



# A calving solution where the cow can choose to leave the calf

*En kalvningsbox där kon kan välja att lämna kalven*

**Torgunn Aslaug Skjerve**

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I denna serie publiceras olika typer av studentarbeten, bl.a. examensarbeten, vanligtvis omfattande 7,5-30 hp. Studentarbeten ingår som en obligatorisk del i olika program och syftar till att under handledning ge den studerande träning i att självständigt och på ett vetenskapligt sätt lösa en uppgift. Arbetenas innehåll, resultat och slutsatser bör således bedömas mot denna bakgrund.

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## 1. Summary

The aim was to evaluate cow-calf behaviour up to 24 h after calving in a new type of group calving area with individual calving pens. The study was conducted at a private dairy farm with 86 cows of Norwegian Red Cattle kept in cubicle housing with two milking robots. A calving area (8.8×6 m) was built by separating parts of the cubicle stall to accommodate a calving area. It had two calving pens (3×2.4 m each), four cubicles and a feeding area. Silage and water was supplied in the feeding area, and 3-5 cows were kept in the calving area. Cows were moved to the calving area at least one day prior to calving, and were locked into the calving pen at signs of contractions, and left there for the first 4 h after calving. Cow-calf pairs were filmed continuously during 24 h with two surveillance cameras. The films were scored continuously from hour 4-24 in periods of two hours. Out of 12 cow-calf pairs recorded, 7 were used for descriptive data analysis. All dams left the calving pen on average 12 times (min 5, max 33), and an average total duration of 1 h and 37 minutes (min 30 min, max 3 h 13 min). Each time they were away during a mean of 38 minutes (min 1 min, max 114 min). Six of the cows left the calf while it was lying down, whereas one cow left the calf when it was active in the pen. One calf followed the dam when she backed out of the pen while the calf was suckling. Four of the calves left the calving pen during the observations. Of these, one spent < 6 min in the cubicle area, while one spent < 2 h in the feeding area. All four dams followed the calves out of the pen. One cow only followed the calf 4 out of 6 times, but the calf was never outside her reach. One calf left the calving pen approximately half an hour before the observations started. Contacts between the calf and other cows were recorded for all calves, but 5 of the 7 dams acted aggressively towards other cows. Other cows entered the calving pen of all cow-calf pairs, but the highest score was 5 times. Once a stronger cow entered the calving pen and forced the dam out of the pen for <3 h. In conclusion this new type of calving area functioned well for the calving cows. All cows left the calving pen during the observations, and no calf was seen actively following the dam for a longer period. The open entry to the calving pens led to unwanted disturbances from other cows, and it is necessary to put more research into how to prevent this. The results are promising, but future research on a larger number of cows from different dairy breeds is important.

## 1. Sammanfatning

Syftet med denna studie var att undersöka kon och kalvens beteende upp till 24 tim efter kalvning i en ny typ av gruppkalvningsbox. Studien genomfördes på en privat mjölkgård med 86 kor av rasen Norsk Rødt Fe i ett lösdriftstall med två mjölkrobotar. Ett kalvningsområde (8.8×6 m) blev bygd genom att dela av delar av liggbåsavdelningen i lösdriften. I kalvningsområdet fanns två kalvningsboxar (3×2.4 m var), fyra liggbåsar och ett foderbord. Ensilage och vatten fanns vid foderbordet, och 3-5 kor var i kalvningsområdet samtidigt. Korna blev flyttade till kalvningsområdet minst en dag innan kalvning och blev instängd i en kalvningsbox vid tecken på närstående kalvning (sammandragningar). Dörren till boxen förblev stängd intill 4 tim efter kalvning därefter öppnades dörren och kon fick tillgång till hela området. Ko-kalv-paren blev filmade kontinuerligt under 24 tim med två övervakningskameror. Filmerna avlästes kontinuerligt från tim 4-24 i perioder på 2 timmar. Av de 12 ko-kalv-paren som blev filmade användes 7 för deskriptiv data analys. Alla kor lämnade kalvningsboxen med et genomsnitt av 12 ggr

(min 5, max 33), och genomsnittlig total längd var 1 tim och 37 min (min 30 min, max 3 timmar 13 min). Varje gång var de utanför boxen i genomsnitt i 38 min (min 1 min, max 114 min). Sex av korna lämnade boxen medan kalven låg ner, medan en lämnade när kalven fortfarande var aktiv inne i boxen. En kalv följde efter kon när hon backade ur boxen medan kalven diade. Fyra av kalvarna lämnade kalvningsboxen under observationsperioden, en av dessa lämnade ungefär en halvtimme innan avläsningen av filmerna började. En av dessa spenderade <6 min i liggbåsområdet, och en spenderade < 2 tim vid foderbordsområdet. Alla fyra kor följde med kalvarna ut av boxen. En av korna följde bara efter kalven 4 av 5 ggr, men kalven var aldrig utanför hennes räckvidd. Kontakt mellan andra kor observerades för alla kalvarna, men 5 av 7 kor hade aggressiva interaktioner med kontaktsökande kon. Andra kor gick in i kalvningsboxen under alla sju observationer, på det högsta 5 ggr. Vid ett tillfälle trängdes en av korna ut av boxen av en annan ko i <3 tim. I konklusion så fungerade denna nya typ av kalvningsområde bra för de kalvande korna. Alla lämnade kalvningsboxen under observationen och ingen kalv följde aktivt efter modern över en längre period. Den öppna ingången till kalvningsboxen ledde till oönskade störningar från andra kor, och det är nödvändigt att undersöka hur man kan motverka detta. Resultaten är lovande, men vidare forskning behövs med andra mjölkkoraser och flera kor.

