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Caroline Constancis, Florence Hellec, Nathalie Bareille, Mette Vaarst. Introduction and development of foster cow systems on organic dairy farms in France. *Biological Agriculture & Horticulture*, 2022, 39 (2), pp.73-90. 10.1080/01448765.2022.2124884 . hal-03819888

HAL Id: hal-03819888

<https://hal.inrae.fr/hal-03819888>

Submitted on 21 Mar 2024

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Introduction and development of foster cow systems on organic dairy farms in France

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ABSTRACT

The rearing of dairy calves, whether in conventional or organic farming, is questioned in society, particularly due to its lack of naturalness caused by the limited contact between age groups. Foster cow systems, where foster cows stay with calves in low-input pasture-based systems, have been implemented in France since 2010. The aims of this study were to explain farmers' motivations for establishing their cow-calf contact systems and to describe the ways in which they have implemented them, in terms of daily practice and as part of their organic dairy farm. A documented investigation of the introduction of these rearing systems in France was carried out. In addition, individual semi-structured interviews were conducted between January and March 2019 on 20 organic farms that had implemented this practice. Farmers' perceptions of the practice were explored through content analysis of the interview responses. Calves were separated from their dam after an average of 4.5 days. The bonding phase was conducted by leaving them together for 2–7 days in small bonding pens. Weaning and separation took place either simultaneously or gradually, between the age of 4–10 months. The farmers perceived these systems as working very well and being easy to implement on grazing-based farms, as well as ensuring good profitability and working conditions. According to the farmers, the calves appeared to have high growth rates and good health status, enabling the first calving at a younger age. These rearing systems seemed to be compatible with an agroecological transition.

ARTICLE HISTORY

Received 10 April 2022
Accepted 12 September 2022


KEYWORDS

Agroecology; calf rearing system; cow-calf contact; farmer experiences; foster cows; organic dairy farming

Introduction

The ethical principles of organic farming, as set out by International Federation of Organic Agriculture Movements (IFOAM) in 2005, are to promote animal health and welfare ([IFOAM] International Federation of Organic Agriculture Movements 2005). Animal welfare is closely connected to the concept of enabling animals to meet their natural needs (Vaarst and Alrøe 2012). Naturalness and animal welfare are also matters of concern for consumers and citizens (Placzek et al. 2021). Research that has analysed the practices of organic dairy farmers has suggested that there is room for improvement, in particular in relation to calf rearing (Marley et al. 2010). On organic dairy farms in Europe, the current management practice is to separate calves from their dam soon after birth, to house them indoors, and to feed them with whole milk from the farm until the age of three months. These calves do not meet adult cows before their first calving (Budzynska and Weary 2008).

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 Supplemental data for this article can be accessed online at <https://doi.org/10.1080/01448765.2022.2124884>

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This current method of rearing dairy calves on organic farms is questioned today on two main aspects. First, some research indicates that separation soon after birth may appear less traumatic, because there is less vocalisation than in the case of separation once the dam-calf bond has been established (Weary and Chua 2000). However, early separation deprives the calf and its dam of natural interaction, such as maternal care, learning, and socialising, and is criticised from the viewpoint of animal welfare (von Keyserlingk and Weary 2007). Second, it has been claimed for decades that weaning by this method is too early and sudden compared to natural weaning, which occurs at between 8 and 11 months (Reinhardt and Reinhardt 1981, *Bos indicus*). For example, Veissier et al. (2013) found that weaning before 10 weeks could lead to behavioural disturbances in calves, such as sucking on body parts of other calves (cross-sucking) or on pen equipment. Even though this is earlier than on organic farms, it indicates that weaning and separation long before natural weaning may affect the behaviour and well-being of the calves. Increasingly, critics in society point to the animal welfare consequences of separation immediately after birth and encourage contact between the cow and calf until weaning (Agenäs 2017).

To improve the living conditions for dairy calves, two main initiatives have emerged that enable rearing systems based on cow-calf contact. Scientists from different European countries have mostly experimented with cow-calf contact on dairy farms (Veissier et al. 2013; Johnsen et al. 2016; Vaarst et al. 2020). Farmers' interest in and experience of organic dam rearing systems has been studied in northern European countries and in France (Vaarst et al. 2020). Other types of cow-calf contact systems exist, where dam-calf separation occurs early, in the first days of the life of the calf and the calf is kept together with one or two other calves by a foster cow taken from the milking herd. In such systems, the calves have free access to the foster cow until late weaning. This type of cow-calf contact systems requires a phase where bonding between the calves and the foster cow is stimulated by leaving them together for 2–7 days separately and help the calves to suckle when necessary. These types of rearing systems were investigated in several experiments in the late 1960s and 1970s in New Zealand (Krohn 2001), and have been implemented in different countries over the last half century. However, they have not been debated or received attention in France, but have been increasingly developed and implemented in the French context (Michaud et al. 2018). France is the second largest producer of dairy products in Europe with 250,000 organic dairy cows, i.e. 7% of the national total (Agence Bio 2020). Therefore, motivations to implement and develop such systems in organic dairy farming in a French context could be relevant to explore more in-depth.

Farmers' interest in and experience of dam rearing systems has been studied (Vaarst et al. 2020) in order to identify practical considerations when opting for this system. But with regards to foster cow rearing, there is little information on how farmers perceive this system, or on how they have implemented it. The aim of this study was to explain farmers' motivations for establishing a foster cow system and to describe the ways in which they have implemented it, in terms of daily practice and as part of their French organic dairy farm.

Materials and methods

Documented investigation of the introduction of foster cow systems in France

A literature review was carried out using local technical journals to investigate the introduction of the rearing systems in France. Foster cow systems in France was the search criterion, which led to finding 20 articles in the French agricultural press. One article of particular interest described a study trip to visit English farms with foster cow systems (Pailler 2013). For this study reported here, the author of the article (Isabelle Pailler, Brittany Chamber of Agriculture) was interviewed about their contribution to the implementation and development of foster cow systems in France.

