The effects of automatic milking with single box facilities on animal behaviour and milk performance on larger farms

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Summary

On the basis of data from two farms with a total of five automatic milking systems[1], the use of the facilities, animal behaviour, frequency of milking and the influence of multiple milkings on the milk yield were analysed. Daily Data was available from 312 days, and was supplemented with data for the monitoring of milk yield. The individual MS are assigned to fixed groups of cows. Cows not appropriate for the MS, were milked in the old herringbone milking parlour. The results show, that with a net milking time of about 14 hours (not including the time required for application, animal change and periods without milkflow) the systems capability was reached. It was also shown, that with more than 42 cows, the milking frequency in the automatic system went down. The cows did not use the system enough in the period from 2 a.m. to 10 a.m. With a mean of 2.89 milkings per cow per day, good values were achieved. With the estimation ability gained through this study, it can be seen that milk performance improvements of about ten percent are realistically attainable, if a good management of the whole system is ensured.

Key words: *Automatic milking, milking capacity, animal behaviour, milk yield.*

Introduction

Automatic milking processes are a future technology for milk producers as a solution for labour, or socio-economic problems. They have a significant impact on animal behaviour, milk yield, labour organisation and agricultural structure. Practical experiences with the implementation of automatic milking systems have been reported by different authors in Schön (2000) or Hogeveen & Meijering (2000). Bohlsen (2000) conducted long-term analyses of several farms using the multiple box system “MS

[1]MS = (Automatic) Milking System(s)

Liberty." His work was part of a larger study (Artmann *et al*., 2000). The publications on single box facilities were based mostly upon short observation periods and small herds. Subsequently, initial results from long term observations from five single box facilities (Trademark "Astronaut") used in two larger closely-co-operating farms were compared. Installation and especially, the first results obtained from single box facilities are presented here.

Farms and installation of the automatic milking systems in the buildings

Two larger commercial (GbR and GmbH) farms in former East Germany serve as the basis for this study. Dairy cattle are the main focus of animal husbandry on the farms. At this time the farms hold a total of 140 and 290 cows respectively. The milk quota is about 1.09 and 2.5*106 litres, respectively. The average yield is 8 500 kg with 3.45 % protein and 4.12 % fat. An annual yield increase of 700 l/ cow and year is expected. The decision to implement an automatic milking system was made because the proximity of the farms to a high-paying industrial area (Volkswagen production centre) made it increasingly difficult to find workers for the farm. Also, to increase yield, the cows were to be milked three times daily. The automatic milking systems were installed on one farm in November and December 1999.

The dairy cows spend the whole year in two L-203 type stables, built during the Communist period. Both stables were remodelled as laying box stalls (one per farm) with slatted floors. Each stable has three laying boxes on the side with feed entrance, and a complete row of boxes on the opposite side. Between the two stables is the milking centre. The room behind the milking parlour is roofed and is used as a deep free yard stall for calving or sick cows.

The automatic milking system is installed in the row of double lying boxes. With a one way gate, the cows can achieve the MS only from the laying area. Due to the givens of the stable, at some points, the cows must pass over the feeding lane. Feed concentrate and water serve as incentives to visit the automatic milking system. The cows are separated into different groups with simple barriers. In the automatic system, only "system conforming" cows are milked. All other cows are milked in the available 2*6 parlour. The reintroduction of cows which have calved or recovered from an illness takes place mostly in the automatic milking systems 1 or 3 of the different farms. In the fourth MS, the cows of the GmbH are milked during their high yield periods, and low performing cows from this farm are milked in the fifth MS. The deciding parameters determining how often the cows are milked each day are tuned differently in each system. During the observation period, a mean of about 230 cows were milked.

Data material and evaluation

Data was collected on the main computer of the MS with an additional program. The files were copied onto ZIP diskettes and transferred to own computers where they were studied and evaluated. Data from the GmbH was available from Feb. 1, 2000, and from the GbR from April 2, 2000 for evaluation. The daily data from the automatic milking system was available from June 6, 2000. Smaller data gaps – due to forgetfulness – could be reconstructed. The last data evaluated is from April 5, 2000. Obtained Data was inspected and evaluated with Access, Excel and SAS. For the calculation of the estimation of milk with the GLM – (General Linear Models) procedure with SAS the following data sets was eliminated: In the case of data without a milk quantity but with a positively or negatively evaluated application, the current and subsequent value; Data with a milking level of <2,5; Data with a calculated interim milking period of <3 or >36 hours; Data from cows lactating more than 450 days.

