CCC systems: https://orgprints.org/id/eprint/42549/
- Leaflet with general recommendations and several farms examples (with different kind of cow-calf contact systems): https://www.fibl.org/de/shop/1660-mother-bonded-calf-rearing.
- Cow-bonded calf rearing in dairy farming – a practical guide (with decision trees, calculation sheets and farm descriptions): https://www.kuhgebundene-kaelberaufzucht.de/wp-content/uploads/Leitfaden-kuhgebundene-Kaelberaufzucht_englische-Uebersetzung.pdf.
- Some videos with English subtitles describing the development of a few CCC-systems in Denmark and Germany and with focus on the development process and the different perspectives of these systems, can be found here:
  - https://www.youtube.com/watch?v=y3A3F8sHd3o.
  - https://www.youtube.com/watch?v=f4Kubh4MX70.
  - https://www.youtube.com/watch?v=VjBWjtc-UIA.
- (subtitles possible to click under 'settings'/the flower where 'undertekster' / 'Untertitel' (=subtitles) can be set to English).

8 References

Abb-Schwedler, K., Maeschli, A., Boss, R. et al. (2014), 'Feeding mastitis milk to organic dairy calves: effect on health and performance during suckling and on udder health at first calving', *BMC Vet Res*, 10, 267.

Ahlman, T., Berglund, B., Rydhmer, L. and Strandberg, E. (2011), 'Culling reasons in organic and conventional dairy herds and genotype by environment interaction for longevity', *J Dairy Sci*, 94(3), 1568–1575.

Anon. (2023), Brancheanbefalinger om økologisk mælk og kød (The sector's recommendations to organic milk and meat. In Danish) https://lf.dk/viden-om/oekologi/lovgivning-og-kontrol/brancheanbefalinger-oekologisk-maelk-og-koed (accessed 18 November 2023)

Anon. (2024) Regler for økologisk kvæghold. Innovationscenter for Økologisk Landbrug (Rules for organic cattle farming. In Danish). https://icoel.dk/media/aijhz2yj/regler-for-oekologisk-kvaeghold-2024.pdf (accessed 24 February 2024)

Aust, V., Knappstein, K., Kunz, H.-J. et al. (2013), 'Feeding untreated and pasteurized waste milk and bulk milk to calves: effects on calf performance, health status and antibiotic resistance of faecal bacteria', *J Anim Physiol Anim Nutr*, 97(6), 1091–1103.

Barth, K. (2020), 'Effects of suckling on milk yield and milk composition of dairy cows in cow–calf contact systems', *J Dairy Res*, 147, 133–137.

Barth, K., Bock, A., Breden et al. (2022) et al., 'Cow-bonded calf rearing in dairy farming - A practical guide.' https://www.kuhgebundene-kaelberaufzucht.de/wp-content/uploads/Leitfaden-kuhgebundene-Kaelberaufzucht_englische-Uebersetzung.pdf. (accessed 18 November 2023)

Beaver, A., Meagher, R.K., von Keyserlingk, M.A.G. and Weary, D.M. (2019), 'Invited review: A systematic review of the effects of early separation on dairy cow and calf health', *J Dairy Sci*, 107, 5784–5810.

Berry, D.P. (2021), 'Invited review: beef-on-dairy—The generation of crossbred beef × dairy cattle', *J Dairy Sci*, 104(4), 3789–3819.

Bertelsen, M. and Vaarst, M. (2023), 'Shaping cow-calf contact systems: farmers' motivations and considerations behind a range of different cow-calf contact systems', *J Dairy Sci*, 106(11), 7769–7785.

BioSwiss - Standards for the Production, Processing and Trade of "Bud" Products. https://www.bioaktuell.ch/fileadmin/documents/ba/Bioregelwerk-2023/deutsch/bs_all_d/rili_e.pdf (accessed 3 July 2023).

Boissy, A., Manteuffel, G., Jensen, M.B. et al. (2007), 'Assessment of positive emotions in animals to improve their welfare', *Physiol Behav*, 92(3), 375–397.

Bolton, S.E. and von Keyserlingk, M.A.G. (2021), 'The dispensable surplus dairy calf: is this issue a "wicked problem" and where do we go from here?', *Front Vet Sci*, 8. https://doi.org/10.3389/fvets.2021.660934

Bonny, S.P.F., Hocquette, J.-F., Pethick, D.W. et al. (2016), 'The variation in the eating quality of beef from different sexes and breed classes cannot be completely explained by carcass measurements', *Animal*, 10(6), 987–995.