Selection and recruitment of farmers

Twenty farmers, who were involved in participative research to assess the impact of foster cow rearing on the growth, health and welfare of calves, were interviewed (Constancis et al. 2020a). To identify the farmers, information was obtained about commercial organic dairy farms that rear calves with foster cows and that are located in the major French dairy cattle production area (north-western France: Brittany, Normandy, Pays de la Loire) from several professional organisations (organic farmers associations, veterinary practitioners, advisers and regional Chambers of Agriculture). This information was used to make a list based on two inclusion criteria: being an organic farm in north-western France, and rearing replacement calves with foster cows. This gave a list of 50 potential farms, which were contacted by telephone. Two farmers declined the invitation to participate in the study due to a lack of time, and no contact could be made with 10 of the farms. The recruitment ended when the first 20 farmers had agreed to take part in the participative research project. All farms were organic in accordance with the current EU-regulation ([EU] European Union 2018) and were inspected accordingly by the same certification body. Interviews with the farmers about their motivations and experience of foster cow rearing were conducted at the beginning of this project. The farmers signed an informed consent letter previously validated by the Oniris Veterinary Clinical and Epidemiological Research Ethics Committee, Nantes, France (CERVO-2018-9-V). The interviewees received no financial benefits for their participation.

Data collection and analysis

Individual interviews were conducted between January and March 2019. These interviews constituted the first step of a long-term study conducted by the first author and aimed at investigating, in collaboration with farmers, the technical and sanitary performance of foster cow systems (Constancis 2021). In this participatory research project phases of epidemiological analysis alternated with phases of formal and informal conversations with the farmers, individually or in groups, regarding various test results (e.g. parasite counts) or the preliminary results of the epidemiological analyses. For this reason, an ethnographic survey method was chosen (Angrosino 2007). Throughout the research project, field notebooks were kept, with written details of all conversations (Emmerson et al. 1995). These conversations were either informal or undertaken as planned interviews with an interview guide, like the data collection for this study reported here. Although such ethnographic methods are not common in epidemiological studies of farmers' perceptions and practices (favouring recorded interviews), they are widely used for studying sociology of agriculture, particularly among researchers interested in issues relating to technical change (e.g. Hellec et al. 2021). As part of a continued communication with the farmers, this method allows the researcher to have a greater proximity to farmers involved in innovations, and thus a better understanding of these phenomena. This ethnographic method was considered to be appropriate for this study with the purpose of monitoring innovative rearing systems.

The individual interviews were conducted by the first author, following an interview guide that included structured and open-ended questions (Supplemental Information). The interviews lasted between 1 and 1.5 hours and were followed by a farm tour led by the farmer. The first author was experienced in undertaking interviews with farmers and before visiting the farms the interviewer was specifically trained in relation to the interview guide used in this study. At all of the interviews, the responses from the farmers to the questions were documented by detailed note taking by the interviewer. The interview guide was structured around four main areas: (1) a general presentation of the farm and the farmer, (2) how the farmer had experienced and implemented this type of rearing system, (3) a detailed description of daily management, and (4) how the farmer perceived the management, challenges and performance (the interview guide is available as Supplemental Information).

The main characteristics of the farmers and their farms were reported by the interviewer on the day or the day after the interview in a table in order to provide a global view of the characteristics of the farms and interviewed farmers.

A content analysis of the interviews was produced using an inductive approach, where a grid of analysis was iteratively built up from themes coming out of the interviews (Brinkmann and Kvela 2014). This grid was used to identify similarities and differences between the farmers' experiences and points of views regarding their motivations to implement and organise their cow-calf contact systems.

Results

The setting: how foster cow systems were introduced and disseminated in France

The results of the review of the French local literature traced back to the introduction of foster cow rearing in France. In September 2009, a group of 17 organic farmers from the Finistère department went on a study trip to the United Kingdom to learn about how improved pasturing could make their farms more profitable through low-input dairy systems. According to Pailler (2013), they visited two particularly interesting farms. On the first farm, 500 dairy cows all calved within six weeks in March-April. At first, 10 groups of 30 calves were bonded to 10 foster cows per group. After the cows were turned out to pasture, approximately 100 foster cows took care of 300 calves, until their separation and weaning at the end of September. This farmer had organised and implemented this rearing system on their own initiative. On the second farm they had recently implemented a similar foster cow system, inspired by the first farm. They had compared two groups of 40 New Zealand Friesian cross Jerseys heifers, one of which was milk bar-fed for 14 weeks, and the other was reared with foster cows. They had weighed the calves at six months of age and found that the foster calves were on average 40 kg heavier than the milk bar-fed calves. In addition, they found the foster cow system easier to work with.

After the study trip, seven of the French farmers decided to implement a foster cow system on their farms in the spring 2010 and 2011. Most of them kept individual foster cows with three to four calves in separate pens during 7 to 21 days for the bonding phase, before turning them out to pasture with the rest of the group. They experienced fewer cases of calf diarrhoea, and observed generally good growth and earlier grazing of the calves. They also found that the foster cow system was fairly easy to manage in most cases. Some of these farmers communicated in the farming related media, and organised visits to their farm for groups of grassland farmers in order to present their foster cow system. Thus, they actively disseminated information about types of systems within the networks of grassland farmers.

As can be seen in Figure 1 and Table 1, the farmers recruited for this study began to implement the foster cow systems between 2013 and 2018. The farmers first heard about this rearing system through colleagues from other farms ($n = 9$), exchange groups ($n = 6$) or via the internet and agricultural press ($n = 4$).

