The performance of heifers reared in a suckling system

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November 2005 – June 2006

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Code number/ name course:	BFS - 80439 Thesis Biological Farming Systems
Period:	November 2005 – June 2006
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Abstract

In this study the effects on the performance of *heifers reared in a suckling system* (suckled heifers) compared to *heifers reared in a bucket system* (bucket heifers) were investigated. Heifers are young dairy cows that started first lactation. Focus was on the following parameters: age and live weight at first calving, milk production, and mastitis incidence. Also, attention was given to Paratuberculosis since suckling systems might increase the risks on its occurrence.

The hypothesis was that suckled heifers reach a higher live weight, at a comparable age, compared to bucket heifers. Usually, farmers use live weight as an indicator to inseminate or introduce the calf to the bull. Hence, suckled heifers compared to bucket heifers can become pregnant at a younger age. Age at first calving could thus be reduced for suckled heifers. Alternatively, suckled heifers have a higher live weight at first calving. This generally increases first lactation milk yield.
Another hypothesis was that suckled heifers, compared to bucket heifers, would perform better in terms of mastitis incidence. The reason behind this is that suckling calves receive important antibodies for their immune system by the uptake of colostrum and milk. Moreover, suckling calves are more exposed to the farm specific pathogens, which might build up resistance.

Suckled heifers and bucket heifers from two organic farms (Farm 1 and Farm 2) were compared. Data from 72 heifers that were born in 2001, 2002 and 2003 was used. The 72 heifers were divided into 7 groups: 2 suckled and 1 bucket group on Farm 1, and 2 suckled and 2 bucket groups on Farm 2. All heifers entered first lactation.

Main results were as follows:

- In contrast with the expectations, no difference in live weight between the suckled and bucket group was found on Farm 1. However, live weight data appeared to be affected by the breeding management. On this farm, artificial insemination was used in the bucket group and the farmer's own bull in the suckled groups. Artificial insemination was carried out with a 100% Montbéliarde cow, while the farmer's own bull was a crossbred of Montbéliarde with a high percentage of Groninger Blaarkop. Montbéliarde cows have a higher adult live weight than Groninger Blaarkop cows. Artificial insemination with genetically identical bulls was applied to all heifers on Farm 2. The suckled heifers reached a significantly higher live weight, at a comparable age, compared to bucket heifers.
- All suckled heifers on Farm 1 had a lower age at first calving compared to the bucket reared heifers. On Farm 2, only suckled heifers that were born in 2003 had a lower age at first calving compared to heifers reared in bucket system.
- Heifers on Farm 1, reared in a suckling system had a lower milk production compared to heifers reared in a bucket system. This lower production could be explained by the breeding management and the reduction of age at first calving. The bull used for artificial insemination was genetically superior (for milk production) compared to the farmer's own bull. Hence, heifers reared in a bucket system had a tendency for a higher milk production compared to the heifers reared in a bucket system. Age at first calving of suckled heifers was reduced with 4.5 months. This reduction in calving age was probably too extreme and thus reduced the milk production.

On Farm 2, no significant difference in milk production between suckled and bucket heifers was found.

- On Farm 1, heifers reared in a suckling system, were born in a different year than those reared in a bucket system. Therefore, mastitis data from suckled and bucket groups were not fully comparable. Average SCC (Somatic Cell Count) of the herd varied a lot between different years. On farm 2, no significant difference in mastitis incidence between suckled and bucket heifers was found;
- Inherent to a suckling system is that calves are drinking part of the saleable milk. A lower age at first calving due to suckling reduces rearing costs. The loss of saleable milk by suckling was totally repaid by a shorter rearing period on Farm 1 and almost completely on Farm 2.
- It was found that the *Parawijzer* was not useful to prevent Paratuberculosis on farms were suckling systems are used, because a number of measures is not applicable on farms using suckling systems.

Preface

Through the room of my living room I have a view over the fields of the neighbouring dairy farmer. Last autumn late in the evening there was a calf walking with it's mother in the pasture, while the rest of the dairy cows already went inside. After phoning the farmer that his cow stayed behind, he answered that calf and cow had to stay outside, because he was trying out to keep them together. This spring I have already seen a few calves with their mother in the herd. My neighbour is experimenting to use a suckling system. Which is really improving my view!

My thesis was carried out at the Louis Bolk Institute, situated in Driebergen, within the project *"Kalf bij Koe"*. The Louis Bolk Institute is an anthroposophical research institute for organic agriculture, nutrition and health care. Research projects are often carried out in a participatory way, with for example farmers.

I would like to thank my supervisors Jan-Paul Wagenaar from the Louis Bolk Institute and Egbert Lantinga from Wageningen University for their support during my thesis. As well, I would like to thank Jos Langhout for helping me with analyzing the data and all other help. Thanks, to Evert Jan Bakker who helped me with the statistical analysis. And finally, I would like to tank the farmers to provide me the information I needed and to tell me about their experiences with suckling systems.

Judith Vertooren, June 2006

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1. Introduction

1.1 Problem analysis

The project *Kalf bij koe* (Calf with cow) started as an initiative of the Louis Bolk Institute (LBI) and some Dutch organic dairy farmers. Both parties felt the need for a change in the conventional calf rearing method, in which calves shortly after birth are separated from their mother. Two dairy farmers introduced a suckling system, in which calves suckled their mother. On both farms data had been collected from suckling and bucket fed calves. Earlier research within the project Calf with cow showed that farmers and experts had high expectations about the long term effects of suckling systems.

Therefore, in this study the effects on the performance of heifers reared in a suckling system compared to heifers reared in a bucket system were investigated. Data from heifers born in 2001, 2002 and 2003 was used. During this study all heifers entered first lactation.
However, data collection had not stopped after 2003. The research will be continued as part of the so called QLIF-project (Quality Low Input Food), funded by the European Union. The QLIF-project aims to improve quality, ensure safety and reduce cost along the organic and "low input" food supply chains. In 2004 on three farms a new start was made to collect data of suckling and bucket fed calves. This study had to develop a method to evaluate data from calves in the QLIF-project.

The study was a continuation of earlier research by Jos Langhout, who investigated the effects of suckling systems in dairy production, Rita van Leeuwen, who studied the growth and development of calves in suckling systems, Gerdien Rouw, who studied the effects of suckling on the somatic cell count of suckling cows and Jasper Herbrink, who collected information about suckled and bucket fed calves in a database.

1.2 Literature review

1.2.1 Suckling as calf rearing method

Suckling systems

In modern dairy farming bucket feeding is the most common used method of calf rearing. Calves are fed with fresh, waste or artificial milk from an open or teat bucket. Reasons why calves are removed from their mother is to control the milk consumption, leaving more saleable milk for the farmer, and concern for disease transmission (Paratuberculosis). With a bucket feeding system there is minimal contact between cow and calf, and it leaves no room for maternal behavior. A more natural calf rearing system is the use of a suckling method, in which mother and calf can show their natural behavior (Krohn, 2001) .
There are different suckling methods, in which calves suckle their mother or a nurse cow until they are weaned. The following suckling methods can be distinguished:

- Single suckling during the colostrum period, which covers the first days after birth. During the colostrum period mother and calf are housed separate from the herd for approximately three days. The cow is only milked mechanically when this is necessary for the udder health of the cow or to support the calf with additional feeding.

- Single suckling with additional milking. After the colostrum period the calf is introduced with its mother in the dairy herd. The milk consumption is *ad libitum*, the cow is milked twice a day mechanically.
- Multiple suckling without additional milking. The calf is placed by a nurse cow with 2-4 other calves. The nurse cow is housed separate from the dairy herd. The milk consumption of the nursed calves is restricted by the number of calves under each nurse cow. The nurse cow is not milked mechanically (Langhout and Wagenaar, 2004).

Combinations of single and multiple suckling are used as well. Calves are weaned after approximately three months, because the organic standards describes a period of 3 months to provide the calf milk. In conventional systems calves are often weaned at about 7-8 weeks of age.

The highest costs of the suckling system is the milk consumption by the calves. In single suckling systems milk consumption of calves is up to 10kg milk per day per calf in the first 14 days and up to 15kg in the period thereafter. In multiple suckling the consumption varies between 5 to 10kg per day (Langhout, 2003). The costs of a suckling system on a farm with 70 cows and an annual replacement percentage of 25%, milk consumption adds up to 8 to 12.5 thousand kg of milk annually. This is the same as the lactation production of 1.5 to 2 cows (Langhout and Wagenaar, 2004). In conventional calf rearing systems, when artificial milk is used, calves are fed with 1.5 to 2.5liter of artificial milk. For cow milk 4liter a day is advised (Anonymous, 1997).

Suckling and the health of the calf

A suckling period after calving gives the calf a good chance of obtaining colostrum by suckling. Sufficient colostrum uptake is usually decreasing the mortality rate of calves (Krohn, 2001). Moreover, suckling calves are exposed to the farm specific pathogens. Both, colostrum and milk contains important antibodies for the immune system of the calf (Ryle and Orskov, 1990).

Moreover, suckling improves the welfare of the calves. When using a suckling system milk is provided at an optimal temperature to the calf and with minimum changes of contamination.

Many experiments show that mortality rate in suckling calves is low. In the experiment of Fulkerson *et al.* (1978) none of the 30 calves died. Preston (1973) did trials involving many thousand of calves which received milk and supplementary feed. The mortality of single suckled calves was 5.2%, the mortality of bucket fed calves was 12.3%. Also, intestinal parasites were more common in bucket fed calves. Presumably, non-fatal as well as fatal infections also develop less frequently in suckled calves (Ryle and Orskov, 1990).

Langhout (2003) observed that calves had a higher daily weight gain than bucket fed calves. This confirms the results of other researchers (Everitt and Phillips, 1971; Bar-Peled *et al.*, 1997; Mejia *et al.*, 1998).

These results are not unexpected. It is known in humans that antibodies in breastfeeding affect the immune system. Breastfeeding has a protective effect against illness of infants (Howie, 1996). As well, it is known that breastfed infants tend to grow more rapidly than non breastfed infants in the first 2-3 months of life and less rapidly from 3 to 12 months (Bonyata, 2006).

Behavior

Suckling systems are more beneficial to the welfare of calves than artificial rearing systems. The calf will be nursed by its mother, suckle milk, learn to eat roughage, have social contact with other calves and have space enough to play and exercise (Krohn, 2001).

An example of behavior problems in conventional systems is cross-suckling. When a calf gets his milk offered in a bucket or teat-bucket, this will not always satisfy the calf's motivation to suckle. An unfilled suckling need can lead to cross-suckling where calves suck the ears, tail and navel of other calves (Krohn, 2001). However, also in suckling systems some problems may arise. At an age of about three months the calves are weaned, mother and calf will be separated. Weaning at three months of age is much earlier than under natural conditions (8-12 months). After separation both cow and calf will vocalize a lot for some days. In contrast, separation after a short term suckling period does not appear to be traumatic for calf or cow (Krohn, 2001).

Calves not used for replacement

About 25% of the calves stay on the farm to replace the herd. All other calves (also from organic farms) are sold to the conventional beef producing industry. With this present system the production chain is not closed, organic produced calves and calves that suckled their mother end up in the conventional sector. In this way the calves do not get the value they deserve. Moreover, this system is not transparent which brings confusion to the consumers.

To tackle this problem two research farms (*Praktijkcentrum Aver Heino* and *Biologisch Proefbedrijf Droevendaal*) carry out the project *Stierkalf waardig.* This project seeks for an animal friendly solution

to rear organic calves. In a research recently carried out by Bech Sàbat (2005) at the Droevendaal farm, artificial calf rearing systems were compared with suckling systems. It was concluded that suckling can be a good and cheaper option to rear these organic calves.

Beside this project, also farmers themselves are introducing initiatives for problems that arise in rearing calves. To compensate for the increased costs with the use of a suckling system, one of the farmers in this study started *Adopteer een kalf (Adopt a calf).* Consumers have the possibility to adopt a calf and visit it two times a year during open days. At this moment there are even waiting lists to adopt a calf.

1.2.2 Age, live weight at first calving and suckling

Weight gain

Both short term single suckling (only suckling during the colostrum period) and long term suckling is increasing daily weight gain of the calves. In multiple suckling weight gain is depending on the daily milk yield of the nurse cow and the number of suckling calves. Everitt and Phillips (1971) compared *ad libitum* suckling with restricted suckling (twice a day suckling) during an 8-week period. *Ad libitum* suckling resulted in an average daily weight gain of 663 versus 745g for restrictive suckling. By comparison, 8 weeks of bucket feeding with 6kg of whole milk resulted in a daily gain of 658g. Compared to bucket-fed calves multiple suckling leads to greater individual variation in gain (Krohn, 2001). One of the reasons of the higher growth rate of suckled calves is the higher fat content in the suckled milk (Mai Van Sanh *et a*l., 1997).

Effects of suckling on age and live weight at first calving

In an experiment conducted by Bar-Peled *et al.* (1997) it was shown that increased growth due to suckling could lead to a higher milk production during first lactation, compared to bucket feeding. Calving age was significant earlier for heifers that had been allowed to suckle, because calves earlier reach an acceptable live weight at which the farmers decide to inseminate the calf.

The study of Van Leeuwen (2004) showed that suckled calves reached a higher live weight at an age of one year, compared to bucket fed calves. This indicated that suckling may lead to a lower age and/or a higher live weight at first calving. This might result in a reduction of rearing costs, due to a shorter rearing time and higher milk production during first lactation. A lower age at first calving can decrease replacement costs of the herd. On the other hand durability and a higher live production can also decrease replacement costs.

It is most optimal to wean Holstein Frisian calves after they reached a live weight of 80kg. Time of first heat of calves lays between 10 and 13 months. They can be inseminated from an age of 15 months (CR-Delta, NRS, 2005). It is recommended by the NRS to inseminate after the calf reaches a live weight of at least 375kg. A lower live weight can have negative effects on future milk production (CR-Delta, NRS, 2005). From an economic point of view an age at first calving of 24 months with a bodyweight of 575kg is recommended (Scheppingen, *et al.*, 1999). The mean Dutch heifer is calving at an age of 26 months (Elbertsen, 2004). But the average age at calving of heifers at organic farms is higher than on conventional farms.

A lot of studies on the effect of live weight and age at first calving have been conducted. Essentially all studies demonstrate that live weight at calving, and not age, has a significant effect on first lactation milk yield. The live weight of a cow is influenced by its age, genotype and the environmental conditions under which its raised. Environmental conditions which are conductive to large size also contribute to high levels of production (Clark and Touchberry, 1962). According to, Fisher *et al.* (1983), also heritability has a significant influence on calving weight and on milk yield as well.

1.2.3 Milk production and suckling

Effect on the suckle cow

Several studies show that suckling can increase milk production of the suckled cow (Peel et al 1979; Thomas *et al*. 1981; Meija *et al.*,1998; Bar-Peled *et al.*, 1995). Milk production is believed to be enhanced due to teat stimulation performed by the calf (Bar-Peled *et al.*, 1995) and the increased degree of udder emptying when the calf suckles the residual milk after milking (Sandoval-Castro *et al.*, 2000). An empty udder has a stimulating effect on the alveoli to excrete milk. Increased milk yield can also be related to an improved udder health when cows are suckled (Meija *et al.*,1998).

