

Final thesis report

The feasibility of the calf at foot housing system



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Abstract

The Netherlands is one of the leading countries in dairy consumption and a potent dairy exporter. Overall, yearly dairy production reaches over 14.2 billion kg. Furthermore, the economic contribution of the sector equalled 7.8 billion in 2020.

There are over 16.000 dairy farmers in the Netherlands out of which only about 30 produce dairy in the calf at foot system. The common practice in dairy production is to separate a calf from a cow at birth. This practice has been introduced during the period of intensification of farming in the middle of the 19th century. A system in which farmers maximise the profit by restricting the expression of the inherent behaviour of cattle. A system in which an animal's needs need to be altered to fit it.

The calf at foot system is a dairy production system in which (most) calves and cows are not separated at birth. The goal of this research is to check the economic feasibility of the calf at foot system and to investigate the existing, practical solutions for housing cows and calves together to encourage more conventional farmers to transition.

To investigate the system desk research, qualitative research and field research have been done. The practical information about the common practice of the calf at foot dairy production has been obtained by using a semi-structured ethnographic data collection.

Seventeen dutch calf at foot farmers have been interviewed about their experience with the calf at foot system out of which eleven have been visited personally to document and analyse the housing solution for cows and calves. Each of the interviewed/visited farmers had their interpretation of the calf at foot system, each implemented something unique to make sure that the system meets the need of the animal, the farmer and the farming style.

The obtained results of the current calf at foot practice have been analysed and presented in this report providing a practical tool for the sector. This report is based on the calf at foot housing system solutions but untimely goes beyond the housing. The benefits and attention points of the system are discussed based on the practical experience of the dutch calf at foot farmers. The inherent behaviour expression of cattle is also compared in the calf at foot system and the conventional dairy production system.

Lastly, a recommendation for some of the relevant stakeholders is given. This section of the report summarises the steps that a conventional farmer is recommended to take to start transitioning into the calf at foot system. The named stakeholders were included in the table below with a summary of the given recommendation.

Animal welfare NGO's	Retailers/ Supermarkets	Government	Farmers
Advising instead of shaming	Take responsibility for origin of sold products	Support calf at foot farmers and transitioning farmers	Educate yourself about the calf at foot production system
Work with the industry	Educate consumers	Less frequent policy changes	Be open to ask for help

Animal welfare NGO's	Retailers/ Supermarkets	Government	Farmers
Keep educating consumers about animal welfare	Take part of the responsibility for the production chain	Help educating consumers	Be transparent towards consumers

Table 0. Summary recommendation for relevant stakeholders

Abstract

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Chapter 1. Introduction

1.1 Background information

The Netherlands is home to 1.59 million cows and calves (2020), which translates to almost one-tenth of the country's human population (Kwakman, 2021). In 2020 there were just under 16.000 dairy farms and even though the number has decreased in the last decade the number of cows per farm has increased. Currently, the average size of a dairy farm consists of 100 cows and over 42 ha.

Yearly dairy production reaches over 14.2 billion kg (Kwakman, 2021). The produced milk is later processed in the country. A farmer can choose whether to sell produced milk to a processor or to process and sell it on-farm.

There are 25 milk processing plants and 52 dairy plants in the Netherlands. Dutch dairy companies processed an estimated 13.85 million kg of milk in 2019 out of which around 65% has been exported, making the Netherlands one of the top five global dairy exporters in the world (Kwakman, 2021).

Based on the numbers presented above it is clear that dairy production plays a significant role in the Dutch economy. The contribution of the dairy sector to the national economy reached 7.8 billion euros in 2020 (dutch dairy in figures, 2020). Which in essence means that many people depend on dairy production as their source of income regardless of their role in the production chain.

Graph 1. below presents an overview of the dairy supply chain. Regardless of the chosen production system or processing method, the goal of dairy production is to sell the end product to the consumer.



Graph 1. Dairy supply chain
Source: ResearchGate

Despite the Netherlands being a leading country in dairy consumption a slow, gradual change in the consumer behaviour can be observed. Consumers are becoming more aware of the environmental and ethical issues of dairy production, some of them are even substituting cow milk with plant-based milk alternatives. This shift in society

stimulates farmers to rethink their production system and maintain a good image of their farms to attract consumers. A growing number of consumers is willing to pay more for animal products with added production values (namely, outdoor grazing or keeping cows and calves together, or other welfare improvements). Due to the intensification of production during the last decades and low milk prices, most dairy farmers are convinced that it is not economically feasible to allow calves to suckle their mothers. What is more, because of the popularisation of housing systems that do not address the natural needs and behaviours of animals a common misconception has been spread that it is safer to house cows and calves separate. In essence, it does not make sense to assume that allowing a mother(cow) to care for her child(calf) is unsafe. Especially because it is not practised with beef cattle. This makes one think that the housing system makes it unsafe and not cow-calf contact. The thing that needs changing is not the natural mammal behaviour of rising offspring but the system animals are kept in. In this report, a concept of the calf at foot housing will be investigated. Especially that in 2021 the Dutch Senate has approved a new amendment to the law concerning pets and livestock. The proposal suggested that from 2023 animals must be provided living conditions that resemble their natural environment and they must be given enough space and opportunities to perform their natural behaviours (NL times, 2021). If this law will be validated it causes the end of intensive livestock production. In this case, the calf at foot system (CaFs) would become a priority for dairy farmers. Furthermore, this also presents a great opportunity to stop trying to adjust an animal to fit a certain farming system but rather adjust the system to fit the natural needs of an animal.

1.2 Problem definition & Research questions

As mentioned above in the background information section, there are around 16.000 dairy farmers in the Netherlands. Out of those farmers only roughly 30 allow cows and calves to stay together for an extended time (longer than one month). This means that, only 0,0025% of dutch dairy farmers allow cows to keep their calves for an extended period of time. Based on their experience this report aims to return the knowledge of more natural dairy production back to the dairy farmers. Also to encourage them to open themselves to the possibility of more natural dairy production, by investigating the practical and economical feasibility of this system. Currently, it seems like this most basic knowledge of dairy farming has been lost through years of intensification of production. Both the economic and practical reasons have been taken into consideration. Therefore, the main research questions will focus on the broad concept of the calf at foot system:

Main research question: How to house cows and calves together for an extended period of time and generate a profitable business model?

This later will be translated into the following sub-questions:

Sub questions:

- 1. What are the essential natural behaviours of cows and calves?*
- 2. Which farmers are already using the calf at foot system?*
- 3. For which farmers and how is this system feasible?*
- 4. How to make this system feasible for other farmers?*

5. *What is the definition of an extended period of time with the calf at foot system?*
6. *What is the practical experience of farmers with the calf at foot system?*
7. *What are the added benefits of the system?*
8. *What are the points of attention with the calf at foot system?*
9. *What do all the farmers that practice this system have in common?*
10. *What housing solutions are already used to house calves and cows together?*
11. *Which housing solutions are recommended to house calves and cows together?*
12. *What recommendation could be made to conventional dairy farmers to transition to the calf at foot system?*

1.3 Thesis outline

This thesis was designed to be a practical guide for dairy farmers that want to adjust their farm system to the calf at foot system. In order to reach that goal, research questions have been presented. Each question has been designed to learn about the common practice of the calf at foot dairy production system in the Netherlands and gain insights into this production system, exploring both its advantages and disadvantages of it. To answer some of those questions a theoretical literature review has been conducted. This part of the research helps to shed light on what natural needs animals have in the dairy farming system and to discover the base of the calf at foot system in the Netherlands. On top of that, it will provide insight into the new laws and concrete guidelines to translate the law into practice. As not all knowledge can be obtained based solely on desk research, interviews with Dutch dairy farmers that use the calf at foot system have been conducted. Together with farm visits and behaviour observations to create a clear picture of the calf at foot system. Additionally, relevant stakeholders and researchers have been asked for their input, experience and opinions. All of those mentioned components have been summarised, analysed and described.

Chapter 2. Literature review & theoretical framework

2.1 Literature review

Natural cattle behaviour

Cows are herd animals, females form herds with calves and heifers. Outside of the breeding season males live separately (in groups or singles). Even though, calves are at the bottom of the social hierarchy they are always protected by the herd. Keeping all cows (milking cows, heifers and calves) in one (family)herd allows them to establish their place in the herd quicker and eliminates the need of reestablishing that order later in life, when a new milking cow is introduced into the herd (Familiekuddes, n.d.). Thanks to that the competition between individuals decreases and more equal and regulated access to feed can be provided. Another important aspect of a cow's natural behaviour is grazing. Cattle naturally spend up to 8 h grazing and approximately 12 h ruminating.

Parturition normally occurs at night on the pasture, most cows would usually separate themselves from the herd (if available space allows it). A calf normally starts sucking approximately 3 h after being born. Before that happens a cow licks the calf to stimulate circulation, respiration, defecation and urination (Mounaix, Boivin, Brule and Schmitt, n.d). The afterbirth is eaten by the cow to avoid being detected by predators. The cow is a hider-follower, which means that the calf is hidden after birth to allow the mother a possibility to nourish herself, however, both cow and calf rejoin the herd a couple of days after birth. As one week has passed a calf begins to follow the mother and the distance maintained between a cow and a calf steadily increases with time but they keep in contact through vocalisation (Mounaix, Boivin, Brule and Schmitt, n.d). During that time a calf begins to form social bonds with other calves.

The natural behaviour of a calf, 1st year of life

Dairy calves are usually able to stand after around 1 h after birth. Calves are born as monastic animals, totally dependent on milk for the first weeks of life.

The ability to absorb the immunoglobulins from colostrum is highest after birth and it decreases rapidly over time. That is why it is crucial for a calf to stand up and suckle as soon as possible after birth. Young calves spend most of their time resting, the lying time declines with age. At around 8 weeks of life, a time spend resting would usually gradually decrease from 65% of a day to 30% (Whalin, Weary and von Keyserlingk, 2021). Around that time of life (6-8 weeks) a calf becomes a ruminant. And spends its time mimicking its mother and starts to graze, while still suckling the mother.

Calves also engage in play behaviours with their peers, the frequency of these behaviours increases after 2nd week of life. Studies have shown that the more space calves had the more they engaged in playing behaviours. Providing access to a large outdoor space may be very important for calves to express their natural levels of walking and playing (Whalin, Weary and von Keyserlingk, 2021). Playing is also motivated by access to feed. Studies have shown that calves reared in a restricted feeding system played less than calves with higher daily milk allowance.

The first social bond naturally made by a calf is the one with its mother, during that time the calf is depended on milk received from its mother. During the first 2 weeks of life, a calf will decrease its social behaviour towards the mother and the bond is mainly instigated by the calf's need for milk. Calves raised with their mothers would typically suckle in 8-11 minutes bouts, although the duration can increase with age. When suckling from the mother, the calf will suckle one teat for a few seconds, then switch teats, with this sequence repeated until the bout ends. Calves engage in less sucking bouts as they age (Whalin, Weary and von Keyserlingk, 2021).

As calves become more independent they tend to interact less with their mothers. However, it has been documented that calf and cow spend as much as 30% of their time together not suckling. One other calf-cow activity is grooming by licking. The importance of this behaviour is not yet well understood (Whalin, Weary and von Keyserlingk, 2021).

As mentioned before a calf mimics its mother's behaviour, perhaps to learn. Many ruminants teach their offspring about dietary selection, which plants to consume and which to avoid (Whalin, Weary and von Keyserlingk, 2021). Experimental work done on dairy cattle has shown that young animals take less time to start grazing while in the company of experienced, older animals. Social learning, especially through modelling or learning by observing another individual, allows young animals to avoid dangerous mistakes and offers protection. Being raised as part of the herd allows a calf to interact with other adult animals not only the mother, there has been little work done investigating those interactions. However many calf at foot farmers have confirmed that calves raised in this system, seem to be more daring and are able to

find their place in the herd easily as adults without the need for competition with other herd members.

Calves spend a considerable amount of time in the presence of other calves when they are 10–40 days of age. The role of playing has also not been researched in depth, but playing may be used to build social skills to thrive in herd settings (Whalin, Weary and von Keyserlingk, 2021).

The natural weaning time is dependent on many factors, however, calves would most likely naturally wean at the age of 9–11 months (Weaning a Calf, 2022). Some calves refuse to suckle after a new calf was born. In natural settings, weaning is a gradual process and it involves a series of events, namely a decrease in milk production, a steady increase in solid food consumption and the mother beginning to reject some feeding attempts. Abrupt weaning does not occur in nature. Moreover, calves appear to retain an affinity towards their mothers and siblings even after weaning. In nature, females would become a part of the herd and most males would leave to come back during the breeding season.

However, in the conventional dairy farming system, the life of a calf looks different. The calves are separated from their mothers almost immediately after birth, some farmers separate the calves even before their mother had licked them. In the conventional dairy farming system in the Netherlands calves are allowed to be housed individually up to 8 weeks in crates often referred to as igloos (RVO, 2020) (see picture 1). The required space per calf varies depending on the weight of the calf, however on average calves are allowed 1,5 m² (RVO, 2020). During that time calves are usually fed two times a day with a bucket or a bottle. The restrictive feeding schedule usually slows down the weight gain and can potentially influence the future development of a calf. In graph 2 weights gains of calves in different systems have been compared. This clearly shows that calves with unlimited access to milk have a better growth rate. Depending on the farm strategy farmers use milk powders or fresh milk. After the time of 8 weeks animals are moved to a dedicated barn where they finally get to interact with their peers.

