Sveriges lantbruksuniversitet
Fakulteten för veterinärmedicin och husdjursvetenskap

Swedish University of Agricultural Sciences
Faculty of Veterinary Medicine and Animal Science

Aspects on cow traffic and management on farms with automatic milking

Aspekter på kotrafik och driftledning på gårdar med automatisk mjölkning

Cow traffic is important in many ways….. Kotrafik är viktigt på många sätt….

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SAMMANFATTNING

Detta examensarbete består av fyra fallstudier. Det har som mål att utröna hur man vid automatisk mjölkning kan främja en väl fungerande kotrafik. Olika tekniska och byggnadsmässiga lösningar analyseras och vissa anpassningar av DeLavals driftledningsprogram föreslås.

Fallstudie 1: Laktationskurvor jämförs från traditionell kotrafik och Feed First™ kotrafik
Fallstudie 2: Gård A – en studie av företrädesfil och kotrafik som helhet
Fallstudie 3: Gård B – en överblick över gården och deras sätt att arbeta
Fallstudie 4: Nyckelfaktorer – hur kan vi avgöra hur bra det går för en VMS-gård?

Fallstudie 1: Laktationskurvor jämförs från traditionell kotrafik och Feed First™ kotrafik

I den här undersökningen analyseras data före och efter ombyggnation till Feed First™ kotrafik. Laktationskurvor jämförs från traditionell kotrafik och Feed First™ kotrafik. Studien ingår ej i den officiella versionen av detta dokument.

Fallstudie 2: Gård A – en studie av företrädesfilen och kotrafiken som helhet

Gård A har två mjölkningsrobotar av märket VMS från DeLaval placerade efter varandra. Gården har Feed First™ kotrafik och en ny kotrafiklösning som ska ge företräde åt kor som av någon anledning har svårt att komma fram till mjölkningsrobotarna. Kotrafiken som helhet har studerats och en del brister har rättats till. Några förslag ges på vilka kor som bör få tillträde till företrädesfilen och en del övrigt som bör åtgärdas på gården gällande kotrafiken. I en jämförelse som gjordes mellan tiden utan företrädesfil och företrädesfilen med de inställningar som tillämpades före denna studie var det endast några kor som hade förkortat sina väntetider före mjölkning.

Fallstudie 3: Gård B – en överblick över gården och deras sätt att arbeta

Gård B har två mjölkningsrobotar av märket VMS från DeLaval. De är placerade bredvid varandra. Gården fungerar bra och är under utvidgning. Kotrafiken fungerar enligt Feed First™-principen. En grind har helt ställts upp så att den kan passeras baklänges. Ett försök har gjorts att utröna hur detta påverkar kotrafiken.

Fallstudie 4: Nyckelfaktorer – hur kan vi avgöra hur bra det går för en VMS-gård?

Ett förslag har tagits fram till hjälp för lantbrukare att bedöma gårdens prestanda. Avsikten är att kunna definiera förbättringsmöjligheter såväl som väl fungerande verksamhet. Lantbrukare ska kunna jämföra sina resultat både med andra gårdar och med sin egen gård för en tid sedan.

SUMMARY

This thesis consists of four case studies. The objective is to find out how to get a well functioning cow traffic in an automatic milking system. Different technical and building solutions are analysed and some adjustments are proposed for the DeLaval herd management software.

Case study 1: Lactation chart comparison from traditional cow traffic and Feed First™ cow traffic
Case study 2: Farm A - a study of the precedence passage and the cow traffic
Case study 3: Farm B – an overview of the farm and their way of working
Case study 4: Key factors – how can we judge how well a VMS farm is working?

Case study 1: Lactation chart comparison from traditional cow traffic and Feed First™ cow traffic

In this survey data is analysed from before and after rebuilding to Feed First™ cow traffic. Lactation graphs are compared between traditional cow traffic and Feed First™ cow traffic. This case study is not included in the official version of this document.

Case study 2: Farm A – a study of the precedence passage and the cow traffic
Farm A has two VMS from DeLaval in a tandem solution. The farm has Feed First™ cow traffic and a new cow traffic solution which should give precedence to a selection of cows. The cow traffic as a whole on the farm has been studied and some problems have been adjusted. Some proposals are given on which cows should be in the precedence passage and some other things that ought to be adjusted on the farm concerning the cow traffic. In a comparison made between no precedence passage and the precedence passage working with the settings they had before the start of this study, only a few cows had shortened their waiting times before milking.

Case study 3: Farm B– an overview of the farm and their way of working
Farm B has two VMS from DeLaval in a parallel solution. The farm is functioning very well and is under expansion. The cow traffic solution used is Feed First™. A gate has been opened up and it is possible to pass it backwards. A short study has been made to find out how this influences the cow traffic.

Case study 4: Key factors – how can we judge how well a VMS farm is working?
In this study key factors are presented that the farmer can use as tools to judge the performance of the farm. Thus the idea is to help the farmer to estimate areas of improvement as well as areas performing well. The farmers should be able to compare their results to other farms as well as their own farm some time ago.

Abbreviations: DMI, dry matter intake; FF cow traffic, Feed First™ cow traffic; mp, (milking pen)=waiting area; ms, milking station; PMR, partly mixed ratio; pp, precedence passage=(VIP lane); trad. cow traffic, traditional cow traffic; VMS, Voluntary Milking System.

Explanations: cow traffic is movements of cows between different barn facilities, to perform different activities, like eating, resting, milking or using a cow brush.
Semi free cow traffic, semi guided cow traffic, selective cow traffic and selectively guided cow traffic are the same
Primiparous cows have given birth to one or several calves at one occasion. Multiparous cows have given birth to calves at more than one occasion.

CONTENTS

INTRODUCTION

This thesis consists of four parts where different aspects of cow traffic at DeLaval farms has been studied.

The company DeLaval provides solutions for dairy farmers all over the world. The company is striving to find new ways and solutions to drive progress in milk production. The aim is to improve milk quality, food production, animal welfare and the environment for both animal and human.

SLU, the Swedish University of Agricultural Sciences, develops the knowledge about our biological resources. Research, education and information about possibilities and risks with different ways of using our forests, landscapes, soils and animals are prosecuted.

The constant work for farmers is to increase the profitability of the farm in a cost-efficient and labour saving manner. They need to know how to improve the farm's capacity and which factors are most important to achieve this.

A system for voluntary milking (VMS; Voluntary Milking System from DeLaval) is an overall solution for the farm. One of the important factors is to have a good functioning cow traffic, which should give the cows the opportunity to come to milking and to eat good feed often enough, this to be able to produce at their maximum with maintained health and well-being and with as little effort as possible for the farmer. The cows should thereby maintain their natural and individual rhythm.

In the beginning of the automatic milking era, as good as all farms had either free cow traffic (no gates stopping the cows from visiting the milking station, eating or resting) or guided cow traffic where the cows had to go milking before going to the feeding area, or semi-free cow traffic where the cows could not go to the feeding area before milking after a certain time had passed since last milking. Some years ago a Swedish farm turned the cow traffic around and the cows had to go milking before resting instead of before eating. This new idea is called Feed First™ cow traffic.

LITERATURE STUDY

Cow traffic solutions

Well functioning cow traffic is the base for profitable milk production with automatic milking. To reach a well functioning cow traffic which is evenly distributed over the 24 hours, the roughage should be distributed 10-12 times per day. Even if there is feed on the feeding table, new fresh feed makes the cows more eager to go there. It is very clear that the cow traffic slows down the hours before new feed is distributed if it is done to seldom. It is preferable that the old feed ends the minutes before new feed is distributed. But there should not be any rush to the feeding table, even distribution over the 24 hours is

better. Less milkings per day for low yielding cows is ok if all cows are milked the correct amount of times and with sensible intervals. (Johansson, B. 2008).

Harms, Wendl & Schön, 2001, found that cows needed to be fetched for milking much more in free cow traffic (15.2 times per day) than in semi free (3.9 times per day) or guided (3.8 times per day) cow traffic. This shows that it is difficult to reach a good flow with totally free cow traffic.

Melin *et al*., 2006, has studied three types of cow traffic, free cow traffic with always access to the feeding areas through control gates, selective cow traffic with access to the feeding areas through control gates until 5 h after the last milking and forced cow traffic with no access to the feeding areas through the control gates. The DMI was about the same in the three cow traffic types, 23.1, 23.2 and 23.5 kg respectively. The cows tended to eat more roughage during the free cow traffic and ruminated for a longer time per day (P F<0.06). During selective cow traffic, cows of high social rank consumed 2.8 kg more concentrates than cows of low social rank did (P<0.10). Cows of high social rank spent significantly more time chewing while feeding. Cows of low social rank had faster chewing rates and spent less time chewing per kilogram DMI. There was no significant difference in milk yield between the treatment groups. There were fewer milkings per day in free cow traffic, although not significant. There were significantly more passages without milking in the milking units in the forced cow traffic. The cows more often passed through the control gates during free cow traffic compared to selective cow traffic.

In free cow traffic the cows walked into the feeding area more times per day than they started a new meal. This shows that either the cows came to the feeding area and went away again without eating or they left the feeding area for a short while within a meal. This opportunity only exists in free cow traffic and Feed First™ cow traffic. In one of two farms cows yielding more than 20 kg per day ate significantly more often than cows yielding less. In the other farm, cows with 3 lactations or more ate significantly less often. The rank or part of lactation did not significantly influence the number of eating occasions (Harms, 2005).

Wendl *et al*., 2000 has studied 11 farms with free cow traffic and 6 farms with guided or partly guided cow traffic. The majority of the farms had Lely milking systems. They mention that the number of visits without milking was variable between the farms. In 50% of the farms the amounts of visits without milking was considerably below the number of milkings, but clearly over the number of milkings in about 30% of the farms. The total visiting frequency (milkings and visits without milkings) was 5 visits per day on herds with 45 cows and 3 visits per day on herds with about 60 cows.

Beck, 2008, found that stdev of milking interval increased when fetching more cows.

Gates

Harms, 2005, studied two farms, one with active selection gates from DeLaval and one with passive selection gates from WestfaliaSurge. A passive gate is unlocked when the cow is allowed to walk through it, but the cow has to push it open. An active gate is opened by compressed air when the cow is allowed to walk through it. Harms noticed in free and semi free cow traffic that the cows in the farm with active selection gates used the gates more than the cows in the farm with passive selection gates. In guided cow traffic there was no difference in gate usage between the two farms. It happened more often with passive selection gates that a cow was noticed and allowed to pass the gate but did not pass. Although the cows were more trained to use the passive selection gates, they were not as good as the active selection gates. Gates near milking stations were not used as often as gates in the middle of the barn. The number of visits to the feeding area in semi free cow traffic was 4.7 with 0.69 visits in the milking stations without milking in the farm with passive selection gates and 5.9 with 0.80 additional visits in the milking stations in the farm with active selection gates.

Choose cows automatically for precedence passage

Method and arrangement for animal management: There is a proposal that the management system should calculate, on basis of the waiting times in the waiting area, whether a cow is low in rank. If the cow is low

ranked and fulfils a milking criterion, she should be guided to the precedence passage in the gate or if the cow is not low in rank but fulfils the milking criterion, she should be guided to the usual waiting area.

Milking

Weiss *et al*. (2004) have seen no negative effects on the milk composition and somatic cell count at changeover from parlour milking to AMS. There was though a 15% reduction of yield after 10 milkings, which they explain by the inhibition of milk ejection due to stress during the first milkings in the MS.

Weiss et al (2004) note that a longer training period in the MS for cows with low coping capacity at the change of environment could possibly prevent a loss in milk yield due to stress at changeover.

All too many cows in the VMS gives many milkings per day but also long and uneven milking intervals for many cows. Many incomplete milkings[*] also results in uneven milking intervals, since the incomplete cows get due for milking very soon again. Uneven milking intervals decreases the production and causes the cell count to rise. Experience from the research farm Kungsängen in Sweden show that when the frequency of incomplete milkings exceeds 3% it causes increased bulk cell count. Incomplete milkings might be because of dirty udders which cause dirty camera glass (Gustafsson & Pettersson, 2008.

2 farms mentioned by Wendl *et al*., 2000, had different milking capacity. One farm had 130 milkings per day and low milk flow (1.3 kg/min) and was working at full capacity. The other farm had also 130 milkings per day but higher milk flow (2.1 kg/min) and had 35% free capacity. This is an example of the importance of high milk flow (harvesting flow). Harms, 2002, points out that the milk flow is decisive for the capacity of the milking system.

Beck, 2008, found that the number of MS visits were higher for cows with lower annual yield vs lower daily yield.

Milking intervals

Gustafsson & Pettersson, 2008 state that a standard variation in milking intervals of 3 hours in a farm with 2 milking stations is normal. The more cows there are, the longer milking intervals and the greater variation.

Melin et al., 2006, found in their study that the length of milking intervals is very important for production yield. The cows were parted into high frequency milking (HF) and low frequency milking (LF) cows. During the first four weeks of lactation all HF cows produced more milk than the LF cows. The older HF cows continued to produce more milk than the older LF group, but the first parity HF cows dropped in milk production during the first 5-8 weeks of lactation and produced less milk than the first parity LF cows. The dry matter intake was lower in the HF first parity group than in the LF first parity group. This had a negative effect on the later production capacity. In this study traditional cow traffic was used (semi free cow traffic). The results indicate that all first parity HF cows did not have sufficient access to the feeding area to fulfil their nutrient requirements and hence they dropped in milk production.

Beck, 2008, found that larger herds resulted in a more even and slightly shorter milking interval.

According to Pettersson, 2005, a high initial milking frequency is important for recently calved cows. The milking frequency during the first 10 weeks of lactation influences the production during the whole lactation.

[*] A milking is concerned as incomplete when the yield is less than half of the expected yield, provided that the expected yield is at least 1 kg. However a teat is not incomplete if the yield is more than 3 kg.

Milk quality

The study of Melin *et al*., 2006, shows that the level of variation in milking intervals significantly effects the somatic cell count in the composite milk, but not the fat, protein or lactose contents.

Feeding

Winter & Hillerton (1995) found that the mean interval between visits to the feeding area was 173.6 min (range 118-186 min). Mean duration of a feeding visit was 59 min. No significant variation ($P<0.05$; ANOVA) was recorded over 5 days.

A high proportion of concentrates in the Total Mixed Ratio or a big amount of feed per visit in the feeding station might result in a decreased number of feed- and milking visits. A big amount of feed in the milking station can cause many dry cows or other hungry cows to go into the milking stations and get rejected. If the amount of rejected cows is big, one solution can be to lower the concentrate dispensing in the milking stations (Gustafsson & Pettersson, 2008).

Harms, 2005, has studied the eating pattern of cows in different cow traffic systems. The number of eating occasions was higher in free cow traffic than in selectively controlled or controlled cow traffic, no matter how long intervals were concerned as parting two eating occasions.

Harms, 2005, measured the time the cows were eating (the time they had their head in the feeding trough). He found no significant differences between different kinds of cow traffic (free, guided or semi free). But he found significant differences between different cow groups in one of the farms; the cows of high rank ate 20 minutes more per day than the cows of lower rank. Cows in their third lactation ate 30-35 minutes shorter than cows in lactation 1 and 2. Cows in the beginning of the lactation ate ca. 35 minutes shorter than cows in a later lactation stage. Cows yielding lots of milk ate more than lower producing cows. In the other farm the only difference he found was that cows in the first third of the lactation ate 15-25 minutes shorter than cows later in the lactation.

When measuring how long the cows were eating (not necessarily with the head in the feeding trough) Harms, 2005, found that cows ate longer time in free cow traffic than in guided or semi free cow traffic. In one of the farms the cows in the third or higher lactation ate shorter time. In the other farm the cows in the second lactation ate longer than cows in the first or third or higher lactation. Cows in the first third of the lactation ate shorter time and later in the lactation they ate longer time. The rank or milk production level had no significant effect on the eating time. The time cows waited before starting eating again was shortest in the free cow traffic and longest in the guided cow traffic.

The major part of the variation in feeding patterns can be explained by differences between cows, not within individual cows. Cows develop feeding patterns that are characteristic for the individual cow and consistent over time. The differences between cows are considerable. (Melin *et al*., 2006)

Social behaviour

At pasture cows are synchronised when feeding or walking. A limited feed area and/or social feeding preferences might de-synchronise the cows and make them behave less natural. (Winter & Hillerton, 1995)

Prolonged waiting in anticipation of milking may be detrimental to the milk let-down response and subsequent yield. Varlykov & Tossev (in Winter & Hillerton) reported an upper waiting time for normal milk release of 30 min and 40 min resulted in significant increases in milking times.

Predictability of the environment has been suggested by Wiepkema (Winter & Hillerton, 1995) as an important state for an animal's welfare.

Cow health

Melin, 2005 measured the cortisol concentrations in the blood of cows and states that controlled cow traffic was not stressful for the cows.

Rank

Harms, 2002, mentions that the cows low in rank go milking between 4 and 6 o'clock and between 14 and 16 o'clock, when it is calmer in the barn.

Harms, 2005, found that cows low in rank went to the milking station and thereafter to the feeding table before fresh roughage was distributed. The cows higher in rank went there when fresh feed was already there. He found this in guided and semi free cow traffic, but not in free cow traffic. He also found that the diurnal rhythm was more settled for cows high in rank.

A significant negative correlation between dominance value and daily concentrate allotment was found, i.e. cows of lower rank had higher concentrate allotments. A significant positive correlation between dominance value and number of lactation days was found, i.e. cows have higher rank late in the lactation. In one of their two tests there was a significant positive correlation between dominance value and milking interval, i.e. cows of high rank have longer milking intervals. All these comparisons are influenced by the fact that cows early in lactation eat more and milk more often. Cows with low concentrate allotments are more eager to go milking since they are hungry. (Ketelaar-de Lauwere, 1996).

Melin *et al*., 2006, stated that subdominant cows spend more time waiting in the waiting area than dominant cows do. Cows that often pass through the milking stations spend more time waiting than other cows.

Ketelaar-de Lauwere et al, 1996 found that cows with higher dominance values spent less time in the waiting area. They also spent less time standing at the feeding gate between 0 and 6 o'clock. The rest of the timebudget (time spent on lying versus standing in cubicle, being on the slatted floor in the lying area versus feeding area, standing in the feeding gate other times than mentioned or visiting the AMS) was not affected by the rank of the cows.

CASE STUDY 1 – LACTATION CHART COMPARISON FROM TRADITIONAL COW TRAFFIC AND FEED FIRST™ COW TRAFFIC

Very many different factors have influenced the results of this study and it is thus not possible to state from this study what has caused the results. This study is therefore internal within DeLaval.

CASE STUDY 2 – FARM A – A STUDY OF THE PRECEDENCE PASSAGE

BACKGROUND

Farm A is built with Feed First™ cow traffic solution and additionally there is a precedence passage beside the usual waiting area. There was at the time of this investigation only this farm which had the type of cow traffic solution called precedence passage, described below. The farmer is very pleased with the solution and for DeLaval it is interesting to evaluate it. Is this something DeLaval should recommend also to other farmers? How is it working at Farm A? Are they pleased with the solution because it improves the cow traffic or just by a coincidence? If more precedence passages are to be built – how should they be constructed?

How can one encourage all cows to go milking as often as is needed for a good, voluminous and withstanding lactation in spite of some cows´ low rank, little interest for milking etc.? One attempt is the precedence passage at Farm A.

Description of the cow traffic solution called precedence passage

When due for milking, most of the cows are led to the right into the waiting area in selection gate 1 and can enter any of the two milking stations. Some of the cows (later called precedence cows) are led straight forward in selection gate 1 and can easily go to milking station 2. Just in front of milking station 2 there is a "push gate" between the precedence passage and the waiting area, which still makes it possible for a high ranked cow in the waiting area to go before a low ranked cow in the precedence passage. This gate is free moving and the cows push it to move it, but it is possible to put a piston on the gate to control it automatically in the future. Hence as it is at the time of this study the precedence passage gives no real precedence to low ranked cows.

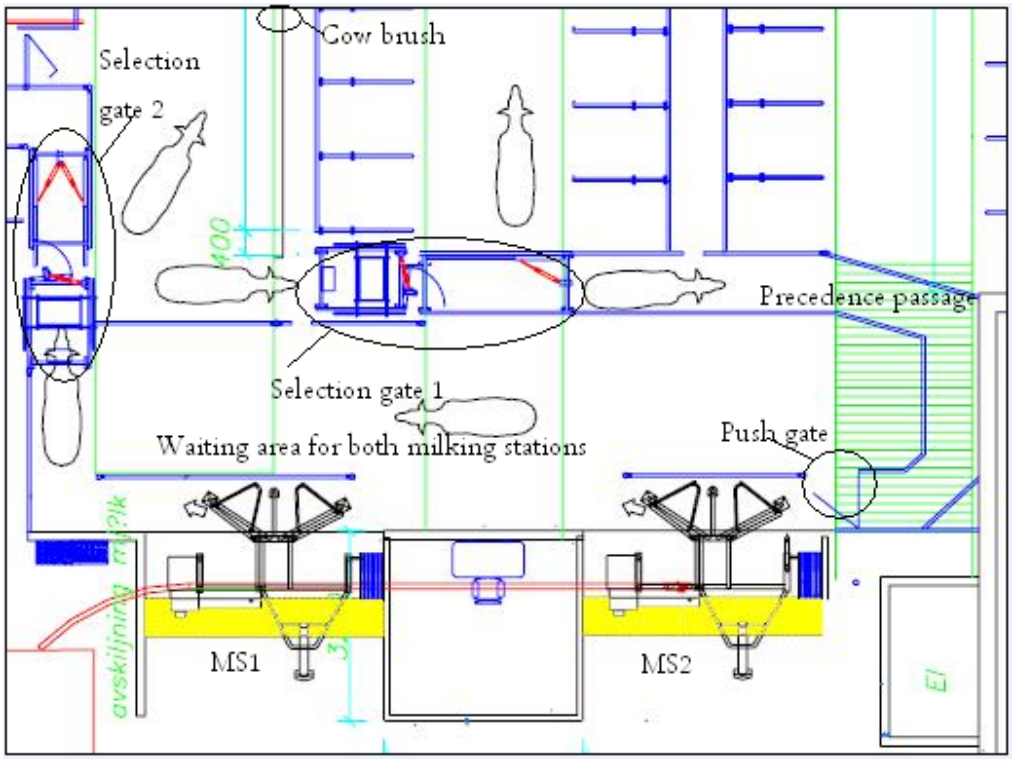


Figure 1. Drawing of the cow traffic solution with precedence passage (pp).

Measurements of the precedence passage (after selection gate 1):
6.5 m forward to wall, smooth 90 degrees bend, 3 m forward, smooth 90 degrees bend, 2.5 m forward to push gate. Width 91 cm except in last 90 degrees bend; width 1.30 m. The total length of the precedence passage, measured in the middle of the alley, is 12 m. In total approximately 7 cows can be in the precedence passage at the same time.

INVESTIGATION

An investigation about the precedence passage and the gates, cow traffic and management at Farm A was made with several purposes;

1. To find out how many cows and which should preferably be in the precedence passage
2. To understand how many cows there should be place for in an optimal precedence passage

3. To find out what factors are important to keep track on to optimize the functioning of the precedence passage and the cow traffic as a whole
4. To see if the health of the cows has been affected by the precedence passage and if so – how
5. To improve the functioning of the gates
6. To improve the utilization of the milking stations
7. To find ways to increase the milk yield per day and MS
8. To see when cows go to the feeding area (peaks and dips)
9. To measure the time cows spend in the feeding area before and after milking and at different times of the day
10. To see which cows stay longest in the feeding area (depending on days in milk, daily yield etc.)
11. To see if the cows are disturbed by the manure scrapers while they are eating

MATERIALS AND METHODS

The data set in the present study consists of registrations of MS visits, registrations in portal IDs and gate passages from Farm A from 2006 and 2007. On 12 Jan. 2007 a first visit to the farm took place. The farmer and employee were asked about feeding times etc.

The cows were in their first to seventh lactation and between recently calved and due for dry off. Most of the cows were used to being milked in the VMS before the precedence passage was built, although some primiparous cows had recently had their first calf and hence were not used to being milked at all.

The cows selected for the precedence passage were in their first to fourth lactation and between recently calved and due for dry off. Most of them were recently calved primiparous cows. One of them was a rödkulla, a small Swedish native breed and one of them had problems with a leg and was therefore considered as low ranked. Some cows were there because according to the farmer they used to block selection gate 2, leading from the waiting area to the feeding area, before they were milked.

To know which cows were blocking gate 2 it was assumed that cows in the waiting area showing up in gate 2 before showing up in ms 1 or ms 2 were blocking the gate.

To be able to handle big amounts of data, make calculations, draw diagrams and fetch data from the farm etc. some different computer programs have been used:
Excel, Visual basic, SAS, Access, Word, the DeLaval Dairy Management software and DialOut EZ together with Tight VNC.

Cow traffic at different times

The cows had the possibility to go grazing until 27 Sep. 2006. The data in this study begins on 28 Sept. 2006. The precedence passage was built on 6 Nov. 2006 and according to the farmer the cows learned very quickly how it works. However they might have hesitated or gotten scared the first time after the rebuilding, so data from the first ten days after the rebuilding were not evaluated. The study ended on 25 Apr. 2007. Since the study was made in winter time and early spring, the cows were not grazing.

As a first step two time periods were chosen for a closer study; 28 Sep. until 5 Nov. 2006 (no precedence passage) and 16 Nov. 2006 until 11 Jan. 2007 (precedence passage). The waiting time from passage through selection gate 1, leading to waiting area vs precedence passage, until identification in any of the milking stations were studied for all cows, for the precedence cows exclusively and for the waiting area cows exclusively. The milking intervals were studied for the same selections of cows. All cows who had data from at least 10 days in a row were included in the study. Obvious artefacts, such as milking intervals of more than 36 hours, were eliminated from records, since the reason for those is often that the cow is ill or has been dry or treated with some kind of medicine. The comparisons were made with all gate passages and with each cow´s waiting times individually. The individual variation in milking intervals, i.e. the standard deviation for each cow, were compared. For comparisons of these two time periods Excel was used.

Until 2 Feb. 2007 the farmer and staff decided which cows and how many should be in the precedence passage. They chose to keep rather many cows there, around 25-30. On 2 Feb. the number of cows was decreased to 14 to evaluate how the waiting times etc would change when fewer cows were in the precedence passage. But unfortunately after just some days the farmer and staff started to increase the number of cows again.

On 7 Mar. the number of cows in the precedence passage was decreased from ca 25 to 11. The cows were chosen on following criteria:

- The 3 cows that had substantially decreased their waiting time from passing gate 1 until milking by being in the precedence passage before
- The 3 cows that had blocked gate 2 most before being milked during 10 days (1 Apr. – 9 Apr. 2007)
- The 3 cows that had the longest waiting time in the waiting area the latest month
- 1 recently calved heifer
- 1 cow recently bought to the farm

The farmer and staff were asked to keep only these cows in the precedence passage for a number of weeks.