Characteristics of the farms, herds and farmers

The farmers participating in the study began organic production, in accordance with the EU regulation ([EU] European Union 2018), between 1998 and 2019 (Table 1). The farms were on average 117 ha (42–275 ha) of which an average of 87% was pasture. The foster cows represented 12% (8% – 18%) of the cows on the farm. On average 19 (10–40) replacement heifers were kept per year, which represented a herd replacement percentage of 27% (20% – 45%). The vast majority of the herds ($n = 15/20$) were crossbred with a wide variety of dairy breeds. Once-a-day milking was conducted on eight farms for at least part of the year. The calving period was either only in spring ($n = 6$), in two periods ($n = 8$), or all year round ($n = 6$). Seven of the farms sold their products directly from the farm or a market, and four also had a dairy processing unit.

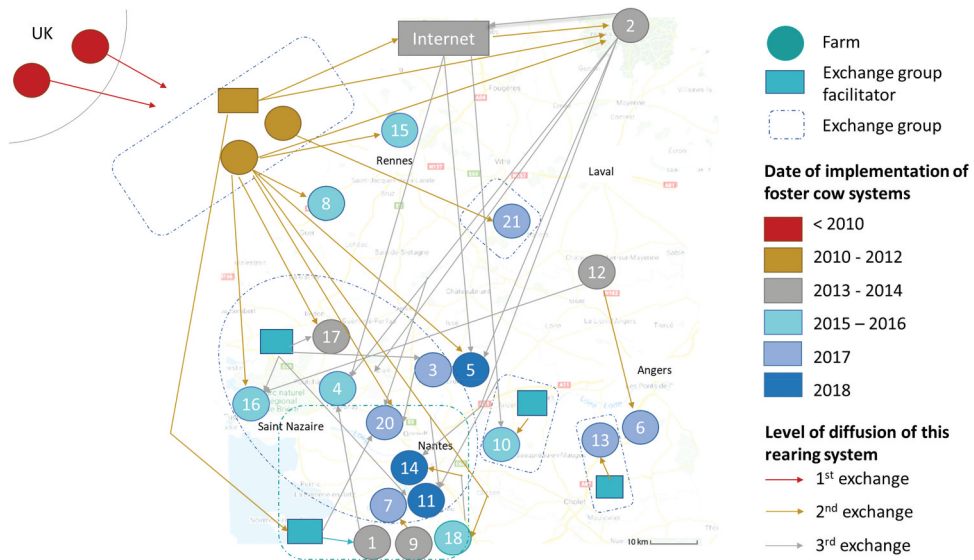


Figure 1. Spatial and temporal description of the implementation of foster cow systems from its introduction in France by the farmers interviewed.

Twelve farmers had higher technical education, four were agricultural engineers, and two had attained a secondary school diploma. Regarding activities and duties outside the farm, almost all of the farmers had participated in between one and five exchange groups, on average over 8 half-days per year (3 to 20 half-days). The exchanges covered many different focal areas, such as management of grazing-based dairy farming, rearing calves with foster cows, once-a-day milking, cross-breeding, seasonal calving and alternative medicines.

Description of the phases of the foster cow system

The calf rearing practices basically consisted of four phases: a compulsory first phase with the dam, followed by an optional phase of artificial milk feeding, a third phase of bonding between calves and a foster cow. After this, the foster cows were on pasture with the calves for several months, before the final and fourth phase of separation and weaning, which generally took place simultaneously or gradually (Figure 2). The challenges of these rearing systems and the solutions identified by the farmers have been discussed in each section below and are summarised in Table 3.

Calving and rearing with the dam

Calving took place either outdoors depending on the weather ($n = 10$), always outdoors ($n = 7$), or always indoors ($n = 3$). Four farmers separated the calves from their dam within one day, 12 farmers left the calves with their dam for between one and three days, and in the four remaining herds, the calves stayed with their dam for more than three days (maximum one month) in the lactating group. On all farms, the calves were permanently with their dam during this period. Immediately after separation from the dam, the calf was bonded to the foster cow ($n = 11$) or went into the artificial milk-feeding phase (whole milk given by the farmer) before being introduced to a foster cow ($n = 9$).

The calves that went into the artificial milk-feeding phase stayed less than three days with their dams. Between two and three litres of milk were given twice a day in teat buckets. The milk given was either non-marketable milk ($n = 3$), milk from the dams ($n = 5$), or milk from the bulk tank ($n = 1$). Some farmers also used this phase as a buffer to separate the calves early from their dam and



Table 1. Characteristics of the 20 organic (in accordance with EU (2018)) dairy farms included in the study.

Farm ID	2009	2014	2000	1998	2016	2018	2000	2019	1998	2011	2012	2017	2007	2009	2017	2017	2017	2017	2009	2017	2017	2017		
Year certified organic	2009	2014	2000	1998	2016	2018	2000	2019	1998	2011	2012	2017	2007	2009	2017	2017	2017	2017	2009	2017	2017	2017	2017	
Year of foster cow implementation																								
Surface area of farm (ha)	90	56	120	60	275	115	200	135	230	60	42	160	100	105	117	48								
Breed	H x N x P	H x M x J x	H	H x J x SR x M	H	J	H x N x BS	N x M x H	H x NR	J x H x NR	H	H x M x J	H x SR x J	N, H	H x H x S	H x M x J	H x M x J	H x H x S	H x H x S	H x M x J	H x M x SR	H x M x SR	H x BS x M x J x SR	
Number of lactating cows	70-75	65	55-60	40	120	100	70	85	100	50	38	50	75-80	60-65	65	14								
Number of foster cows	8	7	6	7	15	10	9	11	20	6	7	7	8	7	12	6	7	7	6	6	7	55-60	7	14
Milk production (L cow ⁻¹ year ⁻¹)	4750	4000	4100	4250	8750	4740	5000	8000	4500	3500	6500	3700	6500	5000	3500	5000	6250	4500	5000	5000	6250	4500	4500	4500
Number of milkings day ⁻¹	1, 2, 1	1, 2, 1	1	2	2	2	2	2	2	1	2	1	2	2	1	2	2	2	2	2	2	2	2	2, 1
Calving periods (month numbers)	all year round	2-4	8-10	3-6	all year round	all year round	all year round	all year round	2-5; 8-10	3-4; 9-10	all year round	3	all year round	2-3; 7-10	1-5	2-3	7-8	3-6; 9-11	2-3	2-3	7-8	3-6; 9-11	3-6; 9-11	

Notes: H: Holstein; N: Normande; J: Jersey, SR: Swedish Red Polled; M: Montbéliarde; RDP: Rouge des Prés (French local breed); P: Pie rouge des plaines (French local breed); BS: Brown Swiss; NR: Norwegian Red; S: Simmental; FR: Flemish Red. x: crossed; 1,2,1: one milking per day only at the beginning and end of lactation; 2, 1: one milking per day only at the end of lactation.

