

Association between Age at First Calving and Milk Yield in Holstein Cows reared in Pelagonia

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Author Details	
Vesna Karapetkovska - Hristova ^{1*} , Zarko Bebic ¹ , Borche Makarijoski ¹ , Bardhyl Limani ² and Godswill Ntsefong ³	
Authors Affiliations	
¹ Faculty of Biotechnical Sciences , University of St. Kliment Ohridski, Bitola , R.N.Macedonia	
² University of Tetovo, Faculty for Agriculture and Biotechnology, Tetovo, R.N. Macedonia	
³ Faculty of Science, University of Yaounde 1, Department of Plant Biology ; Institute of Agricultural Research for Development, Department of Valorisation and Innovation, Yaounde-Cameroon	
Corresponding Author*	
Vesna Karapetkovska - Hristova	
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Abstract: The objective of this study was to analyse the influence of the age at first calving on the length of lactation and the milk yield of Holstein – Friesian cows. In this survey, sixty primiparous cows were analysed, divided in three groups (A-early, B-middle and C-late). All the research parameters were taken from the farm’s book keeping records. LSD method was used to calculate the statistical significance of the differences in the seasons and the groups of cows to a significance level of 0.05 and 0.01. There was a significant difference of the parameter daily milk yield between the groups A and C, $p < 0.05$. Group B showed significant difference $p < 0.05$ compared to group C. The results obtained for the 305 day lactation suggested that group A was significantly different ($p < 0.05$) compared to group B. There was no significant difference in the length of lactation among the groups of the cows. With this study we have determined the optimal age for calving of the Holstein breed in the Pelagonia region farms to achieve better milk production.

Keywords: age of first calving, Holstein-Friesian breed, milk yield, lactation.

INTRODUCTION

Determining the age at first calving of cows is one of the most important factors that affect the efficiency of the farm, through the direct costs of replacing the farm animals (Tozer P., and Heinrich A., 2001). The costs of raising replacement heifers can be reduced by rapid growth and earlier first mating as well as decreasing the age at first calving (Hoffman *et al.*, 1996; Pietersma *et al.*, 2006). There are quite controversial results in the literature on this issue. Some of the authors in their investigations indicate that the increase in the average daily growth before puberty (in order to reach optimal age at first calving), results with a reduction of the amount of milk in the first lactation (after the first calving) (Hoffman *et al.* , 1996; Van Amburgh *et al.*, 1998; Lammers *et al.*, 1999; Abeni *et al.*, 2000; Radcliff *et al.*, 2000). Surveys done by Gardner *et al.*, (1997) showed that Holstein heifers calved at the age of 19.7 months, in their first lactation give 1052 kg less than the heifers calved at the age of 26, 9 months. On the other hand, surveys done by Pirlo *et al.*, (1997) and Waldo *et al.*, (1998) led to the conclusion that there is no connection between the average daily growth and the milk production during the lactation. For this reason, farm management should balance these two opposite sides. Many authors, in their studies found a difference in the age at first calving at different dairy cows breeds depending on their maturity rate (Mourits M., *et al.*, 2000). Differences in the age at first calving of cows of the same breed are given by authors from different countries (Perez *et al.*, 1999; Pirlo *et al.*, 2000; Harel *et al.*, 2006; Berry and Cromie, 2008; Shindarska *et al.* 2016), and in different raising and feeding conditions, etc (Ruiz-Sanchez *et al.*, 2007). The optimal age at first calving is often a result of a variety of subjective decisions which may depend on the current economic situation in the farm and the proper farm management (Berry D., and Cromie A ., 2008). The need to show the optimal season and age at first calving of Holstein - Friesian cows breed in Bitola’s part of the region is obvious. The results of this research, will contribute to further development and modernization of the cattle husbandry and thus, of the livestock in the country. These results should serve as a significant theoretical and practical contribution to the development of the cattle husbandry, and therefore the livestock in the country, leading to its further improvement and modernization, especially in managing the replacement heifers and primiparous cows, entering the dairy herd in cattle farms in the country.