On 10 Mar. two portal IDs registering cows moving from the resting area to the feeding area were mounted in the alleys between the resting area and the feeding area.

On 14 Mar. some changes in the gate settings were made, which made the number of cow trains decrease substantially. Also a board was mounted after gate 2 to prevent cows in the feeding area from putting their head in the gate zone and tease both the gate sensor and the cows that were supposed to pass the gate. This made the gate data more reasonable and easier to interpret.

From 16 Mar. until 22 Mar. the number of cows in the precedence passage was very low due to an external test of gate decisions which did not work. This was discovered on 22 Mar. and the gate decisions were immediately changed back to what they were before.

Between 23 Mar. and 25 Apr. the number of cows in the precedence passage was 11-13 and for test purpose the same cows were there all this time.

Based on the changes and happenings mentioned above, seven different time periods have been compared regarding different parameters on the precedence passage, gates, cow traffic, feeding times etc.

The seven time periods compared

28 Sep. 2006 – 5 Nov. 2006 39 days , in average 142 cows	The cows had come in from grazing. The precedence passage was not yet built.
16 Nov. 2006 – 11 Jan. 2007 57 days , in average 144 cows	The precedence passage was new, it was built on 6 Nov. 2006.
12 Jan. 2007 – 1 Feb. 2007 21 days , in average 143 cows	There were rather many cows in the precedence passage.
5 Feb. 2007 – 5 Mar. 2007 28 days, in average 146 cows	There were fewer cows in the precedence passage, but increasing.
8 Mar. 2007 – 13 Mar. 2007 6 days, in average 153 cows	There were fewer cows in the precedence passage. The gates had not yet been adjusted. The portal IDs registering cows moving from resting area to feeding area were up and running from 10 Mar 2007.

16 Mar. 2007 – 21 Mar. 2007 6 days, in average 150 cows	The gates had been adjusted, but there were nearly no cows at all in the precedence passage, due to an external test.
23 Mar. 2007 – 25 Apr. 2007 34 days , in average 146 cows	The gates had been adjusted. There were few, 11-13 cows in the precedence passage, chosen on special criteria, see above.

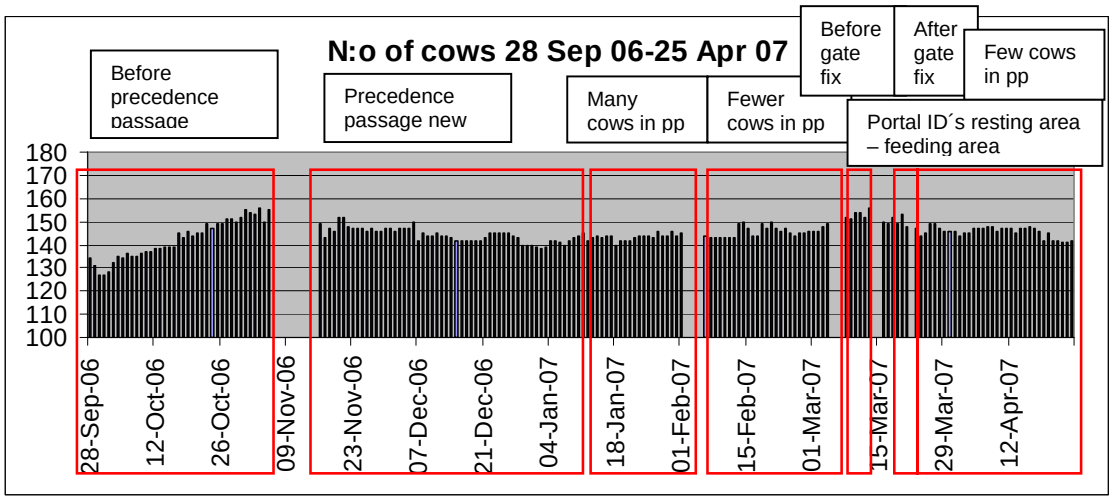
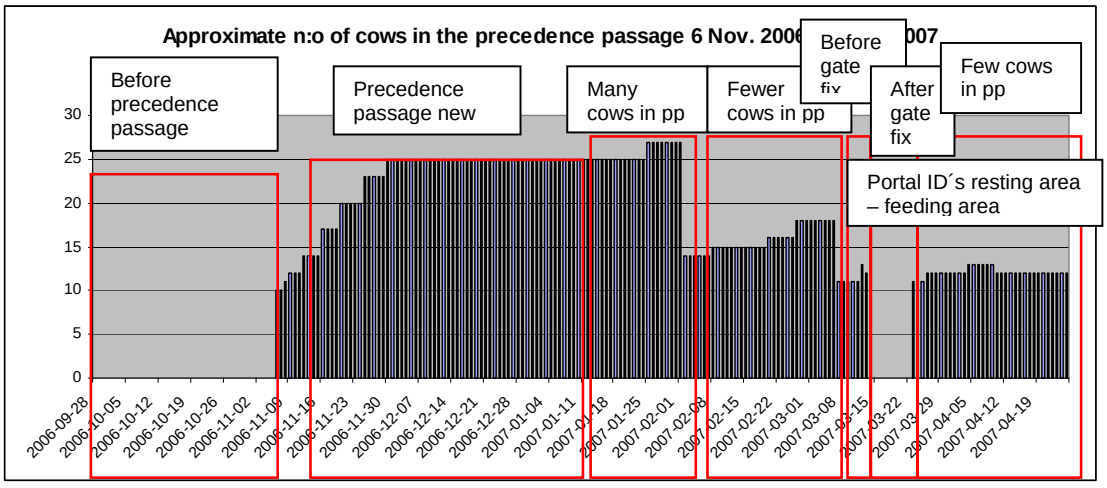


Figure 2. Number of cows present in the VMS area, using gates and MS´s, during the different time periods compared.



RESULTS

Waiting times before milking and milking intervals without or with precedence passage

The average waiting time for all cows after the precedence passage was built was somewhat longer than before, it had increased from 37 to 41 minutes, see Table 1. However if only the cows in the precedence passage are compared with themselves before, the waiting times have shortened from 1 hour to 43 minutes.

For all cows except the ones in the precedence passage the waiting times have increased from 34 to 41 minutes. Their milking intervals were also longer after the precedence passage was built, see Table 2. The average milking interval increased from 11 hours and 27 minutes to 11 hours and 43 minutes. However, if consideration is only taken to the cows in the precedence passage the milking interval has decreased from 12 hours and 5 minutes to 10 hours and 22 minutes.

For the cows in the waiting area the average standard deviation of milking interval had increased by 24 minutes per cow. For the cows in the precedence passage it had decreased by 6 minutes. This indicates that the precedence passage is a help for cows picked out to be there, but disturbes the rest of the cow traffic.

Table 1. Waiting time from passage through selection gate 1, leading to waiting area or precedence passage, until identification in any of the milking stations, below called waiting time. All cows that were in VMS milking at least 10 days of each period included.

		28 Sep.-5 Nov. 2006, before pp			16 Nov. 2006-11 Jan. 2007, with pp		
	(hour:min)	Waiting area, all cows	"Precedence passage cows-to be" in waiting area	Waiting area cows	Waiting area, all cows	Precedence passage cows	Waiting area cows
All gate passages	Average waiting time	0:37	1:01	0:34	0:41	0:43	0:41
	Stdev	1:03	1:45	0:55	1:03	0:42	1:07
	Median waiting time	0:14	0:22	0:14	0:19	0:33	0:17
Per cow	Average waiting time	0:40			0:45	0:43	0:47
	Stdev, average	0:31			0:37	0:11	0:44
	Median waiting time	0:31			0:35	0:44	0:31

Table 2. Milking intervals. All cows that were in VMS milking at least 10 days of each period included.

		28 Sep.-5 Nov. 2006, before pp			16 Nov. 2006-11 Jan. 2007, with pp		
	(hour:min)	Waiting area, all cows	"Precedence passage cows-to be" in waiting area	Waiting area cows	Waiting area, all cows	Precedence passage cows	Waiting area cows
All gate passages	Average milking interval	11:27	12:05	11:21	11:43	10:22	12:00
	Stdev	4:08	4:23	4:05	4:04	3:21	4:09
	Median milking interval	11:01	11:31	10:58	11:21	10:05	11:38
Per cow	Average milking interval	11:53			12:16	10:48	12:38
	Stdev, average	2:30	1:53	2:16	2:39	1:47	2:40
	Median milking	11:39			12:01	10:33	12:24

	interval						

There were 12 cows that had been milking in the VMS already before the precedence passage was built and were selected to go in the precedence passage. Out of these, 4 cows shortened their waiting time with on average 38 minutes and 8 cows prolonged their waiting times with on average 18 minutes. There were 18 new cows in the precedence passage, selected to be there directly after calving. Their average waiting time was 42 minutes. The average waiting times of the 10 new cows not going in the pp was 25 minutes. See Table 3.

Table 3. Differences in waiting time for cows from milking parlour to precedence passage and average waiting time for new cows in precedence passage and waiting area.

	Mp -> pp	New to pp	New to mp
Shorter in pp	4 cows, 38 min		
Shorter in mp	8 cows, 18 min		
Average waiting time		18 cows, 42 min	10 cows, 25 min

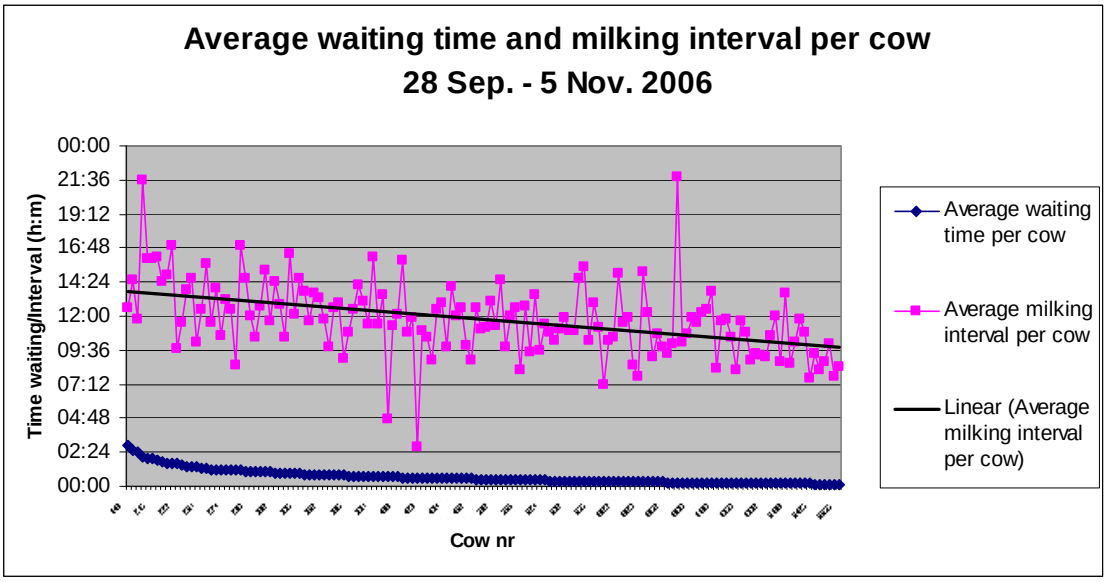


Figure 3. Average waiting time and milking interval per cow (before precedence passage).

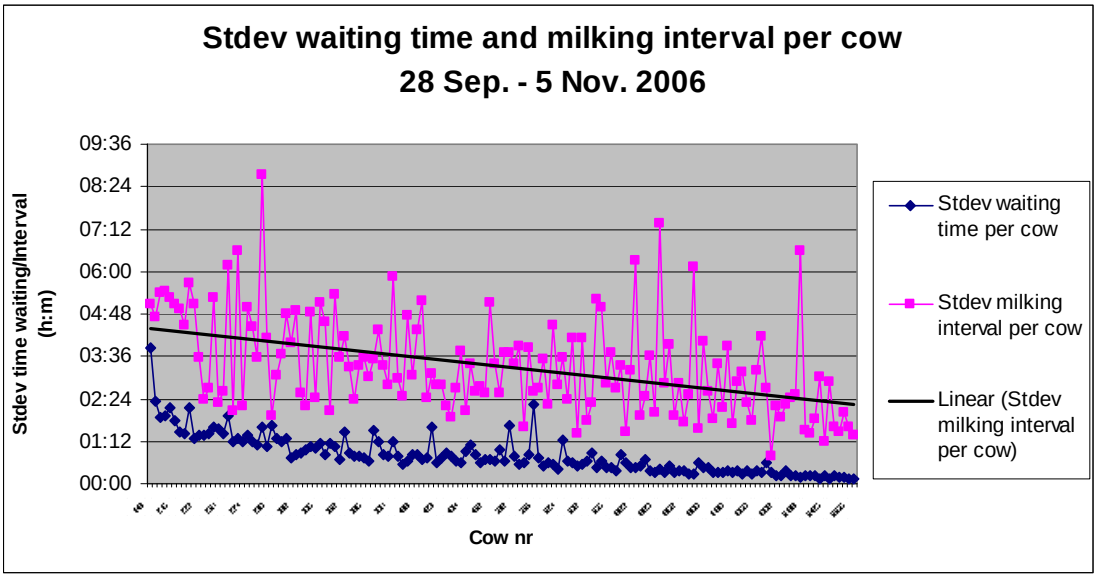


Figure 4. Standard deviation of the waiting time and milking interval per cow (before precedence passage).

Figure 3 and Figure 4 are sorted on average waiting time per cow. The cows with longest waiting time are to the left. The average milking interval is longer for cows with long waiting times. Generally cows with long waiting time also have a high standard deviation in waiting time.

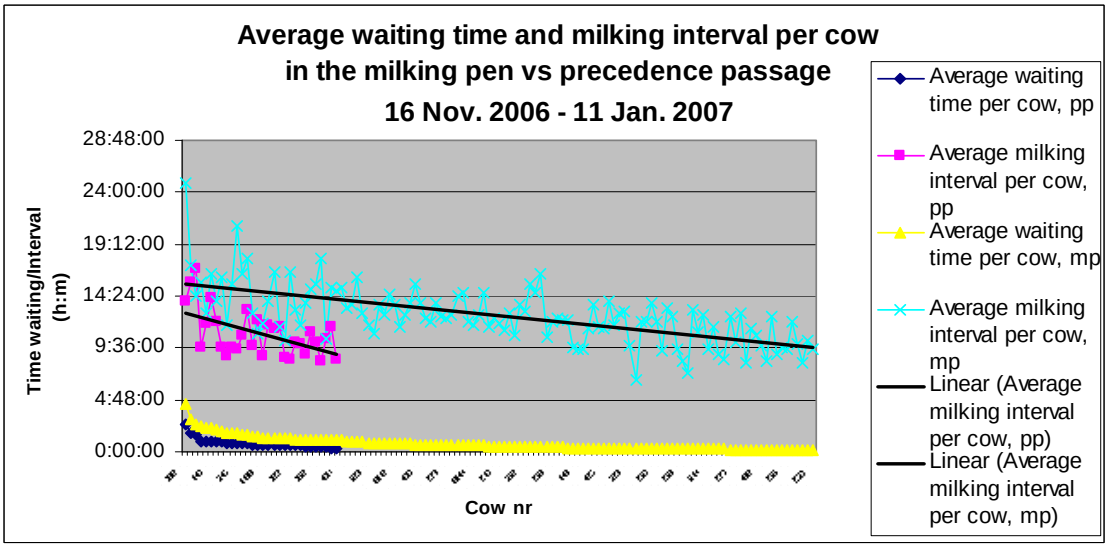


Figure 5. Average waiting time and milking interval per cow in the precedence passage and in the waiting area.

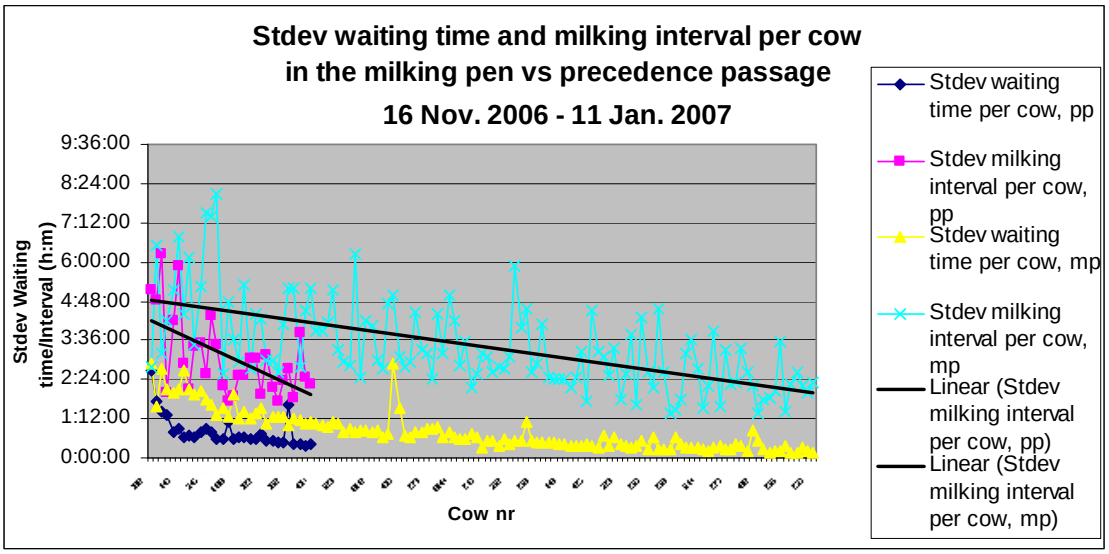


Figure 6. Standard deviation of waiting time and milking interval per cow in the precedence passage and in the waiting area.

Figure 5 and Figure 6 are sorted on average waiting time per cow. Cows with long waiting time also have a high standard deviation in waiting time, with some exceptions. The cows in the precedence passage have among the shortest waiting times before milking.

Table 4. Number of cows, waiting times before milking and milking intervals.

Time period	28 Sep. 2006 – 5 Nov. 2006	16 Nov. 2006 – 11 Jan. 2007	12 Jan. 2007 – 1 Feb. 2007	5 Feb. 2007 – 5 Mar. 2007	8 Mar. 2007 – 13 Mar. 2007	16 Mar. 2007 – 21 Mar. 2007	23 Mar. 2007 – 25 Apr. 2007
Days	39	57	21	28	6	6	34
Average number of cows	142	144	143	146	153	150	146
Waiting time gate 1 – ms1, average per cow (min)	34	37	25	23	22	25	25
Waiting time gate 1 – ms2, average per cow (min)	27	44	26	26	25	28	25
Waiting time gate 1 – ms1, stdev per cow (min)	27	34	25	21	25	46	23
Waiting time gate 1 – ms2, stdev per cow (min)	29	59	20	19	22	60	23
Milking intervals average (h:min)	11:05	11:25	10:46	11:20	12:20	11:41	11:47
Milking intervals stdev (h:min)	3:27	3:34	3:01	3:22	3:29	3:19	3:27
Milking intervals per cow average (h:min)	13:05	12:56	11:25	12:10	13:20	12:23	13:06
Milking intervals per cow stdev (h:min)	4:35	3:40	2:25	2:49	3:38	3:22	4:05

Longer waiting times on certain days?

There was a suspicion that the cows had particularly long waiting times on specific days because of some factor in the surrounding environment. Therefore the waiting times of some cows (the three cows with most observations) were plotted. The result was that the cows had long waiting times on totally different days, see Figure 7-Figure 9.

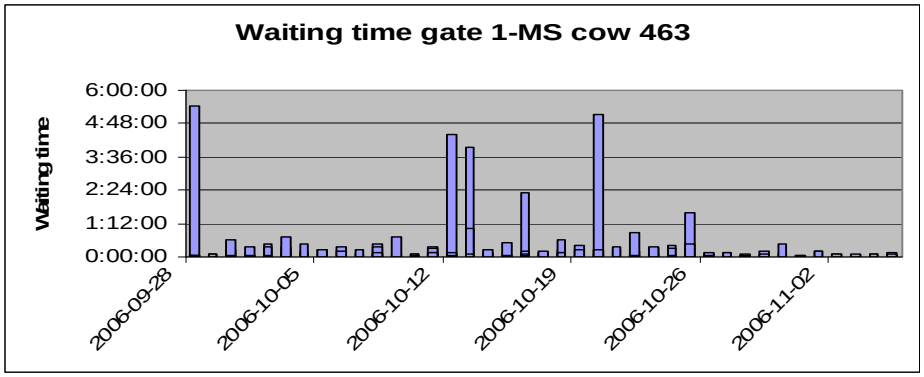


Figure 7. Waiting time cow 463.

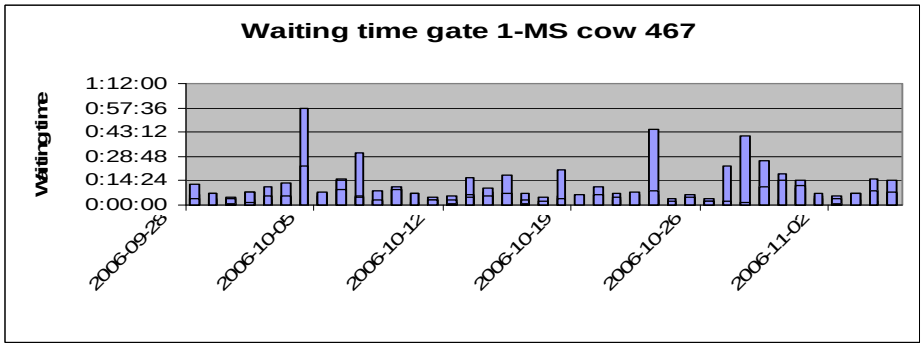


Figure 8. Waiting time cow 467.

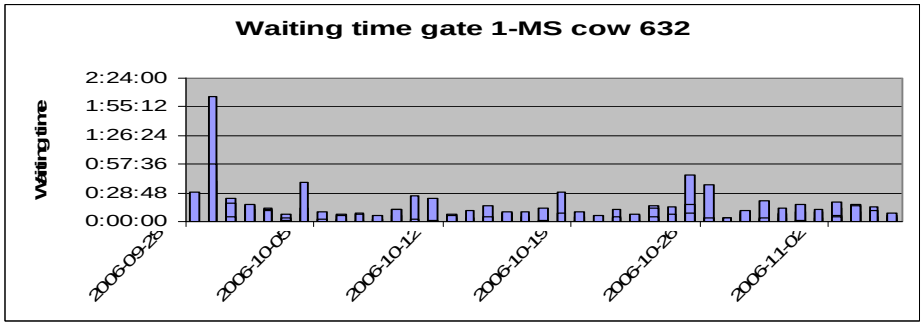


Figure 9. Waiting time cow 632.

Has the milking been affected by the precedence passage?

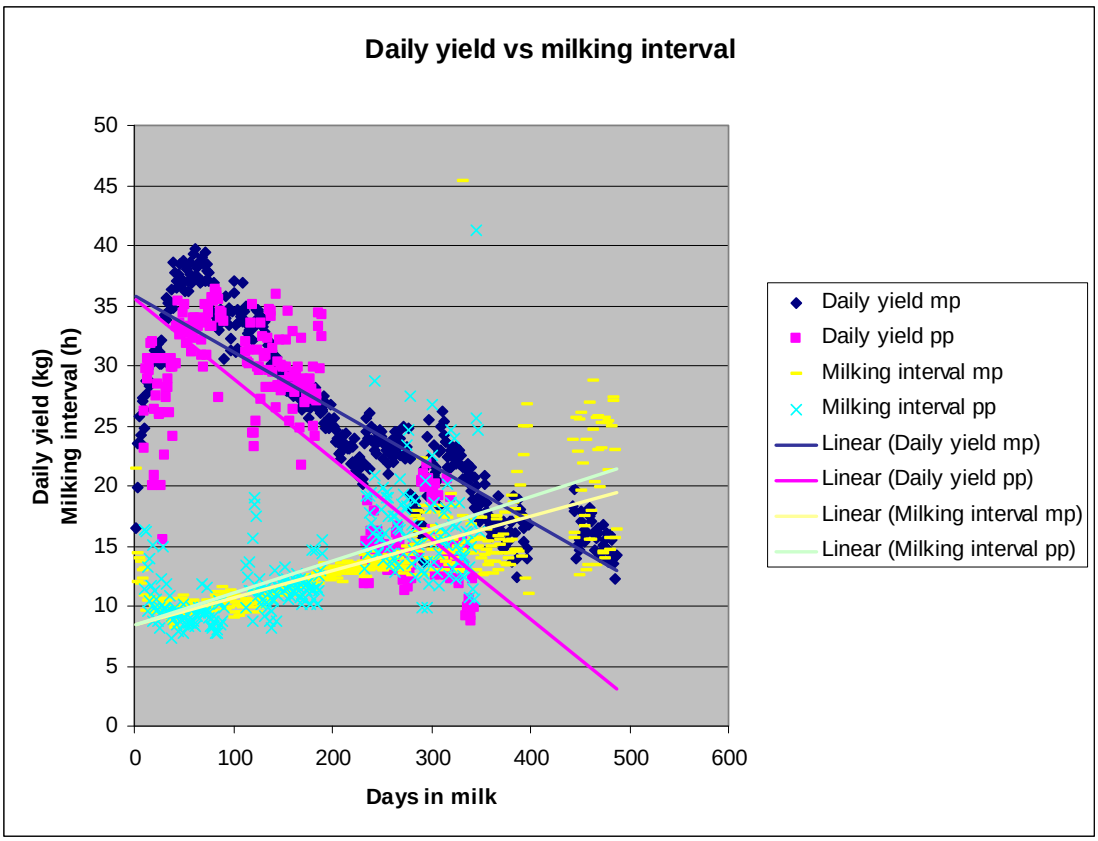


Figure 10. Daily yield vs milking interval for cows in the waiting area (mp) and the precedence passage (pp) based on 10 Mar. – 25 Apr. 2007. 080904

Cows that are in the precedence passage yield less and have longer milking intervals than the rest of the herd in the later part of the lactation, see Figure 10. However no long time effects can be seen from this limited material.