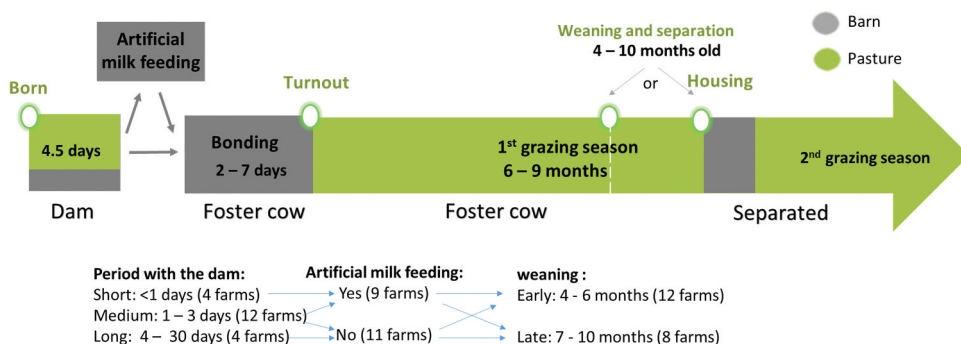


Figure 2. Illustration of the timeline of the foster cow rearing systems.

to ensure they were strong enough to suckle their foster cow. On three farms, the last calf would have a direct transition from the dam to the foster cow, without going into the artificial milk-feeding phase.

Calves intended for sale were managed as replacement calves. The calves were mainly sold at 15 days old (Table 2). A third of the farmers also kept some of the calves and sold them as veal at between two and five months old ($n = 6$) or kept them until slaughter at 2.5–3 years old ($n = 2$).

Bonding process

The calves were separated from their dam and introduced to a cow that was selected by the farmer as a foster cow, based on criteria like high somatic cell counts (SCC), poor fertility, milking issues, lameness or good maternal abilities. None of the foster cows took care of their own calves to avoid one calf being favoured over others. Previously, the farmers had often opted to have the cows culled at the end of their lactation, but these types of foster cow systems enabled foster cows to stay longer on the farm.

Grouping the calves were mostly based on age ($n = 17$), depending on the number of foster calves (up to five per group) and the duration of the calving season. The age difference between calves grouped together with a foster cow was 3 or 4 days ($n = 6$), 7 days ($n = 5$), 10 days to 3 weeks ($n = 6$) or even as much as 1.5 months ($n = 3$). Farmers generally had the experience that bonding at an age of approximately one week worked best, because the calf was then strong enough to suckle the foster cow. Some farmers mixed male and female calves and could benefit from early separation of male calves sold afterwards and adapted the needs of the calves to the milk production of the foster cow, where others avoided mixing female and male calves.

The bonding process normally took place in a separated ($n = 14$) or shared ($n = 2$) pen in the barn and lasted between two and seven days. The foster cows remained permanently with the calves and were not milked.

Deciding on the number of calves per foster cow and establishing the bond between foster cow and calves were most frequently mentioned as the two most important challenges (Table 3). Monitoring of the bonding process was carried out mainly twice a day ($n = 13$), and up to seven times a day. The farmers were primarily concerned whether the calves suckled the foster cow sufficiently ($n = 13$), and attention was given to the behaviour of the foster cow ($n = 8$) to see, for example, whether she licked or kicked the calves, raised her head when the farmer came or was healthy. When the farmer perceived the bond to not be strong enough, they tried to fix the cow e.g. in a feeding rack, or spend time guiding the calf to suckle, and four farmers mentioned that they would prefer to change the foster cow and return the first cow to the lactating herd.

The farmers gradually learned how to select good foster cows, among others in early lactation, and how to ensure that the calves and the foster cow had bonded well, before they were moved to

Table 2. Key characteristics of foster cow management in the 20 organic dairy farms included in the study.

Farm ID	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Number of replacement calves	18	17	15	10	40	22	11	33	18	25	30	12	10	13	15	15	19	16	16	34
Age (weeks) at sale (non-replacement calves)	2-3	2 ¹	2	2 ¹	2	2 ²	2-3	4	2 ²	2 ¹	2	3	2 ¹	3-4	2 ¹	2	2 ¹	2	2-3 ³	2-3
Number of calves per foster cow	2-3	2-4	1-3	1-5	2-3	1-3	2	1-5	2	2-4	1-5	2-4	1-3	1-3	2	1-3	1-2	2-3	2-3	3-4
Time spent with dam (days)	1-3	1-3	1-3	1-3	<1	1-3	>3	1-3	>3	1-3	1-3	1-3	>3	1-3	<1	1-3	<1	<1	>3	1-3
Artificial milk feeding	Yes	No	No	No	Yes	No	No	Yes	No	Yes	No	No	No	Yes	Yes	No	Yes	Yes	No	Yes
Age at weaning (months old)	4	9	6	6	5	5	9	9	10	5	7	8	4	7	6	5	7	8	5	4

Notes: ¹Some calves were sold as veal at between one and five months. ² Some males were sold as beef at 2.5-3 years old. ³Reared only in artificial milk-feeding while replacement heifers went directly from the dam to the foster cow.