Boulton, A.C., Kells, N.J., Cogger, N. et al. (2020), 'Risk factors for bobby calf mortality across the New Zealand dairy supply chain', *Prev Vet Med*, 174. https://doi.org/10.1016/j.prevetmed.2019.104836

Brombin, A., Pezzuolo, A. and Brščić, M. (2019), 'Are we ready for the big change in the dairy production system?', *Res Vet Sci*, 126, 17–19.

Busch, G., Weary, D.M., Spiller, A. and von Keyserlingk, M.A.G. (2017), 'American and German attitudes towards cow-calf separation on dairy farms', *PLoS One*, 12(3), e0174013.

Cardoso, C.S., Hötzel, M.J., Weary, D.M. et al. (2016), 'Imagining the ideal dairy farm', *J Dairy Sci*, 99(2), 1663–1671.

CHAWG (2020) *Fifth Report: GB Cattle Health & Welfare Group*. ©Cattle Health and Welfare Group of Great Britain 2020.

Chua, B., Coenen, E., van Delen, J. and Weary, D.M. (2002), 'Effects of pair versus individual housing on the behavior and performance of dairy calves', *J Dairy Sci*, 85(2), 360–364.

Churakov, M., Eriksson, H. K., Agenäs, S. and Ferneborg, S. (2023), 'Proposed methods for estimating loss of saleable milk in a cow-calf contact system with automatic milking', *J Dairy Sci*. https://doi.org/10.3168/jds.2022-23099.

Coleman, L.W., Hickson, R.E., Schreurs, N.M. et al. (2016), 'Carcass characteristics and meat quality of Hereford sired steers born to beef-cross-dairy and Angus breeding cows', *Meat Sci*, 121, 403–408.

Constancis, C., Ravinet, N., Bernard, M. et al. (2021), 'Rearing system with nurse cows and risk factors for Cryptosporidium infection in organic dairy calves', *Prev Vet Med,* 190. https://doi.org/10.1016/j.prevetmed.2021.105321

Constancis, C., Chartier, C., Leligois, M. et al. (2022), 'Gastrointestinal nematode and lungworm infections in organic dairy calves reared with nurse cows during their first grazing season in western France', *Vet Parasitol*, 302. https://doi.org/10.1016/j.vetpar.2022.109659

Cook, N. B. and von Keyserlingk, M.A.G. (2023), 'Perspective: Prolonged cows calf contact – A dilemma or simply another step in the evolution of the dairy industry?', *J Dairy Sci*. https://doi.org/10.3168/jds.2023-23840

Creutzinger, K., Pempek, J., Habing, G. et al. (2021), 'Perspectives on the Management of Surplus Dairy Calves in the United States and Canada', *Front Vet Sci*, 8. https://doi.org/10.3389/fvets.2021.661453

Curtis, G., McGregor Argo, C., Jones, D. and Grove-White, D. (2018), 'The impact of early life nutrition and housing on growth and reproduction in dairy cattle', *PLoS One*, 13(2), e0191687.

Dachrodt, L., Bartel, A., Arndt, H. et al. (2022), 'Benchmarking calf health: Assessment tools for dairy herd health consultancy based on reference values from 730 German dairies with respect to seasonal, farm type, and herd size effects', *Front Vet Sci*, 9, 990798. https://doi.org/10.3389/fvets.2022.990798

Dairy Australia (2021) https://www.dairy.com.au/dairy-matters/you-ask-we-answer/what-are-bobby-calves (accessed 17 November 2023).

de Oliveira, D., Barth, K., Haskell, M. et al. (2020), 'Methodology for experimental and observational animal studies in cow-calf contact systems', *J Dairy Res*, 87S1, 115-121.

de Vries, A., Overton, M., Fetrow, J. et al. (2008), 'Exploring the impact of sexed semen on the structure of the dairy industry', *J Dairy Sci*, 91(2), 847–856.

Dunne, P.G., Monahan, F.J., O'Mara, F.P. and Moloney, A.P. (2009), 'Colour of bovine subcutaneous adipose tissue: A review of contributory factors, associations with carcass and meat quality and its potential utility in authentication of dietary history', *Meat Sci*, 81(1), 28–45.

