

Dam-rearing of dairy calves:

Lessons from practice for future research & development



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Preface

Interest in dam-rearing of dairy calves is growing among researchers, advisors and farmers. This internal project report collates, synthesizes and conveys scientific evidence and information on systems for dam-rearing as practiced by farmers in northern Europe. We hope this report will serve as inspiration for researchers planning experiments on dam-rearing as well as advisors and farmers developing and implementing systems for dam-rearing in practice.

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Finally, we would like to acknowledge all the farmers, who invited us to visit their farms and show us the functioning of their dam-rearing systems, and we would like to acknowledge the Danish advisors and farmers participating in ongoing discussions on how to advance the concept of dam-rearing of dairy calves.

Front-page photo: J. O. Lehmann.

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1 Introduction

Giving birth to a calf is necessary for a cow to produce milk. Common practice on today's dairy farms is to separate the newborn calf and its mother, the dam, within the first 24 to 48 hours after calving. A recent review (1) of the scientific literature lists four main reasons for the early separation of cow and calf. 1) Early separation is thought to increase financial profits as more milk can be harvested and sold; 2) Artificial feeding of calves allows a closer monitoring of colostrum and milk intake; 3) milk let-down in the parlour is thought to be facilitated by early separation and 4) early separation is thought to minimize stress response for both cow and calf.

However, growing public concerns and a perception that the early separation of dam and calf as a welfare problem (2-4) challenges this practice. Research shows that letting the calf suckle for a longer time than practiced on most dairy farms can entail positive social and behaviour effects for both dam and calf, albeit with a greater risk of distress at a subsequent separation (1; 5; 6). In this regard, it is important to distinguish between two separate events: the physical separation of dam and calf as well as the weaning of the calf from milk. Separation and weaning can occur simultaneously or consecutively, abrupt or gradually, and the same calf can be weaned off first milk from the dam and later off milk from a bucket. In addition, a third important event for the dam and calf is the initial bonding between the two immediately after calving.

Hence, there are a multitude of potential sequences of bonding, abrupt or gradual weaning and abrupt or gradual separation in different types of barn systems such as a barn with cubicles or a barn with deep litter as well as with or without grazing. Several farmers around Europe have developed different setups and systems for managing prolonged suckling of the dam by its own calf in different types of barn and grazing settings. We call these systems cow-calf contact systems (7).

The majority of farmers with a cow-calf contact system have developed these by modifying and adapting existing management practices and barn systems. Hence, very few farmers have a cow-calf contact system designed from the beginning to house cows with their calves during the weeks or months after calving. This report presents a variety of cow-calf contact systems developed in existing barns by European dairy farmers, who have been motivated to implement a cow-calf contact system and developed it from observations, experience and knowledge from literature, courses and colleagues. It serves as support for analyses in three current Danish research projects cow-calf contact systems at Aarhus University, and we furthermore hope this report can inspire prospective farmers, who are considering implementing a cow-calf contact system. Finally, our work has so far focused on systems where cows rear their own offspring, which is defined as a dam-calf contact system (7), but we have where relevant included information about foster cow rearing systems (7) and other cow-calf contact systems.



Fig 1. Electronic smart gates at the Thuenen Institute of Organic Farming in Trenthorst, Germany, control the access of calves to their dams. Photo: JO Lehmann.

1.1 Motivations and considerations for developing a cow-calf contact system

This section is an excerpt of a project report based on interviews and on-farm studies across The Netherlands, France, Norway and Denmark. This report was published as a part of the CORE Organic Cofund project GrazyDaisy, and it later served as a background report for a peer-reviewed scientific article (8). It showed that a wealth of different dam-rearing systems exist. See (9) for details of this study.

Four main angles were found important to consider, when organizing a dam-calf contact system to fit the context and work on the farm well: calf, cow, farmers and farming system.

1.1.1 Seen from the animal's point of view

Dam-calf contact systems can be seen as contributing significantly to the physiology and natural behaviour of calves as well as of mother cows. Three important qualities in dam-calf contact systems were described from animals' perspective: 1) nutrition, 2) care, and 3) learning.

Farmers who choose to establish a cow-calf contact system perceived these three aspects differently, and this was reflected in their choices of how they organised their systems. For example, if a farmer focused on milk-feeding and "nutrition", a system with part-time cow-calf contact (e.g. two times two hours daily access to each other) could be perceived as sufficient to reach the goal of keeping calves with cows. A focus on "care" would motivate the farmer to establish a system in which the cow and the calf had possibilities to stay together for longer time and experience care in terms of licking and protecting the calf while sleeping. If the farmer included "learning" as an important motivation for establishing a cow-calf contact system, he/she would rather consider a more full-time access system, where the calf had the possibilities to follow the cow as much as possible to get to know the whole system. Some farmers perceived the calves to be equipped with capacities and skills through learning from the dam and others in the system, adding to their life opportunities, and they would favour a system where mother cow and calf were together with as little restriction as possible, although such systems require major efforts to organize and keep the overview.

In line with this, some farmers prioritised the calves and wanted to establish a cow-calf contact system primarily to let the calf have 'a natural start in life', where others also gave priority to the natural needs and the motivation of the mother cow. This became clear when some farmers explained why they had established foster cow systems, in which the mother cow is separated early after calving from her calf: these systems were established for the calves.

1.1.2 Seen from the farmers' points of view

The study (9) showed that most interviewed farmers, who had dam-calf contact systems, were mainly driven by the pleasure of seeing it work, and seeing the interaction between calves and cows. They articulated how they were touched and impressed e.g. by the mother cow's consistent 'watching over' her calf, and the pain of separation. A number of the farmers had never been motivated by premium price (and they did not get a higher price for their milk) or consumer demands, but just did it because they found it right, or 'easier' in combination that it brought them other qualities being farmers.

The study (9) also included interviews of farmers, who had been confronted with dam rearing systems for the first time in their lives. Their reactions to the systems pointed to the necessity for the farmer to find a balance between 'trusting the animals' and 'being in control'. They noticed that the farmers with cow-calf contact systems had to trust the calves abilities, because they could

clearly see that the calves found their way in the system and seemed to navigate well in relatively complex systems sometimes with outdoor access. At the same time, they found it frustrating to see young calves in what they perceived as ‘risky environments’, because they came from systems where they perceived themselves to ‘being in control’: for example, they used to know exactly how much milk the calves were drinking on daily basis. This pointed to the need for the humans in the system to redirect efforts and focus when observing animals, and when spending their time with cows and calves.

1.1.3 The naturalness or unnaturalness of cows and calves together on dairy farms

In the study (9), there was a repeated questioning of ‘naturalness’ in relation to dam-rearing. Whilst acknowledging that mother cows and calves were strongly motivated and it was ‘natural’ for them to being together, some farmers also pointed to factors which partly made it ‘unnatural’ for them. This was especially the very high milk yields of dairy cows, which could lead to over-drinking for the calf, or deep udders, which made it difficult to drink for the calf, or the fact that daily life in a large dairy herd might not give a newborn calf sufficient peace to rest.

In line with this questioning, there were also overall questions on how to establish systems, which allowed unrestricted access for cows and calves to being together. The farmers found in different ways that it could be beneficial for them to be in systems where either the calf could find the mother (after the first week or so), or where the mother could find the calf at any time. The latter mostly happened in systems where there was a special cow-calf-area. Some farmers argued for systems in which calves could seek rest and peace in a calf hide.