## **2. Introduction**

At the time of calving it is recommended that the cow is provided isolation in a calving pen, separate from the rest of the herd (EFSA-Q-2008-340). The practice originates from knowledge about the innate behavior of feral cattle which “hide” the calf after birth. However, the motivation to hide may have changed in the modern dairy cow, and thus forced isolation of the cow and calf may be stressful and negatively affect animal welfare. Today's solutions for calving pens are also to a great extent considered by farmers to be impractical, and therefore they are not used (Sandal et al., 2014). In a study by Kjærstad and Simensen (2001) farmers' usage of separated calving pens in cubicle housing was described. While farmers were present during 41% of the indoor calvings, only 13% of the calvings took place in calving pens. A later survey showed a marked increase, but still only 64% of the farms in the study reported that the calvings on the farm take place in calving pens (Österås, 2010). The design of the pens is of special interest for organic dairy producers who according to legislation must keep calf and cow together during the whole (Norway: Forskrift om økologiske landbruksprodukter mv, 2005) or parts (Sweden: KRAV:s regelverk, Chapter 5.5.3) of the colostrum period.

As of today, the cows are kept in the calving pen until the farmer moves them back to the herd. No automatic transfer systems are available, and the cows' motivation to be in contact or re-join the herd is not accounted for. Workable and flexible housing systems allowing more natural behaviour of cow and calf are of great importance, providing not only a better environment for the animals, but also for the working situation of the farmer.

### **2.1 The behaviour of cattle herds**

As the ancestor of today's production animals are extinct it is not possible to observe the original cattle herds. The base of our knowledge about the cattle herds is from observations on feral animals such as the Chillingham cattle studied by Hall (1989) and semi-wild populations of Maremma cattle as described by Vitale et al. (1986). These studies all show certain contradictory results, suggesting that changes in genetics and environment have affected their innate behaviour. The process of domestication is known to alter certain behaviours, and may be one of the reasons behind these differences (Price 1984).

Breeding and mating season varied between the observed populations. Hall (1989) reported year-round mating for Chillingham cattle while during Hall and Moore's (1986) observations on Swona cattle they noted only spring calvings. The size of the herds show great variation. Lazo and colleagues (1994) reported from their observations groups in the range of 13-32 cattle. Smaller herds of less than 10 animals were described by Hernandez and colleagues (1999) based on observations in the Chihuahuan desert. Although the size and mating season varies between the populations, the organization of the herds seems to be similar. Females and sexually immature males gather in stable groups with clear dominance mainly based on age, and few occurrences of aggression are seen within these herds (Rushen et al. 2007). Mature males gather in smaller groups of fewer individuals with the same stable hierarchy (Hall, 1986; Reinhardt et al., 1986; Lazo et al., 1994).

## 2.2 Maternal behaviour in cattle

### 2.2.1 Pre-partum isolation

Although cows in general are herd animals they will, like many other gregarious species, leave the herd to find a suitable birthing place. The degree to which the animals isolate themselves vary both between species and between individuals (Lent, 1974). This variation has also been recorded for cattle (reviewed by Lidfors, 1994). The pre-partum isolation lowers the risk for unwanted interaction with other animals, such as adoption of alien calves and suckling from another cow than the dam, and therefore it is assumed to aid the establishment of the mother-infant bond (Edwards, 1983; Lidfors et al., 1994).

By observing Finn cows, beef cattle and dairy cows kept in different environments, Lidfors et al. (1994) found that few of the animals sought isolation, although periparturient cows showed some degree of separation from the herd with a decrease of animals within a 15 m zone. The results were affected by the environment in which the animals were kept, as well as the rank of the dam. However, for the Finn cows, an old Finnish race, which were kept in an area with dense forest, most cows sought isolation.

### 2.2.2 "Hider"

Two distinct types of strategies are applied by wild ungulates in terms of early protection of the neonate, i.e. "following" vs. "hiding" (Lent, 1974). In "follower" species, close proximity maintained to the mother gives the neonate protection against predators. The offspring of "follower" species are very precocial as they have to be able to stand up and follow their mother quickly after parturition. The "hider species" protects the neonate through periods of separation from the mother, the offspring concealing in vegetation, and the mother feeding or joining the herd some distance away from the hiding place. She will return some times during the day to nurse the young, how often varies depending on the species. (Ralls et al., 1986).

The early life of the hider species are divided into phases according to their related behaviours (Lent, 1974). The first phase after parturition is the postpartum phase, where the mother and the offspring is in intensive and reciprocal contact. Lent (1974) suggests that this lasts between one to twenty hours postpartum(p.p.), dependent on the species. When the post-partum phase ends, the hiding phase begins, and it is at this point we expect to see the characteristic behaviour, where the mother leaves the hiding place in which the offspring stays behind. This phase varies greatly in length from as little as two days up to four months. At the end of the hiding phase the offspring will follow the mother and the two will re-join the herd (Lent 1974). With respect to whether or not cattle are "hidiers" research has yielded inconclusive results. Some researchers suggest a variation due to habitat, breed and domestication (Vitale et al. 1986; Lidfors and Jensen 1988; Lidfors, 1994). However, newer research on "hider" associated behaviours in modern housing suggests that cattle are hider species (Marchant-Forde et al., 2002; Grandinson, 2005; von Keyserlingk and Weary 2007; Proudfoot et.al., 2014; Proudfoot et al., 2014).

