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Selected technical and organizational problems in various milk production systems

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Abstract

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The survey was based on data obtained from the database of the European Dairy Farmers EDF for the years 2012-2016 and covered 141 of the same farms in each of the surveyed years that provided data to EDF for cost analysis. The aim of the research was to supplement the lack of knowledge concerning selected production, technological and economic aspects in farms specializing in milk production. As a result of the research, it was found, among others, that the milk yield of cows in the investigated EDF farms in kg ECM/cow was the highest in farms with permanent housing system of cows breeding, then in farms with automatic milking machines (AMS). The lowest milk yields were characteristic of farms with pasture system of keeping cows. The amount of direct total costs per cow in 2013-2016 was the highest in farms with permanent housing system of cows breeding, then in farms with AMS and farms with a pasture system of keeping cows. The total labour costs in €/cow were the highest on farms with automatic milking machines, then in farms with permanent housing system of cows breeding, while the lowest total labour costs were on farms with the pasture system for keeping cows.

Key words: milk; systems; housing system; milking machines; pasture; keeping cows

Introduction

Dairy farms in Europe operate under different soil, climatic and economic conditions, and they have diverse technical equipment. These conditions determine the choice of the system for maintenance, feeding and milking of cows and the intensity of milk production. Each farm has its own unique production system. Therefore, there is a large diversity of production systems among farms both in the geographic space and in targeted types of such systems (Salou et al., 2017; Van de Steeg et al., 2010).

Among the commonly used milk production systems, several can be selected that stand out with their specific structure of using the basic production factors (land, capital and labour). The pasture milk production system is popular due to its simplicity and low costs as compared to the alcove systems (Macdonald et al., 2010; Ramsbottom et al., 2015). Lower costs are associated with better animal health (Hanson et al., 2013; Palmer et al., 2012; Washburn & Mullen, 2014) and lower labour and feed costs (Dartt et al., 1999; Fontaneli et al., 2005; Ramsbottom et al., 2015; Tozer et al., 2003; White et al., 2002). Despite many proofs of the advantages of the graze milk production system, most dairy cows in conventional production systems of the developed countries are maintained throughout the year in different types of barns, without access to pasture (Becker et al., 2018). Another solution to reduce labour costs in milk production is the use of automatic milking systems (AMS). About 90% of such systems are used in North-Western Europe (De Koning, 2011). The effects of implementing AMS in dairy farms, both positive and negative, can be observed most of all in herd management, behaviour and health of cows and in the quality of the milk produced (Jacobs & Siegford, 2012).

The aim of the research was to provide knowledge on the selected production, technological and economic aspects in dairy farms using the selected milk production systems.

Material and Methods

The research was focused on data obtained from the European Dairy Farmers – EDF database for the years 2012-2016 and covered 141 of the same farms in each of the analyzed years. The farms surveyed provided data to EDF to analyse the cost of milk production. In this study the following parameters of cattle herd management were analyzed: milk yield in kg ECM (Energy Corrected Milk), direct total costs in €/cow and their selected components (insemination costs in €/cow, treatment costs in €/cow, feedstuff costs in €/cow), total labour costs in €/cow, family labour force in labour force units (FWU – family work units), age of first calving (months), calving interval (days). The aim of the research was to supplement the lack of knowledge concerning selected production, technological and economic aspects on farms specializing in milk production. The data were compiled applying descriptive statistical methods using Statistica ver. 13.1 program.

The research was based on the following subdivision of farms into groups: total farms (n = 141), farms equipped with automatic milking systems (AMS) (n = 15). Other groups included farms with conventional milking systems using pasture (n = 47) and farms keeping cows in permanent housing (n = 79).

