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Automatic milking with large herds

Effects on facility usage, cow behaviour and milk yield

Data from five „Astronaut" automatic milking systems (AMS) on two farms over 312 days and 14 months respectively were analysed. The results show that the system limit was reached with a net time between milkings of 14 hours (not counting time requirement for attaching clusters, animal movements through the milking points and when the points were unoccupied). Milking frequency started to decrease from 42 cows per system upwards. During mornings, AMS milkings were notably reduced. The milking frequency achieved (2.89/day) is good. It can be assumed from the calculated estimation function that around 10% increases in milking performance can be achieved through three times per day milking.

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Keywords

Automatic milking, milking capacity, animal behaviour, milking frequency, milk yield

Automatic milking systems (AMS) represent a future-oriented technology for milk producers offering solutions to labour management and in-part sociological-economical problems. [1, 2, 3] reports on practical experiences with AMS on commercial farms. Bohlsen [3] analysed over a longer period several commercial farms using the multi-box system „AMS Liberty". His work was part of a larger study [4]. The publications regarding single box milkers have been based mainly on short observation periods with smaller herds.

First results are given here from a long-term observation of five AMS. Herd descriptions, installation and labour organisation, but especially results based on data automatically recorded from the single box milkers, will be presented.

Herds and AMS installation

The investigation was held on two large farms organised respectively as a GbR and a GmbH. Main livestock enterprise in both cases was dairying. At the time 140 and 290 cows were run. Respective quotas were $1.09 \cdot 10^6$ and $2.5 \cdot 10^6$ litres. Average yield was 8500 kg at 3.45% protein and 4.12% fat. The milkers were housed all year in L 203 barns converted to cubicle loose housing with slatted flooring *(fig. 1)*. The area behind the milking point (2•2•6 FGM) is roofed and was used as a bedded court system for calving and sick cows.

The GbR had two and the GmbH three AMS – in each case single-box „Astronaut" milkers. In November and December of 1999 they were built in the double cubicle row building and put into operation. A fixed group of cows was milked by each AMS. Only cows which conformed to the system were milked by the AMS. Cows giving colostrum, those with unsatisfactory udder shape, temporary illness or lameness or the wrong temperament were milked in an existing 2•6 herringbone parlour. Newcalved and convalescent cows were mainly milked through the AMS 1 in the GbR, or the AMS 3 on the GmbH farm. Cows were milked through lactation peak at the GmbH's AMS 4, and AMS 5 handled the low-production animals. During the trial an average 230 cows were being milked.