In a suckling experiment of Fulkerson *et al.* (1978) thirty Frisian heifers were allocated to two groups. Calves were left with the heifers for 36 hours after calving, then machine milked twice daily (group 1) or machine milked at 6.00hours and suckled at 15.00hours (multiple suckling was used). Heifers in group 2 (suckled) produced 16% more milk during the 300 day lactation than group 1 (milked) heifers. Calves were weaned after 8 weeks. The increased milk production was in excess of the amount of milk removed by the calves; thus the calves were reared at practically no costs in terms of marketable milk. Calves could be reared free of feed costs as well in the experiment of Peel *et a*l. (1979). Here, suckling up to four weeks was used. The costs for the suckling system mentioned in the research of Langhout (2003) are much higher (section 1.2.1), but were calculated for a three months suckling period.

In some trials in which suckling enhanced milk production, other effects on the cows were observed as well:

- suckling may prolong lactation; In several investigations, milk production by cows suckled for up to 12 weeks continued to exceed that of control animals for some time, even after weaning (Kaiser, 1975; Fulkerson *et al.* 1978; Peel *et a*l. 1979), although some results do not confirm this (Thomas *et al*. 1981);
- Suckling may prolong anoestrus. In a 8 weeks suckling experiment, in which cows suckled twice daily, the interval of *post-partum* anoestrus increased by about 6 days for each additional week of suckling. It is desirable that cows exhibit a first oestrus within 38 days of calving. Although the mean *post-partum* anoestrus interval of the cows in this experiment was approximately 66 days. A prolonged *post-partum* anoestrus interval is likely to result in an extended calving interval (Thomas *et al*, 1981). The two farmers in this study did not experienced any problems with extended calving-to-calving intervals until now. Probably, this has to do with the use of nurse cows. Calves suckle their own mother for a short period. Margerison *et al*. (2002) found that less impact on the cows' reproductive occurs if the calves have access to all the cows for suckling than if each cow only suckles her own calf;

Milk fat percentage and milk protein percentage of saleable milk are not influenced by suckling (Thomas *et al*, 1981; Fulkerson *et al.*, 1978; Peel *et al.*, 1979). But in case of restricted suckling, when calves are allowed to suckle after milking, the residual milk that is suckled by the calf is higher in fat and protein contents (Mai Van Sanh, *et al.*, 1997).
Literature is not clear about the effect of suckling on live weight change of the suckled cow. Thomas, *et al* (1981) and Fulkerson *et al.* (1978) found that suckling does not affect live weight change in Frisian cows. However, according to, Margerison *et al*. (2002) cows that suckled a calf lost more weight and body condition than cows whose calves were artificial reared.

Effect on future milk production of the calf

Beside the effect of suckling on the milk production of the suckle cow, suckling can have an impact on the calf's future milk producing capacity. Heifers that had been allowed to suckle have a tendency for a greater milk production than calves fed artificial milk (Bar-Peled *et al.*, 1997). This has to do with a positive correlation between live weight at calving and milk production during first lactation. A higher live weight at calving can increase the first lactation milk yield. A rough indication is every kg extra live weight is providing 10kg extra milk yield during first lactation (Elbertsen, 2004).
Although, a higher live weight can increase milk production, overfeeding prior to puberty can be detrimental to milk production as well (Bailey, *et al*., 1999). A to fast growth can have negative effects on the development of the udder tissue. There is a critical period when overfeeding can have a detrimental effect on udder development. This begins at about 3 months of age and ends at puberty or approximately 9 to 10 months of age. This is referred to as the allometric period of mammary growth. During this period, udder growth and development is 3.5 times that of other body systems. Studies indicate that when over conditioning during this period occurs, milk producing tissue in the udder is greatly reduced and replaced with fat (Bailey *et al.*, 1999). However, not all studies about the development of the udder tissue in relation to calf growth do confirm this. In a research of van Amburgh *et al.* (1998) different growth rates were conducted by different diets, there were no effects on milk production. Besides, suckling is not causing a risk for overfeeding, because the allometric period starts after three months when calves are already weaned.

Lactation curves

A normal lactation curve starts high shortly after calving, is then increasing to a peak production followed by a slowly decrease to the end of the lactation. In Figure 2, the average lactation curve for organic farms from the project *Bioveem* and the average lactation curve for conventional farms from the project *Koeien & Kansen* is shown. *Bioveem* is a Dutch project between 17 organic dairy farmers and several institutes. *Koeien & Kansen* is a Dutch project of 17 conventional dairy farmers and several institutes. In both projects the farms are monitored for several years.

The peak production of cows at organic farms is reached after 5 to 6 weeks and is around a level of 29kg milk. This peak production is about 6kg (or 20%) lower than for cows at conventional farms. At the end of the lactation the average production of organic cows is 15kg, which does not differ much from conventional farms (Smolders, 2006).

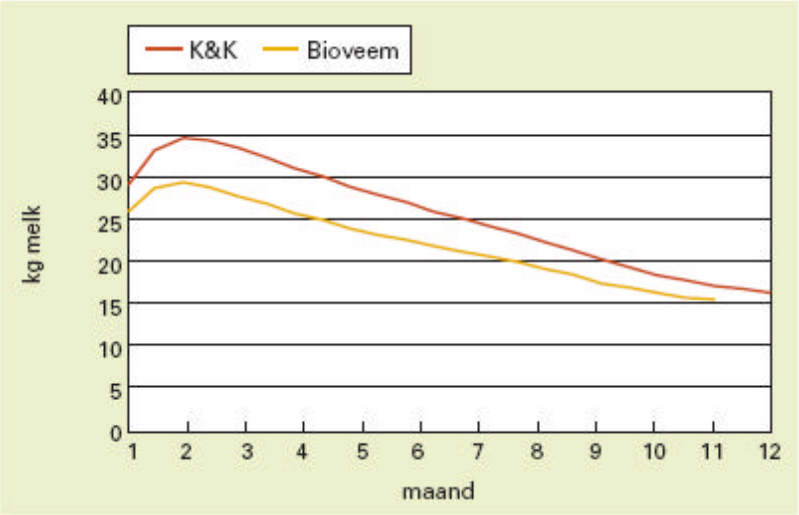


Figure 2 Standard lactation curve for cows at organic farms (average from the project *Bioveem*) and cows at conventional farms (average from the project *Koeien & Kansen*) (source: Smolders, 2006)

There are many factors which are influencing the lactation curve of a cow. According to, NRS (2005) *(i)* older cows are producing more milk in the first part of the lactation compared to heifers, *(ii)* multi parous cows often have a higher milk production than heifers, *(iiii*) calving season is affecting milk production by seasonal effects (mainly through nutrition and climate). In general, cows that calf in October have a higher milk production than cows calving in April. Cows calving in autumn generally have a lower peak production, but the production stays longer on a higher level when fresh pasture becomes available in spring (NRS, 2005).

1.2.4 Mastitis and suckling

Mastitis

Mastitis is an inflammation in the mammary gland and is in most cases caused by bacterial infection (Fröberg, 2005). Sometimes, the infection can be detected by visual observation. This is called clinical mastitis. In case of sub-clinical mastitis no visual abnormalities can be seen. Both, clinical and sub-clinical mastitis can be detected by counting somatic cells in milk (Rouw, 2004).

Mastitis pathogens can be categorized into environmental and contagious pathogens. Environmental pathogens are present in the environment (manure, bedding and soil). Contagious pathogens can infect other cows during the milking process.
SCCs (somatic cell counts) for individual cows above 250,000 cells per ml are seen as critical (Smolders and Baars, 2004). For heifers SCC is generally lower than for multi parous cows. Therefore, SCCs for heifers without mastitis is lower than 200,000 cells per ml (Smolders and Baars, 2004).
A normal SCC curve starts off high shortly after calving, decreases in the first 50-60 days to the lowest level and increases slowly from then on towards the end of the lactation (De Haas, 2003). The slowly increase in SCC is caused by a diluting effect when milk yield is high (NRS, 2005). A normal curve is given in Figure 3.

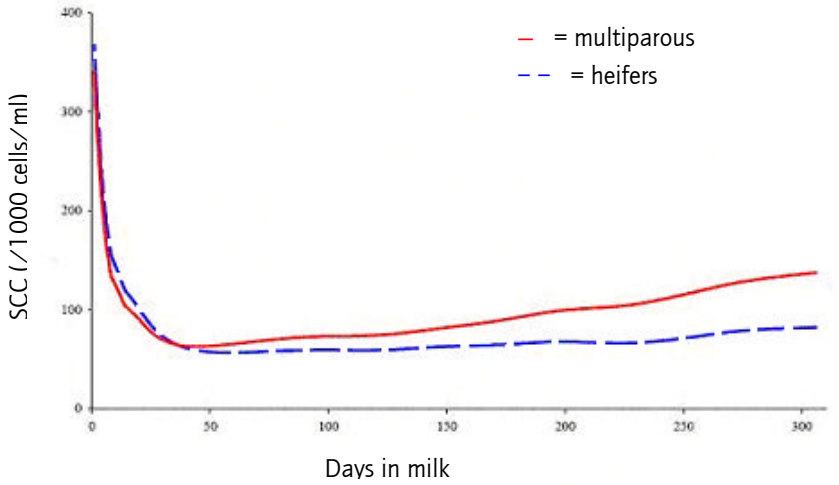


Figure 3 Standard SCC curve for both heifers and multi parous cows (De Haas, 2003)

Tank milk SCC gives an overview on the total udder health on the farm. SCCs for tank milk have to be below 400,000 cells per ml. Above this level farmers are discounted in the price they receive for the milk.
The average tank milk SCC on organic farms is higher than on conventional farms. In a study by Nauta *et al.* (2005), the consequences of converting to organic dairy farming for SCC were investigated. The results showed a significant effect of conversion on SCC. Surprisingly, SCC did not stabilize after some years but increased even 6 years after conversion. According to, Nauta (2000) organic farmers don't see this increased SCC as a problem. It is a logical consequence of the organic system in which the immune system becomes more active and average age of the cows is higher.

The use of antibiotics to treat mastitis and to dry off cows is only limited allowed in organic farming and not allowed in biodynamic farming (Van de Mortel, 2004). Mastitis can be treated with the use of homeopathic or phytotherapeutic preparations.

Effects of suckling on mastitis

Generally farmers use cows with a high SCC as nurse cows. In this way, milk that cannot be sold, is cheap milk to feed the calves. Although it is common practice to feed mastitis milk to calves it can be argued whether it affects the health of the calves. On the other hand, suckling can be a good remedy against mastitis, because the calves empty the udder continuously. Most experiments show that suckling decreases the risks of mastitis in the suckling period and in some cases even for some time after the suckling has been terminated (Krohn, 2001). The lower incidence of mastitis has been attributed to the better emptying of the udder and the cleaning effect of the saliva (Mejia *et al.*, 1998).

1.2.5 Paratuberculosis and suckling

Paratuberculosis

Paratuberculosis or Johne's disease is a chronic disease that causes considerable production losses in adult cattle. The disease is caused by *Mycobacterium Paratuberculosis*. This bacterium causes an inflamed intestinal tract that results in severe weight loss and diarrhoea (Rice, 1990). New infections usually occur when young calves are exposed to a contaminated environment and ingest the organism by licking or sucking the mother cows' udder or vulval area (Rice, 1990). Also other ruminants on the same farm may have the disease. Paratuberculosis occurs in goats and occasionally in sheep. The disease can even be spread by feed (silage) and surface water (GD, 2006). Although, infection starts in early life and new infections are unlikely after six months of age, clinical signs of Paratuberculosis rarely appear until cattle is 2 years old. The peak incidence occurs at 4 to 7 years, but some cases are found in cattle as old as 15 years (Weaver, 2005). Paratuberculosis has considerable economic consequences. Losses are mainly due to decreased milk
production and increased cow replacement costs. Calculations done in 2000 showed that economic losses in the Netherlands caused by Paratuberculosis were € 20 million per year (GD, 2006).

Human can suffer from a disease, called Crohn, that is causing a chronic inflammation of the intestine as well. Possibly, Crohn's disease in human and Paratuberculosis in animals is caused by the same organism. There is still no evidence if there is a relation between the two diseases (Anonymous, 2006).

Suckling and Paratuberculosis

Suckling as rearing system for dairy calves has many positive aspects. However, suckling systems can be in conflict with measures to secure food quality and disease transmission. One of the threats for a more widely acceptance of the suckling system is Paratuberculosis.
To prevent this disease the GD (Gezondheidsdienst voor dieren/Animal health service for animals) developed a *Parawijzer*. This *Parawijzer* contains several measures that are focussing on preventing the distribution of the bacteria. The most important measures are:

- calves will be separated from their mother immediately after birth;
- after the colostrum period, calves should only be fed with artificial milk;
- slurry from older cows should not be spread on pastures grazed by young stock;
- young cattle should not graze land used by cows within the previous 18 months.

It is clear that most of these measures are conflicting with the use of suckling systems. Part of the *Parawijzer* is a checklist with questions. Every question connected to a score. Therefore, it is expected that farms using suckling systems will have a low score when filling in this checklist. The same problem is true for organic farmers. Organic farms are more susceptible for introducing the disease, because this is inherent to the farm management in organic farming; calves are often fed with cow milk and young stock of three months and older stay outside in the pasture (Brouwer *et al.*, 2004).
In a research by Brouwer *et al*. (2004) the Paratuberculosis situation at 83 organic farms was compared to the situation at conventional farms (data of the GD was used). The average score for the *Parawijzer* was lower than the average score at conventional farms. Additional to the *Parawijzer* score, blood tests were taken at 76 organic farms. The percentage organic and conventional farms that were contaminated with Paratuberculosis was the same.

1.2.6 Strong and weak points of suckling systems

To conclude the literature review, an overview of the strong points of suckling systems is given:

- Improved welfare and naturalness; welfare of the cows is increased by suckling, because it leaves room for maternal behaviour. Suckling systems are beneficial to the welfare of the calves, calves will be nursed by their mother, suckle milk, learn to eat roughage at a younger age, have social contact to other calves and have space enough to exercise and play (Krohn, 2001);
- Improved health of the calves; calves have a good colostrum and milk intake. Milk contains antibodies that are present in the local environment and which are important for the immune system of the calf (Ryle and Orskov, 1990). The milk will be provided to the calves at an optimal temperature and with minimum changes on contamination;
- A low calf mortality (Ryle and Orskov, 1990);
- Increased milk production of suckler cows (Peel et al 1979; Thomas *et al*. 1981; Meija *et al.*,1998; Bar-Peled *et al.*, 1995);
- Improved udder health. There is a lower mastitis incidence in suckler cows (Mejia *et al.*, 1998);
- Calves allowed to suckle have a higher daily weight gain (Langhout, 2003). At an age of one year, suckled animals are heavier than bucket-fed calves. This indicates that suckling may lead to a lower age and/or live weight at calving. This might result in a reduction of rearing costs and higher milk production (van Leeuwen, 2004);
- Less labour and an increased working pleasure (Langhout, 2003);
- Keeping calf and cow together has a positive image for the consumer (Langhout 2003);
- Increased naturalness (Langhout 2003).