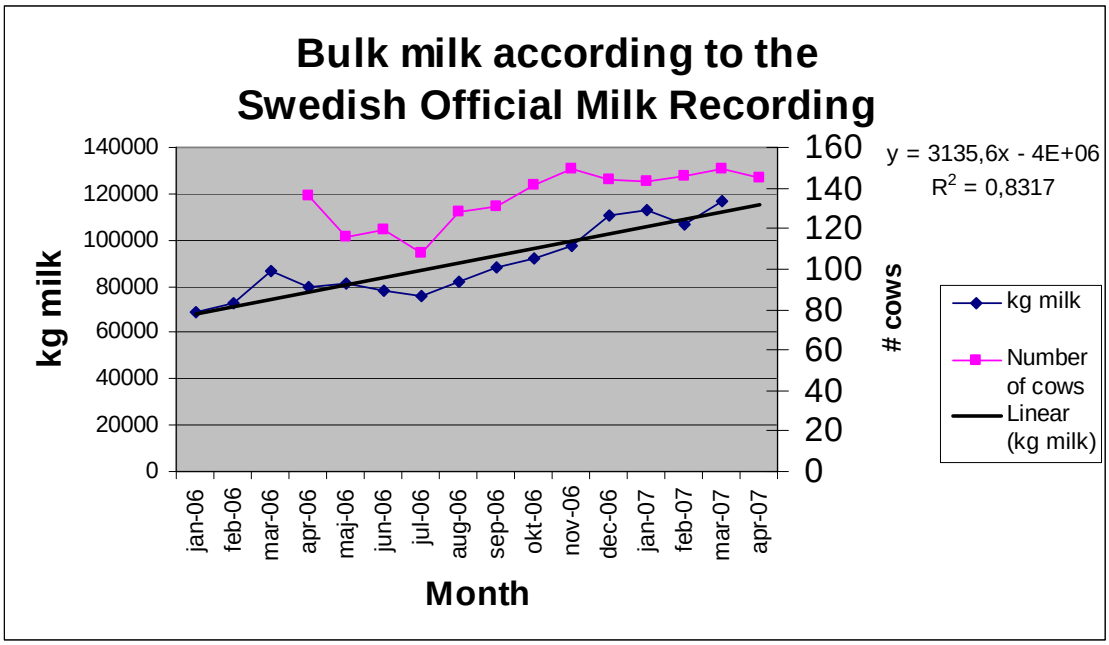


Figure 11. Amount of bulk milk at Farm A 2006-2007.

The amount of milk delivered from Farm A has increased a great deal during 2006. The increase is still going on (June 2007), but it is not increasing significantly more after the precedence passage was built than it was before. See Figure 11.

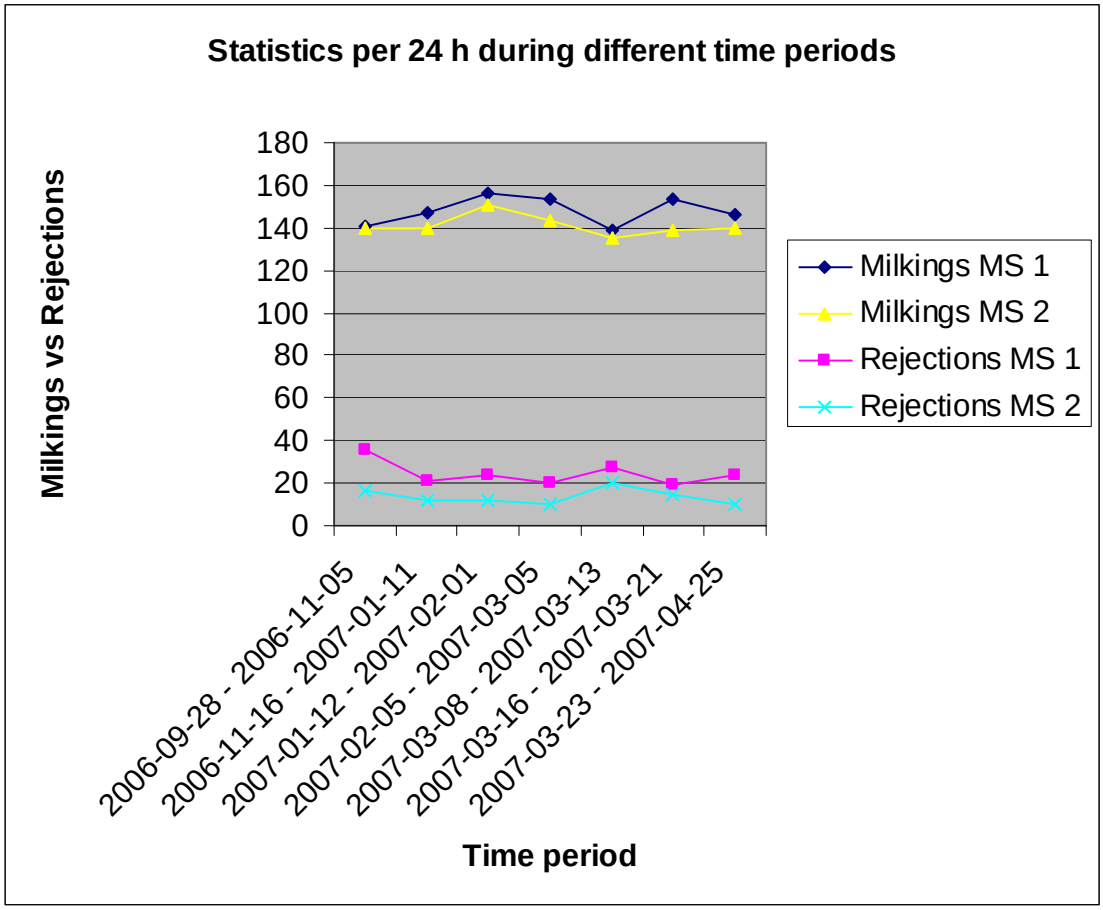


Figure 12. Number of milkings and rejections in MS 1 and MS 2 during the different time periods.

The average number of milkings per day increased after the precedence passage was built (6 Nov. 2006) but later decreased a little again. There is no easy explanation to this concerning number of cows in the herd or in the precedence passage.

The number of rejections in both milking stations was higher from 8 Mar. until 13 Mar. than before and after that time period. That might be because there were very many cow trains (for explanation, see p. 48) through gate 1 at that time and many cows not due for milking came to the milking stations, compare Figure 32 and Figure 33.

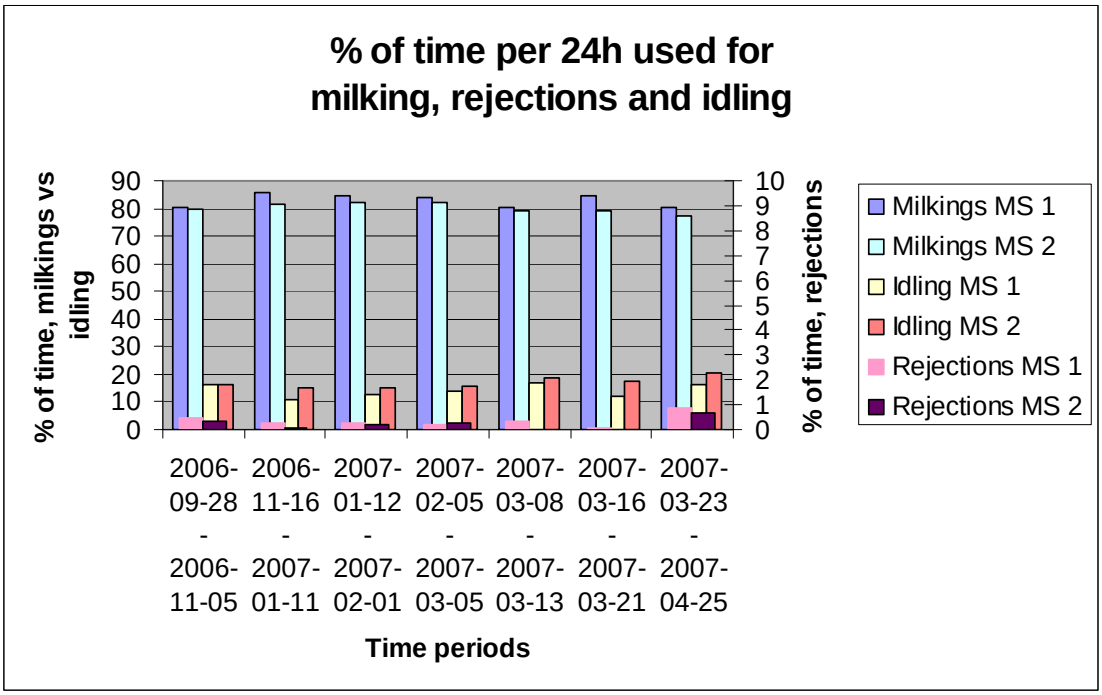


Figure 13. % of time spent on milking, idling and rejecting cows in MS1 and MS2 during the different time periods.

The number of milkings and rejections and also the time used for milking or rejecting cows is all this time higher in MS1 than in MS2. MS2 is idle more than MS1. One reason might be the bend of more than 90 degrees when entering MS2 from the waiting area. The entrance into MS1 is easier and not bent. Therefore cows might prefer being milked by MS1 when entering an MS from the waiting area. The time the cow spends on entering the milking station, before being identified, is idle time. Another reason might be that the cows are used to having competitors from the precedence passage when entering MS2.

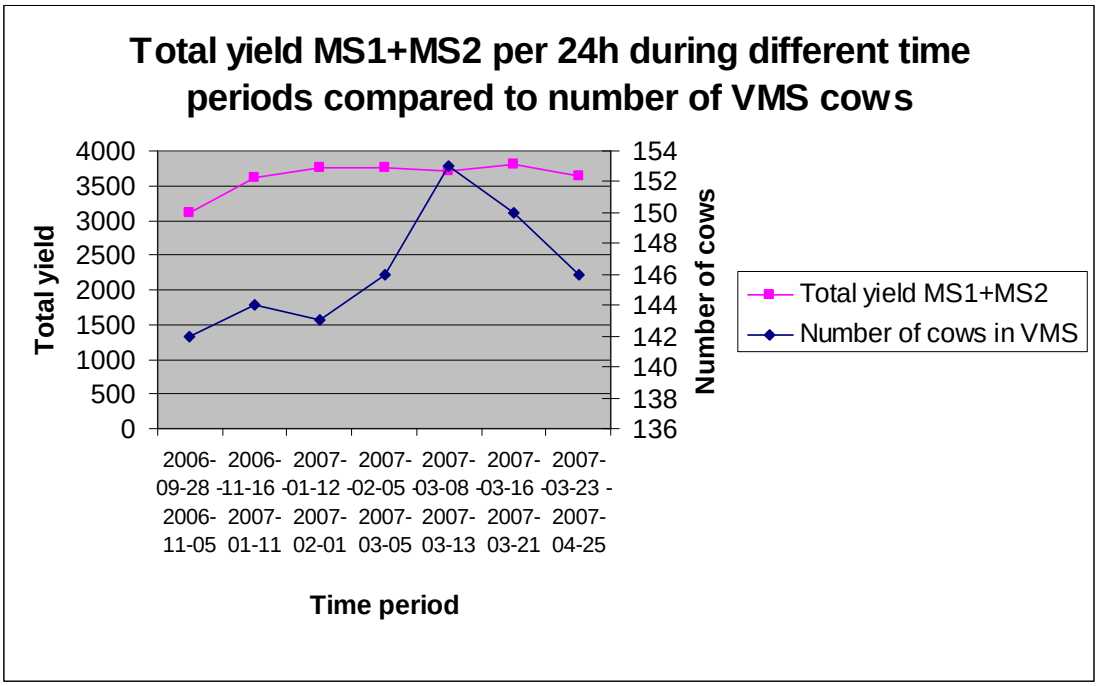


Figure 14. The total milk yield from both milking stations compared to the number of cows milking.

The total yield produced milk on the farm did not rise although there were more cows for some time, see Figure 14. The milking intervals were prolonged when more cows were in the system, see Figure 15. There were less milkings per cow and day when there were many cows in the system, see Figure 16.

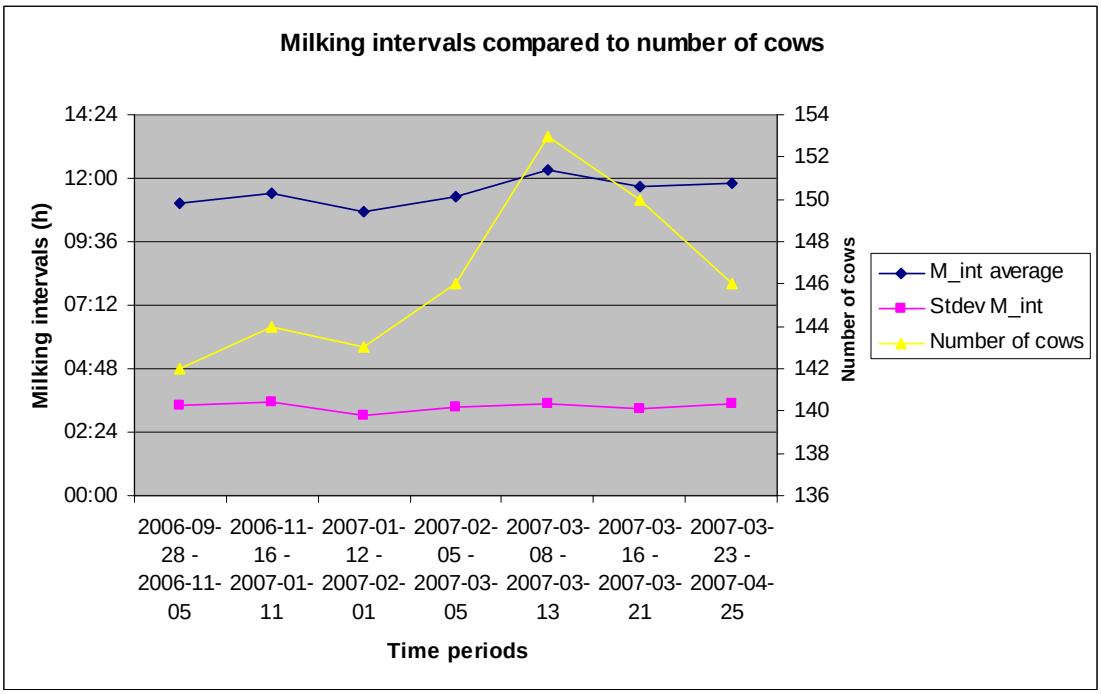


Figure 15. The average milking intervals and standard deviation of the milking intervals compared to the number of cows milking.

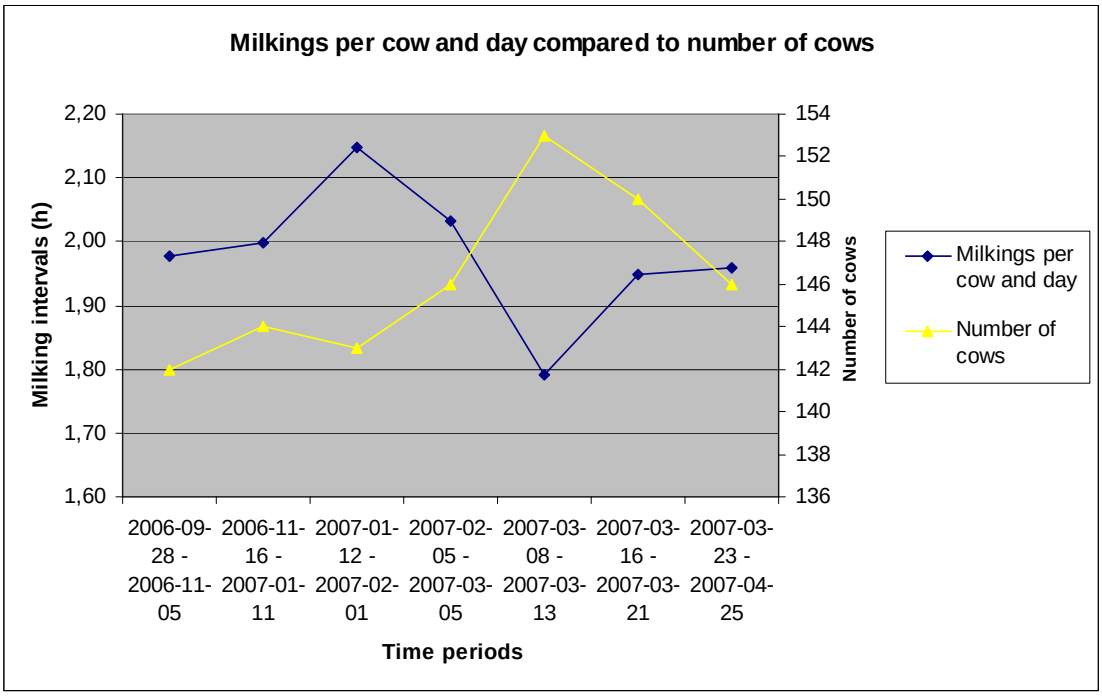


Figure 16. The number of milkings per cow and day compared to the number of cows milking.

The proportion of incomplete milkings is very high, see Figure 17 and Figure 18. The average of the day was 11% in MS 1 and 9 % in MS 2 before the precedence passage was built and 10 % in MS 1 and 12 % in MS 2 after the precedence passage was built. A high proportion of incomplete milkings makes the milking intervals more uneven for the cows concerned, since either they are milked again very soon or one quarter is not milked in a long time. Uneven milking intervals influence the cell count negatively. The recommended maximum limit for incomplete milkings is 3%. (Gustafsson & Pettersson, 2008).

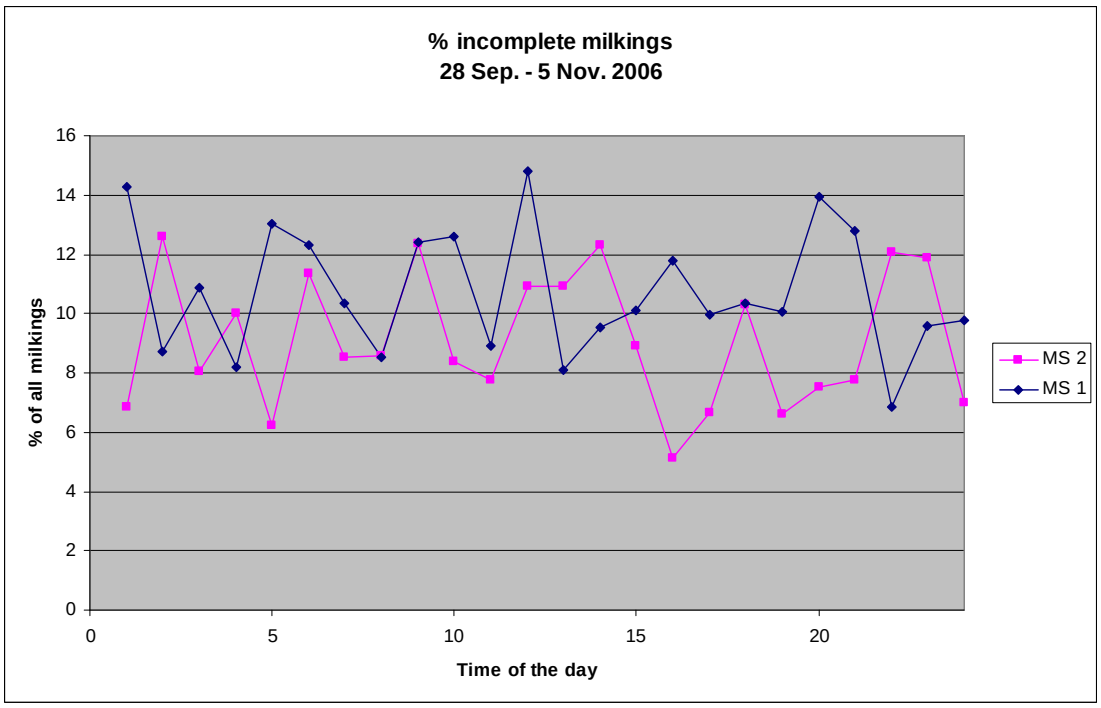


Figure 17. % incomplete milkings of all milkings before the precedence passage was built.

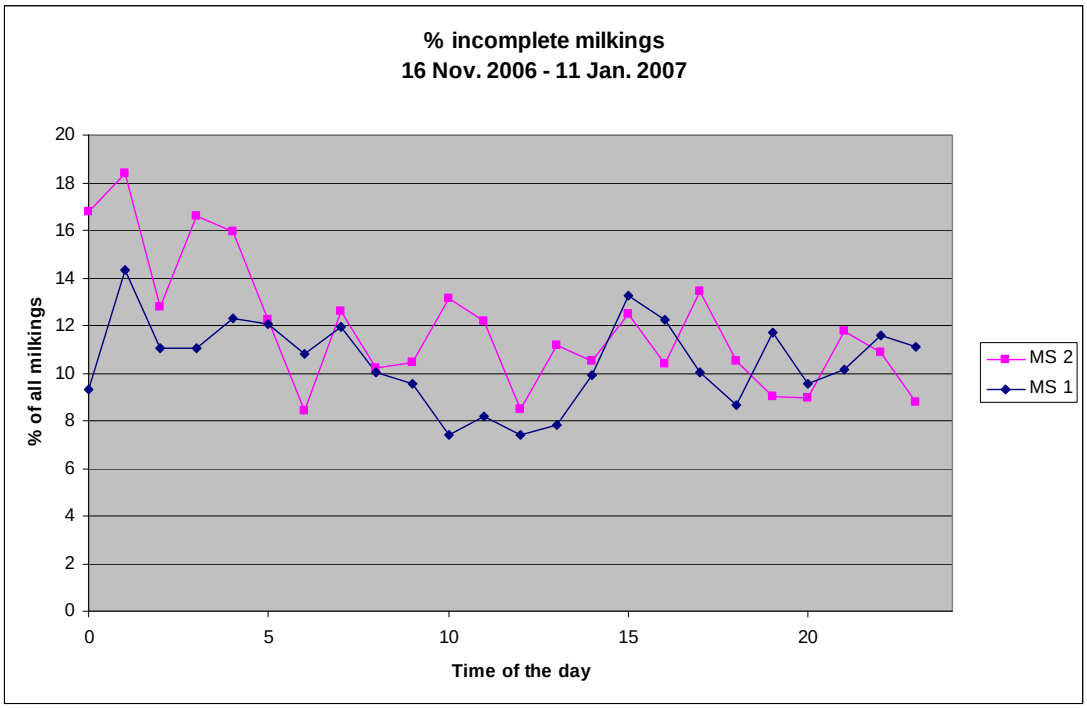


Figure 18. % incomplete milkings of all milkings after the precedence passage was built.

Table 5. Different factors compared between the time periods.

Time period	28 Sep. 2006 – 5 Nov. 2006	16 Nov. 2006 – 11 Jan. 2007	12 Jan. 2007 – 1 Feb. 2007	5 Feb. 2007 – 5 Mar. 2007	8 Mar. 2007 – 13 Mar. 2007	16 Mar. 2007 – 21 Mar. 2007	23 Mar. 2007 – 25 Apr. 2007
Days	39	57	21	28	6	6	34
Average number of cows	142	144	143	146	153	150	146
Rejected cows per day, ms1	35	20	23	20	27	19	22
Rejected cows per day, ms2	16	12	11	10	20	14	10
Rejected cows per day, total	51	32	35	30	47	33	32
Time portal ID – gate 1 (min)					100	100	97
Stdev time portal ID-gate 1 (min)					43	45	33
Time gate 2 – gate 1 (min)	52	52	59	55	35	40	41
Stdev time gate 2 – gate 1 (min)	46	43	49	53	30	29	23
Time gate 1 – portal ID					306	281	270
Stdev time gate 1 – portal ID					123	97	73
			00:15				00:29

			1.09				2.51
			1.19				0.80

The time from registration in the portal ID´s (blue curtains) until registration in gate 1gives a hint about how long the cow is in the feeding area, i.e. eats or stands by the feeding table, before milking. The time from registration in gate 2 until registration in gate 1 shows how long she is in the feeding area after visiting the milking station. The time from registration in gate 1 until registration in the portal ID´s tells how long the cow was in the resting area before she went to the feeding area again.

Cow first in line until milking

It was found that the waiting time in the precedence passage was very much depending on the number of cows waiting there, since it is very difficult for the cows to pass each other, which is intentionally. When a cow is in line for milking she will have to wait until the cows in front of her are ready in the milking station. The time from a cow was first in line in the precedence passage and had a possibility to walk into the MS until she started to be milked was investigated. The longer time a cow first in line in the precedence passage waited before she entered the milking station to be milked, the more cows from the waiting area were milked in between in the same milking station, see Figure 19. The waiting time was slightly correlated with the number of days since last calving, DIM (days in milk), see Figure 20. A negative correlation with the production yield of the cows was also found, see Figure 21. This means that cows with a low production wait longer than cows with a high production.

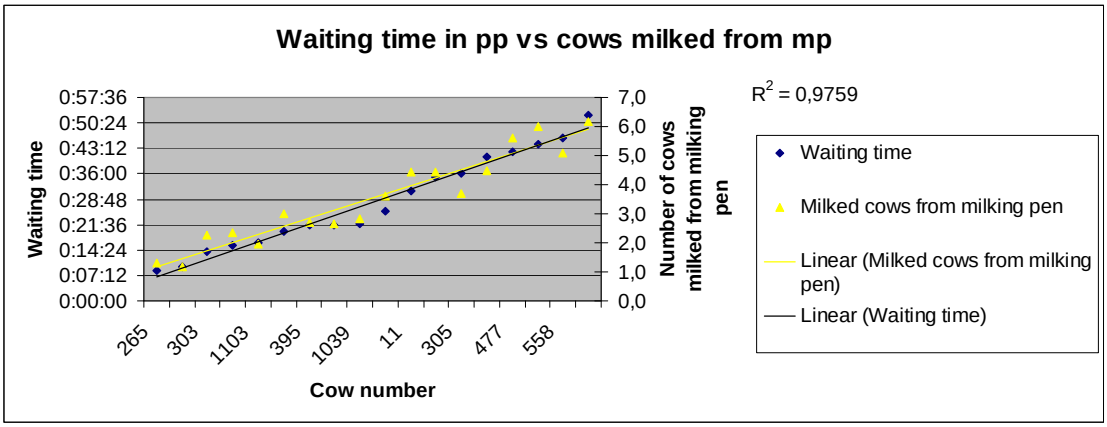


Figure 19. The longer time a cow in the precedence passage waited before she entered the MS to be milked, the more cows from the waiting area were milked inbetween in the same MS.

