ANALYSIS OF MILKING SYSTEM DEVELOPMENT ON EXAMPLE OF TWO BALTIC COUNTRIES

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Abstract. The paper is aimed at analysis of changes in the access to some kind of technical equipment in dairy farms in comparison with some indices concerning changes in the biological potential of dairy production. It was possible to show higher modernity of Polish farms in respect to milk cooling equipment than milking systems during 15-years period, which was taken for the analysis. Moreover, higher and higher technical potential is associated with higher and higher biological potential of dairy production in Poland. The carried out calculations suggest simultaneous development of the technical and biological potential, which decide about milk production effectiveness. Some conditions concerning AMS (automatic milking systems) implementation in two Baltic countries (Latvia and Poland) were presented to compare the effectiveness of use of the AMS in comparison with other modern solutions for milking. The number of automatic milking systems and rotary milking systems in Latvia shows a balanced percentage share. Such results suggest equal significance of the mentioned modern milking systems, which are implemented in Latvian dairy farms. Discussion concerning the problems how to increase profitability of the modern technical equipment use in dairy production was developed.

Keywords: AMS, dairy production, effectiveness, milking machines, modernity.

Introduction

Dairy production constitutes a type of business enterprise established for the harvesting of animal milk, mostly from cows for human consumption. Not only milk and dairy products are a vital source of nutrition for the people, they also present livelihood opportunities for farmers, processors, shopkeepers and other stakeholders in the dairy value chain [1]. Milk has always been counted among products of strategic importance in the food programme. However, the available methods for its production and distribution have changed [2]. The mentioned changes express the technological development as well as technical and organisational improvements in the field of dairy production system. The changes concerning the technological and technical aspects show strong relationships with the structure and size of farm dairy production.

For the recent 50 years, the dairy sector in most developed countries has shifted towards larger herds and greater annual milk production per cow. For example, the US dairy industry has implemented tremendous improvements in efficiencies and milk production since the 1940s [3]. The driving force in this development has been the need to adopt technologies that require large capital investments and hence depend on larger herds to be profitable. Most milk in developing countries is still produced in traditional small-scale systems with little or no mechanization or technological innovations [4].

Its is possible to indicate that the dairy production system is the field of many dynamic changes to reach higher and higher effectiveness, sustainability [3] and possible producer satisfaction [5] concerning milk production in the farm. The dairy production effectiveness as well as farmer satisfaction depend on many factors, where access to more and more modern technical and technological solutions play one of the most important roles. Moreover, results of dairy production comparisons in some countries are the source of valuable suggestions to develop dairy farms and their technical infrastructure [6]. Assessment of technical potential use in dairy production can be inspration to propose some indices referring to economic benefits [7] and other aspects.

The paper is aimed at analysis of changes in the access to some kind of technical equipment in dairy farms in comparison with some indices concerning changes in the biological potential of dairy production. Basing on such proposed aim it was the idea to show differences in some premises to create effective dairy production considered from the view-point of time and regions, where milk is produced.

Materials and methods

To analyze dairy systems and their selected parts some data coming from two Baltic countries, i.e., Latvia and Poland, were taken. The detailed data covered two groups of specific technical

equipment used in dairy farms, i.e., milking machines and milk coolers. The second part of the data included the biological potential of dairy production expressed by annual milk yield per cow.

Within the group of milking machines we have analyzed changes concerning the number of bucket milking machines and pipeline milking machines. However, within the group of milk coolers we have taken into account changes in the number of coolers of milk in buckets and tank milk coolers. The changes were considered for the 15-years period.

The annual milk yield per cow was considered for the country level and regional level. The 1996-2010 period was included in our analysis.

To analyze changes in the technical potential for milking and milk cooling in dairy farms we have proposed an index of equipment modernity (i_{em}). The general method to calculate the index i_{em} needs in the first stage to distinguish some generations of technical equipment used in the considered area of activity. When the considered area of activity in farm dairy production is milking, so it is possible to distinguish some generations (G) of technical equipment:

- bucket milking machines (GI_m);
- pipeline milking machines (GII_m);
- milking parlours ($GIII_m$);
- automatic milking system – AMS (GIV_m).

However, in the field of milk cooling in the dairy farms the following generations of technical equipment can be distinguished:

- coolers of milk in buckets (GI_c);
- tank milk coolers (GII_c).