MATERIALS AND METHODS

Materials

Material used in this research were selected 60 cows of the Holstein – Friesian breed. This research was conducted in a cattle farm located in Bitola's part of Pelagonia. The farm owns 332 cows, with yearly average milk yield of 6,600 kg of milk during the last three years. Cows in the farm are bred in a free system. All the research parameters were taken from the farm's book keeping records, regularly and properly kept by the farm. From these 60 cows, three groups of 20 were established. They were dairy cows that had completed first lactation between 2008 and 2012. Groups taken for this research were formed as follows:

- First Group - A – “Early group” – cows calving for the first time under 24 months of age;
- Second group - B – “Middle Group” - cows calving for the first time from 24-27 months of age;
- Third group - C – “Late group” - cows calving for the first time over 27 months of age;

The relationships between the season of first calving and the following were examined:

- Daily milk production in kg;
- Milk production in kg for 305 days;
- Milk production in kg for a whole lactation;
- Lactation length in days;

The results obtained from this research were processed with statistical methods used for scientific research purposes in the field of animal husbandry.

METHODS

The results of the tests were statistically processed, clearly and concisely presented in tables and graphs where the influence of the season and the age at first calving of cows of the Holstein – Friesian breed can be clearly seen.

The systematization and classification of data resulted to more precise values. It allowed their statistical processing. The next stage was systematization of data in Microsoft Office Excel and their further processing afterwards.

Arithmetic value of the season and age at first calving by groups was calculated and a table formed. The LSD method was used to calculate the statistical significance of the differences of actual parameters between the seasons and ages for milk yield in kg and the lactation length in days among the three groups of cows. The significant level is 0.05 (milk yield) and 0.01 (lactation length) and that represents the significant difference between seasons and groups.

RESULTS AND DISCUSSION

In the first three tables, data for several examined parameters in the three groups of cows is shown. Individual indicators of lactating cows for the first calving season, length of lactation, daily milk production in kilograms (kg), milk production for 305 days in kilograms (kg), and total milk production in kilograms (kg).

From Table 1, it can be concluded that according to the results for daily milk yield of cows, by age groups, the highest average daily production of milk was obtained in the group of primiparous cows at the age under 24 months. The average daily milk production in this group was 24.29 kg. In the group of cows calving for the first time at 24-27 months of age, the average daily milk production was 24.33 kg, and in the group of over 27 months of age - 21.38 kg.

The differences in average milk production between groups A and C and groups B and C are statistically significant at the level of 0.05. There is no statistical significance between groups A and B. From Table 1 it can be concluded that milking cows calving at the age of 24 months and 24-27 months of age have the highest daily milk yield.

It can be observed from Table 2 that the average milk production for 305 days in kilograms, by age groups of cows first calved at the age under 24 months was 7327 kg, the average amount of milk in the group of cows first calved at the age of 24-27 months was 7587 kg and the average amount of milk in the group of cows first calved at the age over 27 months was 6411 kg. From these results (Table 2), it can be concluded that the differences in average milk yield for 305 days of lactation between groups A and C were significant at the level of 0.05.

Table 1 – Daily milk production in kilograms by age groups

Group	Average daily milk production in kilograms, by age groups					
	n	Spring	Summer	Autumn	Winter	\bar{x}
A	20	23,53	22,43	24,52	27,10	24,39*
B	20	22,40	22,90	26,40	26,22	24,33*
C	20	17,38	18,95	22,90	26,29	21,38
		[1]	LSD 0,05 = 2,460169*			
		[2]	LSD 0,01 = 3,725398**			

Table 2 - Milk production for 305 days in kilograms, by age groups

Group	Average daily milk production in kilograms, by age groups					
	n	Spring	Summer	Autumn	Winter	\bar{x}
A	20	7188	6850	7789	7483	7327
B	20	7143	6820	8180	8205	7587*
C	20	5133	5536	6983	7993	6411
		LSD 0,05 = 961,7787*				
		LSD 0,01 = 1456,408**				

Between groups A and B and between groups A and C, there is no significant difference. According to this, the age group of 24-27 months is characterized with the highest milk production for a lactation of 305 days. This fact is confirmed by the results obtained by Tarwacka *et al.* (2011) of which the most optimal age for the first calving was the age of 24-27 months. According to the authors, the first lactation according to the age at first calving is an effective strategy for milk producers in order to reduce their costs. Harel *et al.* (2006) reached similar conclusions from their research where they stated that the highest percentage of primiparous cows with the highest milk yield in the United States are at the age of 23-27 months. These authors suggest that in countries where farming is highly developed, decrease in age at first calving can be recorded. Similar results were obtained by Sawa

(1998) who found that the greatest milk yield was obtained from primiparous cows calving for the first time at the age of 25-27 months. It can be realised that the first calving cows from group B are characterized by the highest milk yield. The differences between group A and group B in terms of milk quantities do not vary in large limits which indicates that the decreasing of the age at first calving does not affect the milk productivity of the first calving cows negatively, and does not reduce the milk yield in large scale during the first lactation. These results are very similar to the research results of the authors Lin CY *et al.*, (1987). They concluded that with proper program of rising of breeding heifers at a younger age, increased profits in milk production in the herd can be provided.