Results

The following results are based on an evaluation of the files for 312 days (Table 1). The functioning of the facilities could not be observed due to the distance between the two farms. The users described it as good. A view to the evaluation of the length of milk withdrawal (measured from the beginning of the milk flow) no problems occurred during the observation period which could not be solved within one day. Occasional disturbances in the length of milking time indicate short term failures, but these can be attributed to inactive periods due to system tasks. Calculated from the mean values a net milking time[2] of between 576 and 791 minutes per day (without time for application, change of animals, and empty periods).

Table 1. Main data from the MS.

Number of MS	1	2	3	4	5
Number of milkings	41 705	37 770	42 825	42 123	37 715
Number of cows on the MS	47.6	44.6	47.9	45.2	45.7
Milking frequency	2.88	2.80	2.93	3.09	2.87
Milking interval (h)	8.33	8.57	8.19	7.77	8.36
Milk quantity	33.10	22.89	31.73	30.01	19.69
Milking time (min / day)	714	524	699	641	503
Dead milking time(min / day)	77	74	80	86	73

[2]Rising net milking time are only possible by more efficient attachment, faster animal change or reduction of the dead times by cleaning or unoccupied MS.

Since the combination of maximum length of milking time and maximum inactive time for the third MS (Cows in the high phase of lactation) is only 921 minutes and the farmer reports that the MS 3 sometimes reached peak performance levels, it can be concluded that a net milking time of about 14 hours is the current highest capacity level on the studied system. In figure 1, the distribution of the milkings over the course of a day is presented.

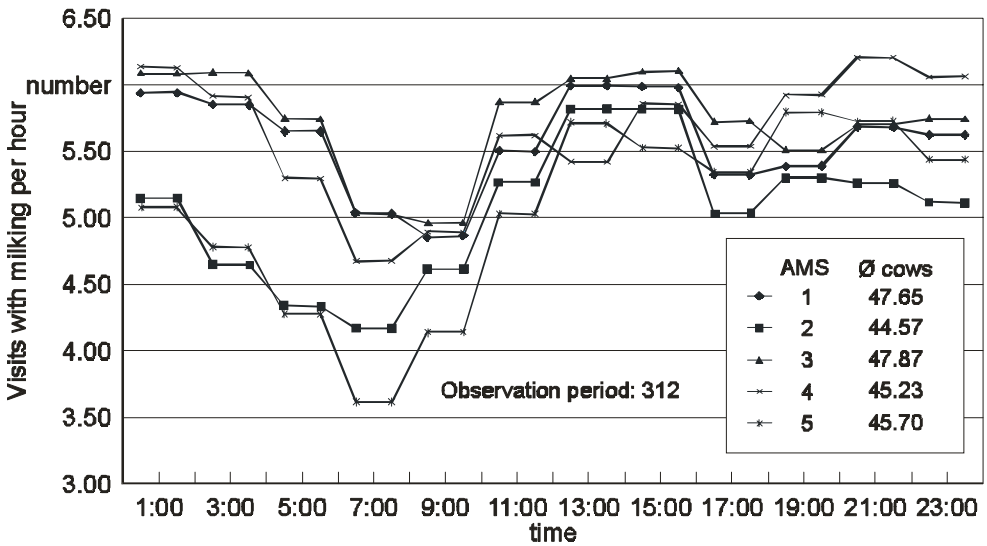

Figure 1. Distribution of milking visits on the MS.

The curves show significant reductions in the visits to the stations from about 2 a.m. to 10 a.m. On the one hand biological resting periods and greater tiredness in advanced lactation stages play a role here (at MS 2 and 5). On the other hand, such management factors as feed presentation, milking of cows which do not voluntarily enter the system, or the instruction of new cows in the system also play a role. A mean of 5.4 milking per hour were carried out. The milking frequency with 2.7 to 3.1 milkings per cow per day is good. A view to the course during the observation period shows that cows lactating longer (MS 2 and 5) are milked less frequently. From a trend function can be seen that the milking frequency declines with an increasing number of cows, it increases with an increasing daily performance of the cows, or rather the amount of daily amount of milk in the MS. The certainty of these estimations are, however, not very secure. With a subsequent GLM function, where the MS number is introduced as a co-variable, a R^2 of 0.65 was achieved.