The proposed index of equipment modernity (i_{em}) can be calculated basing on the equation:

$$i_{em} = \frac{N_{Gh}}{N_{Gn}}, \tag{1}$$

where N_{Gh} – quantity of technical objects representing the highest generation of modernity;
N_{Gn} – total quantity of technical objects used for the considered activity, representing all generations of technical equipment.

The given above approach expressed by the equation (1) creates the premise to compare modernity of technical equipment between some countries at the same current time. But there can be some problems to find the value of the index of equipment modernity (i_{em}) for the previous time, when the current most modern solutions were unknown. So, for the needs of our analysis the index of equipment modernity was calculated for two generations of milking technical equipment (GI_m and GII_m) as well as two generations of cooling equipment (GI_c and GII_c).

Results and discussion

Including the data from the Polish dairy sector the index of equipment modernity was calculated for three selected years (1996, 2002 and 2010) including milking systems and milk cooling systems (Fig. 1).

Analyzing the values of the index of equipment modernity within the considered period it is possible to indicate the increase tendency of the changes. The index of equipment modernity for milking systems (i_{emm}) increased from 2.5 % to 13.8 % within the period 1996-2010. The same tendency is possible to observe in the case of the index of equipment modernity for milk cooling systems (i_{emc}). But the level of changes is completely different. The value of i_{emc} index has increased from 18.1 % to 76.4 %.

Considering changes of the index of equipment modernity it is possible to conclude that there is higher modernity of Polish farms in respect of milk cooling equipment than milking one. It seems to be important that equipping dairy farms with milking systems generates considerably higher costs than milk cooling techniques.

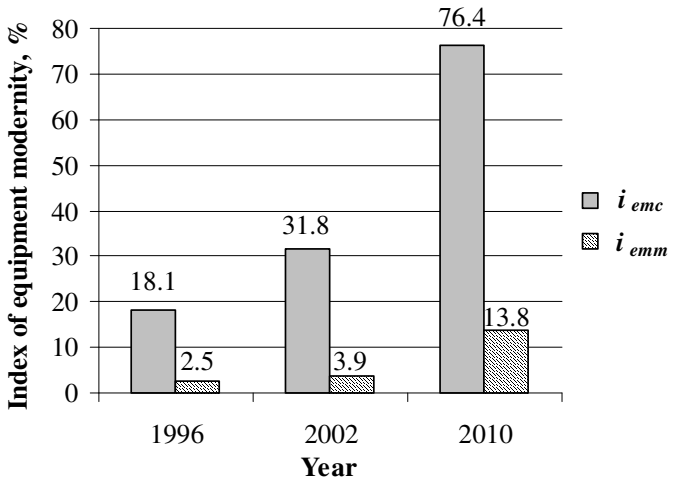

Fig. 1. **Index of equipment modernity:** i_{emc} – index for milk cooling systems; i_{emm} – index for milking systems

The investment costs for technical equipment play an especially significant role in the farms with small-sized cow herds, where lower incomes coming from dairy production decide about more restricted challenges concerning improvement of the technical infrastructure in dairy farms. Moreover, it can be important to notice that implementation of dairy farms with more and more modern equipment for milking is first of all undertaken to safe labour input and increase of the milking capacity, especially in the farms with a higher number of cows. However, the implementation of dairy farms with more and more modern equipment for milk cooling results from the needs to safe energy and fulfil the standards concerning the milk quality, including TBC (total bacteria count). Now in Poland, like in most of the European countries, it is only one obliged class of milk quality, i.e., extra class. There are no other classes, so high efficiency of milk cooling and as a result high effective milk coolers constitute the most important condition to purchase milk from farm to dairy plant. The more effective cooling is possible to perform by means of modern technical equipment, i.e., tank milk coolers, so the fast increase in the number of the mentioned type of coolers in relation to bucket milk coolers decides about high values of the index of equipment modernity for milk cooling systems (i_{emc}).

To calculate the index of equipment modernity for milking systems (i_{emm}) only two generations of milking systems were taken into account, i.e., bucket milking machines and pipeline milking machines. According to the idea of the index we should include the highest generation of milking equipment – AMS, but in 1996 as well as 2002 the automatic milking systems (AMS) were not used in Polish dairy farms. As a result it was impossible to compare the index for the three distinguished years.