Some issues remained unsolved at the current moment, and they need future solutions. One is the difference in many herds between ‘calves to stay in the herd’ versus ‘calves to leave the herds’. These calves often left the herd at an age of 2-3 weeks, and often after abrupt separation, in contrast to the heifer calves, which were meant to become replacement cows later in life. This distinction between ‘categories of calves’, and not least their mothers, was found unfair to some, but unavoidable to others.

1.2 Topics to consider when developing a cow-calf contact system

1.2.1 Level of contact between cow and calf

Full cow-calf contact allows unrestricted physical contact between a cow and its calf where the calf can suckle the cow and the cow can nurse and lick the calf. Limiting the contact between a cow and its calf is termed partial cow-calf contact, and this is implemented in a number of different ways (7). Partial contact systems range from short feeding bouts where the calf is brought to the cow to suckle and removed afterwards to typically a half-day contact, which often is implemented as the time between two consecutive milkings, hence either night or day.

Three types of access between dam and calf were observed at the farms visited for this report, and a fourth type of access is currently under trial at a



Fig 2. Calves reared in a crate and fed milk in a bucket at a Dutch research station. Dams can visit the crate, see hear and touch their calf. Photo: JO Lehmann.

Dutch research station (Fig 2) where calves in pairs are reared in crates and fed milk in a bucket. The crate is placed adjacent to the cow area, and hence the dam can at any point of time while she is in the barn visit, see, hear and touch its own calf, but it is only partial contact since the calves cannot suckle the cows. The scientific literature is currently unclear on what level of contact is more appropriate for either dam, calf or both.

1.2.2 Contact initiation between cow and calf

Some systems allow either the cow or the calf to initiate contact between them defined as cow-driven and calf-driven contact, respectively, whereas other systems allow both to occur. Discussions continue about which is most appropriate for the cow, the calf or both, but most functioning cow-calf contact systems have, as noted, been established within existing barns that originally were not designed for this, which likely was a constraint for the type of contact system to develop.

Cattle as species are hidiers under natural and semi-natural conditions meaning that they seek a secluded area to give birth (10). There are only few descriptions of mother-young behaviour under natural conditions (e.g. 11), and the characteristics of the environment as well as the social group like affects this. However, the general picture is that first few days after calving, cows leave their calf in hiding to forage elsewhere, and they will bring the calf back to the herd 3-10 days after calving. Within a few days, the newborn calf will begin to seek other same age calves, form groups, and the interaction between cow and calf takes place in complex patterns which is not well-described. However, these interactions seems often to be synchronised within the calf group and mainly initiated by the calf, but the cow can also drive contact, especially during the first few weeks.

All farmers visited for this report limited in some way the time that dam and calf are together by controlling when and how dams gain access to their calf. It may be a question of practicality when developing a dam-rearing system within an existing barn and management regime, but electronic smart gates (Fig 1, smart gate for calves) can automate either type of system.

1.2.3 Age of separation of cow and calf

Farmers visited for this report separate calf and dam between four weeks and six months after calving, although some of the farms for practical reasons separate male calves earlier than female calves as they are sold off the farm to be reared for beef elsewhere. Separating dam and calf between before the natural weaning age challenges both dam and calf. As reviewed by Jensen (12), research in beef cattle has compared weaning ages between 3 and 8 month and found that the older (and more nutritionally independent) the calf, the lower the stress response at weaning. Research in dairy, comparing separation (not weaning-off milk) from the dam ranging between one and 14 days of age, showed that the longer the dam-calf contact the stronger the stress response at separation. The effect of calf age when separating dam and calf between 2 weeks and 3 month in dairy cattle is not investigated, but will like cause more separation stress than later weaning. Research on this and whether separation stress is stronger the younger the calf is needed, and should focus on both dam and calf.

1.2.4 Organisation of weaning and separation to minimize frustration

Farmers visited for this report cover a range of different combinations of abrupt and gradual weaning, and sometimes calves meant to be sold off the farm are reared differently from calves kept as replacements. The research suggests that gradual weaning before final separation reduces the calf's responses to separation, but this is mostly investigated in beef cattle, where a so-called two-

step weaning methods has been applied. The method implies that the calves are weaned off milk in the first step and separated from the dam in the second step. Research as shown that the intensity of each of the two steps are lower than abrupt separation. Comparing these two two-step methods, Enriquez et al. (13) found that the behavioural responses of fence-line calves were strongest after the first step, while the responses of nose-flap calves were strongest after separation from the dam, i.e. the second step. This may be because the nose-flap is less effective in weakening the dam-calf bond due to the continued close contact and because the nose-flap does not prevent the calves from attempting to nurse. Using fence-line weaning, preventing nursing, but not physical contact, Johnsen et al. (14) could reduce the vocal response in 8-week-old calves compared to when calves could hear, but not see and touch the dam. However, the study found no effects on dams' responses. Thus, scientific research investigating how to reduce the stress at weaning and separation for both dam and calf is needed.

2 Material and methods

The objective with this project report is to collate and synthesize information on different cow-calf contact systems that can support mainly two current Danish research projects in developing scenarios for system's analyses of dam-rearing of dairy calves. These will be used for analyses of the impact of dam-rearing compared with traditional calf rearing methods on a range of indicators of sustainability and production economics.

The foundation of this report lies on visits to 11 farms from four countries with different cow-calf contact systems (see following section) where their setups, systems and lessons learned were recorded. Each visit evolved around a tour of the farm where the farmer could explain the workings of the systems, choices and compromises made as well as give rough estimates including data on milk production, milk consumed by the calf, calf growth rate, diseases and mortality. Most of the visited farms were extensively managed with relatively low levels of record keeping.

2.1 Farms visited with dam-rearing of dairy calves

Table 1 show an overview of the implemented dam-rearing systems across the 11 farms, and it shows that herd size ranged from 30 to 130 cows and age at separation time ranged from 4 to 26 weeks. Four farms practice seasonal calving, and three different combinations of weaning and separation types were practiced across farms. See (7) for a discussion of different terminologies used to describe cow-calf contact systems.

Table 1. Overview of selected dam-rearing characteristics for farms visited.

Farm	Herd size	Calving system	Dam-rearing system	Separation calf age*	Weaning type	Separation type
<i>Scotland</i>						
Farm 1	55	Spring	Partial	22 weeks	Abrupt	Abrupt
Farm 2	130	½ spring, ½ autumn	Partial	26 weeks	Gradual	Gradual
<i>The Netherlands</i>						
Farm 3	60	Summer	Full	4 weeks	Gradual	Abrupt
Farm 4	60	All-year	Full	10 weeks	Abrupt	Abrupt
Farm 5	65	All-year	Partial	17 weeks	Gradual	Gradual
Farm 6	50	All-year	Full + Partial	16 weeks	Abrupt	Abrupt
Farm 7	45	All-year	Full + Partial	10 weeks	Gradual	Gradual
<i>Germany</i>						
Farm 8	30	All-year	Full	14 weeks	Gradual	Abrupt
Farm 9	50	Spring	Full	15 weeks	Abrupt	Abrupt
Farm 10	40	All-year	Full	4 weeks	Abrupt	Abrupt
<i>Denmark</i>						
Farm 11	250	All-year	Full	2 weeks	Abrupt	Abrupt

*Averages as assessed by the farmer. Average for females is shown when different for males.