The suckling system has the following weak points:

- The guidelines which are used by the GD to prevent Paratuberculosis are not in line with the use of suckling systems (Brouwer *et al.*, 2004);
- The farmer has less control on the uptake of colostrum;
- Poor milk let down and fear for inter-suckling was mentioned by farmers as a weakness of the suckling system (Langhout, 2003). However, inter-suckling was not based on negative experiences of the farmers.

1.3 Research goal and background

Research goal:
To investigate the effects on the performance of heifers reared in a suckling system compared to heifers reared in a bucket system.

Research goal background:
Focus was on the parameters: age and live weight at first calving, milk production and mastitis incidence. Besides, Paratuberculosis was getting attention in this study, because the use of suckling systems might increase the risks on occurrence of the disease.

1.4 Research questions

General research question:
What are the effects on performance of heifers reared in a suckling system compared to heifers reared in a bucket system?

The research question was analyzed by making a tree diagram (Annex 1). Under mentioned are the sub-questions that were extracted from the tree diagram:

1) How do heifers reared in a suckling system perform in terms of milk production, age at first calving, live weight at first calving and mastitis incidence compared to heifers reared in a bucket system?
   a) Can age at first calving be reduced for heifers reared in a suckling system?
   b) Do heifers reared in a suckling system reach a higher live weight at first calving, when calving at a comparable age, compared to heifers reared in a bucket system?
   c) Is a higher live weight at first calving resulting in a higher milk production during first lactation?
   d) Does the shape of the lactation curve of heifers reared in a suckling system show any remarkable aspects compared to heifers reared in a bucket system?
   e) Is mastitis (a SCC above the critical norm) seen less frequently in heifers reared in a bucket system compared to heifers reared in a bucket system?
   f) Does the SCC patterns differ for heifers reared in a suckling system compared to heifers reared in a bucket system?

2) What is the current status of mastitis on both farms?

3) What are the risks for Paratuberculosis on both farms?

1.5 Hypothesizes

- Heifers reared in a suckling system will reach a higher live weight, at a comparable age, than those reared in a bucket system.

- Usually farmers use live weight as an indicator to inseminate or introduce the calf to the bull. This means heifers reared in a suckling system can be inseminated or introduced to the bull at a younger age compared to heifers reared in a bucket system. Therefore, age at first calving can be lower for heifers reared in a suckling system. Alternatively, heifers reared in a suckling system will have a higher live weight at first calving, than those reared in a bucket system. A higher live weight at first calving can results in a higher first lactation milk yield.

- Heifers reared in a suckling system will perform better in terms of mastitis incidence compared to heifers reared in a bucket system.

- Farms were suckling systems are used have more risk for transmitting Paratuberculosis compared to farms were conventional rearing methods are used.

2. Material and methods

2.1 Data sources

On two farms, Farm 1 (farm Vrolijk) and Farm 2 (farm Langhout), data have been collected during the period 1-1-2002 until 31-12-2005 and stored in Microsoft Office Access 2003. The database consisted of information on the used rearing system, calving dates, milk production and live weights. Table 1 gives an overview of the measured parameters. Not all parameters were measured consistent. The database with the original data is available at the Louis Bolk Institute.

Table 1 Overview of the measured parameters

Subject	**Measured parameters**
Rearing	Birth date
	Starting date of suckling own mother
	Finishing date of suckling own mother
	Registration number of the mother cow
	Starting date of suckling a nurse cow
	Finishing date of suckling a nurse cow
	Registration number of the nurse cow
	Weaning date
	Calving date
Milk production records	Kg milk at every test-day
	Percentage milk fat at every test-day
	Percentage milk protein at every test-day
	SCC (somatic cell count) at every test-day
	ISK at every test-day [1]
	LW at every test-day [2]
Live weight	Live weight (kg) at different dates (was not measured consistent)
Total herd	Average SCC (somatic cell count) of the total herd at every test-day

1. ISK (Individuele Standaard Koeproducties/Individual Standard Productions per cow). The ISK value is a parameter which is calculated every test-day for cows between 5 and 305-days in lactation. It is a standard for the mean daily kg of produced milk for a cow with an age of 69-92 months, that calved in February/March and is in day 50 of the lactation (NRS, 2005).

2. LW (Lactatiewaarde/Lactation value). The LW value is a parameter based on farm income. In the calculation are costs for feeding, income for milk contents, age and season of calving and calving-to-calving interval taken into account. Like ISK, this parameter is used to compare cows within farms with each other. The average cow on the farm gets a LW with the value 100. For example, when a cow has a value of 110. It is producing 10% better than an average cow on the farm (CR-delta, NRS, 2005).

2.2 Description of the groups

This research evaluated data, from heifers reared in a suckling system and heifers reared in a bucket system, of two organic farms. In total data of 133 suckling and bucket fed calves had been collected.
Only data of female calves, that stayed on the farm and already entered first lactation, was used. Therefore, data of 72 heifers were analyzed. The 72 heifers were divided into 7 groups (Table 2). A code was given to every group; *suck2002 -1* means suckling heifers born in 2002 on Farm 1, *buck2002 –1* means bucket heifers born in 2001 on Farm 1, s*uck2002 –2* means suckling heifers born in 2002 on Farm 2, etc.

Table 2 Number of female calves of which data were collected and had already entered first lactation

Farm 1		**Farm 2**	
Group	Number of calves:	Group	Number of calves:
Suck 2002 -1	13 [1]	Suck 2002 -2	7 [4]
Suck 2003 -1	6 [2]	Suck 2003 -2	6 [5]
Buck 2001 -1	14 [3]	Buck 2001 -2	16 [6]
		Buck 2002 -2	10 [7]

1. From total 14 suckling calves 1 was sold
2. From total 12 suckling calves, 1 was sold, 1 died, 2 were male, from 2 milk data were not available yet.
3. From total 14 bucket fed calves, none was missing
4. From total 13 suckling calves, 3 died, 1 was sold because of udder problems, one was sold halfway the lactation, and from 1 milk data were not available yet
5. From total 39 suckling calves, 1 died, 16 were male, 7 were sold, from 9 milk data were not available yet
6. From total 18 bucket fed calves, 1 was sold, from 1milk data were not available yet
7. From total 23 bucket fed calves, 1 was sold, 4 died, 8 were male.

2.3 Farm description and management

2.3.1 Farm characteristics

Farm 1 was a biodynamic farm, and Farm 2 was certified organic. The total farm area and number of dairy cows on both farms were more or less similar (Table 3). Both farms differed a lot in used breed, total milk production and farm management. Farm 1 used crossbreds of MRIJ with Montbéliarde and an increasing number of Groninger Blaarkop. On this farm cows were not dehorned. When crossing with a Montbéliarde bull, the horns of the cows became sharper. When using a Groninger Blaarkop bull the herd was getting more oval shaped horns, which was preferred by the farmer. Most cows on Farm 2 were of the Holstein Frisian breed. This breed produces more milk than the double purpose breeds on Farm 1. Therefore, total milk production on Farm 2 was higher compared to total milk production on Farm 2. On Farm 1, the farmer's own bull was used in heifers reared in a suckling system and artificial insemination in heifers reared in a bucket system. The farmer's own bull was a crossbred with mainly Groninger Blaarkop. The bull used for artificial insemination was a 100% Montbéliarde bull. This bull was genetically superior compared to the farmer's own bull. Farm 2 used artificial insemination with genetically identical bulls. A bull was present on the farm, but was not used for heifers included in this study.
Both farms also differed al lot in stable type. Cows on Farm 1 were housed in a deep litter stable with a gradient. The farmer developed this stable type himself. On Farm 2 a cubicle stable was used.
Farm 1 had a lower replacement percentage compared to Farm 2. On average, cows on Farm 1 became older than cows on Farm 2. Hence, less replacement calves were needed on Farm 1.

Table 3 Farm characteristics

	Farm 1	**Farm 2**
Certification	Bio dynamic	Organic
Area	50ha	54ha
Number of dairy cows	62 [1]	63 [2]
Breed	Crossbreds of MRIJ, Montbéliarde and Groninger Blaarkop	>95% Holstein (HF)
Milk production	320,000 kg/year	450,000 kg/year
Mean milk production per cow (305-day production)	5267 kg/year [1] 4.16% milk fat 3.49% milk protein	6689 kg/year [2] 4.35% milk fat 3.56% milk protein
Stable type	Deep litter stable with a gradient	Cubicle stable
Replacement %	20% [3]	30-35% [3]

1. source: testday results 14-12-05
2. source: testday results 10-12-05
3. source: personal communication with farmers

2.3.2 Rearing method

Both farms developed their own suckling system, adapted to their farm management. As a result, the suckling system was developing over time. The used systems are explained below.

Farm 1

Only replacement calves (which were born in summer) were reared in a suckling system. The calves stayed outside with their mother, until it became autumn and stable period was starting (after approximately 2 months). The calves had an *ad libitum* milk uptake when suckling their mother. The mother cow was not milked. When stable period was starting, 1 to 3 calves were placed with a nurse cow (depending on the milk production of the cow) for the duration of approximately 1 month. The nurse cow and calves were housed separately from the herd. The nurse cow was not milked.
Male calves and female calves that did not stay on the farm were bucket fed and housed in single pens.

Farm 2

All calves were reared in a suckling system. Calves that were born in 2002 suckled their mother for a period of approximately two months. A few days after birth the mother cow and calf were introduced into the herd. The calves had free access to suckle their mother *ad libitum*. The mother cow was mechanically milked. After the two months period, 1 to 3 calves were placed together with a nurse cow, for the duration of approximately 1 week. Several nurse cows and calves were placed together in a pen, separated from the herd. Placing a calf with a nurse cow was limiting the milk uptake per calf and the weaning went more gradually. The nurse cows were not milked.
The calves that were born in 2003 suckled their mother for approximately 2 months and a nurse cow for approximately 1 month.

The periods that calves suckled their mother or a nurse cow differed between the groups. Calves in group *suck2002 -2* suckled a nurse cow for a significant shorter period compared to the other suckling calves. Not all calves were weaned after exactly 3 months (90 days). On Farm 1, no significant difference in age at weaning was found. Weaning age of the different groups on Farm 2 differed significantly (Table 4).

Table 4 Rearing methods of the 7 groups

	Farm 1						**Farm 2**							
Treatment	**Suck2002-1**		**Suck2003-1**		**Buck2001-1**		**Suck2002-2**		**Suck2003-2**		**Buck2001-2**		**Buck2002-2**	
	Mean	S.E.M.	Mean	S.E.M.	Mean	S.E.M.	Mean	S.E.M.	Mean	S.E.M.	Mean	S.E.M.	Mean	S.E.M.
N	13		6		14		7		6		16		10	
Suckling mother (days)	56[a]	6.3	50 [a]	4.4	n.d.	n.d.	63 [a]	2.8	55 [a]	2.2	n.d.	n.d.	n.d.	n.d.
Suckling nurse cow (days)	33 [a]	8.1	43 [a]	4.6	n.d.	n.d.	6[b]	1.9	38 [a]	4.0	n.d.	n.d.	n.d.	n.d.
Age at weaning (days)	88 [a]	3.9	93 [a]	2.6	92 [a]	0.2	69[b]	3.4	93 [a]	6.6	90 [1]	n.d.	117[c]	4.3

[a,b] Within a row, means without a common superscript differ (P<0.05).

S.E.M.: Standard Error Mean

n..d..: not determined

1. Age at weaning of group Buck 2001 -2 was not measured. An assumption was made.

2.3.3 Suckling of own calf

Some heifers in this study suckled their own calf during first lactation. None of the heifers on Farm 1suckled their own calf during first lactation. On Farm 2: 2 out of 7 heifers in group *suck2002 -2*, 5 out 6 heifers in group *suck2003 -2,* none of the heifers in group *buck2001 -2* and all 10 heifers in group *buck2002 -2* suckled their own calf during first lactation. This was important to have in mind, because suckling can positively affect milk production and mastitis incidence of the suckler cow.

2.3.4 Feeding

Farm 1

Suckling and bucket fed calves did not receive concentrates until weaning. Until 3 months of age calves were fed with *ad libitum* grass-clover silage. Or, during summer when the herd went outside during day and night, *ad libitum* grass. After weaning, calves were housed in straw pens separately from the herd. They received 1 kg concentrates per calf and *ad libitum* grass-clover silage until 12 months of age. After 12 months calves only received *ad libitum* grass-clover silage.

In summer, milking cows stayed in the pastures (mixture of grass/clover) during day and night. In winter, milking cows were fed *ad libitum* grass-clover silage of a good quality. During summer and winter, additional concentrates were fed in the milking parlour (roughly 2kg pelleted grass and 2kg flaked wheat per cow/day). During autumn, some additional whole plant silage was fed (summer barley from own farmland). This was fed to prevent urea levels in milk and blood becoming to high when cows were fed on late summer grass, which is rich in protein.

Farm 2

Suckling and bucket fed calves did not receive concentrates until weaning. Until 3 months of age calves were fed with *ad libitum* grass-clover silage. Or, during summer when the herd went outside during day and night, *ad libitum* grass. From 3-5 months of age calves received about 1kg of additional concentrates. From 5-12 months only *ad libitum* grass-clover silage was fed.

In summer, milking cows stayed in the pastures (mixture of grass/clover) during day and night. Some concentrates were fed to lure them to the stable for milking. In winter, milking cows were fed *ad libitum* grass-clover silage of a good quality. Additionally, pelleted grass concentrates were fed (roughly 3kg per cow/day). Concentrates were fed with a computer-controlled concentrate feeder.

2.4 Data analysis

Both farms differed a lot in used breed, total milk production and farm management. Therefore, comparisons were made within farms. Results of both farms were presented in separate tables.
The heifers in the different groups differed in year of birth, periods of suckling and breeding management. For that reason, data was analyzed and presented per group.

2.4.1 Age at first calving and live weight

Age at first calving was calculated as the difference between the calving date and the calf's birth date. Live weight of heifers reared in a suckling system was compared to heifers reared in a bucket system. Live weight at first calving was not available in this study. As alternative, an overview of the weight development of the calves was given.
At time of weighing, cows were often not of exactly the same age. For that reason, measured live weights were adjusted to 6 age classes:

- Birth (0 days)
- 2 months (60 days)
- 4 months (120 days)
- 6 months (180 days)
- 1 year (365 days)
- 2 years (730 days)

The measured live weights were added to a class and corrected for the right age. For example; a cow with a live weight of 70kg measured at 58 days of age, was adjusted to class "60 days". The measured live weight at 58 days of age was corrected to an age of 60 days, by adding the missing kilograms gained in the two days (the growth per day in the former class). These corrections were carried out in Microsoft Office Access 2003.