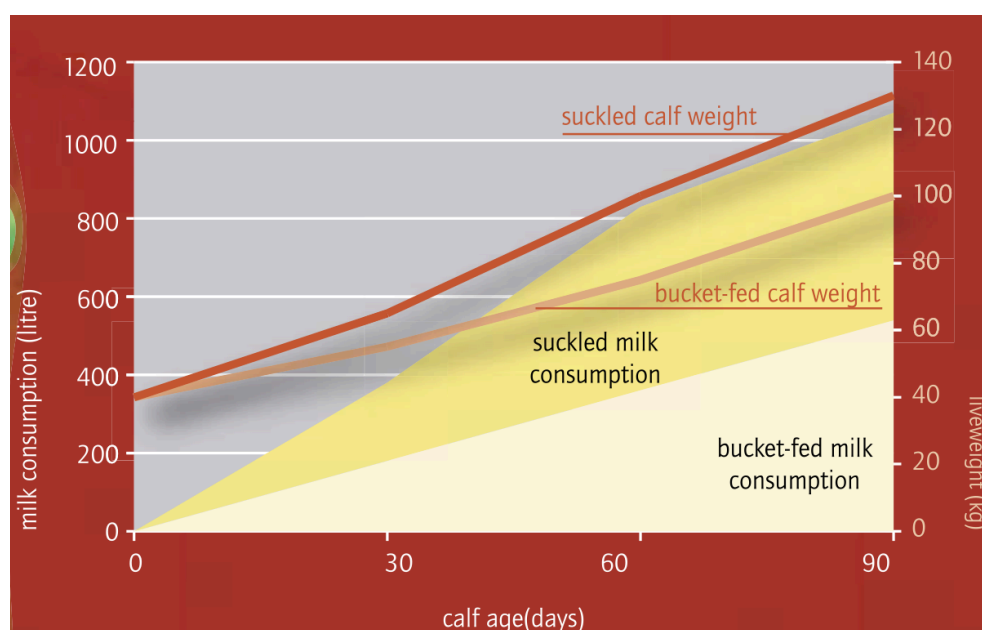
Table 1 above presents a compression of two different farming strategies. More advantages and disadvantages extended later in the interviews.

Calf behaviour	Calf at foot system	Conventional system	Calves in the wild
Licked by mother after birth	+	+/- depending on the farming strategy	+
Suckling by mother	Until weaned by farmers	Possibly only colostrum	Until weaned naturally
Enough space	Calf moves freely with the mother +	Calf housed in a individual crate up to 8 weeks of life -	Calf moves freely with the mother and herd +
Contact with peers	Whole life in groups of different age calves, promotes playing behaviour and learning from older animals (for calves raised in the system)	Housed individually and then only with one age group	Whole life in groups of different age calves, promotes playing behaviour and learning from older animals (all calves)
Established herd hierarchy	Yes from birth	No	Yes from birth
Interacting with other adults	Yes	No	Yes from birth

Calf behaviour	Calf at foot system	Conventional system	Claves in the wild
Behaviour in the stable	Learning from and playing with other herd members	Only with the same age group (after 2-4 weeks in isolation)	Not applicable
Natural behaviour	+	-	++

Table 1. Rearing system comparison

Weight gain comparison of calves in different rearing systems



Graph. 2 Milk consumption vs growth
Source: ResearchGate



Picture 1. Conventional calf housing (Cunningham, 2019)

The history of the calf at foot system.

Since the beginning of cattle domestication, calves have been raised partly separately from their mother or have been slaughtered at an early age. However, only as industrialisation began farming has become more intensive and more emphasis has been put on production yields. Before the intensification of dairy farming in the middle of the 19th century, milking was done by hand, herd size used to be much smaller and farms more diverse in species. There are not many well-documented materials about the cow and calf relationship in earlier centuries. Nonetheless, the old texts and images indicate that a calf was drinking from its mother, or was standing next to the cow during milking. This could indicate that milk production stopped when the calf was weaned and it is likely that a cow was kept "dry" for a longer period and possibly was not inseminated every year, which hugely contributed to their longevity (David Finley, 2019). Back in the day cows were also kept for their pulling force. Over the last 150 years, the dairy industry has become even more specialised and efficient, and the animals have become more disposable, which led to the complete separation of cow and calf in the 20th century and yearly inseminations (Hulshof, 2022). Thanks to the development of breeding and feed processing, cows now produce much more milk than a calf could ever need. Naturally, yearly milk production differs based on various factors some of them being; breed, feed, stage of location and age. However, it can be roughly estimated that the average dutch cow produces around 9.000 litres of milk per year (van Gelder, 2021). To compare Norwegian research has shown that calves allowed unlimited access to milk through a bucket or a bottle with a nipple drunk approximately 8 litres of milk a day and calves that were allowed to suckle drunk around 12 litres of milk a day at an age of two weeks (Ellingsen, 2014). This proves that allowing a calf to suckle by the mother does not mean that there is no more milk for a farmer to sell and yet not many farmers are not open to the calf at foot system.

Calf at foot farmers in the Netherlands

At the moment there are around 30 dairy farmers that allow calves to suckle by their mothers for an extended period, which is not officially defined but it is usually situated between 6 weeks and 3 months. However, there are no generalised criteria for this dairy production system, which means that farmers do not get any financial compensation for allowing the calves to stay with their mothers. Furthermore, the consumers also cannot choose for the calf at foot milk or dairy products in the supermarket. A big percentage of the calf at foot farmers choose to sell their products on-farm. By doing that they can ask for higher prices for their products and consumers are guaranteed full transparency and guarantee of origin. Currently (2022) Beter Leven Keurmerk (the biggest Dutch animal welfare certification mark) is developing a list of criteria for the calf at foot system to incorporate the calf at foot factor. The introduction of this system would allow dutch calf at foot farmers to receive a higher price per litre of sold milk and the consumer would be able to purchase this milk in the supermarkets.

Caring Farmers has developed a list of the calf at foot farmers in the Netherlands. Available here: [Calf at foot farmers map](#).

The health of cow and calf in the calf at foot system

Cow

Calf at foot system can potentially decrease the risk of mastitis in milking cows, thanks to calves sucking the residue milk from the udder (Hurty-Person, 2021). The calf at foot system also supports the uterine health of a cow. Allowing the cow to keep her calf for an extended period of time also prevents separation stress, which can lead to a drop in milk production. On top of that milk production is believed to be enhanced by teats stimulation (Fröberg, 2008).

Calf

There are many studies indicating the benefits of separating cows and calves. Those benefits are usually based on disease transmission. The industry is looking for a justification for cow-calf separation in science. The fact is that calves are born with an underdeveloped immune system. This means that when a calf comes into contact with a pathogen its immune response is much weaker and slower (CalfCare, 2019). A paper which has been published 15 years ago on Johne's disease transmission, states that the calf at foot system can be a rooting problem in the transmission of this disease among calves (Hurty-Person, 2021). However, the research on Johne's diseases does not consider the factor of hygiene related to animal health. This translates to this study being incomplete and lacking evidence. The main way of Johne's disease transmission is bacteria-infested manure (USDA APHIS | Johne's Disease, 2020). Which could indicate that the reason for cow-calf separation is a solution for poor hygiene management rather than disease transmission. Nevertheless, this study has been cited over and over in many publications and used as an (incomplete) argument for premature cow-calf separation.

It has been proven, however, that calves that stay with their mother have improved weight gain, have better social behaviour and reduced abnormal behaviours later in life, namely, they display less aggressive behaviour and do not perform cross-suckling. Mixing of different age groups can have a positive effect on general resistance towards disease agents presented on a farm improving the resilience of a calf.

Time of cow-calf contact in the calf at foot system

Since there are still no fixed criteria for the calf at foot system in the Netherlands, every farmer is free to interpret the duration of the cow-calf contact. However, since the main goal of the system is to return to more natural dairy production thus the natural weaning time and rumen development time should be taken into account. The norm from Stichting Demeter (dutch biodynamic quality label) is that calves should receive fresh milk for 3 months, for that reason farmers who are part of this quality system choose to keep calves with their mothers for 3 months. However, not every dutch calf at foot farmer is part of the Stichting Demeter and not every Demeter farmer is a calf at foot farmer. Thus with regard to above-mentioned factors "extended period of time for cow-calf contact" should not be shorter than 5-6 weeks.

Advantages and disadvantages of the system

Some advantages of the system have already been mentioned above, namely better social recognition among calves, fewer vice behaviours and possibly a more robust immune system. On top of that many farmers have observed calves raised with the dams to be more daring and able to find their place in the herd easier later in life as heifers or milking cows. Thanks to the calf at foot system stress level of calves can be decreased, as they are not housed in isolation during the first weeks of life. Being part of the herd from the start of their lives allows calves to get familiar with the environment they live in. Heifers reared with the dams as calves show fewer stress signs when entering the milking parlour. Furthermore, the stress of being reintroduced to the herd as heifers is much lowered. In addition to that, there is a growing body of evidence that early high and unlimited milk intake leads to higher milk production in the heifers' first lactation.

Apart from behavioural benefits, the calf at foot system presents a great opportunity to improve animal welfare most naturally, this system also answers many ethical questions concerning dairy production.

Most of the often mentioned disadvantages of the calf at foot system are not the fault of the system but mainly of poor management. The fact is that farm management in the calf at foot system has to be adjusted for a farm to keep operating optimally. Some of the often raised concerns in this system are colostrum intake, re-wilding of calves, disease transmission and lower revenue. Those points of concern will be analysed using piratical information obtained during interviews with dutch calf at foot farmers.

2.2 Theoretical framework

The Netherlands is relying on dairy production as a source of income, however, there is only a fraction of dairy farmers that allow calves to suckle their mothers. This should be regarded as an animal welfare issue (Hurty-Person, 2021). Furthermore, based on the new law amendment about keeping pets and livestock from 2023 onwards the calf at foot system may be the only approved way of producing dairy in the Netherlands. The low rate of the calf at foot farmers could potentially be a problem for the production system in the Netherlands.

Decades of intensive dairy production have striped farmers of the primary knowledge about more natural dairy production where produced milk is shared with the calf. It has almost been forgotten that nature meant the milk produced by a cow for a calf. Instead, calves are fed milk powders. It seems odd that a milk producer buys milk or milk powder to feed calves from an external company. The costs of this were briefly compared in point 3 below (Economic benefits). Costs of different methods of feeding are very similar, however, it should be taken into account that calves are weaned later in the calf at foot system. On top of that, allowing calves to suckle could also be a labour and costs saving way of feeding young stock.

However, there are a lot of myths around the calf at foot of dairy production created through generations of farmers separating cows and calves at birth and through the pressure to maximise production. The cow-calf separation is justified by the following arguments (Busch, Weary, Spiller and von Keyserlingk, 2017):

1. Prevents creating cow and calf bond (less separation stress)

The fact is that separation of cow and calf can be very stressful for both (Wenker et al., 2020). It has been suggested that as little as 5 min contact directly after birth is enough to establish a mother-young bond. The bond is later amplified by suckling, licking and grooming (Wenker et al., 2020). Oxytocin is known as a bonding hormone and it has a rewarding effect. Its level increases when the mother feeds her calf, suckling is considered one of the most hedonic maternal activities (Margret Wenker, 2018).

However, many actions can be taken to lower that stress and at birth separation should not be considered the only prevention method. As mentioned before (1st year of life section, page 7) calves become ruminants at around 6-8 weeks of life, which means that their need for milk decreases. This can also be observed in calves spending less time with the mother and more with peers. Meaning that weaning could be performed in an almost stress-free way for both if the animals get a chance to recognise the new situation.

2. Better supervision of colostrum intake

Colostrum management is a time-sensitive matter regardless of the system calves are reared. It is advised to ensure timely colostrum injection as the ability of IgG absorption decreases with time (Neave et al., 2021). Many farmers give colostrum intake management as a reason to keep separating cows and calves. However, the hazard of insufficient colostrum intake exists in both systems (conventional and calf at foot) as many farmers allow the cow to keep the calf for 24 h. This means that to receive the passive immunity the calf must have already ingested the colostrum while it was still by its mother. The practical solutions of dutch dairy farmers are further investigated in this report. However, it seems like regardless of the system farmer intervention and oversight are recommended as part of good colostrum management.

3. Economic benefit (maximising the milk sold)

Many farmers make an argument about the high costs of allowing the calf to suckle the mother. Based on the dutch milk prices it can be said that allowing a calf to suckle is not much more expensive than feeding it artificially. It should be taken into account that calves in the calf at foot system are usually weaned later than in the conventional system, that is why the price of rearing a calf may be higher in the calf at foot system. The current price that a conventional dutch farmer receives for 1 litre of milk is 0,51 € (Economie, 2022) and 0,52 € for 1 litre of organic milk (van der Meulen, 2022). Based on the current prices of milk powder it can be estimated that it costs approximately 0,52 € to feed a calf 1 litre of artificial milk. The argument made in favour of artificial milk is that its composition can be adjusted according to the needs of a calf, however, any artificially made composition cannot support a calf better than its mother milk. On top of that, there are many added benefits of the calf at foot system, among others, heifers that have been raised in this system tend to have higher milk yields compared to heifers raised in the conventional system. Lastly, the time necessary to feed each calf individually could be directed into different tasks that need addressing. Most of the responsibility to take care of the calf falls back onto the mother instead of a farmer, the farmer is there to supervise and navigate the process.

4. Cow-calf housing is not safe

Cow-calf contact is often referenced as being unsafe in terms of disease transmission, and injuries, however, most of the issues arise from improper housing conditions and management. Calf at foot housing solutions are investigated further in this report with references to already used solutions. The above-presented arguments are outcomes of intensive dairy production when the natural needs of an animal are not acknowledged. The calf at foot system offers solutions which acknowledge the natural behaviours and needs of cattle. Furthermore, the stress of separating a cow and a calf prematurely may be associated with changes in the immune system that affect calf health and susceptibility to disease (RSPCA, 2019).

2.4 Summary

Some of the research sub-research questions from this report have already been answered or partially answered by the literature review. All the research questions can be traced back in chapter 1. Based on the literature review it can be summarised that the calf at foot system is definitely a more ethical and natural option for dairy production, however, it is not frequently used by farmers. Only a fraction of dutch dairy farmers allows their calves to suckle for an extended period (1-3 months). This system challenges farmers to step outside of a long enforced stereotype and share produced milk with calves. Hence it is sometimes hard for them to see the feasibility of this system. As mentioned already in chapter 1. Current milk yields can satisfy the needs of a calf while allowing a farmer to still make a profit.

