

REQUIREMENTS FOR AUTOMATIC FEEDING SYSTEMS IN SOUTHERN GERMAN DAIRY FARMS

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ABSTRACT

In recent years, automatic milking systems have found widespread use in southern Germany. For automatic feeding systems a similar trend is predicted. In an online survey, the technological and structural needs of farmers were analysed. It is revealed that the current situation and the desired situation on farms about feeding times differ from each other, which is a driving force. Most farmers feed twice a day (43%), fewer once a day (29%). 34 % of the respondents consider feeding four times a day and 31 % feeding three times a day as meaningful. It turns out that especially the technical reliability and safety for humans and animals are the “absolute priority” or “very important” for 92% bzw. 75%. Not a single respondent choose “undetermined” or “unimportant”. The first economic related priority is time savings. It shows that most people are not very familiar with automatic machinery and need to build up trust first, in advance to the known economic benefits.

Keywords: automatic feeding systems, smart dairy farming, South Germany.

1. INTRODUCTION

Automation is playing an increasingly important role in dairy cattle farming (Ordolff, 2001). Automatic milking systems (AMS) have become widely used in recent years. The main reasons given by the farms were the cutting of work peaks and the flexibilisation of work. Thus, it is understandable that feeding as the next working block will now be the focus of automation (Oberschätzl-Kopp, 2016).

It is interesting that hereby a development from the twenties of the last century is taken up again. Feed is provided to the cows via crane or conveyor systems from high or low silos. The still existing 1930 GDR (German Democratic Republic) type systems partly use their automated belt feeding systems until today. From the 1960s, however, the trend went away from automated feed systems for dairy cows in Western and Southern Germany because the safety of the sampling systems was not always optimally guaranteed. They were replaced by silo and silo cutter and later by silo and feed mixer (Eichhorn, 1985).

The automatic feed systems (AFS) currently available on the market can be divided into several automation levels (Oberschätzl, 2015; Bernhardt, 2019). The easiest level is the food pusher. Here, the feed is still provided with conventional technology but the regular refeeding is done via a corresponding robot. The feed can also be mixed up once again or an additional attraction effect can be achieved by additional concentrates. As a result, the worker is only bound to the feeding times and

the post-shift times distributed throughout the day are automated. The next level is feed distributors. The feed is provided in a feed centre. At the feeding times it is mixed and distributed. Either mixing and distributing is done in one engineering unit, or if more amount is needed per time, mixing and distributing are done in separate units. Most of the distribution units are steered over rails or tracks, whereby they are mostly used in newly built stables. In recent years, autonomous systems without permanently installed control systems are used in the barn. By adding manual control units, these can also be used in old buildings. In this second automation level, the worker is needed only for transferring the feed to the feeding centre. Depending on the storage time of the feed, this work only occurs between once a day and every five days. In between, the employee is responsible only for control and management, which he can flexibly divide accordingly (Doupbrate, 2009).

In order to exclude the possible spoilage of the feed by the intermediate storage in the feeding centre, AFS are also recently offered that can bring the feed independently from the storage silos. These systems are completely autonomous and thus represent the third level of automation. Here, the human labour is needed only for control and management (Kolstrup, 2013).

The aim of this study is to record the technical and specific characteristics that an AFS must meet in order to be accepted by the majority of cattle farmers in southern Germany.

2. METHODOLOGY

A questionnaire was developed for the study to examine the further interest and present knowledge in the southern German agriculture regarding AFS. The questionnaire is based on four expert interviews. The four interview partners cover the areas of practical agriculture, agricultural organizations, AFS manufacturers and scientists. There were very different points of view. All of them, however, referred to working hours, safety and maintenance. On the basis of this experience and the existing literature, a questionnaire design was developed and tested in a pretest with three farms. After the revision, an online questionnaire was developed. The "SurveyMonkey" platform was used, because it best met the requirements.