The given above calculations cover the national scale of dairy production in Poland. But it is possible to include more regional data to analyze some relationships in the field of dairy production. We have put the question: is the modern technical potential in dairy farms associated with the biological potential of dairy production. To find the answer for such question we have collated data concerning the number of pipeline milking systems (technical potential) and annual milk yield per cow (biological potential) for 16 regions (voivodeships) in Poland. Proper data from the 14 regions were taken into account for detailed analysis. Figure 2 shows the result of the analysis, i.e., the relationship between the number of pipeline milking systems and annual milk yield per cow in 2010.

It is possible to indicate (Fig. 2) that increase in the index of equipment modernity is associated with the growth tendency of annual milk yield per cow in the taken into account dairy production regions. It means that higher and higher technical potential is associated with higher and higher biological potential of dairy production. More modern technical equipment is used to operate herds with dairy cows producing more milk per year. As a result higher responsibility concerns modern milking machines, when a bigger amount of milk has to flow by the milking installation.

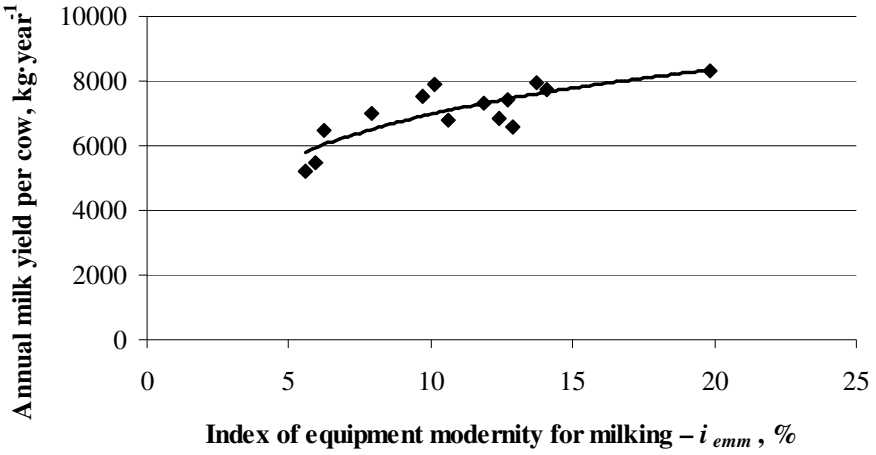

Fig. 2. **Relationship between index of equipment modernity for milking and annual milk yield per cow**

As an alternative approach to the present potential of the milking system on the country scale there can be analysis of some data on the structure of the maintained milking systems. Such aspect can be considered on the base of the data coming from Latvia (Fig. 3).

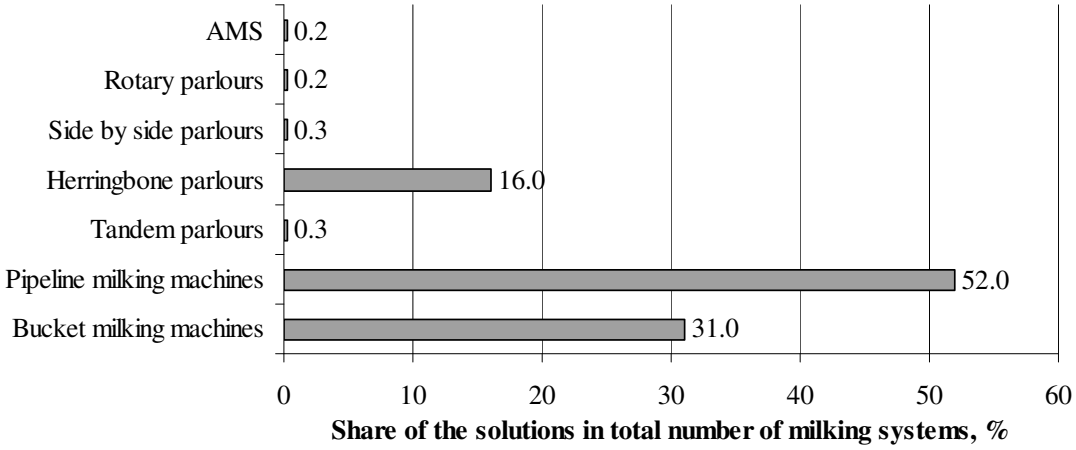

Fig. 3. **Share of milking solutions in total number of milking systems in Latvia in 2013**

The data given in Figure 3 show that the highest share in the total number of milking systems in Latvia concerns the pipeline milking machines. It seems to be important that pipeline milking machines represent a higher level of mechanization that bucket milking machines and from the view-point of the milker give a possibility to operate cows less hard, with higher capacity. On the other hand, the pipeline milking machines constitute a group of solutions considerably cheaper than different types of milking parlours and in the result can be considered as an efficient technical system to milk cows with lower investment costs.