Even though the calf at foot system is believed to create more health risks for a calf, it is also considered to bring many benefits in terms of expressing natural behaviour, social and physical development, and lower stress levels throughout life.

Most of the health risks can be phased out through adjustment of farming strategy, extra attention to barn hygiene and calf observations. The current dairy housing systems rarely pay much attention to the natural needs of cattle, rather they focus on efficiency of production. Whereas this factor is extremely important for a farmer, it is possible to accomplish both (efficiency of production and respect for natural needs of cattle) with a properly adjusted calf at foot system.

Lastly, the consumer factor plays a role in switching to the calf at foot system.

Nowadays, consumers are steadily more curious about the origin of the food they purchase. The study from 2021 about consumption choices in the Netherlands has shown that over 25% of consumers are willing to pay more for more sustainable and/or ethically produced milk (Elsen and van den Akker, 2021). Especially, when the production process is easy to trace and transparent.

Chapter 3. Research design & Methodology

3.1 Research design

This research aims to explore the calf at foot dairy housing system and deduct a common and safe practice. To meet this aim qualitative research has been done (Nunan, D., Birks, D.F., Malhotra, N.K, 2017). The research has been carried out in the field and also using the information obtained from desk research. The desk research has been done using global sources. The field research has been conducted in the Netherlands. The case study focused on Dutch dairy farmers that had already started with the calf at foot system. The 17 farmers have been personally interviewed and 11

farms were visited and analysed. Each farmer is asked a number of questions about their practical experience with the calf at foot system. The list of questions has been included in the appendix on page 54. Photos have been taken to document the visits and these will be used as a reference for the analysis. An additional part of the practical research focused on animal-animal and farmer-animal interactions have been conducted on 2 farms including a conventional dairy farm. The ethogram used for the observations has been included in the appendix on pages 55-58.

3.2 Methods of data collection

The practical information about the common practice of the calf at foot dairy production have been obtained by using a semi-structured ethnographic data collection (Nunan, D., Birks, D.F., Malhotra, N.K, 2017). On top of that 2 farmers have been asked for permission to conduct behaviour/interaction observations. Those observations are going to be conducted using an ethogram. The goal of those observations is to establish how cows and calves behave and interact with one another and the farmers when housed in the calf at foot system compared to a conventional system. The observation is planned to go beyond just the calf-cow contact but also observe the interactions between all the herd members in the calf at foot settings. The observation is planned to be carried out for couple of consecutive hours and if permitted by the farmer, also recorded for future reference. Lastly, a dairy farm with a conventional housing system (at birth separation) is going to be visited to act as a control case.

3.3 Population & Sample design

This study could potentially be useful to all dairy farmers that wish to introduce the calf at foot system on their farm. The population design for this research is the list of the dutch calf at foot farmers created by Caring Farmers. The census method has been chosen to carry out the interviews. There are around 30 calf at foot farmers source, all farmers were planned to be interviewed. However, due to factors like availability, willingness to participate in the research and practices used on-farm at least 15 farmers are planned to be interviewed for this research (Mariampolski, 2001).

3.4 Interview guidelines

As mentioned before, the interview has been designed with the approval of the commissioner (Caring Farmers). The questionnaire consists of four different sections. The first one refers to farm-specific information, among others; the size of the farm, number of animals, production numbers, etc.... The second section focuses on the calf at foot dairy production system. In this section farmers are sharing, how long they allow calves to suckle, how they approach weaning and what type of housing they choose and how much they had spent on modification. The third section of the questionnaire explores animal health and behaviour (both cow and calf) after introducing the calf at foot system. The post-transition questions explore as well the amount of labour, changes in farming strategy and changes in interactions between a farmer and livestock. The last section explores the financial aspects of the transition. Since some of the farmers had already transitioned to the calf at foot system many years ago specific numbers are not required. What is most important in this section is the general estimation of revenue, production costs and income to estimate the profitability of the system. The questionnaire has been included in the appendix.

3.5 Plan of analysis

The analysis is divided into two sections, the outcomes of the interviews and the outcomes of the behavioural observations. The outcomes of the interviews were placed on an excel sheet. Questions asked to the farmers have been open, which means that answers had to be evaluated and rephrased to be able to establish a mode using content analysis done manually (Nunan, D., Birks, D.F., Malhotra, N.K, 2017). Each question has been analysed separately. Based on that analysis a data set has been established to create graphs, diagrams, written explanations and recommendations. The sample (census) will be divided into corresponding groups to analyse the influence of certain factors.

The behavioural observations will be analysed by interpretative techniques. The observations taken at a calf at foot farm and a conventional farm have been compared to the average natural behaviours of cattle.

The research questions are used as structure in the analysis. One of the outcomes of the analysis is a decision tree for dairy farmers that wish to transition into the calf at foot system. Furthermore, semiotics analysis techniques are planned to be used to define consumer cultural trends in their purchasing choices (Nunan, D., Birks, D.F., Malhotra, N.K, 2017).

Chapter 4. Analysis & Results

4.1 Sample description

The sample used for this research is the calf at foot farmers from the Netherlands. Each farmer works in the unique expression of the calf at foot system. Some of the mentioned farmers have been working with this system for 20 years, some a transitioned of couple years ago.

However, it should be noted that most of the dutch calf at foot farmers allow only the replacement herd or only the females to suckle the mother. The rest of the calves (males and/or none replacement herd) are mostly still being separated and reared on different farms, a justification of that is described in further in the report.

Below in table 2 presented the statistics of a calf at foot farm compared to a conventional dairy farm.

Factor	Calf at foot farm	Conventional farm
Number of milking cows	64 cows	101 cows
Average land available	100 ha	42 ha
Average milk production	5500 l per cow per year	9000 l per cow per year

Table 2. System statistics

4.2 Analysis

Sub-research questions discussed

What are the essential natural behaviours of cows and calves?

Cows and calves are social animals who create herds with a defined hierarchy. Even though, calves are at the bottom of that hierarchy they are always protected and taken care of by the herd. Being prey animals cattle is largely motivated by fear. They tend to fear novelty but become accepting of a routine. Moreover, cattle are ruminants, which means that they spend most of their time either grazing and ruminating. That is why sufficient access to an outside pasture is essential to begin addressing the natural needs of cows. Calves on the other hand are born as mono-gastric animals, which means that their rumen has not yet developed and they are fully dependent on milk. Which untimely translates to calves relying on milk until the rumen starts developing (6-8 weeks). Allowing calves to suckle an unlimited amount of milk from a cow leads to their most prominent development and it is also one of the most essential natural behaviour. Furthermore, allowing a calf to be a part of the herd brings many benefits, some of them being; an established place in the herd from the beginning of life and the ability to learn from the mother and the rest of the herd.

Which farmers are already using the calf at foot system?

There are around 30 calf at foot farmers in the Netherlands, those farmers were listed on the website created by Caring Farmers (kalfjesbijdekoe.nl). The locations of those farms have been shown in picture 2 below.

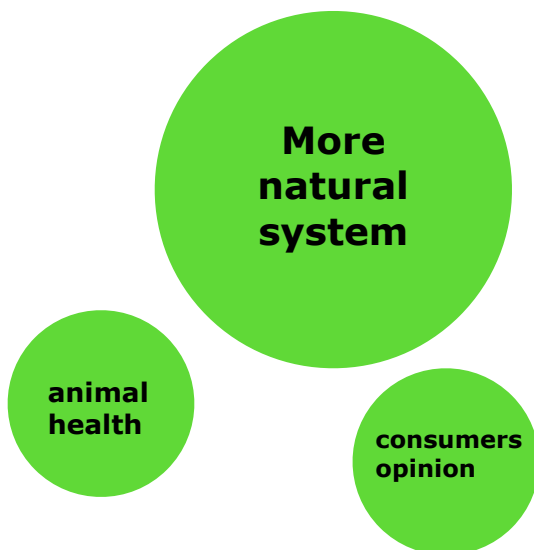


Figure 1. Most commonly named reasons to use the calf at foot system.



Picture 2. The calf at foot farmers in the Netherlands

Most but not all of those farmers operate in an organic or a bio-dynamic farming system. Out of those farmers around 70% had transitioned to the calf at foot system over 10 years ago. As a point of motivation to transition to the calf at foot system the interviewed farmers named three main reasons presented in figure 1.

For which farmers and how is this system feasible?

Based on the experience of the dutch calf at foot farmers, the calf at foot system can be feasible for every dairy farmer as long as the farmer is willing to make adjustments to work with the calf at foot system.

However, some farmers stress the importance of outside grazing, because otherwise, the stall "gets too crowded and less safe" for younger animals. Furthermore, the calf at foot system is motivated by being more natural than the conventional dairy production system, which means that to make it feasible farmers need to be willing to adjust their farming systems. The production/housing system should fit into the natural needs of animals instead of trying to fit animals into the production/housing system. Most interviewed farmers said that they would recommend this farming system to other dairy farmers, but "they have to be motivated and willing to experiment to make this system work on their farm". Which in other words could be translated to the need to adjust the farming strategy while transitioning into the calf at foot system.

How to make this system feasible for other farmers?

Based on the outcomes of the interviews farmers agree that the calf at foot system can be made feasible for almost every dairy farmer. The most important factors that these farmers named were:

Right motivation

According to the interviewed farmers, right motivation entails a shift in perception of milk production. This means creating a farming system in which the natural needs of animals are respected and can be expressed easily and the produced milk is shared with a calf instead of being sold completely.

Educating yourself

The calf at foot farmers stressed the importance of educating yourself before starting with the calf at foot system. They recommended visiting other calf at foot farmers for tips and inspiration. On top of that, it is essential to get a deeper understanding of natural cattle behaviour.

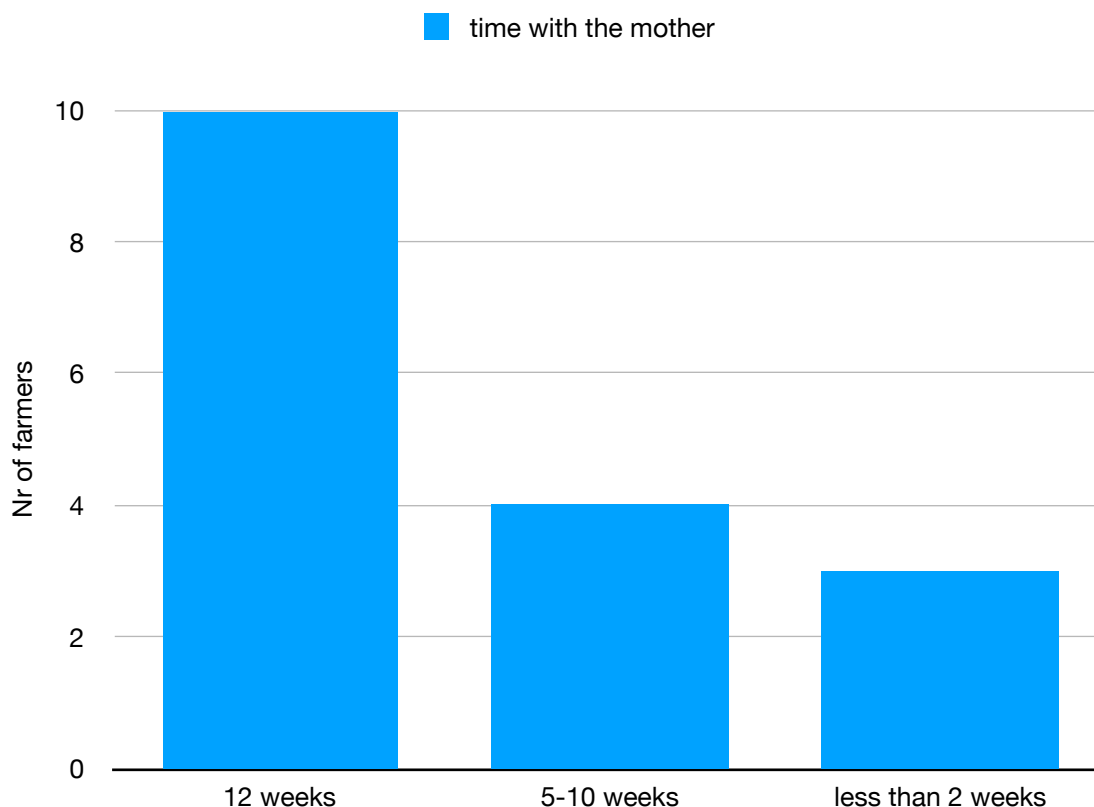
Clear strategy

Lastly, farmers advised to create a clear and new farming strategy to accommodate the calf at foot system.

What is the definition of an extended period of time with the calf at foot system?

The extended period of time with the calf at foot system has not been officially defined by any institution yet. As consequence farmers are free to interpret this period themselves. However, knowing that the full rumen development in calves takes roughly 12 weeks (AFDA, n.d.). Using rumen development as the point of reference the preferred time that the calf should be suckling the mother has been defined as 3 months. However, some farmers choose to shorten the time with the mother due to farm-specific factors. For this research farmers that keep calves with their mothers for less than 2 weeks were not considered the calf at foot farmers. Time up to weeks is

considered too short to be regarded as the calf at foot system. Graph 3 below presents the time farmers allow calves to suckle by their mothers.



