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CHANGES TO THE HACCP SYSTEM IN A DAIRY FARM DUE TO THE INSTALLMENT OF AN AUTOMATIC MILKING SYSTEM

ZMIANY W SYSTEMIE HACCP W GOSPODARSTWACH MLECZARSKICH ZE WZGLĘDU NA ZAUTOMATYZOWANY SYSTEM DOJU

Key words: cost-benefit analysis, milk production, voluntary milking system (VMS), food safety

Słowa kluczowe: analiza kosztów i korzyści, produkcja mleka, automatyczny system dojenia (ASD), bezpieczeństwa żywności

Abstract. The main aim of this study is to summarize the steps of operation of an automatic milking system. The milking system is used in a fresh milk producing farm: the Józsefmajor Experimental and Demonstration Farm of the Szent István University of Gödöllő. The use of automatic milking robot system is unique in Hungary and also in Europe. The installation of the milking robot changed the steps of the formerly installed HACCP system and made the milking process more simple: due to the fully automatic milking process there are less physical and biological critical points. In summary, automatic milking system helps to harmonize the milking, feeding and relaxing period of the herd, and also makes the compliance with food safety regulations easier. The second aim of this study to define the possible cost-benefit changes due to the automatic milking system in the dairy farm. Further aim of this study to shows economic methods which help the farmers to make decision about milking systems.

Introduction

In the Hungarian agriculture, field crop farming is obviously the most successful farm type. The success of field crops farming shows a slight increase after the EU accession, meanwhile the share of all the other farm types has been reduced. However, in the livestock part of the agriculture the cattle farms could save their profit level, expect in the first year of world financial crisis [Illés et al. 2014].

The competitive milk production is achievable only with cost reduction and minimizing diseases which may lead to losses in long term perspectives. The three greatest losses in the dairy cattle industry are reproductive disorders, mastitis and lameness. Environmental factors and genetic heritability also play an important role in developing these problems. The economic losses due to animal health problems (for example mastitis and lameness) are the results of production losses rather than the cost of treatment of the affected animals [Ózsvári et al. 2003a]. The economic losses can be divided into two subgroups: direct and indirect costs. The indirect costs include the reproductive disorders and the loss of milk yields due to pain. The direct cost includes the veterinary cost for treatment, the extra labour cost and the cost of early culling [Warninck 2001]. 70% of income loss in the dairy industry comes from mastitis [Ózsvári et al. 2003b]. According to a farm survey in Hungary, the decrease in milk production of cattle suffering from subclinical mastitis means a EUR 58.9 loss per cattle per year. The amount of discarded milk and early culling due to mastitis and medication costs were responsible for EUR 49.5, EUR 39.1 and EUR 12.9 extra costs, respectively [Fodor et al. 2014].

Farms can keep competitive and profitable production only if they continuously follow the latest innovations and these are adopted in their own farms with the necessary conditions [Illés 1998]. For example, the robotic and automatic milking system is an innovation which is able to improve the competitiveness of the dairy industry.

Food safety is a key factor of food industry. The role of the food quality and safety and the monitoring system is increasing constantly. The costumers need a “from stable to table” monitoring system in the food sector. The increasing importance of food quality and food safety means a key task for the different nations and governments to ensure legislative background for food production and food processing that can protect all of their inhabitants from probable health damages. The Hungarian standards and regulations on fresh milk quality are EU-conform, but some improvement is needed particularly in production technologies and animal welfare. One kind of possible technology improvement will be the automatic milking system.