Edwards-Callaway, L.N., Walker, J. and Tucker, C.B. (2018), 'Culling Decisions and Dairy Cattle Welfare During Transport to Slaughter in the United States', *Front Vet Sci*, 5, 343. https://doi.org/10.3389/fvets.2018.00343

England, Z.A., Maggard, H.L., Fisher, A.D., Roadknight, N.W. and Pempek, J.A. (2023), 'Condition of bob veal calves on arrival at an abattoir in Ohio', *Animal Welfare*, 32, e7,1–8. https://doi.org/10.1017/awf.2022.8

Eriksson, H., Fall, N., Ivemeyer, S. et al. (2022), 'Strategies for keeping dairy cows and calves together – a cross-sectional survey study', *Animal*, 16(9), 100624. https://doi.org/10.1016/j.animal.2022.100624

European Commision 2023. Organic farming in the EU. A decade of organic growth. Agricultural Market Brief No. 20, January 2023, pp.32 https://agriculture.ec.europa.eu/system/files/2023-04/agri-market-brief-20-organic-farming-eu_en.pdf (accessed 24 February 2024)

Ferneborg, S., Napolitano, F., Vaarst, M. et al. (2020), 'Methodology for studying human attitudes and behaviour to cow–calf contact systems', *J Dairy Res*, 87S1, 122–127.

Flower, F.C. and Weary, D.M. (2003), 'The Effects of Early Separation on the Dairy Cow and Calf.' *Anim Welf*, 12(3), 339–348.

Foraker, B.A., Frink, J.L. and Woerner, D.R. (2022), 'Invited review: a carcass and meat perspective of crossbred beef × dairy cattle', *Transl Anim Sci*, 6(2). https://doi.org/10.1093/TAS/TXAC027

Froberg, S., Aspegren-Guldorff, A., Olsson I. et al. (2007), 'Effect of restricted suckling on milk yield, milk composition and udder health in cows and behaviour and weight gain in calves, in dual-purpose cattle in the tropics', *Tropic Anim Health Prod*, 39, 71–81.

GB Calf Strategy (2020). British Calf Strategy Group. https://projectblue.blob.core.windows.net/media/Default/Dairy/Publications/DairyCalfStrategy_200826_WEB.pdf (accessed 17 November 2023)

Grundin, J., Eriksson, H., Fall, N. et al. (2019), 'Review of the regulations concerning organic dairy calf rearing in seven European countries', *Report ProYoungStock Consortium*. https://orgprints.org/id/eprint/39785/ (accessed 17 November 2023)

Hammon, H.M., Liermann, W., Frieten, D. and Koch, C. (2020), 'Review: Importance of colostrum supply and milk feeding intensity on gastrointestinal and systemic development in calves', *animal*, 14, S133–S143. https://doi.org/10.1017/S1751731119003148

Hansen, B.G., Langseth, E. and Berge, C. (2023), 'Animal welfare and cow-calf contact-farmers' attitudes, experiences and adoption barriers', *J Rural Stud*, 97, 34–46.

IFOAM (2020), 'Principles of organic agriculture'. https://www.ifoam.bio/principles-organic-agriculture-brochure, (accessed 17 November 2023)

IG kuhgebundene Kälberaufzucht (2022), Kriterien und Kontrollunterlagen der Interessensgemeinschaft kuhgebundene Kälberaufzucht. https://ig-kalbundkuh.de/kriterien-und-kontrollunterlagen-der-interessengemeinschaft/ (accessed 17 November 2023)

Ivemeyer, S., Brinkmann, J., March, S., Simantke, C., Winckler, C. and Knierim, U. (2018), 'Major organic dairy farm types in Germany and their farm, herd, and management characteristics', *Organic Agric*, 8(3), 231–247.

Johanssen, J.R.E., Kvam, G.-T., Logstein, B. and Vaarst, M. (2023), 'Interrelationships between cows, calves, and humans in cow-calf contact systems – An interview study among Norwegian dairy farmers', *J Dairy Sci*, 106. https://doi.org/10.3168/jds.2022-22999

Johnsen, J.F., Ellingsen, K., Grøndahl, A.M. et al. (2015a), 'The effect of physical contact between dairy cows and calves during separation on their post-separation behavioural response', *Appl Anim Behav Sci*, 166, 11–19.