Graph 3. Extended time with the mother

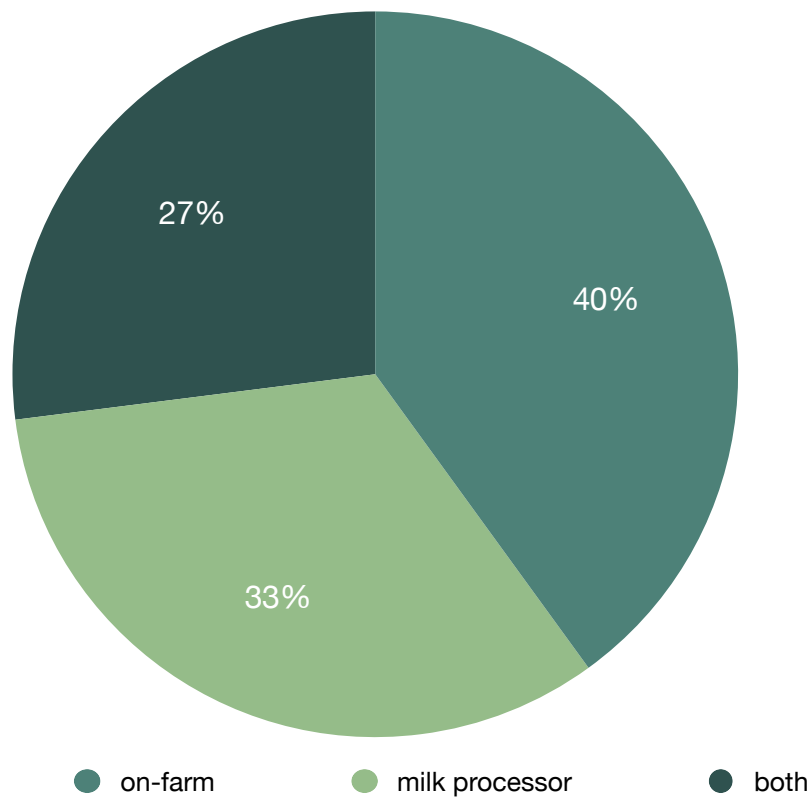
"I observe my young stock when I see that they spend more time with peers than with the mother, then I know I can start weaning them" - CAF farmer about weaning.

What is the practical experience of farmers with the calf at foot system?

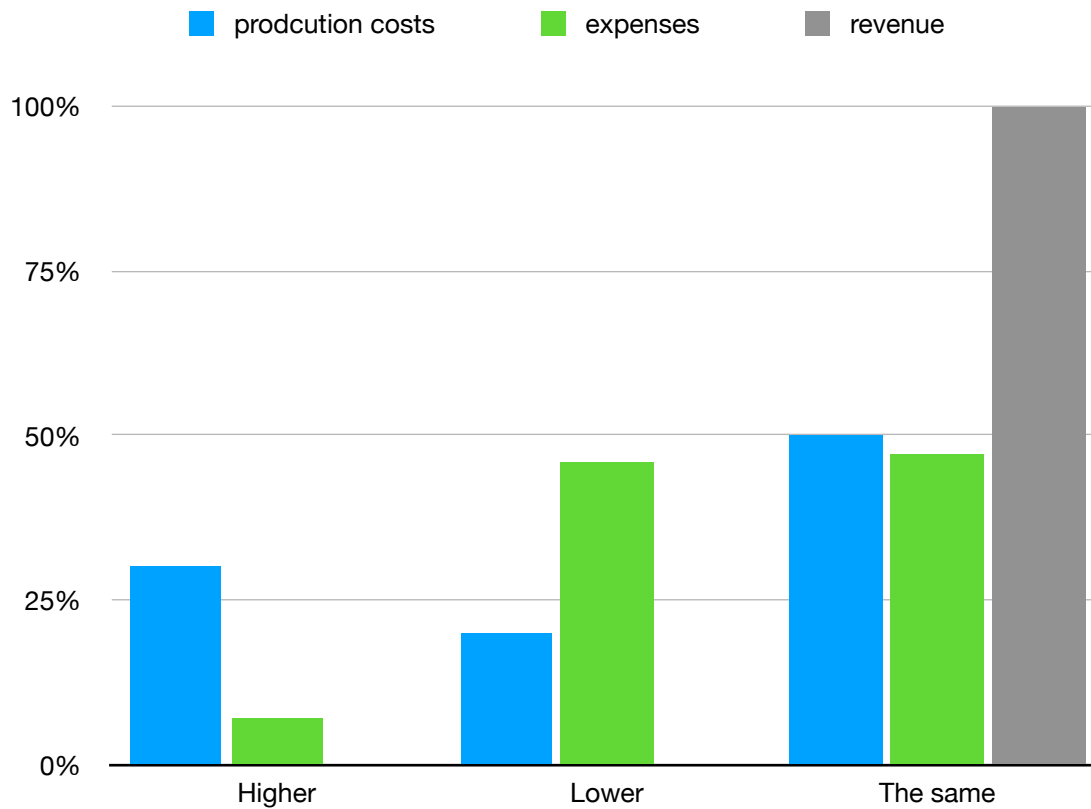
The practical experience of the dutch calf at foot farmers is that they feel more joy and pleasure from their work since they chose the calf at foot system. All of the interviewed farmers would recommend this system to other dairy farmers. However, since there is no quality label yet (2022) that would acknowledge the added value of the calf at foot system. Some farmers decided to process and sell their products on-farm to be able to ask a fair, higher price for their produce. The choices those farmers make to sell their products have been presented in graph 4. Farmers that sell the milk to both, usually only sell milk they have left over after on-farm processing to a milk processor.

Graph 5 below shows the financial situation of the calf at foot farmers after the transition to the system. The categories visible concern production costs, overall expenses and the final revenues.

Furthermore, none of the interviewed farmers had changed their milking system since transitioning to the calf at foot system and the majority of those farmers (85%) did not notice a change in their milk yields. Naturally, farmers acknowledge that until the weaning time there is less milk in the tank to be sold comparing to after weaning time.



Graph 4. Where calf at foot farmers sell their products ?



Graph 5. Farm financial changes in the calf at foot system

Lastly, it should be noted that only two out of all interviewed farmers kept 100% of their young stock on-farm. The rest was equally distributed between keeping only females with their mothers and selling males for veal production or keeping some males and females for reproduction and replacement.

What are the added benefits of the system?

All interviewed farmers agree that the most apparent benefit of the calf at foot system is less work and time spent taking care of calves. One calf at foot farmer adds "I enjoy being able to redirect my time and focus on different tasks while cows take care of calves". Moreover, as part of the herd calves have the opportunity to learn from their mothers and fulfil their social needs.

Furthermore, the practical experience of farmers has confirmed the results of the theoretical research, namely heifers raised in the calf at foot system experience less stress when reintroduced into the herd, thanks to the already established herd hierarchy. On top of that calves raised in the calf at foot system are observed to show less fear towards new conspecific, better weight gain and development. What is more, farmers observe younger animals mimicking and learning from older animals.

Lastly, the unanimous benefit according to dutch calf at foot farmers, is the joy that working with this system brings.

Above all the most compelling benefit of the calf at foot system is creating a dairy production system where the natural needs of cattle are respected and expressed instead of being artificially substituted and denied.

"The biggest benefit of this system is the joy it brings me to see cows with calves together" - CaF (calf at foot) farmer

"I have noticed my calves growing better and being more daring" ~ CaF farmer

Benefits of the system		
Cow	Calf	Farmer
Maternal behaviour expression	Natural behaviour expression	Less time spend working with calves
Less change for udder infection (mastitis)	Learning from other herd members	Joy of seeing cows and calves together
More natural herd structure	Established herd hierarchy	Cows take care of calves
	Better calf growth	
	Ability to play with peers	

Table. 3 System benefit overview

What are the points of attention with the calf at foot system?

According to dutch calf at foot farmers, the calf at foot system is a learning experience, where different aspects require more attention than others. Even though a cow takes care of a calf it does not mean that a farmer does not play an important role in the supervision process. Nevertheless, farmers confirm that since the transition they spend significantly less time taking care of calves. The most important for a calf to ensure its healthy development is the colostrum. That is why colostrum management should be a priority for all dairy farmers regardless of the production system they use. However, some of the interviewed farmers admitted that since the transition into the calf at foot system colostrum management has become more challenging. Corné Ansems admits that, "the calf at foot system allows less control over colostrum management".

Another point of attention with the calf at foot system is weaning and separation trauma. Naturally, cow and calf create a bond during the time of suckling, to avoid separation trauma during and after weaning, calf at foot farmers approach this process with caution. Most of the interviewed farmers used some form of sucking restrictions to prepare animals for weaning. The occurring options among dutch calf at foot famers were:

Nose clips

Plastic nose clips are inserted into the calf's nostrils to still allow contact with the mother but prevent sucking and at some time encourage eating solid food. The duration of this period varied among farmers but was never longer

than two weeks.

Separate pen

Some farmers choose to perform weaning by placing calves into a separate pen and gradually limiting access and time with the mother.

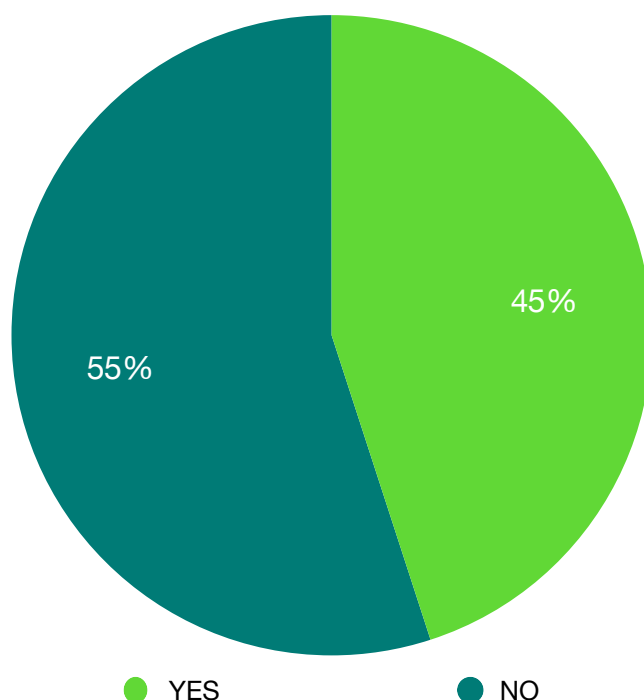
Limited contact

Another common weaning practice is steadily allowing a shorter period of cow-calf contact up to complete weaning. An example of that could be cow-calf contact only at night/day.

Lastly, the often addressed point of attention with the calf at foot system is the re-wilding of calves. Graph 6 below shows the percentage of the calf at foot farmers that noticed the re-wilding of their calves.

However, out of the farmers that responded "YES" some admitted that they did not consider it a problem and saw the re-wildling as a result of a more natural dairy production system.

Did you notice re-wilding of calves after introducing the calf at foot system ?



Graph 6. Re-wilding

What do all the farmers that practice this system have in common?

Each farmer interviewed for this research had their unique approach to the calf at foot system however, all of the interviewed farmers allowed their animals to graze outside (either unlimited access year-round or during summer). One of the interviewed farmers admitted that without access to the outside grazing the barn can become too crowded to house cows and calves together.

“Without the access to the outside my barn would get really crowded” - Charl van de Sande

What housing solutions are already used to house calves and cows together?

As mentioned before as of now (2022) there is no uniform housing system to house cows and calves together. That is why dutch calf at foot farmers convert the housing system they had been using before starting with the calf at foot system to accommodate the needs of cows and calves housed together. All of the interviewed farmers said that they had implemented small changes into their barns to allow the calf at foot system, all of those farmers also said that the investment to allow the modification was not significant. These farmers do not keep all the calves (bull calves) on-farm in the calf at foot system. Ultimately, only small changes have been made to the barn interior to accommodate the calf at foot system and none of the interviewed farmers had to change their milking system. The CaF farmers that keep all calves on-farm, either decreased the number of milking cows in the herd or are currently investing into a barn extension. The adjustments implemented into the barn must allow calves to be safe and satisfied, which in practice means that they need easy access to water, food and rest places. Farmers who choose to transition into the calf at foot system usually installed calf-adjusted mangers and water access. Another important aspect of the transition is proper flooring, in the case of slatted flooring

special attention should be paid to the size of the slats. Too big gaps could be a potential safety hazard for young calves.

Which housing solutions are recommended to house calves and cows together?

Since the calf at foot system is motivated by more natural dairy production, it should correspond with the natural behaviour of cattle.

Considering that, it is recommended to create a separate calving area to allow a cow to separate herself from the herd to give birth. As she would do in nature. Farms with unlimited outdoor access are in lesser need of such a space. An example of a calving pen was presented in picture 3.



Picture 3. Separate calving area

Furthermore, many calf at foot farms provide a space where only calves can enter. A so-called "kindergarten" pen, is presented in picture 4. Thanks to this area calves can choose to separate themselves from adult animals when they want to, which they also would be able to do in the wild.

This solution was often recommended by the CaF farmers. Most of the observed expressions of kindergarten pens served either a double purpose (see pictures 6&7) or were utilising earlier unused space in the barn (see picture 4). Farmers that choose not to provide separate space for calves always allowed unlimited outdoor access.

Moreover, it is important to create/dedicate a space to perform weaning. As mentioned before weaning is a delicate period and the dedicated space must match the chosen weaning strategy. In cases of limited available space in the barn, a weaning area can double as a calving area(see picture 5). Depending on the weaning



Picture 4. The kindergarten pen



Picture 5. Calving/weaning area



Picture 6. Dedicated weaning area



Picture 7. Dedicated weaning area currently used as a calves dedicated space

strategy the weaning area should be able to comfortably house calves for some period of time, which must include food and water source.

The calf at foot farmers stressed the importance of strategically placed fences when working with this system. The position and type of fence depended on its purpose. Some of the existing solutions were presented above.

Pictures 6 and 7 present dedicated weaning area (when closed off) allowing contact with the mother and suckling through the fence. The current position of fences (visible in pictures 6 and 7) allows to create a calf dedicated area (a kindergarten pen). Which is another solution to accommodate the calf at foot system and to be sustainable with the use of space.