In her studies on Finn cows, Lidfors (1994) found that all hiding calves remained hidden on the 3<sup>rd</sup> day after calving, but on the 7<sup>th</sup> all had joined the herd. From studies by Jensen (2011) we have knowledge about the timing of when a dairy cow kept in a modern barn is motivated to re-join the herd. Jensen (2011) studied cow-calf pairs kept in individual pens

with windows facing an adjacent pen. Social behaviour directed towards other cows increased on day 11 compared to day 3 and day 7.

When cow and calf joins the herd, young calves often form a distinct part of the cattle herd. When the young calves are away from their mother during the suckling period, they spend their time in smaller groups of same-aged herd mates known as “crèches” (Sato et al., 1987; Hirata et al., 2003). Although part of the herd, this “mini-herds” acts somewhat independent. Time of weaning of the calves display a large variation, from 7 up to 14 months of age, 10 months seems to be most common (Reinhardt and Reinhardt, 1981). The bond to the mother does not abruptly end with the end of suckling, but continues through adult life, where the offspring is often seen to prefer the company of the mother to other herd members (Reinhardt and Reinhardt 1981; Reinhardt et al. 1986).

Even though many species isolate during the time around parturition, they do not all inherently hide their young. The distinction between followers and hiders is made after the end of the post-partum phase (Lent, 1974).

### 2.2.3 Behaviour during the first 24 hours after calving

Grossly the cows' behaviour after parturition can be described during two specific periods: calf-related activities and return to maintenance behaviour (Ventorp and Michanek, 1991).

In a study of the early behaviour of the dam, Selman and colleagues (1970a) observed that the cows' first priority during the first 8 hours after parturition was to lick the calf. After some time, the interest of the dam shifted towards amnion, amniotic fluid and contaminated straw. New bouts of activity from the calf seemed to result in a shift in the cows' interest towards the calf with continued grooming behaviour (Selman et al., 1970a). Similar observations have also been reported in other studies (Edwards and Broom, 1982; Lidfors and Jensen, 1988; Houwing et al., 1990; Ventorp and Michanek, 1991; Jensen, 2012) In a study cow-calf pairs were observed during the first 24 hours after calving, the trend was that the cow gradually spent more time taking care of her own needs (Edwards and Broom, 1982). Jensen (2012) found that this shift started as early as between the first and the second hour p.p. The licking of the offspring is observed in a number of mammals, and is thought to have many functions promoting the survival of the offspring, such as improving hygiene and stimulating the activity of the new-born (Edwards and Broom, 1982).

Before the calf's first successful suckling, a chain of specific events takes place: the calf first spends some time recovering from the parturition, and then attempts to stand (Houwing et al., 1990; Ventorp and Michanek, 1991). In most cases the dam is observed to stand with her head directed towards, and often licking, the calf's head (Houwing et al., 1990; Ventorp and Michanek, 1991). The same authors have also observed that once the calf is on its feet it will start seeking a teat. The period from birth until the first successful suckling varies, and is depended on factors such as udder conformation and period from birth until first successful standing (Houwing et al., 1990; Ventorp and Michanek, 1991).

### 2.3 Isolation

Although feral cattle live in herds, group housing in dairy production may be challenging, especially at the time of calving. The effect of forced social isolation has been shown to increase stress levels on cattle, manifested through increases in heart rate, cortisol concentrations and more incidences of urination and defecation (Munksgaard and Simonsen, 1996; Boissy and Le Neindre, 1997; Rushen et al., 1999). Although, the dam seeks isolation from the herd pre-partum, forced isolation beyond the calving may be a stressful experience (Watts and Stookey, 2000).

A study to determine the effect of moving the cow close to calving on behaviours and length of labour showed that cows moved during later stages experience longer labours, most likely caused by changes in lying behaviour (Proudfoot et al., 2013). However, the study focused only on the effect on the labour, and therefore it does not provide insight to effects on the cow before and after calving. (Proudfoot et al., 2013). The prolonged forced isolation of periparturient cows has not been studied, and more knowledge is needed for the establishment and usage of cow-calf friendly calving pens.

### 2.4 Aim

The main aim of this study was to investigate how calf and the dam move in relation to each other 0-24 h after calving, when the dam is allowed to leave the calving pen and access other pen mates. This study was conducted as a pilot study for the development of a new calving pen system where not only the innate behaviour of a hider species would be fulfilled, but also with the potential of decreasing the work load for the farmer. Based on the hider species theory, we hypothesized that: "The cow will during the first day after calving (0-24 hrs) leave the calving pen without being followed by her calf."

The research questions addressed were as follows:

1. Will the cow leave the calving pen?
  - i) how soon after calving does she leave the calving pen?
  - ii) how often does she leave the calving pen?
  - iii) how is the cows absence from the calving pen distributed over time?
  - iv) how long time does she spend outside the calving pen?
  - v) how many of the times the cow leaves the calving pen will she visit the feeding area?
2. Will the calf follow the dam if she leaves the calving pen?
  - ii) at what proportion of the times the cow leaves the calving pen will the calf follow?
3. Will the calf leave the calving pen?
  - i) is the calf following the dam?
  - ii) if not, will the dam follow the calf?
4. Will other cows be in contact with the calf?
  - i) will the dam allow contact?
5. Will other cows enter the calving pen?
  - i) when the calf is present?
  - ii) when the calf is not present?