Johnsen, J. F., Beaver, A., Mejdell, C. M. et al. (2015b), 'Providing supplementary milk to suckling dairy calves improves performance at separation and weaning', *J Dairy Sci,* 98(7),4800–4810

Johnsen, J.F., Zipp, K.A., Kälber, T. et al. (2016), 'Is rearing calves with the dam a feasible option for dairy farms? – Current and future research', *Appl Anim Behav Sci*, 181, 1–11.

Johnsen, J.F., Holmøy, I.H., Mejdell, C.M. et al. (2021a), 'A cross-sectional study of associations between herd-level calf mortality rates, compliance with legislation on calf welfare, and milk feeding management in Norwegian dairy herds', *J Dairy Sci*, 104(1), 839–848.

Johnsen, J.F., Kischel, S.G., Sætervik Rognskog, M. et al. (2021b), 'Investigating cow-calf contact in a cow-driven system: performance of cow and calf'. *J Dairy Res*, 1–4. https://doi.org/10.1017/S0022029921000200.

Johnsen, J.F., Johanssen, J.R.E., Aaby, A.V. et al. (2021c), 'Investigating cow-calf contact in cow-driven systems: behaviour of the dairy cow and calf', *J Dairy Res*, 88 (1), 52–55.

Johnsen, J.F., Garmo, R. and Holmøy, I.H. (2022), 'Calf mortality, calf treatments and mastitis treatments in Norwegian dairy herds practicing cow-calf contact versus herds practicing artificial calf rearing', *International Symposium of Veterinary Epidemiology and Economic*, Canada, 403.

Just, A., Wellmann, R. and Bennewitz, J. (2018), 'Estimation of relative economic weights and the marginal willingness to pay for breeding traits of Brown Swiss cattle using discrete choice experiments', *J Dairy Sci*, 101(6), 5207–5213.

Kargar, S., Bahadori-Moghaddam, M., Ghoreishi, S.M. et al. (2021), 'Extended transition milk feeding for 3 weeks improves growth performance and reduces the susceptibility to diarrhea in newborn female Holstein calves', *Animal*, 15(3), 100151.

Khan, M.A., Weary, D.M. and von Keyserlingk, M.A.G. (2011), 'Invited review: effects of milk ration on solid feed intake, weaning, and performance in dairy heifers', *J Dairy Sci*, 94(3), 1071–1081.

Krpálková, L., Cabrera, V.E., Kvapilík, J., Burdych, J. and Crump, P. (2014), 'Associations between age at first calving, rearing average daily weight gain, herd milk yield and dairy herd production, reproduction, and profitability', *J Dairy Sci*, 97(10), 6573–6582.

Leiber, F., Müller, A., Maurer, V., Schader, C. and Bieber, A. (2019), 'Organic dairy farming: towards sustainability'. In M. Vaarst and S. Roderick (Eds) *Improving organic animal farming*. Burleigh Dodds Science Publishing Limited, Cambridge, UK, Chapter 11, 225–244.

Loberg, J. and Lidfors, L. (2001), 'Effect of stage of lactation and breed on dairy cows' acceptance of foster calves', *Appl Anim Behav Sci*, 74(2), 97–108.

Loberg, J.M. (2007), '*Behaviour of Foster Cows and Calves in Dairy Production: Acceptance of Calves, Cow-Calf Interactions and Weaning*', Doctoral Thesis, Swedish University of Agricultural Sciences.

Lund, V. (2006), 'Natural living – a precondition for animal welfare in organic farming', *Livest Sci*, 100(2–3), 71–83.

Mac, S.E., Lomax, S. and Clark, C.E.F. (2023), 'Dairy cow and calf behavior and productivity when maintained together on a pasture-based system', *Anim Bio*, 36(2), 322–332.

Maher, J.W., Clarke, A., Byrne, A.W. et al. (2021), 'Exploring the opinions of Irish dairy farmers regarding male dairy calves', *Front Vet Sci*, 8, 635565.

Malmuthuge, N. and Le Guan, L. (2017), 'Understanding the gut microbiome of dairy calves: opportunities to improve early-life gut health', *J Dairy Sci*, 100(7), 5996–6005.

Marcato, F., van den Brand, H., Kemp, B. et al. (2020), 'Effects of pretransport diet, transport duration, and type of vehicle on physiological status of young veal calves', *J Dairy Sci*, 103(4), 3505–3520.

