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Indicators for milk production by milking pipeline machine in pasture and cowshed system of cow maintenance

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Abstract: *Indicators for milk production by milking pipeline machine in pasturage and cowshed system of cow maintenance.* The aim of the studies was to determine the effect of the organisation of the milk production in the farm with the cow access to pasturage on the time structure of the herd handling and milking with reference to the obtained efficiency indicators of the milk production by milking pipeline machine. The observations covered three months of the pasturage season: May, July and September, in the farm maintaining a herd of 30 dairy cows. In the subsequent months there were indicated clear trends of changes, i.e. the time reduction of the herd entrance to the cowshed and the increase of the time spent on the basic milking. Over the considered pasturage and cowshed period of the milk production season in the farm there were stated the growing percentage share spent on the basic milking with the corresponding percentage share decrease related to the herd handling as part of the milk production system.

Key words: dairy cow, grazing land, management, milking system, milking time

INTRODUCTION

The dairy production is included in the key branches of the food economy system in most countries around the world [Muehlhoff et al. 2013], it is characterised by the same significant potential expressed by the amount of milk produced in the farms and marketed in the processed form.

The dairy production potential is considered according to the individual scale, i.e. at the level of the farm it is formed by a set of biological, technical and technological factors [Gaworski and Leola 2014]. These factors in comparison with the appropriate organisational solutions are the main components of the dairy production system in the farm maintaining the herd of dairy cattle.

The dairy production system in the farm is subject to various assessments in order to explain numerous relations between biological and technical objects, i.e. accordingly animals and technical equipment with reference to specific technological solutions in the production. For example, in the milk production, there can be indicated the studies covering the effect of the cow maintenance system on the milking indicators and milk management [Gaworski and Boćkowski 2012], the effect of the cow herd structure on the milk yield indicators [Gaworski and Brzeziński 2016], the comparison of the

functionality of the indicators related to various milking systems [Gygax et al. 2007], or the relation between the farm size and the efficiency of the use of automatic milking systems [Rotz et al. 2003]. The studies on the milk production are developed by analyses of economic indicators [Cooper and Parsons 1999] in order to determine the conditions for improvement of the efficiency of the use of the milking systems in relation to the investment expenses [Wagner et al. 2001].

The provision of the farm with the specific milking installation is inseparably linked with the animal maintenance system. The bucket milking machines and milking pipeline machines are mainly used in the farms with the stanchion cow maintenance system, however, the various models of the milking halls or milking robots are commonly used in the cowsheds with the loose housing system. In many dairy farms, in addition to the season of the cow maintenance in the animal housings, however, the cows are also grazed from spring to autumn. The cow maintenance on pasturage generates a number of problems, both practical and research ones, including the issues connected with the effects of the intensive use of pasturage [Macdonald et al. 2017], or the effect of the grazing intensity on the impact of the dairy production on the environment [Aguirre-Villegas et al. 2017]. Regardless of improvement of knowledge on the use of pasturages, including the modelling of pasturage systems for cattle maintenance [Beukes et al. 2008], however, many farms must solve a more prosaic problem, i.e. organising the milking of cows maintained on pasturage. In case of pasturages far away from the farm the option is to use a mobile milking machine [Gaworski and Kic 2017]. However, when the pasturages are located close to the farm there is the problem connected with the assessment of the milk production organisation in terms of work performance indicators, inputs and dairy production efficiency in the farm.

The aim of the studies was to determine the effect of the organisation of milk production in the farm with cow access to pasturage on the time structure of herd handling and milking with reference to obtained efficiency indicators of milk production.

MATERIAL AND METHODS

The object of the studies was the farm located in the community of Bieżuń, in the north-western part of the Masovian Voivodeship. The total area of the farm was 40 ha, of which the pasturage situated in the vicinity of the farm covered 7.5 ha. The pasturage was divided into sectors. The cows were grazed in the single sectors in order to prevent the excessive grass crumpling.