The structural objectives were that the questionnaire addresses a wide variety of farm types and guides them through the questionnaire, depending on their answers. This is to prevent the premature termination of the questionnaire by questions that are inappropriate for the farmer. The processing time was 10 to a maximum of 15 minutes, so as not to discourage farmers. The language style was adapted to the respondents. The majority of the questions were chosen in multiple-choice format, because much information can be collected with a small effort for the respondent. Corresponding blocks of information were used during the questionnaire, which served the participant as support in relation to the course of the questionnaire or as information on the current state of the art in case of ambiguity.

The questionnaire was divided into several blocks. After two introductory qualification questions, which clarified the affiliation to the investigation group, a block with general operational questions followed. Subsequently, the focus was put on the usual feeding. In the remainder of the survey, the questions relate to the techniques available on the market. It was asked for the opinion of the respondent and suggestions for improvement. Whereby, however, it was important to inform about the current state of the art in case of ignorance. In order not to frighten the respondents or to trigger negative feelings, care was taken to keep this information as short as possible and to list only the most important.

The questionnaire was active on the portal from 16 April to 6 June 2018. In order to activate the farmer target group different approaches were chosen, whereby the personal address or via known persons and Facebook were the most successful.

During the period of publication, a total of 112 questionnaires were obtained. Due to partial breakage or completion errors, partially incomplete questionnaires are also available. Over the entire questionnaire, however, the minimum answering density is 33.

3. RESULTS

The analysis of the questionnaires showed that the online questionnaire was more likely to attract farm owner or young farm managers. As a result, 86 % of those surveyed were under the age of 35 and farm owners (39 %), farm managers (25 %) or co-entrepreneurs (9 %). Related to the type of farm, 75 % were dairy farmers and the others cattle rams or other cattle. Participants share a 77 % conventional farmers and 23 % organic farmers distribution. The average farm size was 130 dairy cows, with mostly 2 performance groups, which speaks for southern German dairy farms rather for larger farms in the investigation. The farms are run by 2.5 people, most of whom are family members. The typical form of keeping is the cubicle housing and 50 % of the cows have seasonal pasture access. These values show that the target group of sustainable family-run dairy farms in southern Germany is well represented by the questionnaire.