Table 3 - Total milk production (kg), by age groups

Group	Total milk production in kg, by age groups					
	n	Spring	Summer	Autumn	Winter	\bar{x}
A	20	7850	8125	7955	10573	8626*
B	20	7468	6595	9296	11221	8645*
C	20	5072	5510	7826	9184	6898
		LSD 0,05=1309,655*				
		LSD 0,01=1983,192**				

Table 4 – Lactation length in days, by age groups

Group	Lactation length in days, by age groups					
	n	Spring	Summer	Autumn	Winter	\bar{x}
A	20	330	364	326	391	353
B	20	334	301	356	433	356
C	20	292	289	344	351	319
		LSD 0,05=49,07902*				
		LSD 0,01=74,31965**				

According to the results in Table 3 for total milk production (kg), by age, in group A, at primiparous cows at the age up to 24 months, 8626 kg of milk were obtained. In group B, cows calving for the first time at the age from 24 to 27 months gave 8645 kg, and in the age group of over 27 months of age – 6898 kg.

Thus, a conclusion can be drawn that between groups A and C and between groups B and C there is a significant difference of 0.05. Between groups A and B there is no statistical significance. Thus, the age of 24-27 months is the optimal age of first calving. Reducing the age of calving to 24 months, according to the results is justified and does not result in adverse effects, and large differences in milk yield, as confirmed by the results obtained from Losinger CW and Heinrichs JA (1997). They have come to the conclusion that reducing the age at first calving certain advantages are achieved, such as: lower costs, reduced food costs, increased daily milk production in the herd.

Aside the above-mentioned authors, the results of this study interact with the research results obtained by Gnyp and Litwińczuk (1997) indicating that primiparous cows, calved at the age under 24 months and cows of 24-27 months of age have similar milk yields as opposed to primiparous cows, calved at the age over 27 months of age. Milk yield in the group under 24 months of age and 24-27 months, in the results obtained by these authors differed significantly from the cows of over 27 months of age.

The age group B, cows first calved at 24 to 27 months of age, is characterized by prominently higher milk yield compared to group C. Thus, the results also interact with the results obtained by Le Cozler Y., *et al.*, (2007). They stated that the age at which pubertal maturity begins can range from 9-20 months. In order to provide first calving at an average age of about 24 months (to obtain higher milk yield) first estrus should appear at the age of 12-15 months.

According to the results from Table 4, the longest lactation showed the age group of 24-27 months (group B). The lactation length in this group was 356 days. The lactation length in group A was 353 days, while in Group C – 319 days.

The statistical results obtained from the length of lactation between groups A:B, A:C and B:C showed no significant difference (0.05).

CONCLUSION

The results for the average daily milk production (kg), by age groups led to the conclusion that the group A – Early group of primiparous cows gave average daily milk production of 24,39 kg, group B - Middle group of cows with average daily production of 24,33 kg, are recommended age groups for the first calving compared to group C - late group, where according to this research, the smallest average daily milk production of 21,38 kg is obtained;

According to the results obtained from the milk production in a lactation of 305 days, by age groups, the following conclusion is drawn: age group A – Early group of first calving cows at the age under 24 months of age and Group B - Middle group of first calving cows at the age from 24-27 months are characterized by the highest production of milk for 305 days of lactation compared to the C age group - Late group of first calving cows at the age over 27 months of age;

According to the results of the total milk production, a conclusion can be made – Group A - Early group of cows gave an average milk production of 8626 kg and group B - Middle group of cows gave an average milk production of 8645 kg. These two groups are characterized by higher production of milk compared to C - Late group of cows, where the average milk production was 6898 kg;

The results of the lactation length in days, by age group, according to this research, lead to the conclusion that the longest lactation period expressed in days characterized groups A - Early group of primiparous cows and B - Middle group of cows compared to group C - Late group of cows where the shortest lactation period is recorded;

List of Abbreviations: LSD – Least Significant Difference,

Competing Interest Statement: The authors declare that they have no competing interests regarding the publication of this paper.

Author's Contribution:

K.H.V., G.N.N., and M.B. involved in the conception, design of the study. K.H.V., B.Z., and B.L., performed experiment; all authors were involved in data collection, analysis, interpretation and manuscript writing.

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