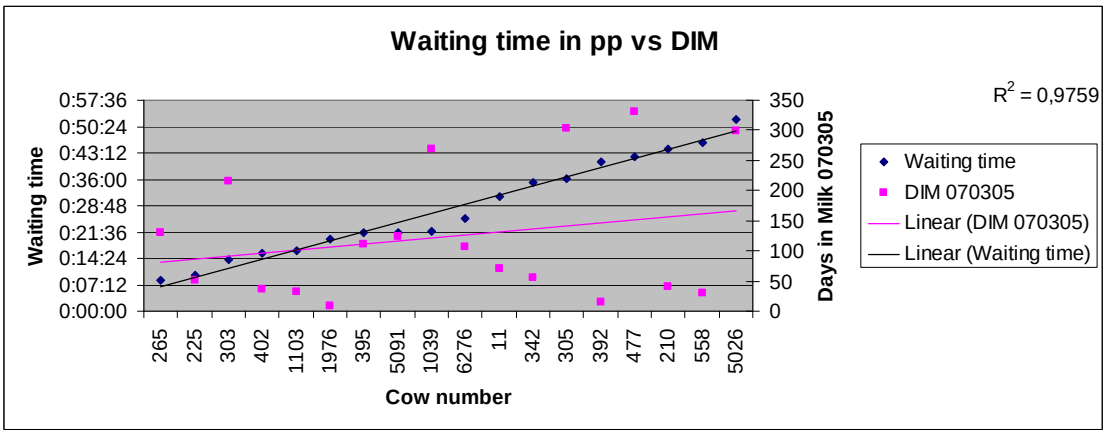


Figure 20. The longer since the cow calved, the longer waiting time when she is first in line in the precedence passage.

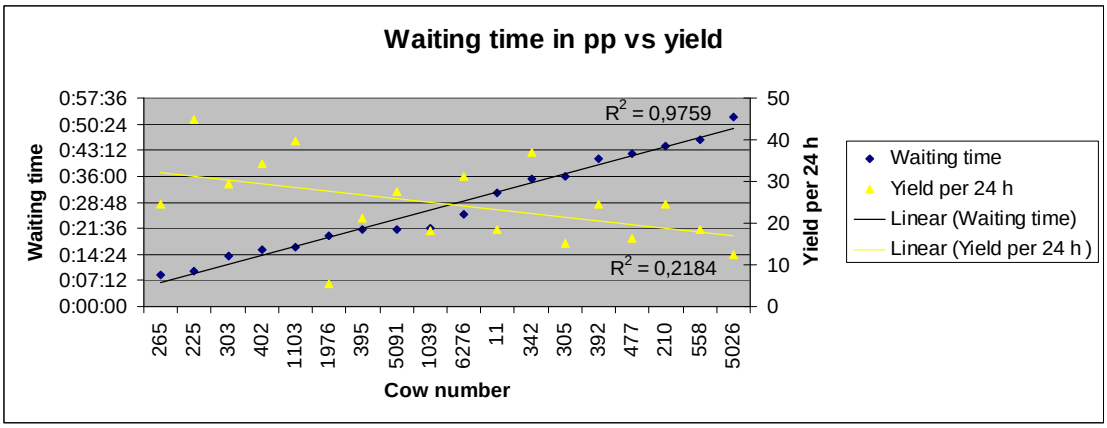


Figure 21. The waiting time from a cow is first in line in the precedence passage until she is being milked is negatively correlated with the cow´s yield per 24 h. This figure is based on 5 Feb. – 5 Mar. 2007.

Results of the reduced number of cows in the precedence passage

The time a cow was first in line in the precedence passage before she entered the milking station was on average between cows 15 minutes when there were approximately 25 cows picked out to the precedence passage and 29 minutes when 12 cows had been picked out to the precedence passage according to the criteria tested, see Table 6. The number of cows that entered the milking station from the waiting area during this time was on average 1.09 versus 2.51. However the time it took before entering the milking station and the number of cows that passed in between varied a lot between individual cows in the precedence passage, see Figure 22 and Figure 23.

The number of cows in the precedence passage was registered each time a cow entered milking station 2 from either the precedence passage or the waiting area. The number of times there was a certain number of cows in the precedence passage can be seen in Table 6.

Table 6. Comparison of many versus few cows in the precedence passage.

	12 Jan. 2007 – 1 Feb. 2007	23 Mar. 2007 – 25 Apr. 2007
Number of cows picked for pp	25	12
Time from first in line in pp – id in ms2	00:15	00:29
Average number of cows from mp that passed while cow was first in line in pp	1.09	2.51
Average cows in pp during 24 h	1.19	0.80
There were __ cows in the pp in	__% of all times…	__% of all times…
0	38	56
1	30	23
2	16	11
3	9	7
4	4	2
5	2	1
6	1	0
More than 6	0	0

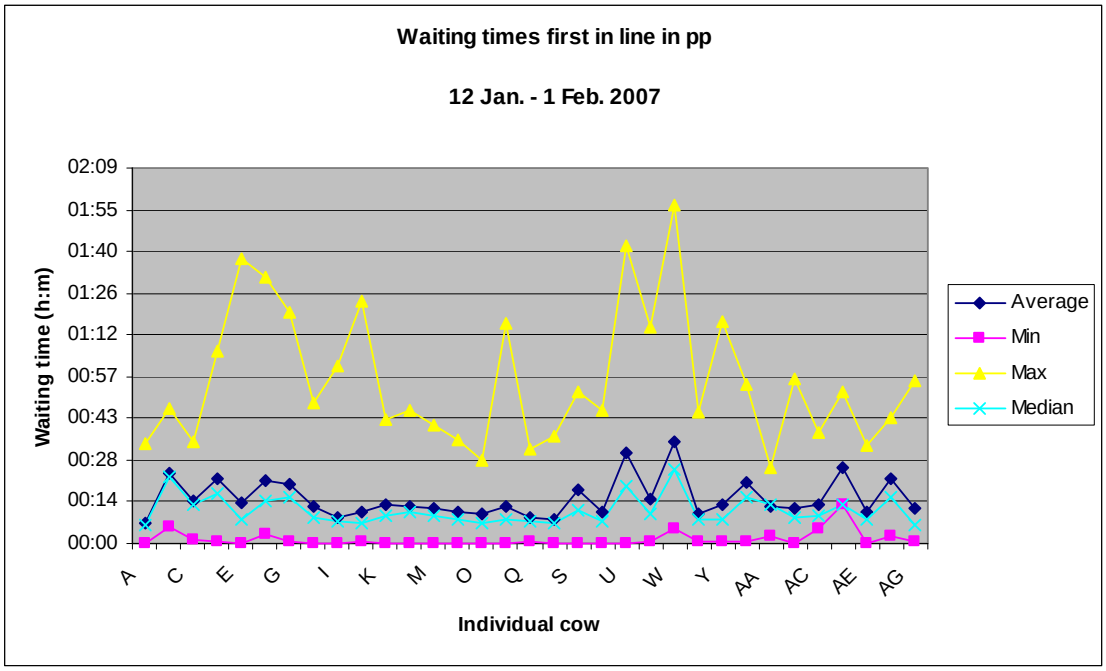


Figure 23. The time a cow is standing first in line in the precedence passage until she enters the MS varies a lot between individual cows.

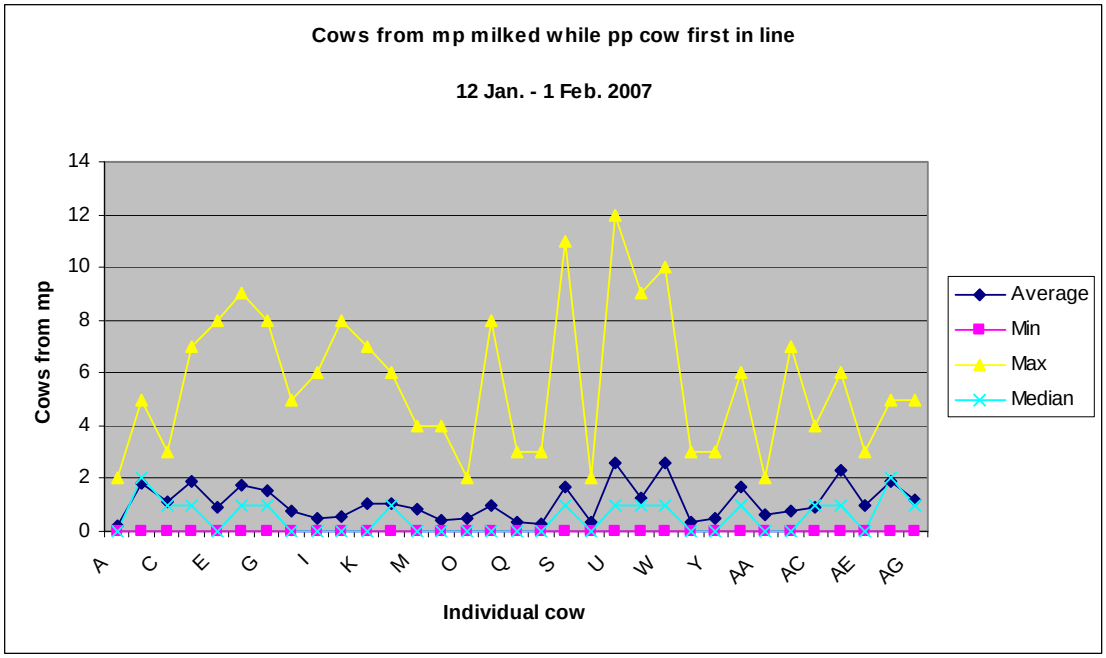


Figure 24. The number of cows entering the MS from the waiting area while another cow is standing first in line in the precedence passage varies a lot between individual cows. If there would have been a piston maneuvering the push gate the cows from the precedence passage would not have had to wait. The waiting time first in line in the precedence passage is thus very much depending on the range of the cow.

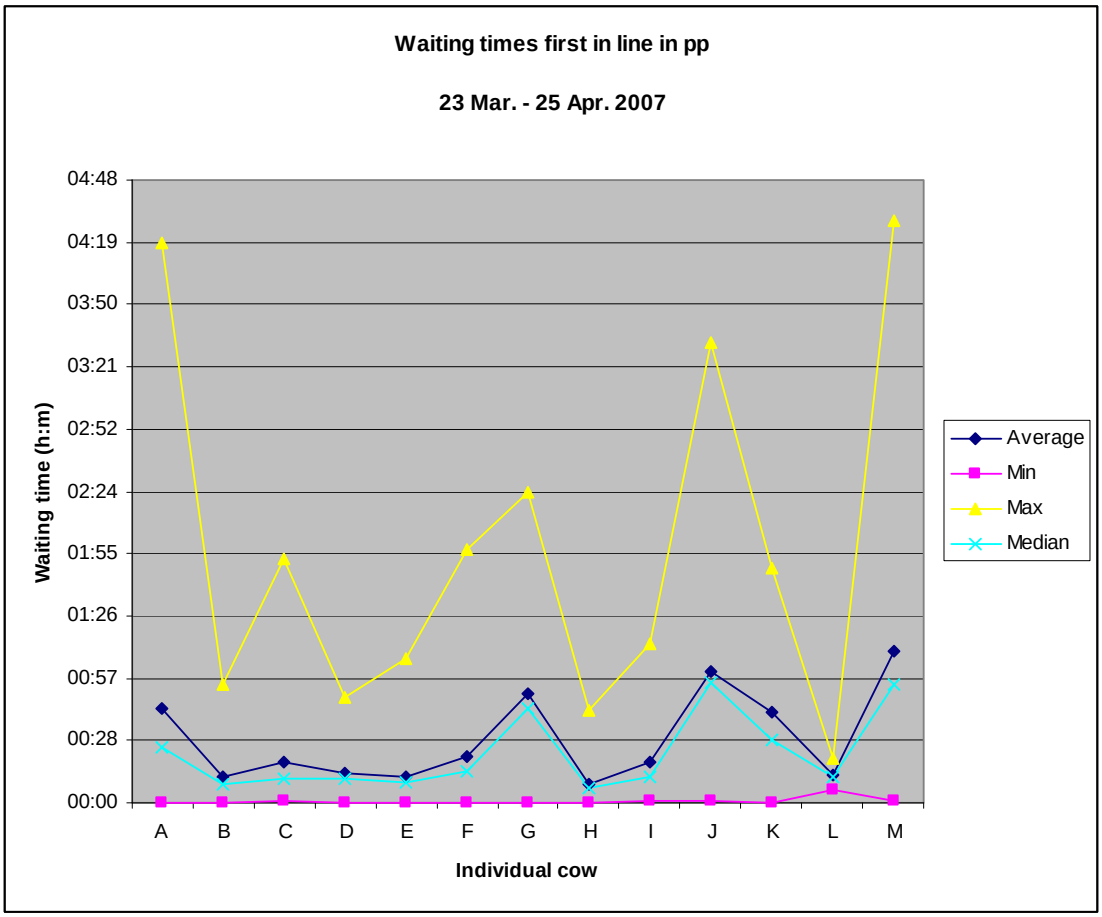


Figure 22. Waiting times for cows first in line in the precedence passage.

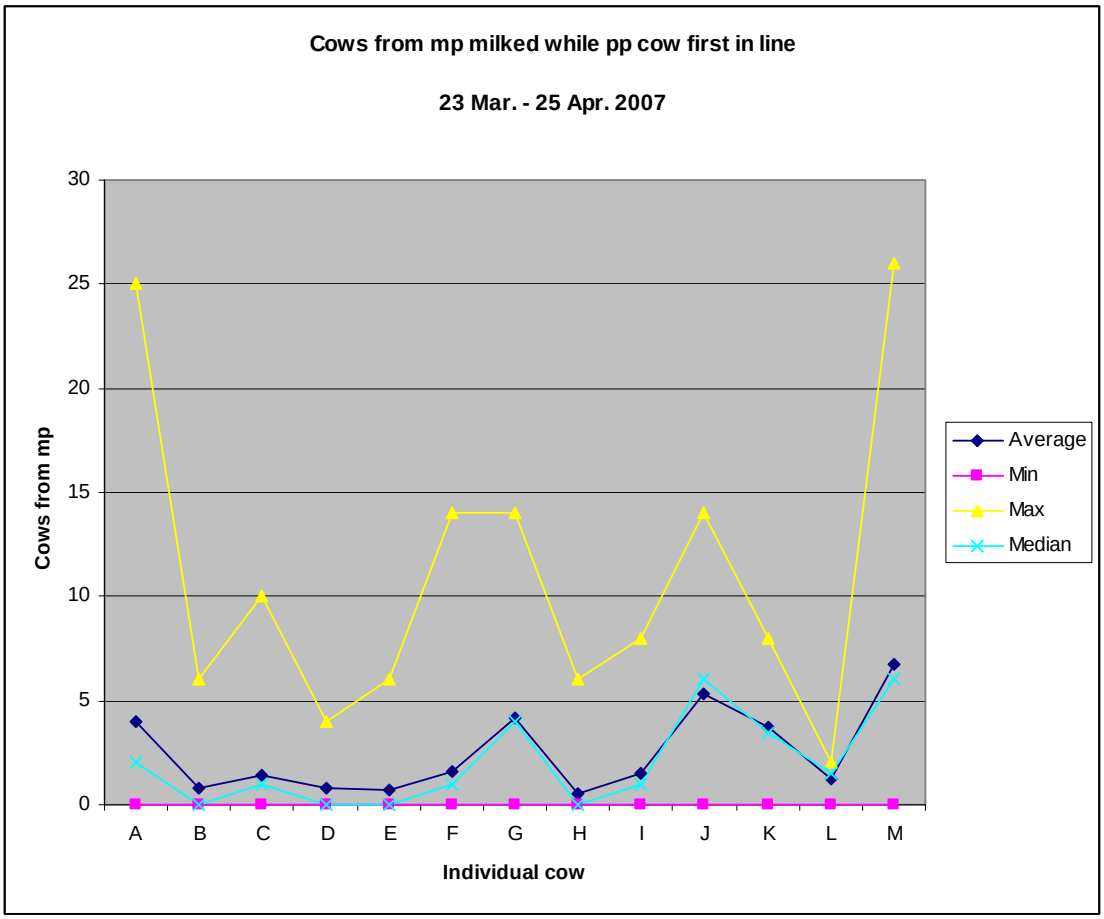


Figure 23. Number of cows from waiting area milked while a cow was first in line in the precedence passage.

Number of milkings at different hours of the day

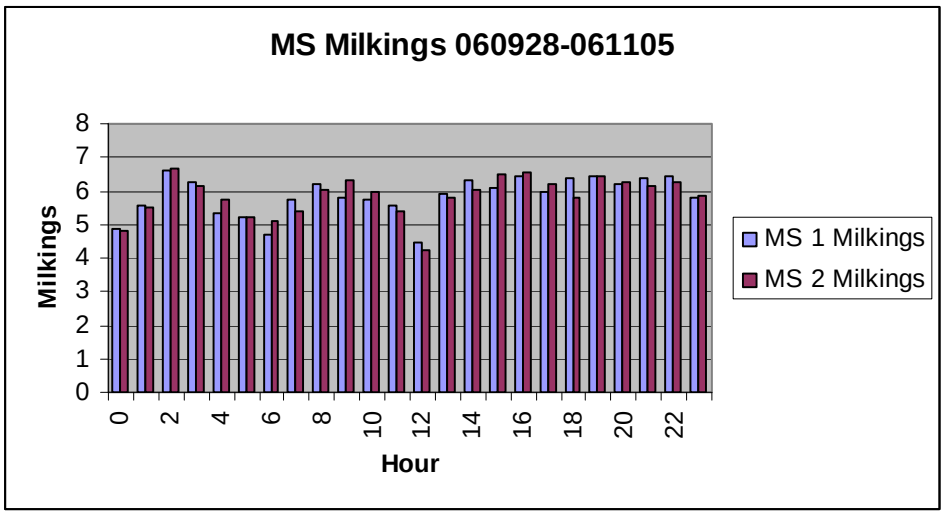


Figure 24. MS milkings each hour of the day 28 Sep. – 5 Nov. 2006.

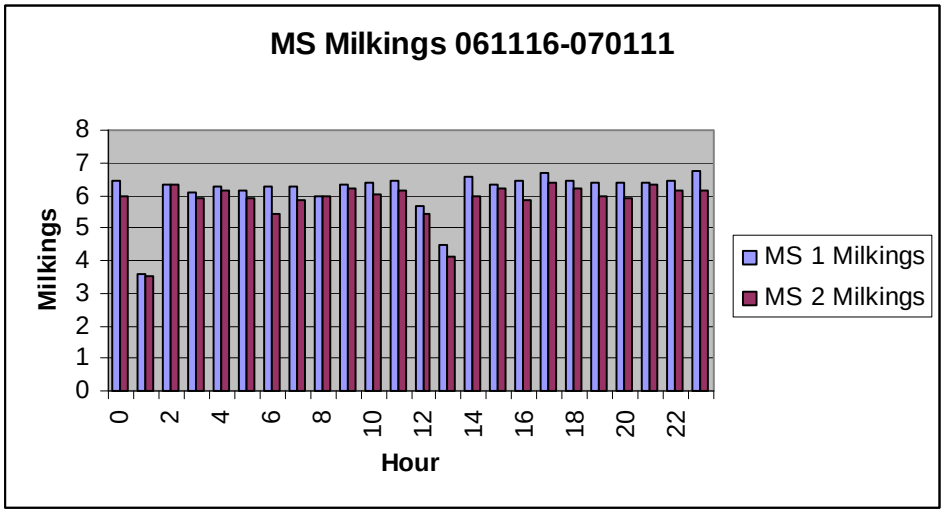


Figure 25. MS milkings each hour of the day 16 Nov. 2006 – 11 Jan. 2007.

The times for system cleaning in both MS:s were 00.00 and 12.00. The main cleaning takes 23 minutes. The number of milkings in MS1are more than in MS2 after the precedence passage was built.

Although the average number of gate passages per day was highest during the period before the precedence passage was built, the number of milkings was lowest during that period. The reason might be the big change in number of cows during the period before 6 Nov., the least they were 127 cows and the most they were 156 cows.

Has the health of the cows been affected by the precedence passage?

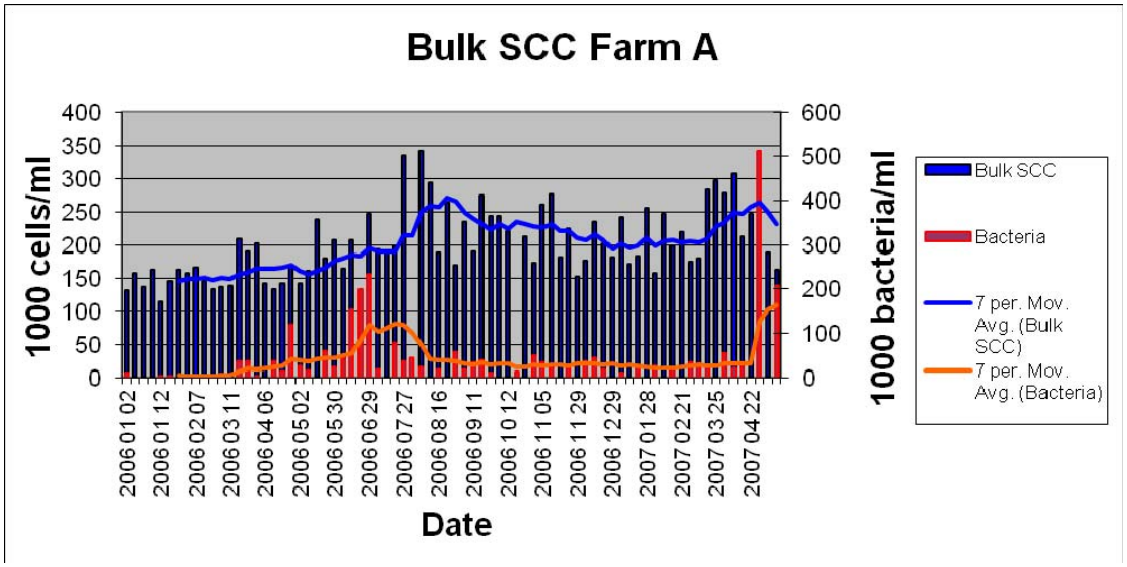


Figure 26. Bulk somatic cell count at Farm A. The precedence passage was built on 6 Nov. 2006.

The somatic cell counts in the bulk milk at Farm A have varied during 2006. It was high some months before the precedence passage was built and has not reached the same low level as before since May 2006. A statistical T-test of the Bulk SCC shows that the cell counts are significantly higher after the precedence

passage was built (P<0,05). However the increase started before the precedence passage was built. A statistical T-test of the bacteria count shows that it has not changed significantly after the rebuilding (P=0,34). See Figure 26.

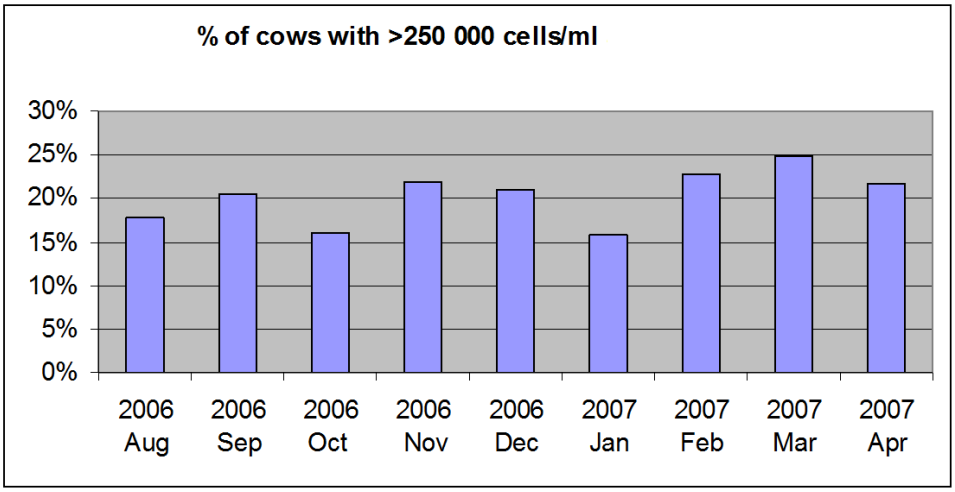


Figure 27. Percentage of cows with more than 250 000 cells per ml.

The somatic cell count was highly variable between and within individual cows. Before the precedence passage was built, the average % of cows with a cell count of more than 250 000 cells/ml was 18%. After the rebuilding the average % was 21%. See Figure 27.

The udder health of the cows has slowly decreased during a long time and did not stop decreasing when the precedence passage was built, see Figure 28 and Table 7. Udder health class of the cows at Farm A. % of all cows. Udder health class is an estimate of how big the risk is that the cow has an infection in the udder. The probability that the udder is infected is 0-9% for udder health class 1 and 90-100% for udder health class >9. (Hallén-Sandgren, 1997). There is a strong negative correlation (-0.81) between % of cows with UHC 0-2 vs UHC 6-9. This shows that the udder health of the cows is slowly degrading, but this trend had started long before the precedence passage was built in November 2006.

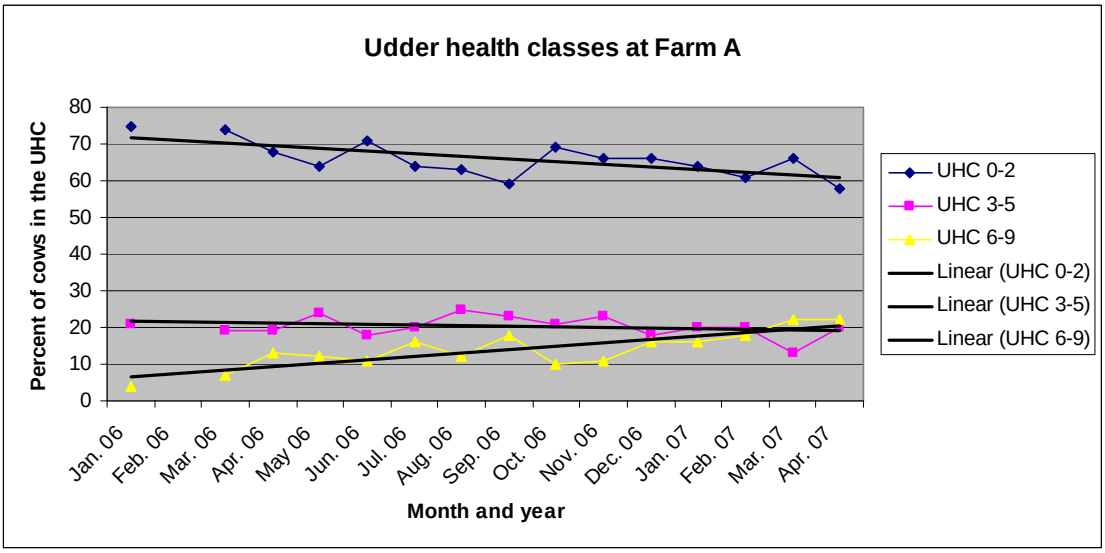


Figure 28. Udder health classes at Farm A Jan 2006 until Apr 2007.

Table 7. Udder health class of the cows at Farm A. % of all cows.

Udder health class	Jan -06	Feb -06	Mar -06	Apr -06	May -06	Jun -06	Jul- 06	Aug -06	Sep -06	Oct -06	Nov -06	Dec -06	Jan -07	Feb -07	Mar -07	Apr -07
0 to 2	75		74	68	64	71	64	63	59	69	66	66	64	61	66	58
3 to 5	21		19	19	24	18	20	25	23	21	23	18	20	20	13	20
6 to 9	4		7	13	12	11	16	12	18	10	11	16	16	18	22	22

Table 8. Number of cows with different diseases.