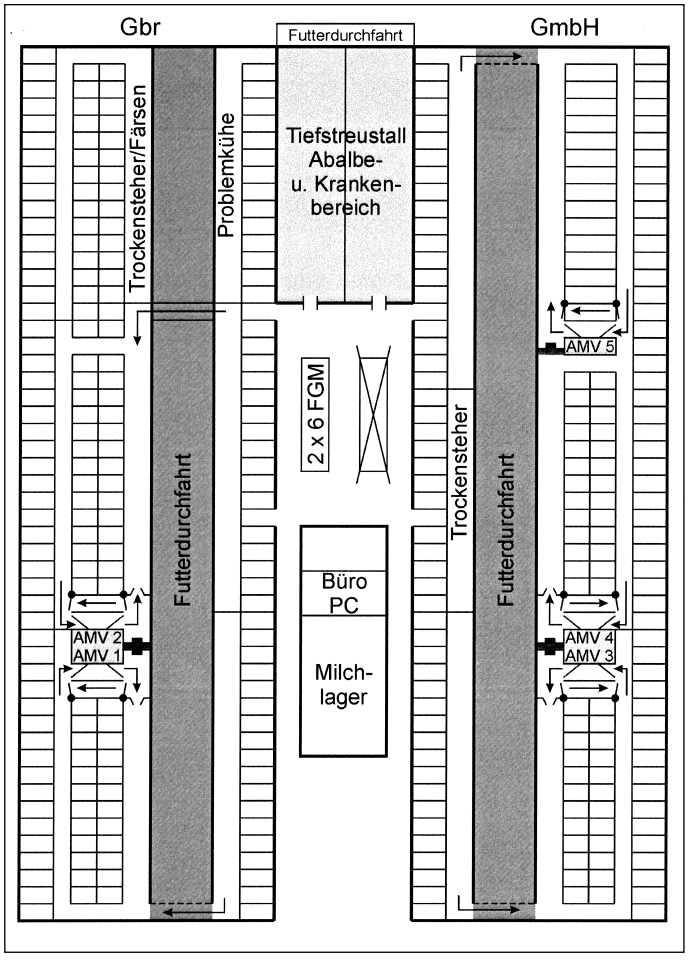

Fig. 1: Housing facility with incorporated automatic milking system

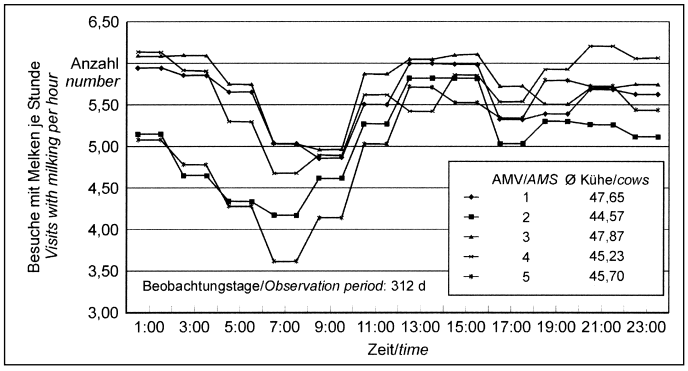

Fig. 2: Distribution of parlour visits with automatic milking systems

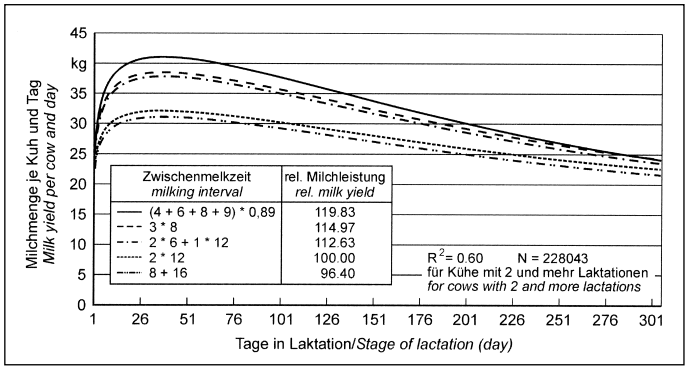

Fig. 3: Estimated milk yields at assumed milking intervals

Data and evaluation

Data collection was through a supplementary program in the AMS control computer. For this the farm manager copied data over several weeks into a separate file, the contents of which were transferred to our computer via zip diskette. Details for the evaluation included milk recording information from 1.2.2000 for the GmbH herd and from 2.4.2000 for the GbR herd. The information recorded daily at the AMS was available from 28.6.2000 to 5.4.2001. Processing and evaluation was carried out over an own programme and Access, Excel and SAS. Ambiguous data was not included in estimations of milk yield in association with milking frequency.

Results

Results were based on evaluation of data from 312 days *(table 1)*.

AMS functioning couldn't be included in the report because of the distance of the farms but this was described as good by the operators. As shown by the evaluation of milking time (starting from first flow), no problems appeared during the observation period which could not be solved within a day. A few gaps in milking time information indicated, however, short breaks which could in part have been caused by system servicing.

The „net utilisation time" can be used as an indirect measurement of AMS performance. This was calculated from milk flow time totals including dead milking time with time for cluster attachment, changing of animals in the box and empty box times left out of the calculation. On average per AMS, milk flow time was between 503 and 714 min/d, and dead time (up to beginning of milk flow) between 73 and 86 min/d. This gave an AMS net utilisation time of between 576 and 791 min/d. In that the combination of maximum milking duration and maximum dead milking duration at AMS 3 (heavy milking cows) was only 921 min/d, and the operator reported that AMS was sometimes working at capacity, a daily net utilisation period of around 14 hours could be taken as representing the current capacity limit of the investigated system. (The net utilisation period can only be improved through more efficient cluster attachment, faster cow changeover in the box and reduction of downtime caused by, e.g., cleaning or the box standing empty.)

Table 1: Basis data of automatic milking system

AMV	1	2	3	4	5
Milkings 10^3	42	38	43	42	38
Cows at the AMS	47.6	44.6	47.9	45.2	45.7
Milking frequency	2.9	2.8	2.9	3.1	2.9
ZMZ (h)	8.3	8.6	8.2	7.8	8.4
Milking-) amount (kg	33.1	22.9	31.7	30.0	19.7
Milking time	714	524	699	641	503
Dead milking time (min/d)	77	74	80	86	73

Figure 2 shows the distribution of milkings throughout the day. The curve progression shows definite breaks in AMS visits, e.g. between 2 and 10 am. This reflects biological rest phases and loss of activity of cows in advanced lactation (at AMS 2 and 5), but also management influences such as feed available, milking of cows not coming voluntarily to the box or training of new cows. On average 5.4 milkings/h took place.

Milking frequencies at the AMS were good at from 2.7 to 3.1 milkings per cow and day. Observation indicated that longer lactating cows (AMS 2 and 5) were milked less often. Trend functions show that milking frequency falls with increasing cow numbers but increases with rising daily yield or the daily amount of milk received by the AMS. With the following general linear model (GLM) which includes the AMS number as co-variable, an R^2 of 0.65 was achieved.

Milking frequency = f (AMV_Nr, NK, ln(NK), TM, TM^2, ln (TM), day's milking)

with NK = number of cows and

TM = amount of milk per AMS and day

The differences between the AMS are interesting. Compared with AMS 1, milking frequencies on AMS 2 and 5 were higher by 0.40; 0.11; 0.21 and 0.58. These results reflected individual cow influences which were not recorded, but also could be caused partly through differing system settings. If one uses the parameter from the above model, varies cow numbers between 35 and 57 and applies as daily milk amount the average herd yield (27.5 kg), then average milking frequency rises to 3.04 with 42 cows with a subsequent reduction. With 55 cows, milking frequency was only 2.74.

When applying AMV, the effect of increased milkings (shorter between-milking times) (ZMZ) on yield is in discussion. Helping to answer this question were 228043 data units. The following approach was chosen:

Milk yield = f (Nr_Lact, ZMZ, ZMZ^2, ZMZ^3, Lact_day, $(Lact\_day)^2$, ln(Lactday)).

The number of the lactation (Nr_Lact) was included as co-variable in the GLM. This showed that only the difference between the first and all further lactations on a 5-%-level was significant. On the basis of the regression coefficients it was calculated how the amount milked in the course of a lactation would be affected when differing ZMZ were applied *(figure 3)*. Lactation curves indicated that milk yield rose along with increasing milking frequency.

If the yield for 2 x day was set at a 100 it was possible with a very high milking frequency to reach a yield increase of nearly 20%, and for 2 x day milking with unsuitable periods between milking a reduced yield of 2.6%. The milk yield curves assume ZMZ that stay the same. The actual behaviour of the cow is decisive for realistic estimations and, with this in mind, achievable yield increase through AMS would lie by 10%, even on well-managed farms.

Literature

Books are signified with •

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