Practical implications of suckling systems for dairy calves in organic production systems – a review

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Abstract

The growing public awareness of practices in livestock production systems leads to an increased doubt on the existing methods and emphasizes a demand to be closer to nature in livestock production. In most dairy production systems cow and calf are separated immediately after birth discouraging all aspects of maternal behavior. In suckling systems cow and young are allowed to spend time together, so the calf is able to suck on its dam and species-specific behavior can be displayed. This article focuses on the different suckling systems established in organic dairy systems and their effects on cow and calf. The beneficial effect on calf growth and the decrease in the occurrence of abnormal behavior (cross-sucking on other calves) when calves are reared with the dam, are scientifically reported, whereas the improved health status, which farmers give as main reason for introducing dam rearing, could not be verified yet. Concerns arise in regard to cow health and milk yield, since milk ejection can be impaired and therefore less milk is obtained at milking. Also the process of weaning poses more difficulties in dam rearing due to breaking the strong bond between mother and young. Based on the current state of scientific research, foster cow systems with additional milking might be a promising alternative: calves can satisfy their sucking motivation and have social contact to mothers/adult cows; on the other hand, weaning stress might be reduced and milking the cows when suckling calves could lead to an increased total milk production. However, a comparison between dam rearing and foster cow systems, also including economical traits, is still missing, and recommendations have to be made with care. Further research is needed to reconcile consumers' demands and the possibilities of farmers using such systems.

Keywords: *dam rearing, foster cow, animal welfare, suckling, milking*

Zusammenfassung

Praktische Konsequenzen Mutter- bzw. Ammen-gebundener Aufzuchtsysteme für Kälber in der ökologischen Milchviehhaltung – eine Übersicht

Das zunehmende öffentliche Bewusstsein gegenüber Praktiken in der Nutztierhaltung lässt vermehrte Zweifel an den existierenden Methoden aufkommen und verstärkt die Forderung nach „natürlicheren" Produktionssystemen. Der vorliegende Artikel beschreibt verschiedene Formen der Mutter- bzw. Ammen-gebundenen Aufzucht in der ökologischen Milchviehhaltung. Wissenschaftlich konnte nachgewiesen werden, dass bei der Mutter-gebundenen Aufzucht ein besseres Wachstum der Kälber und ein verringertes Auftreten von Verhaltensanomalien, bestehen. Eine verbesserte Kälbergesundheit, die bei den Landwirten als einer der Hauptgründe für die Einführung der Mutter-gebundenen Aufzucht gilt, konnte allerdings noch nicht eindeutig aufgezeigt werden. Weiterhin gibt es Befürchtungen bezüglich des Gesundheitsstatus der Kuh und der Probleme bei der Milchgewinnung. Durch auftretende Milchejektionsstörungen wird während des Melkens weniger Milch gewonnen. Auch das Absetzen der Kälber kann Schwierigkeiten bereiten. Die Kälberaufzucht an Ammen, die zusätzlich gemolken werden, scheint hierbei eine vielversprechende Strategie darzustellen. Jedoch gibt es noch keine Studie, welche die beiden Systeme „Aufzucht an der Mutter" mit der „Aufzucht an der Amme", auch im Hinblick auf ihre Wirtschaftlichkeit, vergleicht. Empfehlungen können deshalb nicht uneingeschränkt gegeben werden. Es besteht weiterer Forschungsbedarf.

Keywords: *Mutter-gebundene Aufzucht, Ammenkuh, Tierwohl, Säugen, Melken*

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1 Introduction

In recent years the awareness of farm practices concerning animal welfare has increased. Consumers demand food that has been produced animal-friendly (Toma et al., 2012) and seek more information about the production methods before they make their choice (Napolitano et al., 2010). It seems that consumers' understanding of animal welfare is close to the natural living approach: animals should have the possibility to perform natural behavior, get feed suitable to their physiology and live in an environment as similar as possible to the habitat natural to the species (Lund, 2006). In the consumer's understanding, pigs should be kept outdoors and calves should be able to suck their mothers. Despite this public demand for increased animal welfare standards, farmers are concerned to change their production since increased levels of animal welfare seem to be linked with extra costs and increased prices of the products. Although Napolitano et al. (2010) reported that consumers were willing to pay more for a product when their expectations both of the production methods and on product quality were met, questionnaires on hedonic and purchase intent might not be representative since consumers may declare willingness to pay more for high-perceived quality, but not buying them under economic constraints (Lange et al., 1999). Elgersma (2012) even stated that the opinion of consumers – cows on pasture are more natural and grazing is beneficial for the animals – caused a major Dutch dairy company to promote grazing and pay a premium price for milk from cows spending 120 days with a minimum of six hours per day grazing.

Organic production systems are known for their endeavor to keep their animals under species-appropriate conditions. In their natural environment calves keep sucking their dams between six months up to one year until natural weaning (Newberry and Swanson, 2008). Suckling represents the cornerstone of maternal care (Val-Laillet et al., 2004) and therefore the most natural way of calf rearing is to let calves stay with the mother to suck freely until natural weaning (Lidfors et al., 2005). However, common practice, even in organic dairy systems, is to separate the cow and her calf within the first 24 hours after birth and to raise the calf without further contact to its mother. So the statement from von Keyserlingk and Weary (2007) that all aspects of maternal behavior are discouraged in dairy production except milk production is also true for organic dairy systems. Standard rule (directive (EG) Nr. 834/2007 and directive (EG) Nr. 889/2008) for organic dairy farms is to feed whole milk to the calves, preferable that from the own mother, over a period of three months, which is an improvement in regard to naturalness compared to conventional systems, which usually feed milk replacer. Additionally, German organic organizations state that cow and calf should be kept together for the first 24 hours after birth (Bioland), or recommend suckling in the first few days post partum (p.p.) (Naturland). However, suckling systems, where calves have the opportunity to suck on their dam or on a foster cow and have social contact with other mature individuals until weaning, might be an even better approach to be closer to nature. It seems that organic farmers are more motivated to introduce a calf rearing system, which is more natural (Zumbrunnen, 2012) and allows natural behavior, since dam rearing is mainly found on organic farms. Thus, as Grøndahl et al. (2007) stated, dam rearing, defined as a system in which calves are able to suck their dams for more than the colostrum period and cows are milked additionally (Barth et al., 2007), may satisfy the public concern regarding immediate separation of cow and calf in commercial milk production. Spinka (2006) mentioned that the opportunity to display natural behavior is effective to stimulate an animal's development, leading to long-term effects, and improves its welfare. For example, calves that spent several days with their dams showed higher levels of socially positive behavior three to six weeks after separation. Although the total number of organic farms in Germany practicing one of the many different types of those „natural" suckling systems is unknown, growing interest of like-minded organic farmers can be reported as the increasing demand on workshops and information about dam rearing suggests. Also the growing number of published research (Fröberg et al., 2008; Langhout, 2003; Lidfors et al., 2010; Loberg et al., 2008; Roth et al., 2009b; Wagenaar and Langhout, 2007; Wagner et al., 2012; Zumbrunnen, 2012) shows that the topic of dam rearing on behalf of animal welfare aspects, still raises questions to be solved.