2.4.2 Milk production

Total milk productions of heifers reared in a suckling system were compared to those reared in a bucket system. Only first lactation records were used. In this study, a lot of heifers did not finished their first lactation yet. Hence, total milk productions were not available for all heifers. Therefore, an estimated 305-day milk production was used (305-day productions). After 180 days in milk, the estimated 305-day production has a reliability of 90% (NRS, 2005). In the comparison of total 305-day productions, all heifers with a lactation length >180 days, were taken into account.

Milk productions were standardized to 4% milk fat and 3.3% milk protein, by using the formula:

FPCM (Fat and Protein Corrected Milk) = (0.337 + 0.116 x % milk fat + 0.06 x % milk protein) x
Kilograms of milk.

Some heifers on Farm 2 sucked their own calf during first lactation. For these heifers milk data did not represent the actual produced amount of milk. The calf had drunk part of the milk in the beginning of the lactation. The missing production was added to the total amount of milk produced by the heifer. According to, Langhout (2003) a calf will consume 10kg a day in the first 15 days, and in the period thereafter 15kg a day (in case of suckling own mother). An estimate of the amount of milk which was consumed by the calves was made as follows:

- Male calves or female calves not used for replacement: 15 days x 10kg/day = 150kg (male calves were leaving the farm after 15 days);
- Female calves born in 2004: 15 days x 10kg/day + 45 days x 15kg/day = 825kg (suckled the mother cow 2 months);
- Female calves born in 2005: 15 days x 10kg/day + 15 days x 15kg/day = 375kg (suckled the mother cow 1 month).

The NRS is using different parameters to assess milk productions. Beside total milk production, comparisons were made for LW (Lactatiewaarde / Lactation value) and ISK (Individuele Standaard Koeproducties / Individual Standard Productions per cow). These parameters were explained in section 2.1.

2.4.3 Mastitis

The mastitis incidence in heifers reared in a suckling system was compared to that of heifers reared in a bucket system. Number of heifers with a critical SCC within every group was counted. A SCC above 200,000 cells/ml was seen as critical. According to, De Haas (2003) SCC is often high shortly after calving and decreases in the first 50-60 days to the lowest level. Therefore, when counting number of heifers with a critical SCC, only increased SCCs after 50 days in milk were counted.
Also, another method to compare mastitis incidence in suckled and bucket reared heifers was used. Somatic Cell Scores (SCS) of heifers reared in a bucket system were compared to heifers reared in a bucket system. SCSs are log transformed SCCs (Somatic Cell Counts). Log transforming was used because SCC data were abnormally distributed by extreme SCC values that were reached after an infection (up to 2,000,000 cells/ml). De equation of de Haas (2003) was used:

$SCS = \log_2 (SCC/100{,}000) + 3$

In Table 5 is shown how SCC values and SCS values are related to each other.

Table 5 Log transformed values for different SCC data

SCC (x 1,000 cells/ml)	25	50	100	200	400	800	1600
SCS	1.0	2.0	3.0	4.0	5.0	6.0	7.0

(source: Rouw, 2004)

SCC and lactation curves of heifers reared in a suckling system were compared to a standard curve. Stage of lactation was divided into 0-50, 51-100, 101-150, 151-200, 201-250 and 251-305 days in milk.

The current status of mastitis on both farms was investigated by using the *Gezondheidswijzer "Mastitis"*. This is a protocol, developed by the GD (Gezondheidsdienst voor dieren/Animal health service for animals), to prevent mastitis at farm level.
Graphs were made of the mastitis situation on both farms during several years. Average SCCs of the total herd were used. Tank SCCs were not used, because farmers can influence these results. When tank SCC is close to the 400,000 cells per ml, the farmer can decide to keep the milk of high cell count cows out of the tank.

2.4.4 Paratuberculosis

The farm risks for Paratuberculosis were investigated by using the *Parawijzer*. This is a protocol developed by the GD to prevent Paratuberculosis in the Netherlands.

2.5 Statistical analysis

Data were analysed by using SPSS 12.0.1 for Windows. Normally, the Kolmogorov-Smirnov test can be used to test whether data are normally distributed. However, number of heifers within a statistical comparison was sometimes very low (<4). In that case, the prediction of normality by using the Kolmogorov-Smirnov test is not reliable. Therefore, ANOVA test were done with all data, to calculate the residuals. Q-Q plots were made to test if the residuals were normally distributed. If this was the case, normality of the data was assumed. All data was assumed to be normally divided. Differences between individual means were tested by using the independent-Samples T-test. When using SPSS it is not possible to carry out an one-tailed experiment. Based on the hypotheses, the significance value of the output was divided by two.

3. Results

3.1 Age at first calving and live weight

Farm 1

Age at first calving of heifers reared in a suckling system was significant lower compared to heifers reared in a bucket system (Table 6). This result was not unexpected. In the study of Van Leeuwen (2004), it was already found that suckling calves had a higher growth-rate and maintained a higher live weight than bucket fed calves. Therefore, farmer 1 decided to introduce the suckling calves to the bull earlier, than those that were bucket fed.

Growth between heifers reared in a suckling system compared to heifers reared in a bucket system did not differ. No significant difference was found in live weight at two years of age between heifers reared in a suckling system and heifers reared in a bucket system. However, Van Leeuwen (2004) had found a significant difference in live weight between heifers of group *suck2002 -1* and *buck2001 -1* at an age of 1 year. Thus, calculations were done again according the method of van Leeuwen (2004). Again, it was found that group *suck2002* -1 reached a significant higher live weight at one year of age, compared to group *buck2001 -1* (Annex 2).

No significant differences was found in age at first calving between heifers reared in a suckling system born in 2002 and heifers reared in a bucket system born in 2003. As well, no significant difference was found in growth between this two groups.

Table 6 Age at first calving and live weight at different ages on Farm 1

Treatment	**Suck 2002 -1**			**Suck 2003 -1**			**Buck 2001 -1**		
	N	Mean	S.E.M	N	Mean	S.E.M	N	Mean	S.E.M
Age at calving (months):	13	26.4[a]	0.6	6	26.0 [a]	0.4	14	30.5 [b]	1.3
Live weight (kg):									
At birth	13	42.6 [a]	1.44	1	52.7[b]	n.d.	n.d.	n.d.	n.d.
2 months	11	102.0 [a]	4.28	4	105.4 [a]	6.07	n.d.	n.d.	n.d.
4 months	13	157.8 [a]	4.21	6	165.5 [a]	5.34	n.d.	n.d.	n.d.
6 months	9	207.0 [a]	5.84	3	198.0 [a]	12.25	n.d.	n.d.	n.d.
1 year	9	331.0 [a]	11.07	3	325.8 [a]	8.70	n.d.	n.d.	n.d.
Two years	3	529.6 [a]	16.13	n.d.	n.d.	n.d.	7	510.8 [a]	15.88
LW growth (kg/day):									
0– 90 days	13	1.06 [a]	0.050	1	1.06 [a]	n.d.	n.d.	n.d.	n.d.
90–365 days	9	0.71[a]	0.031	3	0.63 [a]	0.016	n.d.	n.d.	n.d.
0-365 days	9	0.91[a]	0.034	3	0.88 [a]	0.015	9	0.86 [a]	0.015

[a,b] Within a row, means without a common superscript differ (P<0.05).

S.E.M.: Standard Error Mean

n.d.: not determined, because not enough data were available

Farm 2

Age at first calving of heifers reared in a suckling system and heifers reared in a bucket system, born in the same year (*suck2002 -2* and *buck2002 -2*), did not differ significantly (Table 7). Heifers reared in a suckling system and born in 2003, had a significant lower age at first calving than heifers reared in a suckling system and born in 2002 ($P = 0.039$).

Heifers reared in a suckling system had a higher growth than bucket reared heifers. Heifers of group *suck2002 -2* reached a significantly higher live weight than heifers of group *buck2002 -2* at 2,4,6 months and 1 year of age. Growth from 0-365 days of group *suck2002 -2* was significant higher than growth of group *buck2002 –2* ($P = 0.014$).

Heifers of group *suck2003 –2* had a higher live weight at an age of 2, 4 months and 1 year, than heifers of group *suck2002 -2*). Growth from 0-365 days of group *suck2003 –2* was higher than growth of group *suck2002 –2* ($P = 0.052$, nearly significant).

Table 7 Age at first calving and live weight at different ages on Farm 2

Treatment	**Suck 2002 -2**			**Suck 2003 -2**			**Buck 2001 -2**			**Buck 2002 -2**		
	N	Mean	S.E.M.	N	Mean	S.E.M.	N	Mean	S.E.M.	N	Mean	S.E.M.
Age at calving (months):	7	26.0[a]	1.2	6	23.4[b]	0.5	16	26.8[a]	0.9	10	25.9[a]	0.8
Live weight (kg):												
At birth	7	41.0[a]	1.54	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d	n.d.	n.d.
2 months	6	95.7[a]	4.36	5	107.1[b]	n.d.	n.d.	n.d.	n.d.	6	64.9[c]	3.5
4 months	3	124.8[a]	6.37	6	146.8[b]	n.d.	n.d.	n.d.	n.d.	7	109.5[c]	4.3
6 months	3	177.9[a]	14.2	6	184.3[a]	n.d.	n.d.	n.d.	n.d.	8	152.5[b]	10.8
1 year	3	334.1[a]	13.2	3	367.5[b]	n.d.	n.d.	n.d.	n.d.	7	300.5[c]	7.0
Two years	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	6	498.4[c]	18.1
LW growth (kg/day):												
0 - 90 days	6	0.86[a]	0.054	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.
90 - 365 days	3	0.79[a]	0.04	3	0.78[a]	0.03	n.d.	n.d.	n.d.	6	0.77[a]	n.d.
0 – 365 days	3	0.92[a]	0.04	3	1.01[b]	0.12	n.d.	n.d.	n.d.	7	0.82[c]	0.19

[a,b] Within a row, means without a common superscript differ (P<0.05).

S.E.M.: Standard Error Mean

n.d.: not determined, because not enough data were available

Gross analysis

On both farms, the presentation of data did not give a quick impression about the performance of heifers reared in a suckling system compared to heifers reared in a bucket system. A gross analysis was given in annex 3. Suckled groups were compared to bucket groups. On Farm 1

age at first calving of the suckled groups was significant lower compared to the bucket groups. No difference was found in growth. Age at calving on Farm 2 was significant lower for the suckled groups compared to the bucket groups. Growth was significant higher for the bucket groups.

Impression of growth

All heifers, reared in a suckling system, had a higher growth compared to heifers reared in a bucket system. The fastest and slowest growing group were both found on Farm 2. Heifers in group *suck2003* -2 had the highest average growth of all groups included in this study (Figure 8). Their growth was even higher than recommended. Particularly, live weight at 1 year of age was much higher than recommended. Heifers within group *buck2002 -2* had the slowest average growth of all groups. Their growth was lower than recommended

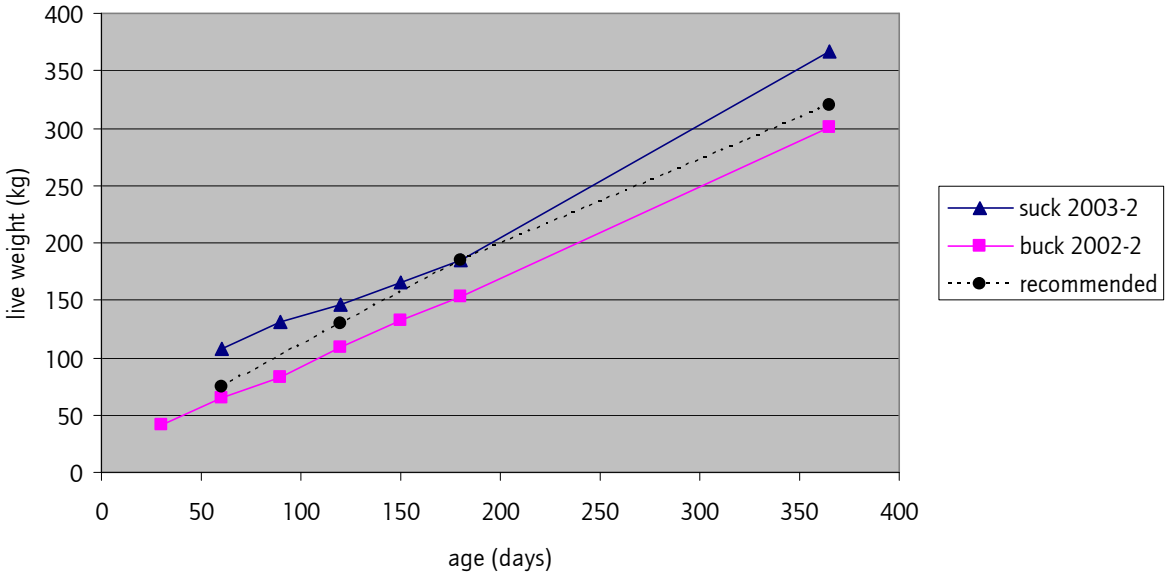


Figure 8 Average growth of heifers within the slowest and fastest growing group

3.2 Milk production

Farm 1

An overview of the milk production records is given (Table 8). To obtain a reliable 305-day milk prediction, only heifers with a lactation length of at least 180 days, were taken into account. None of the heifers in group *suck2003 -1* fulfilled this requirement.

The suckled group (*suck2002 -1*) and bucket group (*buck2001 -1*) were not fully comparable, because heifers in both groups were born in different years. Although, it was found that total milk production of heifers in the suckled group was significant lower compared to the heifers in the bucket group (P =0.0035). As well, milk fat (P =0.0125), milk protein (P =0.0005) and LW (P =0.013) were significant lower for heifers in the bucket group.

Table 8 Overview of milk production records on Farm 1

Treatment	**Suck 2002 -1**		**Buck 2001 -1**	
	Mean	S.E.M.	Mean	S.E.M.
N [1]	12		14	
Total milk production, 305-day (kg) [2]	4,669[a]	190.2	5,368[b]	149.2
Milk fat, 305-day (kg)	190[a]	7.6	211[b]	5.2
Milk protein, 305-day (kg)	154[a]	5.4	184[b]	5.6
DIM (days in milk)	308[a]	17.2	314[a]	19.8
LW	102[a]	3.4	112[b]	2.9
Age at calving (months)	25.8[a]	0.3	30.5[b]	1.3

[a,b] Within a row, means without a common superscript differ (P<0.05).

S.E.M.: Standard Error Mean

1. only heifers with a lactation length > 180 days were taken into account

2. Milk production based on FPCM

Farm 2

On farm 2, no significant differences were found within milk production, milk fat, milk protein, LW or ISK of heifers reared in the suckled groups and heifers reared the bucket groups (Table 9). DIM (days in milk) of both groups was not comparable, because not all heifers had finished their lactation yet.