McCullock, K., Hoag, D.L.K., Parsons, J. et al. (2013), 'Factors affecting economics of using sexed semen in dairy cattle', *J Dairy Sci*, 96(10), 6366–6377.

Meagher, R.K., Beaver, A., Weary, D.M. and von Keyserlingk, M.A.G. (2019), 'Invited review: a systematic review of the effects of prolonged cow-calf contact on behavior, welfare, and productivity', *J Dairy Sci*, 102(7), 5765–5783.

Murphy, B., Crosson, P., Kelly, A.K. and Prendiville, R. (2017), 'An economic and greenhouse gas emissions evaluation of pasture-based dairy calf-to-beef production systems', *Agric Syst*, 154, 124–132.

Nansen, P., Steffan, P., Monrad J., Grønvold, J. and Henriksen, S.A (1990), 'Effects of separate and mixed grazing on trichostrongylosis in first- and second-season grazing calves', *Veterinary Parasitology*, 36(3–4), 265-276.

Natzke, D. (2023), Organic farms get fewer and larger. https://www.agproud.com/ext/resources/2023/01/16/0223pd-infocus.pdf

Neave, H.W., Sumner, C.L., Henwood, R.J.T. et al. (2022), 'Dairy farmers' perspectives on providing cow-calf contact in the pasture-based systems of New Zealand', *J Dairy Sci*, 105(1), 453–467.

Newberry, R.C. and Swanson, J.C. (2008), 'Implications of breaking mother–young social bonds', *Appl Anim Behav Sci*, 110(1–2), 3–23.

Nicolao, A., Coppa, M., Bouchon, M. et al. (2020), 'Early-life dam-calf contact and grazing experience influence post-weaning behavior and herbage selection of dairy calves in the short term', *Front Vet Sci*, 7, 600949.

Nicolao, A., Veissier, I., Bouchon, M. et al. (2022), 'Animal performance and stress at weaning when dairy cows suckle their calves for short versus long daily durations', *Animal*, 16(6), 100536.

Nielsen, B. and Thamsborg, S.M. (2002), 'Dairy bull calves as a resource for organic beef production: a farm survey in Denmark', *Livest Prod Sci*, 75(3), 245–255.

Nielsen, S.S., Alvarez, J., Bicout, D.J. et al. (2023), 'Welfare of calves', *EFSA J*, 21(3), e07896.

NOP eCFR: 7 CFR 205.239 – Livestock living conditions 2023. https://www.ecfr.gov/current/title-7/subtitle-B/chapter-I/subchapter-M/part-205/subpart-C/section-205.239 (accessed 26 February 2023).

Pardon, B., K. de Bleecker, M. Hostens, J. et al. (2012), 'Longitudinal study on morbidity and mortality in white veal calves in Belgium', *BMC Vet Res*, 8(1), 26. https://doi.org/10.1186/1746-6148-8-26

Pedersen, R.E., Sørensen, J.T., Skjøth, F. et al. (2009), 'How milk-fed dairy calves perform in stable versus dynamic groups', *Livest Sci*, 121(2-3), 215–218.

Placzek, M., Christoph-Schulz, I. and Barth, K. (2021), 'Public attitude towards cow-calf separation and other common practices of calf rearing in dairy farming – a review', *Organic Agric*, 11(1), 41–50.

Proudfoot, K. L., Hendricks, J., Higgins, A. et al. (2022), ‚The Entrepreneurs: Dairy farmer perspectives on finding an industry solution for the surplus calf issue—A participatory case study', *Front Sustain Food Syst*, 415. https://doi.org/10.3389/FSUFS.2022.961068

Regulation (EU) 2018/848 on organic production and labelling of organic products and repealing Council Regulation (EC) No 834/2007 2018. (accessed 26 February 2023).

Reiber, C., Wollmeister, M., Sommer, T. and Chagunda, M.G.G. (2020), 'Status quo und Determinanten der Kälbervermarktung von ökologischen und konventionellen Milchviehbetrieben in Baden-Württemberg', (in English: Status quo and determinants of calf marketing of organic and conventional farms in Baden-Württemberg). *Züchtungskunde*, 92(5), 320–338.

Reinhardt, V. (1980), '*Investigation into social behaviour of cattle. Two-year observation on a semi-wild herd of zebu (Bos indicus)*', Springer Basel.

Rell, J. Home, R.; Bähler, C. et al. (2022), 'Motivations for Swiss veal farmers to adopt calf health management strategies that enable reduction in antibiotic use', *Anim Prod Sci*, 62, 5(3), 490–500.