Over the research period the herd numbered 30 cows on average. The herd is under control of milk performance, therefore, the farm was visited by zootechnician once a month in order to measure the amount of milk milked from individual cows and take samples for laboratory assessment. The detailed data on the cow production indicators were available in the Internet system the Online Farmer, which allows individual information about the cowshed of the specific user to be viewed. The amount of milk produced by the farm in question in 2016 was 305,469 l.

The milking took place twice a day, by milking pipeline machine with four milking apparatuses. Milk stored in the cooler was collected from the farm every second day by a milk tanker from the Milkvita dairy in Działdowo. Every day, for each milking time the cows were brought from pasturage to the cowshed with the stanchion maintenance system. The milking in the cowshed was connected with the distribution of concentrated feed with supplements the cows. The cowshed adapted to the maintenance of thirty dairy cows held a valid veterinary certificate.

The cows remained on pasturage from the beginning of May to October. The detailed research data used in the analysis, including the statistical analysis, were gathered in three months: May, July and September, however, in May the data were collected only over 17 days. The research included the measurement of the following time sections: bringing the cows to the cowshed, entrance of the herd to the cowshed, tying the cows, preparation of the milking apparatuses, and preparation of the udders, basic milking and driving the cows to pasturage. The time for bringing the cows to the cowshed was measured from the moment of leaving the sector by the first cow to the moment of entering the cowshed by the first cow. The measurements covering the time of operations performed only for the evening milking. The results of the measurements were collected in the properly prepared form, from which the data were transferred to the spreadsheet of MS Excel.

The structured data were used for the statistical analysis, which included the analysis of the ANOVA variance and the determination of the correlation of the main factors taking into account in the research. The following independent variances were separated in the variance analysis: month, number of cows, sector, percentage share of cows with the lowest (N_{max}) and highest (N_{min}) yield, average monthly yield of cows in the herd and temperature. The air temperature was monitored outside the livestock building [Kocięda 2017].

The statistical analysis was performed with the software Statistica 12.

RESULTS AND DISCUSSION

In the presentation of the research results the time structure of the herd handling connected with the milk production can be divided into two categories. This is the category of the cow handling over the period preceding and following the milking and a set of the time components concerning directly the cow milking. Table 1 specifies the averages times (together with standard deviations) of the individual tasks in the subsequent months of the milk production observation in the examined farm.

The results of research (Table 1) show that, over three examined months, bringing the cows from pasturage to the cowshed generated most of the time in July. However, the interpretation of the differences in the time needed for bringing the cows from pasturage to the cowshed in the particular months is not clear, because during grazing there were changed the sectors where the cows stayed. Thus, the road to be covered by the cow herd was diverse, which could be translated in the time needed for bringing the cows to the cowshed. However, it is worth

TABLE 1. Task completion times (average ±*SD*) as part of milk production in months included in research

Activity	May	July	September
Bringing cows from pasturage [min]	4.88 ±1.16	5.76 ±3.01	4.47 ±0.89
Entrance of herd to cowshed [min]	15.73 ±1.91	13.20 ±3.35	11.90 ±1.93
Tying cows [min]	8.24 ±1.59	8.68 ±3.23	7.46 ±2.23
Preparation of milking apparatuses [min]	5.15 ±1.41	3.81 ±1.07	5.23 ±0.88
Preparation of udders [min]	3.97 ±0.83	4.08 ±0.67	3.81 ±1.05
Basic (evening) milking [min]	83.82 ±4.49	92.78 ±3.13	94.24 ±2.81
Driving cows to pasturage [min]	12.76 ±1.49	13.47 ±1.39	13.06 ±1.60

noting that the results gathered in July are distinguished by the highest standard deviation (*SD* = 3.01 min) in case of the time needed for bringing the cows from pasturage to the cowshed. The significant variations of the time needed for bringing the animals to the cowshed could be caused by wide air temperature ranges in July. The high temperatures outside caused that the cows in order to protect themselves against the sun wandered to the cowshed more willingly.

