Automatic feeding systems for dairy cattle – potential for optimization in dairy farming

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Abstract

A survey carried out on 18 farms in Switzerland, Germany, Denmark and the Netherlands indicates current trends in cattle feeding. An increasing number of farms are relying on automatic feeding to ease their workload, save time and achieve flexibility. The farms surveyed were practical users of automatic feeding systems.
There are various systems which permit the automation of feeding systems. At present rail-guided feed wagons are the best established in practice, but conveyor belts and self-propelled feeders are also used. The number of feed components used differed just as much as the time requirement.
The working time measurements of the automatic feeding systems (AFS) show, that by using an AFS it is possible to save time and achieve greater flexibility. A significant reduction in working time by comparison with a conventional feed-mixer wagon, however, can only be expected in the case of sizeable herds. The working time requirement for automatic feeding systems depends essentially on the removal technique, distance from the feed store and type of silo.

Keywords: automatic feeding, dairy cattle, state of art, working-time

1. Introduction

Automation has long had a place in dairy farming. Automatic concentrate distributors and automatic milking systems have been successfully used for years. For some time now it has also been possible to automate basic ration distribution.

Feeding without a fully automatic feeding system accounts for approximately 25 % of total working time requirement. After milking, this corresponds to the most working time in dairy farming (Schick, 2006).
State-of-the-art feeding technology allows the automatic distribution of basic ration or a mixed basic and fodder concentrate ration using conveyor belts, rail-guided or self-propelled feed robots. The manufacturers claim that automatic feeding makes for a significant easing of the workload, better feeding hygiene and less feed loss. A survey on this was conducted on farms with automatic feeding, and working time measurements were taken.
The aim was to show which systems were available on the market and whether they came up to expectation.

2. Material and Methods

2.1. Survey

The first part of the project, a survey on the state of the art has been carried out in autumn 2008 on 18 farms with automatic feeding systems. Farms with automatic feeding systems (number of

farms in brackets) were identified in collaboration with the companies Cormall (3), DeLaval (2), Mullerup (5), Pellon (1), Rovibec (4) and Trioliet (3). The data was collected on 18 dairy farms with various models of automatic feeding system from the different manufacturers. Farms in Switzerland, Germany, Denmark and the Netherlands were visited for the purpose. The farmers were surveyed on the basis of a questionnaire relating to various areas of farm structure and mechanisation.
Data on the following farming areas were also collected in the survey:

- Information about the farm
- Feed and feed storage
- Feeding mechanisation
- Incorporation into the building
- Motivation for using an automatic feeding system
- Experience and impact of the automatic feeding system

2.2. Working- time measurements

The second part of the project has been concentrated on the working time measurements of the automatic feeding systems.
The recording of working time data was carried out at task element level in the form of direct measurements taken while observing work on four farms in Germany with rail-guided AFS. Time measurement was effected by means of Pocket-PC and time recording software. The data were entered on a planned-time data base, statistically analysed and incorporated in the PROOF model calculation system (Schick, 2006).
The working time requirement for two farm variants (60 and 120 animals) was then modelled.

The model was based on the following assumptions:

- Daily silage removal and feed table cleaning for a feeder-mixer wagon and rail-guided AFS
- Feeder-mixer wagon capacity: 14 m^3
- When feeding with AFS the herd was split into two lactating groups, no groups were created for the feeder-mixer wagon
- For feed distribution with a feeder-mixer wagon the feed was pushed three times a day, this work did not apply with an AFS
- Ration adjustment programming for AFS was carried out once a week, twice a year for the feeder-mixer wagon
- The ration consisted of five basic fodder components

3. Results

3.1. State of the Art (Survey)

In automatic feeding the interaction of individual elements is important, from feed store to feeding table. There are therefore various technical approaches to AFS (Fig. 1). These include stationary systems such as conveyor belts, and mobile systems such as self-propelled or rail-guided feeder-mixer wagons.