Table 9 Overview of milk production records on Farm 2

Treatment	**Suck 2002 -2**		**Suck 2003 -2**		**Buck 2001 -2**		**Buck 2002 -2**	
	Mean	S.E.M.	Mean	S.E.M.	Mean	S.E.M.	Mean	S.E.M.
N [1]	6		4		16		10	
Total milk production, 305-day (kg)[2]	6,296[a]	273.7	5,546[a]	551.5	6,246[a]	302.1	6,088[a]	331.3
Milk fat, 305-day (kg)	252[a]	12.3	218[a]	25.0	256[a]	13.1	231[a]	18.5
Milk protein, 305-day (kg)	207[a]	10.0	176[a]	19.5	208[a]	9.6	186[a]	11.2
DIM (days in milk)	343[a]	30.0	212[b]	7.8	368[c]	19.3	401[ac]	33.3
LW	105[a]	5.0	99[a]	9.7	103[a]	4.15	94[a]	6.4
ISK	33.9[a]	1.3	31.0[a]	2.7	33.7[a]	1.6	31.1[a]	2.4
Age at calving (months)	25.3[a]	1.1	23.0[b]	0.5	26.8[a]	0.9	25.9[a]	0.8

[a,b] Within a row, means without a common superscript differ (P<0.05).

S.E.M.: Standard Error Mean

1. Only heifers with a lactation length > 180 days were taken into account

2. Milk production based on FPCM

Suckling of own calf

The milk production of heifers on Farm 2, that were reared in a suckling system and suckled their own calf, was compared to heifers on Farm 2, that were reared in a suckling system and did not suckled a calf (Table 10). No significant differences were found in milk production, kg milk fat or kg milk protein.

Table 10 Milk production records on Farm 2

Treatment	**Heifers that suckled own calf**			**Heifers that did not suckled a calf**		
	N	Mean	S.E.M.	N	Mean	S.E.M.
Total milk production, 305-day (kg)[1]	15	6,010[a]	272.8	21	6,219[a]	236.2
Milk fat, 305-day (kg)	15	230[a]	13.9	21	254[a]	10.4
Milk protein, 305-day (kg)	15	186[a]	9.2	21	210[a]	8.8

Only heifers with a lactation length > 180 days were taken into account

[a,b] Within a row, means without a common superscript differ (P<0.05).

S.E.M.: Standard Error Mean

1. Milk production based on FPCM

Gross analysis

The results of the 4 different groups did not give a quick impression about the performance of heifers reared in a suckling system compared to heifers reared in a bucket system. Therefore, a gross analysis was given in Annex 4. Both suckled groups were compared to both bucket groups. On Farm 1 bucket groups had a higher milk production compared to suckled groups. No significant differences in milk production records were found on Farm 2.

It can be expected that, heifers that suckled their own calf, have a lower measured production than the predicted 305-day production. Hence, the calves had drunk part of their milk.

Predicted 305-day milk productions that were expected on genetically information of the heifers, were compared to actual produced 305-day productions (Annex 5). Remarkable, heifers that suckled their own calf did not have a lower 305-day milk production than expected.

3.3 Mastitis

3.3.1 Mastitis and suckling

Farm 1

A high percentage of heifers in group *suck2002 –1* had an increased SCC during first lactation (Table 11). From the total number of times the critical norm was exceeded it can be seen how many times high SCCs were returning after recovery. High SCCs were often returning in group *suck-2002 –1*.

Table 11 Percentage high SCC cows and total number of times the critical norm (>200.000 cells/ml) was exceeded on Farm 1

	N	**% high SCC cows**	**Total number of times critical norm was exceeded**
Suck 2002 -1	13	69%	15
Suck 2003 -1	6	0%	0
Buck 2001 -1	14	29%	5

SCSs of heifers in the suckled group (*suck 2002 -1*) and the bucket group (*buck 2001-1*) were not fully comparable, because heifers in both groups were born in different years. Although, a higher SCS was found for heifers in the suckled group (P = 0.026); (Table 12). A SCS above 4.0 was seen as critical (comparable with a SCC of 200,000 cells/ml). The mastitis situation of heifers in the suckled group was critical during first lactation.

Table 12 Mean SCS on Farm 1

Treatment	**Suck 2002 -1**			**Buck 2001 -1**		
	N	Mean	S.E.M.	N	Mean	S.E.M.
Mean SCS	11	4.3[a]	0.3	14	3.2[b]	0.3

Only heifers that finished their first lactation were included. There were no heifers with finished lactations in group suck 2003 -1

[a,b] Within a row, means without a common superscript differ (P<0.05).

S.E.M.: Standard Error Mean

Farm 2

It was remarkable that none of the heifers in group *suck2002 -2* had an increased SCC, compared to 50% in group *buck2002 -2*; (Table 13). High SCCs in group *buck2002 –2* were often returning after recovery. One heifer in this group exceeded the critical norm 4 times during first lactation.

Table 13 Percentage high SCC cows and total number of times the critical norm (>200.000 cells/ml) was exceeded on Farm 2

	N	**% high SCC cows**	**Total number of times critical norm was exceeded**
Suck 2002 -2	7	0%	0
Suck 2003 -2	6	17%	2
Buck 2001 -2	16	31%	8
Buck 2002 -2	10	50%	12

No significant difference in SCS was found between heifers reared in a suckling system and heifers reared in a bucket system (table 14). The suckled and both bucket groups had an average SCS below the critical norm (<4.0).

Table 14 Mean SCS on Farm 2

Treatment	**Suck 2002 -2**			**Buck 2001 -2**			**Buck 2002 -2**		
	N	Mean	S.E.M.	N	Mean	S.E.M.	N	Mean	S.E.M.
Mean SCS	5	3.0[a]	0.2	16	2.9[a]	0.2	10	3.4[a]	0.4

Only heifers that finished their first lactation were included. There were no heifers with finished lactations in group suck 2003-2

[a,b] Within a row, means without a common superscript differ (P<0.05).

S.E.M.: Standard Error Mean

Gross analysis

A gross analysis was given in Annex 6. When suckled groups were compared to bucket groups, no significant differences in SCS were found.

Suckling of own calf

The SCS value of heifers on Farm 2, that were reared in a suckling system and suckled their own calf, was compared to heifers that were reared in a suckling system and did not suckled a calf (table 15). No effect of suckling on the mastitis incidence was found.

Table 15 Mean SCS on farm 2

Treatment	**Heifers that suckled own calf**			**Heifers that did not suckled a calf**		
	N	Mean	S.E.M.	N	Mean	S.E.M.
Mean SCS	15	3.2[a]	0.3	21	2.8[a]	0.2

Only heifers that finished their first lactation were included. There were no heifers with finished lactations in group suck 2003 -1

[a,b] Within a row, means without a common superscript differ (P<0.05).

S.E.M.: Standard Error Mean

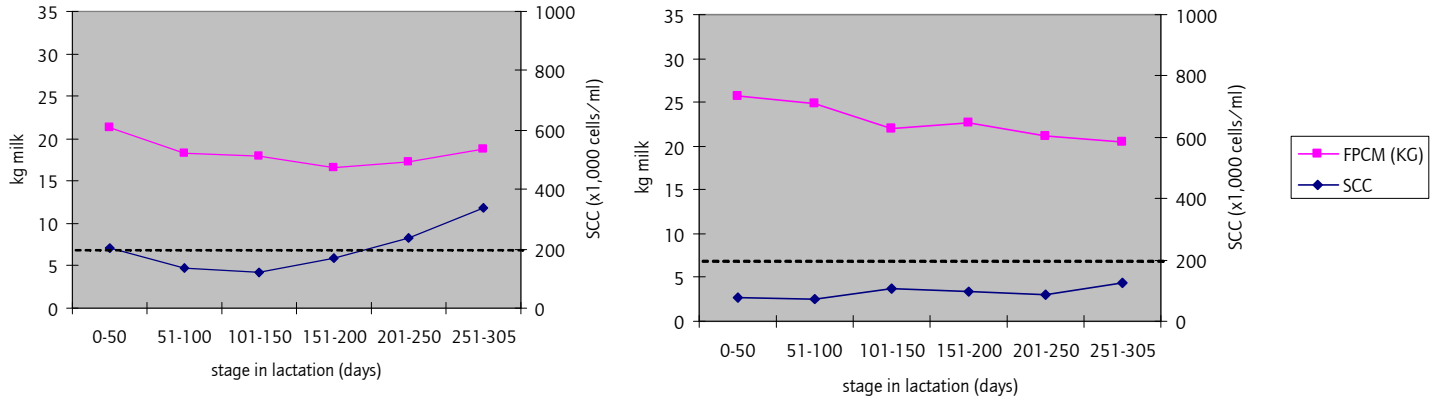
3.3.2 Mastitis in relation to milk production

SCC and lactation curves are given for every group, except for group *suck 2003 -1*. Curves from heifers in this group are not given, because only 1-3 test days were available yet. Curves were compared to a standard SCC pattern and lactation curve. A standard lactation curve is shown in Figure 2 (section 1.2.3) and a normal SCC pattern can be seen in Figure 3 (section 1.2.4).

Farm 1

Although, it looks like the SCC of heifers reared in a suckling system, group (*suck2002* -1), was increasing towards the end of the lactation (Figure 9a), this increase was caused by one heifer (6716) with a SCC of 2,908,000 cells per ml at the end of its lactation. SCC in the bucket group (*buck2001 -1*) was slowly increasing towards the end of the lactation. The average of the group stayed under 200,000 cells/ml.

In both groups, *suck2002 -1* and *buck2001 -1* the lactation curve was, comparable with the standard curve, decreasing towards the end of the lactation. However, the figures give the impression that a peak production was missing. Milk production of the bucket group (*buck2001 -1*) started at a higher production level than the suckled group (*suck2002 -1*).



a. *Suck2002 -1*

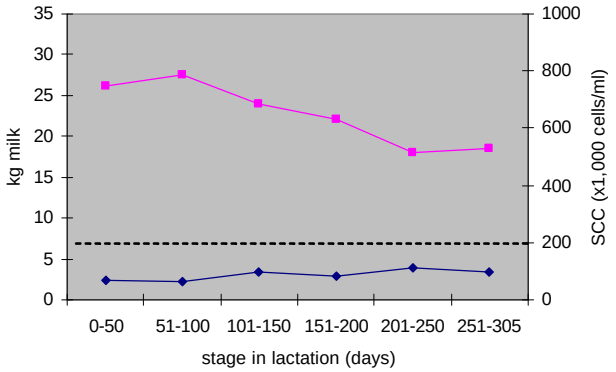
b. *Buck2001 -1*

Figure 9 Lactation and SCC curves for groups on Farm 1

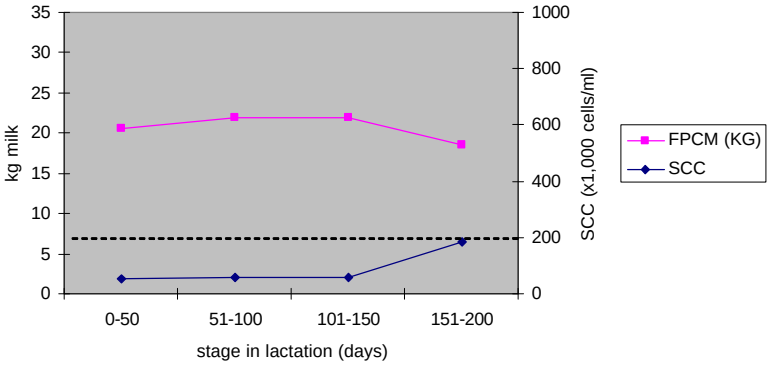
Farm 2

SCC of group *buck 2002 -2* appeared to be high in the beginning of the lactation (Figure 10d), but this was caused by two heifers with extreme SCCs (4,310,000 and 1,853,0000 cells/ml). If these heifers were left out, the curve did not show any increase.

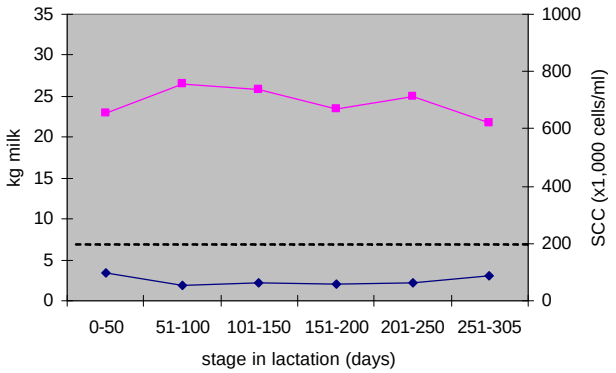
Milk production of group *suck2002 -2* started on a higher level compared to other groups on Farm 2 (Figure 10a). A peak production was missing in the lactation curve of group *suck2003 -2* (Figure 10b). Milk production of group *buck2001 -2* stayed on a high level during the lactation. This was caused by a second peak production after approximately 210-250 days in lactation (Figure 10c). The lactation curve of group *buck2002 -2* was giving the impression that milk production started at a low level compared to other groups (Figure 10d).



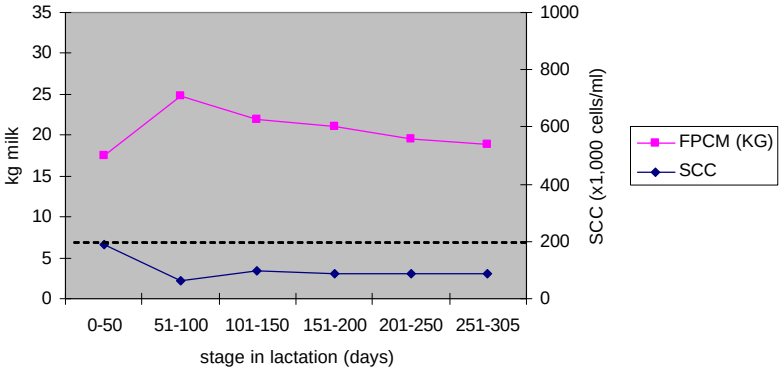
a. *Suck2002 -2*



b. *Suck2003 -2*



c. *Buck2001 -2*



d. *Buck2002 -2*

Figure 10 Lactation and SCC curves for groups on Farm 2

3.4 Mastitis status on both farms

3.4.1 Mastitis status

On both farms, average SCC of the herd was high during last year (Table 16). Both farms exceeded the limit of 400,000 cells per ml a few times during 2005. Also, on both farms, percentage of high cell count cows was high compared to the norm of 15% (Van de Mortel, 2004). The average percentage of high cell count cows after calving in the Netherlands is 23% (Poelarends and Smolders, 2004). Hence, percentage of high cell count cows after calving was high on both farms.

Table 16 Overview of the mastitis situation on both farms in 2005 (MPR-results 14-12-05)

	Farm 1	**Farm 2**
Average SCC of the herd in 2005 (x 1,000 cells per ml)	344	307
% of high cell count cows (=250,000 cells/ml)	37%	24%
% new high cell count cows (=250,000 cells/ml)	12%	9%
% high cell count cows after calving (=250,000 cells/ml)	35%	45%

The *Gezondheidswijzer "Mastitis"*, was used to investigate strong and weak points of mastitis prevention on both farms. The results showed that strong points in preventing mastitis on Farm 1 were; keeping the milking machine as optimal as possible and good milking methods. On Farm 2, attention was not paid on keeping the milking machine as optimal as possible or at good milking methods, but on "other measures" (selling cows with high SCCs, using a dip after milking, etc.) to prevent mastitis (Annex 7).