Main Principles of HACCP System

The development and introduction of this food safety system in farms was the first step to meet EU criteria. The main principles of HACCP food safety system (Hazard Analysis and Critical Control Points) are the following [Vágány, Dunay 2003]:

- 1) to identify any hazards that must be prevented, eliminated or reduced to an acceptable level;
- 2) to identify the critical control points at the step or steps at which control is essential to prevent or eliminate a hazard or to reduce it to an acceptable level;
- 3) to establish critical limits at critical control points which separate acceptability from unacceptability for the prevention, elimination or reduction of identified hazards;
- 4) to establish and implement effective monitoring procedures at critical control points;
- 5) to establish corrective action when monitoring indicates that a critical control point is not under control;
- 6) to establish procedures to verify that the measures outlined in subparagraphs (1) to (5) are working effectively. Verification procedures shall be carried out regularly;
- 7) to establish documents and records commensurate with the nature and size of food business to demonstrate the effective application of the measures outlined in subparagraphs (1) to (6).

As the aim of HACCP system is to find the possible hazards and critical points in the process of fresh milk production. Five critical control points were determined, namely: starting of production, formation of cow groups (cows at the same production level), examination of milk, filtration of milk, chilling.

The automatic milking system

The concept of milking automation is to reduce manual labour and give the farmer more time for other matters. It can save time and money with bigger herds and can even improve udder health and lifetime production. Principally the automatic milking systems were developed for family-type farms. Despite this there are numerous example of using automatic milking systems at big-sized intensive dairy farms with good production parameters. According to the practice the automatic milking technology is successfully operable in both family farms and industrial dairy farms.

In our days the market of robot milking system mostly settles down in Holland, France, Germany and Russia. In the market until the beginning of 1990s, there was no commercially-produced robot milking system available.

The first ideas for a robot milking machine appeared in 1985 in England. The full-scale development projects of DeLaval started in the early 90s. In 1996 the DeLaval's Voluntary Milking System (VMS) was launched. The first working VMS made its debut at Hamra Farm, in Sweden, in September 1998. In 2012 there were more than 8000 active robotic milking system all over the world [www.delaval.com/en].

The substance of the robotic VMS to the persistent moving of livestock is guaranteed. The cows feed, milk and relax when they want according to their own needs. Robotic VMS is comprised of automated feeding, milking, analysing, reproduction, and cooling processes. The application of this system delivers lower feeding costs, improved breeding performance and healthy, productive cows.

Due to the use of robotic VMS the number of human interventions has been reduced and dairy farms have improved. The incidences of the herd diseases like mastitis are reduced too because of the more accurate technology. The robotic VMS is mostly used in a closed livestock. It is possible to use robotic VMS on a pasture based technology if the pasture is located directly next to the milking system. The theoretical capacity of the robotic VMS is about 75 milking cows. Practice shows that the economic capacity is between 60 and 70 milking cows with the controlled animal circulation. The difference between the milking systems comes from investment cost, annual cost and benefits and expected life time. The following facts should be considered in the decision-making process of the introduction of milking systems:

- special features of the stable;
- extra investment cost of the equipment compared to conventional milking;
- expected life span of the system;
- balance of extra costs and extra saving compared to conventional milking;
- extra yield and quality improvement and higher income;
- indirect effects for example: less herd diseases;
- better production parameters;
- possible subventions.

The implementation of automatic milking system needs a careful evaluation process based on several factors: cost, annual operation costs, capacity, reliability and service options. All parameters are important when making this kind of investment. The total time when the cow stays in the milking robot affects the number of cows that can pass through the milking robot, and it also influences the milking robot's capacity. An optimal capacity utilization is important to ensure good economy with milking robots. Milking robot capacity utilization is important for the results of the investment, and this kind of test is not the only one for testing capacity utilization; the number of kg milk per day is also an important parameter.

Material and methods

The examined farm is József major Experimental and Demonstration Farm of the Szent István University of Gödöllő. The farm was established in 1992, by the Department of Farm Economics and Management of Gödöllő Agricultural University (the present Szent István University). The farm is specialized in fresh milk production. In 2003, as a first step to meet the EU food safety criteria the HACCP system was implemented [Vágány et al. 2003].

The presently operated DeLaval Voluntary Milking System (VMS) was installed in April 2013 in order to improve the quality of the milk produced. Before this investment the number of livestock on the dairy farm was roughly 100 milking cows and 100 calves and heifers. The total milk production in this time was approximately 650 thousand litres per year. The quality of the milk was really good, the ratio of extra milk was 77.9%, first class milk was 16.8 % and second class milk 5.3%.