### 3. Material and methods

This study was conducted at Nye Reitan Samdrift, Steinkjer, Norway during two periods; late February - March 2014, and April 2014. The farm has 85.9 cow-years of the breed Norwegian Red Cattle, kept in a cubicle housing with two milking robots (DeLaval VMS).

*Table 1. Animals observed in the study with cow lactation number, calf sex, if the cow-calf pair was excluded from analysis and reasons for exclusion*

<b>Cow no.</b>	<b>Lactation number</b>	<b>Sex of calf</b>	<b>Excluded</b>	<b>Reasons for exclusion</b>
1444	1 <sup>st</sup>	Female		
1462	1 <sup>st</sup>	Female	X	Calf wandered out of calving area during the night
1428	1 <sup>st</sup>	Female		
1423	1 <sup>st</sup>	Female		
4234	2 <sup>nd</sup>	Male	X	Milk fever
1324	2 <sup>nd</sup>	Male		
1280	3 <sup>rd</sup>	Male	X	Calf blind on one eye
1234	4 <sup>th</sup>	Female		
1295	2 <sup>nd</sup>	Female		
1278	3 <sup>rd</sup>	Female		
1236	3 <sup>rd</sup>	Male	X	Calved outside calving pen late evening, not detected until morning
1160	4 <sup>th</sup>	Male	X	Milk fever

#### 3.1 Animals and experimental design

In total 12 cows with their calves were used in the study (Table 1). The practice on the farm is to remove the calf directly after birth, so none of the animals had any previous experience with taking care of a calf. All cows were moved to the calving area (figure 1) at least one day prior to calving. Attempts were made to house all cows inside the calving pen at calving. The door to the calving pen was locked at signs of imminent calving (contraction), and if the cow was not in the pen when contractions started, she was moved there. If the cow calved outside the calving pen the cow and calf were moved into the calving pen.

After the calf was born, the door into the pen was kept closed for 4 h to allow time for the cow and the calf to bond and to secure the calf's supply of colostrum. If the calf did not suckle itself, the staff tried to help it finding a teat. If this was not successful, the calf was

bottle fed 4 h after calving. The door to the calving pen was opened after 4 h, and remained so until the end of the observations. Both cows and calves could move freely between the calving pen and the calving area with other cows (figure 1). Water and silage was available in the pen.

### 3.2 Calving area

A calving area ( $8.8 \times 6$  m, figure 1) was built by separating a part of the cubicle stall with a fence and plywood walls. The calving area contained two calving pens, four cubicles and a feeding area, allowing us to observe a small number of cows in the periparturient period. To investigate when/if the cows would leave the calving pen, other cows were kept in the calving area at all times. Both cubicles and calving pens were bedded with wood shavings. Additionally, the calving pens were supplied with a small amount of straw.

Silage and water was supplied in the feeding area and in the calving pens during calving and the following 4 h after calving. During the first observation period silage was supplied in the calving pens during the whole observation period, but the practice was abandoned as the other cows entered the calving pens to feed, disturbing both the observations and the cow and calf. The calving area allowed visual, hearing and tactile contact with the rest of the herd. Between 3 and 5 cows were kept in the area.