3 Examples from farms with dam-rearing of dairy calves

3.1 Cases from Scotland

3.1.1 Farm 1

The farm is organic with a herd of 55 Holstein x Ayrshire crossbred cows that calve within a 12-week window in spring. Cows graze as much as possible from April to October, and feeding consists of baled grass silage that occasionally is supplemented with either grass or lucerne pellets if silage quality is less than expected. Calves are offered baled grass silage from one week of age in a deep litter area separate from the cows. The farm has an overall focus on self-sufficiency with feed and holistic grazing and is integrated with its own milk processing and delivery service. Dam-rearing has been practiced since 2018.



Fig 3. Calves and their dams have partial contact through a barrier at night. Photo: JO Lehmann.

3.1.1.1 Barn layout

Lactating cows are housed in a cubicle barn with rubber mattresses and a solid floor with a rubber mat that is cleaned with a scraper. Within this barn, adjacent to the cubicles, there is a deep litter area where dam-reared calves have access, and where they both be fed and separated from the dams. Cows can at any time reach, touch hear and see the calves through or over the barrier separating the deep litter and cubicle areas.

3.1.1.2 Management of dam-rearing

A newborn calf is kept with its dam fulltime the first one week after parturition after which they are separated every night and kept in a deep litter area. During the day, calves have free access to their dams in the cubicle area or outside on pasture. Separation and weaning occurs simultaneously and abrupt after four to six months, and the timing is based on the apparent willingness of the calf to be separated. Calves are moved across the road to maintain a distance between calves and their dams, but both dams and calves have a down-period of around two days where they hardly eat. All heifer and bull calves are kept and raised similarly on the farm.

3.1.1.3 Milking, milk yield and milk consumption

Cows are milked in a milking parlour and produce around 2,000 to 2,300 L per lactation for the dairy, and calves are estimated to consume an additional 1,500 L per lactation. First lactation cows occasionally refuse to let milk flow to the milking machine, and this is solved within a few days by letting the calf suckle one teat while the three others are being milked.

3.1.1.4 Lessons learned

The separation and weaning stage is the most challenging, and a gradual weaning before separation with a nose flap is being considered. Dam-rearing requires the same amount of work, but it is a different kind of work where you spend more time with observations of the animals. In general, a dam-rearing system requires sufficient space, easy access and motivated people, as there is a steep learning curve. Heifers are generally wilder as a dam-rearing system brings out the personality in animals, but this can be managed through handling. Suckling can be difficult for the calf if it is sick.

3.1.2 Farm 2

The farm is organic with a herd of 130 Holstein x Montbéliard x Swedish Red crossbred cows that are split in two stable groups where one group calves in February/March and the other group calves in October/November. The two groups graze separately. Beside pasture, cows receive lucerne pellets in the parlour in addition to grass silage in the feed bunk. Calves have access to silage and pasture once they enter the group of lactating cows. The farm focuses on self-sufficiency with feed and is integrated with its own cheese factory, farm shop and experience park. Dam-rearing has been practiced since 2016.



Fig 4. Only calves have access to a separate area in the center of the cow barn. Photo: JO Lehmann.

3.1.2.1 *Barn layout*

The barn for lactating cows is equipped with cubicles that are lined with a rubber mat and with flexible plastic tubes as a separation between stalls. The floor is solid and cleaned with a scraper. There is a separate area in the centre of the stable with a solid floor and rubber mats where only calves have access.

3.1.2.2 *Management of dam-rearing*

Calving occurs in individual calving pens with rubber mats and sawdust as bedding. Each of 12 calving pens open up to a common area where up to 12 newly calved cows stay together for the first three to five days after parturition. Calves stay together with their dams fulltime the first three months and part-time during the day from the age of three to six months where, at night, calves stay in a separate area within the lactating cow barn. Cows can at any time reach, touch hear and see the calves through or over the barrier separating the calf and cubicle areas. Calves have access to feed within the calf area. One week before separation at six months of age, calves are equipped with a nose flap to prevent them from suckling the dam, and hence they are weaned. All heifer and bull calves are kept and raised similarly on the farm.

3.1.2.3 *Milking, milk yield and milk consumption*

Cows are milked once per day in a milking parlour before separation, two times per day after separation and once per day the final few weeks before drying off. Cows deliver around 4,000 L per lactation for the dairy, and calves are estimated to have consumed 2,000 to 2,500 L at the time of weaning. Milk-let-down is sometimes a problem with a first-lactation heifers, but it generally goes away on its own.

3.1.2.4 *Lessons learned*

The first year was a complete disaster, but it seems that the cows have to learn the system, and not it is no longer a problem. In the beginning, cows appeared to think that they were being separated every day. Only few cows complain at separation. It is important with enough space for cows and calves to lie together, and regular contact between farm workers and calves is important to prevent wild animals. The few cows that so far have been raised in the same system appear to be easier to work with compared with earlier. Proper colostrum and a clean calving area are essential.

3.2 Cases from The Netherlands

3.2.1 Farm 3

The farm is biodynamic with a herd of 60 Old Friesian dairy cows where calving occurs on pasture from April to October. Roughage is either grass silage or pasture, and lactating cows are supplemented with faba beans, oats, rye and grass pellets. Hence, calves have access to pasture and the same ration as cows, and they receive a concentrate after separation. The farm is integrated with a café and a bed & breakfast as well as a small pig production. Dam-rearing has been practiced since 1991.



Fig 5. Dam-rearing has been practiced since 1991. Photo: JO Lehmann.

3.2.1.1 *Barn layout*

The barn for lactating cows has a row of cubicles with deep litter along each side, slatted floors and a feeding isle down the centre of the barn. Calves, their dams and all other lactating cows are mixed within the barn, and a small separate area for calves is only used for a gradual separation process.

3.2.1.2 *Management of dam-rearing*

Calves and their dams stay together for the first three weeks after parturition after which they are kept in separate area with partial contact through or over a barrier for three to four days. A few days before the partial separation, calves are tied up when cows are let out and fed milk in a bucket before being let out to pasture as well. At full separation, calves are moved to a different barn with other calves where they are fed milk in a bucket.

3.2.1.3 *Milking, milk yield and milk consumption*

Cows are milked two times per day all-year round in a parlour and produce around 5,500 L per lactation for the dairy. Calves are estimated to consume around 6-7 L per day while suckling their dam, and they are allocated 4-6 L per day in bucket after separation. This totals around 500 L per calf including bucket feeding. A few cows have problems with milk-let-down right after calving, but they can generally be milked the following day.

3.2.1.4 *Lessons learned*

Cows react more to separation than calves, and the reaction of calves to separation can be minimised by ensuring that they are feel full by feeding enough milk. Calves are separated after three weeks to prevent them from consuming too much milk and prevent them from becoming too wild and hence difficult to handle. Socialisation with humans is important. Grazing calves with their dams is relatively easy albeit challenged by some of calves that hide in hedges around the pasture. However, if a too strong bond forms between the calf and its dam right after calving, then they may have to be separated immediately as it may create problems at a later separation. Similarly, cow and calf will be separated immediately if the cow will not recognise its calf. There is no specific measure to prevent calves from entering the milking parlour as calves appear not to want to follow their dam in there.

3.2.2 Farm 4

The farm is organic with a herd of 60 cows of mixed breeds including Holstein-Friesian, Fleckvieh, Emmerij and Blaarkop. Cows graze the majority of the year unless the ground is very wet or covered with snow. Feeding is grass based with either pasture or grass silage, and cows are only supplemented with a mixed concentrate in early lactation. Calves are kept in the same group with all lactating cows until separation and move together both indoors and outdoors. Dam-rearing has been practiced since 1996.