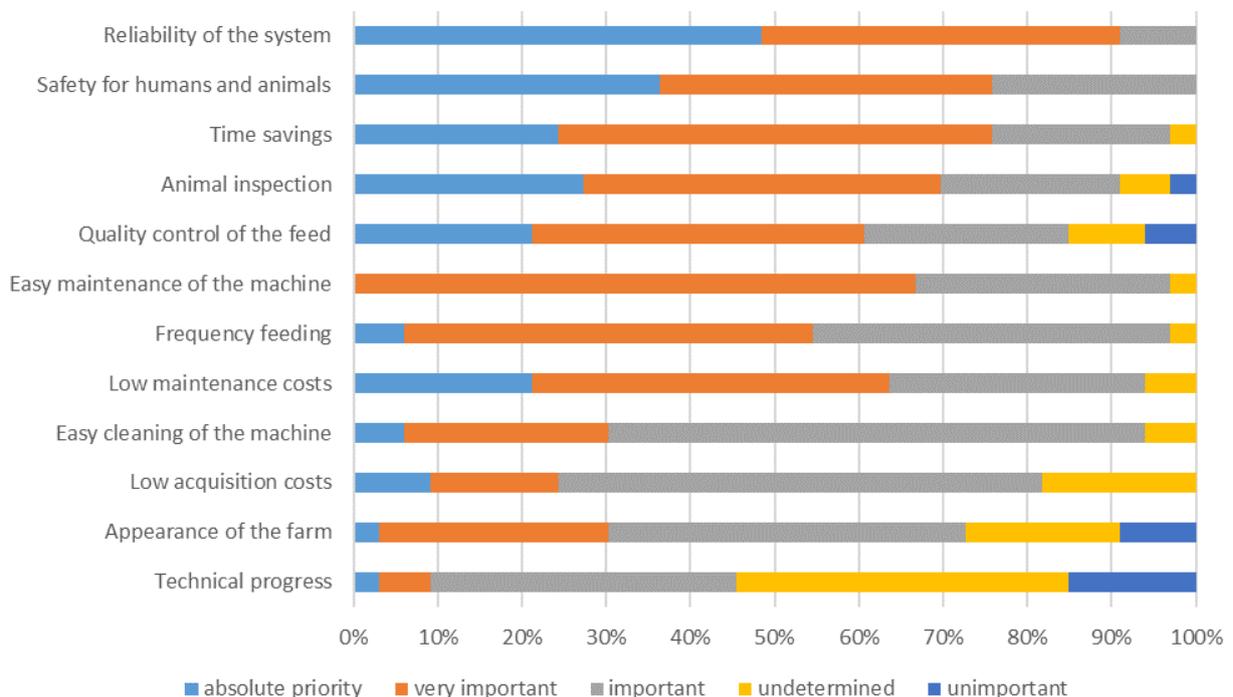


Figure 1. User requirements for automatic feeding systems

The analysis of the current feeding shows that 43 % of the farmers feed twice a day, but 29 % feed only once a day. In the subsequent question about the number of feedings that are considered meaningful, 34 % of the respondents decide to feed four times a day and 31 % to feed three times. This shows that the current situation and the desired situation differ from each other. The reason for this is usually in the labour force equipment. This problem of feeding and workload is also reflected in the query of daily working hours for feeding. Here, the values vary extremely. Within the replies, values appear that can be easily classified as unrealistic by simple calculations. Such jumps in value are often a sign that no exact farm data are known. The typical feeding technique is the attached feed mixer with 47 %. In addition, self-propelled feed mixers and silo block cutters are used.

The second part of the questionnaire deals with the topic of automation at the farms. In 45 % of the farms, there is no automation, 25 % have an automatic milking system, an automatic manure gate and / or an automatic feeder.

At the beginning, the requirements of the farms were queried to the AFS in order not to falsify the answers with already asked detailed questions. Based on the distribution in Figure 1, it can be stated that, above all, the "reliability of the system" has "absolute priority" among the persons surveyed or is "very important". As well as very important characteristic was mentioned above all the "security for

humans and animals" as well as the "time saving". Less important were "technical progress" and "modernization of the business". The factors "animal control" and "quality control of feed" are also important for the persons interviewed. The importance of low acquisition or low maintenance costs is in the midfield.

The reliability of the system is an important point. This concerns in particular the failure safety of the plant, since, depending on the system, the building structure is restructured in such a way that it can no longer be fed with a standard system. The feeding can then be done only by hand which is a significant peak work in the number of animals. Also important in this context is the proximity to customer service. This is the most important aspect of choosing between different manufacturers in most farms. In this group of questions there were also often reported experiences of old AFS from the 1960s, even if the farmer has not personally experienced this.

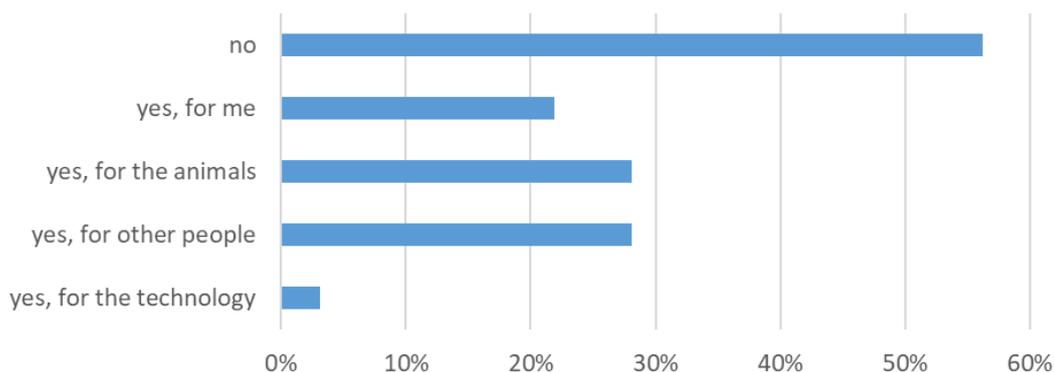


Figure 2. Security concerns for automatic feeding systems

Also, with a very high priority the security for humans and animal was mentioned (Figure 2). In comparison, 56 % of respondents see no direct danger despite this high priority across all farms. The main concern of the respondents is the safety of animals and third persons (28 % each), especially in fully autonomous systems with their own feed intake in the silo.