Due to at most the moderate asymmetry of the distributions of the examined features for comparison of their size, the average was used in the study for individual features related to the analyzed farms. The total cost of milk production was determined in accordance with the EDF methodology. These costs include the following components, European Dairy Farmers (2011), Wojcik (2012):

- direct total costs – cost of purchase of animals, veterinary costs, costs of medicines, insemination costs, other costs related to milk production, costs of purchase of feedstuff and production of the farm's own feed (costs of seed, fertilisation, plant protection) and other costs related to plant production,
- labour costs – wages costs, alternative costs of family labour, third party services, fuel, energy, maintenance of machinery, depreciation of machinery, alternative costs of machinery,
- costs of buildings – lease costs of buildings, building maintenance costs, depreciation of buildings, the costs of alternative buildings,
- land costs – costs of land lease, land maintenance, agricultural tax, alternative land costs,
- milk quota costs – costs of renting a milk quota, penalty for exceeding a milk quota, alternative costs of a milk quota,

Table 1. Average parameters of farm' groups

Feature	Farms															
	2012			2013			2014			2015			2016			
	AMS (n=13)	PF (n=45)	PHS (n=79)	AMS (n=18)	PF (n=42)	PHS n=(81)	AMS (n=17)	PF (n=41)	PHS (n=81)	AMS (n=16)	PF (n=43)	PHS (n=79)	AMS (n=21)	PF (n=37)	PHS (n=84)
Cows number [heads]	146	145	282	155	136	319	168	149	324	177	165	328	169	181	336
Forage area [ha]	134.1	87.3	189.9	163.7	89.3	218.5	162.7	94.6	230.3	184.2	99.2	231.0	134.7	113.6	191.3
Stocking rate [LU/ha forage area]	1.81	1.66	1.79	1.67	1.69	1.82	1.82	1.70	1.80	1.82	1.79	1.69	1.87	1.67	1.76
% of forage area rented	50	50	57	51	50	56	49	51	56	55	48	63	43	50	59
Land productivity [t ECM/ha forage area]	16.8	13.0	16.5	15.1	13.2	16.3	16.5	12.9	17.2	17.6	13.6	16.2	18.3	12.4	17.4
Labor input [h/cow/year]	38.4	45.1	51.2	37.2	42.9	50.8	38.3	39.7	51.6	38.8	41.1	52.0	38.4	40.3	48.6
Labor productivity [kg ECM/h]	264	205	208	268	210	209	277	219	217	305	220	218	295	220	238
Capital input [1000 Euro/cow]	8.85	5.28	6.71	8.93	5.76	6.56	8.13	5.34	6.71	9.24	6.77	6.50	10.20	6.22	6.50
Capital productivity [t ECM/1000 euro]	1.52	1.79	1.31	1.17	1.88	1.31	1.18	1.88	1.21	0.94	1.69	1.26	1.10	1.59	1.85

Note: AMS means farms using Automatic Milking System, PF – farms with grazing system and PHS – farms with permanent housing system
Source: own calculation on EDF

• other costs, which include consultancy services, insurance, membership fees, other general economic costs.

In the analysed farms, the PHS farms were characterised by the largest herds of cows, the AMS and PS farms were about twice smaller in this respect (Table 1). The highest intensity of use of fodder area was characteristic of the AMS farms, in which the average cow stock amounted to 1.8 LU/ha of fodder area. These farms also had high soil productivity, comparable to PHS farms and about 30% higher than on PF farms. During the analysis period, average labour expenditures on the farms decreased (by about 3%). Low workload on AMS farms translated into high labour productivity, on average about 65 kg of milk more was produced on these farms than on the PF and PHS farms. The lowest capital expenditure on PS farms resulted in the highest productivity of this resource. In comparison to AMS farms, about 600 kg ECM more was produced per each 100 Euro.