	Jan-06	Feb-06	Mar -06	Apr -06	May -06	Jun-06	Jul-06	Aug -06	Sep-06	Oct-06	Nov -06	Dec -06	Jan-07	Feb-07	Mar -07	Apr -07
Mastitis	1	2	1	0	1	0	1	2	3	5	2	8	7	8	4	3
Total ill cows	1	3	5	1	4	1	4	7	6	6	3	9	11	12	4	5

There were no cows with Acetonemia during 2006 and until April 2007. The number of cows with other diseases is shown in Table 8.

Cow traffic

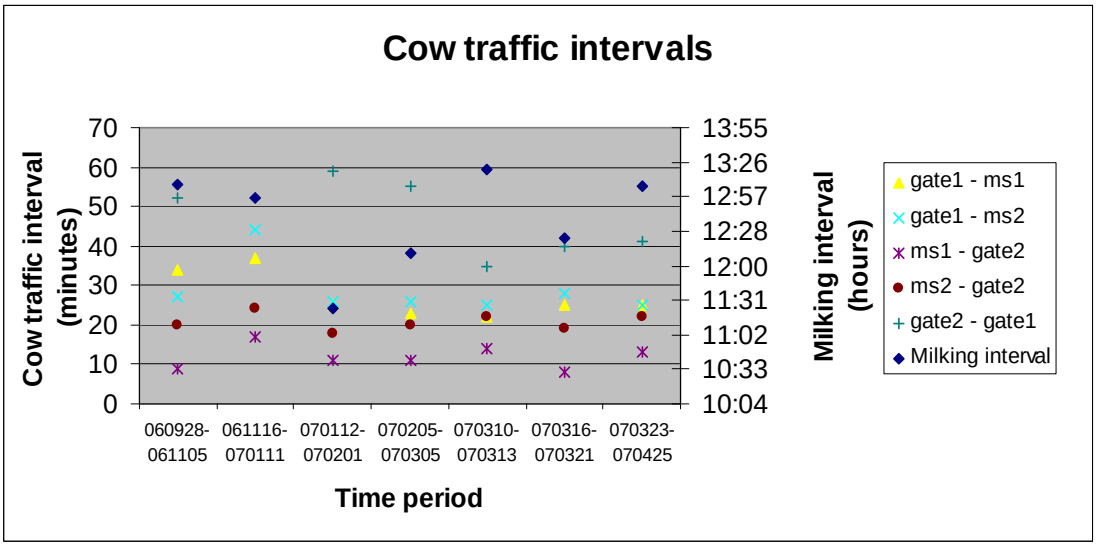


Figure 29. Average intervals between different cow traffic actions and milking intervals for all cows at Farm A during the time periods compared.

The time it took to leave the waiting area

Times to get from ms1 vs ms 2 to gate 2 were studied and compared. The times and the standard variations varied. (Excelfil m diagram finns Tider ms-g2)

Table 9. The time it took the cows to go from the milking stations to gate 2.

Time period	28 Sep. 2006 – 5 Nov. 2006	16 Nov. 2006 – 11 Jan. 2007	12 Jan. 2007 – 1 Feb. 2007	5 Feb. 2007 – 5 Mar. 2007	8 Mar. 2007 – 13 Mar. 2007	16 Mar. 2007 – 21 Mar. 2007	23 Mar. 2007 – 25 Apr. 2007

Days	39	57	21	28	6	6	34
Average number of cows	142	144	143	146	153	150	146
Time ms1 – gate 2, average per cow (min)	9	17	11	11	14	8	13
Time ms2 – gate 2, average per cow (min)	19	24	18	20	22	19	22
Time ms1-gate 2, stdev	13	21	13	12	32	13	12
Time ms2-gate 2, stdev	19	21	14	18	31	18	19

GATES AND GATE PROBLEMS

Gate passages per day

The number of gate passages in gate 1 varies more than in gate 2. This is normal, since the cows walk through gate 1 before milking and resting but through gate 2 only after milking. If the flow of cows increases, it ought to influence gate 1 more than gate 2.

The number of erroneous registrations has no correlation to the number of gate passages.

Table 10. Gate passages.

Time period	28 Sep. 2006 – 5 Nov. 2006	16 Nov. 2006 – 11 Jan. 2007	12 Jan. 2007 – 1 Feb. 2007	5 Feb. 2007 – 5 Mar. 2007	8 Mar. 2007 – 13 Mar. 2007	16 Mar. 2007 – 21 Mar. 2007	23 Mar. 2007 – 25 Apr. 2007
Days	39	57	21	28	6	6	34
Average number of cows	142	144	143	146	153	150	146
Gate passages per day and cow, gate 1	5.9	5.4	5.8	5.2	4.9	5.7	5.7
Gate passages per day and cow, gate 2	2.6	2.5	2.5	2.4	2.2	2.3	2.4
Total gate passages per day gate 1	833	781	834	763	757	857	833
Total gate passages per day gate 2	370	365	359	353	330	350	350
(SysAreaGUID:0) in gate 1, % of all gate passages	21	16	14	14	4	3	5

Gate 1 - errors

There were very many registrations of SysAreaGUID (=error registrations) in the files from selection gate 1, about 13% of all gate registrations in February. This indicates that something is wrong, probably the sensor checking that cows have passed through the gate is dirty or skewed so that some cows cannot be recognized having passed the gate. This results in an unsure gate observation. The sensor that registers which cows have walked through the gate was cleaned and its position was corrected on 2 Mar. 2007.

Gate 1 – cow trains

After talking to the employee on the farm I got suspicious about the number of cow trains in selection gate 1. A cow train is when a cow follows another cow and comes to the same area as she. The reason of a cow train is that the gate closes too early, so the cow allowed to walk through the gate gets squeezed over her hips and the gate has to open again. Another cow can follow. Sometimes this second cow is lead to the correct area, sometimes to the wrong area, always to the same area as the cow she is following. The first cow might become scared of passing the gate and therefore might not come there as often as she should in the future.
Cow trains might make cows unwilling to pass gates and influence the cow traffic negatively. The cows might get longer milking intervals and also longer feeding intervals. The MS has to handle more cows without milking permission, since they have come to the waiting area in cow trains. In addition, the wearing of the gate is increased.

At Farm A in gate 1 there were about 46 cow trains every day. After talking to gate expert Fredrik Ruda, some decisions were made about how to change the gate settings. On 14 Mar. 2007 the gates got some new settings. For gate 1 the time from when the gate opens until it closes again was changed from 2.5 to 3.5 seconds. For gate 2 the time from when the gate opens until it closes again was changed from 2 to 3.5 seconds. The cylinders are changed so that it should take maximum 2 seconds instead of 2.5 seconds to close a gate once it has started closing.

Gate 2 – not milked cows blocking the gate

A rather serious problem appears when cows on their way from the waiting area to the feeding area are not able to pass gate 2, since some other cow is blocking the way. This happens often and on some occasions the waiting area has got overfilled with cows already milked. The cows blocking gate 2 are not milked but probably eager to go to the feeding area, so they walk to gate 2 and stay there, in the way for other cows. They don´t do this on any special time such as when feed arrives on the feeding table, but the blocking occasions are widely spread over the whole 24 h. See Figure 30. Times and durations of cows blocking gate 2 before being milked are evenly spread over the whole 24 h. Some cows block the gate more than others and the worst ones seem to be cows with very low feed ration or no feed at all in the milking stations, see Figure 31. Number of times and feed rations of cows blocking gate 2 before being milked are slightly negatively correlated. The cows blocking the gate most are those with very low concentrate feed rations. When a cow is standing in the photocell area of a gate for more than 5 minutes the duration is timed out and therefore no durations of more than 5 minutes have been registered.

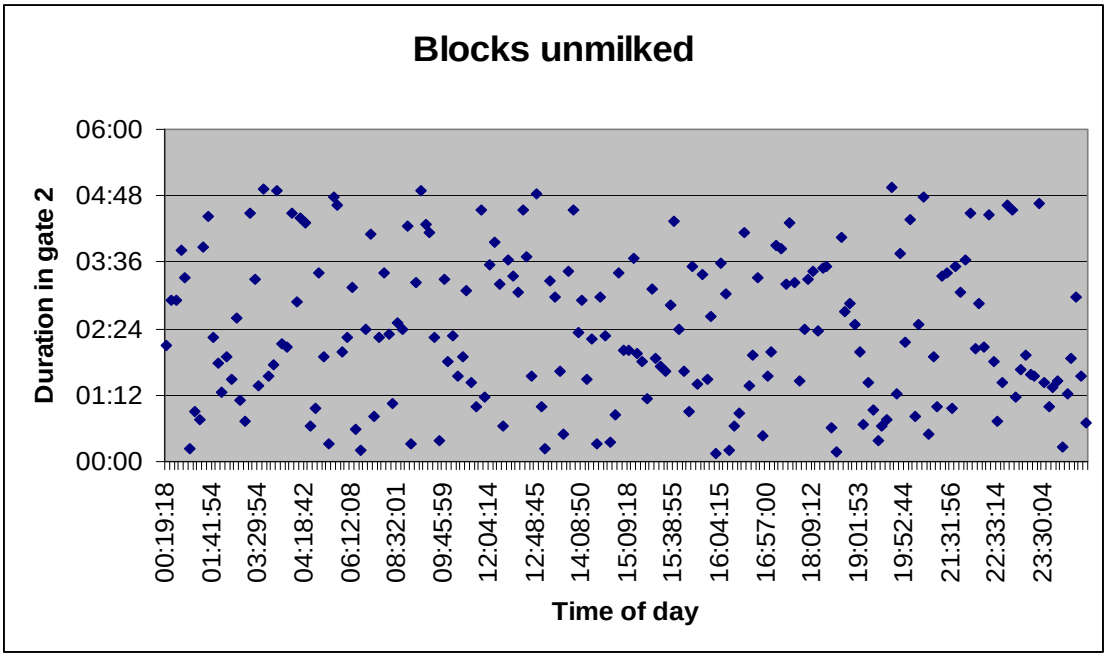


Figure 30. Times and durations of cows blocking gate 2 before being milked are evenly spread over the whole 24 h. Duration photo cell 1 – photo cell 2 in gate 2 (minutes). Based on 1 Apr. – 9 Apr. 2007.

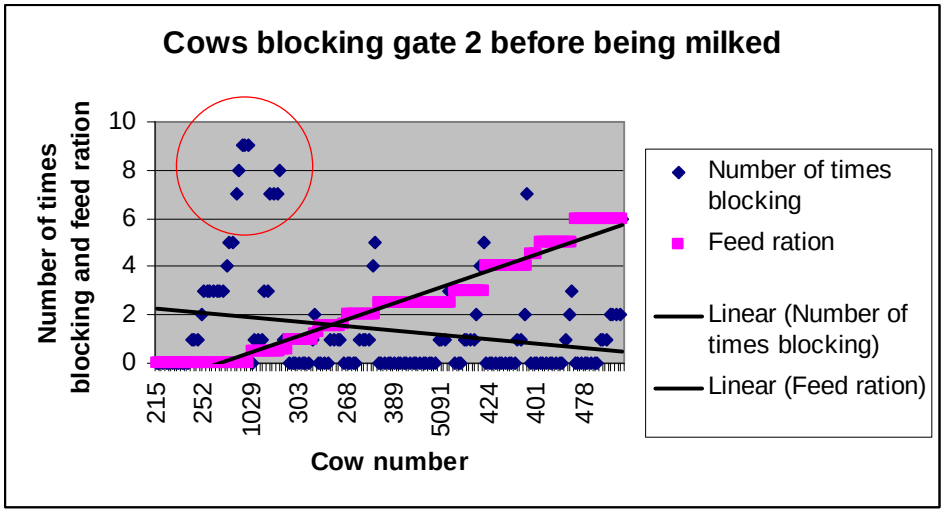


Figure 31. Number of times and feed rations of cows blocking gate 2 before being milked are slightly negatively correlated. The cows blocking the gate most are those with very low concentrate feed rations. Based on 1 Apr. – 9 Apr. 2007.

Gate 2 – cows in the feeding area blocking the gate

After gate 2 there was possible for cows standing in the feeding area to put their head between two pipes and stop other cows from passing the gate on their way from the waiting area and also the cows in the feeding area could get registered as if they had walked through gate 2 again. This gave funny gate passing data and therefore a plywood board was mounted on the pipes, see picture 6 in Appendix 2.

RESULTS OF THE NEW GATE SETTINGS AND FIXES

Gate 1 – errors decreased

By the sensor cleaning and positioning on 2 Mar. the % errors of all gate registrations in gate 1 decreased from 13% to about 4%, see Figure 32. The sensor in gate 1 was cleaned and positioned on 2 Mar. 2007. The number of unsure observations (SysAreaGUID:0) decreased a lot.

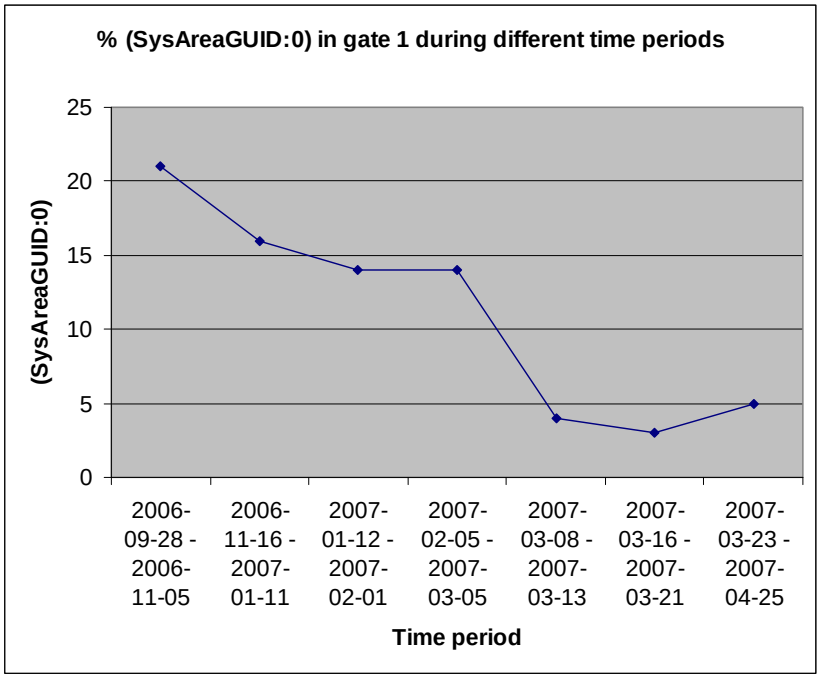


Figure 32. The sensor in gate 1 was cleaned and positioned on 2 Mar. 2007. The number of unsure observations (SysAreaGUID:0) decreased a lot.

Gate 1 – cow trains decreased

The fixes on 14 Mar. gave following results:

- The number of cow trains in gate 1 decreased from about 46 per day to about 12 per day (app. 30 day average before and after change of gate settings). See Figure F. The decrease has continued, probably because the cows have learned how the gate works now, and the last week before this study ended, 19-25 Apr. 2007, the average was 3 cow trains per day.
- The number of cow trains in gate 2 was not significantly changed (before 1.7% and after 2.6%)
- The number of cows getting double registrations as if they had passed the gate again decreased a lot.
- The average milking interval has increased (!) from 11:40 to 11:48.
- The number of rejected cows has decreased from 34 to 32 per day.
- The number of milkings per day has increased from 279 till 282 (2 MS).
- The number of gate passages in gate 1 has increased to what it was earlier, see Table 10. Gate passages.and Figure 34. Average number of gate passages per day and cow.

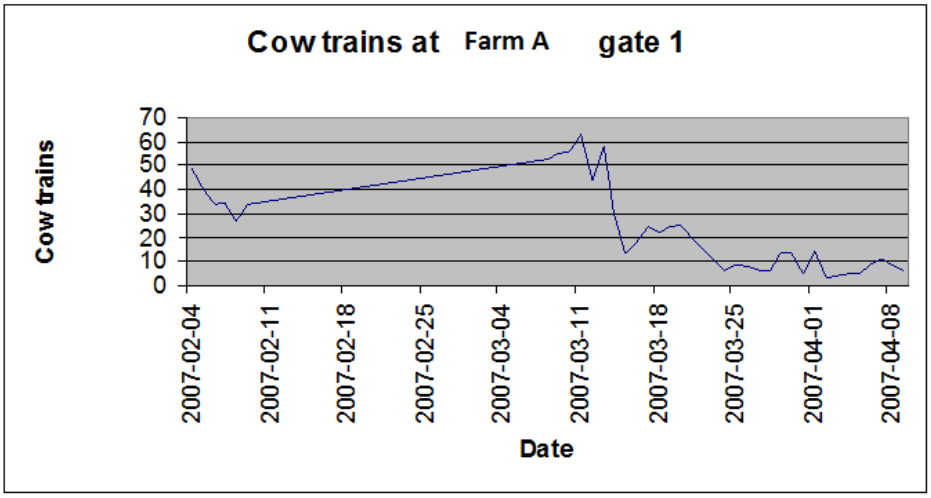


Figure 33. The gate settings in gate 1 were changed on 14 Mar. 2007. The number of cow trains decreased a lot.

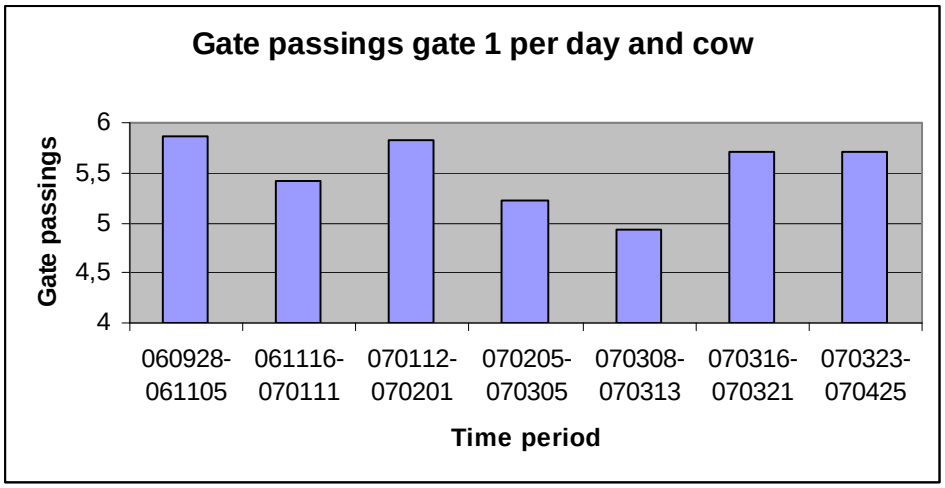


Figure 34. Average number of gate passages per day and cow.

Gate 2 – not milked cows blocking the gate

Nothing was done to solve this problem, but some advice is given to the farmer under Discussion.

Gate 2 – cows in the feeding area blocking the gate

The problem from cows in the feeding area blocking the gate was reduced a lot when the plywood board was put on the pipes on 14 Mar. 2007, but still cows can walk the wrong way from the feeding area through the one-way gate after gate 2.

TIME SPENT ON DIFFERENT ACTIONS IN THE BARN

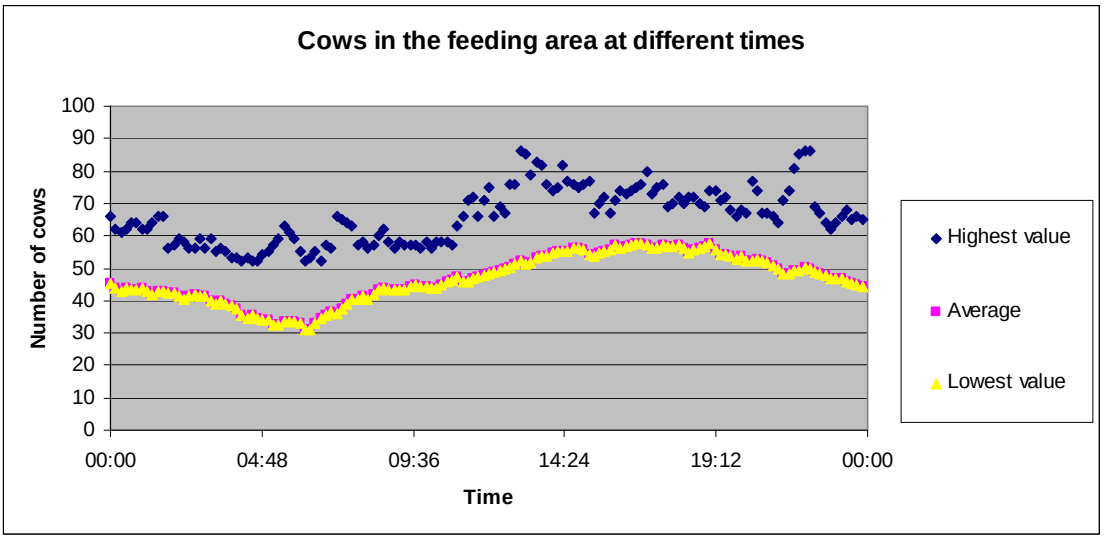


Figure 35. Number of cows in the feeding area from 10 Mar. until 25 Apr. 2007. Average number of cows during this time period was 150. 080905

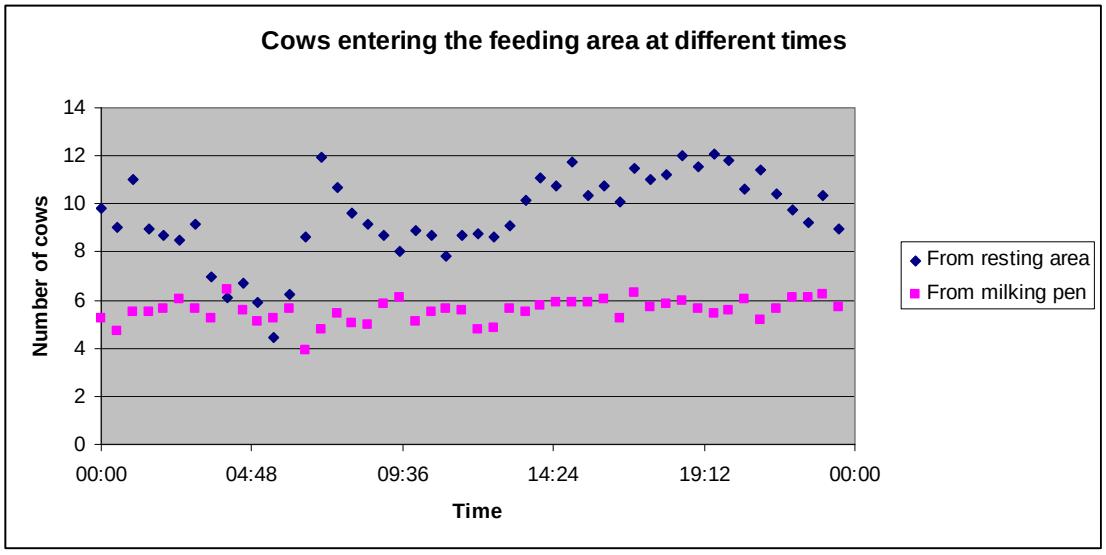


Figure 36. Number of cows entering the feeding area at different times of the day from 10 Mar. until 25 Apr. 2007. There are 30 minutes between each dot. 080904

The relatively lower number of cows early in the morning indicates that there is too little feed on the feeding table at this time. From the waiting area the flow of cows is rather constant the whole day around, but from the resting area there are fewer cows coming early in the morning and suddenly lots of cows around 7 0´clock in the morning. (According to the farmer feed is dispensed evenly every second hour until 8 o'clock.)

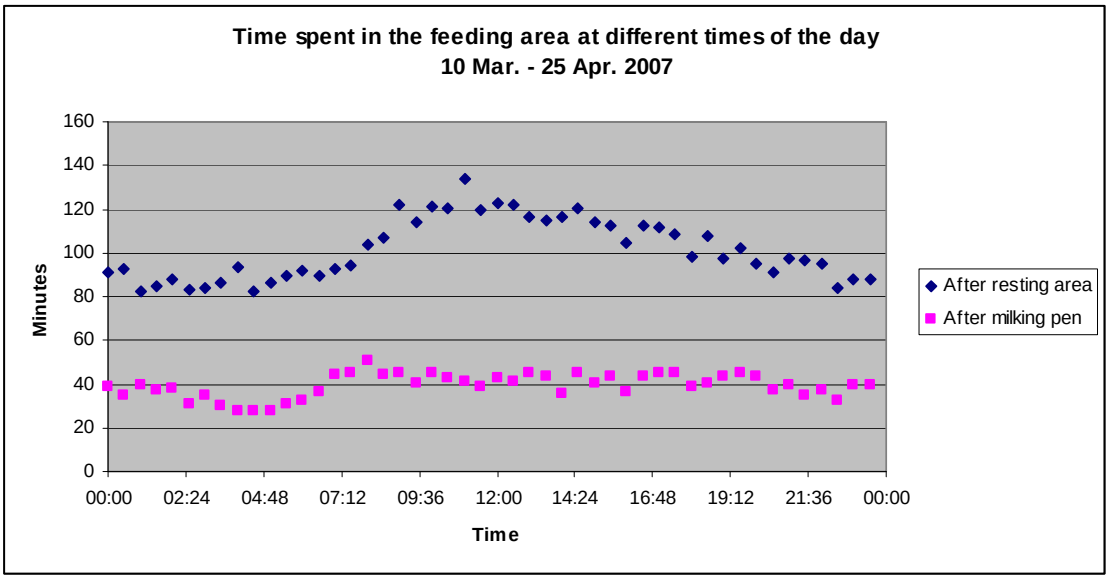


Figure 37. Time spent in the feeding area at different times of the day during an average fortnight.

The cows spend more time in the feeding area after they have been resting than they do after milking.