The entrance time of the cow herd to the cowshed is much more objective for comparisons (due to the limited impact of external factors); the time was measured as the period between the entrance of the first and last cows to the livestock building. The data specified in Table 1 show that the entrance time of the cows to the cowshed has gradually decreased from 15.73 ±1.91 min in May to 11.90 ±1.93 min in September with successive months considered in the research. Such a trend of changes can be explained by the fact that over the time the animals acquire skills of efficient movement, entrance to the cowshed and occupation of appropriate places assigned to them in the lying area where the milking by milking pipeline machine was performed. The acquisition of the skills of the specific behaviour by the animals translates into the time reduction of the implementation of some tasks in the farm – in this case – the time of entrance to the cowshed. After the winter cow maintenance in the cowshed the animals require learning certain behaviours afresh, which was confirmed by the research results of the entrance time to the cowshed in May in comparison to the subsequent months. The separate elements of the considerations are young animals in the herd, i.e. the cows in the first lactation, which must acquire certain skills from the beginning, in this case, connected with the entrance to the cowshed. The impact of the introduction of young cows to the herd on the course and preparation time/cow handling in the milking parlour was demonstrated by Gaworski and Brzeziński [2016].

When comparing the research results as part of the other operations specified in Table 1, there can be indicated the relatively small differences of the measured times within the analysed tasks and the May – September period, except

the basic milking time. The difference between the shortest (in May) and the longest (in September) milking time exceeded 10 min, i.e. 12% – Figure 1.

There is no doubt that the amount of milk produced in the farm, which significantly differed in the examined periods, could show the impact on the different milking time. In the subsequent months (in May, July and September 2016) the amount of milk obtained was accordingly 26,124; 29,298 and 30,613 l. The amount of milk to be obtained per cow within a month was determined taking into account (on the basis of the data on the rotation of the herd in the farm) the average statistical number of the cows in the herd in the subsequent examined months (30, 29.5 and 30.2). In May, July and September it was accordingly: 871, 993 and 1,014 l. To compare, the average annual (in 2016) cow milk yield in the farm was 10,182.3 l. When confronted with the data on the milking time (Table 1) there can be indicated that the animal milk yield was the main factor determining the time designed for the basic milking in the examined farm, which corresponds to the results of other research teams [Hansen 1999].

In the context of the organisation of the milk production system in the examined farm, the data specified in Table 1 provide an incentive to compare the structure of the time spent on the particular groups of operations. As it was mentioned, the first group includes the operations connected directly with milking (preparation of milking apparatuses, preparation of cow udders and basic milking), the second one comprises the other operations mentioned in Table 1. The comparison of the percentage share of the groups of operations connected directly with the milking and herd management in the mentioned months was graphically illustrated in Figure 2.

In accordance with the comparison of the data in Figure 2 the percentage share differentiation of the time spent in the farm on the milking and herd handling connected with the milk production can