Fig 6. Cows and calves graze together outside.
Photo: JO Lehmann.

3.2.2.1 *Barn layout*

Lactating cows are kept in a barn where there is a slatted floor adjacent to the feed bunk and a large deep litter area. Calves are kept inside right after separation in separate area with a slatted floor and concrete cubicles with chopped straw.

3.2.2.2 *Management of dam-rearing*

Cows calve among the lactating cows either on pasture or in the deep litter area, and heifer calves stay with dams the first ten weeks after calving whereas bull calves are sold after two weeks. In both cases separation occurs abruptly, and weaning of heifer calves occurs abruptly simultaneously with separation. At separation, heifer calves are moved to a different barn and kept inside for some time where they are fed concentrate and hay. Afterwards these calves are mixed with older calves and allowed to graze again.

3.2.2.3 *Milking, milk yield and milk consumption*

Cows are milked two times per day all-year round and produce around 6.000 L per lactation for the dairy, and calves are estimated to consume 15-16 L of milk per day while suckling, which totals around 1.100 L per calf. Milk-letdown is rarely a problem.

3.2.2.4 *Lessons learned*

Calves were previously separated after three months because calves become too fat and drink too much milk if they stay together with their dam for more than ten weeks. Bonding of calves and humans can be an issue, but this is handled by feeding the calf concentrate after separation as they learn where their food comes from. A few cows will steal the calf of other cows, which requires attention. Milk fever is more prevalent now, which is probably related with frequent suckling. No specific measures are taken to prevent calves from entering the milking parlour or any other area, so this does happen, but it is not perceived as a problem.

3.2.3 Farm 5

The farm is conventional with a herd of 65 Holstein cows where calvings are distributed throughout the year. Grazing is practiced during summer where dams with their calves graze a separate area. All lactating cows are fed a mixed ration with maize and grass silage, soy and potato residues. Calves reared by the dam are fed a concentrate mixture in addition to suckling. Dam-rearing has been practiced since 2007. The farm is integrated with a cheese factory and a farm shop.



Fig 7. A smart gate (center) gives access to the milking robot. Photo: JO Lehmann.

3.2.3.1 Barn layout

There are two separate and adjacent areas for lactating cows where one is a deep litter area, and the other has a slatted floor and cubicles with mattresses and sawdust. Two smart gates and a milking robot ensures that only cows rearing a calf can gain access to the deep litter area. All cows have to go the cubicle area to get access to the feeding alley, but there are two separate grazing areas. Cows calve in the deep litter area where they can be kept separate from the other cows. Calves have access to separate area for themselves within the deep litter area where they are fed a concentrate feed and water. Furthermore, a separate area within the deep litter area can be created with gates to facilitate a gradual separation and weaning process. After a completed separation, calves are housed in separate barn with a slatted floor and cubicles with sawdust.

3.2.3.2 Management of dam-rearing

Cows spend the first two days after calving together in a temporary calving pen within the deep litter area. Heifer calves are separated from the dam 120 days after calving whereas bull calves are separated after 45 days, and the milking robot gradually reduces the proportion of the day where the dam is allowed into the deep litter area relative the age of the calf. Four weeks before separation minimum two calves at a time are moved into a separate pen within the deep litter area where calves can suckle the dam through a barrier as well as have physical and visual contact over the same barrier. Two weeks before separation the barrier is closed to prevent calves from suckling, but they still have physical and visual contact over the barrier. At separation, calves are moved to another barn.

3.2.3.3 Milking, milk yield and milk consumption

Cows are milking in a milking robot, and cows rearing a calf have to pass through the robot to access the feeding alley, which ensures minimum two milkings per day for these cows as well. Cows produce on average 9,500 L per lactation delivered to the dairy, and the farmer estimates that each calf suckle on average 12-15 L per day throughout the dam-rearing period, which totals around 1,600 L per calf.

3.2.3.4 Lessons learned

Calves are manually handled from right after calving to ensure a socialisation with humans and prevent wild heifers. The milking robot along with smart gates and an adaptable pen within the deep litter area are key components in the gradual separation and weaning of calves from their dams.

3.2.4 Farm 6

The farm is biodynamic with mixed herd of 50 cross-bred cows that include Holstein-Friesian, Friesian, Jersey, Brown Swiss and Emmerij. Cows graze the majority of year and are fed grass and maize silage as well as a mix of peas and barley in a feeding box and a mixed concentrate in the parlour. Calves are fed silage and concentrates during the partial separation process. Calvings are distributed throughout the year, and dam-rearing has been practiced since 2007.



Fig 8. A separate pen with a flexible barrier adjacent to the lactating cows is used for gradual separation. Photo: JO Lehmann.

3.2.4.1 Barn layout

All lactating cows, dry cows and calves reared by their dam are housed as one large group in a sloping hill barn with deep litter and direct access to pasture as well as a slatted floor adjacent to the feeding alley. A separate pen with deep litter next to the feeding alley is used for a gradual separation and weaning of dam-reared calves. After separation, calves are moved to a different barn.

3.2.4.2 Management of dam-rearing

Cows calve among other cows either inside in the barn or outside on pasture. Ten heifer calves are kept for replacements, and they have two months of fulltime contact with their dam followed by two months of partial contact through a barrier between their pen and the slatted floor next to the feeding alley. Calves can suckle their dam for the first 1.5 weeks after the partial separation. Heifer calves and all bull calves sold off farm are abruptly weaned 2.5 weeks after calving and sold off the farm. All cow and calf pairs are given a homeopathic relaxation agent as a part of the separation process.

3.2.4.3 Milking, milk yield and milk consumption

Cows are milked twice per day all-year-round except for the last 60 days prior to drying off where they are milked once per day. Cows produce around 5.300 L per lactation for dairy, and the farmer estimates that calves suckle at least 400 L during the two months of fulltime contact.

3.2.4.4 Lessons learned

This system requires space, and the farmer wishes to build a new barn with 12 m² per cow compared with the current 6 m² as some calves have been lost to cows stepping on them. There is a relatively high frequency of so-called milk diarrhoea from calves drinking too much milk, but this appears not to affect their overall health. Calves are often given attention and handled manually during the partial separation period, which helps to prevent wild heifers. Nervous cows become calmer after a winter inside the barn. Calves appear to learn not to go into the milking parlour.

3.2.5 Farm 7

The farm is conventional with a herd of 45 Holstein-Friesian cows with calvings distributed throughout the year. All cows graze during the day during summer while calves reared by their dam are kept inside. Feeding of cows is based on cut fresh grass and grass silage as well as a concentrate mix given in the milking parlour. Calves are fed milk and concentrate after separation. Dam-rearing has been practiced since the late 1990'ties.

3.2.5.1 Barn layout

The barn for all lactating cows and calves reared by the dam has a scraped solid concrete floor adjacent to the feeding alley and cubicles with deep litter bedding. Attached to the end of the barn, there is pen with deep litter and a concrete floor that is used for a gradual separation and weaning of calves. Calves separated from their dam are housed in a separate barn with deep litter. Individual calving pens are with deep litter.

3.2.5.2 Management of dam-rearing

Cows calve in individual calving pens where they stay with their calf fulltime for the first three days to ensure sufficient bonding between cow and calf. Cow and calf are then joined with the remaining group of lactating cows, and hence all cows and calves reared by their dam are managed as one group. Calves stay with their dam indoor for six weeks, followed by up to four weeks of partial contact. The calves cannot follow the cows on pasture during summer. The farmer chose this because of big roads close to the farm. Calves can suckle their dam through a barrier during the first part of the period with partial contact after which they are fed milk in a bucket. Calves can at all times hear, see and touch their dam over the barrier. Hence, the farm practices a combined gradual separation and weaning of calves from their dams except for calves sold off the farm as they are abruptly separated at two weeks of age.