The robotic VMS is located in the herringbone milk parlour (5*2) used from 1996. The DeLaval VMS included:

- feeding module (auto feed calculator, automatic feed time control),
- DelPro MDi¹,
- quarter milking,
- cow monitor² and calendar³,
- activity metres.

¹ Mastitis Detection Index (MDi): measure conductivity, blood and milking interval.

² Cow monitor get information about quarter flow rate, volume and cleaning status of the milking process.

³ Cow calendar monitoring milk yields, flow rates, time, conductivity and blood levers for each quart.

Cost-benefit analysis versus investment analysis

The critical point of cost-benefit analysis is to accurately measure the advantages and disadvantages of the investment. In practice, cost-benefit analysis can be used in the case of production level decisions or investment decisions. The benefit is the advantage which comes from the technology and the cost is the value lost due to the investment distracting resources from other alternatives [Mishan 1982].

In classical investment analysis the investment and operational costs and incomes at different times are correlated. The most important dynamic investment analysis indexes are NPV, IRR and dynamic rotation rate [Illés 2000]. The difference between the cost-benefit analysis and the classical investment analysis is presented in Table 1.

The aim of this study is to identify the factors taken into consideration in a cost-benefit analysis.

Table 1. The difference between cost-benefit analysis and classical investment analysis

Tabela 1. Różnica między analizą kosztów i korzyści a klasyczną analizą inwestycyjną

Specification/ <i>Wyszczególnienie</i>	Investment analysis/ <i>Analiza inwestycyjna</i>	Cost-benefit analysis/ <i>Analiza kosztów i korzyści</i>
Investment analysis/ <i>Analiza inwestycyjna</i>	total cost/ <i>koszty ogółem</i>	extra cost/ <i>koszty dodatkowe</i>
Cost-benefit analysis/ <i>Analiza kosztów i korzyści</i>	different between expected annual incomes and costs/ <i>różnica między oczekiwanymi rocznymi przychodami i kosztami</i>	extra cost, cost saving, extra production value compare to the original technology, indirect effects/ <i>dodatkowe koszty, oszczędność kosztów, dodatkowa wartość produkcji w porównaniu do oryginalnej technologii, wpływ pośredni</i>

Source: own study based on [Mishan 1982, Illés 2000, Székely et al. 2000]

Źródło: opracowanie własne na podstawie [Mishan 1982, Illés 2000, Székely et al. 2000]