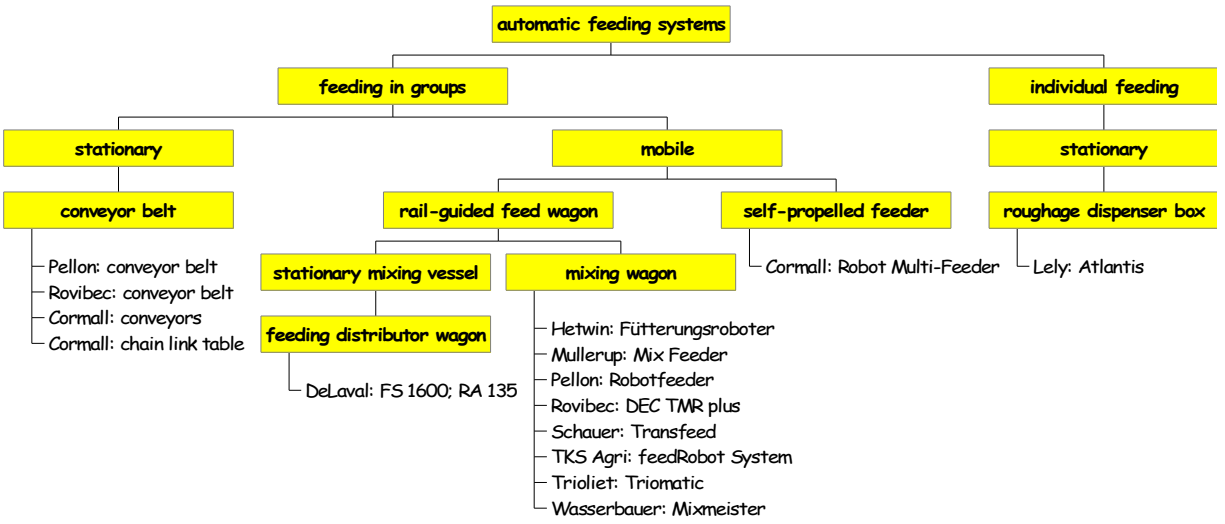

Fig. 1: Organisation chart of the automatic feeding systems

Conveyor belts (Fig. 2 left) are one stationary solution which has already been used on working farms for some time. A plough pushes the feed down from the conveyor belt above the feeding table (Fig. 2 centre).
Bale openers or tower silo cutters automatically load the conveyor belt. A high level of automation is also possible with horizontal silo installations by using in-line mixing vessels. The conveyor belt systems are driven by an electric motor.

Another stationary system is the chain link table (Fig. 2 right). This is a chain with pushers on a narrow feeding table. A conveyor belt takes feed from the storage or mixing vessels to the feeding table. The pushers then distribute the feed on the feeding table for a length of up to 90m.

Fig. 2: Conveyor belts can distribute individual feed components or mixtures. They are either mounted above head height (left and centre) or in the feeder (right), and in new buildings can be built in straight away (left and centre) or retrofitted.

Automatic mobile feeding systems include self-propelled feeders. Cormall's Robot Multi Feeder is fully automatic. The robot is controlled by a sensor and an induction wire let 2-3 cm into the floor. The dispensing wagon can be filled automatically from one or more stationary mixing vessels by doctor rolls and can eject the feed either to the right or left. The Multi Feeder is driven by a diesel engine.

Rail-guided feed wagons (Fig. 3) steer a middle course between stationary conveyor belts or chainlink tables and mobile self-propelled feeders. Here a feed hopper with a weighing device is suspended from a rail. Power is provided by batteries, trailing cables or a supply voltage rail with continuity contacts. Control (frequency of feed distribution, ration composition etc.) is mostly carried out by way of a computer directly at the feed hopper. Here filling takes place at stationary storage or mixing vessels near the feeding table. In rail-guided systems a distinction is generally made between distributor wagons and feed mixer wagons.
An exact description of the systems was given in ART Report 710 (Nydegger & Grothmann, 2009).