3.2.5.3 Milking, milk yield and milk consumption

Cows are milked two times per day all-year-round in a milking parlour and produce on average 5,600 L per lactation for the dairy, and the farmer estimates that calves suckle around 1,200 to 1,400 L over a total milk feeding period of 12 weeks. Milk letdown are mostly not a problem, and calves appear to quickly learn not to get into milking parlour.

3.2.5.4 Lessons learned

Calves require attention from the farmer soon after calving as socialisation with humans does not happen on its own, but calm cows on this farm generally also produce calm calves. Grazing very young calves is not done as calves have previously run onto a nearby major highway. A separate pen for gradual separation and weaning and sufficient bonding time in a calving pen are key components.



Fig 9. All cows and calves reared by their dam roam the cubicle barn. Photo: JO Lehmann.

3.3 Cases from Germany

3.3.1 Farm 8

The farm is organic with a herd of 30 cows of the old Holstein breed. All animals can graze throughout the year, and calvings are distributed all-year-round. All animals including calves reared by the dam are fed pasture, grass silage and vegetable scraps. Bull calves are raised on the farm until slaughter at 24 months of age. The farm is integrated with a vegetable production, a farm shop and a bed and breakfast. Dam-rearing has been practiced since 2015.



Fig 10. Cows and calves share a deep litter area. Photo: JO Lehmann.

3.3.1.1 *Barn layout*

The barn for all lactating cows and calves reared by the dam is split in three parts with no roof between them and all open sides. The two bedding areas are deep litter with straw, and the third area is a feeding alley with slatted floors on three sides. The remaining floors are solid concrete.

3.3.1.2 *Management of dam-rearing*

Cows calve among the other lactating cows either in the deep litter area or on the adjacent pasture. Cows are not milked for the first three to four days to ensure that all colostrum goes to the calf. Calves reared by the dam stay with all lactating cows as one common group fulltime for the first 100 days after calving, and they are gradually weaned off milk with a nose flap the last 10-14 days before abrupt separation. All calves including bull calves are raised in this system.

3.3.1.3 *Milking, milk yield and milk consumption*

Cows are milked once per day in a milking parlour and produce an average of 2,000 L per lactation for the dairy plus around an estimated 2,000 L that is suckled by the calf. Calves quickly learn not to enter the milking parlour, and milk letdown is not perceived as a problem.

3.3.1.4 *Lessons learned*

Cows are highly attentive to their calves for the first ten days after calving. Sufficient colostrum and observation right after calving are essential for calf survival. Some calves drink too much milk and get milk diarrhoea, but this is not perceived as a problem. If the gradual weaning period is too long, then some calves will learn to circumvent the nose flap and start suckling again. The nose flap will in itself start a gradual separation process because the calf will start to retract from the dam. Calves appear to learn from older animals. The first new first lactation cows that were raised in this system came into the herd in 2018, and they appear to know the social structure of the herd in a better way.

3.3.2 Farm 9

The farm is a biodynamic cooperative farm with a herd of 50 Brown Swiss cows. Feeding is grass based with fresh cut grass and pasture in summer and hay in winter as well as a mineral supplement. Only bull calves receive a concentrate mix and leftover weigh from cheese production. Calving occurs periodically throughout the year. The farm is integrated with a cheese factory, vegetable production and packaging as well as holiday apartments.

3.3.2.1 Barn layout

The barn is built with a feeding alley down the centre with a milking parlour and cubicles with deep litter for lactating cows in one side. The other side has several deep litter areas for heifers, dry cows and calving area. There is a solid drained and scrape floor on either side of the feeding alley. Calves reared by the dam are where the lactating cows are whereas newly separated calves are in separate pen with deep litter next to where cows move in and out of the barn to go to pasture.

3.3.2.2 Management of dam-rearing

Calves calve in individual calving pens where they stay with their calf for three days. They are milking for the first time 24 hours after calving. Calves stay with their dam for three to four months when weaning starts to occur on its own. Separation is carried out gradually with gate that restricts the amount of time per day that a calf spends with its dam, and in effect, this gradually weans the calf simultaneously. A few cows refuse to sufficiently take care of their calf or refuse to let milk down during milking, and their calves are either paired with a foster cow or raised as bucket fed.

3.3.2.3 Milking, milk yield and milk consumption

Cows are milked two times per day in a standard milking parlour, and they produce around 3.600 L per lactation for the dairy plus around 1.600 L for the calf.

3.3.2.4 Lessons learned

The system needs to be flexible to handle that not all cows or all calves respond similarly to bonding, suckling and debonding. If the calf feels full, then separation is less of a problem for the calf compared with the dam, and the majority of times this goes well, albeit some cows will complain. This system needs sufficient space, and it can be challenging in winter if there is not enough space inside the barn.



Fig 11. Newly separated calves are kept near where cows walk in and out of the barn. Photo: JO Lehmann.

3.3.3 Farm 10

The farm is organic with 40 Simmental and Simmental x Holstein crossbred cows, calving in blocked groups throughout the year. Grazing spans from March to December, with the aim to enable grazing as long as weather permits.

Supplementation during grazing consists of hay and freshly cut forage legumes and grass. In winter, cows are fed with hay and grass silage. As long as the calves stay with their dams and nurses, they have access to the same feed as the lactating cows. After weaning at four months of age they either graze in summer or receive concentrate and high-quality hay in winter. Dam-rearing has been practiced since 2017.



Fig 12. Calve and her dam on the pasture with other lactating cows. Photo: S Perdana-Decker.

3.3.3.1 Barn layout

The barn is built with spacious cubicles with deep litter separated for lactating and dry cows. Feed is offered on a feeding alley. The floor throughout the barn is solid and scraped automatically. Calves have a separate space bedded with straw in the middle of the barn, with a fence that enables eye and physical contact to their mother cows in the lactating herd. Heifers are kept at the second farm location approximately two kilometers from the lactating herd.

3.3.3.2 Management of dam-rearing

During grazing, cows calve among the other lactating cows on the pasture, and in winter in a separate deep litter pen. After calving, cows are kept with their calf in a separate area in the barn for three to four days until a close bond has developed. Afterwards, they join the lactating herd on the pasture or in the barn, and the mother returns to be partially milked (4 – 12 L per day). Male calves are sold to an organic beef farm with nursing cows after two to four weeks of age. Female calves are separated from their mothers to join a nursing group of two to three calves per nurse after four weeks, where they stay until four months of age. During grazing, the nursing group stays on a separate paddock, and during winter calves stay inside their pen in the barn where they are joined by their nurse during milking times.

3.3.3.3 Milking, milk yield and milk consumption

Cows are milked twice per day in a tandem milking parlour with six stalls. They produce an average of 5,500 L per lactation, of which approximately 1,500 L is suckled by the calves. During suckling, milk letdown is seen but not considered problematic.

3.3.3.4 Lessons learned

The system is managed flexibly, for example, depending on the number of calves in similar age, and demand of male calves by the cooperating beef farm. The farm has perceived a substantial reduction in time spent managing the calves through dam-rearing, since the daily tasks of cleaning calf pens or feeding have become redundant. They also experience less health problems among their calves. No problems were observed with leaving the calves on the pasture with the dairy herd. It is however important to keep the calves accustomed to humans to ensure easier handling as soon as they join the herd as lactating cows.

