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Precision livestock management

A new approach for competitive livestock management more in line with animal welfare

Precision plant production is considered world-wide to be an innovative procedure. The basic idea of surveying environmental and production data on an exact and differentiated basis and controlling the production process on the basis of these data can also be transferred to livestock management, whereby computer supported sub-processes can be integrated in an overall system. The basis for precision livestock management is electronic identification of individual animals and recording of performance and animal data. By exchanging information between system elements, individual animal care and far-reaching automation of all work operations is possible. This permits new housing systems which satisfy higher requirements of animal welfare and cost effectiveness.

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The basic principle of precision farming is based on plot-related data survey and process control, without sacrificing the technological advantages of large-scale farming. By analogy with this, precision livestock management relates to data acquisition, animal supervision, feeding and herd management all related to the individual animal (*fig. 1*). Thus in relatively large herds it is possible to completely exhaust the genetic performance potential of each individual animal, without having to sacrifice herd management geared to animal welfare.

Precision livestock management taking precision dairying as an example

Technical solutions and new approaches to livestock management which are both competitive and at the same time in line with animal and environmental requirements are explained and considered, taking dairy farming as an example. The key technology is a low-cost, electronically readable and tamper-proof animal identification. With the individual animal identification cows can be surveyed, steered and monitored in the function areas feeding, milking and resting (*fig. 2*).

Precision feeding methods

Many loose housing farms already apply individual concentrate feeding via demand feeding. The feed concentrate demanded and the feeding frequency of each individual animal are at the same time recorded for the herd management.

For performance-related, individual overall balancing it is necessary to record and steer the individual total feed intake too. For this purpose weighing troughs have been developed in which the cow is identified at the feeding rack and the feed intake is determined by the difference in weight in the trough.

The results show substantial fluctuations in the basic feed intake of the individual animals. The data are an important indication of the individual basic feed conversion of the animals, for breeding, and also for early identification of nutritional physiology disturbances. However, the high technical outlay for individual animal recording of basic feed intake can currently only be justified on experimental farms. On practical farms, the individual feeding frequency and/or feeding time at the feeding table can be recorded as an auxiliary quantity at justifiable expense. It might also be possible to measure the individual feed intake on a sample basis using a few weighing troughs.

Automatic milking

Whereas systems are available for animal identification and to a limited extent for precision feeding, there has so far been a lack of automated milking systems suitable for practical use. The first successful experiments in automating milking were carried out in the eighties [1, 2]. Some of these function models became the basis for further developments as marketable systems. At the present time over 400 automatic milking systems are installed world-wide, above all in the Netherlands. They are of central importance for animal surveillance and process control within the context of precision dairying.

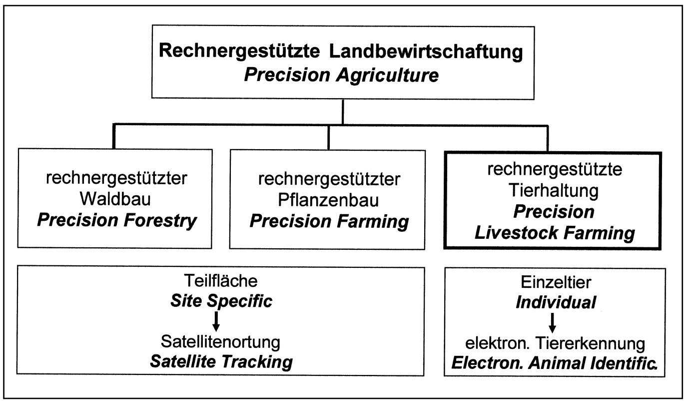

Fig. 1: Computer-aided methods in farming

In automatic milking systems one milking cluster is sufficient for up to 60 lactating cows. That is why a high outlay in electronic subsystems for quality and animal supervision is justified for the individual milking cluster. A few examples are set out below:

Milking frequency and milk yield
In the case of automatic milking, in addition to the milk yield, data on milking behaviour are also available, especially as regards milking frequency. By combining the two data records it is not only possible to draw conclusions on the performance development, but also to identify initial indications of disturbances in animal behaviour and animal health. Short-term drops in yield are frequently connected with a change in milking frequency. The causes (for instance foot diseases) are to be investigated.

Quarter milk
Quarter-milk-related milk flow curves serve to optimise milk withdrawal (for instance via quarter-milk-related steering of milk withdrawal), but also provide first indications of current secretion disturbances.