With this review paper we want to give an overview of the different types of suckling systems, their benefits and implications for practical use.

2 Characteristics of suckling systems

Suckling systems were stated to be more beneficial for the welfare of the calves (Krohn, 2001): calves are thought to learn to eat roughage earlier and have social contact with other cows and calves. During introduction of suckling systems in the modern dairy sector, many different manifestations have developed, according to the situational conditions given on the farm. Furthermore, in scientific research suckling systems are characterized to be either permanent or restricted, sucking either on the own mother or on a foster cow. This leads to difficulties in giving practical recommendations from scientific work. Farm practice even shows mixed forms of those systems as is discussed later on. In his review about suckling systems, Krohn (2001) based his characterization on the purpose and the duration that cow and calf spend together: long-term suckling without and with milking (the latter was described as restricted suckling) until weaning and short-term suckling up to one week p.p. without milking the mother. Although Krohn (2001) suggested that short-term suckling is superior to long-term suckling in regard to production and behavior of the cow, the present article mainly refers to long-term suckling systems, since the prolonged contact of calf and dam occurs to be more natural. Table 1 gives an overview about the main characteristics of the two suckling systems addressed in this article, including the comparison with artificial calf-rearing in organic systems. Artificial calf-rearing in organic systems is defined as immediate separation of cow

and calf after birth, housing the calf in a singular pen up for one week followed by group-housing of calves at the same age and feeding whole milk via bucket or automate feeder fitted with an artificial teat. Contrary to Krohn (2001), we classify the systems on the type of contact to the mother: calves having contact to their own mother versus calves having no contact to their mother but contact to a foster cow.

3 Sucking on the dam

3.1 Differences between permanent and restricted suckling

In permanent suckling systems calves are allowed to attend and suck their dam freely at any time until weaning. Dam and young are usually kept together apart from the herd for the first few days after birth and get introduced to the herd afterwards. The strong bond between cow and calf establishes within hours after birth (Newberry and Swanson, 2008) and the calf will prefer its mother over other cows (Spinka and Illmann, 1992). Characterized by affiliative behavior like allogrooming, provision of nourishment, warmth, protection, resting in contact, synchronizing activities and maintaining proximity, the social bond is a preferential mutual, affectionate, emotional attachment that is relatively long lasting and survives temporary separations (Newberry and Swanson, 2008). However, Veissier et al. (1998) could show that when access to the udder is denied for a few hours during the first day of life, lambs did not establish a preferential relationship to the dam. Therefore, the first suckling bouts seem to be necessary for the awareness of the maternal features and after the bond is established within the first three days of life, suckling is not necessary to maintain it anymore. This is also the moment, when in restricted suckling systems, cow and calf are separated for a certain time period (e.g. calves are allowed to have contact with the cows for one hour after each milking). The cow rejoins the milking herd and the calf is introduced to other calves about the same age in a group-housing pen. Further on, the effects of permanent suckling are discussed and additional features of restricted suckling will be discussed where necessary.

3.2 Effects on the calves

3.2.1 Health

Ingestion of colostrum is essential for the establishment of the calf's immune system shortly after birth and associated with the occurrence of diarrhea (Kunz et al., 2009). On most farms calves are bottle-fed colostrum to guarantee sufficient colostrum intake. Edwards (1981) reported that only 6 % of the calves sucked within the first hour p.p. and only 32 % managed to suck within six hours after birth. It can be assumed that the control of colostrum intake should have high priority and calves should be assisted by the farmer. Additionally, Selman et al., (1970a) stated that in wild ungulates and horses the udder represents the highest part of a female's underbelly and the offspring will search for feed at this point. They hypothesize that dairy cows seem unsuitable for suckling calves due to their lower udder and Edwards (1981) confirmed that the latency of first sucking increased with parity due to poorer udder confirmation, which resulted in misdirection for teat-seeking. Furthermore, it has been shown that beef cows were sucked earlier p.p. than dairy cows (Selman et al., 1970b). Nonetheless, it seems that there are beneficial effects of dam suckling as well. Although not affecting colostrum intake significantly, Selman et al. (1971) found that mothered calves were much brighter, much better at standing and more eager to suck at six hours p.p. compared to conventionally reared calves. The same authors could show that mothered calves, although not consuming more colostrum than their non-mothered conspecifics, had significantly higher serum immune globulin concentrations

Table 1
Characteristics of calf-rearing systems

	Dam	Foster cow	Artificial/Automate
Contact to mother	yes	no	no
Milking of cow	yes	after weaning of the calves	yes
Contact to mature individuals	yes	yes	no
Milk intake	up to 17 kg (Bar-Peled et al., 1995)	restricted by the amount of other calves sucking the same cow	restricted up to 10 % of birth weight (Khan et al., 2011)
Control of ingested milk	no control	no control	yes
Weight gain	high	dependent on competition for milk	dependent on milk allowance
Maternal behavior	yes	sometimes	no
Cross-sucking[1]	practically none	practically none	often
Allosucking[2]	practically none	usual	no
Udder health	effects unclear	effects unclear	not impaired by suckling
Milk ejection problems	yes	not reported	no

[1] calf sucks on body parts (udder, scrotum) of other calves
[2] calf sucks on more than one cow (non-maternal)

48 hours p.p.. They attributed this to a prolonged grooming, which could make the mothered calves more efficient absorbers of immune lactoglobulin and Schiessler et al. (2002) hypothesized that the absorption rate with commercial colostrum might be lower. The same authors point out that this could also be due to the quality of the colostrum since higher concentrations of IgG were found in the colostrum of the dam compared to colostrum powder.

Keeping the calf with its dam allows the calf to suck anytime. As a consequence, calves suck more often while ingesting lower amounts of milk at a time. Sommer (1995) recommended feeding smaller amounts at more occasions, because the ingestion of more than 1.5 liter at a time might lead to undesired fermentation of milk in the rumen due to the low capacity of the calf's abomasum. In suckling systems the high milk intake is also associated with diarrhea between the fourth and tenth day p.p., but reported to have no detrimental effects on performance of the calves and to disappear without treatment within a few days (Wolters, 2006). Another reason for the occurrence of benign diarrhea could be allosucking, the sucking of calves on different cows, due to a varying milk composition of the cows (personal communication in Wolters, 2006).