In feed quality, 58 % tend to direct silo removal without intermediate storage to prevent feed spoilage. Short-term temporary storage of up to one day would still be acceptable for 39 %.

The responses about the control options of the AFS are evenly distributed over all possible answers, only the control via a remote control was considered sensible by only 27 %. The most popular is the control of an app for the smartphone (63 %).

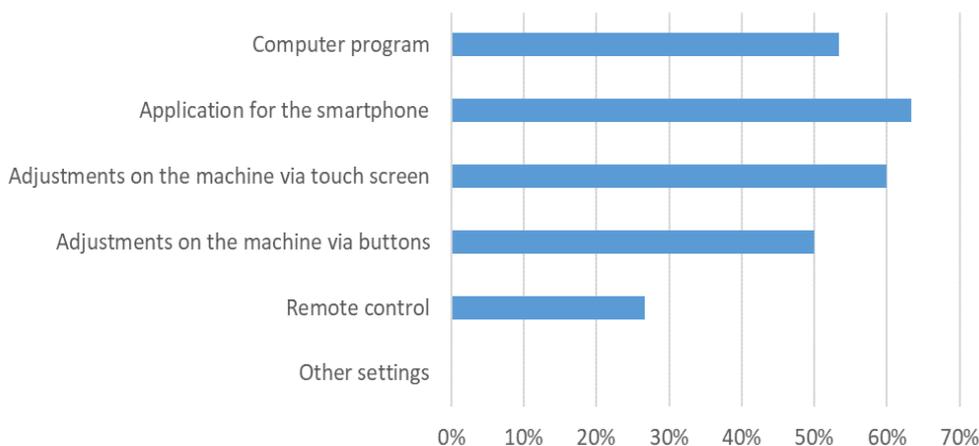


Figure 3. Control system for automatic feeding systems

The targeted energy supply of the system also reveals the trend towards electrical drives in agriculture. A previous study revealed that 52 % would prefer to drive on batteries, 27 % would prefer a separate

track and only 21 % would choose a combustion engine (Oberschätzl-Kopp, 2018). In this picture also fits the 45 % of respondents' self-generated electricity for operation use.

Clearly answered was the question whether the AFS was manually generated, e.g. should be used in old buildings. This was answered by 100 % of the farms with yes.

As the analysis of willingness to pay illustrates, there is a clear tendency that respondents are willing to spend more, depending on the level of automation. While a simple feed pusher is only worth a maximum of € 10,000 (71 %) for most participants, they are willing to spend up to € 50,000 (84 %) on the current standard (attached, externally loaded mixing wagon). For a semi-automatic system, the respondents say costs of € 75,000 are reasonable (90 %), while a fully automated system may cost up to € 100,000 (80 %). Only 5 people (16 %) were willing to invest up to 150,000 € for the fully automatic variant.