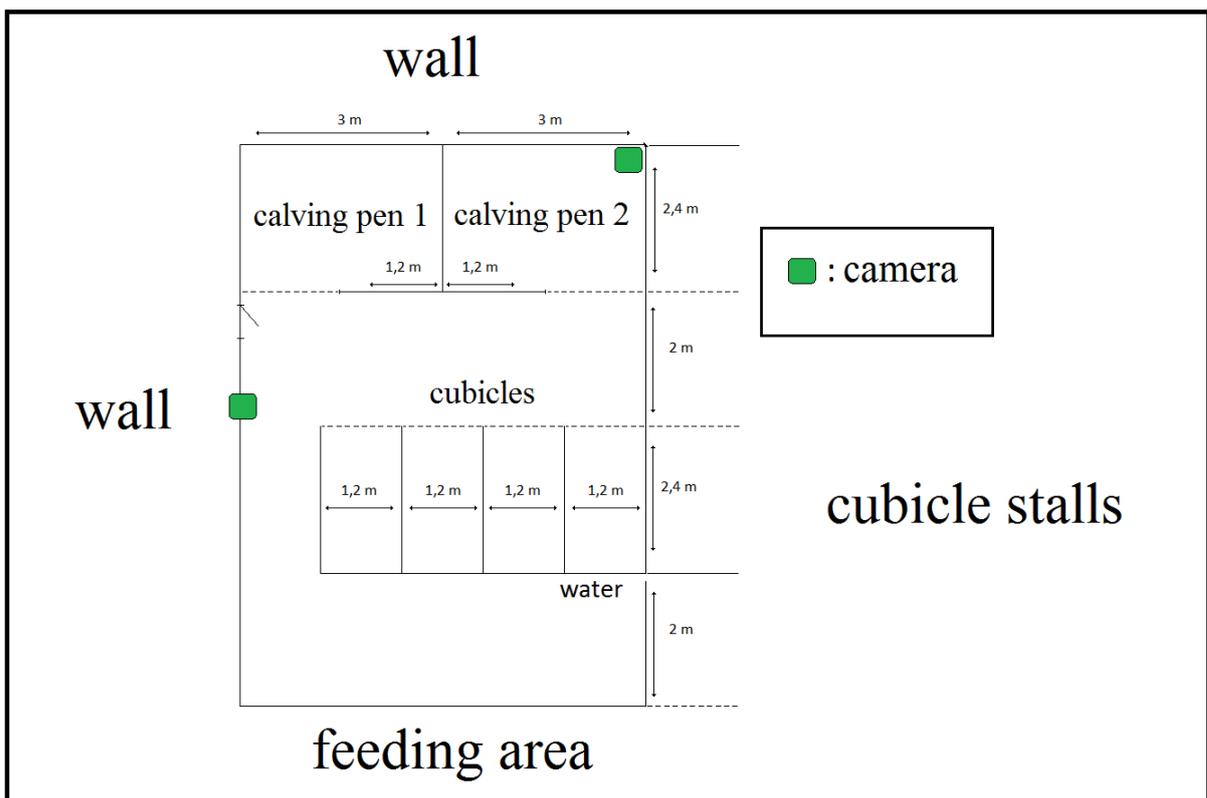


Figure 1. Layout of calving area. The walls separating the two calving pens, and the calving pen from the cubicle area was 2.4 m and 1.8 m high respectively. The wall between the feeding area and the cubicles was 1.8 m high. The opening of the calving pens had lockable doors.

### 3.3 Method of observation

The cow-calf pairs were filmed continuously during the 24 hours with two surveillance cameras (figure 1) and recorded by an *AVTECH Push video DVR* placed in the stall's office room. The films were scored from hour 4 to hour 24 in periods of two hours. Both duration and frequency of behaviours of the dam and the calf were recorded directly into Excel-sheets. The recorded behaviours and their definition can be found in table 2 and 3. One person was responsible for all recordings.

Table 2. Behaviours and their definitions recorded in cows and calves

Behaviour	Definition
<b>Dam leaves calving pen</b>	Cow leaves calving pen with all four feet outside the calving pen
<b>Dam returns to calving pen</b>	Cow entering calving pen with all four feet inside calving pen
<b>Calf leaves calving pen</b>	Calf leaves calving pen with all four feet outside calving pen *
<b>Calf returns to calving pen</b>	Calf entering calving pen with all four feet outside calving pen *
<b>Dam and calf leaves calving pen</b>	Dam and calf leaves calving pen at the same time, both leaving with all four feet outside the calving pen
<b>Dam and calf returns to calving pen</b>	Dam and calf returns at the same time, both entering calving pen with all four feet
<b>Other cow enters calving pen when calf not present</b>	Other cow entering calving pen with at least two feet inside calving pen when the calf is not present in the calving pen
<b>Other cow enters calving pen when calf present</b>	Other cow enters calving pen with at least two feet when calf is present in the calving pen
<b>Other cow in contact with calf</b>	Other cow with head within 1 meter of the calf. Continuous bouts of head within 1 meter of the calf is recorded as 1 contact.
<b>Confrontation dam and other cow</b>	Dam lowers head and/or butts when other cows' head is closer than 1 meter

\* periods under 10 sec not recorded

Table 3. Behaviours and definitions of durations

Durations	
<b>Dam outside calving pen*</b>	Measured from behaviour "Dam leaves the calving pen" to behaviour "Dam returns to the calving pen" calculated as the time from 00:00:00 to xx:xx:xx
<b>Calf outside calving pen*</b>	Measured from behaviour "Calf leaves the calving pen" to behaviour "Calf returns to the calving pen" calculated as the time from 00:00:00 to xx:xx:xx.
<b>Dam and calf outside calving pen*</b>	Measured from first "leaves the calving pen" to last "returns to the calving pen"

\* cubicle area/feeding area also recorded

### 3.4 Data analysis

All cows were video filmed from 0-24, but only the films from 4 to 24 hours after calving were analysed. As the data compromised a small number of subjects, and no control group was used, the data was analysed descriptively. Frequencies and durations of behaviours are shown as individual recordings per cow and calf, means, minimum and maximum.

## 4. Results

### 4.1 Will the cow leave the calving pen?

All the dams left the calving pen a number of times during the observation period, with a mean frequency of 12 (min 5, max 33; Table 4). The maximum duration of a single period spent outside the pen had a mean of 38 minutes (min 10, max 114 minutes; Table 4). The total duration of time spent outside the calving pen had a mean of 01:36:54 hours (min 51, max 03:12:41; Table 4). The mean hour when the cow left the pen was hour 10 past partum (min 5, max 14; Table 5). Only one calf was seen to follow the dam. This happened when the dam backed out of the pen while the calf was suckling. The same cow was the only cow to leave while the calf was standing up and moving around in the pen, the remaining six cows only left when the calf was laying down. The active calf did not follow its dam (Table 5).