Rell, J., Wunsch, N., Home, R. et al. (2020), 'Stakeholders' perceptions of the challenges to improving calf health and reducing antimicrobial use in Swiss veal production.' *Prev Vet Med,* 179, 104970.

Renaud, D.L., Duffield, T.F., LeBlanc, S.J. et al. (2017), 'Management practices for male calves on Canadian dairy farms', *J Dairy Sci*, 100(8), 6862–6871.

Riefer, A. and Hamm, U. (2008), 'Changes in families' organic food consumption', *AgEconSearch*. https://ageconsearch.umn.edu/record/43653/

Roadknight, N., Mansell, P., Jongman, E. et al. (2021), 'Blood parameters of young calves at abattoirs are related to distance transported and farm of origin', *J Dairy Sci*, 104(8), 9164–9172.

Roche, J.R., Friggens, N.C., Kay, J.K. et al. (2009), 'Invited review: Body condition score and its association with dairy cow productivity, health, and welfare', *J Dairy Sci*, 92(12), 5769–5801.

Rørvang, M.V., Nielsen, B.L., Herskin, M.S. and Jensen, M.B. (2018), 'Prepartum maternal behavior of domesticated cattle: a comparison with managed, feral, and wild ungulates', *Front Vet Sci*, 5, 45.

RSPCA. (2023), RSPCA Welfare Standards for Beef Cattle. https://science.rspca.org.uk/documents/d/science/web-beef-welfare-standards-2023-1 (accessed 17 November 2023)

Sandelin, A., Hälli, O., Härtel, H. et al. (2021), 'Effect of farm and animal-level factors on youngstock mortality and growth on calf rearing farms', *Prev Vet Med*, 193, 105416.

Sans, P. and de Fontguyon, G. (2009), 'Veal calf industry economics', *Revue de Médecine Vétérinaire*, 160, 420–424.

Santman-Berends, I. M. G. A., de Bont-Smolenaars, A.J.G., Roos, L. et al. (2018), 'Using routinely collected data to evaluate risk factors for mortality of veal calves', *Prev Vet Med*, 157, 86–93.

Schlipf. (1908), *Handbuch der Landwirtschaft (in English: Handbook of agriculture)*, 16. edition, Verlagsbuchhandlung Paul Parey Berlin

Schneider, C., Bieber, A., Spengler Neff, A. and Ivemeyer, S. (2021), 'Separation and weaning of calves reared in cow-calf contact systems.' *ProYoungStock - Practice Abstract*. https://orgprints.org/id/eprint/43342/1/schneider-etal-2021-42549-CORE_Organic_practice%20abstract_ProYoungStock_EN.pdf (accessed 6 July 2023)

Simon, G., E. Hillmann and Barth, K. (2023), 'Pasture-based fattening does not cause severe non-perforating lesions in veal calves of dairy breeds', *JDS Com*, 4(6),496–501

Sirovica, L.V., Ritter, C., Hendricks, J. et al. (2022), 'Public attitude toward and perceptions of dairy cattle welfare in cow-calf management systems differing in type of social and maternal contact', *J Dairy Sci*, 105, 3248–3268.

Sirovnik, J., Barth, K., de Oliveira, D. et al. (2020), 'Methodological terminology and definitions for research and discussion of cow-calf contact systems', *J Dairy Res*, 87S1, 108–114.

Skelhorn, E.P.J., Garcia-Ara, A., Nova, R.J., Kinston, H., Waapenaar, W. (2020), 'Public perception and opinon of rose veal in the UK', *Meat Sci*, 167, 108032.

Soberon, F., Ryan, C.M., Nydam, D.V. et al. (2011), 'The effects of increased milking frequency during early lactation on milk yield and milk composition on commercial dairy farms', *J Dairy Sci*, 94(9), 4398–4405.

Soil Association (2023). Soil Association Organic Standards for Great Britain. Farming and Growing. Version 1.2: published on 12th January, 2023. https://www.soilassociation.org/media/23372/sa-gb-farming-_growing-standards.pdf (accessed 17 Novmeber 2023)

Spengler Neff, A., Schneider, C. and Ivemeyer, S. (2023), '*Cow-reared Calf Husbandry in Dairy Farming*.' FiBL, Frick, Schweiz. https://www.fibl.org/de/shop/1660-mother-bonded-calf-rearing

Stampa, E., Schipmann-Schwarze, C. and Hamm, U. (2020), 'Consumer perceptions, preferences, and behavior regarding pasture-raised livestock products: a review', *Food Qual Pref*, 82, 103872.