In conclusion, the health status of suckling calves is controversially discussed. Some studies found no improved health of dam-reared calves (Roth et al., 2009b), whereas there are reports of improved health (Magaña Monforte et al., 1996; Wolters, 2006). Many factors influence the health status of the animals as it depends on sufficient intake of colostrum within the first day p.p., the quality of colostrum and the amount of milk provided. Furthermore, health state is affected by husbandry, management and feeding practices (Svensson et al., 2003). In which way the health status of the dam or the other members of the herd can affect the calves' health has yet not been studied. The reduced use of antibiotics and the improved health status of the animals seem to be the superior reasons for farmers to introduce dam suckling (Zumbrunnen, 2012), and Soberon et al. (2012) recently showed that milk production in first lactation was lower in animals, which received antibiotics as pre-weaned calves compared to calves, which had no antibiotic treatment during that time. The decreased milk yield was also most likely due to sickness and nutrient partitioning in the treated animals.

3 2.2 Growth

Better growth rates and higher body weight at weaning of calves sucking their dams have been reported in several studies (Le Neindre et al., 1979; Metz, 1984; Metz, 1987; de Passillé, 2001; Roth et al., 2009b) compared to conventionally reared calves. This is mainly attributed to the higher milk intake of calves sucking freely, which can account for up to 17 kg per day (Table 2).

Milk intake by calves in suckling systems is usually estimated by differences in body weight of the calves before and after sucking (Weight-Suckling-Weight-Method). Calves have to be separated from their dams for a certain amount of time before suckling and differences in the reported milk intakes in Table 2 could be due to different separation times. Therefore, it is more common to report weight gains instead of milk intake. Lidfors et al. (2005) could show that the life weight gain of fostered calves did not differ from calves receiving 8 liter of whole milk per day, but was higher compared to calves reared under standard methods (5 liter whole milk per day). According to Spinka and Illmann (1992) suckling might be superior to teat feeding by resulting in higher milk consumption and fewer digestive problems. In contrast to the hypothesis that only the amount of ingested milk makes the difference in growth rates, it was reported by Krohn et al. (1999) that even when prevented from sucking but allowed contact with their mother, calves gained weight twice the rate of calves separated from their mother immediately after birth. This is in line with a calculation in an on-farm evaluation (Schlooss, 2007) resulting in a numerically higher milk conversion ratio for dam-reared calves when compared to foster cow reared or bucket fed calves (milk intake in kg/kg weight gain: 8.45, 9.28 and 9.92; respectively). Although calves are not able to consume all the milk offered by the dam in the first days of life and preferred the front quarters (Barth et al., 2009), they sucked on all four teats after two to three months. Furthermore, no residual milk was left from

Table 2
Milk intake by calves

Author(s)	Breed	Type of nursing	Milk intake (kg/d)
Plum and Harris, 1971	Holstein		4th week p.p.: 9.2 ± 1.0 12th week p.p.: 11.7 ± 1.1
Bar-Peled et al., 1997	Cows: Holstein Calves: 20 Holstein heifer calves	fostering one calf + milking (3 times daily; udder emptying 6 times in total)	16.9 ± 2,5 (1st week p.p.: 10.5 ± 3.7 42nd day p.p.: 21.6 ± 3.5
de Passillé et al., 2008	Holstein	Dam rearing (suckling 2 x daily, 2 hours post milking)	1st week: 6.5 ± 0.7 9th week: 12.5 ± 1.4
Barth et al., 2009	Holstein and Red Pied	Dam rearing without additional milking	2nd week p.p.: 2.6 ± 1.0§ 12th week p.p.: 4.7 ± 1.7§

§ this was estimated once a day after separation of cow and calf between 3 and 5 hours; so it represents the milk intake per feeding bout.

calves at the age of four months, which was found in a study of Plum and Harris (1971) with Holstein cows under beef cattle management. Objections to high milk consumption might be the higher tendency to rear obese calves (Wolters, 2006) and to delay the intake of solid feeds that is necessary for early rumen development.

Addressing the first point, it was stated that after abrupt weaning suckled calves usually show a growth slowdown and lower daily weight gains for ten weeks after weaning (Price et al., 2003, Veissier et al., 2013). Therefore, higher weaning weights are beneficial to compensate for that time. In addition to this, Soberon et al. (2012) found that higher weaning weights could improve lifetime productivity. To achieve a better performance as first lactating cows and even in subsequent lactations, nutritional manipulation must start immediately after birth and continue for five weeks in form of liquid feed, with whole milk being superior to milk replacer (Moallem et al., 2010). If growing rate is enhanced, bull calves for beef production, can be sold earlier, thus saving costs for rearing (Wolters, 2006).

Calves are usually provided with solid feed a few days after birth to promote intake of roughage and concentrate, which should stimulate rumen development. Bar-Peled et al. (1997) observed no intake of solid feeds in calves, which were allowed to suck three times daily during the first six weeks of their life. Similarly, Fröberg and Lidfors (2009) stated that freely sucking calves ate less solid feed and rested more as the control group. Interestingly, more rumination behavior was observed in the freely sucking calves, which could only be explained as an effect of management differences. However, recent findings show that in calves fed high volumes of milk, dry matter intake (DMI) of solid feed was promoted and rumen development enhanced without affecting weight gain (Khan et al., 2011). Contact with the dam can also stimulate intake of solid feed, whereby social learning from the mother could be the pivotal trigger (Flower and Weary, 2001; Ehrlich, 2003). Schiessler et al. (2002) even hypothesized that the high haematocrit and haemoglobin levels measured in blood of suckled calves might be due to a higher ingestion of iron with hay and straw.

3.2.3 Behavior

Abnormal behavior is often found in artificially reared calves and can lead to impaired performance later on in life. Cross-sucking, especially in older calves, which are more at risk for being cross-sucked, can result in udder trauma and inflammation (Laukkanen et al., 2010). A lot of scientific work has been conducted to find the trigger for this abnormal behavior and it seems that feeding behavior plays a major role. Laukkanen et al. (2010) observed that the place where cross-sucking occurred, shifted with the age of the animals from the rest area when young to the feeder area when older. Almost no abnormal oral behavior, like cross-sucking or tongue-rolling, occurred in calves freely sucking their dams, whereas allosucking, calves sucking on other cows than the own mother, was reported and seemed to occur when milk supply by the mother was insufficient for the calf. The short milk intake time and the amount of small proportions offered at the automatic feeder (Fröberg and Lidfors, 2009), an inappropriate energy supply (Roth et al., 2009a), or the unsatisfied sucking motivation (de Passillé, 2001) were mentioned to be triggers for cross-sucking behavior. When spending more time feeding hay, durations of cross-sucking other calves decreased (Roth et al., 2008).