3.4.2 Mean SCC before and during the use of a suckling system

On both farms, there was a lot of variation in average SCC of the herd during and between years (Figure 11). From January 2003 until December 2005 average SCC of the herd varied from 139 - 714 x 1,000 cells per ml on Farm 1, and from 142 - 769 x 1,000 cells per ml on Farm 2.

Suckling did not have a positive effect on the average SCC of the future dairy herd. Both farms introduced the suckling system in 2002. On both farms, the first heifers reared in a suckling system started lactating in October 2004. Average SCC of the herd was, on both farms, not improved after suckled heifers started their first lactation.

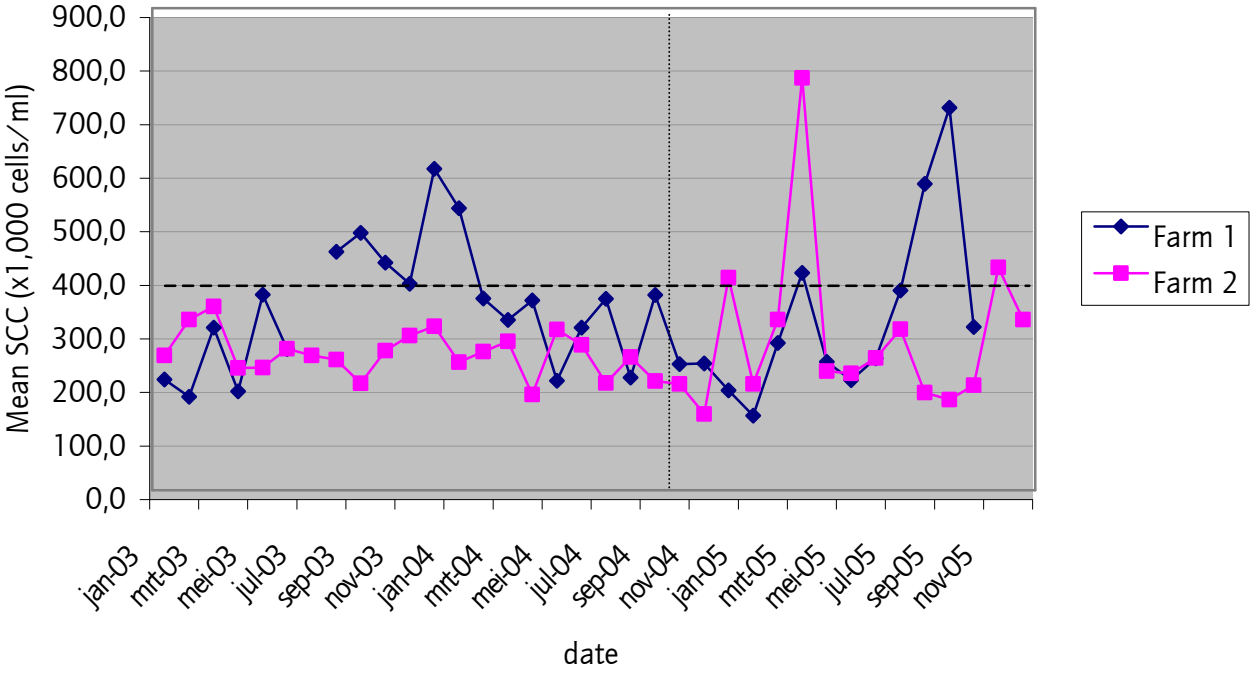


Figure 11 The average SCC of the herd

3.5 Paratuberculosis

Both farms did not take part of the preventive program of the GD. In the 2003 on both farms manure samples were taken to test if the farms were contaminated. At that time, Paratuberculosis was not found on Farm 1. Manure samples on Farm 2 showed contamination with the Paratuberculosis bacterium. It was not known which cows were contaminated, because pooled tests were done. Hence, the contaminated animals were not replaced.

The *Parawijzer* was used to find the risks on both farms for introducing and spread of the disease. It consists of a list of questions, every question is connected to a score. The list is divided in several subjects. For both farms the score per subject is shown in Table 17.

Table 17 Results *Parawijzer* for both farms

Part of Parawijzer	Topic	Score Farm 1	Score Farm 2	Total to gain score
Subject 1	Calving	200	0	300
Subject 2	Calf rearing until weaning	132	60	420
Subject 3	Calf rearing after weaning	96	66	180
General	Hygiene	50	50	70
	Registration	0	0	30
Total		**478**	**176**	**1000**

Both farms had a low total score. On Farm 1, scores were low for the subjects: calf rearing until weaning, calf rearing after weaning and registration. Farm 2 had a low score for all subjects, except for hygiene.
Scores for calf rearing until weaning were low, because calves were fed with cow milk in stead of milk powder, and calves did not stay inside until 3 months of age. Scores for calf rearing after weaning were low, because calves were not housed separately from older cows, manure from cattle sheds was spread on pastures grazed by young stock, and young stock could drink from surface waters. Both farms did not make a registration of calves born under unhygienic circumstances or that were suspected of disease.

Both farms had an exception to the standard measures. Slurry from cattle sheds should not be spread on pastures grazed by young stock. However, Farm 1 used composted manure instead of slurry. Because the bacteria which is causing Paratuberculosis can survive in the environment (outside an animal) for more than a year, composted manure was still seen as a risk factor in this study.
Another measure is: cows should calve in clean stalls or in dry and uncontaminated areas outdoors. On Farm 2, the whole corridor within the stable was used as calving stall. Because cows were fed with *ad libitum* grass silage, a lot of grass silage was stored in the corridor. Calving cows polluted a lot of silage and the calves came in contact with the silage as well. For the farmer it was not seen as a problem when the cow polluted some silage. Although, grass silage can be contaminated with the Paratuberculosis bacteria which can infect the calf. Therefore, the calving stable on this farm was seen as a risk factor in this study.

Both farms had low scores for questions about risks for introducing the disease (table 18). However, the use of suckling systems is not increasing the risk for introducing the disease. Measures to prevent introduction of the disease are not connected with the use of suckling

systems. For example, if using suckling systems calves can still be kept inside until one year of age. The use of suckling systems is increasing the risks for spreading the disease within the farm, when it is already present.

Table 18 Results *Parawijzer* for questions about introducing the disease on both farms

Questions	**Score Farm 1**	**Score Farm 2**	**Total to gain score**
Calves stay inside until one year of age	0	0	70
Drinking from surface waters	0	0	38
Buy cows from other farms	20	20	20
Use manure from other farms	15	15	15
No contact with goats	8	8	8
Disinfection of boots, etc. when entering the farm	0	0	20
Machines that enter the farm are free of manure	15	15	15
Total	**58**	**58**	**186**

3.6 Costs of the suckling system

The suckling costs of group *suck2003-1* on Farm 1 and group *suck 2003-2* on Farm 2 were compared to the costs of a bucket system (Table 19). Number of days that calves suckled their mother or a nurse cow were used to calculate the suckling costs (Table 4). For loss of milk by suckling the mother cow, an organic milk price of €0.38 kg milk was used. Often nurse cows with high SCCs were used. Additionally, on Farm 2 cows that were selected to be replaced were used as a nurse cow. Before these cows were slaughtered they first had to gain weight. Meanwhile, these cows were used as nurse cows. Therefore, loss of saleable milk, when suckling a nurse cow, was valued lower than when suckling the mother cow. It was set at a price of €0.19 kg milk.
In case of bucket feeding an average milk consumption of 6kg a day of cow milk per calf per day was used (Anonymous, 1997). It was assumed that no milk of high cell count cows was used in the bucket feeding system.

Extra milk consumption costs by suckling were €124,- per calf on Farm 1, and €142,- per calf on Farm 2. Milk consumption costs were higher on Farm 2, because calves suckled their own mother 5 days longer compared to suckling calves on Farm 1.

Table 19 Milk consumption costs for a suckling period of 90 days

	Farm 1	**Farm 2**
Bucket feeding system:		
Milk consumption	6 kg/day	6 kg/day
Duration	90 days	90 days
Total consumption by bucket feeding	540 kg/calf	540 kg/calf
Total costs bucket feeding (€0.38 kg milk)	**€205,-**	**€205,-**
Suckling system:	*Suck2003 -1*	*Suck2003 -2*
Suckling own mother:	50 days[1]	55 days [1]
Milk consumption 10kg/day	14 days	14
Milk consumption 15kg/day	36 days	41
Milk consumption by single suckling	680 kg/calf	755 kg/calf
Costs single suckling (€0.38 kg milk)	€258,-	€287,-
Suckling nurse cow:	43 days[1]	38 days[1]
Milk consumption 10kg/day	43 days	38 days
Milk consumption by multiple suckling	430 kg/calf	380 kg/calf
Costs multiple suckling (€0.19 kg milk)	€82,-	€72,-
Suckling costs of both groups	€340,-	€359,-
Total suckling period:	93 days	93
Total costs suckling system when suckling 90 days:	**€329,- (340x90/93)**	**€347,- (359x90/93)**
Extra consumption cost by suckling per calf:	**€124,-**	**€142,-**
Total consumption by suckling	1110 kg/calf	1135 kg/calf
Extra consumption by suckling vs. bucket feeding	**570 kg/calf**	**595 kg/calf**

1. Number of days the suckled group, suckled own mother or a nurse cow (table 4)

On both farms, a shorter rearing period was found for heifers reared in a suckling system compared to heifers reared in a bucket system. A shorter rearing period due to suckling will save costs. Group *suck2003-1* had a 4.5 months shorter rearing period compared to the bucket group (*buck2001 -1*) on Farm 1. On Farm 2, the lowest significant difference in age at calving was found between group *suck2003 -2* and *buck2002-2*. The suckled group had a 2.5 months shorter rearing period compared to the bucket group. Rearing costs of €1,54 per heifer per day were used (Asseldonk *et al*. 2001). Which is comparable to the total rearing costs of €1200,- per heifer calculated by CR-Delta (2006). The average heifer is calving at an age of 26 months (780 days). 780 x €1,54 = €1201,-
The loss of saleable milk was totally repaid by a shorter rearing period on Farm 1 and almost repaid on Farm 2 (Table 20).

Table 20 Final costs of the suckling system

	Farm 1	**Farm 2**
Extra consumption cost by suckling per calf:	€124,-	€142,-
Shorter rearing period due to suckling:	4.5 months (135 days)	2.5 months (75 days)
Savings by shorter rearing period (€1,54/heifer/day):	€208,-	€116,-
Final costs of the suckling system per heifer:	**€-84,-**	**€26,-**

3.7 The view of the farmers

Farm 1

The farmer had high expectations of the effects of suckling on the mastitis incidence of the future herd, reared in a suckling system. The farmer did observe some positive effects of suckling on the mastitis incidence of cows, when a high cell counts cow was suckled by several calves. But an effect on the future herd, reared in a suckling system, was not observed until know.

Since introducing the suckling system, the farmer clearly observed an increased natural behaviour in his cows. Cows take good care of their calves. Especially heifers that were allowed to suckle themselves showed a very strong maternal behavior. When the calf was not removed, the mother cow was sooner reestablished after calving and the calf had an optimal start. Moreover, when calves were part of the herd, the herd was better balanced. But a strong natural behaviour had some negative aspects as well. Often, the maternal bond was so strong that the separation at weaning gave a lot of stress. According to the farmer, the longer you keep cow and calf together the harder it gets.

The farmer preferred replacement calves that were born in summer, because they are stronger and have a better start than calves born in winter.

Some KI was used in the bucket reared calves. The farmer observed a higher milk production and a better growth in this calves. The bull used for artificial insemination was genetically superior compared to his own bull.

Farm 2

According to the farmer, cows performed better in a suckling system, because they were feeling better (a better welfare). Cows can show their maternal behavior. He observed that calves were carefully nursed by the cows. Sometimes young calves were very dirty (full of manure), but at the end of the day the mother had totally cleaned it by licking her calf.

Introducing the suckling system improved the total farm. Not only animal welfare improved, also farm income and working pleasure of the farmer increased. However, not only the rearing system was changed, the feed strategy was adjusted as well. The amount of concentrates fed was reduced and roughage increased. This resulted in lower feed costs, decreased milk yields, but increased milk solids. The farmer is aiming now for high amount of milk solids.

The long lactations of some heifers on Farm 2 were remarkable. One of the heifers in this study obtained a lactation length of 646 days. This long lactations were part of the management strategy of the farmer. His view on this is that you ask for udder health problems when drying off a cow which is still high producing. Moreover, if cows have a prolonged anoestrus it stays at an extensive farm longer economically profitable to continue milking, even when production is low. As long the cow was producing more than 10kg milk a day, the farmer was not drying off the cow.

The farmer observed positive effects of suckling on mastitis. The mastitis situation of nurse cows was often improving, because calves continuously emptied the udder. Also, cows that had to be slaughtered, but first had to gain weight, were used as a nurse cow. By using these cows, suckling costs became very low.

The farmer was developing the suckling system on his farm over time. Therefore, he expected the suckling heifers that were born in 2003 to perform better than the suckling heifers born in 2002. The suckling heifers of 2003 reached a higher live weight at a younger age than those of 2002, but no differences in milk production were found.

4. Discussion

4.1 Age and live weight at first calving

In this study the effects on the performance of heifers reared in a suckling system compared to heifers reared in a bucket system were investigated. The hypothesis was that heifers reared in a suckling system reach a higher live weight, at a comparable age, than those reared in a bucket system. This could have the following consequences:

- Heifers reared in a suckling system can become pregnant at a younger age compared to heifers reared in a bucket system. Hence, age at first calving can be reduced for heifers reared in a suckling system;
- Alternatively, heifers reared in a suckling system will have a higher live weight at first calving than when reared in a bucket system. A higher live weight at first calving can increase first lactation milk yield.

On Farm 1 no differences in live weight between heifers reared in a suckling system and heifers reared in a bucket system was found when corrected live weights were used. In the method of Van Leeuwen (2004), all live weights of heifers at an age between 400 and 500 days were used. When using this method, it was found that heifers reared in a suckling system reached a higher live weight than those reared in a bucket system. Although, a higher live weight for heifers reared in a suckling system was expected, no difference in live weight was found when using corrected live weights. Live weight data was affected by the breeding management. Artificial insemination was used in the bucket group and the farmer's own bull was used in the suckling groups. The bull used for artificial insemination was a 100% Montbéliarde cow, while the farmers own bull was a crossbred of Montbéliarde with a high percentage of Groninger Blaarkop. An adult Montbéliarde cow has a higher live weight (650 - 800 kg) (Koole-liebregts, 2006) compared to the live weight of an adult Groninger Blaarkop cows (approximately 550kg) (szh, 2006). Heifers on Farm 2, that were reared in a suckling system, reached a higher live weight, at a comparable age, compared to bucket reared heifers.
On both farms, live weight was used as an indicator to inseminate or introduce the calf to the bull. However, the moment of insemination or introduction to the bull is subject to the decision of the farmer. Therefore, the farmer can affect age at first calving. All heifers on Farm 1, that were reared in a suckling system, had a lower age at first calving compared to the bucket reared heifers. On Farm 2, only heifers that were reared in a suckling system and born in 2003 had a lower age at first calving compared to heifers reared in bucket system.
These live weight results are supported by the experimental results of Bar-Peled *et al.* (1997). In her experiment the weight gain and production parameters of Holstein heifers that were allowed to suckle were measured. 20 suckling calves were allowed to suckle for 6 weeks. 20 control calves were used. The results of the experiment indicated that heifers that suckled milk the first 6 weeks after birth had higher average daily weight gains and a higher live weight at calving than calves that were not allowed to suckle.