Table 3. Challenges experienced by the farmers interviewed in their foster cow systems and the identified solutions at implementation.

Challenges at implementation	Solutions identified by the farmers
Bonding	
Foster cows did not accept foster calves	Changed the foster cows, chose one week old calves
Bonding pen too large	Smaller pens
Foster cows too late in lactation, so less interested in calves	Selected foster cows in early lactation
Bonding process in groups with all calves and all foster cows, instead of individual pens	Separated bonding pen with only one foster cow and her foster calves
Lack of feeding rack/possibilities to lock the cow during first times of suckling.	Blocked the cow at the feeding rack or with shackles if necessary
Lack of experience regarding areas of concern in the foster cow system	Spent more time and paid more attention during bonding
How many calves to foster per foster cow?	
Calves were drinking too much milk	Increased the number of calves per foster cow
Calves were not drinking enough milk	Two calves only per foster cow, weaned the smaller calves later
Rearing on grass	
One more group on pasture	Two wires on the fences in pastures
Calves could break or pass under the wires	Farmers spent more time, changed them to paddock more frequently
Wild calves	Left the foster cows in the barn for a week at weaning/separation, as a two-step weaning
Considerable vocalisation and breaking through fences during separation	
Foster cows	
Foster cows became too thin	Gave extra fodder or concentrate
Failed insemination of foster cows	

the group of foster cows with calves. Once implemented, the farmers assessed the bonding process as easy ($n = 6$), relatively easy ($n = 10$), or not always easy ($n = 4$).

Foster cows and calves on pasture

Calves born at the beginning of the year were turned out from the beginning of March to mid-May. Some farmers added extra wires to fences to prevent the calves from passing underneath (Table 3). Farmers practicing seasonal calving stressed the importance of the group having an age difference of less than one month ($n = 3$), or less than two months ($n = 4$). The group of calves with foster cows went to remote paddocks, allowing the lactating cows to graze on pasture closer to the milking parlour.

Most farmers went to see the foster cows and calves once or twice a day ($n = 17$). One third of the farmers took this opportunity to feed the foster cows. Nearly half of the farmers ($n = 8$) went into the paddock and approached the calves as much as possible to prevent them from becoming difficult to catch or handle later in life. A quarter of the farmers changed paddock every one or two days to improve contact with the calves and to prevent gastrointestinal nematode infections.

Weaning and separation

The weaning of calves and separation from the foster cow took generally place simultaneously. This was either during the grazing season ($n = 11$) mainly in September, or during housing between November and March ($n = 9$), when they were between 4 and 10 months old (Table 2).

At separation, the foster cows and the heifers were placed in two different barns, or the foster cows stayed on pasture and the heifers were housed in the barn ($n = 13$). Five farmers used only one barn, but with no contact between the calves and the foster cows. One farmer (F9) permitted contact through a fence for one week, and one (F12) used nose flaps before separation. The majority of the farmers found that the heifers vocalised for two or three days, and about one third of the farmers

($n = 6$) left one or two foster cows with the calves at weaning for at least a week, or until first calving, and had experienced that this made them more quiet

Farmers' perceptions of the foster cow systems

All of the participating farmers were satisfied with rearing calves with foster cows, and several farmers said that it was a pleasure to rear them this way, and that they would not change their systems. The farmers gave different reasons for their satisfaction with this practice: natural and ethical aspects ($n = 10$), simplified and/or reduced work ($n = 10$), increased profit ($n = 8$), high growth rates ($n = 8$), and good animal health ($n = 9$). These considerations also reflected their motivation for setting up this type of cow-calf contact systems.

Ethical and natural aspects

The better image seen from a societal and environmental viewpoint was one motivation indicated by farmers, including being long at pasture and using no chemical inputs. Farmer F8 mentioned his personal pleasure as a motivation: *'When I visited a farm with a foster cow system, I thought it was lovely to see the calves on pasture with their foster cows'*.

The farmers considered their foster cow system to have improved animal welfare: they presented it as being more natural, closer to a beef cattle system and without stereotype behaviours. Farmer F3 explained that there was no stress during the turnout thanks to the presence of the foster cows, and Farmer F12 thought that the later the weaning was done, the more natural it was. Affiliation behaviours such as licking and sniffing were described by the farmers. The first author also counted one third of the calves suckling in the inverse parallel position (data not shown), which indicated a well-established bond between calves and foster cows (Sirovnik et al. 2020). From the farmers' perspective, these types of cow-calf contact systems seemed generally more in consistency with the principles for organic agriculture. No farmer spontaneously mentioned the dam-calf separation.

The farmers perceived that a transmission of knowledge took place between the foster cows and the calves. They had seen the calves being guided and taught to eat or graze by the foster cows ($n = 15$). Four farmers simply summarised this, saying that the cows taught the calves *'everything about life'*, while others mentioned specific aspects, such as calves following the cow's pace (F18 and F20), getting to know the fences and walking on a walkway (F16), or generally getting used to the housing and grazing facilities on the farm (F18). Moreover, four farmers indicated that the calves started grazing on their first day on pasture. However, some farmers also admitted that they were not sure whether this was learned by copying the foster cows ($n = 6$), or whether the calves grazed *'naturally'* or *'by instinct'* ($n = 4$). These farmers were very satisfied with this process: *'The calves do not wander away from the foster cows so they do not leave the paddock even though they may pass under the wires'* (F6) or: *'The cow teaches them how to reproduce and reassures the heifer during her first calving'* (F13).