Fig. 3: Rail-guided feeding system with dispensers (Pellon)

The visited farms had between 28 and 390 dairy cows, the largest farm being in Denmark with a 3.6 m kg milk quota. The useful agricultural area of the farms varied between 18 and 640 ha; the largest one being a Danish one. Two farms from Switzerland kept their cows in tied housing. The average milk yield was mainly (9 farms) between 8000 and 9000 kg/year.

Up to ten feed components could be automatically fed on the farms. Grass silage and maize silage were mostly utilized for the ration, followed by hay and soya. A total of four farms split their lactating dairy cows into feeding groups, generally divided according to milk yield and lactation stage. The maximum number of the feed distributions was 13 per day, on average fresh feed was dispensed 7.2 times a day on the farms. Most of the farms distributed fresh feed 8 times a day and automatically fed up to ten feed components. Grass and maize silage was most frequently used in the rations, followed by hay and soya. On 16 of the farms individual fodder concentrate was dispensed for the cows.
Grass and maize silage was stored predominantly in a horizontal silo, hay and straw as square bales. Before AFS was installed seven of the 18 farms already fed a total mixed ration with a milling cutter mixer wagon or feeder-mixer wagon.
On two farms the feed distribution started at 3 o'clock in the morning, on other three, between 4 and 5 o'clock and on eight farms between 6 and 7 o'clock in the morning. The feed distribution ended in the period of 17:00 and 2 o'clock at night. Only on one farm, the animals were fed all night.
14 of the 18 farmers stated that the main reason for installing an automatic feeding system would be the savings on the labour burden and on the time. Another reason would be the structural reasons. In new animal buildings the space for the feeding table can be reduced, this way saving construction costs. In old buildings the space gained often serves to expand lying or exercise areas. In old buildings the space gained as part of reorganisation often served as an extended traffic area or lying area. Other reasons are increased flexibility and more accurate herd feeding.

All the farmers rated reliability and functionality as good to very good. Ease of operation was overwhelmingly marked good to very good. Some fault was found with excessively small displays on the feeding robots and a long familiarisation phase. Clear control computer layout was rated by the farmers as good to average.

Following the requisite familiarisation period, the expectations of the feeding system were met on all the farms, especially with regard to reduced working time and flexibility. Many farm managers found that the animals suffered considerably less stress. Thanks to feed distribution several times a day they judged that lower rank animals were able to ingest more and feed better, even with more than one animal per feeding place. Some farms with automatic milking systems found an increase in the number of milkings per day. The reason was assumed to be greater herd activity due to feeding several times a day.
A few farmers expressed reservations about the safety of machinery with automatic start-up, especially as regards children, despite existing emergency stop and cut-off functions.

3.2. Working- time measurements

The data from the measurements of the working- time have been valuated and compared with the ones from the currently used feeding techniques. This shows the potential of time saving in dairy farming when the right feeding technique is utilized.

Working time modelling showed that a farm with 60 animals and AFS had to spend 50.6 manpower minutes (MPmin)/day and a farm with 120 animals 65.2 MPmin/day. This includes the working time requirement for ration management, daily storage container filling and daily feed table cleaning.
Feeding the same herd with a feeder-mixer wagon, including feed distribution and feed pushing three times, would require 71.3 MPmin/day for 60 animals and 202.8 MPmin/day for 120 animals. With a working time saving of 112.15 MPmin/day there are substantial differences in favour of AFS when filling dispensers and a feeder-mixer wagon for 120 animals. In addition, the time requirement for feed distribution does not apply at all to an AFS (Fig. 4).