Contact to the dam not only reduces the occurrence of abnormal behavior but also has positive effects on the development of the social ability of the offspring. Flower and Weary (2001) reported that calves kept with their mother for 14 days exhibited more intense social behavior towards unfamiliar calves. In a study with foster cows, Vaarst et al. (2001) found that calves, which were kept with their mothers three days p.p., sniffed, licked and rubbed a nurse cow more often than calves separated from their dam immediately after birth. Therefore, the first days of a calf's life seemed to influence its behavior towards unknown cows as well as other calves significantly. Social learning in early life is more efficient than later in life and the mother is the major social partner, since the first and strongest bond occurs between the dam and its young (Veissier et al., 1998). The age at the time of contact to conspecifics is important for the strength of the bonds established. Heifers grouped after birth formed closer bonds between each other than heifers grouped at six months (Veissier et al., 1998). Although the relationship between dam and young fades over time and calves begin to form groups with peers, a preferential relationship with the dam seems to remain even after suckling ends. Also when prevented from sucking, the preference for the mother remains (Veissier et al., 1990a,b). Newberry and Swanson (2008) reported that bonds between mother and young can persist even beyond separation and the birth of subsequent offspring. Half as much agonistic behavior at the feeding site was found in groups that consisted of mothers and daughters (Swanson and Stricklin, 1985).

3 2.4 Long-term effects

Not many studies addressing long-term effects of dam rearing of dairy replacements have been published yet (Le Neindre and Sourd, 1984; Le Neindre, 1989a,b; Bar-Peled et al., 1997, Wagner et al., 2012). Heifers reared on a foster cow were socially more active and had clearer social structures relative to individually reared heifers (Le Neindre and Sourd, 1984). Furthermore, dam-reared animals showed prolonged licking and suckling of their calves, which was interpreted as more maternal behavior than cows reared in isolation (Le Neindre, 1989a). A more recent study by Wagner et al. (2012) also revealed long-term effects on social behavior when heifers were introduced to the milking herd shortly before calving. They found that mothered heifers showed more submissive postures, which might reduce the amount of aggression received. Therefore, they seemed to better cope with social challenges, which is in accordance with Latham and Mason (2008), who reported that maternal deprivation could enhance stereotypic behavior or result in animals, which are less able to cope in a low-stress manner with normal social interactions with conspecifics.

Long-term effects on performance traits were reported by Bar-Peled et al. (1997). They could show that heifers, which were allowed to suck during the first 42 days of their life, were younger at their first calving and tended to produce more milk than heifers reared by bucket feeding of milk replacer.

3.3 Effects on the cows

When thinking about the effects of suckling on the cow, first thoughts might be the impairment of milk production and the occurrence of udder health problems like teat damage or infections due to open teat channels after frequent suckling. However, it seems that farmers also introduce suckling systems to prevent mastitis or profit from calves sucking on infected quarters to decrease or even heal the inflammation. The effects on health and milk production will be discussed and moreover metabolism traits, fertility and welfare aspects will be addressed.

3.3.1 Udder health

Although Krohn et al. (1990) suggested that several days of suckling calves may have health benefits for the cow, such as reducing incidence of mastitis, concerns occur that there even could be a transmission of pathogens when the calves are not sucking their dam exclusively. Furthermore, Spinka and Illmann (1992) speculated that the calf might not be able to consume the increasing quantities of milk produced by its dam, which could lead to milk suppression and in further consequence to mastitis.

In a study by Walsh (1974) a very low infection rate in fresh lactating cows, which were sucked twice daily by 4 calves, was found. In contrast, the machine milked cows, which were in the same stage of lactation, had a much higher infection rate (Walsh, 1974). It seemed that stage of lactation played a role, since in late lactation, the infection rate of twice daily machine milked or twice daily sucked cows did not differ anymore (Walsh, 1974). In addition, suckling did not improve the udder health of cows, which were machine milked in mid-lactation (Walsh, 1974). In contrast to this, Thomas et al. (1981) did not find differences in the udder health of cows machine milked or sucked by at least 3 calves independent of the time (morning or afternoon), the frequency and duration (up to eight weeks) of suckling. A combination of milking and suckling could be beneficial as Fröberg et al. (2008) found that cows suckling their calf twice daily in addition to machine milking tended to have lower California Mastitis Test (CMT) scores than machine milked cows.

In contrast to the opinion that cows with mastitis could profit from suckling, it has to be stated that the motivation of calves to suck on infected quarters seems to be relatively low. Nicht (2005) could show that in 69 % of the cases, calves did not suck on infected quarters. Therefore, a health enhancing effect might be doubtful. However, when forced to suck on infected quarters (no other milk source available or all quarters infected), the same author found that after sucking on infected quarters for two weeks, no sign of a clinical mastitis in the sucked quarters was detectable (Nicht, 2005).

Teat damage from suckling has been reported by Thomas et al. (1981). The longer and the more intense teats were sucked by at least 3 calves, the more damaged they were and milking of the cows was difficult. After weaning, damaged teats recovered rapidly without any implications for milking (Thomas et al., 1981). The same authors recommended suckling for shorter periods (one or two weeks) to avoid teat damage and prolonged anoestrous intervals p.p. Similar to this, Rasmussen and Larsen (1998) showed that teat conditions were worse when calves were sucking compared to machine milking. The fear of an increased risk of bacteria colonization on teats with impaired skin condition could not be verified. Moreover, the authors suggested that suckling might help to remove bacteria from the teat skin and the mixture of milk and calf's saliva left on the teats did not support bacterial colonization. Anterior to Rasmussen and Larsen (1998), Rigby et al. (1976) found a lower incidence of mastitis in suckling cows. The authors also attributed this to better udder emptying and bacterial inhibitors in calves' saliva.

