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RESEARCH ARTICLE OPEN ACCESS

Effects on the Milk Yield caused by an AMS Energy Failure

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SUMMARY

Scientific experiments within the design approach "Integrated Dairy Farming – Stable 4.0" have been carried out to investigate cattle behavior in an AMS under a power cut of limited time. Milk yield and animal welfare were under particular focus. The results show various reactions under stress and, in particular, we observed a decrease in milk yield, not only of individual animals but also of the whole herd**.**

Keywords: AMS, energy failure, milk yield, stable 4.0, animal welfare

I. INTRODUCTION AND OBJECTIVES

A variety of factors, such as less physical work, more flexibility and ~~an~~ individual milking require a significant increase in automatization in Bavarian dairy farms today. Nowadays approximately 1,200 dairy farms use automatic milking sytems (AMS) (Sprengel and Korndörfer, 2014).

The use of an AMS requires a change not only ofwork organization, but also of energy management. This energy managementmust ensure that the required network capacity for the automatization is available 24 hours per day. Studies have shown that Europe's power grid stabilityhas been relatively reliable in recent years. However, supply reliability varies between member states (Roon and Buber, 2013).

There have been significant power cuts in Europe all the same, most recently on July 1, 2015 in France about 600,000 private householdswere without electricity for some time, and on April 8, 2014 in Munich, about 26,000 households had tocope without electricity for more than two hours.

Especially the extremely highly mechanized and automated dairy farms of the future will require energyincreasingly for electricity and heat. The project "Integrated Dairy Farming - Barn 4. 0" (Höld et al., 2015) was established in order to attain a highproportion of self-produced energy in total power consumption on the one hand and to minimize the strain on the public power grid on the other(Höld et al., 20015).

The aim of the sub-project "animal technology interaction" within the concept approach "Stable 4.0" is to quantify possible stress reactions of dairy cows to failures of milking robots due to power cuts. Heart frequency and variability were measured, release of cortisol metabolites, rumination activity, movements and behaviour were recorded and evaluated in order to recognize possible stress reactions.

This study examines the number of AMS visits in relation to the milk yield before, during and after a simulated power cut. The effects were shown on individual cows as well as on the whole herd.

II. MATERIAL AND METHODS

The study was carried out on four commercial dairy farms (B1 to B4) in Bavaria, Germany from March 2014 to August 2014. The farmers used Lely astronaut milking technology.

The number of milking cows in the respective companies was between 52 and 73. On every test farm 12 lactating cows, Fleckvieh,wereselected. In each of these farms cattle both in calf and in cycle were monitored. The number of lactations between one and seven, and averaged 2.4. The cows were between two and eight years old. The average age was therefore 3.9 years and slightly below the average age of German milk cattle of 4.6 years in 2011 (ADR, 2013). The tests took 13 days per farm in each case. Pulse belts to measure heart activity were put on to the animals six days before data admission so that they could get used to the test procedure (habituation). Data was collected for more than seven days on each farm, every basal measurement lasting for three days and the test measurement itself four days.

The basal measurement showed the state of the animals without any influence of AMS failure by power cuts. For the real test measurement the usual milking behaviour of the focus cows was analyzed and then the milking right of the respective focus cow was blocked, for two hours within 24 hours on the first day of testing(block time). On the second day of testing the milking right was blocked for four hours to raise the likelihood of an AMS refusal. On the following two days of testing the block time was fixed individually per cow from two to a maximum of four hours, to avoid a too high strain on the udderand in order to not reduce the milk yield too far.

The relevant data for the parameters "milk yield" and "forecast milk yield" were obtained from Lely Holding S.à r.l.'s software programme for the Astronaut milking technology (Lely, n.d.) of the third farm B3.

First all data were collected using the programme Excel 2010, processed graphically and are currently being evaluated with the programme "R" (R version 3. 0. 1, The R foundation for Statistical Computing).

III. RESULTS

Video monitoring showed that direct stress reactions of the cows can clearly be observed over a longer period than the actual "technology failure".It could be observed, among other things, that some cows despite possessing a milking right did not voluntarily visit the AMS any more for several hours, but had to be driven there by the farm manager. First evaluations of the focus cows' milk yield showed that not only at the time of the simulated energy failure, but also already in the habituation phase a difference between the forecast and actual milk yields appeared.

By programming block times for the respective focus cows the number of AMS visits increased.

