PROFESSIONAL AND ECONOMIC REASONS FOR ADOPTION OF PRECISION DAIRY FARMING

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Abstract: *Precision milk production is the application of technologies to measure physiological, behavioural, and production indicators on individual animals to improve management strategies and farm performance. Bigger herds as well as more and more complex farming systems, linked with the availability of new information technologies, are prompting an evolution to an increasingly data-driven dairy management approach. The interdisciplinary concept of precision dairy farming sets very high standards for data management. Parameters can be observed by technologies which involve per day milk yield, milk elements, footstep number, temperature (in varied places and forms on and within the cow), daily body weight measuring, milk conductivity and automatic estrus-detection verification. The purpose of this paper was to gain new vision into milk producers' decision-making and the reasons of adoption of precision systems.*

Keywords: *precision dairy farming, monitoring, decision-making, optimization*

INTRODUCTION

One of the most unpredictable, the most profit sensitive enterprise of the common section of agriculture and economy is milk production. Wathes et al. (2008) have defined precision livestock methods as it has apostrophized animal growth, animal product output systems, endemic diseases, animal behaviour, and the physical environment of a livestock building. According to Borchers (2015) precision dairy farming technologies ensure a diversity of functions to dairy farmers. Eastwood et al. (2012) determined it as the adaptation of information and communication systems for enhanced control of fine-scale animal and physical resource variability to optimize economic, social, and environmental dairy farm performance. As Hostiou et al. (2017) say time savings are noticed because robots and sensors take on recurrent physical works (milking, feeding) while simplifying the traceability of animals (e.g. heat or health problems).

Schulze et al. (2007) found that a precision dairy farming set-up consists of the following components: a sensor that generates data, a model that gives a physiological interpretation of the data, a management decision making process and finally decision implementation. The elemental goals of precision dairy farming are to

- maximize individual animal performance,
- detect diseases early, and
- minimize to employ medication through preventive health measures **[6].**

The producer observation of features monitored by precision dairy farming technologies. However, because farmers need to invest first, an important question is what the value of these technologies is for the producer. For milk producers, precision dairy farming technics have the possibility to eliminate subjectivity from decision-making processes, reducing the need for qualified and experienced labour in animal management **[9]**. Among others, calving has opportunity to be forecasted using these same parameters and technologies. Excitement about technical capabilities must be balanced with consideration of implementation challenges and economic realities **[2]**.

Whereas there exist practical and ethical concerns **[15]**, precision livestock farming in general and precision dairy farming mostly promise enrichment of animal well-being with respect to conventional farming methods, for example, through the early detection of illness and timely treatment. So as to deliver on these promises, a plenty of data must be analysed to establish meaningful insights, for instance, to detect signs of illness **[13]**. After having a smart phone-based microsimulation tool for the optimal decision to be made on selling/keeping the ill cow (suffer from mastitis), authors have started a new applied research project to improve the quality of the decision and the profitability. Local data gathered of the given dairy farm are applied instead of national average values of the critical parameters such as chances to get the illness again, length of the dry and productive periods etc. Preliminary profitability improvement results are reported. This time the lactation curve is taken into consideration as well as the amount of produced milk is also utilized as a basis of decision.

Since the anticipated milk price is volatile, it is worth to design scalable models to get efficient solutions **[5]**. According to some studies it is useful to make predictions **[11]**. The competitive atmosphere resulting from price volatility and uncertainty created by some of these new challenges often leads dairy farmers to focus on productivity rather than animal welfare **[8]**. In present study the prospect of effective economic modelling of an important decision is analysed: when to negotiate the cow after a diagnosed new mastitis. After visiting a few local farms, and getting to know more about the problem, it can be stated, that usually they sell a cow when it is in a true bad condition. So far it looks like a cow is treated with the proper medicine once it gets ill with mastitis, and it is kept - if it is not in a truly bad shape that it should be sold. Using some mathematics, simulations and programming the expected profit of an animal can be estimated for the cases of keeping or selling it. This way farmers do not have to keep unprofitable cows.

