Scientific Papers. Series D. Animal Science. Vol. LXIII, No. 2, 2020
ISSN 2285-5750; ISSN CD-ROM 2285-5769; ISSN Online 2393-2260; ISSN-L 2285-5750

RESEARCH ON THE ECONOMIC EFFICIENCY OF FARMS IN THE FUNCTION OF THE MILKING SYSTEM

Andrei-Cristian MATEI[1*], Ștefofil CREANGĂ[1,2], Mădălina-Alexandra DAVISESCU[1], Bogdan-Iosif DOBOȘ[3], Ioana POROSNICU[1], Bianca-Maria MĂDESCU[1]

[1]Research and Development Station for Cattle Breeding, Iasi-Ungheni no.9, Dancu, Iasi, Romania
[2]Faculty of Animal Sciences, University of Agricultural Sciences and Veterinary Medicine of Iasi, Romania
[3]Faculty of Materials Science and Engineering, "Gheorghe Asachi" Technical University of Iasi, Romania

*Corresponding author email: mateiandrei135@gmail.com

Abstract

The economic efficiency of dairy farms is influenced by many factors and depends on their management. Some research shows that the conventional milking system (CMS) is more cost effective than the automatic milking system (AMS). The data collected for carrying out this research come from the accounting records of the dairy cow farms (from 2018). From the current study it appears that the capital expenditures were significantly higher in the case of farms with AMS than in the case of farms with CMS and the total incomes for the farms with AMS and CMS were 1745.2 RON/t milk and respectively 1785 RON/t milk, and the net productions were 1117.61 RON/t milk for farms with AMS and 1155.14 RON/t milk for farms with CMS. In terms of personnel costs, they are higher in farms with CMS, 512.3 RON/t milk, whereas in AMS farms staff costs do not exceed 484.1 RON/t milk. Following the observations, the two milking systems have similar profitability in the market conditions of the Romanian economy.

Key words*: costs, milking system, profitability, revenues.*

INTRODUCTION

The number of dairy farms exploited for milk production, using the automatic milking system (AMS), is constantly growing, especially in Eastern Europe. In 1987, the Dutch company Lely, invented the milking robot, starting its marketing in countries with advanced animal husbandry (Huijps et al., 2008). In Romania, about 6% of farms use AMS, this percentage is constantly increasing. It is recognized that, in agriculture, zootechnics is a basic sector, mostly as an economic weight in the countries considered developed, being the main source of high biological value proteins indispensable to human nutrition (Butler and Holloway, 2016). In terms of feeding the population, specialized international bodies (FAO and OMS) consider that optimal nutrition is the result of the combination of 2/3 foods of plant origin and 1/3 foods of animal origin, especially milk, meat and eggs (FAO, 2015). Moreover, a direct and significant correlation was established between increasing milk production in the future and reducing infant mortality, but also between increasing the availability of milk for consumption and reducing the consumption of alcoholic beverages. There are approximately 250 million cows supplying milk all over the world. There are about 10 million dairy cows in North America, 23 million in the EU and 6 million in Australia and New Zealand. Milk production is on the rise in Asia, including in countries that are not traditionally known for their milk consumption, such as China, which now has more than 12 million cows producing milk (FAO, 2015). Research on the economic efficiency of the use of AMS and conventional milking systems (CMS) has been mainly based on normative models, focusing on the return on investment (Daily Nation, 2017). Conventional milking systems represent those with vacuum system, the first such milking device was designed in 1851 by Hodges, but it included the whole uterus and which later (1860) was developed with rubber glasses and vacuum pipes, which led to the creation of milking machines, whose operating principles are still valid today, only that they have been improved and diversified (Rossing and Hogewerf, 1997).

