Decision support heuristic for dairy farms

Abigél Mester, Emília Heinz, Balázs Bánhelyi, Elvira D. Antal, Edit Mikóné Jónás, József Horváth, Tibor Csendes

Abstract: After having a smart phone based microsimulation tool for the optimal decision to be made on selling/keeping the ill cow (mastitis) last year, we have started a new applied research project to improve the quality of the decision and the profitability. We can get improvement by utilizing local data of the given dairy farm 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. We report on the preliminary profitability improvement results. This time we take into consideration the lactation curve, and we also utilize the amount of produced milk as a basis of decision.

Keywords: milk production, mastitis, profitability, stochastic optimization, microsimulation

Introduction

One of the most unpredictable, the most profit sensitive sector of the common section of agriculture and economy is milk production. Since the anticipated milk price is volatile, we have to design scalable models to get efficient solutions [5]. According to some studies it is gainful to make predictions [7]. In the present study we investigate the possibility of effective economic modelling of an important decision: when to sell the cow after a diagnosed new mastitis illness. After visiting a few local farms, and getting to know more about the problem, we can say, that usually they sell a cow when it is in a very bad shape.

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 really bad shape that it has to be sold. Using some mathematics, simulations and programming we can estimate the expected profit of an animal if we keep it or sell it. This way farmers do not have to keep unprofitable cows.

The whole planned research will last for years. First step is to show that the realistic based conception has it's own limitations. Later we plan to extend the system to a data mining and decision support system based on sophisticated method. We shall also complete our model to incorporate the related connecting economic subsystems such as the animal food production and milk processing.

Material and method

Material

A project like this requires close cooperation between programmers and agriculture workers. While we were collecting data for our study, we have visited a few diary farms. Using the most important factors of a cow's life we have built a pretty simple but hopefully detailed enough model.

With just a few information we can simulate the future of a cow. The starting data includes some data about the cow from the age to the illness number. And we also calculated some probabilities to make our 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. Although the milk production of a cow follows a specific curve, the dairy cycle curve, according to our computational tests, to optimise the purchasing decision, we can assume that the milk production is constant within the dairy cycle.

Let's look at some simple, specific data about mastitis as an example. We assume that the actual mastitis requires 5 days of healing with a probability of 70%, and 10 days with probability 30%. An additional interval of 15 days is needed to first profit from the milk production. To get ill, we have a daily probability of just 0.05% if it will be the first mastitis of the given cow, 0.1% for the second, 0.2% for the third, and 0.4% probability for all the later illnesses.

All of the profits in different states of the cow can be calculated from the data which is collected in diary farms, or using dispersion, or even using the daily data from local diary farms' databases.

Method

With our microsimulation model we investigate the possible best way to decide when to sell the ill cow. The basis of our technique is to simulate the life of a cow on daily basis. In other words, we start with a cow of a given age, number of already suffered mastitis illness, and in a given phase of the dairy cycle. For each day we check a list of possible event in the life of a cow. If an event is possible then we generate a random number to simulate a realistic experiment. This way we generate a list of events for the rest of the cow's life. So we can manage multiple events at the same time. For example we can keep on counting the lactation cycle days, while the cow is ill. While computing the possible events we use the same which were used during the calculation of our data. So 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 proper dry period, the milk production will resume. The cycle of that cow ends by its selling. The date of the purchase can be determined by our simple rule of thumb: we sell the cow if it reaches either the 6th mastitis, or its 10th year of living.

Having a model for the financial description for a cow, we simulate 100 times the possible outcome to have an approximate stochastic description of the distribution function of the profit. Then we can determine an optimal decision on the expected achievable profit. This microsimulation approach is similar to 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.

Results

By using our simulations we can predict the future of a cow, as you can see it in Figure 1.

Object oriented Java implementation not only makes it easier to supplement our program with newer and newer methods, but we can easily connect the algorithm with an Android implementation.

The simple program that is capable to solve such problems with straightforward input data is available for smart phones and tablets (having Android 6.0 or newer operating systems) at www.inf.u-szeged.hu/∼banhelyi/Buu

We shall update it regularly, and we also plan to implement the application in such a way that also earlier versions of Android should run it.

Figure 2. presents a sample of our prototype:

Figure 1: Cumulated profit of a cow in HUF according to the days spent in the farm. The minimal, maximal, average and 2 further quartiles curves of the distribution are depicted. These results were obtained based on 100 independent simulations of the probabilistic events in the model.