Milk frequency = f (MS_Nr., Number of Cows, ln (Number of Cows), Daily Amount of Milk, Daily Amount of Milk², ln (Daily amount of milk), daily milk yield)

The differences of the co-efficients of the co-variables are interesting. They show that in comparison to MS 1, the milking frequency of the MS 2 to 5 are above those of MS 1 by 0.3955; 0.1074; 0.2149; and 0.5830 respectively. On the one hand, these values reflect the influence of non-documented cow characteristics, and on the other hand are at least partially related to differing settings in the systems. If one uses the estimated parameters from this model, and varies the number of cows from 35 to 57 cows, and set the daily milking yield to the mean herd performance (27.5 kg / day), then an increase in the mean milking frequency to 3.04 with 42 cows with a subsequent progressive decline is obtained. With 55 cows the frequency was declined to 2.74. This relationship indicates the capacity levels of the system.

In relation to the implementation of MS it has not yet been clearly defined, what effects multiple milkings have on the milk yield. To clarify this question, all available daily data and milk yield data, taken before the daily data, were used. After data preparation 228 043 data sets were available for an estimate of the regression function (GLM) (Table 2). For the Estim- tion the following approach was chosen. It proved to be significant in all parameters

Milk quantity = f (Lactation Number, MI, MI², MI³, Day of Lactation, (Day of Lactation)², ln (Day of Lactation))

Table 2. Description of the most important influence factors.

Variable	Unit	Mean	s	Minimum	Maximum
Milk Quantity	kg	9.92	3.29	2.5	31.1
Milking interval (MI)	h	8.41	2.50	3.02	34.57
Days in Lactation	days	170.51	101.24	4	450

The lactation number was introduced as a co-variable. Only the difference between the first and all further lactations at a level of 5 percent were significant. On the basis of the regression coefficients it was calculated how the milk quantities behave during the course of a lactation under the assumption of different milking intervals (Figure 2). The lactation courses principally show that with an increasing milk frequency (the higher curve is 3.5 milking prow cow and day) the milk performance increases. If the performance for two milkings with 12 h milking interval is set to 100 %, then a very high milking frequency shows a yield increase from almost 20 % and for three daily with the same interval an increase of about 15 %. If a cow visits the MS regularly twice a day, and the milking intervals are not advantageous (8 hours or 16 hours MI) then the milk yield decrease of 2.6 %.

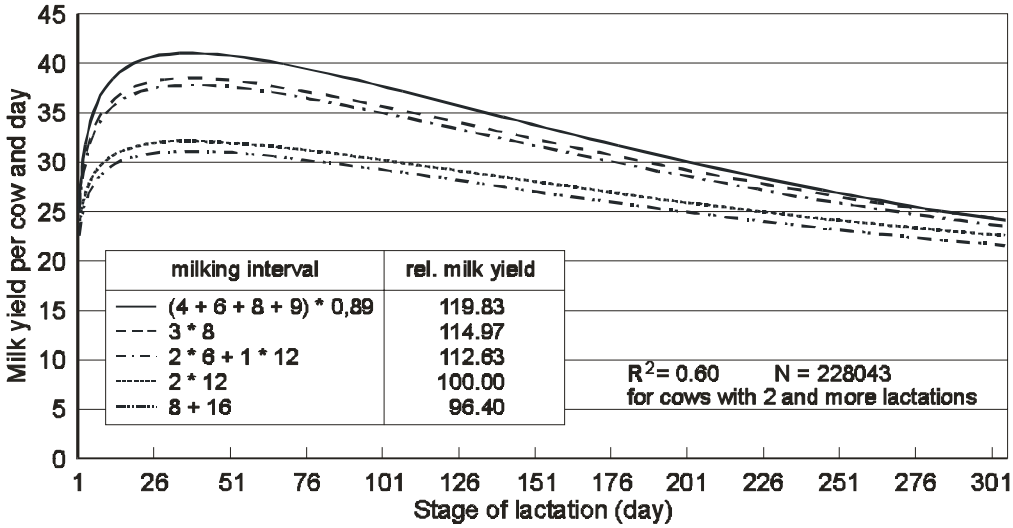

Figure 2. Estimated milk yield by assumed milking intervals.

The calculated milk yield curves assume a consistent milking interval over the course of the lactation. For a realistic estimate, the actual visiting performance of the cow is more important. These evaluations are planned on the basis of the available data, supplemented with future data. The influence of multiple milking on the content of the milk must also be clarified.

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