The CMSs currently used in our country are organized in milking rooms, specially designed for this purpose and are represented by: horizontal milking platforms in parallel, frontal, in tandem, arranged in a broom, roller type and unilactor type (Maciuc, 2006). Moving from an CMS to AMS requires a new management approach and a change in the workload for the staff (Oude Lansink et al., 2002). The use of AMS eliminates the milking process, but includes new tasks such as controlling and cleaning AMS, periodic visual control of animals in order to observe whether or not there have been flocks, etc. (Stokes et al., 2007). In the CMS, the key interactions between lactating cows and humans occur during milking and occasional herd health practices. The practical and social advantages of such technologies include the availability of extra time for dairy farmers and improved work flexibility (de Koning, 2010). Because farmers often have little time flexibility and often have difficulties in securing reliable labor in some areas, it is not surprising that researchers have reported positive adoption of AMS (Mathijs, 2004) improved labor efficiency, increased flexibility, shortened working hours and lower physical workloads. The advantages and appeal of AMS to a farmer's lifestyle are clearly evident (with no proof of negative effects); however, in order to ensure economic viability and future long-term survival, it is important to investigate the ability of cows to adapt and perform in such a framework (Dearing et al., 2004). The objective of this paper was to compare the profitability of dairy cows, depending on the milking system used. This objective was achieved by analyzing the accounting data of the studied farms. Hyde and Engel (2002) found that the investment in AMS was profitable. In contrast, in a study by Dijkhuizen et al. in 1997 it was concluded that the investment in a AMS was not profitable, and Rotz et al. (2003) concluded that the use of AMS does not provide economic benefits to most farms in the United States. The only empirical comparison, from an economic point of view, between farms with AMS and CMS was conducted by Bijl et al. (2007), who concluded that farms with CMS were more profitable than farms using AMS. Since then, no sub-food comparisons have been published economically. In a study conducted on 105 farms in Belgium, Denmark, Germany and the Netherlands (Mathijs, 2004) there was a 20% reduction in the costs of physical labor in the case of AMS, but in the short term a low profitability can be recorded due to the expenses of capital, which are raised in this case. Previous research has not determined whether adopting a AMS can replace the cost of staff work (Tse et al., 2017). Farms that are based on milk production, as the main source of income, are more likely to try to improve their organization's management in order to make the farm more efficient (Bravo-Ureta et al., 2007). The stress response of cattle in various environments has been extensively studied in an attempt to understand the changes in their emotional state. Milking in AMS compared to CMS has been shown to minimize cow stress as indicated by lower cortisol levels by Maina et al. (2018). The cost of feeding dairy cows constitutes the highest percentage of the total cost of milk, and in this case, significant progress has been made in which the reduction of food expenditure is almost impossible. Thus, the manager of a dairy cow farm can act on the technical details to obtain the desired profit (Coleman and Hemsworth, 2014). One of the main reasons for investing in an automatic milking system is the desire for more flexible working hours, but also more free time (Holloway et al., 2014). Indeed, some previous research has reported savings in labor following the adoption of AMS, but at the same time it has been hypothesized that capital expenditures would increase due to high maintenance costs but also to a much larger investment (Svennersten - Sjaunja and Pettersson, 2008). The modification of the milking system coincides with a change of daily work activities, which requires more attention for the verification of dairy cows. Maina et al. (2018) found that the adoption of new technologies in the dairy sector requires considerable investment with high capital expenditures. Efficiency is a major problem in the economy of agricultural production and is measured by comparing the value obtained with the expected one. The economic efficiency in the case of farms, is a product of technical efficiency together with the allocation efficiency (Wilson, 2008).

MATERIALS AND METHODS

The data collected to carry out this study come from the accounting records of the dairy cow farms, registered in 2018. In this research, 10 farms using automatic milking system and 20 farms using conventional milking systems were studied. The database included information on incomes (for example, milk production revenues and other agricultural activities), fixed costs (for example, building and machinery maintenance costs), variable expenses (e.g. feed costs, reproduction, energy, water) and general information about the respective farm regarding the number of hectares of land used, the number of animals, etc. All farms were fetching and milking their cows twice daily. All incomes and expenses are expressed in one tonne of milk (using the total quantity of milk quota), and subsequently these results were analyzed with a t test to compare farms with CMS with those with AMS. Statistical calculations were performed with the IBM SPSS V.22 software.

RESULTS AND DISCUSSIONS

Annual economic reports are generally of interest to farmers who pay particular attention to the finances that represent the performance of the respective farm. The farms in this sample can thus be characterized as farms wishing to obtain and keep track of financial performance, their purpose being to help in making the best management decisions.

Table 1. Overview of information on farms studied

	AMS (n=10)		CMS (n=20)		
Elements	**Average**	**Standard deviation**	**Average**	**Standard deviation**	**p-value**
Total land used (ha)	115	27.8	110	28.2	0.77
Milk production/animal/year (kg)	9142	980	8964	816	0.11
Fat (%)	4.38	0.12	4.31	0.12	0.17
Protein (%)	3.45	0.08	3.49	0.10	0.0006

Table 2. Description of the input and output variables used to analyze the efficiency and average values (with the std deviation) for farms with automatic milking system (AMS) and those with conventional milking system (CMS)