The percentage share of the most modern solutions, i.e., automatic milking systems and rotary parlours is not so high in Latvian dairy farms. But it can be interesting to show some differences in the number of the mentioned technical solutions during the last few years. Such comparison can be an answer to an important question put recently by dairy farmers: which milking system should be chosen to operate cows in the farm? The result of the comparison is showed in the Figure 4.

It is possible to indicate some differences in the increase of the used milking systems (Fig. 4). In 2007 there was only one rotary milking parlour and six AMS installed in dairy farms. Seven years later there was an opposite situation: a higher number of rotary milking parlours than AMS installations. To explain such situation it seems to be important that rotary milking parlours and AMS constitute alternative solutions for many farmers who decided to equip their farms with modern milking systems. Such dilemma, i.e., which milking system to choose is undertaken in many scientific analyses [8] to find the best solution for farms with different work conditions, like the farm size [9].

Generally, the choice of milking installation for the farm depends on many criteria. One of them is utilization indices of milking systems and cow management [10]. But the scientific problems concerning milking systems are not fully solved, so there are premises to develop research on technical, technological and economic aspects concerning rotary milking systems [11], AMS [12] and other technical solutions for milking.

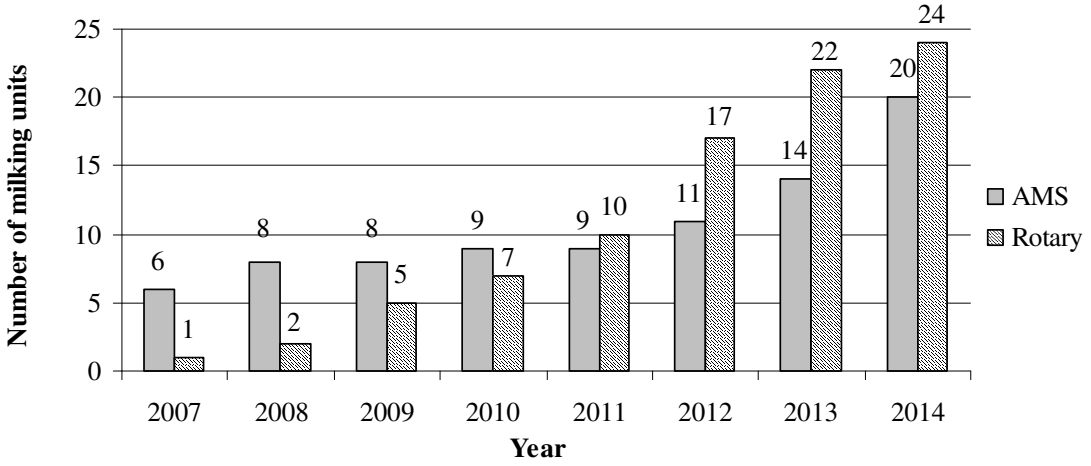

Fig. 4. **Number of AMS and rotary milking systems in Latvia within the period 2007-2014**

Local research is needed to identify the specific constraints on smallholder production systems and develop appropriate solutions as many of the mechanical and technological solutions developed for large-scale dairy farms are too costly or complex for smallholders to adopt [4].

Conclusions

The carried out analysis shows higher modernity of Polish farms in respect of milk cooling equipment than milking systems. Equipping dairy farms with milk cooling systems generates considerably lower costs than milking techniques. Such way it is possible to achieve two aims: save energy for cooling and keep high quality of cooled milk.

Higher and higher technical potential is associated with higher and higher biological potential of dairy production. Such observation concerning the Polish dairy production system suggests simultaneous development of the mentioned potentials, which decide about milk production effectiveness.

Comparison concerning the number of rotary milking systems and automatic milking systems in Latvia shows a balanced percentage share of the mentioned technical solutions within the analyzed period. Such results suggest equal significance of the modern milking systems, which are implemented in Latvian dairy farms.

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