Exact live weights at calving were not available in this study. It was assumed that, if calving age was not reduced, live weight at first calving would be higher for heifers reared in a suckling system compared to bucket reared heifers.

4.2 Milk production

A higher live weight at first calving can increase first lactation milk yield (Bailey, *et al*., 1999). In this study it was not found that a higher live weight of heifers reared in a suckling system compared to those reared in a bucket system, was resulting in a higher milk production during first lactation. On Farm 1, it was even found that milk production of the suckled group was lower compared to the bucket group. The lower production of heifers reared in a suckling system was probably caused by the breeding management and the extreme reduction of age at first calving. Artificial insemination was used in the bucket group, while the farmer's own bull was used in the suckled groups. The bull used with artificial insemination was genetically superior (a better breeding value for milk production) compared to the farmer's own bull. Therefore, heifers on this farm, reared in a bucket system, had a tendency for a greater milk production than those reared in a suckling system. Moreover, artificial insemination was carried out with a 100% Montbéliarde bull, while the farmer's own bull was a crossbred of Montbéliarde and a higher percentage of Groninger Blaarkop. The average milk production of the Groninger Blaarkop breed is lower than that of the Montbéliarde breed (NRS, 2005). An other explanation for the higher milk production of heifers reared in a suckling system was the extreme reduction in calving age. Calving age of heifers reared in a suckling system was reduced with 4.5 months compared to heifers reared in a bucket system. Probably, this high reduction in calving age had a decreasing effect on milk production.
On Farm 2, no difference in milk production between heifers reared in a suckling system and heifers reared in a bucket system was found. However, suckled and bucket groups on Farm 2 were not fully comparable, because some heifers suckled their own calf during first lactation. Suckling increases milk productions of the suckled cow (Peel et al 1979; Thomas *et al*., 1981; Meija *et al.*,1998; Bar-Peled *et al.*, 1995). For example group *suck2002 -2* and group *buck2002 -2* appeared to be very suitable to make comparisons, because both groups included heifers born in the same year. However, all 10 heifers in the bucket group suckled their own calf during first lactation, while only 2 out of 7 heifers in the suckled group suckled their own calf during first lactation. However, it was found that suckling a calf did not affect the milk production of the heifers in this study.
In contrast with the results found in this study, do the experimental results of Bar-Peled *et al.* (1997) indicate that, heifers allowed to suckle, had a tendency for a higher milk production during first lactation compared to heifers reared in a bucket system.

Total milk production and the shape of a lactation curve are both affected by environmental effects. When comparing milk production data, milk productions actually have to be corrected for environmental effects. The NRS is correcting data for:

- Age at calving;
- Calving season;
- Days in lactation;
- % of milk solids;
- Calving interval (NRS, 2005).

However, in this study, milk production data were not corrected for environmental effects. The correction tables that are used by the NRS were not made available for this study. Instead of the methods of the NRS, milk productions can be corrected for age at calving and calving season by grouping the test cows in 4 seasons (calving dates between: Jan-Mar Apr-Jun, Jul-Sep, Oct-Nov). Comparisons have to be made within seasons. This was not done in this study because the number of heifers was too low.

On both farms the shape of the lactation curves showed some deviation in respect to the standard lactation curve. This was probably caused by several environmental effects. For example, many lactation curves for individual heifers on Farm 1, showed a slight second increase in production when cows went outside in spring and fresh pasture became available. On Farm 2 some deviation in lactation curves was caused as well by heifers that suckled their own calf. For these heifers, the measured milk production at the test days was lower than the real amount of milk produced. Caused by the calves that drunk part of the milk in the beginning of the lactation. The NRS is using the amount of milk produced at the test-day to calculate the parameters ISK and LW. Therefore, these parameters given at the first test-days of the lactations were deviated.

4.3 Mastitis

The hypothesis was, that heifers reared in a suckling system would perform better in terms of mastitis incidence compared to heifers reared in a bucket system. Heifers on Farm 1, that were reared in a suckling system were born in a different year than those reared in a bucket system. On this farm there was a lot of variation in average SCC (Somatic Cell Count) within years. Therefore, mastitis data from suckling and bucket heifers was not fully comparable. In contrast with the expectations, it was found that heifers reared in a bucket system had a significant lower SCS compared to heifers reared in a suckling system. This difference in mastitis incidence was probably not caused due to suckling. It appeared to be caused by accidental differences in resistance of the herd against mastitis between years.
On farm 2, no significant difference in mastitis incidence between heifers reared in a suckling system and heifers reared in a bucket system was found. Some heifers on Farm 2 suckled their own calf during first lactation. Suckling can decrease the mastitis incidence in suckled cows (Krohn, 2001). However, it was found that suckling a calf did not affect the mastitis incidence of heifers on Farm 2.

On both farms there was a lot of variation in average SCC of the herd within and over years. In 2005 average SCC of the herd on Farm 1 was close to the 400,000 cells per ml. A high mastitis incidence can have several causes. Probably the unusual housing type was affecting SCC levels. In an experiment of Kloeze and Jelsma (2004) it was found that percentage of high cell count cows is higher on farms were a deep litter stable is used compared to cubicle stables. On Farm 2, an extreme high average SCC of the herd was observed in 2005 (Figure 11). According to the farmer, SCC is increasing a few times during the year on his farm. Probably, the herd is sometimes temporary more susceptible for mastitis bacteria. This can be caused by for example whether influences. However, the average SCC in 2005 was very extreme and could not be declared in this study.

4.4 Paratuberculosis

Because cow and calf are not separated after birth, the use of a suckling system is increasing the risks for transmitting Paratuberculosis when it is already present at the farm. The *Parawijzer* is not useful to prevent the disease on farms using suckling systems, because a number of measures is not applicable on farms using suckling systems. Moreover, the research by Brouwer *et al*. (2004) showed that the average score for the *Parawijzer* was lower for organic farms compared to conventional farms, but that percentage organic farms

contaminated with Paratuberculosis was not different in comparison to the percentage conventional farms contaminated with Paratuberculosis.
However, that does not mean nothing has to be done to prevent the disease. As long as, there is no clearness about the relationship between the human Crohn disease and Paratuberculosis, it is important to work on prevention of the disease (Kijlstra, 2006). Kijlstra (2006) is recommending to only use suckling systems on farms that are free of the disease. Additional, farms can be monitored by the methods that are used by the GD to monitor farms that are uncontaminated. The farmer is free to choose three options which are:

- Once every two years individual blood tests of all cows at the farm of three years and older
- Once every two years individual milk tests of all milk producing cows;
- Once every two years individual manure samples of all cows of two years and older (GD, 2006).

Blood and milk tests trace the antibodies against the disease, while manure tests trace the bacteria itself.
Manure tests can trace the bacteria about one year earlier than blood and milk tests, but they are expensive and it takes a long period (8 to 16 weeks) before the results are known (GD, 2006).

According to the farmer on Farm 2, symptoms of Paratuberculosis are not increased since using suckling systems. However, only older cows show symptoms of the disease. The heifers in this study will probably not show any symptoms yet.
The use of suckling systems in relation to Paratuberculosis has a positive aspect as well. Most organic farmers feed the calves milk from the tank. In this way, calves receive a mixture of milk from the total herd. This is increasing the risk for Paratuberculosis. When using a suckling system, calves only receive milk from their mother and a nurse cow. So, their will be contact with milk of less cows.

4.5 Disease transmission

Both protocols the *Parawijzer* and *Gezondheidswijzer "Mastitis"* were based on preventing disease by
minimizing contact between pathogens and animals. In organic farming it is believed that cows with a good immunity have resistance against farm specific pathogens. Contact between pathogens and animals is not avoided. Disease transmission between calf and cow will probably stay a point of discussion because of different views. The calf receives antibodies from the mother cow that will protect the calf against diseases. On the other hand, when cow and calf stay together disease transmission can occur as well. It is not known in which of those two situations the calf will suffer the least from diseases. In my opinion, diseases that can include risks for human health need extra attention.

4.6 Costs of the suckling system

The total costs of the suckling system were repaid on Farm 1 and almost repaid on Farm 2, by lower rearing costs due to suckling. However, age at calving on Farm 1 was reduced by 4.5 months. Probably this extreme reduction in calving age was reducing milk productions of the heifers as well.
Average rearing costs of €1,54 per heifer per day, for a heifer calving after 26 months, were used in the calculation (Asseldonk, *et al*., 2001). However, rearing costs are varying per farm.

The costs of rearing depend on the rearing period and the durability of a cow. Rearing costs of a heifer calving at 30 months are higher compared to a heifer calving at 26 months. The durability of a cow is affecting rearing costs, because a longer production period is decreasing the costs for rearing. A cow that produced a lot of milk during his live has lower rearing costs per kg/milk then a cow with a short production period. Perhaps, suckling can increase the durability of the herd by a better resistance against farm specific pathogens. And thus, decrease rearing costs even more.

4.7 Comparability of the data

Measurements in this study were done at two real farms (no research farms). Therefore, measurements were not always taken very consistent and many environmental influences were not excluded. Even though, the data of heifers in this study was not fully comparable, this study is providing a good method for the evaluation of the heifers in the QLIF-project (a continuation of this project). Within this project, data is collected of calves which are more suitable for comparison. This data could not be used here, because calves did not entered first lactation yet.

5. Conclusions and recommendations

5.1 Conclusions

- On Farm 1, a difference in live weight between heifers reared in a suckling system compared to heifers reared in a bucket system was found at an age between 400 and 500 days. No difference in live weight was found on this farm when using corrected live weights. Growth on this appeared to be affected by the use of genetically superior bulls in the suckling group. Heifers on Farm 2, reared in a suckling system, reached a significant higher live weight, at a comparable age, compared to heifers reared in a bucket system

- Heifers reared in a suckling system can be inseminated or introduced to the bull earlier, than those reared in a bucket system. Hence, age at first calving can be reduced for heifers reared in a suckling system.

- Live weight at first calving was not measured in this study. The data could not prove if live weight at first calving of heifers reared in a suckling system, was higher compared to those reared in a bucket system, when calving at a comparable age.

- Milk production data on Farm 1 was not fully comparable, because it was affected by the use of genetically superior bulls in the bucket reared heifers. As well, the reduction of age at first calving of heifers reared in a suckling system was affecting milk production. No difference in milk production between heifers reared in a suckling system and heifers reared in a bucket system was found on Farm 2.

- Data about mastitis incidence was not fully comparable on Farm 1. Heifers in the bucket and suckling groups were born in different years, while there was a lot of variation in average SCC of the herd within years. No difference in mastitis incidence between suckled and bucket groups was found on Farm 2.

- Farms using suckling systems have more risk for transmitting Paratuberculosis compared to farms using conventional rearing methods. It is important to test farms were suckling systems are used on the presence of the disease. The *Parawijzer* is not useful to prevent Paratuberculosis on farms were suckling systems are used, because a number of measures is not applicable on farms using suckling systems.

- Loss of saleable milk was totally repaid by lower rearing costs on Farm 1, and almost repaid by lower rearing costs on Farm 2.

- This study is providing a good method for the evaluation of the data from heifers in the QLIF-project.

The general conclusion is: suckling systems can decrease age at first calving of heifers reared in a suckling system. Milk production and mastitis incidence of heifers reared in a suckling system is not different from heifers reared in a bucket system.

5.2 Recommendations

Further research within the project *Kalf bij koe* already started with the QLIF-project. The recommendations can be taken along in this project.
Concerning the collection of data it is recommended to collect data of suckling calves that received the same treatment. In this study, there was a lot of variation in suckling periods and weaning age. Registration have to be made of heifers that suckled their calf. Furthermore, more data have to be collected. More data makes it possible to compare heifers that start lactating in the same season. And so, there will be less seasonal effects. In addition, measurements have to be done more consistent. The following parameters have to be measured or registered:

- General information: birth date, weaning date, period of single suckling, period of multiple suckling, calving date;
- Growth: live weight at birth, at 2,4,6 months, 1 year and at first calving;
- Milk production: total production, 305-day production, % milk fat and milk protein, DIM, SCC, LW and ISK.

Remaining parameters as age at weaning, age at first calving, etc. can be calculated from this data.

A suckling system is a more expensive rearing method compared to the bucket system. However, this expensive rearing period can be repaid by an earlier age at first calving. It would be interesting to study what will be the (economically) most optimal suckling period and reduction in age at first calving. Another interesting subject for further research is: causes contact of calves with farm specific bacteria more disease or is it resulting in a stronger herd;

Since attention is paid by the Louis Bolk Institute and other institutes to suckling systems, the number of farmers that start experiment with suckling systems is increasing. If this increase is going on, special attention has to be paid by the NRS, to the effect of suckling on the lactation curves of suckling cows. When calves drink part of the milk, the beginning of the lactation curves become de-shaped. Parameters which are calculated from measured milk production (ISK-values, LW) become deviated as well. When many farmers start using suckling systems this could even influence breeding values of bulls.

Paratuberculosis can be a threat for a more widely acceptance of suckling systems within the agricultural sector. Therefore, it is important to encourage farmers that use suckling systems to monitor the Paratuberculosis status at their farms.