Tančin, V., Harcek, L., Broucek, J. et al. (1995), 'Effect of suckling during early lactation and changover to machine milking on plasma oxytocin and cortisol levels and milking characteristics in Holstein cows', *J Dairy Res,* 62(2), 249–256.

Tichenor, N.E., Peters, C.J., Norris, G.A., Thoma, G. and Griffin, T. S. (2017), 'Life cycle environmental consequences of grass-fed and dairy beef production systems in the Northeastern United States', *J Clean Prod*, 142, 1619–1628.

Vaarst, M., Nissen, T. B., Østergaard, S. et al. (2007), 'Danish stable schools for experiential common learning in groups of organic dairy farmers', *J Dairy Sci,* 90(5), 2543–2554

Vaarst, M., Hellec, F., Sørheim, K. et al. (2019), 'Calves with their dams in dairy cow systems', *CORE organic report*, p. 59. https://orgprints.org/id/eprint/36915/2/fullreport-pdf-version-december-2019.pdf

Vaarst, M., Hellec, F., Verwer, C. et al. (2020), 'Cow calf contact in dairy herds viewed from the perspectives of calves, cows, humans and the farming system. Farmers' perceptions and experiences related to dam-rearing systems', *Landbauforschung - J Sust and Organic Agric. Syst*, 70(1), 49–57.

Vaarst, M. and Christiansen, I.A. (2023), 'Three years of situated social learning and development of diverse cow-calf contact systems in Danish organic dairy farms', *J Dairy Sci*, 106. https://doi.org/10.3168/jds.2022-22755

van Knegsel, A.T.M., Burgers, E.E.A., Ma, J. et al. (2022), 'Extending lactation length: consequences for cow, calf, and farmer', *J Anim Sci*, 100(10), 1–10.

Veissier, I., Caré, S. and Pomiès, D. (2013), 'Suckling, weaning, and the development of oral behaviours in dairy calves', *Appl Anim Behav Sci*, 147(1–2), 11–18.

Vogt, A., Barth, K., Waiblinger, S. and König von Borstel, U. (2024)'Can a gradual weaning and separation process reduce weaning stress in dam-reared dairy calves? A comparison with the two-step method', *J Dairy Sci*. https://doi.org/10.3168/jds.2024-23809.

Wallenbeck, A., Rousing, T., Sørensen, J.T. et al. (2019), 'Characteristics of organic dairy major farm types in seven European countries', *Org Agr*, 9(3), 275–291.

Weary, D.M., Ventura, B.A. and von Keyserlingk, M.A.G. (2016), 'Societal views and animal welfare science: understanding why the modified cage may fail and other stories', *Animal*, 10(2), 309–317.

Webb, L.E., Bokkers, E.A.M., Heutinck, L.F.M. et al. (2013), 'Effects of roughage source, amount, and particle size on behavior and gastrointestinal health of veal calves', *J Dairy Sci*, 96(12), 7765–7776.

Wenker, M.L., Bokkers, E.A.M., Lecorps, B. et al. (2020), 'Effect of cow-calf contact on cow motivation to reunite with their calf', *Sci Rep*, 10(1), 14233.

Wenker, M.L., Verwer, C.M., Bokkers, E.A.M. et al. (2022), 'Effect of type of cow-calf contact on health, blood parameters, and performance of dairy cows and calves', *Front Vet Sci*, 9, 855086.

Wieczorreck, L. and Hillmann, E. (2022), Ist die ammengebundene Aufzucht eine tiergerechte Alternative zur künstlichen Aufzucht von Milchviehkälbern? (In English: Is a foster cow rearing system an animal-friendly alternative to artificial rearing of dairy calves?) In *Aktuelle Arbeiten zur artgemäßen Tierhaltung 2022*, KTBL-Schrift 11530, 90–100.

Willer, H., Schlatter, B. and Trávníček, J. (Eds) (2023), '*The World of Organic Agriculture. Statistics and Emerging Trends 2023*', Research Institute of Organic Agriculture FiBL, Frick, and IFOAM – Organics International, Bonn (accessed 2 February 2023).