3.4 Case from Denmark

3.4.1 Farm 11

The farm is an organic herd with 250 cross-bred cows that included Holstein-Friesian, Montbeliarde and Viking Red. Cows are fed a total mixed ration based on grass and maize silage as well as mixed concentrates. Cows graze during the summer and have access to an outdoor exercise area during winter. Calves are fed water and concentrates in a calf creep. Calvings are distributed throughout the year, and dam-rearing has been practiced since 2019.



Fig 13. Calves with their dams in the barn.
Photo: Christine Dilling.

Cows graze during the summer months and are housed in a cubicle barn during winter but with access to an outside exercise area. They are fed TMR with grass and maize silage. Calves are housed indoors with their dam for the first 2-3 weeks of life and are then paired to a nursing cow.

3.4.1.1 *Barn layout*

Lactating cows without calves are housed in a classic free stall cubicle barn whereas lactating cows with calves are housed in a separate barn with a deep litter area. Calves have a separate creep with two calf huts within the deep litter area. Calves are after separation from the dam paired with a nurse cow, and they are housed in a deep litter area within the same barn as lactating cows with their calves.

3.4.1.2 *Management of dam-rearing*

Cows calve in individual pens, and the two are moved to a common deep-litter pen after 24 hours where they stay for 2-3 weeks with full-time contact, except during milking. Cow and calf are then separated abruptly by moving the cow to a different barn. The calf is moved to a smaller pen along with 2-3 other calves where they are paired with a nurse cow. The process of pairing takes up to a week, until the cow accepts all. Nurse cow and calves are then moved to a different deep-litter section, with other nursing cows and their calves, in the opposite end of the barn than the dam-rearing deep-litter. Nurse cows and calves are let on grass during the summer months. They remain together until calves are 3 months where they are abruptly weaned.

3.4.1.3 *Milking, milk yield and milk consumption*

Cows are milked twice per day all-year-round in a carousel and produce around 11.000 L per lactation for the dairy. Calves suckle at least an estimated 10-14 L per day during the weeks of fulltime contact, but this is hard to estimate as some cows appear to hold milk back. The nurse cows are not milked.

3.4.1.4 *Lessons learned*

The farmer has been very happy that he has had the chance to experiment, make changes and adjust since he started out with minimal housing materials and instead used straw bales and the like. From this they also learned that the calf creep should be with see-through fencing otherwise the cows were nervous since they could not always see their calf. They have some problems with milk let-down in the milk parlour while the calf suckles and thus decided on the combination of dam-rearing and nursing cows. They are very happy with having the calves on grass during the day and they are easy to move later as heifers as they are used to the routine.

4 Addressing three key issues raised by dairy farmers

Farmers considering a form of dam-rearing as a part of their dairy calf management typically raise a number of questions concerning issues that include barn layout, management and consequences for their current system. Whereas the first chapter presented examples of how other farmers have created their dam-rearing system, this chapter will address three questions concerning the consequences of changing to dam-rearing. Their common characteristic is that they are difficult to quantify accurately in both practice and in experiments.

4.1 Potential decrease in saleable milk

The decrease in saleable milk resulting from the implementation of a dam-rearing system depends largely on three factors: The length of the milk feeding period, the amount of milk normally fed per calf per day and the amount of milk suckled by the calf per day in the dam-rearing system. Table 2 shows the decrease in saleable milk per lactation, and this is calculated as a function of the amount of milk consumed by a calf per day in a dam-rearing system (columns) and the amount of milk consumed by a calf per day in a milk feeding system. The latter is split by the length of the milk feeding period (weeks) and the amount of milk fed per calf per day (rows). The table below assumes that there is no effect of implementing a dam-rearing system on the total lactation milk yield of a dairy cow after weaning and separation from its calf as this is what research currently suggests (*1*). Hence, if you normally feed 8 L per day for 8 weeks, and you implement a dam-rearing system where the calf consumes 16 L per day instead of 8 L, then the total decrease in saleable milk is 448 L per lactation if dam-rearing is 8 weeks as well.

Table 2. The potential reduction in saleable milk as a combination of milk suckled per day in a dam-rearing system and the amount of milk fed in a traditional system.

Milk feeding		Litre of milk per calf per day in a dam-rearing system										
Weeks	L / day	10	11	12	13	14	15	16	17	18	19	20
8	4	336	392	448	504	560	616	672	728	784	840	896
	6	224	280	336	392	448	504	560	616	672	728	784
	8	112	168	224	280	336	392	448	504	560	616	672
	10	0	56	112	168	224	280	336	392	448	504	560
9	4	378	441	504	567	630	693	756	819	882	945	1,008
	6	252	315	378	441	504	567	630	693	756	819	882
	8	126	189	252	315	378	441	504	567	630	693	756
	10	0	63	126	189	252	315	378	441	504	567	630
10	4	420	490	560	630	700	770	840	910	980	1,050	1,120
	6	280	350	420	490	560	630	700	770	840	910	980
	8	140	210	280	350	420	490	560	630	700	770	840
	10	0	70	140	210	280	350	420	490	560	630	700
11	4	462	539	616	693	770	847	924	1,001	1,078	1,155	1,232
	6	308	385	462	539	616	693	770	847	924	1,001	1,078
	8	154	231	308	385	462	539	616	693	770	847	924
	10	0	77	154	231	308	385	462	539	616	693	770
12	4	504	588	672	756	840	924	1,008	1,092	1,176	1,260	1,344
	6	336	420	504	588	672	756	840	924	1,008	1,092	1,176
	8	168	252	336	420	504	588	672	756	840	924	1,008
	10	0	84	168	252	336	420	504	588	672	756	840

4.2 How much weight do calves gain?

Several studies recorded daily growth of dam-reared dairy calves and compared this with calves reared by the farmer. Table 3 summarizes results of some of these studies that combined cover a range in the length of the dam-rearing period as well as different dam-rearing systems.

Table 3. Growth¹ of dam-reared dairy calves from studies² with and without a control group. Values in units per day.

Ref.	Treat.	Days	Suckling	Milk feeding, L	Concentrate, kg TS	Roughage, kg TS	Growth, g	Milk yield, kg
(15)	1	10	Fulltime	0	0	0	1,090	10.9
	2	10	No	6.8	0	0	530	19.5
(16)	1	56	Fulltime	0	0.013	0.01	1,434	?
	2	56	No	4.9	0.406	0.183	664	?
	3	56	No	8	0.178	0.086	826	?
(17)	1	70	Fulltime	0	ad lib	ad lib	966	?
	2	70	No	≤12	ad lib	ad lib	859	?
(18)	1	91	Fulltime	0	0.019	?	1,096	?
	2	91	Restricted	0	0.041	?	1,022	?
	3	91	No	≤8	0.234	?	765	?
	4	91	No	≤8	0.239	?	791	?
(19)	1	90	Fulltime	0	ad lib	ad lib	1,080	18.3
	2	90	No	6	ad lib	ad lib	658	26.3
	3	90	No	6	ad lib	ad lib	630	27.6
(20)	1	42	Halftime	0	ad lib	ad lib	900	26.3
	2	42	Halftime	~2	ad lib	ad lib	900	25.3
	3	42	No	8.2	ad lib	ad lib	900	40.5
(21)	1	49	Fulltime	0	?	?	1,184	?
(22)	1	7	Fulltime	0	0	0	389	?
	2	14	Fulltime	0	ad lib	ad lib	700	?
	3	21	Fulltime	0	ad lib	ad lib	790	?
(23)	1	10	Fulltime	0	0	0	1,369	17
	2	10	No	6	0	0	664	25.7
(24)	1	42	Restricted	0	0.095	0.06	1,197	20.8
	2	42	No	5	0.495	0.031	632	30.8
(25)	1	56	Restricted	0	ad lib	ad lib	480	?
	2	56	No	5.1	ad lib	ad lib	470	?
(26)	1	35	Restricted	0	0.01	0.01	1,165	24.9
	2	35	No	6.8	0.01	0.01	811	?