Results and Discussion

Figure 1 shows the level of milk yield in the farms under study. The milk yield of cows in the surveyed total farm population increased from 8794 kg in 2012 to 9251 kg ECM per cow in 2016. In farms using automatic milking system the milk yield of cows in the analysed period increased from 8794 kg ECM in 2012 to 9791 kg in 2016. The highest milk yield of cows was characteristic of farms keeping cows in the permanent housing system. The milk yield of cows in this system increased from 9233 kg ECM in 2012 to 9906 kg ECM per cow. The milk yield of cows in automatic milking herds was slightly higher than the yield of cows in the general population of farms and slightly lower than the milk yield of cows kept in the permanent housing system.

The milk yield of cows, depending on the year, in the group of farms using AMS was from 1.2% to 3.8% higher than the milk yield in the total group of farms. The milk yield of cows on farms equipped with AMS was lower than the yield of cows from farms keeping cows in the permanent housing system. Research by Tse et al. (2018) shows that one of the advantages of the introduction of automatic milking machines is the increase in milk production from 3% to 11%. In turn, studies by De Koning and Rodenburg (2004) and Bernier-Dodier et al. (2010) show that after the introduction of the automatic milking system, the cow milk yield increases from 2% to 25%. However, one should bear in mind that some researchers such as Spolders et al. (2004), Migliorati et al. (2005) and Rotz et al. (2003) argue that the introduction of AMS does not affect the milk yield increase. In the analysed farms with AMS the level of cow milk yield growth was slower and amounted to 1.2% per year. The lowest milk yields were characteristic of farms keeping dairy cattle on pasture. The milk yield in this group of farms was 7892 kg of ECM milk in 2012 and decreased to 7442 kg ECM in 2016.

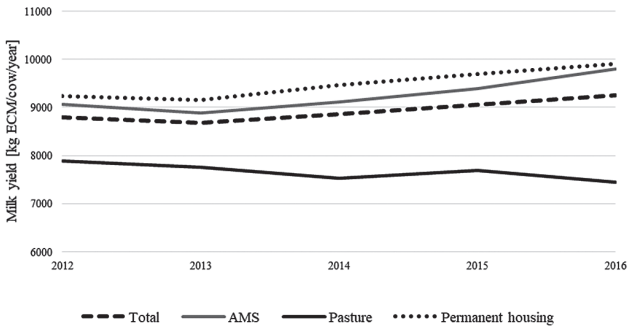

Fig. 1. Milk yield of cows in kg ECM/cow/year
Source: own calculation on EDF data

Figure 2 shows the amount of direct total costs in the surveyed population of farms.

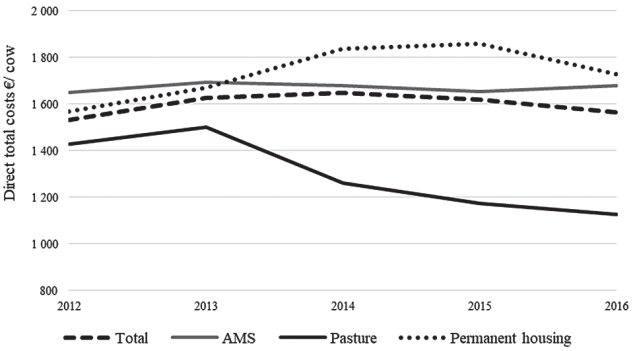

Fig. 2. Direct total costs in €/cow
Source: own calculation on EDF data

In the general population in 2012-2014, direct total costs increased from 1533.2 €/cow in 2012 to 1647.4 €/cow in 2014 to decrease to 1564.6 €/cow in 2016. On farms equipped with AMS, the direct total costs per cow were stable and ranged from 1650.7 €/cow to 1692.2 €/cow. On pasture farms, direct total costs increased from 1428.2 €/cow to 1501.5 €/cow in 2012-2013 and in the following years of the study decreased to reach 1127.7 €/cow in 2016. On farms keeping cows in the permanent housing system in the years 2012-2015 we observe an increase in the analysed cost category from 1567.3 €/cow to 1858.9 €/cow. In 2016, these costs amounted to 1729.9 €/cow.