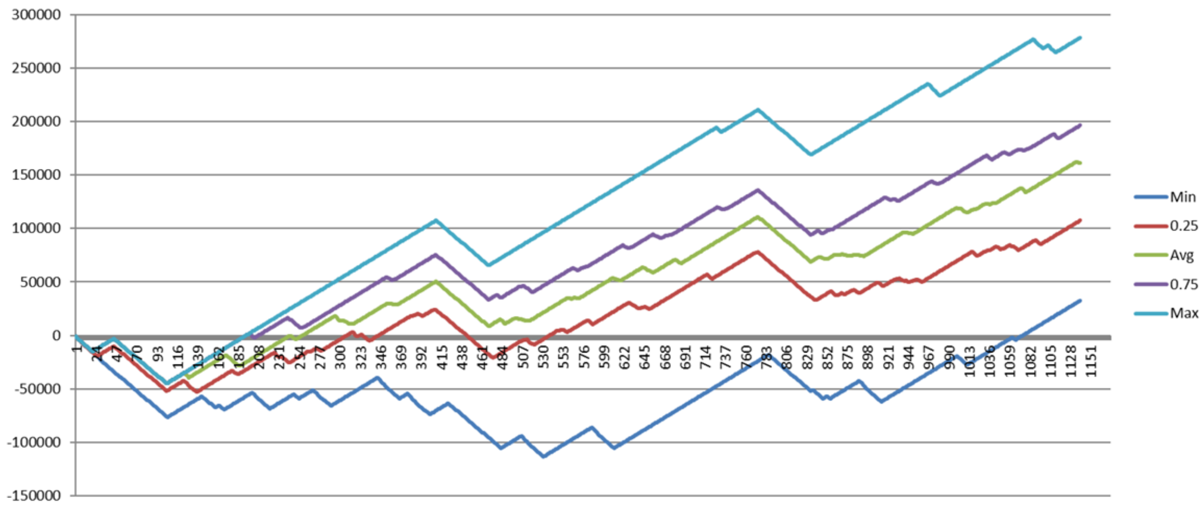
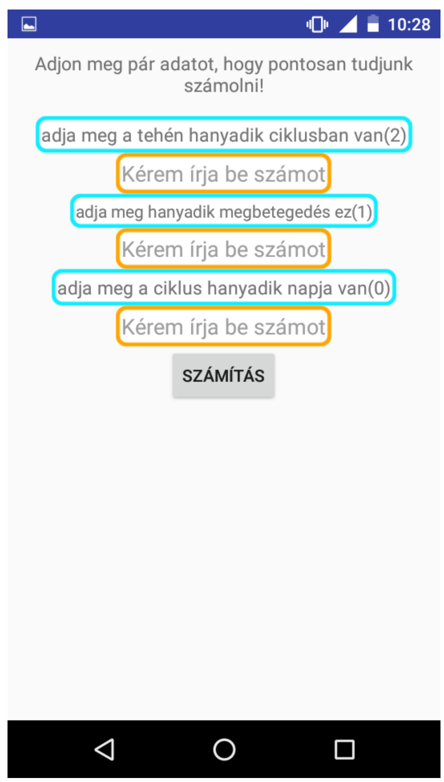


Figure 2: It is easy to add all of the input data using the Android program.



Acknowledgements

The authors are grateful for the android application coding and testing support given by Kristóf Mátéffy and Zsombor Gellérfi.

This work was supported by the project "Integrated program for training new generation of scientists in the fields of computer science", no. EFOP-3.6.3-VEKOP-16-2017-0002. The project has been supported by the European Union and co-funded by the European Social Fund.

References

[1] Bernát Almási, Endre Palatinus. COMPUTATIONAL MODELLING OF THE ECONOMIC EFFECT OF THE TRAVEL TIME BASED TICKET SYSTEM, *Student Research Competition (TDK), University of Szeged*, 2010.

[2] Balázs Bánhelyi, Tibor Csendes, Abigél Mester, Edit Mikóné Jónás, and József Horváth. WHEN TO SELL THE COW?, *Review on Agriculture and Rural Development*, 2017.

[3] Balázs Blázsik, Tibor Csendes. ECONOMIC MODELLING OF THE TRANSITION FROM A TRAVEL TIMES BASED TO A TRAVEL TIME BASED TICKET SYSTEM, *Research Report for the Szeged Transportation Inc., KNRet*, 2010.

[4] Tibor Csendes, László Pál, Oscar H. Sendín, Julio R. Banga. THE GLOBAL OPTIMIZATION METHOD REVISITED, *Optimimization Letters Volume 2, pp. 445-455*, 2008.

[5] Pat Dillon, Thia Henessy, Laurence Shalloo, Fiona Thorne, Brendan Horan. FUTURE OUTLOOK FOR THE IRISH DIARY INDUSTRY: A STUDY OF INTERNATIONAL COMPETITIVENESS, INFLUENCE OF INTERNATIONAL TRADE REFORM AND REQUIREMENT FOR CHANGE, *International Journal of Diary Technology, Volume 61, Issue 1, pp. 16-29.*, 2008.

[6] Zsuzsanna Fekete, RoSwitha Baumung, Birgit Fuerst-Waltl, Krisztián Keller, Ferenc Szabó. THE EFFECT OF MILK YIELD ON THE PROFITABILITY AND ECONOMIC WEIGHT OF SELECTED TRAITS, *Zuchtungskunde, Volume 84, Issue 6, pp. 463-473.*, 2012.

[7] Margaret D. March, Laurence Shalloo, David J. Roberts, Willie Ryan. FINANCIAL EVALUATION OF HOLSTEIN FRIESIAN STRAINS WITHIN COMPOSITE AND HOUESED UK DIARY SYSTEMS, *Livestock Science, Volume 200, pp. 14-22.*, 2017.