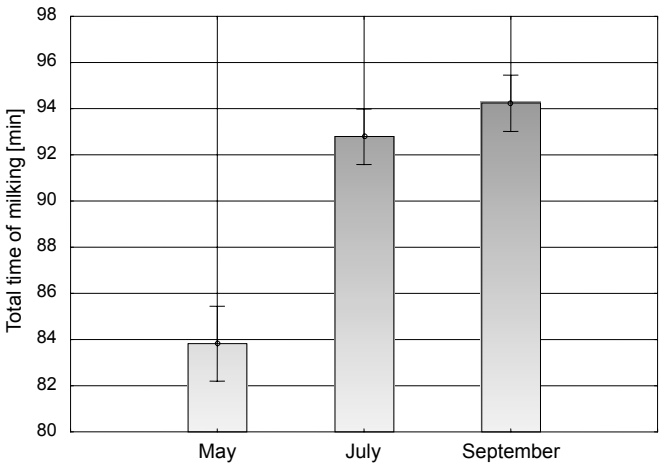

FIGURE 1. Distribution of average values of cow milking time in analysed months

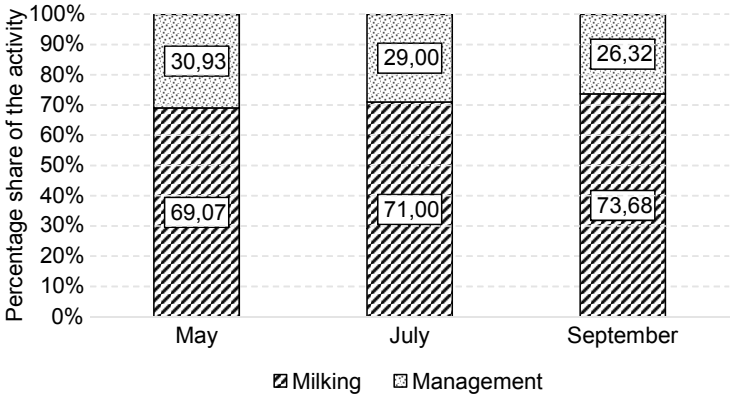

FIGURE 2. Percentage share of groups of operations connected directly with milking and herd management in mentioned months

be observed in the subsequent months of research. The percentage share of the milking time increases in the subsequent months with the parallel decrease of the percentage share of the time spent on the management of the dairy cow herd. Thus the structure of the labour input in the milk production process changes.

The results of the ANOVA variance analysis indicated the materiality of differentiation ($p < 0.001$) of the cow milking time in the particular months, as well as the amount of milk to be obtained in the cow herd in the considered months.

When developing the issue of the cow milking, the detailed research also covered the assessment of the use of the milking apparatuses and the consumption of the materials for the maintenance of the milking installation hygiene. The group of the selected indicators connected with the cow milking in the farm was specified in Table 2.

The indicators considered in the studies (Table 2), including the average amount of milk obtained annually per apparatus, average daily water and washing agent consumption per cow are comparable with the results of the earlier research [Gaworski and Kubczak 2015] performed in the farms equipped with the milking pipeline machine installation.

TABLE 2. Indicators of dairy production in examined farm

Indicators	Indicator value
Number of milking apparatuses [pcs]	4
Average number of cows per milking apparatus [head]	7.5
Average amount of milk obtained annually per milking apparatus [l]	76 367.3
Average number of cows handled per milker [head]	15
Milking time per cow [min]	7.04
Average daily water consumption per cow [l]	5.5
Average daily washing agent consumption per cow [ml]	12.1

The data gathered over three months were used to determine a correlation matrix of the main factors considered in the research. The higher correlation coefficient ($r = 0.776$) was stated in

case of the relation of the basic milking time with the milk yield of the cow herd. Among the statistically relevant correlations ($p < 0.05$) there can be mentioned the relation of the time spent on bringing the cows to the cowshed with the time of the entrance of the cows to the cowshed ($r = 0.263$), as well as the time of the entrance of the cows to the cowshed with the time of tying the cows in the room ($r = 0.358$). The graphical illustration of the relations of the basic milking time with the milk yield of the cow herd is presented in Figure 3.

The cow maintenance in the pasturage and cowshed system inspires the acceptance of appropriate organisational solutions which can ensure the high milk production efficiency with many benefits relating to the herd of dairy cows at the same time. The stay of the dairy cattle outside the livestock building means access to the sunlight, having a positive impact on animal well-being and welfare, reproduction improvement and general animal health situation. The other benefit resulting from grazing the cows on pasturage is a beneficial effect of green fodder, one of the cheapest feedstuff, which can be consumed without limitation [Hanson et al. 1998]. The grazing on pasturage covers the cow demand for vitamins, and among other valuable components in green fodder there are mentioned beta-carotene and unsaturated fatty acids. The feeding of green fodder helps to increase the amount of unsaturated fatty acids in milk fat with the reduction of saturated fatty acids [Tozer et al. 2004]. The awareness of the benefits resulting from the cow maintenance on pasturage should make the agricultural producers