3.3.2 Milk production of cows

Beneficial effects of suckling referring to a higher total milk yield of the dams have been reported by Bar-Peled et al. (1995). They showed that total milk production was highest in cows milked three times and suckled additionally (by 2 calves) three times a day compared to six times milking or three times milking, respectively. They hypothesized that mammary development had been enhanced due to the completely emptying of the udder. In agreement with this, Cozma et al. (2013) reported higher total milk yields (total milk = milk gained by machine milking plus milk suckled by the calves) for Saler cows with calf contact at milking. Krohn (2001) mentioned that long-term suckling in early lactation can stimulate milk synthesis to a greater extent than milking alone, which might be due to a higher oxytocin release while suckling compared to milking. Although the 305-days milk production was higher in cows milked and suckled relative to only milked cows, milk, which was gained by machine milking, decreased from 40.7 % to 23 % (of total milk production) until the 6th week p.p. (Bar-Peled et al., 1995). This seemed to be due to the higher amount of milk ingested by the calf. Another detrimental effect has been reported by Krohn (2001), de Passillé (2001) and Lidfors et al. (2005), all describing the poor milk ejection in the milking parlor during the period when cows suckled their calves. During nine weeks of milking twice daily with subsequent nursing two hours afterwards, average milk yields at milking were even 20 % lower than in the control group (de Passillé et al., 1997). According to Thomas et al. (1981) the time, frequency, intensity and duration of sucking does not affect the total milk yield of lactation. The same authors also showed, that for the total milk yield of the lactation it does not make a difference whether a cows is machine milked over the whole lactation or sucked up to the 8th week p.p. and machine milked from then on.

After short term suckling for ten days p.p., the drop in milk yield from machine milking caused by the weaning process lasted for five days (Metz, 1987). Concerted to this, Bar-Peled et al. (1995) also reported a sharp decrease in milk yield after six weeks of suckling and milking when calves were removed. They found that milk yield stabilized in week twelve for the group, which was milked three times a day and sucked three times a day. In contrast to this, it has been stated that milk yield at machine milking returns to the control level within one week after weaning, independent from the duration of the nursing period (Metz, 1987; de Passillé et al., 2008).

The carry-over effect of an increased frequency of udder emptying during the first six weeks of lactation was obvious in cows machine milked six times daily, while cows, which were milked and sucked six times, in total produced much lesser milk for more than four weeks after weaning of the foster calves (Bar-Peled et al., 1995).

Considering the amount of milk ingested by the calf and the remaining residual milk, total milk yield did not differ between machine milked cows and cows, which additionally nursed their calf two times daily (de Passillé et al., 2008). Thus, there was no advantage for milk production in dam rearing (de Passillé et al., 2008).

Measuring the milk production of cows when suckling their calves impairs the breeding value evaluation based on the milk performance recordings since the amount, which is ingested by the calf, can only be defined by the weight-suckle-weight method. However, this method is time consuming and not practical. Using the alternating test method for milk performance recording can be an alternative: gaining just one milk output within twelve hours either from morning or afternoon milking and in the subsequent milking from the alternating time, just requires separating cow and calf for twelve hours. For calves with permanent contact this might be correlated with increased stress compared to calves with restricted contact, which might be another advantage for using restricted suckling in milk production systems.

3.3.3 Milk composition

During a suckling meal, fat content increases and lactose content decreases to a minor extent. Also the fat composition changed during suckling resulting in higher amounts of short-chain fatty acids (SCFA) and lower amounts of C18:1. Costa et al. (1998) reported that after-stimulation was important in regard to milk fat composition: beef cows that were after-stimulated had lower content of SCFA and higher values for C18:1. Furthermore, Costa et al. (1998) showed that saturated fatty acids (SFA) decreased and unsaturated fatty acids (UFA) in milk increased with after-stimulation and that the higher content of α-linolenic acid (C18:3 n-3) could account for higher product quality e.g. healthier for the consumer. Additionally, calf presence at milking increased the milk concentration of palmitic acid (C16:0) and decreased stearic (C18:0), linoleic (C18:2 n-6), α-linolenic and total poly-unsaturated fatty acids (PUFA) in the study of Cozma et al. (2013). When dairy cows, which are allowed to suckle their calves, are milked, fat content in the milk gained by machine milking decreased (Barth et al., 2007; Schneider et al., 2007; Mendoza et al., 2010; Cozma et al., 2013), which might be due to milk ejection problems and hence udder emptying and milking of alveolar milk are incomplete. In contrast to this, milk protein content seems to be unaffected by suckling (Barth et al., 2007; Mendoza et al., 2010). However, Cozma et al. (2013) found a significantly decreased protein content in milk obtained by machine-milking for Saler cows when the calf was present, but only a numerically decrease for Holstein cows.

3.3.4 Milk performance and hormones

The milk of a dairy cow is stored in the alveolar (80 %) and the cisternal (20 %) compartment of the udder. Cisternal milk is the first milk gained by milking and active expulsion is required to force the alveolar milk into the cistern. The most important hormone in this process is oxytocin, which is released after tactile udder stimulation. Bruckmaier and Wellnitz (2008) reported that being sucked by a calf is superior to hand milking and machine milking in regard to oxytocin release. Emotional stress can result in an inhibition of oxytocin release, which leads to losses of milk and can increase the health risk for the cow if the udder is not emptied completely (Bruckmaier and Wellnitz, 2008).

Plasma concentration of hormones (oxytocin, prolactin, growth hormone) during suckling was found to be higher than during machine milking in a study of Bar-Peled et al. (1995). Similarly, prolactin and plasma cortisol concentration increased during suckling, but also machine milking led to an increase in prolactin and cortisol (de Passillé et al., 2008).

Contrary to the findings of Bar-Peled et al. (1995), de Passillé et al. (2008) did not find differences of plasma oxytocin levels in cows milked by machine or in cows nursing their own calf, but during machine milking oxytocin release of nurse cows was depressed. Furthermore, Tancin et al. (1995) could show that even during the first machine milking following a few weeks suckling period the oxytocin release was decreased.

To overcome the problem of impaired milk ejection, Barth et al. (2011) olfactorily stimulated sucked cows in the milking parlor with presenting a cloth rubbed on the coat of the cows own calf, to trigger an increased oxytocin release. The results showed no improvement of milk ejection with the olfactory stimulus. The authors hypothesized that the scent on the cloth might have not been strong enough or that other stimuli such as visual or audible contact are needed additionally to trigger milk ejection.

Milk let-down during machine milking of cows suckling their calf twice a day after milking seemed not to be disturbed in the study done by Fröberg et al. (2008), but the applied method is questionable since only the time of appearance of the cisternal milk was recorded. Since it is not practical to bring calves to the milking unit, there is no advantage for milk production by keeping cow and calf together and suckling and milking during the same period was not recommended by Krohn (2001).