What recommendation could be made to conventional dairy farmers to transition into the calf at foot system?

According to dutch calf at foot farmers, almost every dairy farmer can change their farming strategy to accommodate the calf at foot system. The recommendations given by those farmers were as follows:

"Believe that you can do that on your farm"

"Have a clear farming strategy"

"Find your motivation and just do it"

"Visit other calf at foot farmers and educate yourself"

Transitioning farmers were recommended to consider the space that needs to be invested to work this system successfully (see figure 2). When transitioning to the calf at foot system farmers should definitely adjust their colostrum management. Many calf at foot farmers choose to milk the colostrum and give it to the calf with a bottle. This practice assures sufficient colostrum injection and allows to build a bond between a calf and a farmer. What is more, as mentioned before outdoor grazing is a crucial factor in providing safe and sufficient space for cows and calves. Furthermore, when transitioning farmers should choose where to sell their produce. Almost half (47%) of the interviewed farmers chose to sell their products on-farm instead of selling the milk to the milk processor. Their main motivation is the ability to ask for “a fair price” for their products since there is no quality label (yet*) that would acknowledge the added value of the calf at foot system.

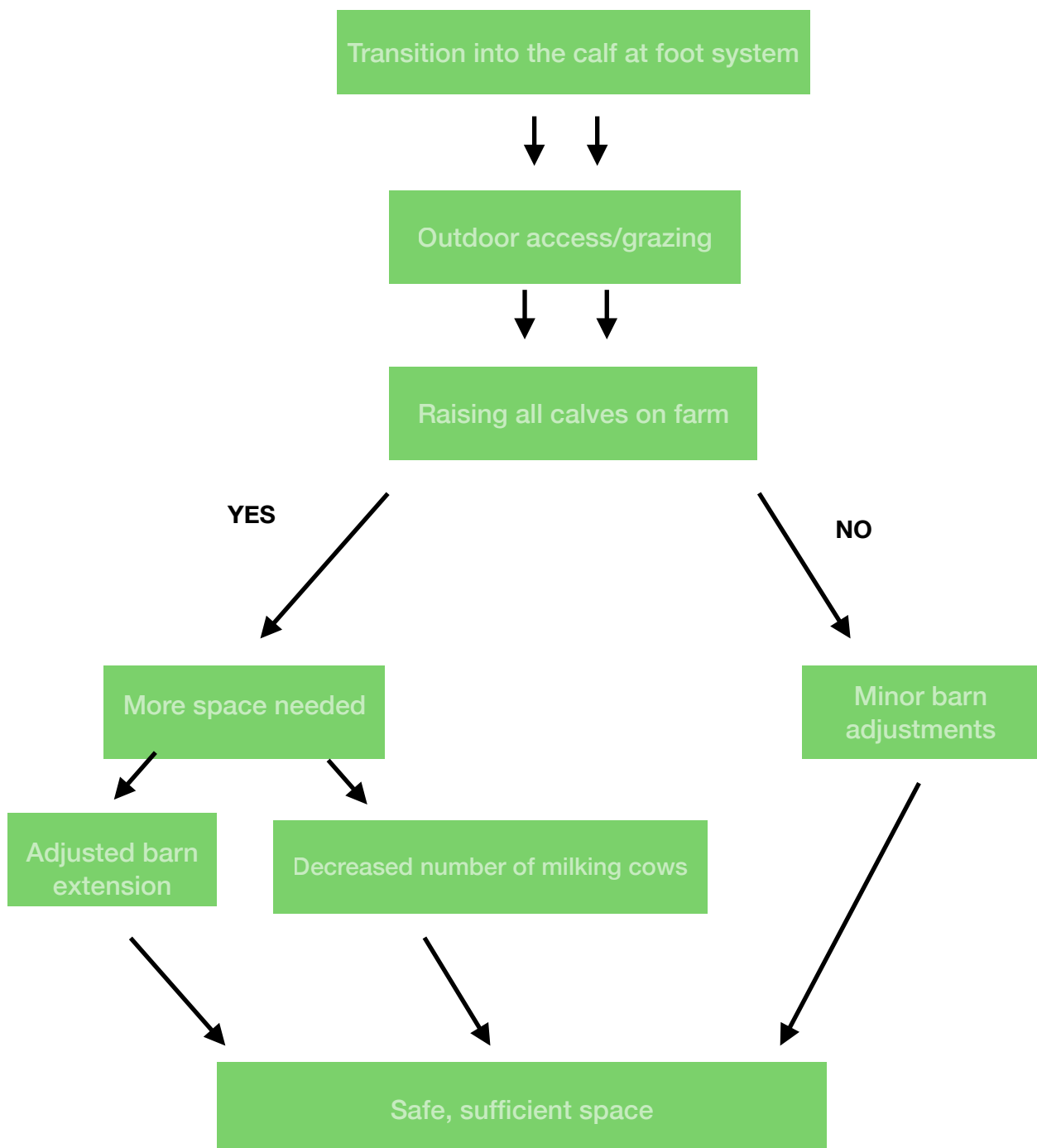


Figure 2. General space recommendation

* The beter leven keurmerk is working towards implementing the calf at foot system into the BL star system.

Based on figure 2 it can be seen that allowing all calves to be reared in the calf at foot system, requires a bigger investment of space or a potential barn extension. Currently, only a small percentage of the dutch calf at foot farmers rear all calves on-farm. Mainly due to financial reasons most of the dutch calf at foot farmers allow only female calves in the calf at foot system to suckle.

Main research question

How to house cows and calves together for an extended period of time and generate a profitable business model?

Based on the answers to the sub-research questions an answer to the main research question can be formed. In order to generate a profitable business model while housing cows and calves together a farmer need to change the farming strategy. It is not possible to safely and profitability house cows and calves together in the housing system adjusted to house only adult animals. However, with minor changes to the barn interior (named previously) a farmer can begin the calf at foot journey. Without the investment of additional space or downsizing of the milking herd, a farmer can rear the replacement young stock in the calf at foot system.

At this moment only a small percentage of the dutch calf at foot farmers rears all their young stock on-farm and keeps both male and female calves equally long with their mother. A common practice at the moment is to sell the spare calves to be reared on a different farm without the possibility to suckle. An additional investment of space (or downsizing the milking herd) may be necessary to rear all calves in the calf at foot system.

As far as barn adjustments necessary to house calves safely are concerned there is usually no need for an expensive investment, farmers choose a strategically placed system of fences to provide a separate area for calves (kindergarten pen), weaning area and calving area. Naturally, when housing cows and calves together accurate access to (lowered) feed and water must be provided for the calves.

As mentioned before farming strategy needs to be changed. A farmer needs to reevaluate :

- Hygiene management
- Health management
- Colostrum management

Furthermore, as presented in graph 4 many (page 21) CaF farmers choose to process the milk on-farm into all types of dairy products. This allows them to ask for a higher price and have direct contact with the consumer. Even though it is possible to generate profit by selling the calf at foot milk to the processor, the added value of the milk is not acknowledged in the selling milk price. On top of that, that allows those farmers to be more competitive with big conventional farms and have direct contact with consumers.

Chapter 5. Ethogram analysis

5.1 The calf at foot system

The behavioural/interaction observations have been conducted on one of the dutch calf at foot farm (Ruimzicht farm in Halle). During observations interaction between

calves and their mothers, calves and a farmer, calves and calves and calves and other adult animals were observed. Factors like a calf's place in the herd hierarchy and calf development in the family herd have been included in observations. A full ethogram has been included in the annex (pages 55-58). Based on the literature review in chapter two the natural behaviours of cattle (both cows and calves) have been identified and the observations were meant to check if the calf at foot system addresses those natural behaviours and how does the conventional production system correspond to those behaviours.

Calf's contact with the mother

During the observations, there were five calves in the herd in different stages of life. The youngest calf was born three days before the observation the oldest was six weeks.

The most often observed interaction between calves and mothers were:

- Licking



Picture 8. A calf being licked by this mother



Picture 9. A calf licking the mother

Cows were observed licking their calves for around 1 min three times during a 30 min period. The licking act was later returned by a calf, which means that calves also lick their mothers. In this case, the frequency and duration were lower.

- Drinking milk



Picture 10. A calf suckling the mother



Picture 11. A calf hidden in the high grass



Picture 12. A calf being called by a mother to suckle

Sucking by the mother has been present with all of the five calves. The youngest two calves (below 2 weeks old) have still been hidden in the pasture when the herd returned to the barn for morning milking (it should be noted that the farmer allows

free unlimited access to the outside). During milking the cows that had not had their calves next to them would hold on to their milk more than cows that had their calves in the parlour with them. After milking, two mother cows would return to feed their calves in the pasture. The older calf of the two (over a week old) was brought back to the herd by the mother. The younger calf (3 days old) was visited by the mother in the hiding space, fed and then returned to hiding. The mother was defensive about me approaching the hiding area. The calf of 3 days old spend around 5 min sucking and it drank only from one teat, the calf of around a week old spend 6,5 min sucking and it used two different teats.

Photos above (number 10-12) present a cow visiting the hidden calf to let it suckle. After suckling, the calf returned to its hiding place, and the cow remained to graze close by the hiding place. She began returning to the herd only after I have moved away.

Calf's behaviour in the herd

It can be clearly stated that calves are an integral part of the herd. They interact with the herd and are protected by it. Below is an analysis of certain observed behaviour and interaction of calves in the herd.

- Calf in the milking parlour

The calves on this farm are allowed to enter a milking parlour when mothers are being milked. The presence of the calf stimulates oxytocin release and a cow is more likely to give more milk. Also when calves visit a milking parlour with their mothers they learn the routine of being milked from the beginning of life, which contributes to a lower level of stress when calves become milking cows. This practice also eliminates the need for a farmer to teach the animals the routine, in this system, it is taught by the mother. However, it should be noted that no calf on this farm is forced to enter the parlour. The calves only do so if they wish to follow their mother. Furthermore, forcing a calf to enter this space can lead to traumas and problems entering a milking parlour later in life.

- Calf with peers

Peers' interactions have been divided into three categories:

1. Calves born in the same year

The calves younger than a week have been observed mainly sleeping. One of them remained hidden in the pasture and it did not interact with the herd. It was visited by the mother to be fed. The other calf was brought can by the mother to the herd but it remained sleeping and resting almost the whole time. The older calves (over two weeks old) were observed to intensively interact with each other. There was a lot of socialisation by licking. The younger calves would mimic the older ones by trying to graze. On top of that, there was a lot of licking and sniffing involved. Some playing attempts were observed among them.



Picture 13. A calf socialising with peers

2. Young stock born last year

Animals born last year had a very strong bond with one another. They were observed to keep close to each other while grazing, resting and ruminating. They have engaged in lots of playing, chasing and mounting behaviours.

3. Mixed age groups

The number of was not significant interactions spotted between mixed age groups of young stock. However, the older animals acknowledged the youngest calves as part of the herd by sniffing them or lying close to them. The youngest calves were observed trying to mimic the older ones' behaviours, like grazing and attempts at playing.



Picture 14. A young calf (less than 2 weeks old) resting surrounded by herd members

- Calf with other adults

According to literature, there is not much information available on interactions between calves and other adults (not their mothers). However, some interactions were observed. The most often occurring interaction was calves being sniffed by other adults. A calf was also observed licking an adult that was not its mother. Overall adult cows seemed to protect the youngest calves by lying close by them when the calves were resting/sleeping.

- Calf with the farmer

Calves were not afraid of the farmer and they would let him approach without escaping. The farmer values early socialisation and creates a bond with a calf by feeding it colostrum with a bottle. This practice has more benefits, namely good colostrum management and preventing re-wilding of calves.

Social bonds

It is clear that cattle create social bonds within and outside of their age groups. Those social bonds help calves' learning process. Thanks to trying to mimic the mother and other herd members calves learn where to find water, graze and ruminate.

5.2 Conventional system

The behaviour observations were conducted on two conventional dairy farms (the names remain anonymous). Since both of those farmers separate calves and cows at birth interactions between those animals were not possible. In this section, the behaviour of calves and interactions between them are analysed.

Calves in the conventional system are separated from their mothers at birth, depending on the time of birth, sometimes before the mother was able to lick the calf dry. After that, a calf is placed in a separate pen and it remains there for up to four weeks (the time depends on the farmer but it is never shorter than two weeks). During that time calves are fed usually two times a day with a bucket. In this life stage the calves were observed to be very eager to try and suckle on pieces of clothing or fingers. It is important to keep in mind that during that time calves are not able to play or socialise with peers.



Picture 15. A conventional calf pen

Consequently, this makes a farmer the only interaction point.

After the time in a separate pen, calves are moved to the group housing pen, the pens are usually divided by age. During that time calves are not granted access to the outside grazing area. The amount of provided milk is gradually being limited to encourage calves to eat solid food.

There were limited interactions and playing attempts observed in the group pen of calves. Calves seemed more interested in people present in the barn and tried to interact with them.



Picture 16. Calves in the conventional group pen

5.3 Comparison of both systems

There are many differences in the inherent behaviour expression of animals in both of those production systems. The start of life is much less enriched for calves as they spend the first weeks of their life in individual pens. During this time a calf bonds with the farmer instead of the mother and peers as it would in the calf at foot system. The bond is created based on the source of food. Table 4. below compares other typical calf behaviours.

Type of behaviour	Calf at foot system	Conventional system	In the wild
Licked by the mother	Yes always	Sometimes	Yes always
Contact with the mother	Yes	No	Yes
Contact with peers	Yes	Only the same age group	Yes
Contact with other adults	Yes	No	Yes
Learning from other herd members	Yes	No	Yes
Outdoor grazing	Yes	No	Yes

Table 4. Behavioural comparison of both systems

What is more, farmers in the conventional system often mention the need to encourage a calf to start grazing and feed on solids. In the calf at foot system calves are observed to try solid food much earlier in life. The mimicking of older (and adult) animals is a starting factor for calves learning from the rest of the herd. On top of that calves trying to suck on clothes and/or fingers clearly show a unsatisfied need to express suckling behaviour. The lack of expression of this behaviour can contribute to cross suckling in adult life or other vice behaviours.