Figure 3 shows costs of feed per cow in the farms under study. In the whole surveyed group of farms the average

costs ranged from 932.6 €/cow (2012) to 963.6 €/cow. The highest feed costs were observed in the group of farms with permanent housing system.

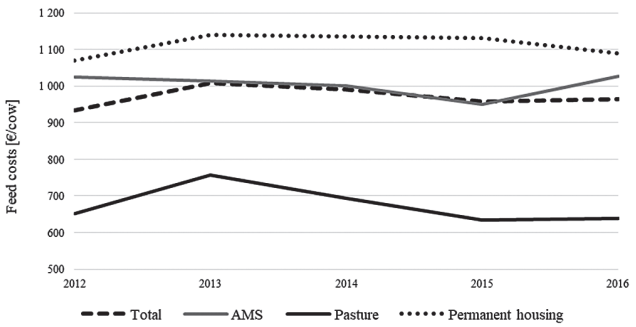

Fig. 3. Costs of feed per cow
Source: own calculation on EDF data

Feedstuff costs in this group of farms ranged from 1068.6 €/cow (2012) to 1090.0 €/cow (2016). On farms using AMS, feedstuff costs ranged from 949.7 €/cow to 1027.4 €/cow. The study does not confirm the results of Baines (2002) and Rasmussen et al. (2002) surveys on rising feedstuff costs due to increased milk production on farms with AMS. The lowest feedstuff costs were characteristic of farms with the pasture system for keeping cows. On these farms, the cost of feed in the period in question ranged from 651.1 €/cow to 638.2 €/cow.

Figure 4 shows the level of the costs of insemination of cows in the period considered. The costs of insemination in the years under study showed a downward trend. In the group of farms in total, these costs reduced from 67.7 €/cow in 2012 to 61.7 €/cow in 2016.

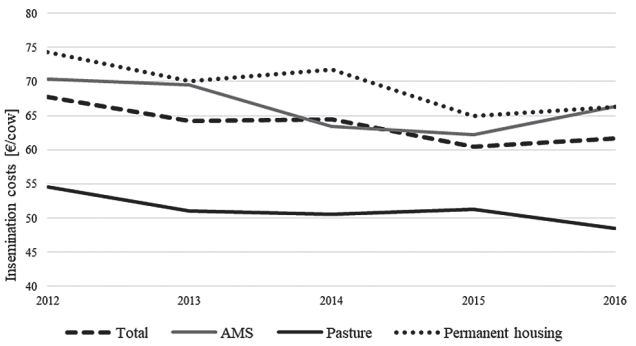

Fig. 4. Insemination costs
Source: own calculation on EDF data

The group of farms with AMS recorded a decrease in insemination costs from 70.3 €/cow (2012) to 62.0 €/cow in 2015 and an increase in insemination costs to 66.3 €/cow in 2016. The highest insemination costs were reported by farms with the permanent housing system for keeping cows and ranged from 70.3 €/cow (2012) to 66.3 €/cow (2016). The lowest costs of insemination were characteristic of farms using pastures. During the survey period this cost decreased from 54.5 €/cow (2012) to 48.5 €/cow in 2016. The low costs of insemination in these farms can be explained by their breeding system and the resulting general health of cows (Radkowska, 2012).

Figure 5 illustrates the amount of treatment costs in individual groups of farms under survey. In the years 2012-2015 the amount of these costs per cow on average in the surveyed farms was about 100 €/cow. The highest treatment costs were reported by farms with cows bred in the permanent housing system and they ranged from 112.5 €/cow (2012) to 107.5 €/cow (2016).