3.3.5 Lactation length

Lactation length was unaffected by any of the treatments applied in the studies of Thomas et al. (1981). According to Everitt and Phillips (1971), cows suckling for the first two months of lactation and being machine milked afterwards remained longer in milk than cows being milked right from the beginning of lactation (e.g. 111 days in milk [DIM] for a milked heifer and 284 DIM for her suckling twin sister).

3.3.6 Metabolism, body weight and body condition

Meeting the high energy demands caused by milk production in early lactation is only possible with the mobilization of body reserves. Therefore, dairy cows usually are in a state of negative energy balance, which makes them more vulnerable to sickness. Carbonneau et al. (2012) revealed that metabolic imbalances can be limited when cows were sucked for five days p.p. and additionally milked from day three onwards. In the studies of Thomas et al. (1981) and Mendoza et al. (2010), the live weight change over the first weeks of lactation was not significantly different between sucked or machine milked cows. However, Mendoza et al. (2010) reported that BCS score did not start to increase until week seven p.p.

In a study from Bar-Peled et al. (1995) cows, which were machine milked three times per day, and in addition suckled tqo foster calves also three times daily, did not compensate their higher milk yield by increasing dry matter intake as cows milked six times daily did. Thus, suckler cows lost significantly more body weight and it took them until the 18th week p.p. to achieve the weight they had at calving. In accordance to this, Everitt and Phillips (1971) reported that cows, which were sucked for the first few months of lactation and being milked afterwards, did not gain as much body weight during lactation as cows, which were machine milked over the whole lactation. Similarly, Boonbrahm et al. (2004) found that suckling cows tended to lose more body weight than milked cows and subsequently gained less weight.

3.3.7 Fertility

In contrast to dairy sheep and goats, which are known for their lactational anoestrus, the main factors affecting the duration of p.p. anoestrus in cattle are the nutritional status and suckling (Montiel and Ahuja, 2005). Suckling prolongs the p.p. anoestrus interval in beef cows for up to 90 days (Montiel and Ahuja, 2005), which is not that distinctive in dairy cows. Holstein cows suckling up to eight weeks p.p. had a 25 days prolonged p.p. anoestrus interval compared to machine milked cows, which showed their first p.p. oestrus after 32 days (Thomas et al. (1981). Also the number of suckled calves seems to influence the anoestrus interval. Wettemann et al. (1978) found that crossbreed range cows suckling only one calf (own offspring or foster) show their first oestrus p.p. significantly earlier than cows of the same breed suckling 2 calves. Nevertheless, the plasma progesterone levels of these cows were increased indicating luteinisation of follicles without ovulation or ovulation without oestrus (Wettemann et al., 1978). Álvarez-Rodríguez et al. (2010) compared the interval to first p.p. oestrus between different types of suckling (once-daily nursing for 30 minutes [RESTR1], twice-daily nursing for 30 minutes [RESTR2] and ad libitum nursing [ADLIB]) and reported no significant differences, although numerically cows nursing ad libitum had the longest p.p. anoestrus (45, 44, and 56 for RESTR1, RESTR2 and ADLIB, respectively).

Another important parameter when discussing the fertility of cows is the calving-conception interval (= days open). In the study of Bar-Peled et al. (1995) conception rates in suckling cows were superior, although their reproductive activity was suppressed until calf removal. In accordance to this, Broucek et al. (1995) reported that cows, which fostered calves for two or three weeks in their first month of lactation, had shorter days open-periods and lesser services per conception than machine milked cows. Furthermore, short term suckling (ten days p.p.) shortened the calving-conception interval of the cows significantly (Metz, 1987).

Williams and Griffith (1995) found that the maternal identification, mainly due to olfactorial and visual recognition, and selectivity of the cow's own calf also has an influence on reproductive performance. Removing the cow's own calf resulted in an increase of serum LH concentrations within 48 hours and suckling unrelated calves did not alter these increases.

Beyond that, Krohn et al. (1990) hypothesized that suckling could reduce the incidence of placental retention and Jainudeen and Hafez (2000) stated that the uterus involutes faster in suckled cows than nonsuckled cows.

3.3.8 Maternal behavior

Dairy cattle production usually discourages all aspects of maternal behavior except milk production (von Keyserlingk and Weary, 2007) by separating mother and offspring immediately after birth. Understanding the importance of maternal behavior should finally attract attention since in recent times the demand for animal-friendly produced products is increasing.

It has been reported by Le Neindre (1989a) that the method of rearing the dam affected the bond to her calf. Mothered cows appeared more „maternal" than non-mothered cows and licked and nursed their calves better. Although Krocker (1996) stated that calves from cows with good mother abilities need less time to first successful sucking, calves from mothered cows needed more sucking attempts before the first sucking relative to calves from non-mothered animals (Le Neindre, 1989a). Nonetheless, dam-reared animals were sucked more often than conventionally reared ones in the same study.

In an on farm case study Wolters (2006) observed that mothers interrupted the offspring when exaggerating. The same author had the impression that primiparous cows had less antagonistic interactions in presence of their calves, which was interpreted as a calming effect of the young towards other cows. Similarly, Szabò et al. (2013) showed that antagonistic interactions were lower when introducing unfamiliar young goats into an adult herd while both adult goats

and young goats had kids. According to them, the presence of the kids could either have a distracting effect on the mothers or via suckling-related physiological pathways, alter their mothers' behavior. The role of oxytocin as having a relaxing, „anti-stress" and pro-social effect has been described before (Uvnäs-Moberg and Eriksson, 1996; Uvnäs-Moberg, 1996).

On the other hand, problems might occur when the mother is dislodged by a more dominant cow, which tries to „adopt" the calf. The fact that some cows adopt foreign calves could also be beneficial for calves with mothers showing little interest in their offspring.

Welfare implications occur when the social bond between mother and young gets broken in consequence of the weaning process (Spinka and Illmann, 1992; Price et al., 2003, Loberg et al., 2008).

4 Suckling foster cows

Foster cow systems occur in manifold forms, but mainly differ in the number of foster calves sucking on one cow and the whereabouts of the foster cows own calf.

One of the prior requirements for a well-functioning foster cow system is the calf's experience in the colostrum period. Calves mothered for the first three days after birth performed earlier sucking and more often; thus being more successfully fostered to late-lactating nurse cows compared to bucket fed calves (Vaarst et al., 2001).