Furthermore, many conventional farmers do not provide outdoor grazing access for calves, but instead, choose to house them inside in limited space. Compared to the calf at foot system the calves in the conventional system were hardly observed playing with each other.

Lastly, when the calf is introduced to the herd in the conventional system there is usually a lot of stress involved and it is necessary to reestablish herd hierarchy. In the calf at foot system when a calf comes back into the herd as a heifer there is no need for that as the hierarchy has already been established at the beginning of life. Overall it can be concluded that the calf at foot system allows calves to express more inherent behaviours and allows them to bond with other herd members and learn from older animals.

Chapter 6. Conclusion & recommendations

The discussion and recommendation are based on the content of the analysis. However, the order of the questions has been changed, the sub-research has been joined and categorised together to allow a broader angle for discussion and conclusion.

The sub-research questions will be discussed in the following group order:

Group 1. Natural cattle behaviour

What are the essential natural behaviours of cows and calves?

What is the definition of an extended period of time with the calf at foot system?

Group 2. The dutch calf at foot farmers

Which farmers are already using the calf at foot system?

What is the practical experience of farmers with the calf at foot system?

Group 3. The practical feasibility

What do all the farmers that practice this system have in common?

For which farmers and how is this system feasible?

How to make this system feasible for other farmers?

Group 4. Benefits and attention points of the system

What are the added benefits of the system?

What are the points of attention with the calf at foot system?

Group 5. Housing solutions and recommendations

What housing solutions are already used to house calves and cows together?

Which housing solutions are recommended to house calves and cows together?

What recommendation could be made to conventional dairy farmers to transition to the calf at foot system?

6.1 Discussion

Group 1. Natural cattle behaviour

The driving force behind the calf at foot system is to come back to the more natural way of dairy production which respects the natural behaviour of cattle and biodiversity. Suckling the mother, socialising with peers and learning from the herd are some of the behavioural expressions returned to a calf by the calf at foot system. Not only does the calf benefit from the system, but the cow also as she gets to raise her calf which definitely adds another ethical layer to this system. The interesting experience shared by some of the dutch calf at foot farmers was admitting that they only understood the importance of allowing cows to raise their cows after becoming parents themselves. In the wild, a calf is naturally weaned from the mother after around 9-11 months. However, in a domesticated animal production system, this period of time would not be feasible to allow to build a sustainable business model. That is why the rough estimation of three months with the mother was made based on the estimation of other quality labels, such as Demeter and BLK. The time recommended to feed milk to a calf. By the time a calf reaches three months of age, it is no longer dependent on milk as its main source of food and the calf can easily begin its journey as a ruminant. In some cases, individuals are ready to be weaned before that. They would usually spend less time suckling and more time grazing with peers. It, however, has to be noted that thorough observation is needed to wean before the recommended time, since early weaning may bring a negative effect on both cow and calf.

Group 2. The dutch calf at foot farmers

Only a fraction of dutch dairy farmers allows the cows to keep their calves. However, the number of dairy farmers interested in the calf at foot system is slowly growing. Some of the pressure to change the current farming system comes from consumers and their growing interest to know the origin of their food. Nevertheless, changing a farming system based solely on consumer opinion may not be the right motivation. The result of study published by BioJournaal NL has shown that the majority of dairy consumers believe that all organic and/or bio-dynamic dairy farms do not separate

cows and calves. Which is obviously not true. However, this could explain the growing demand for organic dairy and clearly expose the need for more focused consumer education.

The calf at foot system goes beyond the organic label and it focuses on the aspect often overlooked by many other production systems, the animal. Many calf at foot farmers choose to process and sell the produced milk directly on-farm. The reason for that is simple, selling produce on-farm allows farmers to ask for a fair, higher price, which is currently not possible commercially. Out of all interviewed farmers, 25% admitted that their production costs increased while the revenue remained the same. The lack of change in the revenue can be explained by the fact that at this moment no commercial dairy processor acknowledges the added value of the calf at foot system. This may also be a reasons why bull calves are still being separated on those farms. Consequently, the calf at foot farmers choose to process (a part) of their produced milk and sell it themselves. This also allows them to talk directly to the consumers and share the story behind their dairy products. This direct contact and transparency allow consumers to understate the price behind the product. Without collective awareness about the current food production chain, selling the calf at foot produce in commercial supermarkets could prove difficult. Because food produced locally and on a small scale will most likely always be more expensive to produce than factory-farmed food. However, without an understanding of the production process, most consumers are less likely to choose the more expensive product among other cheaper options.

Furthermore, it should be noted that (currently) only a small percentage of the calf at foot farmers allow all their young stock to suckle the mothers or to remain with the mother equally long as the replacement young stock. In terms of economical feasibility, this is understandable as allowing all calves to remain on a farm requires a much bigger investment of space and resources. In this case, farmers choose either to lower the number of milking cows in the herd or to extend the available housing space. Both are hard to accomplish without a higher selling price and consequently a higher revenue. A higher selling price goes hand in hand with consumer awareness and willingness to pay more for animal products.

Group 3. The practical feasibility

What brings all calf at foot farmers together is definitely the willingness to look for more animal and environment-friendly ways of dairy production. Every interviewed farmer had a unique way to express those factors in practice. However, what they all have in common is the motivation to be an innovative change in dairy production and understanding of the natural needs and behaviour of cattle. This can be easily referenced by the fact that all of those farmers allowed their animals to graze outside. The access to outside grazing makes it possible for these farmers to keep the replacement young stock with their mothers without major space investment. This furthermore, creates a safe environment for calves with the implementation of only minor barn changes. So it could be said that the calf at foot system is feasible for all dairy farmers who already practice outdoor grazing and are willing to change their farming system. Farmers that do not yet allow their animals to gaze outside should implement this change as a first step before they move to the calf at foot farming system.

To change the current production system to the calf at foot system a farmer needs to get educated about it. The calf at foot system basically erases a lot of common beliefs about dairy production. Which in a way means that a farmer should get re-educated. This could be accomplished either by benefiting from the experience of already practising calf at foot farmers or hiring an expert. A farmer that stopped with the calf at foot system a couple of years ago admitted that he definitely missed the guidance of someone more experienced and that given the chance to work with the support of

an expert he would try to transition again. This clearly shows the need to share that knowledge to support more farmers in this transition.

Group 4. Benefits and attention points of the system

The calf at foot system has many behavioural benefits for both cows and calves, they are able to express behaviours that were denied to them in the conventional dairy farming system (Koskamp, 2022). Taking into account the new possible law amendment about keeping animals in the conditions allowing natural behaviour expression, it seems like the calf at foot dairy production may be the only way to keep producing dairy. Below mentioned three main points of attention:

Colostrum
management

Socialisation

Weaning

Colostrum is essential for a calf to build immunity and develop properly. That is why it is extremely important to make sure that the calf drinks a sufficient amount. Naturally, a farmer is easily able to assess if the colostrum has been drunk, however in the calf at foot system the amount is harder to assess and control. A solution used by some dutch calf at foot farmers is to milk the colostrum and to give the colostrum to a calf by the bottle. Thanks to that a farmer knows exactly how much colostrum has been consumed. Furthermore, the temporary bottle feeding allows a calf to build a bond with a farmer and prevents re-wilding. However, many dutch calf at foot farmers allow others to socialise with their calves by opening their farms, either to visitors or to mentally disabled people (Zorgboederij). Lastly, the aspect of the calf at foot system that needs special consideration, is weaning. In nature weaning never happens abruptly and it is an act of both a cow and a calf being ready to separate. However, due to the financial feasibility of the system, a farmer cannot afford to wait for a calf to wean itself. The process of weaning should be integrated gradually to avoid separation trauma. The common ways of weaning have already been described in the analysis section of this report. However, what can be added is, that farmers should spend time observing the animals. When a calf is starting to be ready to be weaned it will most likely spend less and less time with the mother and more time with its peers. Furthermore, a calf should never be fully weaned before the rumen is developed.

Group 5. Housing solutions and recommendations

In order to house cows and calves together dutch calf at foot farmers choose to use the already existing barn and adjust it to rear calves as well. As mentioned before outdoor access seems to be crucial. When outdoor access is present, safety and comfort inside the barn should be provided. The most basic modifications that should be provided are water mangers and feeders accessible for calves (if a farmer chooses not to feed concentrate then easy access to another source of feed should be provided). Furthermore, the most common modification that dutch calf at foot farmers implemented were:

Kindergarten pens

A kindergarten pen is a space dedicated exclusively for calves, here they can choose to separate from the herd.

This space is important for creating social bonds among calf and allows them to rest away from the rest of the adult herd members. The size of the kindergarten pens varied depending on the available space, herd size and number of calves reared in the calf at foot system. All of the interviewed farmers had designed an expression of calf dedicated area. One of the possible solutions were already presented in the analysis chapter (photos 4-7, page 26-18). Some other ideas included fencing a part of the barn, visible in picture 17.

Depending on the farming strategy a farmer may choose to create a calving pen for cows. Most of the conventional dairy farms use those. For farmers that wish to transition to the calf at foot system, it would be recommended to keep making use of the already existing pens. Cows that are first-time mothers or the cows kept previously in the conventional dairy system may need time to adjust to the new

situation of having a calf and taking care of it. The privacy of a separate calving pen allows a cow to bond with a calf away from the herd. Farmers that allow year-round outdoor access usually also do not use calving pens. With the year-round access to an outdoor pasture, a cow can choose to separate herself from the herd for birth.



Picture 17. Kindergarten pen solution

Weaning area

A size, location and design of a weaning area depend on the chosen weaning strategy (see page 22). Depending on, if the farmer chooses to wean all calves at the same time or couple at a time the size of the weaning area will be respectively different. It is important to keep in mind

that weaning should never happen abruptly, this can cause separation trauma for both cow and calf. That is why farmers use a simple system of strategically placed fences to allow for graduate weaning. When fences are used to separate a calf from a cow they are usually placed in a way to still allow suckling for some time (see picture 18). Gradually, another fence can be added to only allow visual contact.

Another commonly used weaning solution is inserting a plastic clip into the nose of a calf, which disables a calf to suckle. After a certain amount of time (usually around 1-2 weeks) the clip is removed and cows and calves are separated. Usually, they are placed on neighbouring pastures and/or pens to maintain visual/vocal contact at first.



Picture 18. Weaning solution

Resting space

The resting space for calves does not need to be extended or even specially separated. The resting space is not the same as a kindergarten pen, however, a kindergarten pen can be used for rest as well. When adjusting the barn for the calf at foot system a farmer should keep in mind that calves need much more rest and are significantly smaller than an adult cow. For that reason, many farmers chose a deep litter stall or partly deep litter stall (see picture 19). This solution allows calves to rest almost anywhere in the barn. Farmers with a slatted floor system must pay attention to the width of the gaps, otherwise, there is a risk of a calf's hoof getting stuck in them. Below, presented some of the already existing solutions:



Picture 19. Deep litter barn, suitable rest place for calves

Picture 20 below presents a calves' dedicated (but not separated) resting area which during weaning can be fenced off and double as a weaning pen. The calves can also rest in the adult laying spaces, however, then a farmer should make sure that there are enough lying spaces for the whole herd. As conventional farmers usually allow 80% of lying spaces. If there is not enough space for the interior herd, the calves most likely will be chased away by older animals higher in the herd hierarchy.



Picture 20. Calves resting in secluded barn area

The main research question

How to house cows and calves together for an extended period of time and generate a profitable business model?

Generating a profitable business model with the calf at foot system is possible without implementing many expensive changes when not all calves are reared at the farm. It should be noted, however, that even if the barn does not need to change much, the mindset of a farmer should. The shift in the mindset includes a more holistic approach toward animals. For the calf at foot system to be profitable, the farmers need to understand the natural behaviour of cattle in the wild and try (to a certain extent) to recreate it in domesticated settings. Furthermore, with a broader understanding of wild cattle behaviour, a farmer will most likely be more willing to share the produced

milk with a calf. Even feeding calves with the already milked milk was often referred to by the interview CaF farmers as a labour unsustainable solution.

It has to be taken into account that some farmers may be reluctant to change their perspective on dairy production for fear of lower income or financial losses. A great step forward would be rewarding/supporting calf at foot farmers and/or transitioning farmers by offering a higher price for their milk. An example would be a quality label that acknowledges the calf at foot system.

This could also contribute to another important issue, namely allowing all calves to be reared with their mothers equally long, not only the replacements. As was mentioned before only 10% of all calf at foot farmers are currently rearing all their young stock with the mother. Others choose for a shorter time with the mother for bull calves or choose not to lead then suckle at all and still separate them. Regardless, their effort to change should be acknowledged and encouraged by offering a fair price in return. So that it can be more feasible for those farmers to allow all calves to suckle with the mother equally long.

Untimely, the essence of a successful transition to the calf at foot system is creating a housing solution that answers the natural needs of cattle instead of trying to phase out those needs by placing cattle in an unsuitable housing system.

6.2 Conclusion

Sub-research questions

Group 1. Natural cattle behaviour

To conclude, the calf at foot system allows cattle to express natural inherent behaviours for cows and calves. Firstly, most calves are allowed to suckle their mothers and create bonds with all the herd members. Secondly, cows can keep the calf and share the produced milk with both a farmer and a calf. The milk is shared with the calf for up to three months, after this time the rumen is developed. When calves spend more time with their peers than with their mother then, they are ready to be weaned. Weaning should never happen abruptly, but rather gradually with proper strategy.