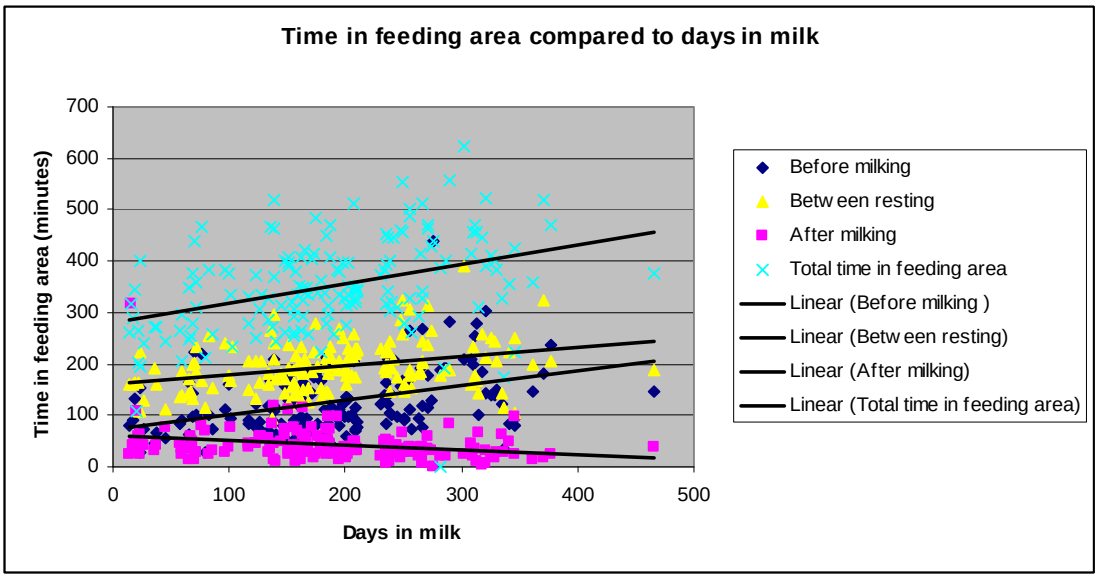


Figure 38. Time spent in the feeding area vs days in milk. Based on 10 Mar. – 25 Apr. 2007.

Early in the lactation the cows spend about 1.5 hours in the feeding area after resting, about 1 hour after milking and about 2 hours between two resting occasions. Later in the lactation they stay even longer time in the feeding area after resting and between resting occasions but they stay shorter after milking.

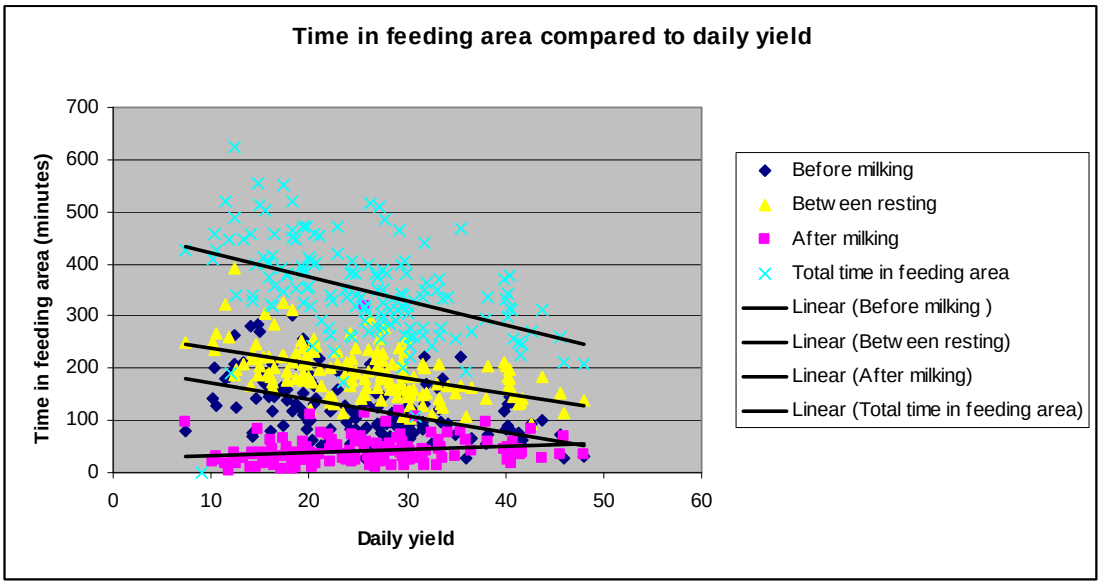


Figure 39. Time spent in the feeding area vs daily yield. Based on 10 Mar. – 25 Apr. 2007.

When cows produce less milk per day they spend more time in the feeding area after resting and between resting occasions. After milking they spend shorter time there.

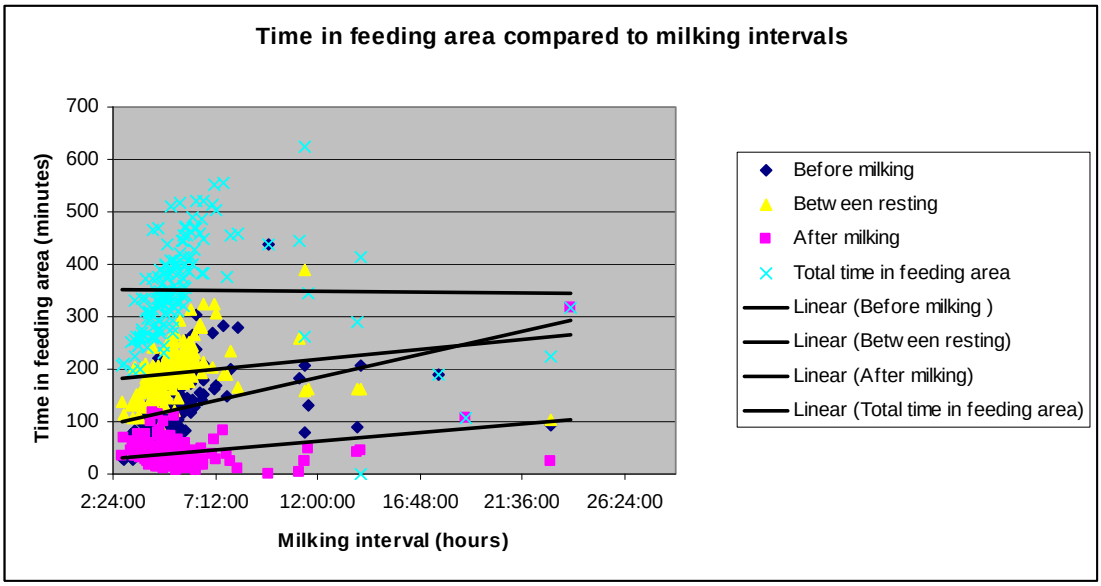


Figure 40. Time spent in the feeding area vs milking interval. Milking intervals of more than 36 h have been discarded.

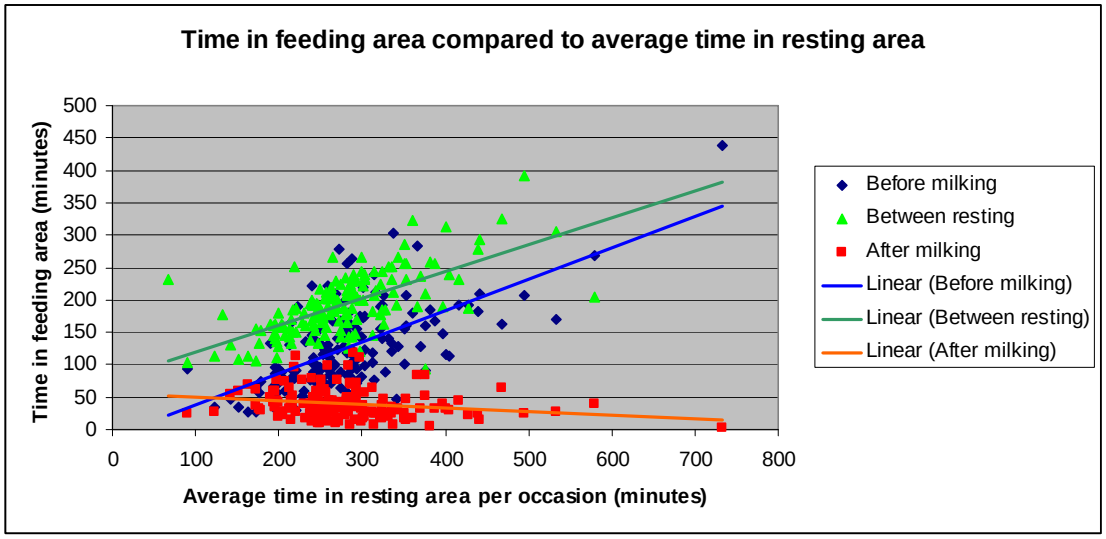


Figure 41. Time spent in the feeding area compared to time spent in the resting area. Based on 10 Mar. – 25 Apr. 2007.

The longest feeding visits were the ones between two resting occasions and the shortest feeding visits were after milking. The cows spent more time in the feeding area before milking or between resting occasions, the more time they had spent in the resting area. Hence there is a positive correlation between average time in resting area and time in feeding area before milking (0.63) and also between average time in resting area and time between resting (0.65). But after milking there is a weak negative correlation (-0.20); probably the cows are rather tired and content after milking and like to have some resting time. Between resting means that the cow was in the resting area both before and after the feeding visit.

The rank of the cows was guessed from the time it took them to go from gate 1 to milking (example see Figure 42, cows high in rank to the left) and from milking to gate 2. The average values of each cow has been used. The cows with short waiting times are supposed to be high in rank and the cows with long waiting times are supposed to be low in rank.

However this way of deciding rank seems to very unsure, since only 3 cows were found among the 10 with shortest times in more than one column in Table 11 and the correlation of the order of waiting times from gate 1 to ms 1 vs ms 2 was only 0,01 and the correlation of the order of waiting times from ms 1 vs ms 2 to gate 2 was -0,10.

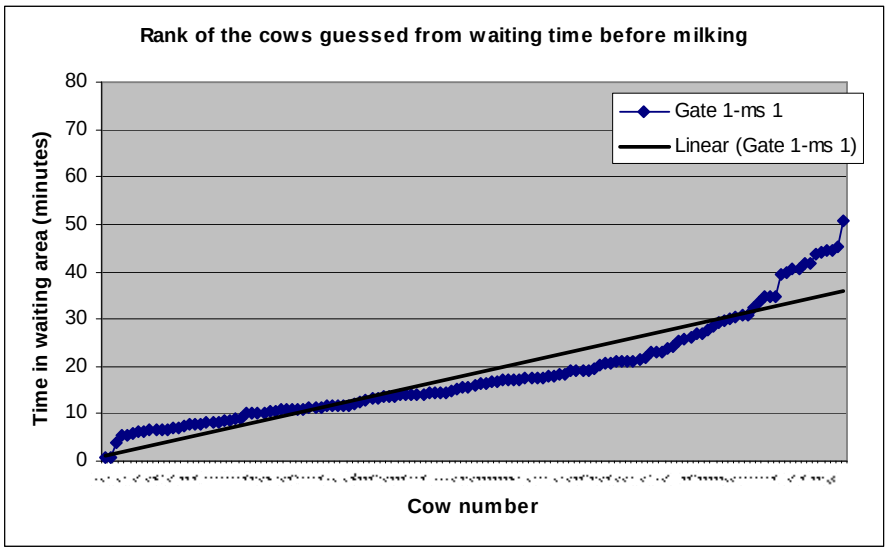


Figure 42. Waiting times gate 1 – ms 1.

Table 11. The ten cows guessed highest in rank before and after milking guessed from waiting times from gate 1 to milking station 1, from gate 1 to milking station 2, from milking station 1 to gate 2 and from milking station 2 to gate 2.

Highest in rank g1-ms1	Highest in rank g1-ms2	Highest in rank ms1-g2	Highest in rank ms2-g2
5	37	36	101
145	136	38	61
147	36	44	99
13	19	23	38
59	9	19	132
136	76	132	11
32	66	42	47
56	94	87	100
127	134	82	56
20	147	11	133

CALCULATIONS

The number of cows per day during each time period was calculated using Microsoft Visual Basic and as a control the formula below was used in Excel for a number of random days:

=SUM(IF(FREQUENCY(A(row of first date):A(row of last date);A(row of first date):A(row of last date))>0;1))

The SAS statistical program was used to handle the big amounts of data from registrations in portal ID´s, gates and MS´s. Times for different movements of the cows were calculated, e.g. time from passing a portal ID until passing gate 1 and time from passing an MS until passing gate 2. The intervals between gate passages, milkings etc were calculated as well as the amount of time spent in the feeding area and the number of cows in the feeding area at different times of the day.

Average milking intervals of the cows at Farm A have been calculated with two different programs; SAS and Excel. The original data are the same; the cow traffic reports from the herd management software. The results look different because in Excel the average milking interval from all cows within a specified time

period was calculated (average milking interval) but in SAS the average milking interval of each cow was calculated and thereafter the average of all those (average milking interval per cow).

How many cows should there be place for in an optimal precedence passage?
Presumed there is a cylinder on the gate to give real precedence to cows in the precedence passage,

The approximate normal waiting time from gate 1 until being registered in an MS is more or less 30 minutes. Let´s suppose that the precedence cows should have an approximate waiting time of the half of this, i.e. 15 minutes.
If 150 cows are milked per day in an MS, about 6.5 cows are milked per hour. Hence milking a cow including walking in and out of the MS takes about 9 minutes.
If 2 cows are in the precedence passage, it will take about 18 minutes for the second one to start being milked. If 4 cows are in the precedence passage, it would take about 36
minutes for the last one to start being milked. That is more than the approximate 30 minutes the cows normally wait at Farm A.

The conclusion is that it is enough with place for 2-3 cows in a precedence passage.

Answers to the questions investigated

Under INVESTIGATION a number of factors are mentioned which were to be investigated in this study.
An investigation about the precedence passage and the gates, cow traffic and management at Farm A was made with several purposes;

1. Rather 25 than 12 cows should be led to the pp, compare Table 6. Comparison of many versus few cows in the precedence passage. Only cows who shorten their waiting time compared to the mp should be in the pp. However with this high number of cows it has happened that the pp was full and cows could not go through gate 1, but had to wait. The mp cows could not pass and hence MS 1 was idling instead of milking, which is very bad.
2. In an optimal precedence passage there should be place for some cows so that they can push each other forward, but if there is place for too many cows they might have to wait long. The pp should not be longer than the length of 4 cows, app. 7 m. Since cows often are slowed down by bends, it should be as straight as possible.
3. Factors important to keep track on to optimize the functioning of the precedence passage and the cow traffic as a whole are gate functioning (cow trains and squeezed cows as few as possible), avoid crowded areas in the barn (by moving cow brushes etc), cows stopping other cows from passing gates (might be fixed with settings for milking or by changing the setup of a gate) and feed available on the feeding table (more cows in feeding area and they stay longer if feed available) – all these factors can increase the flow of cows in the barn.
4. The health of the cows is slightly worse than before the pp was built, however the decrease started before the pp was built and does not seem to be dependent on the pp.
5. The gate settings of gate 1 have been changed and a board has been mounted after gate 2. The number of cow trains, errors and unsure observations in gate 1 have decreased substantially and the number of double registrations in gate 2 has decreased.
6. The number of milkings increased but not significantly. The number of rejections decreased but not significantly.
7. The milk yield per day and MS in NOT increased by having many cows in the VMS system. The number of milkings and the milk yield reach a maximum and if more cows are there the milking intervals will be longer and the individual cows will yield less milk per day and cow.
8. The cows go from the resting area to the feeding area more in the morning around 6.30 and between ca 14 and 22 in the evening. They go there very little between ca 3 and 6.30 in the morning. From the waiting area there is a constant flow of cows to the feeding area all day around.
9. There are more cows in the feeding area in the afternoon and evening than other times and least cows in the early morning (ca 3-6.30). The cows stay longer in the feeding area in daytime than between 20-7 after resting and the stay very short after milking between 3-6.30 in the morning.

10. The cows spend in total more time in the feeding area in the later part of the lactation. Early in the lactation the cows spend about 1.5 hours in the feeding area after resting, about 1 hour after milking and about 2 hours between two resting occasions. Later in the lactation they stay even longer time in the feeding area after resting and between resting occasions but they stay shorter after milking. Since the daily yield is higher in the beginning of the lactation they spend more time in the feeding area when the daily yield is lower.
11. The cows don´t seem to be disturbed by the manure scrapers while they are eating.

CASE STUDY 3 - FARM B – AN OVERVIEW OF THE FARM AND THEIR WAY OF WORKING

BACKGROUND

Farm B is another farm with Feed First™ cow traffic from the day the farm was built. The farm was pointed out as a farm with good production results. A short study has been made of the way they work with the objective to find what management routines make the farm successful.

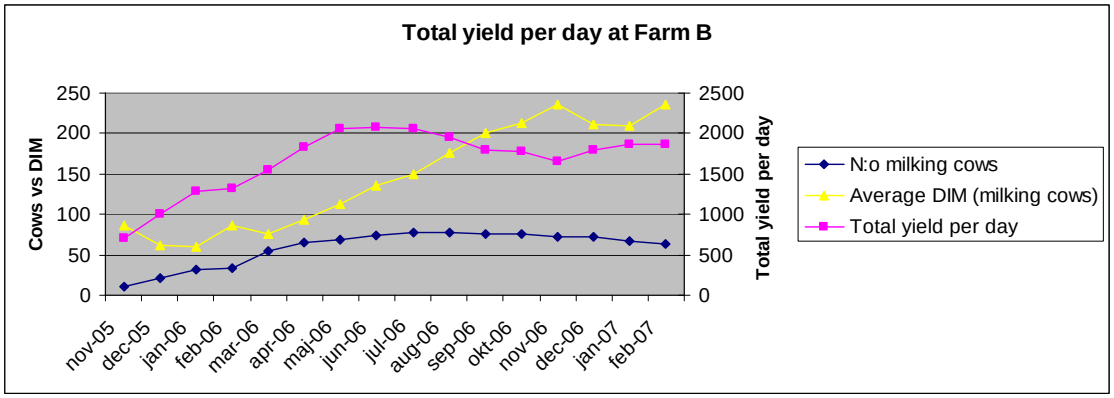


Figure 43. The total yield per day has increased a lot, but decreased during autumn 2006 due to fewer recently calved cows.

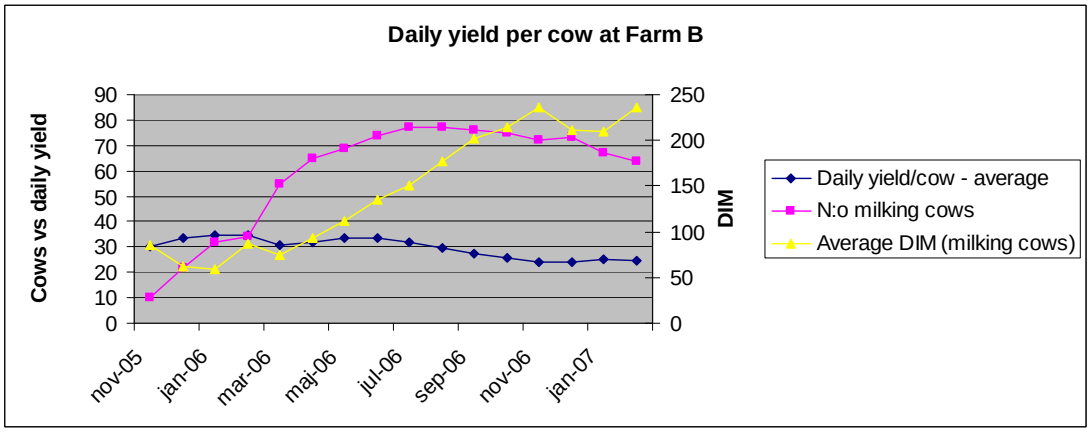


Figure 44. The daily milk yield per cow decreased during autumn 2006 due to fewer recently calved cows, which means higher average Days In Milk.

Although the number of cows increased June - September 2006, the total yield per day decreased. This is because many cows are in the later part of the lactation and thus giving less milk per day.

Health status of the cows

The bulk cell count is stable around 200.000 cells/ml. Fat is at 4.2%, but was lower in the summer when it was hot outside. Protein is at 3.5%. The bacterial count is very low, around 10 bacteria/ml except at one occasion when it was very high of unknown reason.

MATERIALS AND METHODS

Definition incomplete milking: a milking session where the milk yield for any quarter is below 50% of the expected quarter milk yield. In addition, the expected quarter yield must be estimated to more than 1 kg. However a teat is not incomplete if the yield is more than 3 kg.

If a teat cup is kicked off when less than 75% of the expected yield has been milked, the teat cup should be reattached.

Definition abnormal milking: The user can decide what should be considered as abnormal and cause an increasing value in the cow monitoring board.

INVESTIGATION

Since farm B has had a very good production result and the farm is increasing, it is interesting to talk to the farmer and learn what they do to get these good results. The aim of this investigation is to find what management routines make the farm successful. Further these routines were to be presented as advice to other farmers.

The farmer was asked about his work, how the milking of new cows is performed, routines around calvings, grazing, cleaning, feeding etc… Most answers were as expected, as probably most farmers do their work. Some more or less remarkable things are shown under RESULTS.

A special cow traffic solution was found on the farm; a gate was opened up and possible to pass from behind. Three time periods were chosen for a closer study and comparison of the gates;

24 Aug. – 17 Oct. 2006 before the gate from the feeding table to concentrates vs milking was opened

13 Nov. 2006 – 4 Jan. 2007 after the gate was opened

12 Feb. - 12 Mar. 2007 after a second MS was installed, the gate was moved but still kept open and some more cows are in the system

RESULTS

Management routines

When a cow has recently calved and comes to the VMS milking, the farmer sees to that she goes to milking within a reasonable time. If there is a known risk of milk fever, the milking is manually stopped in advance.

Recently calved primiparous cows are often pushed to milking for some days. The cows who learn slowest are old cows that are new in the farm and have a calf there for the first time.

One cow has so far been automatically teached when beginning her second lactation and that worked well. Automatic teach of teat positions after the dry period has been tested also on some other cows. It did not work very well since the teats were placed in unusual positions.

Cows not leaving the MS until there is an alarm (15 minutes) have been very few before, but now since there is some over capacity in the MS:s this happens now and then during the night.

Gate opened up

Table 12. Comparisons between the three chosen time periods.

	24 Aug. – 17 Oct. 2006	13 Nov. 2006 – 4 Jan. 2007	12 Feb. – 12 Mar. 2007
Milking intervals, average	10:38	10:24	9:22
Milking intervals, stdev	2:50	2:42	2:46
Milking intervals, average primiparous cows			8:53
Milking intervals, average multiparous cows			10:02
Intervals between visits in MS, average	10:35	10:08	9:04
% of visits in MS not preceded by gate passage to waiting area (cow trains)	1.3	4.1	3.3
Rejected cows in MS per day	0.8	5.2	6.3

Since the gate has been opened in October 2006 by disconnecting the cylinder from the gate, gate passages and cow trains can not be correctly registered. The time from gate passing until milking in MS can not be calculated.
The milking interval per cow has decreased since the gate was opened. So has the standard deviation of milking intervals per cow, but the latter has recently increased again, probably since more cows are in the system.
The number of cows entering the MS when not due for milking has increased since the gate was opened, which shows that some cows go the wrong way in the gate in cow trains. See Table 12.

The farmer says the cows pass the gate more often now, particularly the primiparous cows. Since it is not possible to register number of gate passages, cow trains etc. nothing can be significantly stated. An unanswered question is if the gate settings were optimal before the gate was opened or if they could have been improved to get a better flow in the cow traffic.

The explanation why the milking intervals are shorter now than before is probably due to fewer cows taking time from the MS and after 5 Feb. 2007 a second MS giving the cows opportunity to go milking with shorter waiting times. The intervals between visits in the MS have decreased of the same reason.

Milking deviations

During the time from 1 Sep. 2005 until 1 Mar. 2007 there has been approximately the same amount of incomplete vs abnormal milkings from all teats, see Table 13.

Table 13. incomplete vs abnormal milkings per teat of all milkings.

%	Inc RR	Inc LR	Inc RF	Inc LF	Abn RR	Abn LR	Abn FR	Abn LF
MS1	6.5	6.3	6.1	6.1	9.1	8.0	7.2	7.9

On 5 Feb. 2007 a second MS was installed. Since there is some over capacity with two MS:s there are not as many milkings in MS2 as in MS1. The very first seven days are excluded from Table 14, which shows the incomplete vs abnormal milkings from 12 Feb. until 1 Mar. 2007.

Table 14. % incomplete vs abnormal milkings per teat of all milkings.

%	Inc RR	Inc LR	Inc RF	Inc LF	Abn RR	Abn LR	Abn FR	Abn LF
MS1	10.3	10.3	10.1	9.7	9.4	9.3	8.7	8.6
MS2	14.0	11.9	10.8	8.9	7.8	7.6	8.1	8.1

Fetching of cows

The farmer and staff were asked to note which cows were fetched or poked at for milking and how many times for 30 days. 8 days´ observations are missing, but the 22 days it was noted there were totally 17 cows fetched or poked at on totally 55 occasions. 12 of the cows had calved within the last 30 days and the ones who had calved earlier were fetched maximum 3 times each during the 22 days. 14 of the cows were in lactation 1. One cow was fetched 15 times, one cow 13 times and the rest of the cows maximum 4 times each. This is in accordance with the farmer´s statement that they seldom have to fetch other cows than recently calved primiparous cows.

CASE STUDY 4 – KEY FACTORS – HOW CAN WE JUDGE HOW WELL A VMS FARM IS WORKING?

BACKGROUND

To be able to judge how well a VMS-farm is working some kind of performance judgement is needed. It should be easy to understand for people not used to statistics and likewise.

MATERIALS AND METHODS

A number of criteria that can be used to judge the performance of a VMS farm were set up. The criteria were given four levels of performance judgement – bad, ok, good and very good. The criteria were discussed with different people working in different parts of DeLaval and an Excel sheet with a proposal of how it could look was sent to DeLaval VMS people in Sweden and over the world. They were asked to mark the five most important factors and give comments on the performance levels and the whole idea. Their answers were analysed and a specification for VMS herd management software was written.

RESULTS

See the **Specification for key factors or VMS performance optimization** in Attachment 4.

The five most important factors for judging the functioning of a VMS was according to this study:

1. Milk yield / MS /24h
2. Cells, max % of cows over a limit of 250 000
3. Missed teats
4. Evenness in MS usage per 24h
5. Average harvesting flow

The list of key factors can be a part of the herd management program and can be shown to the farmer or others on the farm. It can also be used as a basis of a discussion when a service man or advisor is visiting the farm.

It is also possible to have one list of VMS based key factors and another list of cow based key factors.

DISCUSSION OF ALL PARTS

Good working cow traffic is very important for every farm with an automatic milking system. It is important to have a good flow of the cows through different parts of the barn and grazing areas. A good working cow traffic is when the cows are willing to move around in the barn and at the grazing. They should expect something nice after every gate and in every milking station. They should never get disappointed when they come to a gate, since it is not opened.

It is important to choose a cow traffic system that suits the working routines on the farm, but it is even more important to have a good farm management in total and to have a good feeding strategy. Great changes of cow traffic can be made just by changing the composition of the feed. It is also very important that the cows walk fast into and out of the milking station, if a high capacity shall be possible to reach.

Feed first™ or not

This study is internal and hence not included in this official version.