4.1 Effects on the calves

No research articles about the health status of calves reared with foster cows compared to sucking on the dam exist in the knowledge of the authors. However, when multiple suckling, e.g. two and more calves sucking on the same cow, occurs, the incidence of diarrhea deriving from an overconsumption of milk might be lessened. Health problems could occur when the foster cow rejects a calf, not allowing it to suck anymore. The rejected calf either has to find another foster cow or will suffer from severe malnutrition, if the farmer does not detect the failed sucking attempts.

4.1.1 Growth

Since calves have to share the foster cow, competition for milk occurs. In a study done by Vichova and Bartos (2005) about allosuckling in a beef suckler cow herd, calves that allosucked most frequently tended to grow less intensively and reached lower weaning weights. The authors reported that the most important effect on growth gain and weaning weight was the birth weight of the calves. They predicted a higher incidence of allosucking in calves with lower birth weight and lower maternal sucking rate. Also the age of the mother played a role since there was a greater allosucking incidence for calves born to younger mothers. Related to foster cow systems, it could be assumed that motherless calves would not gain as much weight as the own calf of the foster cow. It was observed that the cow's own calf sucked more than the foster calf (Le Neindre, 1989a) and therefore the alien calf did not gain as much weight as the own calf (Loberg and Lidfors, 2001).

Limitation of sucking frequency (in this case: two times daily) results in a greater uniformity in weaning weight of foster calves compared to calves, which have unrestricted access to their foster dams (Everitt and Phillips, 1971).

4.1.2 Behavior

When the own mother is available 10 out of 16 calves prefer the mother (Spinka and Illmann, 1992). However, calves display enough behavioral plasticity to obtain milk after losing their own dam when still remaining in a group with other cows. On doing so, 11 out of 13 motherless calves sucked on more than one cow (Spinka and Illmann, 1992). Zumbrunnen (2012) reported that farmers describe the reaction to separation from the mother to be less stressful when calves were able to suck foster cows. The advantage of foster cow systems in regard to bucket feeding is the increased social contact the calf experiences. Even if not getting adopted by a foster cow, calves raised in foster cow systems are in social groups, allowed to suck as often as the cow allows, get fresh warm milk and care from the cow, e.g. licked, rubbed, stimulated to eat what cow eats (Lidfors et al., 2005). Hence foster calves showed more social behavior and sniffing the environment (exploration), but less rumination and eating TMR compared to control calves (Lidfors et al., 2005).

4.2 Effects on the cows

4.2.1 Health

Zumbrunnen (2012) reported that foster cows were often selected due to their impaired milk quality (high SCC) and/or poor udder quality. Farmers believe that suckling has a beneficial effect and can even heal affected quarters. As stated before, calves avoid sucking on infected udders and the beneficial effect must be questioned. In the unpublished study of Barth and Knappstein (unpublished data), nine of the 22 non-infected quarters of 9 cows, which were turned into foster cows from mid-lactation, were infected at drying off. Only 5 of the 14 prior infected quarters were pathogen free afterwards. Thus, the healing effect of suckling of affected quarters seems to be dubious, and therefore more scientific studies are needed. Forcing calves to suck on infected quarters is questionable since the sickness of the cow could influence the growth of the dairy calf due to the lower casein and higher albumin proportions in the milk. Furthermore, the health of the dairy replacement heifers might be negative affected as well, since pathogens received with the milk could establish in the udder and cause problems when lactating.

Schlooss (2007) suggested another beneficial effect on the foster cow: if a cow suckles her own and more than one additional calf, the udder was emptied completely, which might not be the case when only the own calf sucks due to the high milk production of the dam.

4.2.2 Performance

Foster cows, which were not milked but sucked two times daily by 4 calves, produced more milk than twice daily machine milked cows, but it was not clear if this difference was caused by suckling or a better udder health in the sucked cows (Walsh, 1974).

Cows, which fostered calves for two weeks during their first month of lactation, produced more milk in the whole lactation than machine milked control cows. Prolonging this suckling period to three weeks caused a lower yield compared to the control cows (Broucek et al., 1995).

Suckling 2 foster calves three times per day in addition to a three times per day machine milking during the first six weeks p.p. resulted in a significant higher milk yield compared to six times daily machine milking (Bar-Peled et al., 1995).

As expected, changing the frequency of udder emptying from six to three times daily by weaning or reducing the machine milking frequency lowered the milk yield, but more in cows which fostered calves in addition to machine milking (Bar-Peled et al., 1995).

Fostering calves during the first two months of lactation increased the milk production thereafter compared to cows machine milked from the onset of lactation (Chandler and Robinson, 1974; Everitt and Phillips, 1971).

Furthermore, the additional milking of the foster cow might be superior to permanent suckling without milking, because cows can be easier controlled at milking times and the steady contact to humans is advantageous for animal handling.

4.2.3 Behavior

The acceptance of alien calves was supported by the absence of the own calf for 4 to 30 days (Lidfors et al., 2005; Loberg and Lidfors, 2001). Even cows in late lactation (six months) can be used as foster cows and it seems that suitability as foster cow depends more on the individual character of a cow than stage of lactation or breed (Loberg and Lidfors, 2001). Although bonding between foster cow and calf occurs, it has not been proofed yet, if the bond between foster cow and calf is as strong as the dam-calf-bond (Loberg et al., 2007).

5 Restricted suckling

In restricted suckling systems the contact between calf and cow is limited to the time of milk consumption only. Time of contact, before or after cows are milked, the length of contact, only for milk consumption or for a few hours, and the relation to the cow, if it's the own mother or a foster cow, can vary widely.

Restricted suckling systems are less labor intensive than bucket rearing in regard to supplying feed, since milk processing for feeding the calves is no longer required. The sucking motivation of the calves seems to get more satisfied when sucking on a cow and contact to mature animals is given, whereby it might be insufficient concerning the importance of social learning possibilities, e.g. calves are not able to imitate feeding behavior and learn to ingest roughage at an early stage of life. Superior to permanent suckling is the fact that more salable milk can be obtained at milking, although milk ejection problems can still occur (Barth, unpublished data). When restricted suckling systems on foster cows are performed, the milk amount might not be enough for calves, which are allowed to suck after milking and therefore calf's health and growth might be impaired. On the other hand, restricted suckling after milking guarantees the complete emptying of the cow's udder, which might not be the case with milking only. When using the alternating test method for milk performance recording, restricted suckling can help to lessen the stress of both cow and calf during the separation time (twelve hours), since calves are already familiar with the separation from the cow.

At last, the process of weaning might be less stressful for the animals since both mother and young are used to spending only a short time together.