Animal behaviour

The farmers were concerned that calves could become *'wild'*, which was a challenge identified with this type of rearing systems (Table 3). As indicated above, some farmers tried to overcome this, e.g. by establishing contact during the artificial milk feeding phase, spending time with them on pasture, or moving them frequently, sometimes in combination with feeding them on pasture. They did not find that their foster calves were wild ($n = 15$), or even calmer than those reared traditionally. For example, farmer F7 explained: *'Before, I used to go to see them in the pasture every two or three days, now I go at least once a day so that they are less wild'*. Other farmers took advantage of the weaning phase to *'replace'* the bond with the foster cow with a closer connection to themselves as humans, as e.g. told by farmer F16: *'I put more effort into animal contact at pasture than at bonding. I go to the paddock twice a day and feed them. Whether or not they become wild depends on us. Thanks to the care I give them, the calves are quieter than those reared without foster cows'*. Farmer F10 confirmed

this: 'I go to visit them every day for 30 minutes. I bring them concentrate feed, I move the electric fence every two days and I turn them out on the 20-acre paddock to avoid that they become wild afterwards'.

After their first calving, the farmers found that the heifers that had been reared as calves in foster cow systems integrated easily into the lactating herd ($n = 8$); some even felt that they integrated better than the ones reared previously ($n = 6$). Farmers explained this by the fact that calves reared with foster cows were used to being close to larger animals and to living in groups. They were thus already familiar with the herd codes and mixed more easily with the rest of the dairy herd.

Heifer and foster cow performance

Seven farmers noticed better growth of the calves reared with foster cows, and a reduction in age at first calving. The farmers aimed at having heifers calving at 24 months old ($n = 14$), or 28 to 30 months old ($n = 4$), which represented a reduction of 2 to 12 months compared to their previous system. Less frequently, the farmers also noticed lower growth rates after weaning ($n = 2$) and were concerned that heifers were too fat to inseminate (F15).

Some farmers noticed that the foster cows could have poor body condition and required extra care and feed after separation from the calves, and even beforehand on pasture. Farmer F6 had learned that the foster cows needed to be fed as other dairy cows: 'Before, I used to feed the foster cows only with the left-overs from the dairy cows. But it wasn't rich enough and now I give them the same feed as the dairy cows', and they limited the number of calves per foster cow to two and weaned the calves earlier. Contrary to this, some farmers had found that two calves per foster cow would cause the calves to drink too much. This illustrated that the number of calves per foster cow was a potential challenge of many of these rearing systems (as mentioned by 5 farmers, Table 3), and needed experience in each context.

Disease risk in calves and foster cows

Farmers said that rearing calves with foster cows helped to significantly reduce health problems in young calves. Before the implementation of this system, more than half of the farmers ($n = 11$) had problems with neonatal diarrhoea. Since establishing the foster cow system, five farmers mentioned diarrhoea on their farm, while the others no longer encountered this problem, such as farmer F16, who said: 'I had problems of calves with diarrhoea at the end of winter in the previous system, which was difficult to manage. Implementing this system has allowed me to clean out the barns, which has reduced the diarrhoea problem'.

Three farmers reported diarrhoea when the calf was with its dam, and explained this as being caused by intake of too much milk. Gastrointestinal nematodes had been a problem for one third of the farmers before the implementation of the foster cow system. Four of those farmers had treated all calves systematically at housing. Since implementation, only three farmers had treated calves selectively. With regard to dictyocaulosis (*Dictyocaulus viviparus*), two farmers said that they had had infested calves in the past, but no longer had any after having implemented their cow-calf contact system. The vast majority of the farmers ($n = 18$) used phytotherapy as a preventive and/or curative measure.

Working conditions and economic concerns

Half of the farmers found that this rearing system helped them to improve their working conditions. Some farmers ($n = 8$) had succeeded in reducing their workload by up to one hour per day. The farmers also emphasised that there had been a change in the nature of their work, which was now based more on trust in the animals and observing them. A foster cow system was perceived as simpler, requiring less mechanisation (because less or no extra feed needed to be harvested and brought to the animals), as well as less routine work (such as cleaning buckets, carrying heavy milk cans to the calf house, or cleaning pens).

These types of cow-calf contact systems were also viewed as profitable, with a reduction in the purchase of drugs, straw and concentrate, since the calves were fed by cows or grazed themselves on the pasture. Farmer F8 also stressed economic aspects: *‘When I converted to organic farming, I didn’t want to carry on doing what I did before. Also, in organic farming, the price of concentrate feed and straw is higher and I didn’t want to increase the costs to the farm’*. Moreover, farmers said that their foster cow system had resulted in calving at a younger age, which meant a reduction in the animals’ unproductive phase. The farmers also considered that the foster cow systems optimised the milking parlour by removing cows with high SCC, thus enabling them to sell high-quality milk, which was sold at a better price.

Discussion

Methodological considerations

The aim of the present study was to present and examine farmers’ perceptions and experience of their foster cow systems. Generalisation of qualitative research results from studies like this, is not recommended or should be done with care, as the results are obtained from participants within a specific context and with specific experiences that must be understood (Malterud 2001). This study was carried out in a specific geographical area with a temperate oceanic climate and with a small number of farmers who had all, in recent years, implemented a foster cow system and developed it to fit within their specific farming context. In two other surveys conducted in 2018 among farmers rearing calves within a cow-calf contact system in different parts of France, similar management practices were found (Belluz and Hellec 2018; Michaud et al. 2018). The potential bias of the results of this study was acknowledged as the study was based on interviews where the responses were documented by note taking as opposed to audio-recorded and transcribed. Additionally, the potential bias in the results was also noted in that only farmers who were still engaged in this type of rearing systems and who had agreed to take part in this participative research project were interviewed. It would have been interesting to interview also farmers who had abandoned this type of rearing systems and to ask them why. In another survey mentioned below, eight farmers (7%) had abandoned their cow-calf system because of poorly adapted buildings, as well as the possible transmission of pathogens due to inter-sucking (Michaud et al. 2018).