		AMS (n=10)		CMS (n=20)		
Variable	**Data from farm accounting**	**Average**	**Standard deviation**	**Averag**	**Standard deviation**	**p-value**
Animals	Total number of cows	176	27.9	165	28.2	0.76
Capital expenditure (RON/tons milk)	Expenses for buildings	202.2	84	184	79	0.91
	Expenditure on machinery and equipment	401.5	170	304.4	150.2	0.0028
	Total capital expenditures	603.7	254	488.4	229.2	0.0030
Personnel expenses (RON/tons milk)	Total staff costs	484.1	78	512.3	176.47	0.60
Expenditure on materials (RON/tons milk)	Feed for animals	50.23	15.43	51.4	12.82	0.28
	Concentrates + premixes	329.32	26.74	328.46	28.5	0.98
	Fertilizers	48.65	9.32	49.88	9.72	0.18
	Pesticid	12.3	2.78	12.1	3.14	0.096
	Reproduction	43.42	12.4	42.98	11.8	0.68
	Medication	64.2	4.5	64.4	4.2	0.16
	Energy and water	74.67	8.3	75.8	9.1	0.001
	Elimination of manure	4.8	1.25	4.84	1.4	0.46
	Total expenditure on materials	627.59	80.72	629.86	80.68	0.12
Revenue (RON/tons milk)	Milk income	1600	130	1645	129	0.74
	Income from the sale of animals	120	24.5	116	24.4	0.61
	Revenue from other activities	25.2	4.7	24	4.7	0.45
	Total revenue	1745.2	159.2	1785	158.2	0.90
Net production (RON/tons of milk)	Total revenue - Expenditure on materials	1117.61	78.48	1155.14	77.52	0.77

Table no. 2 presents an overview of the inputs and outputs for the 30 farms studied in total. Expenditure and revenue were reported on a tonne of milk to allow comparison between farms on lactation (305 days), and the weight of milk in fat and protein. As expected capital expenditures were significantly higher for AMS farms than for CMS farms. These higher costs are due to the higher costs of maintaining and constructing buildings and installations, because in the case of AMS farms the rate of equipment replacement is higher. However, estimates of the economic life of a AMS are not available, so it would be beneficial to assess the lifetime of the AMS to allow for a reliable comparison with the farms where CMS is used. In terms of personnel costs, they are higher in the farms with CMS, 512.3 RON/t milk, as more employees are needed to perform the milking of the cows, while in the farms with AMS the personnel costs do not exceed 484.1 RON/t milk. The costs of the materials are about the same in both situations because the animals benefit from the same feed ration, the same drug treatment, etc. No differences were observed between the farms with AMS and those with CMS on the sold productions, the net income resulting from the sale of the productions registering near values. The total revenues for the farms with AMS and CMS were 1745.2 RON/t milk and 1785 RON/t milk respectively, and the net yields were 1117.61 RON/t milk for the farms with AMS and 1155.14 RON/t milk for farms with CMS.
Therefore, from table no. 2 it can be observed that the farms with AMS have higher capital expenditures, but the net production is not different between the farms with AMS and those with CMS. This shows us that the small, insignificant differences in personnel and material expenses observed in CMS farms, offset the capital expenditures of AMS farms. Hyde and Engel (2002) have found that the investment in AMS is profitable. In comparison, a 1997 study by Dijkhuizen et al. concluded that investment in AMS was not beneficial, and Rotz et al. (2003) concluded that the use of AMS does not offer economic benefits to most farms in the United States. The results of previous studies showed that investments in AMS were not profitable for farms in the Netherlands (Dijkhuizen et al. 1997) and the United States of America (Rotz et al., 2003). The results of the current study show that the net production does not differ depending on the milking system, indicating that the economic efficiency of the farms with AMS and CMS is similar. However, farms that use milking robots are expected to be more profitable in the future, with increased labor and energy and water spending (Dijkhuizen et al., 1997). Maina et al. (2018) found that the implementation of new technology in the dairy sector requires significant investment with high capital expenditure. A major disadvantage of AMS is that it can make milking a limited number of cows / day, and in large farms such as some in the US, AMS is not cost effective because it requires a large number of milking robots, which leads to a high investment, while labor costs are lower in the US than in Europe (de Koning, 2010). Research into cow health and physiology has been conducted to investigate the possible long-term effects of the type of milking device. Improvements or no significant changes in cow health have been reported in the AMS when farms are well managed (Svennersten-Sjaunja and Pettersson, 2008), especially when cows remain managed on pasture. In addition, previous research compared the two different brands (Lely and DeLaval) of milking equipment and found that one brand was correlated with more restless activity than the other, which is a limitation of the present study. As the AMS changes the way cows are handled and communicate with humans, especially with the introduction of voluntary cow traffic, it is important to consider how this change affects the relationship between humans and animals (Bravo-Ureta et al., 2007).

CONCLUSIONS

The current study was based on the accounting records of dairy farms in Romania that use automatic milking systems and conventional milking systems, in order to investigate whether the economic efficiency differs depending on the milking system. Farms with AMS had higher average capital costs (603.7 RON/t milk) compared to CMS farms (488.4 RON/t milk).
Sustainability issues play an increasingly important role in milk production, so innovative technologies are also present in this area, in order to streamline specific production

processes in order to achieve the best economic results.

Total labor costs and net output were not significantly different between AMS farms and CMS farms. Thus, the economic efficiency of the farms with AMS and those with CMS was similar.

With the overall health and behavior of cows showing small and inconsistent variations between system types, the welfare of cows in both system types is likely to be similar and dependent on good management. Management is highly dependent on humans, indicating that the human element in the milking system is likely to have the greatest effect on cow output and welfare.

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