Milk quality
In automatic milking it is vital to monitor milk quality and udder health, since there is no visual check by the milker. In order to identify udder diseases, the electrical conductivity of the milk is currently primarily used. Various examinations have shown, however, that the electrical conductivity cannot identify mastitis diseases with a sufficiently high degree of precision [3]. An udder-quarter-specific survey of the electrical conductivity is not sufficient either. That is why further parameters are to be included for more comprehensive monitoring of udder health and milk quality, such as for instance body temperature, or optical monitoring of the milk condition. These data are to be evaluated with „more intelligent“ programmes.

Oestrus detection
If only activity is used to identify oestrus, about 70 to 80 % of the oestrus incidents can be determined correctly, but with wrong positive report of about 20 to 30 % [4]. By linking these data with the milk temperature, the hit – miss quota can be improved [5]. The use of improved evaluation algorithms such as the Fuzzy Logic Method appears to be particularly successful [6].

Animal behaviour
Automatic milking systems can be supplemented with relatively little technical outlay with passage monitoring in the rest area and feeding area. This makes it possible to record the time spent by the animals in the resting, milking and feeding areas and to evaluate these. Initial evaluations on the time-space behaviour of cows in loose boxes show considerable differences between the individual animals and daily fluctuations.

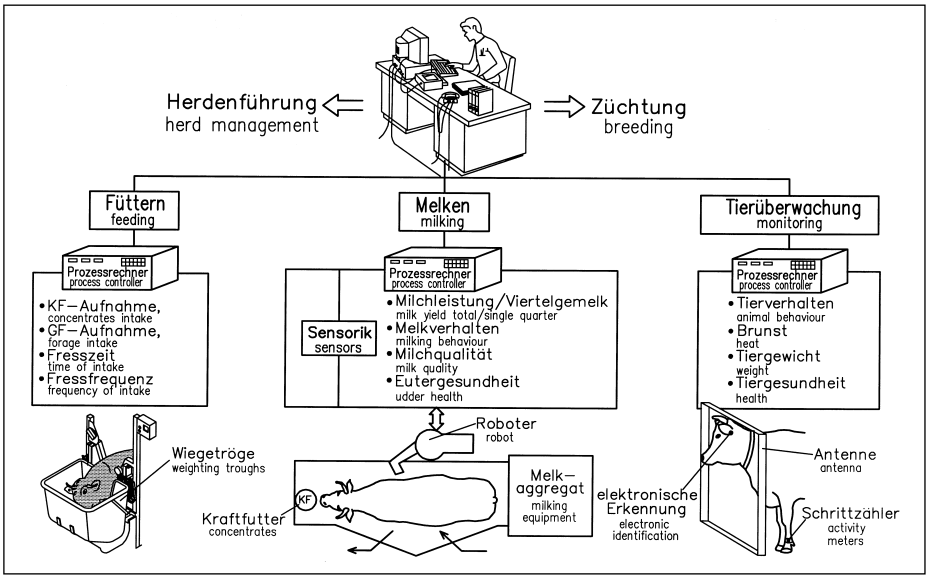

Fig. 2: Computer-aided animal husbandry, using the example dairying

Consequences of precision dairying for designing management systems

Precision management methods, and in particular automatic milking systems, make a fundamentally new approach possible in the developments of new management systems in dairy cattle farming, with a series of crucial advantages.

1. Precision housing systems make it possible to keep the animals more in line with animal requirements, at the same time with intensive individual animal feeding and animal monitoring.
2. The production rhythm is not determined by the human work rhythm (two sessions a day in the animal housing), but by the life rhythm of the animal in feed intake and milk yield. This leads inter alia to an improvement in performance willingness.
3. Humans are released from being closely tied to their work cycles. This not only improves work conditions to a critical extent, but also makes it possible to design the housing systems consistently in line with animal requirements.

On the basis of these findings various outdoor climate housings with loose boxes have been developed in recent years, whereby the loose box housing with outdoor feeding represents a good compromise between wind and weather protection and the need of the animals for climatic stimuli. The minimum construction investments require 4-row loose box housing for medium-sized herds [7]. This is also a favourable solution for automatic milking systems. The compact construction method (short paths for the animals) and consistent separation of resting and feeding areas allow favourable cow handling.

Conclusions

The scientific challenge and the objective of future research work lie not only in further automation of work procedures, but above all in steering and monitoring the animal/technology/environment interactions, with housing systems close to nature. Further sensors are necessary for this in order to record physiological animal parameters, health status, feed intake, product quality and environmental parameters completely. In addition, biological-technical models for process control and monitoring are necessary in order to keep high-performing animals on a competitive basis, in line with animal and environmental requirements. This requires a research network between various disciplines, including economic and ecological impact assessment.