These systems can be viewed as innovations that emerged from a ‘bottom-up’ process and were adopted by ‘innovators’ (Rogers 2003), with fewer than 2.5% of dairy farmers making up the fringe of pioneers. The background of the participating farmers generally included higher education than the national average. Indeed, only 10% of the farmers in the study had not had a higher education, compared to 76% of all French farmers (Forget et al. 2019). Those interviewed continued to learn and develop through exchange groups and training for farmers, whereas only 17% of French farmers undertook at least one training course in 2017 (Forget et al. 2019). This may explain the rapid dissemination of these foster cow systems through networks, exchange groups and the social environment of organic farmers. These networks are part of the grassland farmers’ movement, also known as the ‘graziers’ movement, which was set up in the 1980s and 1990s in different western countries to promote grazing dairy systems (in the US: Hassanein and Kloppenburg 1995; in France: Deléage 2004). Through context-specific adjustments and developments, the grazing dairy systems appeared to be diversified in many different ways and, at the same time, to be sustainable on the farms where they were implemented. Moreover, foster cow systems are currently receiving a lot of interest and keep attracting new farmers.

Foster cow systems

Foster cow systems were explored focusing on the farmers’ motivations to implement such systems, as well as on how they were experienced. The farmers who implemented a foster cow system were

confronted with challenges, and their solutions and adaptations were diverse. The bonding phase between the foster cow and the foster calves seemed to be the biggest challenge in the foster cow system, yet critical to its success, according to the farmers interviewed. Johnsen et al. (2016) identified similar challenges. Krohn (2001) also described this phase as crucial, because the calves were at risk of malnourishment if rejected and unnoticed. The foster cow may often show preference for one or two specific calves (Loberg et al. 2008; Johnsen et al. 2016). The farmers found solutions and once they had implemented them the bonding phase felt much less challenging. Weaning and separation took place either at the same time or gradually. One third of farmers weaned their calves at an age, which can be characterised as a natural age between 8 and 11 months (Reinhardt and Reinhardt 1981). This age at weaning was higher than in many dam rearing systems (Krohn 2001; Michaud et al. 2018; Vaarst et al. 2020). When separating the calves from their foster cows, they seemed to be more quiet when a foster cow was left among them, which was also supported by (Loberg et al. 2008) and (Johnsen et al. 2016). Overall, the farmers seemed very satisfied with this type of rearing system, which can be implemented within a wide range of grazing-based farming systems.

Calf and foster cow behaviours and naturalness

Bonding between the calves and the foster cow seemed to be stimulated in the studied cow-calf contact systems. (Johnsen et al. 2016) suggested that nursing and suckling activate physiological processes that create bonds and stimulate maternal behaviours. This bond is both nutritional and social. It encompasses social learning and the exchange of affiliative behaviours, as was also mentioned by farmers (Newberry and Swanson 2008). Learning is also less restricted outdoors, which may enable the calf to fit in more smoothly into the dairy system later in life, for example by learning about electric fences, walkways, grazing and different feedstuffs (Vaarst et al. 2020). This may also have enabled the calves to be more confident when exploring their surroundings (Krohn 2001; Vaarst et al. 2020). Thus, the bond between calves and foster cow is close to a maternal bond, as also previously described (Kent 1984; Krohn 2001).

The studied cow-calf contact systems seemed quite unrestricted compared to many other calf rearing systems. Calves in unrestricted systems can choose the frequency and size of meals that will fit their physiological and behavioural needs (Loberg and Lidfors 2001; Johnsen et al. 2016). Calves that are allowed to suckle freely from their dam or foster cow, will drink more both in terms of amount and frequency, compared to calves fed artificially (Langhout and Wagenaar 2006; Grøndahl et al. 2007). Drinking from a cow's udder is more natural than drinking from a teat bucket or directly from a floor bucket. None of the farmers in this study mentioned stereotypical calf behaviours, as highlighted by Johnsen et al. (2016).

However, a foster cow system requires a separation between the calf and its dam. This separation is not a part of a 'natural system' and is of ethical concerns, especially seen from the dam's point of view. A similar concern can be expressed for herds practicing cow-calf contact systems, which only include female calves intended to become replacement cows, and sell off all other calves to veal- or calf-rearers.

Farmers in this study were aware that the calves could become difficult to handle, as has already been mentioned in relation to dam-rearing systems (Johnsen et al. 2016; Vaarst et al. 2020). However, to prevent such behaviours, the farmers in this study spent more time with the calves during bonding, on pasture, or in the separation phase, which meant that this was not a problem for them.

After their first calving, the heifers reared with foster cows integrated well into the lactating herd and their introduction seemed to be less stressful in the farmers' experience. Some studies have also indicated that integration into the dairy herd was easier when calves were in contact with their dam until weaning, suggesting that they have enhanced social skills (Wagner et al. 2012), where it otherwise can be stressful and require longer time (Duve et al. 2012; Kälber and Barth 2014).

Impact on calf and foster cow performance

Improved calf health was one of the most frequently mentioned motivations for implementing a foster cow system in both this and another French study (Michaud et al. 2018). Some interviewed farmers noticed a decrease in their veterinary costs. The findings on this are contradictory, but other studies reported similar observations in cow-calf contact systems (Michaud et al. 2018; Vaarst et al. 2020). In particular, farmers noted that neonatal diarrhoea decreased in foster cow systems in French and Dutch studies (Wagenaar and Langhout 2007; Michaud et al. 2018; Constancis et al. 2021). Regarding gastrointestinal nematodes on pasture, calves were infected to a lesser extent due to a 'diluting effect' by the foster cow grazing together with the calves (Constancis et al. 2022).

The farmers in the study reported higher growth rates in calves reared with foster cows than in those that were bucket fed, which was in accordance with other studies (Krohn 2001; Wagenaar and Langhout 2007; Constancis et al. 2020b). Earlier first insemination and calving were also found by Langhout and Wagenaar (2006) and Johnsen et al. (2016). Some studies on dam-reared heifers showed that, the conception rates at first insemination were higher and the calving interval was shorter for cows that had been dam reared (Johnsen et al. 2016).