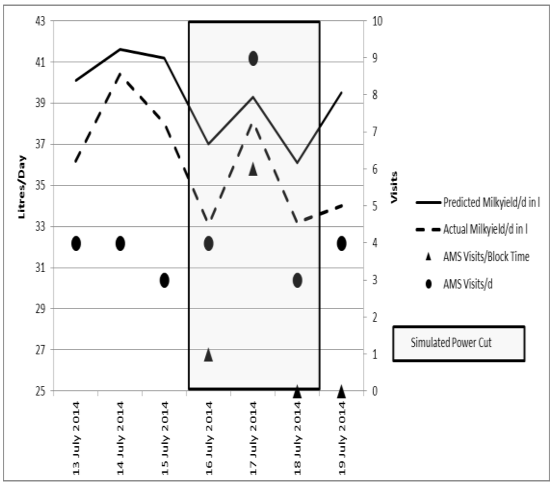

Fig. 1 milk yield and AMS visits of focus cow 6 B3

Figure 1 shows exemplarily that the collected milk of focus cow 6 of farm B3 on average was 3.1 liters under the milk yield predicted by the robot. The biggest divergence of 5.5 liters was observed on the last of testing. On this day block times were no longer set for any focus cows within the AMS.

Focus cow 6 of B3 visited the AMS on an average 3.75 times per day and was successfully milked three times a day. By setting block times the number of visits increased up to nine times on the second day, however, the successful milkings remained three times a day.

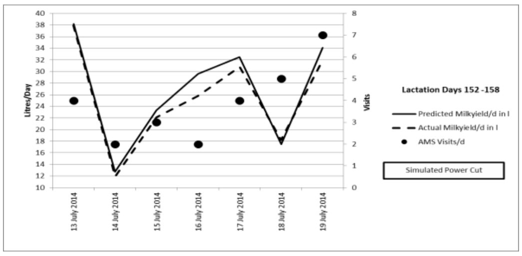

Fig.2 milk yield and AMS visits of a comparable cowin B3

Figure 2 shows the milk yield of a comparable cow with the same lactation as focus cow 6 of B3. This cow was not in the group of focus cows. It therefore was not wearing any measuring equipment and was not a part of sampling or block time setting. This shows that the calculated, predicted milk yield by AMS, is almost identical to the actual milk yield. On the first two days of testing the actual milk yield is less than the forecast.

In the days prior to the simulated power cuts for the focus cowsthe comparable cow visited the AMS on average three times a day with an average of 2.1 successful milkings. From the simulated failure until the last days of the experiment the number of visits increased from two to seven. But the number of successful milkings remained almost the same at 2.3.

Figure 3 is the evaluation of the milk yield of the entire herd of B3, with 67 milking cows, which shows a nearly constant average milk yield per cow per day in the ten days prior to the test and the simulated power cut (including the habituation phase). From the first simulated power failure (block times) to ten days afterwards, the average milk yield per cow per day decreased by more than 0.5 liters.

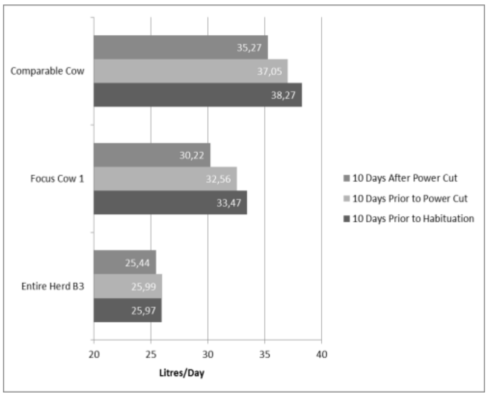

Fig. 3 average milk yield before, during and after a simulated energy failure

This can be shown for individual animalswith the milk yield of focus cowand a comparable cow outside the test group with a similar lactation status. For the focus cow as well as with a comparable cow the milk yield decreased from the time of the simulated power cut, nearly identically, by seven and six percent, respectively.

IV. CONCLUSION

Stress reactions can be detected by various hormones, by physiological and/or behavioral parameters and therebygive information on animal welfare. This study tries to consider the milk yield as one of these assessment criteria. However, intensive statistical analysis and a combination of all results still have to be carried out.

The first finding is that a stressor such as an energy failure within an AMS, simulated bysetting individual block times by cow, reduces the milk yield not only of the affected cows, but also of the whole herd. This can possibly be explained by the existing rank order within the herd: If the focus animal is a cow of a higher rank, it will block the AMS for all animals of lower rank. These have to wait until they have free access to the AMS and thereby possibly come under stress, accompanied by declining milk production. Cows that were directly affected by the simulated power cut (focus cows), responded to the multiple rejections of AMS with a declining milk yield. This can be considered as a potential stress indicator. For the purposes of animal welfare a prolonged power failure of the AMS should therefore be avoided by all means.

The results of this research project and all other test results will be part of the sub-project animal-machine interaction within the concept approach "Integrated dairy farming - stable 4.0". Potential stress reactions of dairy cows shall be presented in cases of energy failure within AMS. The overall test results should ultimately provide information on whether fluctuationor failures in the power supply have an impact on animal behavior or whether temporal shifts in the daily routine create stress responses in dairy cows. With this, ethological criteria for quantitative and qualitative analysis can be established and validated, with which adequate animal behavior in an increasingly automated process of engineering in a dairy farm can be considered under autonomous control options within the scope of a comprehensive On-farm-energy-management system.

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