Group 2. The dutch calf at foot farmers

Even though it is possible to generate profit in the calf at foot system, many conventional farmers are still reluctant to consider a transition. Part of the reason is the lack of financial incentives. It is more profitable to produce milk conventionally. That is why the calf at foot farmers should be able to sell their milk for a higher price to the processor. This is a way of acknowledging the production system, similar to organic and conventional milk. Currently, it is close to impossible for the calf at foot farmers to compete with mass-produced commercial dairy. Based on the conducted interviews it can be concluded that not every dairy farmer wants to be a milk processor and marketer. Hence the value of the calf at foot milk should be included in the supply chain. Furthermore, to allow all calves to suckle the mothers for an extended period, farmers need compensation for the invested time and space that will allow them to implement necessary modifications in their farming strategy and barn interior.

Group 3. The practical feasibility

To conclude farmers that wish to make this system feasible on their farms must be willing to change the current farming strategy and be willing to tune into the expression of inherent cattle behaviour. Outside grazing is essential, otherwise, it is not possible to rear cattle in conditions similar to nature. Lastly, farmers should have access to help and advice when it is necessary. Current calf at foot farmers are open to sharing their experience with other transitioning farmers. The rise of interest in the calf at foot system creates a great opportunity for advisors to enter this field.

Group 4. Benefits and attention points of the system

With the (most likely) coming regulation changes (in 2023) it would be advisable for conventional farmers to transition into the calf at foot system. What is more, with the gradually rising consumer awareness and the transparency that is expected from produces, a growing number of consumers is more willing to choose ethically produced animal products, especially when they know the story behind it. On average the calf at foot farms were concluded to be more biodiverse and sustainable than conventional farms. Which seems to be the most important benefit of the system and apart from the ethical side, the most important shift that this system offers. The points of attention discussed already in this report are a result of a more natural, changed production system. As such these should be an aspect to keep in mind while transitioning and organising a new farming strategy.

Group 5. Housing solutions and recommendations

The dutch calf at foot farmers use their old barn interior to house cows and calves together, each farmer added some modifications to make a unique expression of the system. Thanks to these modifications they were able to safely house cows and calves together and generate profit. The most important lesson that can be learned from those farmers is to be creative with already available resources and space. The second important lesson that a lot of farmers could benefit from is to be open to change in the production system and open to asking for help and advice when transitioning.

Main research question

How to house cows and calves together for an extended period of time and generate a profitable business model?

The profitable business model could be divided into economical factors and social (sustainability) factors. The calf at foot system addresses both of those aspects. Namely, it can be concluded that by adjusting the production strategy and accommodating necessary changes it is possible to generate profit in this system. Moreover, the system encourages farmers to take social responsibility for the way of dairy production. The shift in the production system should come hand-in-hand with transparency and consumer education. So that this can work organically on a simple supply and demand principle. The choices that consumers make are crucial to embrace this way of farming. That is why consumer education is so important. The knowledge about the true cost of dairy production should be made widely available to consumers. This way consumers can understand the difference in prices between products better and ultimately vote with their money. Additionally, farmers should be encouraged to transition by making it financially beneficial to produce in the calf at foot system. A recognisable quality label could allow the farmers to increase their

revenue and allow better choices. Nowadays it seems like farmers often have to choose between high revenue or high welfare for animals. This unfortunately leads to conventional farmers increasing the number of milking cows and adding a more processed feed to increase production numbers. This is not ideal for both the environment and animal welfare. It is also the reason why small, local farms are suppressed by big conventional farms. Once the added value of the system is included in the selling milk price the current CaF farmers may be able to allow all calves (male & female) to remain with their mothers equally long. Right now the investment of money and space (see figure 2.) goes beyond the financial capacity of some calf at foot farmers. That is why financial support is important to help those farmers take the next step into the calf at foot dairy production.

Discussion

The feasibility of this system depends on the whole dairy production chain. It starts from the farmers and goes all the way to the consumers, through all the relevant stakeholders. The current expression of the calf at foot system can be made feasible on almost every dairy farm (outdoor access is recommended). However, this way of production will most likely never be more profitable than the conventional way of dairy production. Especially if all calves are reared on-farm. This is understandable because the conventional way of production was created to produce cheap and fast. According to information presented in chapter 2 (theoretical framework), the price difference between feeding a calf powdered milk and fresh milk is not significant. However, the difference in price does not acknowledge the amount of drunk milk. A calf with unlimited access to milk can drink up to 12 litres of milk a day (the general average was estimated to be 10 litres per day). A calf in a conventional system is fed around 6 litres of milk a day, which according to many current pieces of research is not enough. The extra amount of milk (that is needed for the proper development of an animal) is what discourages the industry to the calf at foot system. Because this difference makes it more expensive than the conventional system, however, it does not influence the feasibility of the system. To successfully produce in this system, farmers need to relearn to share the milk with a calf and value inherent behaviour expression. The calf at foot system has the potential of becoming a leading way of dairy production globally. Even though the calf at foot products are relatively easily accessible in the Netherlands, it would be best to make them accessible also in supermarkets. However, before that can happen the consumers should get educated about the production of animal products so that they could make conscious choices.

The table below shows the overview of the price of estimated calf rearing in both systems. It is visible that the CaF system is more expensive, however, it provides a much better start to life in terms of development, health, natural behaviour and animal welfare and as such should be seen as an investment into the future herd.

	Conventional system	The Calf at foot system
Amount of milk drank (average)	6 litres per day	10 litres per day
Time till weaning	8 weeks *	12 weeks *
Milk price	€ 0,50 (conventional milk price)	€ 0,52 (organic milk price)

	Conventional system	The Calf at foot system
Sum (Per calf from birth till weaning)	€ 168	€ 437

Table 5. Calf rearing price overview

* weaning time may differ depending on the farm strategy

Furthermore, the price overview presented in table 5 clearly explains why only a small percentage of the calf at foot farmers allow all calves (male&female) to stay with their mothers. Without a higher selling milk price, this practice may not be attainable for many farmers due to considerably higher production costs and more needed space.

6.3 Recommendations

The recommendation given based on this report has been divided into separate categories:

Barn recommendation

The barn should be an expression of a safe environment for both cows and calves. The modifications shown in this report (chapter 4.) could be used as a guideline or point of reference for transitioning farmers. The transitioning farmers are recommended to use already available space to start

and modify it accordingly. It would not be recommended, however, to transition into the calf at foot system without established outdoor access first.

Farming strategy

The change in the farming system requires a change in farming strategy. Aspects like colostrum management, weaning and calves' dedicated space have to be adjusted accordingly. The transitioning farmers are recommended to pay special attention to hygiene and health

management. In case of many health problems on-farm, it would be recommended to focus on solving those first before starting with the calf at foot system, as calves have much lower immunity than adult cows.

Awareness

Raising awareness about this way of farming is important to make it more accessible for other farmers. The more information is accessible about this system the easier it is for farmers to implement it on their farms and avoid making discouraging mistakes. Especially since there is

still a lot of stigma around this way of production.

One cannot begin to talk about awareness without including consumer awareness. Educating and informing consumers about the production of animal products should be on top of the priority list. Only then, consumers can make conscious choices about their purchases. However, the responsibility for that should not fall on farmers alone. The whole supply chain should work towards higher transparency.

Motivation

The motivation behind the transition is one of the most significant success factors according to the dutch calf at foot farmers. The way of thinking about dairy farming

needs changing, transitioning farmers should start thinking about their cows as mothers with jobs and not as milk machines. The beginnings after the transition to the calf at foot system may be challenging, mainly because both cows and farmers need to learn a new routine. That is why a strong motivation is essential.

Fair prices

The introduction of a quality label that would acknowledge the added value of the calf at foot system could significantly help with:

- Attracting new farmers to transition
- Taking the calf at foot system further and allowing all calves to suckle by the mother equally long.

Currently, it is not possible for all farmers to do that due to financial or space-related issues. Offering them fair, higher prices for produced milk without the need to process it themselves could be an incentive to start with this system.

Chapter 7. Research contribution and advice

7.1 Academic contribution

The academic contribution of this research is the knowledge of how to house cows and calves together for an extended period of time in the calf at foot system. As a result of this research interested parties can navigate through necessary barn modifications and changes in the farming strategy. This research does not tell farmers exactly how they should change their farms, it simply gives guidelines on how to make the calf at foot system feasible for every dairy farmer. This research has shown that it is indeed feasible and safe to house cows and calves together and generate profit. Some of the common beliefs around this system have been proven wrong and/or inaccurate (see theoretical framework page 12). Which can potentially persuade more conventional farmers to transition into this system. This research could stimulate more attention to this way of farming and hopefully forces relevant stakeholders to start a conversation about gradually improving the whole supply chain.

Based on this research, as well as, the interviewed dutch farmers it is visible that calf welfare is significantly under-addressed in the conventional dairy system. Based on the overview from chapter 2 "the beginning of a life of a calf" and confirmed by behavioural observations it can be concluded that calves are limited in expressing their inherent natural behaviours in the conventional production system. Research conducted by Whalin, Weary and von Keyserlingk in 2021 on wild calves stated that calves allowed unlimited access to milk engage in playing with peers more often than calves with limited access to milk. Based on this research it can be concluded that it is indeed true and that according to dutch dairy farmers calves raised in this system with unlimited access to milk are healthier, more daring and robust also later in life as milking cows. Lastly, an important contribution of this research is for the dairy industry to see calves as an integral part of a herd and not as a by-product of milk production.

7.2 Managerial contribution/advice

The managerial contribution is divided into four sub-sections, each section is directed to a different part of the dairy supply chain or supporting organisation. Farmers alone cannot make a real difference in the farming system, more than just farmers have to be addressed. Moving toward more animal-friendly agriculture many relevant stakeholders have to change their business models.

Farmers

Farmers definitely play a key role in changing the production system. They are the base, thanks to their willingness to change their way of farming they can have a real impact on the lives of animals, and the quality and environmental impact of produced food. The managerial

contribution of this research to conventional farmers is changing the perception of the calf at foot dairy production by proving that it is feasible. Furthermore, it gives the farmer guidelines on how to approach such a transition. Farmers that are curious about this production system can use this research as a guide in navigating them through the necessary steps. Another piece of advice that could be given to dairy farmers is to share their practices and educate each other. During the farm visits, it has been made clear that each farmer had their own story and experience. Yet, thanks to that transparent exchange of knowledge and experience, universal guidelines for the calf at foot system can be created.

The following guidelines should be analysed and implemented before transitioning into the calf at foot system. It should be noted that these guidelines were created based on the housing requirements of the calf at foot system and as such may not be complete in all aspects. It is still most recommended to visit multiple calf at foot farmers before approaching to transition into this production system. The first-hand knowledge and experience of fellow farmers will never substitute guidelines put on paper. However, as a point of reference the list below was created.

Before the transition:

1. Addressing any existing health & hygiene problems on-farm
2. Provide an outdoor grazing access
3. Making sure that flooring in the barn is suitable for calves
 - (It is also possible to limit calves' access to parts of the barn not suitable/safe for them)
4. Implementing necessary adjustments to provide access to food and water for calves
5. Making sure there is enough laying space for **ALL** animals in the barn
6. Choosing a weaning strategy and creating a suited, dedicated space
7. Creating an area dedicated for calves
 - (This space is not essential especial if the farmer provides year-round unlimited outdoor access)
8. Allowing a cow a possibility to separate herself from the herd for parturition
 - (Either by creating a dedicated calving area or providing unlimited outdoor access)
9. Checking (and improving if necessary) the colostrum quality
10. Organising a new colostrum management strategy
11. Plan to include some form of socialisation with the calves

After the transition farmers are encouraged to keep evaluating the system, adjusting it if necessary and asking for help and advice when it is needed. It should also be kept in mind that allowing a calf unlimited access to fresh milk will always be more expensive than restricting the milk access as it is done in most conventional dairy systems. This difference should be seen as an investment in a healthy calf (and milking cow later). Lastly, it should be acknowledged that the milk produced by a cow is originally meant for a calf, and as such it should be shared with it.

Animal welfare NGO's

The animal welfare NGO's were created from the need to address the animal welfare issue in today's animal production systems. It is not a secret that thorough out the years of intensive animal production the natural, inherent well-being of farm animals is often forgotten. The NGO's play an extremely significant role in exposing some of those practices and informing the public about them. There is a growing need to conform to higher animal welfare standards. However, some of the animal welfare NGO's have a bad reputation among animal producers. This in a result creates a conflict between animal producers and animal welfare NGO's. Consequently, not much is changing in terms of on-farm animal welfare. Striving to create an actual change for farm animals should be the common goal of farmers and NGO's that they strive to achieve together.

Supermarkets

Supermarkets have a strong influence on consumers' buying habits. The reason for it may be the convenience of buying all the groceries in one place, easy packaging and discounts. However, not many supermarkets take responsibility for the products they sell. Naturally, most consumers are influenced by the price of the products when making the purchase. The cheapest products are usually of the highest environmental impact. Which can mean that even if the calf at foot dairy products were available in the supermarkets consumers would most likely be reluctant to buy them, having multiple cheaper options. The supermarkets have the advantage of having direct contact with consumers, causing them to be able to communicate and educate the consumers about the reason for price differences and the origin of the products. However, not many supermarket chains are doing that. Most of the retail sector still puts the responsibility only on the producers to solve ethical and environmental issues present in the sector. When in truth each part of the dairy production chain should strive to work together to take responsibility for the existing ethical and environmental issues present in the whole chain.

Government

The government plays a significant role in creating policies and organising the agricultural sector. The government has the power to introduce the necessary, much-needed changes in the agricultural system and to support those who are already presuming the change towards more sustainable and ethical dairy production.

7.3 Recommendation for future research

The calf at foot system is not the common way of dairy production, causing there to be little research done on it. This should be the first indicator that to have a full, scientific overview of the calf at foot system, the research done in the conventional production system should be repeated in the other system as well. Only then can there be a clear picture of the calf at foot system. Furthermore, not much attention is paid to the role of a calf in the dairy production system. Based on the literature search the information available about the natural behaviour and needs of dairy calves is limited. The importance of the calves is only stressed when they become adults and join the herd as a milking cows. In order to fully understand the benefits of the calf at foot system, its importance of calves should be researched in depth.