MATERIALS AND METHODS

A project like this requires close cooperation between programmers and agriculture workers. Using the most important factors of a cow's life a well simple but hopefully detailed enough model is built. With just a few information the future of a cow can be simulated. The starting data includes some data about the cow from the age to the illness number. Some probabilities also calculated to make the researchers' decisions more realistic from some historical data. For example, with the higher number of mastitis it will be more likely that a cow gets ill again. However, the milk production of a cow shows a special curve, the dairy cycle curve, according to computational tests, to optimize the purchasing decision, it can be assumed that the milk output is constant within the dairy cycle.

The whole planned research will last for years. First step is to show that the realistic based conception has its own limitations. It is also planned to step the system up to a data mining and decision support system based on refined method. We shall also terminate our model to incorporate the related connecting economic subsystems such as the animal feed production and milk processing.

RESEARCH RESULTS

Let's look at some simple, specific data about mastitis as an example. It is assumed that the current mastitis needs 5 days of healing with a probability of 70%, and 10 days with probability 30%. A supplementary interval of 15 days is needed to first profit from the milk production. To fall sick, a daily probability of just 0.05% is given if it will be the primary mastitis of the cow in question, 0.1% for the number two, 0.2% for the third, and 0% likelihood for all the later illnesses. All profits in different states of the cow can be calculated from the data which is collected in dairy farms, or using dispersion, or even using the daily data from local dairy farms' databases.

With microsimulation model the best possible way is investigated to settle when to sell the cow suffer from mastitis. The basis of the way is to simulate the life of a cow on daily basis. Putting it the other way around, the examination started with a cow of a given age, headcount of already suffered from mastitis, and in a given stage of the dairy cycle. For every day a list of possible events in the living of a cow is checked. If an event is possible then a random number is generated to simulate a realistic experiment. This way a list of events for the rest of the cow's life is set up. As a result, multiple events at the same time can be managed. For example, researchers can keep on counting the lactation cycle days, while the cow is ill. While computing the possible events the same can be applied which were used during the calculation of existing data. Therefore, the methods to determine the possible events can rely on fixed data, probability dispersion, or even a full list of historical data.

A few regularities can be discovered, like after a suitable dry period, the milk production will resume. The term of that cow ends by its selling. The time of the purchase can be determined by simple rule of thumb: selling the cow if it comes at either the 6th mastitis, or its 10th year of living. Having a model for the financial documentation for a cow, 100 times the possible outcome is simulated to have a rough stochastic description of the distribution function of the profit. Then an optimum decision on the expected achievable profit can be determined. This microsimulation outlook is similar that used to investigate whether a time-based ticket system is better than the existing trip based on in public transportation in Szeged **[1, 3]**. The coding was made in Java language, and the simulation programs were run on a blade server.