6 Management

6.1 Expenditures

To our knowledge, no scientific reports addressing the expenditures, both of money and time, in suckling systems compared to conventional dairy production systems have been published yet. However, there are some case studies comparing the costs of the different systems. In her on farm evaluation Schlooss (2007) calculated the expenditures of money in different rearing systems and found that costs (including milk and expenses for veterinarian), were lower for dam and foster reared calves than for conventionally reared animals (260, 267, 305 Euro /calf, respectively).

If calves are kept in the same barn with the cows, more work might arise cleaning the lying area of the cows, especially in cubicle housing, since calves dirty parts, which will not get dirty with housing cows alone. Furthermore, the temporary separation of cows and calves, e.g. for milking, is time consuming. Selection gates might be an opportunity to decrease the time exposure, but the extra installation costs have to be kept in mind.

Farmers stated that working in suckling systems was much easier, but the demands for the farmers are higher, since those systems afford more flexibility and are more time consuming in regard to animal observation. Restricted suckling systems with additional milking might possess advantages as cows can be observed at milking and calves can be examined when getting separated from the cows.

It should also be pointed out that scientific inquiries are missing, thus making an interpretation difficult.

6.2 Housing

Keeping cows and calves in permanent contact requires some modifications compared to conventional systems. Providing a separate area for the calves, where they can rest without contact to other cows and have access to feed and water, is recommended. However, calves should have the

possibility to watch the cows feeding and to have access to the feed of their mothers, so they might imitate their behavior and start eating roughage and solid feed earlier. Having a separate calf area can be advantageous as well when cows and calves have to be separated for milking or later for gradual weaning. Additionally for foster cow systems, access to the foster cows can be postponed for older calves, thus giving the younger ones the possibility to gain more milk without competing against stronger calves. At the same time it simulates natural weaning process for the older calves since less milk is available after the young ones sucked. Potential dangers for the calves free ranging in the cow barn, which have to be considered and adjusted where necessary, can be scrapers and the manure system, the feed rack of the cows, the partitioning of the cubicles, slippery or slatted floors and other cows, that might act aggressively (Waiblinger et al., 2013) or accidently crush calves as well. If the mother develops strong protective instincts she can be a danger to humans trying to handle her offspring.

To ensure the development of a strong bond between dam and young, the calves should be alone with the mother for the first few days of life, where there's no disturbance from conspecifics and calves can suck on their mothers exclusively. When separated from their mothers immediately after birth, calves lost the ability to suck within six days (Finger and Drummer, 1969), thus it's crucial to keep cow and calf together for a certain amount of time p.p. to ensure calves sucking on their mothers exclusively and to ensure the development of a strong cow-calf bonding. Thereby, a sufficient number of maternity pens have to be available, so it can be assured that cows and calves have „their privacy" in the crucial first days after parturition.

6.3 Weaning

Natural weaning occurs when calves are between six and twelve months; the time when the neonate has grown to four times of its birth weight (Newberry and Swanson, 2008). When milk supply decreased in sheep, the distance between offspring and mother increased, as the young increased grazing activity (Napolitano et al., 2008). In dairy production systems calves are weaned at an age between two and three months. In contrast to the artificial rearing systems, calves allowed to suck not only suffer from the immediate denial of milk but also from the separation to the mother at weaning. Therefore, it has been discussed if suckling systems with abrupt weaning are detrimental in regard to welfare aspects. Krohn (2001) stated that separation after two to three months of suckling is traumatic and influences the behavior of both dam and calf to a larger extent compared to short-term suckling. Furthermore, Stehulova et al. (2008) could show that cows are more influenced by separation from the calf than the other way round when kept together for one day, four days and seven days, respectively. But they also remarked that in long-term suckling systems, the higher stress in cows after later separation only lasted for about one day and therefore may not represent a serious compromise of the well-being of the cow. However, alternatives for the abrupt weaning have been described. Newberry and Swanson (2008) recommend that weaning is easier when the offspring stays in a familiar environment with familiar pen mates. They found that a weaning method, which still allows contact between mother and young, e.g. separation by a fence, is less traumatic. Similar to these findings, Loberg et al. (2007; 2008) found that weaning in two steps, prevention from sucking with a nose-flap two weeks prior to separation, reduces behavioral stress in foster cows (2007) and fostered calves (2008), with the latter expressing less vocalization and walking, hence more lying and ruminating. In contrast to this, Stehulova et al. (2008) could show that the heart rate in dairy calves after separation was not influenced by contact or no contact to the dam and that calf age or contact with the calf after separation had no effects in the heart rates of cows, with the implication that heart rates were only recorded one hour before and one hour after separation. Contrary to the physiological response, the magnitude of both cows and calves behavioral response, e.g. vocalization, sniffing, placing the head out of the pen, was increased when auditory and visual contact between dam and young after separation was allowed.

Another weaning method described as being more natural (Schlooss, 2007) for foster cow systems would be to allow the access to the foster cow for older calves after younger ones already have been sucking, so less milk is available for the older calves. If this strategy is superior to abrupt weaning has not been estimated as far as the authors know.

It seems that each weaning strategy is always associated with stress in both cows and calves and that the best way to wean calves has not been revealed yet.

7 Conclusions

Consumers' demand for more naturally produced animal products has led to changes in animal production systems in the past. Especially in organic production systems, there are approaches to allow more natural behavior of the farmed species. Concerning suckling systems in dairy cow production, the methods applied should use modern technique to achieve more naturalness instead of „going back to the roots". The variety of suckling systems used today emphasizes that farmers choose their system in accordance with the main goal of the farm and the available means e.g. building-related and labor economic aspects. Thus, recommendations for the practice are difficult. Furthermore, studies addressing the evaluation of the overall system, as well as on long-term effects on animal productivity and on economic opportunities, e.g. placing dairy products on the market, which are labeled for their value as animal friendly produced in suckling systems, are still missing.

Not only in respect of the practicability but also in regard to the performance of the cows (milk yield, milk composition, fertility) and the calves (social development), we recommend a mixed system of both dam rearing and foster cows. In this respect, cow and calf are separated after a few days but allowed contact for a certain time period after each milking.

Calves are grouped and mothers have access to the calf group after each milking. The ratio between cows and calves depends on the milk yield of the cows and the number of calves in the group, but each cow suckles her own and at least one additional foster calf. After a certain time period, freshly calved cows replace the suckling cows and therefore the calves of the latter become foster calves. The daily milking allows the control of the cows and maintains the human-animal contact, which makes the milking after weaning easier. On the other hand, it encourages the behavioral needs and gives the cows and calves the opportunity to develop social relationships. Therefore, mother-bonded rearing could contribute to an improved welfare of the animals in dairy production systems.

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