¹Average growth in g per day over the length of the experiment (see column days).

²Studies used Holstein (17; 20; 22-25), Polish Black and White (15), Swedish Red (16), Norwegian Red (21), Ayrshire (26) or a mix of breeds (18; 19).

The growth of a calf is a result of feed type and allowance, age as growth capacity changes with age and an influence of disease pressure. Hence, both the length of the dam-rearing period, the type of dam-rearing system and additional feed supplementation as well as daily milk production of the dam may influence the growth of the dam-reared calf whereas the comparison with no dam-rearing is influence by the amount of milk fed by the farmer in these systems. This is reflected in the variation in growth rates shown in Table 3 as it ranged from 389 to 1,434 g per day, and, albeit with

a large variation, the mean daily growth rate of fulltime, halftime, restricted and no dam-rearing was 1,010, 900, 966 and 708 g per day, respectively. Table 3 shows that it is possible to achieve a daily gain of dam-reared dairy calves across different dam-rearing systems, but it is not possible to show a difference between the different dam-rearing systems due to other underlying factors including supplementary feeding and length of dam-rearing period.

4.3 How much milk do calves drink?

There is no direct way of measuring how much milk a calf consumes by suckling a cow. The amount consumed is likely a combined effect of the age of the calf, the amount of time that a calf and its dam spend together, whether or not a calf has to share with other calves, milk yield and hence milk availability as well as the availability of water and other feed items. Often weight gain is used as indirect measure or simply the difference in weight of the calf before and after a short suckling event (6), albeit the latter is only possible in restricted dam-rearing systems. Another approach is to utilise estimated norms for energy requirements per kg of growth for growing dairy calves to calculate how much milk a calf would need to suckle to meet this requirement. Figure 12 shows mean weight of calves in weeks 1 through 13 after calving at four different growth rates. With an average growth rate of 600 g per day, a calf will grow a total 54 kg over 13 weeks whereas it will grow 135 kg if the average growth rate is 1,500 g per day.

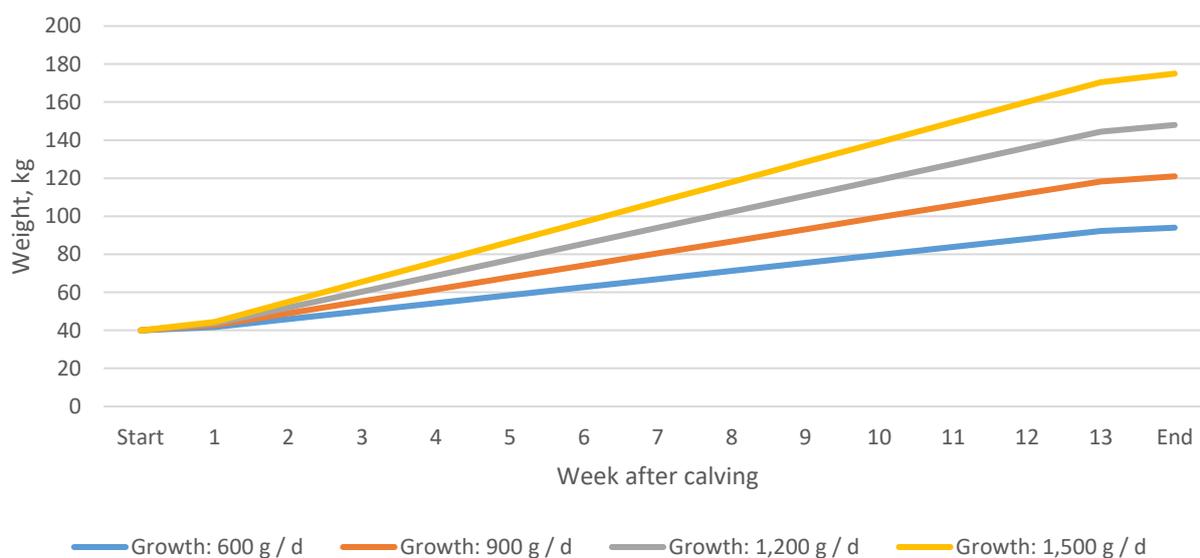


Figure 14. Mean weight of calves for up to 13 weeks after calving with four different growth rates and a birth weight of 40 kg.

Danish norms (27) for energy requirement for growth of dairy calves calculate energy need based on daily growth rate whereas the American norm (28) is the sum of energy requirement for maintenance and growth based on daily growth rate. Table 4 shows the daily amount of energy-corrected milk (ECM: 4.2 % Fat, 3.4 % Protein) needed to meet the energy requirement of four different growth rates. For Danish norms, the average kg ECM per day needed to meet energy requirement increases from 7.9 to 13.2 kg when growth rate increases from 600 to 1,500 g per day. Similarly, American norms increase from 6.2 to 14.9 kg ECM per day. Furthermore, calves need 19.2 (American norms) to 22.0 (Danish norms) kg ECM per day at the end of the 13th week after calving if milk is to meet all energy required to support a growth of 1,500 g per day. However, data used to develop these norms are at least 20-25 years old, and it is likely that an assumed growth rate of 1,500 g per day is beyond the original intention of the norms. Nevertheless, they give an idea of

how much milk is needed where, of course, some of this milk may be replaced with other feedstuffs.

Table 4. Kg energy-corrected milk (ECM: 4.2 % Fat, 3.4 % Protein) per day needed to meet energy requirement at four different growth rates based on Danish and American norms.

	Kg ECM per day, Week after calving						Total kg ECM		
	Start	1-3	4-6	7-9	10-13	End	Sum	Per day	Per kg growth
<i>Danish norms (27)</i>									
Growth: 600 g / d	4.4	5.1	6.8	8.4	10.4	11.4	718	7.9	13.3
Growth: 900 g / d	4.4	5.5	8.0	10.5	13.4	14.9	878	9.7	10.8
Growth: 1,200 g / d	4.4	5.9	9.2	12.5	16.4	18.5	1,039	11.4	9.6
Growth: 1,500 g / d	4.4	6.3	10.4	14.6	19.4	22.0	1,200	13.2	8.9
<i>American norms (28)</i>									
Growth: 600 g / d	4.7	5.1	5.8	6.5	7.2	7.6	567	6.2	10.5
Growth: 900 g / d	6.2	6.9	8.1	9.3	10.5	11.1	803	8.8	9.9
Growth: 1,200 g / d	7.9	8.9	10.8	12.4	14.1	14.9	1,066	11.7	9.9
Growth: 1,500 g / d	9.6	11.0	13.6	15.8	18.0	19.2	1,355	14.9	10.0

5 Comparisons and cross-cutting issues

The 11 private farms surveyed for this project report reflect a broad variety of cow-calf contact systems that substantiates the diversity shown in a survey by FiBL, the Swiss research institute of organic agriculture, in 2015(29). Their work specifically illustrate the changing practice during the weeks after calving within individual cow-calf contact systems as farmers combine full-time, part-time and restricted short time access with the use of nurse cows.