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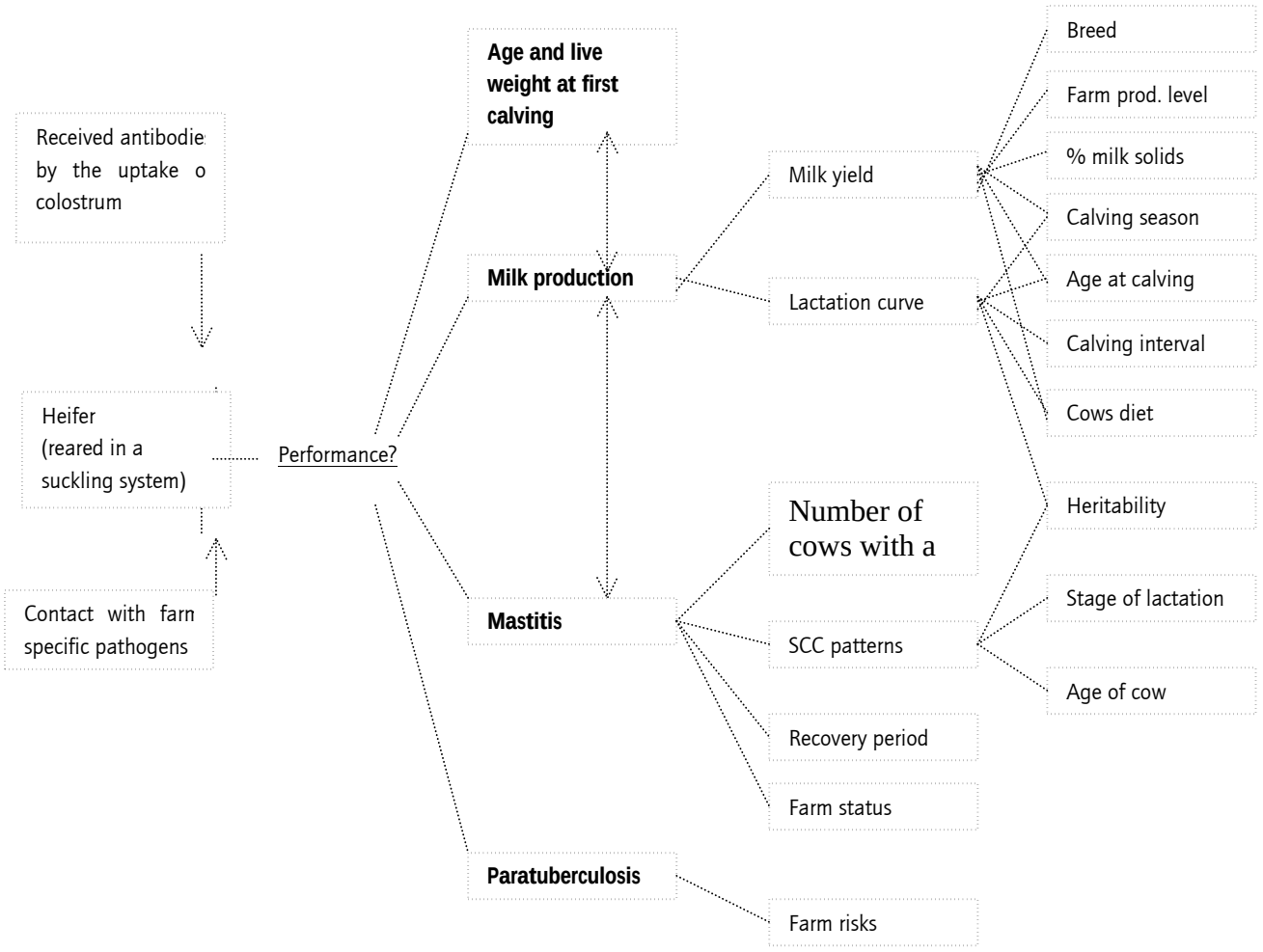
Annex 1: Tree diagram

Focus was on the parameters: milk production, age and live weight at first calving, mastitis incidence and Paratuberculosis.
The different components of the tree are influencing each other. For example, milk yield is influenced by the used breed, the production level of the farm and percentage of milk solids, calving season, etc.



Annex 2: Live weight at 1 year of age according a different method

In the method of van Leeuwen (2004) ages between 400 and 500 days were used to calculate live weight at approximately 1 year of age. In this study calculations according this method were only done for Farm 1. The average ages by the time of weighing were calculated. The average ages for both groups were more similar and did not differ significantly (P= 0.33) (Table 25). Therefore, it was assumed that age at which live weights were taken did not influence the measured live weights as such (Van Leeuwen, 2004).
Live weights of heifers of group *suck 2002- 1* at an age between 400 and 500 days were significant higher than those of group *buck 2001-1* (P = 0.031). No significant difference was found between live weights of group *suck2003 -1* and *buck2001 -1*.

Table 25 Live weights at an age between 400 and 500 days on Farm 1

Treatment	**Suck 2002 -1**			**Suck 2003 -1**			**Buck 2001 -1**		
	N	Mean	S.E.M	N	Mean	S.E.M	N	Mean	S.E.M
Age (400-500 days)	10	448.4[a]	11.9	4	444.8[a]	8.2	9	440.8[a]	11.4
Live weight (400-500 days)	10	400.2[a]	12.7	4	356.0[b]	15.1	9	364.3[b]	12.5

[a,b] Within a row, means without a common superscript differ (P<0.05).
S.E.M.: Standard Error Mean

Annex 3: Gross analysis age at first calving and live weight

Age and live weight at first calving at different ages on Farm 1

Treatment	**Suckled groups**[1]			**Bucket group**[2]			
	N	Mean	S.E.M.	N	Mean	S.E.M.	P
Age at calving (months):	19	26.3	0.45	14	30.5	1.34	0.000
Live weight (kg):							
At birth	14	43.3	1.51	n.d.	n.d.	n.d.	
2 months	15	102.9	3.45	n.d.	n.d.	n.d.	
4 months	19	160.2	3.36	n.d.	n.d.	n.d.	
6 months	12	204.7	5.18	n.d.	n.d	n.d.	
1 year	12	329.7	8.40	n.d.	n.d.	n.d.	
Two years	3	529.6	16.1	7	510.8	15.9	NS
LW growth (kg/day):							
0 - 90 days	14	1.06	0.05	n.d.	n.d.	n.d.	
90 - 365 days	12	0.699	0.02	n.d.	n.d.	n.d.	
0 – 365 days	12	0.905	0.03	9	0.862	0.02	NS

S.E.M.: Standard Error Mean

NS: not significant

n.d.: not determined because not enough data were available

1. suckled groups = suck2002 –1and suck2003 –1

2. bucket group = buck2001 –1

Age and live weight at first calving at different ages on Farm 2

Treatment	**Suckled groups**[1]			**Bucket groups**[2]			
	N	Mean	S.E.M.	N	Mean	S.E.M.	P
Age at calving (months):	13	24.8	0.74	26	26.5	0.6.3	0.048
Live weight (kg):							
At birth	7	40.3	1.54	n.d.	n.d.	n.d.	
2 months	11	100.9	3.07	6	64.9	2.77	0.000
4 months	9	139.5	4.78	7	109.5	3.02	0.000
6 months	9	182.2	5.40	8	152.5	4.29	0.000
1 year	6	350.8	9.85	7	300.5	6.95	0.000
Two years	n.d.	n.d.	n.d.	6	498.4	18.11	
LW growth (kg/day):							
0 - 90 days	6	0.856	0.06	n.d.	n.d.	n.d.	
90 - 365 days	6	0.785	0.02	6	0.769	0.01	NS
0 – 365 days	6	0.968	0.03	7	0.817	0.02	0.000

S.E.M.: Standard Error Mean

NS: not significant

n.d.: not determined because not enough data were available

1. suckled groups = suck2002 –2 and suck2003 –2

2. bucket groups = buck2001 –2 and buck2002 –2

Annex 4: Gross analysis milk production

Overview of milk production records on Farm 1

Treatment	**Suckled groups**[1]			**Bucket group**[2]			
	N	Mean	S.E.M.	N	Mean	S.E.M.	P
Total milk production, 305-day (kg)[3]	12	4,669	190.2	14	5,368	149.2	0.040
Milk fat, 305-day (kg)	12	190	7.6	14	211	5.2	0.013
Milk protein, 305-day (kg)	12	154	5.4	14	184	5.6	0.005
DIM (days in milk)	12	308	17.2	14	314	19.8	NS
LW	12	102	3.4	14	112	2.9	0.013
Age at calving (months)	12	26	0.3	14	30	1.3	0.020

Only heifers with a lactation length > 180 days were taken into account

S.E.M.: Standard Error Mean

NS: not significant

1. suckled groups = suck2002 –1and suck2003 –1
2. bucket group = buck2001 –1
3. Milk production based on FPCM

Overview of milk production records on Farm 2

Treatment	**Suckled groups**[1]			**Bucket groups**[2]			
	N	Mean	S.E.M.	N	Mean	S.E.M.	P
Total milk production, 305-day (kg)[3]	10	5,996	283.7	26	6,185	211.7	NS
Milk fat, 305-day (kg)	10	238	12.8	26	246	10.8	NS
Milk protein, 305-day (kg)	10	195	10.4	26	202	8.4	NS
DIM (days in milk)	10	290	27.5	26	380	17.4	0.050
LW	10	103	4.7	26	99	3.6	NS
ISK	10	33	1.3	26	33	1.3	NS
Age at calving (months)	10	24.4	0.7	26	26.5	0.6	0.035

Only heifers with a lactation length > 180 days were taken into account

S.E.M.: Standard Error Mean

NS: not significant

1. suckled groups = suck2002 –2and suck2003 –2
2. bucket groups = buck2001 –2 and buck2002 –2
3. Milk production based on FPCM

Annex 5: Test day model

The Dutch Test day model is a model which is used by the NRS (Nederlands Rundvee Syndicaat/Dutch dairy Syndicate) to calculate breeding values for milk production. The model can calculate the milk production of a cow which is expected on his genetically information. Therefore, milk productions of the test days are corrected for effects which are not genetically. De model is correcting milk productions for:

- Fixed effect (Days in milk, age and season of calving, stage in lactation, stage in pregnancy, heterosis and recombination effects, length of dry period)
- Genetic effects (The breeding values of a cow)
- Herd effects (Every year a farm specific lactation curve is made. For example some farms can have a farm management in which heifers perform very well, but which is less positive for multi parous cows.
- Permanent environmental effects (The part of the production curve of a cow which can not be declared by the fixed-, genetic- or herd effects. For example a cow could have suffer from a disease during the rearing period. This disease could have a negative effect on her future milk production (NRS, 2005).

In this study the Test day model was used to calculate expected 305-day productions. This expected productions were compared to the actual produced 305-day productions. The heifers could have produced better or worse than expected on their genetically information. Data was delivered by the NRS. For the analysis of the data Paired sample T-tests were used.
An overview of expected and actual milk, milk fat and milk protein of the different groups on both farms is given in Table 1.

Table 1 Overview on Test day model results on both Farms

	Expected 305-day production			**Actual 305-day production**		
Group	Milk (kg)	Milk fat (kg)	Milk protein (kg)	Milk (kg)	Milk fat (kg)	Milk protein (kg)
Suck2002 –1	5,377	214	181	4,418	185	151
Suck2003 –1	5,485	222	185	4,341	178	151
Buck2001 –1	5,186	209	174	5,325	208	182
Suck2002 –2	6,139	254	214	6,111	255	211
Suck2003 –2	5,702	228	198	5,718	232	202
Buck2001 –2	6,213	263	216	5,864	249	203
Buck2002 –2	6,180	267	219	5,533	231	187

In Table 2 it can be seen that both group suckling groups on Farm 1 (*suck2002 -1* and *suck2003 –1*) had a significant lower milk production than expected. Surprisingly, the heifers on Farm 2 that had suckled their own calf did not had a lower milk production than expected (Table 3) . While the calves had drunk part of their milk.

Table 2 Expected and actual produced 305-d production of all groups

	Expected 305-day production (kg milk)			**Actual 305-day production (kg milk)**			
Group	N	Mean	S.E.M.	N	Mean	S.E.M.	P
Suck2002 –1	10	5,377	35.7	10	4,418	242.4	0.02
Suck2003 –1	6	5,485	4.8	6	4,341	201.0	0.02
Buck2001 –1	12	5,186	63.4	12	5,325	220.8	NS
Suck2002 –2	8	6,139	180.0	8	6,111	282.6	NS
Suck2003 –2	5	5,702	206.7	5	5,718	586.3	NS
Buck2001 –2	15	6,213	125.1	15	5,864	284.4	NS
Buck2002 –2	10	6,180	134.1	10	5,533	389.5	NS

S.E.M.: Standard Error Mean

NS: not significant

Table 3 Expected and actual produced 305-d production of heifers that suckled own calf on Farm 2

	Expected 305-d production (kg milk)			**Actual 305-d production (kg milk)**			
	N	Mean	S.E.M.	N	Mean	S.E.M.	P
Heifers that suckled own calf	17	6,005	115.7	17	5,687	299.1	NS
Heifers that did not suckled a calf	21	6,215	104.1	21	5,908	211.3	NS

S.E.M.: Standard Error Mean

NS: not significant

Annex 6: Gross analysis mastitis incidence

Mean SCS on Farm 1

Treatment	**Suckled group**[1]			**Bucket group**[2]			
	N	Mean	S.E.M.	N	Mean	S.E.M.	P
Mean SCS	11	4.3	0.3	14	3.2	0.3	0.026

Only heifers that finished their first lactation were included.

S.E.M.: Standard Error Mean

NS: not significant

1. suckled group = suck2002 –1

2. bucket group = buck2001 –1

Mean SCS on Farm 2

Treatment	**Suckled group**[1]			**Bucket groups**[2]			
	N	Mean	S.E.M.	N	Mean	S.E.M.	P
Mean SCS	5	3.0	0.2	26	3.1	0.2	NS

Only heifers that finished their first lactation were included.

S.E.M.: Standard Error Mean

NS: not significant

1. suckled group = suck2002 –2

2. bucket groups = buck2001 –2 and buck2002 –2

Annex 7: Results “Gezondheidswijzer Mastitis”

Results Gezondheidswijzer “Mastitis” Farm 1

Strong points	**Weak points**
Milking machine:	
- Milking machine is measured and tested 6 monthly	
- teat cups are frequently replaced	
Milking method:	
- cows are milked twice a day (milking more times a day is even better for udder health)	- cows with critical looking milk are not milked as last ones or separately
- time between morning and evening milking is 12 hours	
- before milking teats are cleaned with a paper towel (one per cow)	
- after milking a dip is used	
- heifers and dry cows do not enter the milking stable (they are not coming in contact with mastitis bacteria which can be present in the milking stable)	
Other measures:	
- cows with extreme SCC’s are sold	- no bacterial samples of high SCC cows are token
- SCC is measured every 4 weeks by the NRS	- when choosing a bull the mastitis-index is not taken into account (the mastitis-index indicates the genetic resistance of a bull against mastitis)
- there are no cows from outside the farm introduced into the herd	- places were cows are resting are not daily cleaned (a deep litter stable is used)
	- The stable is not totally cleaned once a year

Results Gezondheidswijzer “Mastitis” Farm 2

Strong points	**Weak points**
Milking machine:	
- teat cups are frequently replaced	- Milking machine is not measured and tested 6 monthly
Milking method:	
- cows are milked twice a day (milking more times a day is even better for udder health)	- heifers and dry cows are entering the milking stable (they come in contact with mastitis bacteria which can be present in the milking stable)
- before milking teats are cleaned with a paper towel (one per cow)	- cows with critical looking milk are not milked as last once or separately
- after milking a spray is used	- time between morning and evening milking is varying between 7 to 17 hours
Other measures:	
- cows with extreme SCCs are sold	- The stable is not totally cleaned ones a year
- SCC is measured every 4 weeks by the NRS	
- there are no cows from outside the farm introduced into the herd	
- from cows with high SCCs bacterial samples are token	
- when choosing a bull the mastitis-index is taken into account	
- places were cows are resting are cleaned daily	