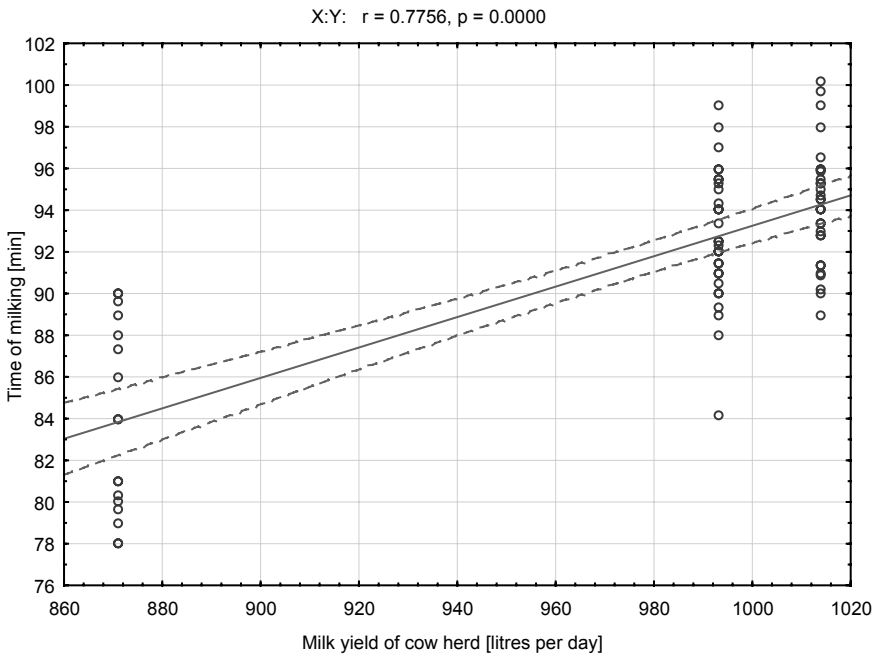

FIGURE 3. Time correlation of basic milking time and milk yield of cow herd

be ready to implement the cow grazing option, which can be stimulated by a financial bonus system for milk coming from cows with access to pasturage [Danne and Musshoff 2017].

CONCLUSIONS

1. From among seven analysed time sections in the research on the milk production system in the farm, only in two cases there were indicated clear trends of changes in the subsequent months (May – July – September), i.e. the time reduction of the herd entrance to the cowshed and the increase of the time spent on the basic milking.
2. In the subsequent months of the pasturage and cowshed period of the milk production season in the farm there were stated the growing percentage share spent on the basic milking with the corresponding percentage share decrease related to the herd handling as part of the milk production system.
3. The cow maintenance on pasturage and resulting benefits for animals and milk quality provide an incentive for the development of the studies supporting the organization of the pasturage and cowshed cow maintenance and milk production system.

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Streszczenie: *Wskaźniki pozyskiwania mleka dojarką przewodową w pastwiskowo-oborowym systemie utrzymania krów.* Celem badań było określenie wpływu organizacji produkcji mleka w gospodarstwie, w którym krowy mają dostęp do pastwiska, na strukturę czasu obsługi stada i doju z uwzględnieniem osiąganych wskaźników efektywności pozyskiwania mleka dojarką przewodową. Obserwacje prowadzono przez trzy miesiące sezonu pastwiskowego (maj, lipiec i wrzesień) w gospodarstwie utrzymującym stado 30 krów mlecznych. W kolejnych miesiącach wskazano na jednoznaczne tendencje zmian, tj. zmniejszanie czasu wejścia stada do obory oraz wzrost czasu poświęcanego na dój właściwy. W rozpatrywanym okresie pastwiskowo-oborowego sezonu produkcji mleka w gospodarstwie stwierdzono rosnący, procentowy udział czasu poświęcanego na dój właściwy przy równoczesnym zmniejszaniu procentowego udziału czasu na obsługę stada w ramach systemu pozyskiwania mleka.

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