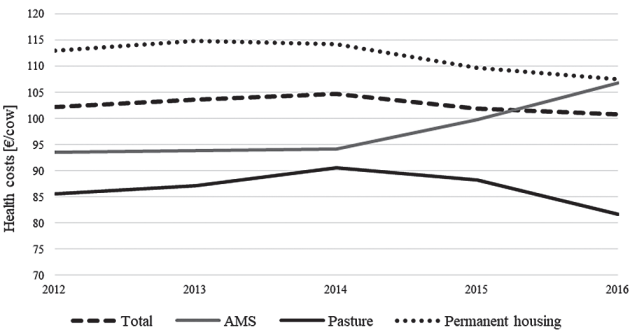

Fig. 5. Cow treatment costs
Source: own calculation on EDF data

In 2012 -2014, the treatment costs on AMS farms were stable at around 94 €/cow, rising to 106.8 €/cow in 2015-2016. The lowest treatment costs were recorded in the group of farms using pastures for cows breeding. In this group of farms, the cost of cows' treatment increased from 85.5 €/cow to 90.5 €/cow in years between 2012 and 2014, and decreased to 81.7 €/cow in the year. These costs can be associated with lower production intensity and higher degree of animal health in this breeding system.

Total labour costs in the surveyed EDF farms in the years 2012-2016 decreased (Figure 6). In the total farms population these costs decreased from 1453.0 €/cow in 2012 to 1384.6 €/cow in 2016. The highest total labour costs were characteristic of farms with AMS and in 2012-2015 they varied between 1697.6 – 1483.7 €/cow, so as to increase in 2016 to 1574.4 €/cow.

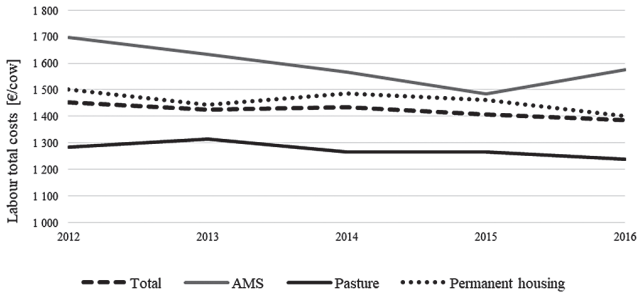

Fig. 6. Total labour costs
Source: own calculation on EDF data

On farms keeping cows in the permanent housing system, the total labour cost in the analysed period decreased from 1500.3 (2012) to 1399.8 €/cow. On pasture farms the total labour cost was the lowest, ranging from 1284.2 €/cow (2012) to 1237.2 €/cow (2016).

On EDF farms, the employment of family labour force (Figure 7) expressed in units of family labour force (FWU – Family Work Unit) is stable and amounted to 1.6 FWU in the years 2012-2016. Farms with AMS in years 2012-2014 decreased the employment of the family labour force from 1.6 (2012) to 1.5 FWU (2014) between 2012 and 2014 to increase to 1.7 FWU between 2015 and 2016.

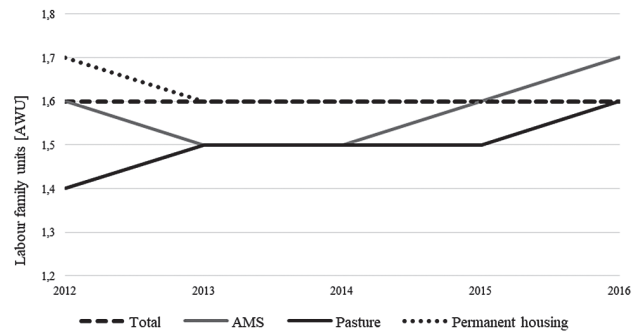

Fig. 7. The employment of family labour force
Source: own calculation on EDF data

A similar process can be observed on pasture farms grazing cows. In this group of farms, the employment of the family labour force increased from 1.4 in 2012 to 1.5 FWU between 2013 and 2015, to reach the level 1.6 FWU in 2016. The most stable employment of the family labour force occurred in farms with permanent housing system of cows breeding. These farms recorded a decrease from 1.7 (2012) to 1.6 FWU between 2013 and 2016.