Namely:

- the role and benefits for calves to interact with other herd members
- the role and importance of playing with peers
- the impact that growing up in the calf at foot system as a calf has on adult milking cows
- Importance of sufficient milk intake for later stages of life

To point out the differences between those production systems, research comparing the development of calves in both systems should be conducted and an evaluation of their performance as a milking cows should also be done. Then the benefits of the calf at foot system could be scientifically proven. Which could contribute to seeing a calf as an essential part of the herd.

Researchers nowadays start to realise that calves in the conventional dairy system are weaned too early and are underfed says Ann Margaret from the Norwegian School of Veterinary Science (2019). The MSD manual (the veterinary manual) recommends trying and weaning calves as soon as possible, as according to the manual the risk of enteric diseases during the liquid feeding period is higher. It remains unclear whether this is also the case for the calf at foot system, or only when calves are fed artificially. Since there is a limited amount of research done on the calf at foot system it can be assumed that the research on which the MSD manual is based, was also conducted in the conventional production system. Which would make it inaccurate. There are many hazards for milk contamination in the conventional calf rearing system, which can be a cause of mentioned enteric diseases. Moreover, the limited feeding practice is also justified by the possibility of the excess milk leaking into the punch and rotting there. However, according to research on the calf's abomasum conducted by Kristian Ellingsen of the Norwegian Veterinary Institute in 2014, a calf that had unlimited access to milk and that was allowed to drink their fill had no cases of milk spilling into the paunch. Which could mean that calves fed with a bucket two times a day, felt the need to drink all the milk quicker to feel sustained and that could have created the leakage.

Furthermore, it would be recommended to conduct more behavioural research on adult cows to establish differences in behaviour between cows that are allowed to keep their calf and the cow from the conventional system. Lastly, udder health and overall health benefits for dairy cows in the calf at foot system should be researched further as there is not much data available at the moment. According to Hurry-Person (2021) suckling can decrease the change of mastitis, but there are possibly more health benefits for the cows in the calf at foot system. The more benefits of the calf at foot system are scientifically proven to more open the industry is going to be for it.

Reference

AFDA, n.d. *Development of the Calf Digestive System*. [online] Teagasc.ie. Available at: <<https://www.teagasc.ie/media/website/publications/2017/Section4-Rumen-development.pdf>> [Accessed 8 June 2022].

Aphis.usda.gov. 2020. *USDA APHIS | Johne's Disease*. [online] Available at: <<https://www.aphis.usda.gov/aphis/ourfocus/animalhealth/nvap/NVAP-Reference-Guide/Control-and-Eradication/Johnes-Disease>> [Accessed 14 April 2022].

Arwebshop.nl. 2022. *Kalvolac Power 20 kg*. [online] Available at: <https://www.arwebshop.nl/kalvolac-power?gclid=CjwKCAjwsJ6TBhAIEiwAfl4TWAni2NoUa044X_oiTjdb2EKDOgYKVGIIInlzyPcD0RiAlb7EyA8wFxoCU3MQAvD_BwE> [Accessed 28 April 2022].

Busch,, G., Weary, D., Spiller, A. and von Keyserlingk, M., 2017. *American and German attitudes towards cow-calf separation on dairy farms*. [online] NCBI.nlm.nih.gov. Available at: <<https://www.ncbi.nlm.nih.gov/pmc/articles/PMC5354428/>> [Accessed 28 April 2022].

CalfCare, 2019. *Why are calves so vulnerable to illness?*. [online] CalfCare.ca. Available at: <<https://calfcare.ca/management/health-and-welfare/treatment-and-prevention/why-are-calves-so-vulnerable-to-illness/>> [Accessed 25 May 2022].

Cunningham, C., 2019. *Family dairy saves money by making their own calf hutches - Farmers Weekly*. [online] Farmers Weekly. Available at: <<https://www.fwi.co.uk/livestock/housing/family-dairy-saves-money-by-making-their-own-calf-hutches>> [Accessed 24 May 2022].

Ellingsen, K., 2014. *Calves aren't being given enough milk*. [online] Sciencenorway.no. Available at: <<https://sciencenorway.no/agriculture--fisheries-animal-husbandry-animal-welfare/calves-arent-being-given-enough-milk/1400429>> [Accessed 13 April 2022].

Elsen, M. and van den Akker, K., 2021. *Betalingsbereidheid van consumenten voor duurzame(re) producten*. [online] Acm.nl. Available at: <<https://www.acm.nl/sites/default/files/documents/consumentenonderzoek-betalingsbereidheid-duurzame-producten.pdf>> [Accessed 24 May 2022].

Familiekuddes.nl. n.d. *Familiekuddes*. [online] Available at: <<http://www.familiekuddes.nl/1-de-kudde/>> [Accessed 14 April 2022].

Fröberg, S., 2008. *Effects of Restricted and Free Suckling - In Cattle used in Milk Production Systems*. [online] Pub.epsilon.slu.se. Available at: <https://pub.epsilon.slu.se/1901/1/Kappan_081108_epsilon.pdf> [Accessed 8 June 2022].

van Gelder, K., 2021. *Netherlands: milk yield per cow 2020 | Statista*. [online] Statista. Available at: <<https://www.statista.com/statistics/1097599/average-milk-yield-per-cow-in-the-netherlands/>> [Accessed 13 April 2022].

Herd, T., 2014. *Feeding Young Dairy Calves - Management and Nutrition - MSD Veterinary Manual*. [online] MSD Veterinary Manual. Available at: <<https://www.msdsvetmanual.com/management-and-nutrition/nutrition-dairy-cattle/feeding-young-dairy-calves>> [Accessed 18 July 2022].

Hulshof, C., 2022. *Koeien en kalveren - Melken is van alle tijden, radicale scheiding niet - Foodlog*. [online] Foodlog. Available at: <<https://www.foodlog.nl/artikel/melken-is-van-alle-tijden-radical-scheiding-koe-kalf-niet/>> [Accessed 13 April 2022].

Hurty-Person, J., 2021. *Cow-calf separation: A look at the research and public opinion behind this practice*. [online] Progressive Dairy. Available at: <<https://www.progressivedairy.com/topics/calves-heifers/cow-calf-separation-a-look-at-the-research-and-public-opinion-behind-this-practice>> [Accessed 14 April 2022].

Kingfeed.net. 2022. *Weaning a Calf*. [online] Available at: <<https://kingfeed.net/blog/70924/weaning-a-calf>> [Accessed 26 April 2022].

Koskamp, G., 2022.

Kwakman, R., 2021. *The Netherlands: Facts, figures, and farm trends in the dairy sector - Dairy Global*. [online] Dairy Global. Available at: <<https://www.dairyglobal.net/world-of-dairy/the-dutch-dairy-industry-facts-figures-and-farm-trends/>> [Accessed 13 April 2022].

Mariampolski, H., 2001. *Qualitative Market Research*. Brooklyn: QualiData Research Inc.

Melkvee.nl. 2022. *AVG & Cookiemelding*. [online] Available at: <<https://www.melkvee.nl/marktcijfers/>> [Accessed 28 April 2022].

van der Meulen, H., 2022. *Inkomen op biologische melkveebedrijven vrijwel onveranderd*. [online] Agrimatie.nl. Available at: <<https://www.agrimatie.nl/ThemaResultaat.aspx?subpubID=2232&themaID=2267&indicatorID=2089>> [Accessed 28 April 2022].

van der Meulen, H., 2018. *Schaalgrootte en inkomen melkveehouderij*. [online] Agrimatie.nl. Available at: <<https://www.agrimatie.nl/SectorResultaat.aspx?subpubID=2232§orID=2245&themaID=7474>> [Accessed 15 July 2022].

MOUNAIX, B., BOIVIN, X., BRULE, A. and SCHMITT, T., n.d. *Cattle behaviour and the human-animal relationship: Variation factors and consequences in breeding..* [online] Edepot.wur.nl. Available at: <<https://edepot.wur.nl/312679>> [Accessed 13 April 2022].

Neave, H., Sumner, C., Henwood, R., Thoday, H., Watson, T. and Webster, J., 2021. *Dairy farmers' perspectives on providing cow-calf contact in the pasture-based systems of New Zealand*. [online] journal of dairy science. Available at: <[https://www.journalofdairyscience.org/article/S0022-0302\(21\)00972-3/fulltext#%20](https://www.journalofdairyscience.org/article/S0022-0302(21)00972-3/fulltext#%20)> [Accessed 29 April 2022].

NL Times. 2021. *Dutch Senate approves amendments to the animal law, farmers concerned*. [online] Available at: <<https://nltimes.nl/2021/06/02/dutch-senate-approves-amendments-animal-law-farmers-concerned>> [Accessed 25 April 2022].

Nunan, D. , Birks, D.F., Malhotra, N.K. (2020)Marketing Research: Applied Insight. 6th edition. Pearson, Harlow, England.

2019. *RSPCA*. [online] Available at: <<https://kb.rspca.org.au/knowledge-base/why-are-calves-separated-from-their-mother-in-the-dairy-industry/>> [Accessed 23 June 2022].

RVO, 2020. *Welzijnseisen voor kalveren*. [online] RVO.nl. Available at: <<https://www.rvo.nl/onderwerpen/dierenwelzijn/regels-huisvesting-verzorging/kalveren>> [Accessed 24 May 2022].

Veeteelt.nl. 2022. *Economie*. [online] Available at: <<https://veeteelt.nl/economie>> [Accessed 28 April 2022].

Wenker, M., Bokkers, E., Lecorps, B., von Keyserlingk, M., van Reenen, C., Verwer, C. and Weary, D., 2020. *Effect of cow-calf contact on cow motivation to reunite with their calf*.

[online] [www.nature.com](https://www.nature.com/articles/s41598-020-70927-w.epdf?sharing_token=7IvKyd1FV47gdpGgWisLbdRgN0jAjWel9jnR3ZoTv0PTsDY40STj6qtzeTSO_U7y7xk8g35ttd0Ulp6WAI2ceXbqIA3l15HU9lxNuQ4ybOS3W9R9ISv5hXXS5ZusH_H8qoLzdOK48EBLGGrriEW5iu2PjXlgEsl_kCZtk_siMck%3D). Available at: <https://www.nature.com/articles/s41598-020-70927-w.epdf?sharing_token=7IvKyd1FV47gdpGgWisLbdRgN0jAjWel9jnR3ZoTv0PTsDY40STj6qtzeTSO_U7y7xk8g35ttd0Ulp6WAI2ceXbqIA3l15HU9lxNuQ4ybOS3W9R9ISv5hXXS5ZusH_H8qoLzdOK48EBLGGrriEW5iu2PjXlgEsl_kCZtk_siMck%3D> [Accessed 28 April 2022].

Whalin, L., Weary, D. and von Keyserlingk, M., 2021. *Understanding Behavioural Development of Calves in Natural Settings to Inform Calf Management*. MDPI.

Zuivel.nl.org. 2020. *dutch dairy in figures*. [online] Available at: <<https://www.zuivel.nl.org/uploads/images/Publicaties/Dutch-Dairy-in-Figures-2020.pdf>> [Accessed 13 April 2022].

Annex

List of questions in qualitative research.

Farm specific

1. How many cows do you have?
2. How many hectares?
3. Do you only keep cows or also other animals/types of agriculture?
4. Do your cows graze outside?
5. How long per day?
6. Is your farm organic?
7. How much do you produce per cow per year?
8. What milking system do you use?
9. How would you describe your farm?
10. Where do you slaughter your animals?

Questions about the system

11. How long do you keep calves together with a cow?
12. Since when do you keep cows and calves together? (How many years)
13. And why this long?
14. How do you perform weaning?
15. Do you prepare calves for weaning?
16. How long does weaning take at your farm?
17. What happens to calves after weaning?
18. Do you keep female and male calves?
 - If yes, do you keep them equally long?
 - If no, what do you do with bull calves?
19. How long did it take you to transition?
20. Why did you choose to transition? What was the motivation?
21. What housing system do you have?
22. Did you redesign the barn to accommodate calves?
23. How is the herd structured?
24. How big was that investment?
25. Was your farm operative during the time of transition?
26. What was the hardest point of the transition?
27. What was the easiest?
28. Would you recommend this system to other farmers?
29. What is the most important before you can start?

30. Would you be open for a farm visit?
31. Your views on bull calves production?

Specific questions post transition

1. Do you find you have more or less problems with calves' health since transitioning?
2. More or less labour?
3. Outbreaks?
4. Mortality?
5. Did you change your milking system since the transition?
6. Has your milk yield changed?
7. Did you have a problem with re-wilding?
8. What do you do against wilding?
9. Do you find your cows being more aggressive?

Income/costs/ revenue

10. Do you have higher or lower production cost?
11. Do you have more or less expenses after the transition?
12. Is your revenue higher or lower since the transition?
13. Where do you sell your products?
14. Do you ask higher price for your products since the transition?
15. Is it easier or harder to sell them?

16. Would you like to be a part of it?
17. Have you seen *kalfjes bij de koe* website ?
18. Do you know you are on it?

19. Would you be agree for an interview for CF website?
20. Would you agree to be featured on CF website?
21. Do you want to join private farmer what's app group?

Ethogram

	Contact with mother	Contact with peers	Resting
Activities observed			
Frequency			

	Contact with mother	Contact with peers	Resting
Duration			
Remarks			

Interactions	With farmer
Does the calf escape when approached by the farmer ?	

Interactions	With farmer
Does it approached the farmers by itself ?	
How does the mother react to calf being approached ?	
Remarks	

Interaction	With other adults
Is calf being groomed by other adults ?	
Is calf sucking by other adults ?	
Remarks	