The precedence passage

How many cows should be in the precedence passage and how long should a precedence passage be? The purpose is that cows in the precedence passage should shorten their waiting time compared to what it would be if they were not in the precedence passage. If there are too many cows in a precedence passage, the cows in the end will have to wait long time before milking, e.g. the cow coming as no 6 in the row will have to wait for at least app 5*8=40 minutes. This would be the case if only cows from the pp were milked, but if also higher ranked cows from the waiting area are milked it would take even longer time. Consider also that there is no water or feed available in the pp. For this reason a precedence passage should never be made too long or contain too many cows.

If we assume a “normal waiting time” before milking to app. 30 minutes, the following reasoning can be made: In the pp the normal waiting time should be shorter, let’s say 15 minutes. It takes app. 8 minutes for a cow to enter the ms, get cleaned and milked and exit the ms. If 2 cows are already in the pp when a third comes, the waiting time would be at least 2*8=16 minutes. If there is place for more than 4 cows in the pp, the 5th would have to wait for 4*8=32 minutes. That is longer than the assumed normal waiting time. With such a long waiting time in the pp only cows usually waiting extremely long before milking get help from the pp. Hence the pp should not be longer than the length of 4 cows, app. 7 m. Since cows often are slowed down by bends, it should be as straight as possible.

At Farm A it has happened that there were so many cows in the pp that gate 1 was blocked and no cows could enter the waiting area. This leads to MS1 being idle since no cows can reach it, which is very bad for the cows and the milk yield. In this case there are clearly too many cows in the pp. When the study was made there was no way to sort cows in some other direction if there were too many in the pp, but such a function exists today in the gate settings.

Many cows (until 2 Feb. app. 26 cows) have been lead to the pp, which makes the queue there rather long. If fewer cows had been lead to the pp, probably the time they had to wait would have been reduced. The cows that were in the precedence passage until 2 Feb. were according to data not the ones that gained most from being there. Actually most of them (8 out of 12) had longer waiting times in the precedence passage than they had in the waiting area before. But some cows were put in the precedence passage because they used to block the way for other cows at selection gate 2 before they were milked. If that is a working solution of the block gate-problem, it is a good reason to have those cows in the pp even if their waiting time increases.

Since the waiting times in the pp were shorter when 25 cows were there than when 12 cows were there, a thought I have come to is that maybe the cows push each other forward and the time a cow is waiting until entering the MS is shorter when more cows are in the pp than if a cow can stand there alone and ruminate for a long time. This might differ between different farms depending on the possibility for cows to rest and

ruminate in peace in the resting area. Some cows might consider the pp a good place for resting and ruminating.

The differences between the two time periods might be because of the precedence passage, but some other things have also changed. Some cows have been dried off or culled and some other cows or heifers have calved. The total milk yield from the farm has increased, which it has also done during the whole year before the precedence passage was built. The number of milkings per day has also increased before and after the precedence passage was built.

The farmer and staff at the farm point out that the precedence passage is very useful when teaching heifers or new cows to enter the MS. As mentioned above, the pp is useful to get rid of cows in the waiting area not yet milked who are blocking gate 2 and preventing other cows from leaving the waiting area.

In Figure 10 is shown that cows in the precedence passage yield less and have longer milking intervals than the rest of the herd. Probably this is not because of the precedence passage per se but because rather suitable cows have been picked out to be there. It indicates that the cows in the precedence passage are lower in rank. If they had been in the precedence passage for a longer time (since beginning of the lactation) they might had had the opportunity to utilize their capacity better and reach a higher level of milk production.

The time it took for cows in the precedence passage before entering the ms and the number of cows that passed in between varied a lot between individual cows in the pp, see Figure 22 and Figure 23. This indicates that some of the cows, the ones waiting long before milking although they are first in line in the pp, are very low in rank. These cows would have better help from the pp if they did not have to let cows from the mp pass before entering the ms. This would be changed if the push gate had a piston.

The reason of the number of rejections in the MS:s increasing from 8 Mar. until 13 Mar. and after that decreasing again might be that there were many cow trains through gate 1 at that time, which made cows not due for milking come to the waiting area. Another reason can be the changes made after gate 2 on 14 Mar., making low ranked cows walk easier through that gate instead of trying to get more feed in the MS:s.

Cow first in line in the precedence passage

The fact that there are more cows passing into the MS to be milked the longer a cow is first in line in the precedence passage is rather easy to change. If the push gate had a cylinder and could be manouvered automatically, so that the precedence passage was a real precedence for low ranked cows, they wouldn't have to wait for the other cows. The waiting time increases with days in milk, which is probably because the cow is more eager to be milked shortly after having a calf.

How to optimize the use of the precedence passage

The factors to keep track on to optimize the use of the precedence passage are:
Gates should function well with no or very few cow trains.
Keep a smooth flow of cows all day round to avoid long queues at certain times.
Put a cylinder on the push-gate to make the precedence passage a real precedence for some cows.

If a cylinder is put on the push gate on the way into MS2 from the precedence passage, so that the gate can not be moved by cows but is moved according to the management system, the pp can offer real precedence to the pp cows no matter how many cows are in the pp or mp. It must be possible in the management system to set conditions for the cylinder/gate such as if any cow is in the pp she should be given precedence before cows in the mp. If the cow first in line in the pp does not enter the MS within a certain time, e.g. 5 minutes, a cow from the mp can be let in and then the pp cow should get a new chance etc.

It would be nice to give some cows precedence always and some cows if a very long time has passed since they were milked last time and if not more than X cows are waiting in the pp, otherwise lead them to the waiting area. That was not possible when the study was made but would be possible today. This

presupposes that it is possible to keep track on the number of cows both in the waiting area and in the precedence passage by counting cows passing gates.

Cows who often pass through the milking stations (high yielders) spend more time waiting than other cows, so they might need a quicker way to milking through the precedence passage.

Gate 1 - errors and cow trains

It is important to check the gates and their sensors, keep them clean and have correct settings for the gates. Probably the Errors and the cow trains are rather common problems that service people from DeLaval can help farmers to avoid. The future management system should provide the farmer with data of number of cow trains, errors etc.

Gate 2 – not milked cows and cows in the feeding area blocking the gate

Since there is a problem with cows blocking gate 2 before milking and since the cows blocking the gate most have very low feed rations, an idea is to give a small feed ration to the cows that have no concentrate feed ration at all and that block the gate often. This would probably make them more willing to enter the MS before going to the gate leading to the feeding table.

Further the farmer is recommended to fix the one way gate after gate 2 to hinder cows from walking the wrong way to further improve the cow traffic.

Cow traffic – how else can the flow of cows increase?

The rotating cow brush placed in the feeding area rather near gate 1 seems to be a hindrance for cows wanting to go to gate 1 for milking or resting. When a cow or two are using the brush they are standing in the way of cows walking to the gate. There is often no place beside them either, since there are cows eating from the feeding table. The brush can be moved further away from gate 1, which would probably increase the flow of cows through gate 1.

Milk yield per cow did not increase

The fact that the total yield produced milk on the farm did not rise although there were more cows for some time, indicates that the milking stations are overloaded or badly utilized. The milking intervals were prolonged when more cows were in the system, which indicates that the cows can not come to milking often enough. (See Figure 15. The average milking intervals and standard deviation of the milking intervals compared to the number of cows milking. and Figure 16. The number of milkings per cow and day compared to the number of cows milking.) Hence their production decreases. If this is the reason of the total amount of milk not rising, it is no idea to keep such many cows milking. It would be better to dry off some cows, e.g. some with low harvesting flow, and use the free time to milk the rest of the cows more often to keep up their capacity. Each cow that is in the barn has to eat, not only for producing milk but also for her own maintenance. This makes each cow a cost and if some cows are taken away although the same amount of milk is produced, that should give better economy. This is a general problem encountered on many farms (Pettersson, G. 19 Sep. 2008, personal communication). Another solution would be to milk some cows in another milking system at times when there are many cows on the farm.

A big amount of feed in the milking station can cause many dry cows or other hungry cows to go into the milking stations and get rejected. The gates can be corrected so that no or very few dry cows reach the milking stations. If the amount of rejected cows is high, one solution can be to lower the concentrate dispensing in the milking stations (Gustafsson & Pettersson, 2008). An opposite problem can be seen at Farm A, when cows that are given no or very little feed in the milking stations are blocking gate 2 before they go milking and get access to the gate. Cows that yield less than 28 kg per day get very little or no concentrates in the milking stations. Harms. 2005, mentions that cows get at least 0.6 kg concentrates in the milking stations no matter their milk production. Maybe this would be a good idea also at Farm A. The problem shows that it can be difficult to use PMR and only give concentrates in the MS:s but have no other feeding stations.

Probably the capacity of the MS:s can be better utilized if cows with higher harvesting flow are used and the number of rejected cows is lowered, which can partly be done by avoiding cow trains in the gates.

Which cows fit best in the VMS system?

In a VMS system it is important to milk as many cows as possible yielding as much as possible in as short time as possible. Cows with low flow or taking very long time when teat cleaning or attaching the teat cups or cows with very low yield do not fit in a system when striving for good economy. If there are other milking systems than VMS on the farm, the cows that do not fit in the VMS system can be moved there. Here are some ideas of how we can find these cows.

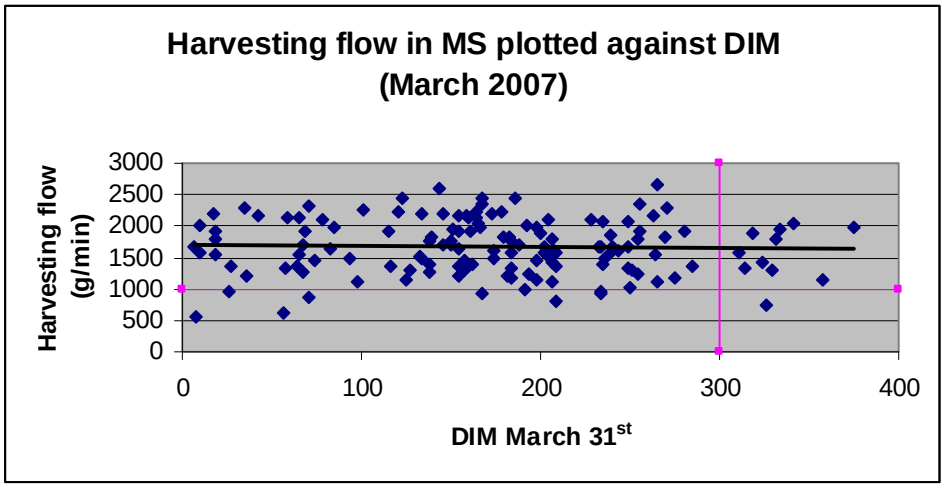


Figure 45. The cows within the lower right square have very low harvesting flow and were calving a long time ago. An idea is to dry them off if there are many cows in the MS:s, since these cows take long time to give little milk.

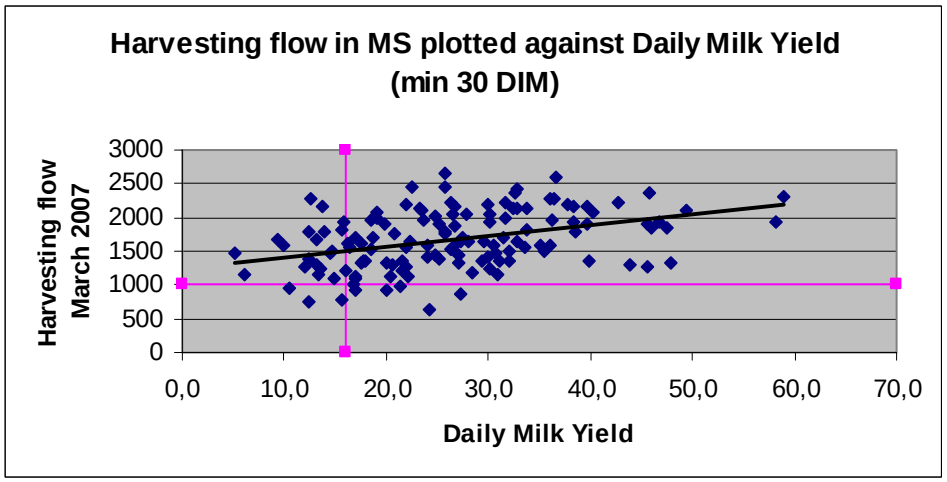


Figure 46. There is a small positive correlation between the daily milk yield and the harvesting flow in the MS. The cows within the lower left square have very low harvesting flow and give little milk per day. These cows can be dried off if there are many cows in the MS:s and free some time for the rest of the cows.

Table 15. The 10 animals at Farm A that had the lowest harvesting flow in March 2007.

Animal number	Harvesting flow in MS March 2007, g/min	Days In Milk	Daily Milk Yield, kg
558	630,7	60	24,1
1022	743,3	329	12,5
261	788,9	212	15,7
526	877,3	74	27,3
279	915,7	170	17,0
463	934,3	237	20,1
6110	965,5	237	10,5
1100	985,9	194	21,3
464	1022,7	253	16,9
431	1098,2	268	14,9

The harvesting flow is the average flow from the cow entering the MS, during teat cleaning, milking, spraying of the teats until the exit gate of the MS is opened. Since there is no correlation to the days in milk and a small correlation to the daily milk yield, the harvesting flow says something about how well the cow is adapted to the system. Since there were many cows in the VMS system at Farm A at this time, and the system is idle very short time, a good way to utilize the MS:s better might be to dry off or cull the cows with the lowest harvesting flow. The 10 cows in Table 15 were the least adapted to the VMS system, seen in this way.

The cow traffic and cow behaviour

Weiss et al (2004) note that a longer training period in the MS for cows with low coping capacity at the change of environment could possibly prevent a loss in milk yield due to stress at changeover. At Farm A, the training for new cows has been some weeks in the resting and feeding area, but not in the milking stations since there have been all too many cows. This might cause the milk yield to become lower than it could have been if the cows had been trained also in the MS and felt comfortable there already from the first milking. If there are many cows in the VMS group it might be worse letting heifers go through the MS:s with feed only, since this takes time from the system.

In the two farms studied more deeply in this thesis, the farmers and staff were asked how many cows they usually fetch for milking. The farmers thought that they fetched very few. They were also asked to note in a book when they fetched cows, but very few cows were noted as being fetched. Probably the cows don´t need anybody to poke at them actively, but many cows react on somebody walking behind them and rise because of that.

The waiting times before milking in MS2 are somewhat longer than before milking in MS1. This might not just have to do with the precedence passage per se, but can also be a result of the rather tight turn the cows have to make when walking from the waiting area into MS2.

A thing to remember is that generally adding more gates increases waiting times for the cows in a herd. (van Hoven, F., personal communication 19 Mar. 2007)

Harms, 2005, noticed in free and semi free cow traffic that the cows in a farm with active selection gates used the gates more than the cows in a farm with passive selection gates. This indicates that cows find it easier to walk through an active gate which opens up to let the cow pass than to walk through a passive gate which the cow herself has to open up.

Harms, 2005, concludes that free cow traffic is best regarding feed intake but not so good regarding milking frequency and cows that need to be fetched for milking.

Sällvik, 2000, states that the “old truth” that cows have a strong group behaviour is not quite right. Cows are individuals and develop their own diurnal pattern with feed intake, milking, ruminating and resting to optimize their comfort and satisfaction with as little effort as possible. This makes it easier to have a well functioning cow traffic with individual settings in gates etc.

Time spent on different actions

Sambraus, 1991, states that the natural day spent by a cow is regular. In nature cows eat in the morning at dawn and in the evening dusk. The rest of the eating occasions depend on the length of the day. When few eating occasions are possible in day light, they also eat around midnight. When allowed to eat ad libitum the cows eat in two phases. This indicates that cows are dependent on the day light when they eat. The question is whether the light in the barn is enough to make them willing to eat at other occasions than in nature or if there is an in-built sense for time and they refer eating at “natural” times. The distribution of feed is one way to entice the cows to go eating.

The number of cows in the feeding area was lowest in the early mornings. There were suddenly many cows entering the feeding area around 7 o’clock. See Figure 35. Number of cows in the feeding area from 10 Mar. until 25 Apr. 2007. Average number of cows during this time period was 150. 080905 The farmer says that feed was evenly distributed at 2, 4, 6, and 8 o’clock. If that is correct, it might be the cows´ inbuilt biological clock that makes the number of cows in the feeding area low in the early morning. It might be a human entering the barn that makes many cows go to the feeding area around 7 o’clock.
The time cows waited before starting eating again was shortest in the free cow traffic and longest in the guided cow traffic. (Harms, 2005). This indicates that cows in guided cow traffic can not eat as often as they want to.

Rank

The shorter waiting time per cow, the shorter milking intervals, see Figure 3. This indicates that cows with short milking intervals are high in rank.

Figure 40 shows that cows with long milking intervals spend more time in the feeding area. A guess it that cows of low rank have to stay long in the feeding area to be able to eat enough and after that they have to wait in the waiting area longer than the cows of higher rank and these two factors have the effect that the milking intervals get very long.

The dominance of a cow to other cows had no significant effect on the milk yield in a study of two AMS farms. The rank did not affect the number of milkings or the number of visits without milking in different cow traffic systems. (Harms, 2005).

Harms, 2005, found that cows low in rank went to the milking station and thereafter to the feeding table before fresh roughage was distributed. The cows higher in rank went there when fresh feed was already there. He found this in guided and semi free cow traffic, but not in free cow traffic. Since Feed First™ cow traffic is free regarding the feed intake, the differences in feed intake between high ranked and low ranked cows should be less compared to traditional cow traffic.

The farmer’s influence on status of the farm

The farmer in farm B is very interested in his work, tries lots of new things and makes changes all the time. He seems to know his farm and his cows very well. This is a very important factor to make a farm work well!

The farmer in farm A is interested in the cows, but seems less interested in working with the computer as a help to make changes or try new things. More education on DeLaval management software might be a help to get better control on the farm. There were many small things that I found during this survey that altogether contributed to some problems and difficulties to increase and keep up the production and utilize the VMS in an efficient way. Examples are gate configuration and gate functioning, awareness of feeding

times and when feed ends on the feeding table and awareness of milking settings in the management system.

The number of incomplete milkings varies during the day and night. It might have to do with the routines for cleaning the camera. A dirty camera cannot see the teats and hence the robot arm cannot attach the teatcups. The number of incomplete milkings is highest in the night and early morning after the precedence passage was built, see Figure 18. Maybe the cleaning routines on the farm have been changed although that was not observed in this survey?

Standardisation – the herd management software can be better utilized

Since there are many levels of the milking settings at Farm A, there seems to be a need of standardisation, which is possible in version 2007 of the herd management software. Farm A has version 2006. It seems to be common among farms that they are not really aware of their settings in the herd management software. According to Carlgren, 2008 many out of 31 farms in Sweden and Denmark thought they had some other settings than they really had.

At Farm A the milking settings are set per individual cow. Most cows are allowed to be milked again 540 min (=9 hours) after last activity or when the expected yield is 11 kg. The cows whose expected yield should be less than 11 kg when due for milking were at the time between 5 and 202 days in milk (DIM). See example in Table 1. In version 2007 of the herd management software it is possible to handle these settings as a batch in an easier way than before and hence standardise them. This is a good way to avoid forgetting to change back strange settings such as cows being due for milking when the expected yield is 5 kg (probably a cow who had high cell counts or similar). However farmers need to be shown how to do this.

Table 16. Milking settings for the cows at Farm A farm on 8 Feb. 2007.

Time	# cows	exp. yield 15 kg	exp. yield 11 kg	exp. yield 10 kg	exp. yield 9 kg	exp. yield 8 kg	exp. yield 7.8 kg	exp. yield 5 kg
360	6	1	4	1				
390	14		12	2				
400	1	1						
440	6			3		3		
500	15		2	10	1		1	1
525	1	1						
540	102		99	1		2		
550	1			1				
Total	146	3	117	18	1	5	1	1

An overall impression is that the herd management software can be better utilized if the farmer and staff get to know more about how to use it. Some kind of education about the software would be good.

Some recommendations

If possible – give less concentrated feed at the feeding table, since all cows eat the same. Give more concentrate in the milking stations, especially to high yielding cows and give some more to those blocking gate 2 most. To make more time available in the milking stations and avoid long waiting times for the cows – dry off cows that have a low harvesting flow a bit earlier than is done today. The selection of which cows to keep or cull can also be based more on the harvesting flow than is done today.

Winter &Hillerton (1995) used a Friedman Test to analyse daily variation between cows in the number of feeding visits and milking frequency. Two-way analysis of variance to compare mean duration of visits to feed and time interval between feed visits and milkings.

Farm B:
The gate was opened up in October 2006. The cylinder was disconnected from the gate. The cylinder still moves when a cow comes but the gate is tied open. The cows are able to go backwards to the feeding table area as long as the gate is in the right position and no other cow is standing in the way.

There is a one-way gate keeping the cows from going through the gate from the waiting area to the feeding table.

Since the opening of the gate the flow through the gate has increased substantially according to the farmer. According to the VMS technical specialist visiting the farm the number of cows passing the gate increased with about 100 per day directly after the gate was opened. Unfortunately it is not possible to check how many cows go the wrong way in cow trains, since those are not registered when the gate is open.

A wish from the farmer and the VMS technical specialist is to make it possible to choose a default direction (in this case the waiting area; left) to which the gate should move back after a cow has passed in any direction (right or left). This would make it more difficult to pass the gate from the concentrate feeding stations to the feeding table.

So far there seems to be no problem with cows going from the concentrate feed to the feeding table blocking the way for cows on their way in the correct direction, but this might become a problem when the number of cows is increased in the summer.

Before the gate was opened the gate settings were 3000 msec from opening to closing and the time it took to close was app. 2-2.5 sec. This seems to be normal settings, but could maybe have been improved to make the gate work better.

The gate seems to be more a factor of stress than is the VMS, according to the farmer. The question is whether this is a common opinion or if the gate settings were not optimal before opening up the gate?

The people at Farm B are very keen on having no or very few red-marked cows (not milked since 12 vs 15 h primiparous cows vs multiparous cows), something I think help the cows to keep as high yield as possible. This is another important factor to make the farm work well. See Svennersten-Sjaunja & Pettersson, 2005 Effect of milking freq on lact persistent ina n autom mS.

The farmer wants the feed at the feeding table to end since he is aiming at increasing the flow of the cows. Sometimes the feed ends one hour before the next feeding occasion, sometimes shorter time. This is contradictory to the recommendations given by Gunnar Pettersson, SLU, who states that there should always be feed at the feeding table to make the cows eager to go there. An important factor is how often feed is given to the cows. In Farm B feed is given 10 times per day and the cows don´t have to rush to the feeding table each time the feed car comes. According to the farmer, the heifers or low ranked cows are not affected negatively from too little feed, since feed is given such many times per day.

There is usually low activity in the barn between 9.30 and 10 or 12 according to the farmer. He would like to improve the activity at this time, but since the milk car comes at 9.30-10 and main wash is done 10-10.30, he does not know what to do about it.

In the beginning of March slatted floor was put in the waiting area.

CALCULATIONS

Statistical analyses

SOURCES OF ERRORS

Case study 1: Lactation chart comparison from traditional cow traffic and Feed First™ cow traffic

Cows who have got ill (e.g. mastitis) but although not taken from the VMS might contribute with some mysterious data. When digging into the data some cows were realised to have milked very little during some days but anyhow matched all other criteria set up. These cows are very few and were kept in the data.

Case study 2: Farm A – a study of the precedence passage and the cow traffic

Some reports made in the herd management software 2006 include only cows that were still at the farm when the report was made. Cows that have been culled since then are missing in the report. Therefore some statistics may be false. Knowing this many things have been calculated from database-data, which contain all cows. Therefore the values in some tables above might differ from the values in other tables.
However the reports of cow traffic used in the SAS program are made in the herd management software 2006 and therefore some cows might be missing.

There were difficulties getting detailed information from the farms Farm A and Farm B about when and which cows were fetched or poaked at, when small changes from routines occurred etc. They were given one book each to fill in but after 4-6 weeks the information in the books were scarce.

CONCLUSION OF ALL PARTS

A precedence passage can be a good way of improving the cow traffic in a farm but under the right circumstances: not too few or too many cows, rank low cows or other problem cows, recently calved heifers and cows who should milk often. Push gate should have a cylinder to make it work better and software must be improved to make it work. Many other things are important to make the cow traffic work: gates working well with clean sensors and correct settings to avoid cow trains. Gates should preferably not be put in a corner, since the risk of cows blocking the gate is increased there. Brushes, feeding stations and other things that make cows stop and stand still should not be put in a narrow alley or corner and not in front of a gate or at the entrance to or exit from a milking station. It is important to keep control on the farm, being a step in front of the things happening, having the guts to test new functions and constantly keep an eye on the cows, cow traffic, milking stations etc.
It is important to always have fresh feed on the feeding table and distribute it often to make the cows willing to go to the feeding area. The management software should be easy to handle and graphs, pictures etc. should be easy to interpret and understand. There should be clear advices to the farmer about what work to emphasize to increase milk production with healthy cows and a reasonable work load.

It seems to be more important to keep track on small details such as those mentioned above, than to have a certain kind of cow traffic.

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References of Case study 4

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Figure label list

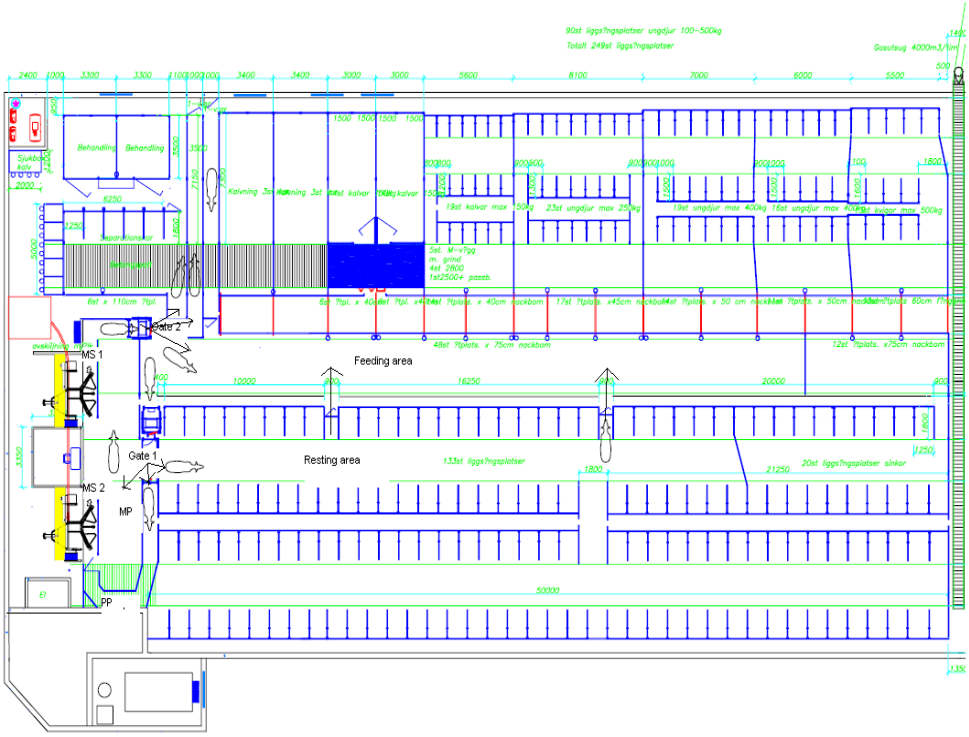
Table label list

ATTACHMENT 2.