Table 5 summarises this development for the first 12 weeks after calving where several of the farms apply a restricted short time suckling regime either just before or just after milking, and six farms move calves to suckle a nurse/foster cow rather than the dam for a part of the milk feeding period. Both practices are often implemented to minimise the decrease in saleable milk from implementing dam-rearing.

Table 5. Applied sequence of dam-rearing systems¹ on ten commercial farms in relation to week after calving.²

Week	Farm									
	1	2	3	4	5	6	7	8	9	10
1	F	Rb	F	F	F	Rb	Rb	F	F	P
2	F	N	Rb	Ra	Ra	N	Rb	F	F	P
3	P	N	Rb	Ra	Ra	N	Rb	F	F	P
4	Ra	N	Rb	N	Ra	N	Rb	N	F	P
5	Ra	N	N	N	Ra	N	Rb	N	F	P
6	Ra	N	N	N	Ra	N	Rb	N	F	P
7	Ra	N	N	N	Ra	N	Rb	N	F	P
8	Ra	N	N	N	Ra	N	Rb	N	F	P
9	Ra	N	N	N	Ra	N	Rb	N	Rd	P
10	N	N	N	N	Ra	N	Rb	N	Rd	P
11	N	N	N	N	Ra	N	Rb	N	Rd	P
12	N	N	N	N	Ra	N	Rb	N	Rd	P

¹F = fulltime access; P = partial access (typically half day); Ra: Restricted short term access after milking; Rb: Restricted short term access before milking; Rd: Restricted short term access during milking; N: Nurse cow. All farms keep dam and calf separate from the rest of the herd for at least one to two days after calving. Farms did not necessarily separate cow and calf 12 weeks after calving.

²Adapted from a report published by FiBL(29).

Furthermore, two Dutch farms with dam-rearing formed the experimental basis for a master's thesis (30) from 2003. The first farm kept dam and calf together full time for the first three days in a calving pen and later for 14 to 30 days in the group with all other lactating cows, after which calves transfer to a foster cow for the remaining 60 to 80 days of the milk-feeding period. Tactile, visual and audio contact with the dam remain while the calf is nursed by a foster cow. The second farm also kept dam and calf together in a calving pen for the first three days, but afterwards dam and calf stay together full time for 65 days among the other lactating cows before a foster cow is used to gradually wean and separate dam and calf. The first farm keep all cows and calves in deep litter barn whereas the second farm keep cows and calves in a cubicle barn, but here calves have exclusive access to a calf crèche with deep litter.

Finally, a Danish farm have practiced a cow-calf contact system for over 25 years (31) with cows calving among the other cows before they are moved to a separate pen where they can stay alone for a few days. Afterwards the farmer applies a partial dam-rearing system where dam and calf spends the night together and are separate during the day, while cows are grazing. Cow and calf stay together for up to a few weeks in a group after which the farmer the gradually removes half of the

cows, such that each cow nurses two calves. All calves are separated abruptly at the same time, which means that some calves still need milk feeding and others are up to 4-5 months of age.

5.1 Crosscutting issues

Hence, there is a large variation in how farmers operationalise cow-calf contact systems on both extensive and more intensive farms, but there are issues, which most farmers face when implementing a cow-calf contact system. Some considerations were discussed in the introduction based on (9), and the 12 farms surveyed for Table 5 listed the following eight points (See reference (29) for details) as common important prerequisites for a proper function across farms of their system:

- 1) Cows will accept being sucked by other calves if their own calf is present.
- 2) Daily and intensive observations are crucial
- 3) Restrictive suckling after milking requires that udders are not emptied at milking
- 4) Teats of foster cows needs particular attention
- 5) Gradual changes and adaptation time are crucial
- 6) Calves risk becoming obese if they suckle too much
- 7) Anyone can practice dam-rearing anywhere if they are convinced of the system
- 8) The farm manager has to be observant and be able to react flexibly

Besides management, several crosscutting issues relate to the setup of the barn, and the diversity in barns systems shown in this and previous reports indicate that the type of barn may not be a limiting factor, although only a minority of farms practices cow-calf contact. However, three themes appear when combining this and previous reports and focusing on dam-rearing and with implications for system setup.

5.1.1 Amount of contact

The amount of contact between cow and calf is determined by both the number of days they spend together, the number of hours per day and how this varies as the calf ages. These likely influences the amount of milk a calf consumes and hence the growth rate of the calf and the amount of saleable milk. As shown previously, there are not good data on these effects despite their potential for influencing farm income. Furthermore, more scientific evidence needs to be developed to decipher the behaviour and welfare effects of amount and type of contact, and research based simulation studies could shed more light on the range of individual effects that farmers may face when implementation a cow-calf contact system.

5.1.2 Location of contact

Some farmers have a designated cow area for cows that are rearing a calf, and they then control when the cow is permitted to enter whereas other farmers keep all cows together with calves reared by their dam. In these situations, cows are often either allowed to go to the calf, or the calf is simply removed at some point. These choices may merely be a consequence of the initial barn setup where in the latter case calves are simply kept inside the existing cow facility. In contrast, having a separate area for cows with calves possibly allows for this area to amended to a higher degree to meet the demands of calves. However, comparing with behaviour of the relationship between cow and calf in natural or semi-natural conditions means that more scientific evidence is needed to investigate what to recommend to farmers.

5.1.3 Organisation of separation

The final theme concerns the organisation of separation of the cow and calf, and this handled quite differently across farms. Figure 13 shows two examples from two farmers attempting to gradually restrict the amount of contact with barriers, but we do not yet know whether this is better or worse for the cow, the calf or both when compared with abrupt separation. Furthermore, the length of the dam-rearing period may influence what is best besides having a major effect on the physical organisation of the separation area.



Figure 15. Two examples of setups where farmers could gradually separate cow and calf. In both cases, calves can reach the cow through a barrier that later can be blocked with a chain (left) or wood (right).

5.2 Conclusion

This project report shows that there is a plethora of cow-calf contact systems in practice that mostly have been developed by pioneer farmers through trial and error. This complicates and challenges the setup of scientific research into these systems and the applicability of results and hence recommendations across farms. However, this also holds an opportunity for gaining new understandings of the workings of dairy farming that in the can form the basis for recommendations to farmers considering to implement a cow-calf contact system.

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7 Supplement

Several farms that practice dam-rearing of their dairy calves describe, discuss and talk about their systems, choices and management through their own websites, Facebook pages and YouTube channels. The following sections contain references and links to a few selected farms that all present their practice online.

7.1.1.1 The Ethical Dairy, Scotland

A dairy farm integrated with its own cheese and ice cream factory, farm shop and experience park. Their extensive blog in English describe in detail how, among other things, their dam-rearing system works in practice.

Link: <https://www.theethicaldairy.co.uk/>

7.1.1.2 De Öko Melkburen, Germany

A dairy company with currently three dairy farms as suppliers. Their website, blog and YouTube channel (in German) illustrate their dam-rearing systems as well as a host of other characteristics for their farms, dairy factory and farming in general.

Link: <https://deoekomelkburen.de/>

7.1.1.3 Smiling Tree Farm, England

A small mixed farm with both dairy and beef cows. Their blog describe their dairy-cow-calf system in English.

Link: <https://www.smilingtreefarm.com/>