Some farmers in the study reported that the foster cows were too thin at weaning, as has also been shown in other studies (Margerison et al. 2002; Kälber and Barth 2014; Constancis et al. 2020a).

Farmers' considerations regarding the selection of foster cows

The foster cows in this study were mainly chosen based on high SCC, which has also been found in other studies (Wagenaar and Langhout 2007). In some studies suckling was reported to have a positive impact on udder health, while in other studies no effect has been detected (Kälber and Barth 2014). A potential risk of cross-contamination can be due to calves suckling several foster cows (Wagenaar and Langhout 2007). However, feeding calves with milk from cows infected by *Staphylococcus aureus* had no subsequent effect on udder health at the first calving of heifers that were fed this milk (Abb-Schwedler et al. 2014). Farmers also mentioned lameness as a selection criterion for foster cows. These rearing systems could have a curative effect on lameness, explained by the fact that the foster cows stay on the pasture (Hernandez-Mendo et al. 2007), without having to walk to the milking parlour twice a day.

Some of the farmers preferred to select foster cows based on their maternal behaviour, which was also recommended by Wagenaar and Langhout (2007), because this supports the 'natural aspect' of these types of cow-calf contact systems. Loberg and Lidfors (2001) found that the maternal behaviour of the cow was more important in determining its ability to accept calves than its lactation stage, while some of the farmers in this study found that a newly calved cows often were better at taking care of their calves and produced sufficient amounts of milk.

Farmers' working conditions

Working conditions in terms of the physical and mental workload, as well as the working hours are central for dairy farmers, who generally work long hours (Duval et al. 2021). In this study, the farmers stressed that their working conditions improved with the foster cow system, which was one of the motivations for implementing and keeping it. Similar experiences were found in the studies by Michaud et al. (2018) and by Belluz and Hellec (2018). A dam rearing system can be labour-intensive, depending on how it is managed (Johnsen et al. 2016). However, as mentioned by the farmers in this study, the foster cow system required less labour-intensive work and greater monitoring efforts. As Vaarst et al. (2020) indicated, cow-calf contact systems are based on

confidence and trust in the abilities of the calves and cows. This study stressed that humans needed to rely on their ability to observe and judge complex situations.

Moreover, the foster cow system appears to be a loosely coupled system (Coughenour 2003), meaning that farmers can adapt it according to the characteristics of their farms and their management practices. Farmers mentioned points requiring attention in order to succeed in implementing this system, but there is no best way to do so. Through context-specific adjustments and developments, these cow-calf contact systems appeared to diversify in many different ways, still being perceived as sustainable on the farms where they were implemented.

A rearing system that is part of a search for farm autonomy

The foster cow systems in this study were often accompanied by other specific farm characteristics, which were part of an overall shift towards more agroecological farming systems, although the farmers themselves did not use this term. Indeed, agroecology provides ecological principles with which to study, design and manage sustainable agro-ecosystems that are productive, economical in terms of inputs, socially just and economically viable (Altieri 1995). Seen from this perspective, farmers are not only executors of a turnkey solution, but should rather be viewed as actors involved in reinventing their profession (Dumont et al. 2013), as was the case of the farmers in this study, who set up a foster cow system, which contributed to and became part of a more holistic farming system approach.

The farmers interviewed all had grazing-based systems and produced the majority of their own cereals and protein crops, which enabled them to be self-sufficient in terms of feed and straw for their cattle. In relation to dairy cow farming, agroecology can take the form of grazing-based systems that preserve cultural landscapes linked to local cattle breeds (Beudou et al. 2017; Vollet et al. 2017). As also done by the farmers in this study, cross-breeding with rustic breeds adapted to local microclimatic conditions has been mentioned as part of an agroecological approach (Dumont et al. 2013). One third of the farmers mentioned foster cow rearing as being economically profitable, even though more adult cows needed to be cared for. Several elements were noted to have contributed to this, such as reduced veterinary costs, a shorter indoor period, a shorter duration of heifer rearing, and valorisation of bulk milk. In fact, increasing the longevity of the cows in the herd made it possible to reduce the herd's replacement rate and thus the number of replacement heifers. However, the biggest saving for these farmers was probably linked to the autonomous management of this system, with limited purchases of inputs thanks to grazing and the possible valorisation of products processed on the farm (on-farm market). Agroecological dairy farming systems based on grazing were also shown to be economical in a study carried out in the same geographic area as the present study (Dumont et al. 2013). This study showed that the lower milk sales on these agroecological farms was largely offset by the overall reduction in input costs, including feed costs, which were almost halved, as well as mechanisation expenses (Dumont et al. 2013).

Conclusions

The foster cow systems, as implemented by a group of French organic dairy farmers, allowed calves to have a long and early first grazing season in the constant presence of foster cows and a close-to-natural late weaning for the calves. According to the farmers, these types of systems enabled the calves to learn from the foster cows and to engage in social behaviours that are close to the natural situation, giving them a high degree of welfare. Calves reared with foster cows appeared to have fewer disease problems and higher growth rates. These factors motivated the farmer to implement this system. The farmers generally found that foster cow systems improved their working conditions and their connection to the calves through regular monitoring and contact. The different types of impact on the farmers, the calves and the foster cows mentioned by the farmers should be

included in future studies. In the present study, the foster cow systems were often combined with seasonal calving periods, cross-breeding with robust breeds and once-a-day milking. This emphasised the importance of not only considering the impacts of a foster cow system in isolation, but in combination with other initiatives, which altogether can be seen as part of a larger agroecological transition.

Acknowledgments

Caroline Constancis is a grateful recipient of a grant from the Pays de la Loire Region and INRAE (French National Research Institute for Agriculture, Food and Environment). This study was funded by the GrazyDaiSy project (H2020 ERA-net project, CORE Organic Cofund ID-number 1871). The authors sincerely thank all the dairy farmers who participated in this study.

Disclosure statement

No potential conflict of interest was reported by the author(s).

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