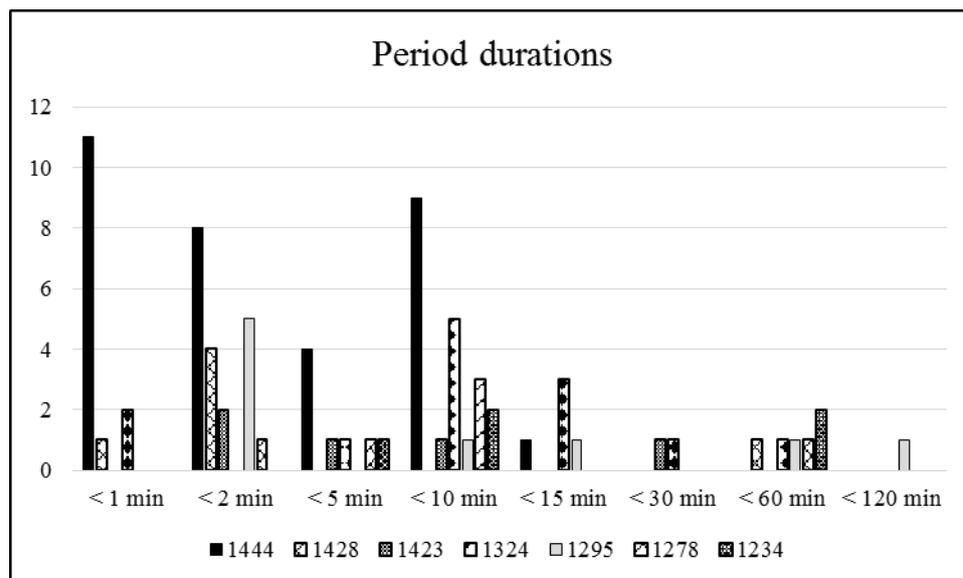
*Table 4. Frequency, max duration each occasion and total duration of periods the cow was outside the calving pen*

Cow	Frequency outside	Max duration (minutes)	Total duration (minutes)
1444	33	10	113
1428	6	44	51
1423	5	19	30
1324	13	58:	146
1295	10	114	192
1278	10	35	75
1234	5	39	93
<b>Average</b>	<b>12</b>	<b>383</b>	<b>96</b>

The data for all behaviours varied greatly between individuals. Cow no. 1444 had the biggest deviation from the other dams (Table 4 and 5, Figure 2). The shorter periods (< 1 min to < 5 min) continued in “bouts” throughout the observation period, where the cow would move in and out of the pen many times. Following the calf laying down, 2-4 such “bouts” would follow closely after the other, during which she made contact with other cows standing by the wall outside the observation area.

Table 5. Activity outside calving pen (“long period” defined relative to the length of the rest of the cows’ absence periods)

Cow	First left (hour p.p)	First long period (hour p.p)	Feeding area visits (times)	Left when calf active (times)	With calf (times)
1444	5 <sup>th</sup>	11 <sup>th</sup>	21 of 33	-	-
1428	13 <sup>th</sup>	15 <sup>th</sup>	2 of 6	-	-
1423	15 <sup>th</sup>	20 <sup>th</sup>	3 of 5	-	-
1324	8 <sup>th</sup>	15 <sup>th</sup>	7 of 13	1 of 13	1 of 13
1295	8 <sup>th</sup>	16 <sup>th</sup>	8 of 10	-	1 of 10
1278	14 <sup>th</sup>	16 <sup>th</sup>	6 of 10	-	5 of 10
1234	9 <sup>th</sup>	16 <sup>th</sup>	3 of 5	-	-



Average	10 <sup>th</sup>	16 <sup>th</sup>	7 of 12	-	-
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Figure 2. Frequency of period durations for each individual cow.

## 4.2 Will the calf leave the calving pen?

Four of the calves left the calving pen during the observation period (Table 6). Three of the cows followed the calf the one time the calf left the pen (Table 6), and the fourth followed four of five times (Table 6). The fifth time the calf was never out of reach for the cow. Only one cow-calf pair went to the feeding area when they left the calving pen (Table 6).

Table 6. Calf activity outside the pen

	Calf outside (times)	Cow follows (times)	Longest duration of calf outside (min)	Calf and cow in feeding area (Y/N)
1444	0	0	-	-
1428	0	0	-	-
1423	1	1	5	N
1324	1	1	2	N
1295	1	1	120	Y
1278	5	4	6	N
1234	0	0	-	-

Cow 1324's calf left the calving pen one time for less than 2 minutes during the observation period. This happened during suckling when the dam backed out of the pen, and the calf followed the teat of the dam. Cow 1295's calf left the calving pen for a period of 2 hours between 18:39 and 20:33, and crossed over to the feeding area. The dam followed immediately and stayed close to the calf for the entire period. Cow 1278's calf left the pen five times, four of which the dam followed. In the two other periods the calf was never out of reach for the dam. These periods were no longer than 3 minutes. The longest period the calf and the dam spent outside the pen was 6 minutes. They never left the cubicle area.

## 4.3 Will other cows be in contact with the calf?

Contacts between the calf and other cows was recorded for all seven calves with an average of less than 15 contacts (min 1, max < 25, Table 7). Five of the seven dams acted aggressively towards other cows with an average confrontation frequency at less than 20 (min < 5, max < 50, Table 7).

Cow no. 1160 and cow no. 1423 calved in close intervals to each other, and was therefore filmed at the same time. 1160 was excluded from the study due to milk fever (Table 1). In the 17th h after calving she was forced out of the calving pen by a stronger cow while the calf was resting. She was not able to return before the 21th h after calving. During this 3 h period she continuously tried to contact both her own calf and 1423's calf, leading to a high number of contacts (< 20) from this cow alone (Table 7). The contacts between the calf and other cows than 1160 were few (< 5). The dam behaved aggressively towards other cows a few times (< 5).

Cow no. 1295 and her calf spent approximately three hours in the feeding area, during which contact and aggression could not be observed. The information about this pair is included in the data set, but the possible lost data should be kept in mind.