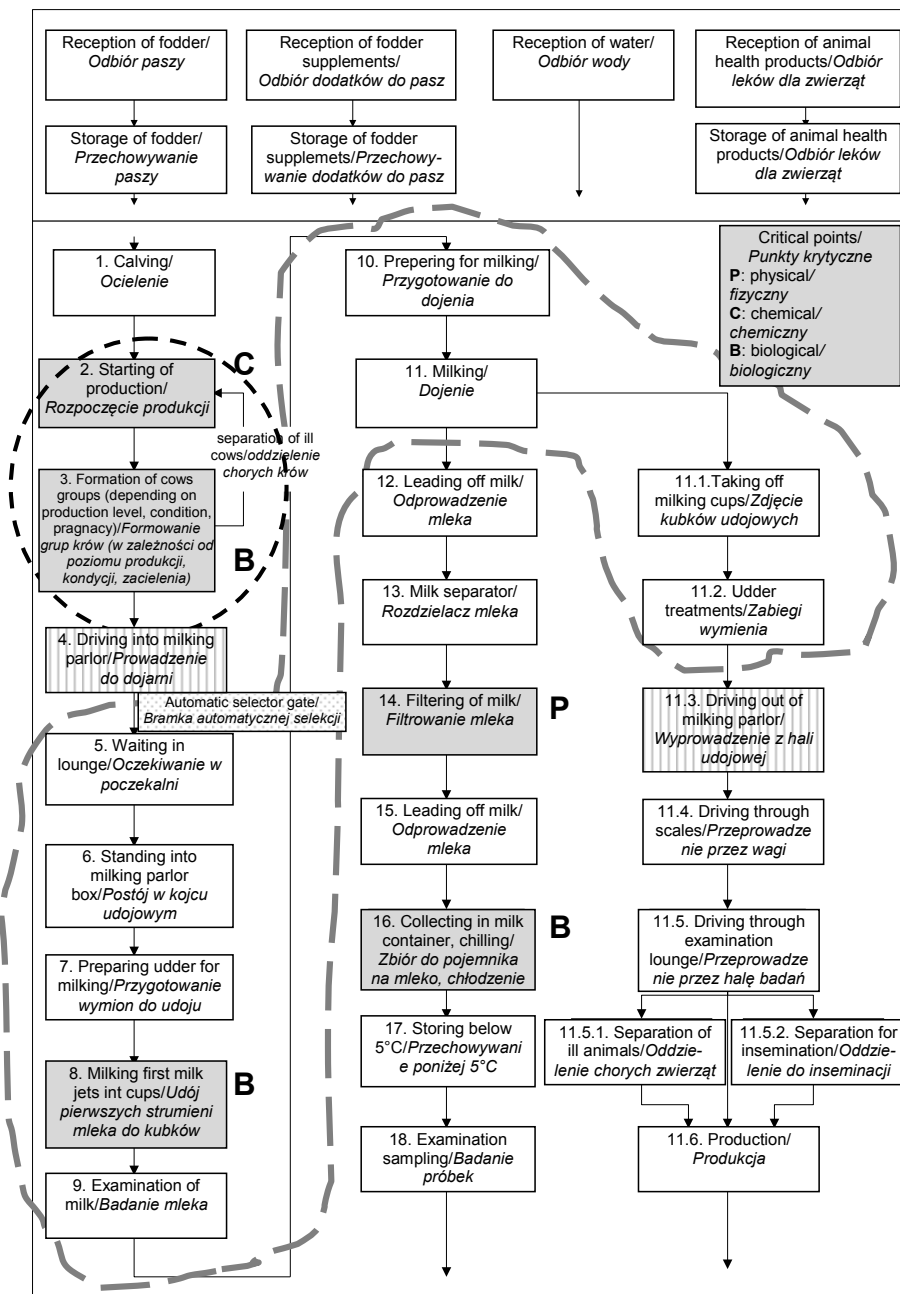
Results

Before installing the robotic VMS there was a complete parlour reconstruction. This reconstruction included the evolving of the controlled animal circulation (new sorting gate, new watering system). The aim of this study is to present economic methods which help the farmers to make decision about milking systems.

Figure 1 shows the changes in milk production and HACCP system resulting from the robotic VSM. In the formation of cow groups the teat position of the cow becomes very important, because the robotic VMS is not able to milk the abutting udder. The driving into and out of the milking parlour happened naturally. The cows go into the parlour because they can eat the forage there. Before the cows go into the robotic VMS they should go through the selector gate. The selector gate drives the cows which have certification of milking (it identifies the cows with chips) into the robotic VMS lounge. Milking production from step 5 to step 11.2 happens totally automatically in the robotic VMS.

There is one separate “milking” cup which makes the cleaning of udder and milks the first jets. The first milk jets goes into a separate tube. In this tube the robotic VMS system measures MDi per quarter and alerts if the cow is at risk of developing mastitis. After milking the system sprays the udder with antiseptic, (Fig. 1). The biological hazard of milking production is lower with the robotic VMS system than with the conventional one because the system is able to earlier filter out the cows with possible mastitis.

Because of the instalment of the robotic VMS a 10% reduction of livestock was necessary. The capacity of the robotic VMS is 70 milking cows per day in comparison with 90-100 cows before. Despite production loss (in milk and calf production) thanks to livestock reduction there is income growth which results from higher milk productivity (double the income loss of livestock reduction). Approximately 65 cows can be milked with one robotic VMS so it was necessary to reduce the livestock but thanks to higher productivity higher forage per cows should be observed.