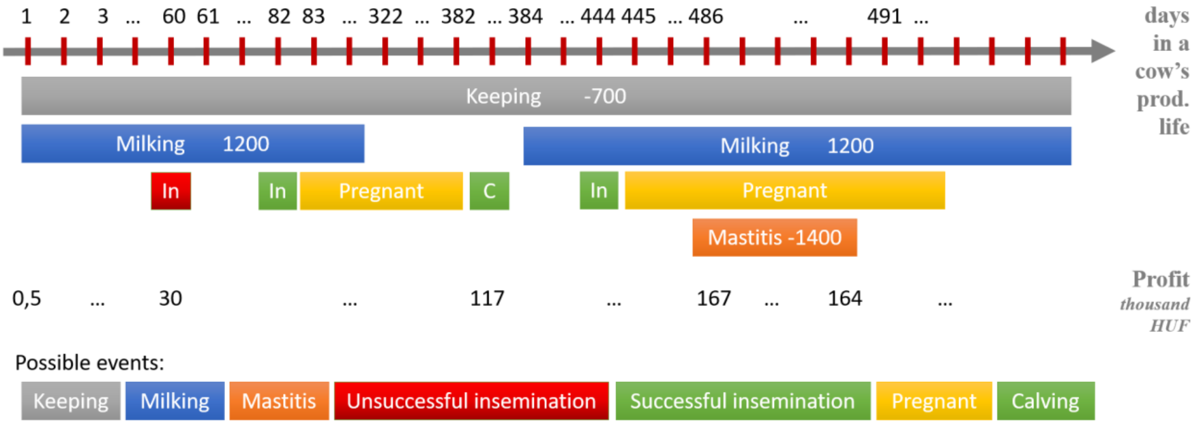

Figure 1. Labelling technique on a simple simulation

A labeling technique to our simulation model is added. It allows us handling several events happening at the same time. For example, while the cow is pregnant it can get ill, and it will have mastitis meanwhile it is producing milk. Using this method by summarizing the daily income and outcoming the profit values can be gaot day-by-day (Figure 1). Also implementing and using new labels is quick and easy, so the model is easily extendable. And last but not at least mostly similar but different events can exist at the same time, it only should be chosen which one is the most desired to be used in the model.

By using the simulations, the future of a cow can be predicted, as it can be seen in Figure 2. Data is presented by the aggregated profit of a cow in HUF according to the days spent in the farm. The minimum, maximum, average and 2 further quartiles curves of the distribution are depicted. These outputs were obtained based on 100 independent simulations of the probabilistic events in the model.

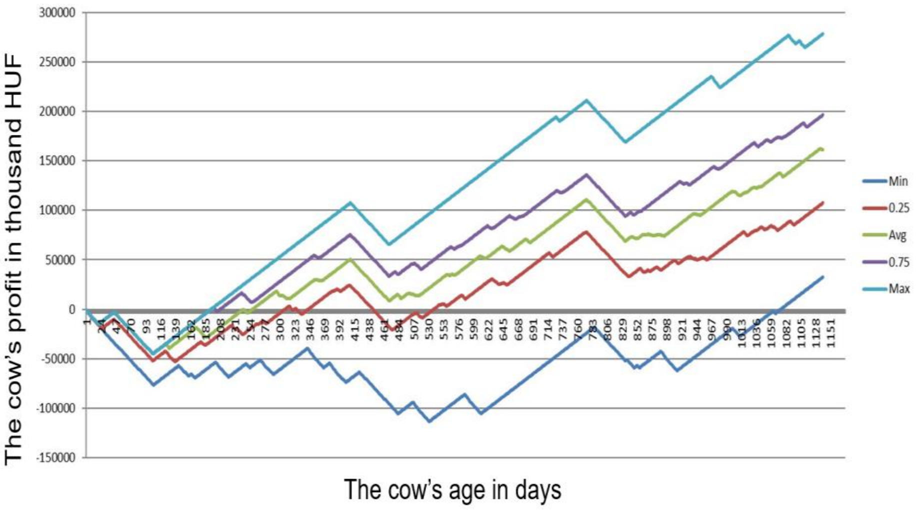

Figure 2. Profit values of a cow

CONCLUSIONS

Digitalization of agriculture has led to the rise of precision dairy farming, which struggle for the synchronous improvement of productivity as well as animal well-being in dairy farming through advanced use of technology such as movement sensors and milking parlours to observe, control, and improve milk production processes. The first attempt of authors to apply a decision-making tool in dairy farming gave useful results in optimization of profitability. When dairy farmer makes a good decision on the most appropriate time of cow culling the expected per cow profit could increase by 150-200 EUR. Decision-making is supported by the method what authors developed. Further experiments are under planning by which novel results can be expected. Multifunctional rumen sensors will hopefully give us valuable information about some physiologic processes as well as it could be applied for illness forecasting while the application also could save some labour.

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