*Table 7. Contact with other cows*

Cow no.	Calf contact with other cow (times)	Aggressive behaviour towards other cow (times)
1444	< 10	-
1428	1	-
1423	< 25	< 5
1324	< 15	< 20
1295	< 5	< 5
1278	< 20	< 50
1234	< 5	< 5
Average	< 15	< 20

#### **4.4 Will other cows enter the calving pen?**

Other cows entered the calving pen of all cow-calf pairs, but this did not happen often, the highest score was five times (Table 8). During a period when the cow no. 1295 and her calf was outside the calving pen, another cow entered and laid down. When the dam and the calf returned the dam did not attempt to drive away the other cow. The other cow left during a period when the dam was in the feeding area.

*Table 8. Other cows entering a calving pen containing a cow-calf pair*

	Other cow enter (times)	Dam present when cow enter (times)	Calf present when cow enter (times)
1444	2	2	2
1428	1	1	1
1423	5	5	5
1324	5	5	5
1295	3	2	2
1278	5	4	5
1234	2	2	2

Cow no. 1295 and her calf spent a period of 1:54:00 hours outside the calving pen (Table 4). During this period another cow entered the pen and laid down (Table 8). When they returned the dam did not attempt to drive away the other cow. When the calf was lying down in the pen, the dam stayed in the pen with both the other cow and the calf. The calf stood up and walked around in the pen in periods, and during this time the dam positioned herself as close to the calf as possible. The other cow left during one of the periods the dam was in the feeding area. During the 16<sup>th</sup> hour p.p. another cow entered into the calving pen while the dam 1278 was in the feeding area. When the dam came back she re-entered the pen, but the other cow was allowed to stay.

## **5. Discussion**

### **5.1 Will the cow leave the calving pen?**

In the study all seven cows left the pen at least five times during the first day (4-24 h) after calving. The cows displayed a large variation at which time after calving they chose to leave the calving pen.

The longer period of absence (> 15 min for all others than 1444) happened after one or two initial short periods outside the calving pen for all cows (< 15 min for all others than 1444). This is most likely due to the gradual decrease in interest towards the calf and the increasing awareness of her own needs of feed and water, as described in a number of studies (Selman et al, 1970a; Selman et al. 1970b; Edwards and Broom, 1982; Edwards, 1983; Ventorp and Michanek, 1991; Jensen, 2012) . The big large variation in the first starting point of the periods may indicate large individual differences among the cows regarding how long time it takes for the focus to shift to a degree where she leaves the calf to take care of her own needs such as feeding and self-grooming. It is however possible that the design of the experiment affected this results, and I will make some comments about this later in the discussion.

It has been reported that the cow is responsible for maintaining the proximity between herself and the calf (Selman et al., 1970a; Ventorp and Michanek, 1991; Edwards, 1983). This was also observed in this study while the calf was active. If the calf left the pen the cow either followed or stood close enough that she could reach the calf. It seems as the cow's behaviour in many ways was determined by the activity level of the calf: if the calf was lying down she appeared to be more relaxed towards other cows and also venture away from the area where the calf was lying. If on the other hand the calf was active, she would stay close and be more aggressive towards other cows. This is in concurrence with other studies where it has been observed that the cow paid more attention to herself and less to the calf while the calf was resting (Edwards and Broom 1982; Lidfors and Jensen 1988; Houwing et al., 1990; Ventorp and Michanek 1991; Jensen 2012). It was also during

this period she would leave the pen.

With previous studies in mind, it is assumed that the cows' motivation to leave the pen during the first 24 hours after calving would be to forage, and not to seek contact with other herd members. Unfortunately supplying feed in the calving pen, which was done for the first cow-calf pairs, had to be abandoned due to that other cows then entered the calving

pen to feed there. Although it was possible to record when a cow entered the feeding area, the design of the study did not allow recordings of the cows' behaviour during the time they spent there. Due to this it is hard to predict the cows' motivation for leaving the pen. However all cows visited the feeding area at least two times, and it can be assumed that this was related to feeding. One cow was observed to be in frequent contact with herd members, but this was also the cow which deviated the most from the rest of the cows (Cow no. 1444). The study did not intend to fully study the cows' motivation for leaving the calf in the pen. Although the position of the cows during the time outside the calving pen was recorded, these recordings alone are not sufficient to make conclusions on why the cows choose to enter different parts of the calving area. Finding methods which gives indicators as to why the cow leaves the calving pen will be of importance for later studies. No doubt, understanding what it is we provide outside the calving pen the cow wants to access is of importance for future calving pen design.

Part of the requirements for organic milk production is to allow a longer period of contact between cow and calf. Still several studies show that the reaction of both the cow and the calf to separation is amplified during the first 7 days (Lidfors, 1996; Weary and Chua, 2000; Flower and Weary, 2001). The current legislation for organic milk production states that the cow and calf should have prolonged contact during the colostrum period, but the previously mentioned studies opens up for questioning whether this contact actually could have a negative animal welfare impact. In that case it could be of interest to identify a point in time where the cow and calf are more ready to adapt a separation. One approach might be to consider the cow's motivation for social interaction with other herd members. Jensen (2011) suggested that dairy cows are motivated to re-join the herd by the 11<sup>th</sup> day after parturition, and Lidfors (1994) observed that all free-ranging calves had joined the herd at day 7 after parturition. It is possible that separating the cow and the calf at a point when the cow is motivated for contact with other adult animals is to be preferred. The creation of calf "crèches", which is done in free-ranging cattle may indicate that also calves' motivation for interaction with other herd members of a similar age increases at the time when the pair join the group. It is possible that this could decrease the reaction to the separation also for the calf, especially if housed in groups with other calves.