--- necessary changes in technology/niezbędne zmiany w technologii, □ not necessary in VMS/niekonieczne w VMS, ▣ new elements/nowe elementy — happened automatically/stało się automatycznie
 ■ critical point/punkt krytyczny

Figure 1. Technology change of fresh milk production
 Rysunek 1. Zmiana w technologii produkcji mleka świeżego

Source: own study based on [Vágány et al. 2003]

Źródło: opracowanie własne na podstawie [Vágány et al. 2003]

Table 2. Changes in milk production due to the robotic VMS
 Tabela 2. Zmiany w produkcji mleka ze względu na robota VMS

Specification/Wyszczególnienie	Changes of robotic VMS/Zmiany robota VMS	
	technology based/ oparte na technologii	keeping based/ utrzymujące podstawę
Number of worker/Liczba pracowników	less/mniejsza	-
Livestock/Inwentarz żywy	less/mniejszy	-
Number of technology waste/ Ilość odpadów technologicznych	higher/większa	-
Milk production/ Produkcja mleka	less/higher/ mniejsza/większa	less/higher/ mniejsza/większa
Equipment shift/Zmiana sprzętu	higher/większe	-
Service kit/Zestaw serwisowy	higher/większe	-
Electricity cost/Koszt energii elektrycznej	higher/większe	-
Antiseptics/Środki antyseptyczne	less/mniejsze	-
Hoof care/Pielęgnacja racic	higher/większa	-
Cost of hoof care/Koszt pielęgnacji racic		higher/większy
Forage/Pasza	less/higher/mniej/więcej	-
Grazing area/Obszar wypasu	-	smaller/mniejszy
Calving/Odchów	-	harder/trudniejszy

Source: own experiment in Józsefmajor Experimental and Demonstration Farm
 Źródło: badania własne w Józsefmajor Experimental and Demonstration Farm

Equipment shifts happen more often because the robotic VMS does more milking per day than the conventional one. Fewer workers are necessary because there are no persons required in the milking house (Tab. 2).

Summary and conclusions

On the basis of practical experience with the robotic VMS, farmers should achieve a higher productivity and organization level. It is necessary to have a complex way of thinking about the milking system and the linked technology (feeding, keeping, etc.). The basic condition of efficient and economical operating of the robotic VMS is controlled animal circulation which helps to harmonize the milking, feeding and relaxing period of the livestock and even simplify the formerly used HACCP system. The objectives of Józsefmajor Experimental and Development Farm with the introduction of automatic VMS in addition to the obligations were to expand the quantity and the proportion of extra quality milk production by using this system, which helps to prevent faults and hazards by way of an efficient monitoring system. In future examinations we would like to measure possible changes in the practice and would like to introduce these changes in money and investment analyses.

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Streszczenie

Glównym celem badań było przedstawienie etapów pracy systemu automatycznego dojenia. Taki system dojenia jest używany w eksperymentalnym i przykładowym gospodarstwie Józsefmajor należącym do Uniwersytetu Senta Istvána w Gödöllő, które produkuje świeże mleko. Automatyczny robot do dojenia jest unikatem na Węgrzech, ale również w Europie. System HACCP został zainstalowany przed dziesięcioma laty w celu zwiększenia jakości produkowanego mleka oraz aby sprostać wymogom UE. Zamontowanie robota do dojenia zmieniło etapy systemu HACCP oraz uczyniło proces dojenia prostszym. W dodatku, dzięki pełnemu zautomatyzowaniu procesu dojenia, pojawia się mniej fizycznych i biologicznych punktów krytycznych. System automatycznego dojenia pomaga zharmonizować dojenie, karmienie oraz czas wypoczynku stada, a także ułatwia sprostać wymaganiom dotyczącym bezpieczeństwa żywności.

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