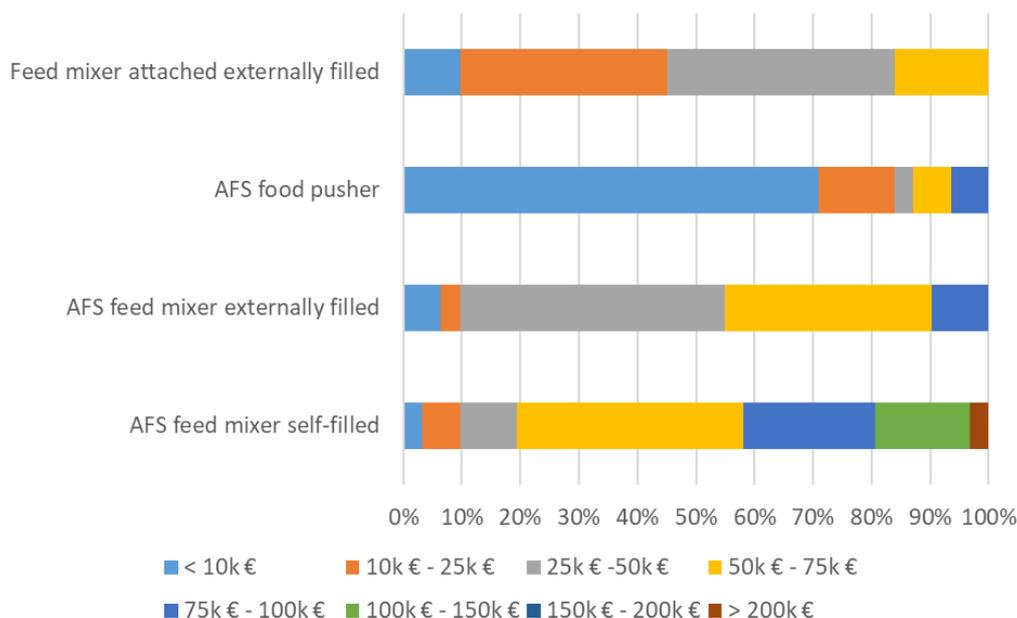


Figure 4. Cost estimate for an automatic feeding system

4. DISCUSSION

The evaluation of the questionnaire revealed some clear preferences. So it was considered by all participants to be useful to be able to use an AFS manually even in old buildings. The most important for the respondents was the reliability of an AFS. In addition, the high feed quality must be ensured by the correct storage of the feed, even outside the silos. Another advantage for the participants was the combination of mixing and transport wagon, i.e. a departure from the stationary mixer. The energy supply with batteries was the most preferred.

Some of the respondents' concerns could also be categorized. Doubts about security are rather subliminal, while the technical reliability of the AFS is in the foreground. Looking back at the interviews that led to the development of the questionnaire, connections could be established. The Farmers subgroup has already expressed concerns about a possible machine failure, as well as a possible lack of service by the manufacturers.

It was interesting that the majority of the participants were prepared to invest a higher sum in the acquisition of an AFS, if this can then be operated more cost-effectively and effectively saves working time.

5. CONCLUSIONS

It is noticeable in the investigation that, despite many young respondents, a certain scepticism can be observed. This is probably explained by the lack of knowledge about automated systems. Currently, it seems that the worries about safety dominate the debate about these automatic feeding systems rather than its many advantages. The industry needs to pick up this discussion and convince potential users about their safety issues with good communications, practical testing and relatable advertising.

Working hours play a crucial role for AFS as feeding after milking is the second major work block in classic operation. Therefore, it is assumed that especially companies with AMS will be interested in AFS in the future. This aspect was also experienced in the survey. However, it is to be observed that the possible change cause uncertainties in the field of animal control. This is currently involved in feeding and would then have to be reorganized. The shifts from physical work in feeding to more mental work in animal management is difficult to estimate by respondents. Sometimes it is even mentioned if this does not make even more work than now. This indicates the complexity and abstractness of automation and digital processes farmers are faced with. Companies need a clear vision and understanding of their products to simplify and increase usability for farmers.

Also important for farms is the flexible use in old buildings or with a manual driver, which speaks against rail-bound systems. For fully autonomous systems that bring the feed itself in the silo speaks the desire for high forage quality without intermediate storage. Farmers know the impact of not only varying components in ratios but also its nutrition quality. It has to be goal to automate routine work that is also not very crucial. Work that is very critical for the processes on farm need to be supervise easily by the farmer. The expansion of renewable energies and the trend towards sustainability and autarchy are reflected in the result, that Electric drive systems are preferred by most farmers. It can be expected that more farm machines will be available with electric drive in near future.

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