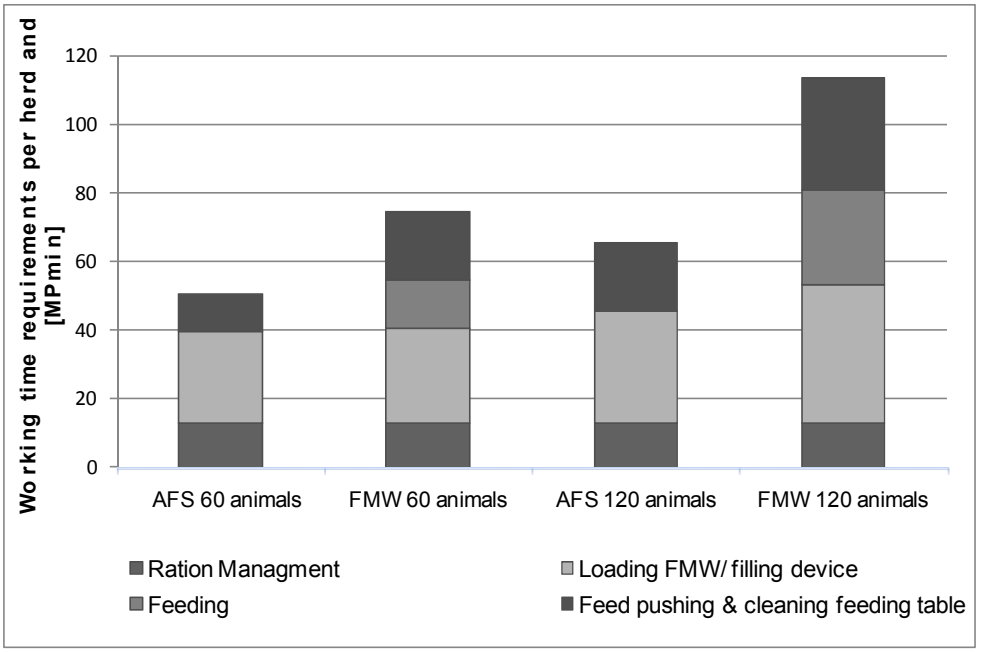

Fig. 4: Comparison of the daily working-time requirement between automatic feeding systems (AFS) and feeder-mixer-wagon (FMW)

4. Conclusions

The survey showed that an automatic feeding system can be installed not only on farms with a big herd or a high milk yield but also on small ones. The prevalence of the automatic feeding systems is focused on most of the parts from Scandinavia, Denmark and the Netherlands, however the interest in other countries is continuously increasing. Many farmers had stated that they reached increased work flexibility, the system proving to be very good at times of peak workload. All the farmers rated reliability and functionality as good to very good.
Many farmers stated that their animals were significantly less stressed. Due to feeding several times per day, even with more than an animal per feeding place, they thought that low-ranking animals were able to take more and better feed.

By using an AFS it is possible to save time and achieve greater flexibility. A significant reduction in working time by comparison with a conventional feed-mixer wagon, however, can only be expected in the case of sizeable herds. It appears that not much time can be saved with herds numbering 60 animals, but flexibility for the farm manager becomes significantly greater. In view of the relatively high amount invested in an AFS, the profitability of such a system must be

decided on a farm by farm basis. In principle an AFS can be a good opportunity for optimising working time and workload in dairy farming.
Working time measurement modelling showed a significantly lower time requirement for AFS than for a conventional feeder-mixer wagon. This supports corresponding statements by farmers in the survey conducted previously (Nydegger & Grothmann, 2009).
Bisaglia et al. (2008) arrived at a similar result in a simulated comparison of working times between AFS and feeder-mixer wagons. Assuming a herd of 150 milking cows, the daily working time saving with AFS is 100 minutes.

AFS are relatively expensive and require a high initial investment (approx. € 80,000 – 170,000). The reason is that if at all possible they should be used for all feeding groups, including dry cows and young animals. The storage containers for the various feed components, particularly roughage, account for a substantial proportion of the investment cost, so the number of basic ration components used has a major effect on investment cost.

Many farmers stated that their animals were significantly less stressed. Due to feeding several times a day, even with more than one animal per feeding place, they thought that low-ranking animals were able to take more and better feed. Some farmers saw this result in a higher milk yield and better fat-protein ratio, particularly during the first lactation.

The hypothesis that the increase of the feeding frequency by using an automatic feeding system could have an influence on the performance of the animals or on the milk composition will be subject of further investigations.

5. Literature

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