Figure 8 shows the age of the first calving. In the general population of EDF farms and the group of farms with permanent housing system the average age of the first calving fell in the 26th month of the heifer's life. In the group of farms with AMS, the analysed age of first calving in 2012 was 27 months and in subsequent years of the survey it decreased to 26 months.

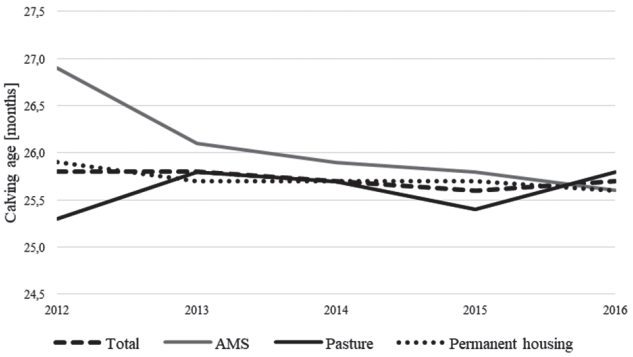

Fig. 8. The age of the first calving
Source: own calculation on EDF data

On farms in the pasture system in 2012, the age of the first calving was 25 months, while in the following years of the survey it oscillated within 26th month.

Figure 9 shows the results of research on the average length of calving interval. In the total population of the surveyed farms, this interval decreased from 405 to 400 days in 2012-2016.

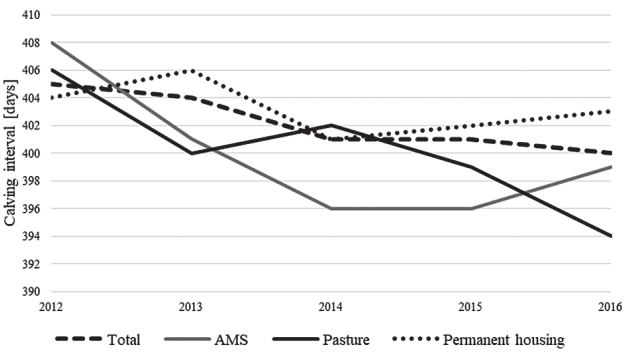

Fig. 9. Calving interval
Source: own calculation on EDF data

In the group of farms with AMS, this period decreased from 408 to 399 days in the analysed period. On farms with permanent housing system of cows breeding, this period ranged from 406 to 400 days, and on farms with pasture system from 406 to 394 days.

Conclusion

On the basis of the conducted research, the following conclusions were formulated:

• The milk yield of cows in the surveyed EDF farms in kg ECM per cow was the highest in farms keeping dairy cows in the permanent housing system, then in farms with automatic milking machines (AMS). The lowest milk yields were characteristic of farms with pasture system of keeping cows.

• The amount of direct total costs per cow in 2013-2016 was the highest in farms with permanent housing system of cows breeding, then in farms with AMS and farms with the pasture system of keeping cows. Similar correlations occurred in feedstuff costs, insemination costs and cow treatment costs.

• The total labour costs in €/cow were the highest in farms with automatic milking machines, then in farms with permanent housing system of cows breeding, while the lowest total labour costs were in farms with the pasture system for keeping cows. As a result of the use of automatic milking systems, farms reduced an employed workforce, introducing in this place a family workforce. This problem should be verified in further studies on the use of automatic milking machines in dairy farms on a larger test sample.

• The employment of family labour in 2012-2015 was the highest in farms with permanent housing system of cows breeding, then in farms with AMS and farms with a pasture system of keeping cows. Attention is drawn to the increase in the employment of family labour on farms with AMS between 2015 and 2016. This increase is likely to be linked to a reduction in the paid labour and an increase in the employment of family members.

• The age of the first calving in all studied groups decreased to reach about 26 months in the last year of the study. A similar trend was observed in the case of the calving interval which in the last year of the study was within the range of 393-403 days.

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