It is possible that amount of feed available in the calving pens contributed significantly to the variations seen in regards to time of the cows first period outside the calving pen. Looking at the results, the cow which was observed while ample amount of feed was still supplied in the calving pen (1423), indeed was the latest to leave. Then again, it was also during this observation there was the most disturbance from the other cows, which might have affected whether the cow felt it was safe to leave the calf or not. In further studies it is crucial to find a solution, so that the availability of feed in the calving pen can be ruled out to make sure hunger did not "force" the cow to leave. It might also be of interest to find a way of recording the amount of disturbances from the environment.

Another factor which might have had an impact on the results, is that the cows were not milked, which could have made the cows uneasy due to pressure in the udder. The choice to do so was based on the assumption that it would be a disturbance for both the cow and the calf. In addition there is a large variation among cows in reaction towards milking, especially for the primiparous which has not been milked before. Still, milk production do differ between cows, and a procedure to avoid or estimate possible impact of this variable

should be in place for a later study. It may be as simple as to record staleness of the udder or occurrences of leakage.

## **5.2 Will the calf leave the calving pen?**

The possibility of the calf to follow the dam out of the pen was one of the main issues. Technical solutions which allows for the calf to leave is easy to create, as the larger size of the cow makes a natural barrier if the calf leaves through a smaller opening. On the other hand, hindering the calf from following the cow is a true challenge. In the end we decided to not exclude the factor of the calf following from the project, but rather incorporate it and through this also look for indicators of hider-strategy behaviour.

Four out of seven calves in this study was observed outside the calving pen during the observation period, where of one of these was suckling when the cow backed out with her back feet of the pen. He quickly returned and it could easily be considered as more of an “accident” than a decision to explore the outside environment. One calf was observed outside the calving pen about half an hour before start of observations and will therefore not be considered in this discussion.

The calves’ reason for leaving might have been to find a new resting place as observed in other hider species such as the domestic goat (Lickliter, 1984), but it might also be related to the calf searching for a teat to suckle. If this is the case it is also possible that calves with a higher degree of satiety, i.e. calves which are better at suckling, is less likely to venture away from the pen. Another theory could be that the calf simply stumbled out of the calving pen, i.e. did not consciously choose to leave the pen. As not all of the calves left the calving pen it is reasonable to assume that the two latter theories applies.

When the calf left the pen the dam would either immediately follow or be within reach of the calf. When she followed an interesting behaviour pattern appeared which could be described as “shepherding” the calf back. The cow would block the calf from moving in certain directions, either with the body or the head, until the calf was back in the calving pen. It has been observed that hiding calves prefers hiding places close to vertical vegetation(Langbein and Raasch, 2000). It can be speculated that the cows perceived the calving pens as a more suitable hiding place due to the protecting walls, and therefore attempted to direct the calf back in this direction.

## **5.3 Will the calf be in contact with other cows?**

Contact between the calf and other cows was rare, except for the calves that spent time outside the calving pen. In other studies of cows and calves in group calving pens, other periparturient cows were often observed to lick alien calves, and calves were frequently observe to suckle from other cows (Edwards, 1983; Illmann and Špinka, 1993; Lidfors et al. 1994). In this study, although at least one of the other cows present in the calving area was closer than one week to parturition, licking of an alien calf was very rare. Suckling from another cow was not seen for any of the calves included in the behavioural recordings.

A recent study suggests that cows prefer to calve in secluded areas (Proudfoot et al., 2014). This may indicate that providing protected areas in group calving pens can reduce disturbance and the risk of the calf suckling other cows. It can also provide a more suitable

calving place, decreasing disturbance from the environment and other cows. Such a solution would also mean that the cows would not be isolated from their peers, eliminating the forced isolation as practiced today. The extra work load would be limited, which might open for farmers being more willing to keep cows in the pen for a longer period, and thereby also reduce number of calvings in the cubicle areas. In practice, this study was conducted in such a group calving pen with sheltered areas for calving. However, this study was conducted on a very small number of animals and focused on the time after calving, so to establish if this could be a good solution further investigation is required.

#### **5.4 Will other cows enter the pen?**

As the other cows entering the calving pen did not attempt to groom or suckle the calf, the entries into the calving pen seemed more related to the resources provided by the calving pen than the calf *per se*. Having an open entry will make it difficult to supply the pens with feed without contracting unwanted interest from other cows, so in the future it might be better to find a solution where only the dam may enter the pen. If the having an open entry to the calving pen is of interest, it would be preferable to exchange the cubicles for resting areas similar to the ones in the calving pen, without the sheltering walls, as some of the cows seemed to prefer the pens for resting.

For two of the cow-calf pairs, another cow entered and laid down in the calving pen. Although the other cows were allowed to stay, this might be stressful for the dam as her contact with the calf is to some extent hindered. This may especially affect weaker and lower-ranked animals, and measures to prevent this should be taken, both in future studies and possible new calving pen solutions.

#### **5.5 Conclusion**

In conclusion the cow did leave the calving pen, and the calf did not follow. However in such a small scale study it is important to regard its limitations. The small number of animals and the big variation among them makes it difficult to draw any strong conclusion regarding the motivation of the cow to leave the calving pen and the influence of these results on future husbandry practices. It does however suggest a direction for further studies. The hypothesis of this study is closely related to the hider/follower-theory. More generally, as to whether dairy cows and calves display behaviours expected in hider species during the first 24 hours p.p., the answer is yes. This indicates that pursuing further studies on subjects based on hider strategy may prove valuable for decision regarding the future husbandry of dairy cattle.

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