Presentation of Farm A

The farm is situated in the county of Västergötland in Sweden. Earlier there was a cow stable with tied-up cows, but that burned in 2003. In 2005 the new VMS barn was built, a loose housing barn with 4 rows of resting cubicles on one side of the feeding table and place for the recruitment stock on the other side. The stable was ready in October 2005 and two VMS units were installed. The farm is authorised by KRAV, the Swedish control association for organic farming.

Layout



Picture 1. Drawing of Farm A with the precedence passage (pp).

On 6 Nov. 2006 a precedence passage leading to one of the milking stations was built.

County	Västergötland
Number of cows	141 milking, 21 dry (12 Jan. 2007)
Calving season	concentrated Aug-Dec, but they aim at calvings all-the-year-round
Yield	Steadily increasing, 6992 kg ECM per cow and year in 2006 (Swedish Official Milk Recording)
Recruitment	All heifers are saved
Milkings per cow and day before/after precedence passage	1.98/2.00

Grazing

Available pasture area	ca 40 hectares (at least 50% of dry mass intake must be grazed according to KRAV, if less during part of the grazing period the grazing should be at least 50% of the roughage intake)

Additional feeding	30-50% of intake, same Total Mixed Ratio as wintertime in the beginning of summer, later more concentrate since the grazing part gets less nutritious
Grazing season	aims at ca 10 May-1 Oct.
Available pasture	24 h per day, water available on pasture

Animal management

Introduction of heifers before calving has so far been just some weeks in the resting and feeding area, but not in the MS:s since there are all too many cows.

Hoof care	1-2 times per year
Calf rearing	There is often a nurse cow (who is later to be culled) for young calves. Milk diverted but usable is given to the calves with a calf feeder. Due to KRAV the calves get only fresh milk.

Milking

The milking settings are set per individual cow. Most cows are allowed to be milked again 540 min (=9 hours) after last activity or when the expected yield is 11 kg.

Bulk milk SCC	The SCC has increased during the winter and is at a level slightly above what it was before the precedence passage was built.
Incomplete milking	A milking is concerned as incomplete when the yield is less than half of the expected yield, provided that the expected yield is at least 1 kg. However a teat is not incomplete if the yield is more than 3 kg.
Abnormal milking	At Farm A around 50% of the cows have settings concerning blood; if there is more than 1200 ppm blood in the milk from one teat or more than 1000 ppm blood in the composite milk, the milk should be diverted and the value in the cow monitoring board should increase. Only one cow has settings concerning conductivity; if more than 7500 µS/cm in the composite milk, the milk should be diverted.

Feeding

Feeding of roughage is done ca. 10 times daily. No feeding stations are available. The same Total Mixed Ratio is given to all cows.
Feeding times:
Automatic conveyor belt dispenses feed every second hour, hence approximately 16, 18, 20, 22, 00, 02, 04, 06 and 08. In the late morning the feeding table is supposed to be emptied by the cows. Leftover feed is swept towards the cows at around 12 o'clock. The conveyor belt is started manually when needed at 12-16.

The amount of feed is app. 550 kg per feeding occasion except at around 12.00 when app 1000 kg is given.
Maximum concentrate yield per day (in MS) 6 kg
Maximum concentrate yield per visit (in MS) 2 kg
Cows yielding less than 28 kg per day get no or little feed in the milking stations.

The content in the Total Mixed Ratio varies with the nutritional state of the silage. On 12 Jan. 2007 it was:
Whole grain, 3rd harvest, forage 84% (=roughage)
Barley 7%
Oats 6%

Beans 3%
This Total Mixed Ratio is calculated to cover 28 kg milk per day.

Stable system

Type of stable	Loose housing barn with 4 rows of resting cubicles in the resting area on one side of the feeding table and place for the recruitment stock on the other side and in another building. DeBoer ventilation, see picture 10 in Attachment 2.
Built in year	2005
Resting area	150 cubicles, sparsely littered with sawdust, height over concrete floor 21 cm Concrete floor with urine drainage
Manure scraping	Concrete floor automatically scraped every second hour, takes 15-20 minutes per time Resting cubicles and alleys manually scraped once per day
Feeding area	Total Mixed Ratio from automatic conveyor belt every second hour except 10-16, when overflow on the feeding table is moved towards the cows and manual feeding is done when needed Room for 50 cows at the feeding table
Cow brush	A rotating cow brush is placed in the feeding area, alongside the row of resting pens and rather close to gate 1
Water	13 water bowls alongside the feeding table + 2 in the milking pen, but none in the resting area and none in the precedence passage
Milking units	2 VMS placed in the waiting area, tandem solution Precedence passage leads to MS2, waiting area gives possibility to enter MS 1 or MS 2. After milking all cows enter the waiting area.
Due for milking	9 hours after last milking or 11 kg expected yield, but see under “Milking” above.
Selection gate	Selection gate 1 at entrance to waiting area (L=resting area, F=precedence passage, R=waiting area) and selection gate 2 at exit from waiting area (L=treatment pen, F=grazing (summertime), R=feeding table)
Treatment pen	Entrance after the waiting area is left in selection gate 2, exit manually to the feeding area

Routines in the stable

Workers	Owner, 1 employee, sometimes daughters of owner, corresponding to 2 full time workers.
Cows back from dry	The cow is most often led to gate 1 and thus comes to the waiting area. The function Trap cow is used in the management software and the teat positions are teached and the cow is watched during the first milking.
Cows late for milking	Nearly no cows are fetched even if they are late for milking. But it is checked whether they have caught mastitis or some other injury.

The cows are always able to go from the resting area to the feeding area. When they leave the feeding area they have to pass a gate (selection gate 1), directions see below. See gate settings below for closer information on what is done when.

After milking in any of the MS:s all cows enter the waiting area. Leaving from there they have to pass another gate (selection gate 2), directions see below.

Gate settings

Selection gate 1 at entrance to waiting area (L=resting area, F=precedence passage, R=waiting area), see Picture 1.
Cows due for milking are led to the right to the waiting area.
Cows in the group “Precedence passage” due for milking are led forward to the precedence passage.
If there are more than 14 cows in the waiting area, cows due for milking are led to the left to the resting area, unless they have not been milked since 12 hours – in that case they are led to the right to the waiting area anyway.
Cows not due for milking are led to the left to the resting area.

Selection gate 2 at exit from waiting area (L=treatment pen, F=grazing (summertime), R=feeding area), see Picture 1.
Cows due for milking are not let through the gate, but stay in the waiting area to be milked.
Cows incompletely milked (definition see Milking above) are led to the right to the feeding area if more than 10 minutes have passed since they were milked.
Cows in the group “Treatment pen” are led to the left to the treatment pen.
In summer, cows not due for milking are led forward to go grazing outside.
Cows not due for milking are led to the feeding area.

Pictures from Farm A.

Picture 1. Selection gate 1 seen from the precedence passage. When the picture was taken the gate was closed and the last cow walking through it had gone to the right (=left in this picture); to the waiting area.

Picture 2. The precedence passage at Farm A. The cows walk the way the red arrows show.

Picture 3. The end of the precedence passage, view from the waiting area. In the middle of the picture one can see the push gate which separates the precedence cows from the waiting area cows. To the right is MS2. In and around the precedence passage there is slatted floor.

Picture 4. The push gate at the entrance to MS2. The red arrows show the way for precedence cows. The green arrow shows the way for waiting area cows. It is possible to put a cylinder on the push gate and make the precedence passage a real precedence for e.g. low ranked cows.

Picture 5. The entrance to MS1. The floor in the waiting area has rather great differences in level, both before MS1 and before gate 2, leading to the feeding table. Cows who have been milked in MS2 have to walk through the first lower part of the floor and then either through the second part of the lower floor or through MS1. Maybe this is part of the reason why there are more rejected cows in MS1 tan in MS2. Sometimes cows are standing in the way of gate 2, in the second lower part of the floor.

Picture 6. In the red oval one can see the hole between the pipes, where cows used to put their head from the feeding table side and keep other cows from walking through gate 2 to the feeding table. This also gave false registrations in gate 2. On March 14th a board was put in this place to get rid of the problem and it has helped a lot. Cows walking through gate 2 no longer hesitate as much as before.

Picture 7. There are often many cows at the feeding table. Since the farm has TMR (Total Mixed Ratio), the only surplus feed the cows get are the concentrates in the MS:s. Naturally it takes longer time at the feeding table with TMR than with PMR+feeding stations.

Picture 8. The portal IDs that register which cow goes from the resting area to the feeding table and when don´t have any shield plates to prevent transponders outside the lane from being read. It was considered to expensive for this short test. Instead a statistics program (SAS) is used to sort out which registrations are most probably true vs false.

Picture 9. The rotating cow brush at Farm A is popular among the cows. It is placed in the feeding area near the backside of the resting cubicles. When cows are using it and other cows are eating from the feeding table, it is very crowded for cows wanting to pass on their way to gate 1 and milking/resting. An idea is to move the brush further from gate 1, i.e. to the left from this picture.

Picture 10. DeBoer Ventilation at Farm A. When it gets to warm in the barn, the walls are automatically let down to let more air in. This is combined with natural ventilation through the roof ridge.

ATTACHMENT 3.

Presentation of farm B

Farm B is situated in the county of Västergötland in Sweden. Earlier there was a cow stable with tied-up cows, but that burned in 2004. In 2005 the new VMS barn was built, a loose housing barn with 3 rows of resting cubicles on one side of the feeding table and place for the recruitment stock and dry cows on the other side. The stable was ready in October 2005 and a VMS unit was installed. On 5 Feb. 2007 a selection gate was moved and another VMS unit was installed. The barn is about to be built out in the summer 2007.

When I first visited the farm on 2 Mar. 2007, the number of milking cows was 82 and there were 21 dry cows.

County	Västergötland
Number of cows	82 milking, 21 dry (2 Mar. 2007)
Calving season	they aim at calvings all-the-year-round
Yield	10 000 kg in 2006 (according to farmer)
Recruitment	All heifers are saved, the farm is increasing
Milkings/cow and day	2,51 (2 Mar. 2007)

Grazing

Available pasture area	ca 25 hectares (the milking cows 3 ha)
Additional feeding	same amount of feed in summer as in winter
Grazing season	May-Aug. 2006, plan to let the cows out earlier 2007
Available pasture	24 h per day, water not available on pasture

Animal management

Introduction of heifers	No introduction. Newly calved primiparous cows are most often easy to milk, about 5% are nervous.
Recently calved cows	Milked within reasonable time, watched first milking
Bulk cell count	steady around 200.000 cells/ml
Hoof care	1 time per year until now, more often in the future
Calf rearing	Calves are moved from the mother very soon after birth. They usually suckle once before the cow is moved to VMS milking. The calf becomes beestings for 4 days.
Bull	Sometimes there is a bull among the cows.

Milking

The milking settings for some cows are made with System settings, DeLaval Herd Management Software 2007. Since this is a new function, more cows will have these settings in the future. For primiparous cows when they are in the beginning of the lactation they are allowed to be milked 380 minutes after previous milking or when the expected milk yield exceeds 10 kg. After 50 days the limits are 600 minutes after previous milking or when the expected yield is 11 kg. For cows from their second lactation the settings are 380 minutes or 10 kg the first 50 days of the lactation and then 600 minutes or 12 kg, see

Table 17. The rest of the cows´ milking settings are made manually in about the same way.

Table 17. Milking system settings in the herd management software.

Primiparous, DIM 1-50 380 min, 10 kg	Primiparous, DIM 51-end 600 min, 11 kg
Multiparous, DIM 1-50 380 min, 10 kg	Multiparous, DIM 51-end 600 min, 12 kg

In the MS settings “Stop feeding when maximum one teat is still being milked” is used.

Feeding

Feeding of roughage	10 times daily with intervals of app. 2.5 h, grass silage with some straw for structure
Concentrate feeding stations	6, placed next to each other
Maximum concentrate yield per day per cow	18.5 kg
Maximum concentrate yield per visit in feeding station	2.0 kg
Maximum concentrate yield per day (in MS)	no limit within ration
Maximum concentrate yield per visit (in MS)	2.5 kg
Dispensing rate	0,5 kg/min

Table 18. Roughage feeding times at Farm B.

2.00	4.30	7.00	9.00	11.30	14.00	16.00	18.30	21.00	23.30

The amount of feed given each time is approximately 400 kg or 160 kg dry matter. This varies depending on the amount of cows in the barn. At 6 o´clock every morning leftover feed is swept from the cows to the heifers.

Concentrate is fed in the concentrate feeding stations, solid 420 and unik.

Stable system

Type of stable	Loose house barn with 3 rows of resting cubicles on one side of the feeding table and place for the recruitment stock on the other side. Natural ventilation through the roof ridge.
Built in year	2005, VMS from start
Resting area	66 cubicles, soon built out to 160, littered with short chopped straw every morning Concrete floor with urine drainage
Manure scraping	Concrete floor automatically scraped every hour, resting cubicles manually scraped 2 times per day
Feeding area	1 eating place for 2.5 cows
Water	8 water bowls along the feeding table, 1 in waiting area, will soon be changed to water tub.
Milking units	2 VMS placed parallel. After milking all cows enter the feeding table area. The floor in the milking stations is flushed for 7 sec between every second cow.
Cow brush	A rotating cow brush is placed near the feeding table just outside the MS exits. Before the second MS was installed, the brush was in front of the separation gate, which worked very well. Since the gate was moved, cows are now in the way of other cows exiting the MS:s and therefore the brush is to be moved. Two more brushes are being bought. See picture 10.
Treatment pen	Placed near exit from MS1, cows are manually moved to/from the treatment pen.
Selection gate	Selection gate at entrance to waiting area (L=waiting area, R=feeding stations), since October 06 the gate is always open

and the cows are able to go backwards to the feeding table area as long as the gate is in the right position. See pictures 12 and 13 in Appendix 2. There is also another passage leading from the concentrate feeding stations to the feeding table area.

Gate settings

Feed-only-animals go left to VMS training if they have not passed this way since more than 12 hours.
Cows due for milking go left until there are 7 animals in the waiting area.
Cows not due for milking, but who should be fed, go right.
Cows due for milking and who have waited at least 10 hours since they were milked go left although there are already 7 animals in the waiting area.
All other cows go right to eat.

Routines in the stable

Workers	Owner+wife, 1 employee, corresponding to 2 full time workers.

System cleaning is performed at approximately 10.30, 18.15 and 01.00 in MS1 and at 10.30 and 01.00 in MS2.

Layout

See drawing,

Pictures from farm B.

Picture 11. The rotating cow brush at Farm B is placed just outside the exit
from the MS:s and has to be moved. The leftmost cow is exiting an MS from milking.

Picture 12. Since the gate was opened up in October 2006, the cows are able to walk backwards from the feeding stations to the feeding table, here is an example.

Picture 13. Six concentrate feeding stations are placed in an area, where the cows can go from the feeding table area when they are not due for milking.

ATTACHMENT 4.

Specification for key factors or VMS performance optimization

Subject			Ref.No.
Specification for key factors or VMS performance optimization			
			Replacing
			New
Issued by	**Department**	**Date**	**Page No.**
Helene Sundborger	VMS	2007-04-20	78
Approved by	**Department**	**Date**	**No. of pages**
Ola Markusson	VMS	Date	83
Recipient			
Herd management program developers			

Background

Many VMS farms are managed in an efficient way regarding cow traffic, feed handling, milking intervals etc. Unfortunately there are a number of farms that don´t succeed very well and that find it hard to know what factors to concentrate on to improve the performance of the farm or how to follow up what they are doing.

The Herd management software of today (2007) gives a lot of information to the farmer but does not tell whether the results of the farm are good or bad. Statistical data can be difficult to interpret, understand and follow up.

Location in the herd management system

It should be easy for the user to find this function. There can be a link from the status window and there can be an icon in the upper icon row.

General

Some important factors of how to judge a VMS farm should be presented in the Herd management software. This should be done automatically once a month or when the user chooses to see the farm results. Each factor should be shown as a rolling average of the last 30 days and with the previous 30 days in brackets.

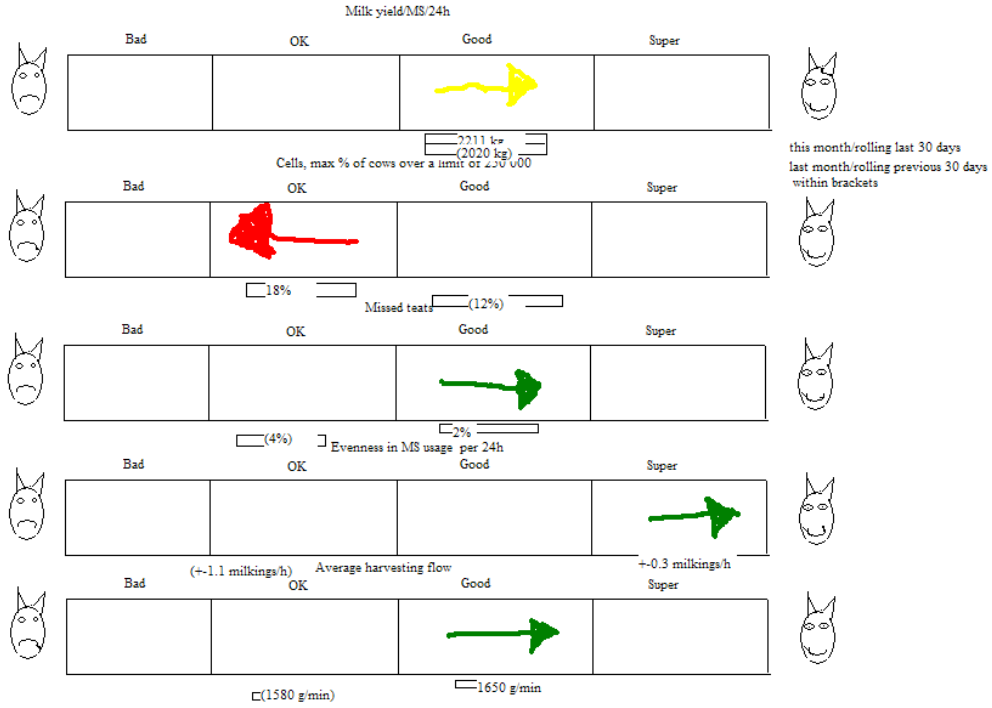
The principle is to display what is bad, ok, good or excellent and also what is improving or impairing. The results should be shown in a very simple way, so that even a person not used to diagrams, numbers etc should easily understand.

It should be possible to export the results to Word, Excel etc. and to print it or save it in a file.

The first step will be to show five factors. Later this can be built on with more factors. The factors can be shown in priority order according to DeLaval and with the possibility for the farmer to change the order.

Display

An example of how to display the results is shown below. The example shows five factors and each factor is displayed between a sad cow (bad/low result) and a happy cow (excellent result). The arrow is green if the factor is nearer the happy cow this month than last month, red if it is nearer the sad cow this month than last month and yellow if it is on the same place as last month. The exact result is written below the arrow for this month and last month´s result in brackets below the place where the arrow was last month.



What to do when something is improving or impairing

It should be possible to double click on each arrow and get a short information text about what is meant and examples of what can be done to improve the result.

Example 1:

Double clicking on the yellow arrow under Milk yield/MS/24h would show this information text:

Last 30 days the milk yield/MS/24h was 2211 kg.

The previous 30 days it was 2020 kg. Thus it is improving!

To improve it even more you can e.g.

- Check your vacuum level
- Check that your camera is clean (clean the sponge)
- etc

Example 2:

Double clicking on the red arrow under Cells – max % of cows over a limit of 250 000 would show this information text:

Last 30 days Cells – max % of cows over a limit of 250 000 was 18%.

The previous 30 days it was 12%. It is thus impairing.

To improve the udder health and avoid high cell counts you can e.g.

- Change/clean the bedding in the resting area
- Change liners if necessary
- Milk the cows with high cell count more often
- etc

Example 3:

Double clicking on the green arrow under Missed teats would show this information text:

Last 30 days Missed teats was 2%.

The previous 30 days it was 4%. It is thus improving!

Keep on working as you do!

Limits for what is bad, ok, good or excellent

Hard to set the limits

The limits of what is considered as bad, ok, good or excellent are very difficult to set. The judge depends on many things, e.g. in which country the farm is situated, which race the cows are, special interests or priorities of the farmer, organic or conventional farming, the size of the herd etc.

Default settings and farm settings

The limits should be set by DeLaval in Sweden (original default setting) but possible to change by DeLaval people in each country (countrywise default setting) and some of them (or all?) also possible to change by the farmer. It should always be possible to turn back to the default setting in case you have changed to something strange or change your mind.

Begin with the farm result

Another possibility is to let the first result of each farm be the ok result and let each farm see how that changes. This would however make it impossible to compare the results between farms, which might be of use.

The factors to be judged

The five factors to start with

After discussions within DeLaval following five factors has been chosen to be the five most important:

1. Milk yield/MS/24h

2. Cells, max % of cows over a limit of 250 000

3. Average harvesting flow

4. Missed teats in MS attach

5. Evenness in MS usage per 24h (except cleaning times)

The table below shows suitable default settings from DeLaval Sweden.

Factor	Time period	Bad	OK	Good	Excellent
Milk yield/MS/24h (kg)	1 month (rolling 30 days)	<1000	1000-1750	1750-2500	>2500
Cells, max % of cows over a limit of 250 000	1 month (rolling 30 days)	>20%	15-20%	10-15%	<10%
Average harvesting flow	1 month (rolling 30	<1200	1200-1600	1600-2000	>2000

(g/min)	days)				
Missed teats in MS attach	1 month (rolling 30 days)	>6%	3-6%	1-3%	<1%
Evenness in MS usage per 24h (except cleaning times)	1 month (rolling 30 days)	+- >2 milkings/hour	+- 1-2 milkings/hour	+-0.5-1 milkings/hour	+- <0.5 milkings/hour

Factors that might be built on in the future

See the list below for examples of factors that can be built on in the future and their limits.

Key factors in a VMS farm to be able to judge the success/performance of the farm

Key factor	Time period	Classification - bad	Classification - ok	Classification - good	Classification – excellent	Comments
Cow-status						
Milk yield/cow/year, kg	Latest year	<8800	8800-9800	9800-10800	>10800	
Milk yield/cow/day, kg	Latest 14 days	<25	25-28	28-31	>31	works only if calvings all-year-round
Milk yield/MS/24h, kg	Latest 1 month	<1000	1000-1750	1750-2500	>2500	
Milkings/cow/24h average, day 1-50 in lact	Latest 1 month	<2	2-2,3	2,3-2,7	2,8-3,2	
Milkings/cow/24h average, day 51-300 in lact	Latest 1 month	<1,8	1,8-2	2-2,3	2,3-2,7	
Evenness of milking intervals per cow	until lact week 40	>3 h + or -	3 h + or -	2 h + or -	1 h + or -	example ok is 8 h + or - 3 h, i e 5-11 hours
Udder Health Class, average	Latest 6 months	>4,0	2,1-4,0	1,1-2,0	<1,0	
Udder Health Class 0-2, % of cows	Latest 6 months	<60% class 0-2	60-75% class 0-2	75-90% class 0-2	>90% class 0-2	
Cells, average per cow	Latest 1 month	>=300	200-300	100-200	10-100	
Cells, max % of cows over a limit of 250 000	Latest 1 month	>20%	15-20%	10-15%	<10%	
Bacteria	Latest 1 month	>25000/ml	10000-25000/ml	5000-10000/ml	<5000/ml	
% of cows treated against masitis	Latest 3 months	>20%	15-20%	5-15%	<5%	
Hoof health, % of cows with hoof problems	Latest 1 month	>20%	15-20%	5-15%	<5%	
Milk minus feed	Latest 1 month	economy…				DDM in future
Hormones???						
Average harvesting flow	Latest 1 month	<1200 g/min	1200-1600 g/min	1600-2000 g/min	>2000 g/min	
Decrease in yield per month of lact, average	Latest 3 months	>4 kg/cow	2,5-4 kg/cow	1,5-2,5 kg/cow	<1,5 kg/cow	
Latest % of expected yield <80%	Latest week					
Produced milk – delivered milk	Latest week					
Culling frequency	Latest 6 months					
VMS-status						
Waiting times in the area before MS, average	Latest 1 month	>1 h	40 min-1 h	15-40 min	<15 min	
Evenness in MS usage per 24h (except cleaning times)	Latest 1 month	>2 milkings + or - /h	1-2 milkings + or - /h	0,5-1 milkings + or - /h	<0,5 milkings + or - /h	graph/histogram in DDM needed

Missed teats	Latest 1 month	>=6%	3-6%	1-3%	<1%	
Incomplete milkings	Latest 1 month	>=6%	3-6%	1-3%	<1%	
Evenness visits to feeding table	% of all cows/30 min	>25% of cows + or -	15-25% of cows + or -	5-15% of cows + or -	<5% of cows + or -	
No of eating occasions/cow, average	Latest 1 month	<5 times/d	5-6 times/d	6-7 times/d	>7 times/d	
No of eating occasions/cow, stdev	Latest 1 month	Some cows<3 times/d	All cows>3 times/d	All cows>4 times/d	All cows>5 times/d	
MS time idling	Latest 1 month	>30%	20-30%	10-20%	0-10%	
Other important factors						
Kick offs	Latest 1 month	lots	many	some	Very few	
No of cow trains per day through gate	Latest week	>12 per gate	6-12 per gate	2-6 per gate	<2 per gate	Depending on the no of passages
Body scoring						may come later, to complicated now
Locomotion scoring						may come later, to complicated now
Actual milking time Average milk flow during actual milking time						
Attach time						
Cleaning teats time						
Milk yield per milking						
Number of unsuccessful cleanings						

EXAMPLE	**Farm 1**		**Farm 2**		**Farm 3**	
Key factor	**Value**	**Classification**	**Value**	**Classification**	**Value**	**Classification**
Cow-status						
Milk yield/cow/year, kg						
Milk yield/cow/day, kg						
Milk yield/MS/24h						
Milkings/cow/24h average, day 1-50 in lact						
Milkings/cow/24h average, day 51-300 in lact						
…et cetera, see above…						

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