

## **The effect of age at first calving on the milking performance of primiparous Jersey cows**

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### **SUMMARY**

The aim of this study was to determine the effect of age at first calving on the milking performance of primiparous Jersey cows (261 cows). Analyses were conducted on 2461 test day milking samples from 17.09.2007 to 26.07.2016. The primiparous cows were divided into four groups according to their age at first calving ( $\leq 24$ ,  $> 24-26$ ,  $> 26-28$ ,  $> 28$  months), and their daily milk yields were compared. Fourfold contingency tables were prepared to investigate the distribution of the population of cows calving at different ages and the peak daily milk yield. The significance of the association between factors was estimated using Fisher's exact test. To illustrate the course of 305-day lactation in primiparous cows varying in age at first calving, linear graphs were plotted with linear trends for daily milk yields. Primiparous Jersey cows calving at the age of  $> 26-28$  months of life had the highest daily milk yield. In terms of the contents of basic milk constituents in the first lactation, the most advantageous age at first calving was  $> 24-26$  months of life. However, a younger age at first calving ( $\leq 24$  months) was associated with a lower somatic cell count in milk as well as a more favourable lactation curve for daily milk yield. The results of the study may suggest that Jersey cows calving at an earlier age (up to 24 months) may have a longer productive life and thus better performance parameters.

**KEY WORDS:** Jersey cattle, age at first calving, milking performance

### **INTRODUCTION**

The age of cows at first calving is one of the factors potentially influencing milk production (Antkowiak and Kliks, 1999; Juszcak et al., 2001; Salomończyk and Guliński, 2010). In heifers, it is difficult to identify the optimal time for natural service or artificial insemination to ensure maximum utilization of their genetic potential for high productivity. On the one hand, economic aspects are of great importance, while on the other hand the physiological condition and health status of primiparous cows are crucial. This is because the reproductive life of cows begins when they reach

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sexual maturity, which primarily depends on their degree of development and their age. However, the age at which cows reach sexual maturity may to some extent be modified, e.g. by modifying their feeding. To reduce the length of the rearing phase in young female cows, more intensive feeding regimes are recommended (Pytlewski et al. 2017). According to Heinrichs et al. (2005), diet, housing conditions and management factors may affect the health and growth of calves and their age at first calving, and may also have long-term effects on the animals. Salazar-Carranza et al. (2014) suggested that the milking performance of primiparous cows is associated with their age at first calving. Heise et al. (2018) suggested that the genetic models used to forecast the longevity of cows need to be corrected to take into account their age at first calving. The productive life of cows begins with the start of their reproductive life cycle, which may be earlier or later. It is generally accepted that age at first calving in cows probably modifies their performance traits.

The Jersey breed, as a single-purpose dairy breed, differs in many respects from the Polish Holstein-Friesian breed popular in Poland. The main differences concern body size and milk yield and composition. According to Boothby et al. (2020), the impact of age at first calving on production, fertility and longevity in Jersey shows a similar trend to that seen in the Holstein, though possibly on a lesser scale.

The aim of the study was to determine the effect of age at first calving on the milking performance of primiparous Jersey cows.

#### **MATERIAL AND METHODS**

The analyses were conducted in a herd of Jersey cows kept on the Stadnina Koni Iwno Sp. z o. o. horse farm. The study was based on performance testing records of dairy cows. Data were collected on the milking performance traits of 261 primiparous cows. Analyses were conducted on 2461 test day milking samples taken from 17.09.2007 to 26.07.2016. Until 2014 the cows were kept in a tie-stall management system, while at present they are kept in a loose housing system. The barn is equipped with a parallel milking parlour with 20 milking stalls. The TMR feeding system was used throughout the study period. The main components of the diet were maize silage, alfalfa silage, ensiled maize grain, straw or hay (depending on the milk yield group), beet pulp, and brewer's grain. The TMR also included vitamin and mineral mixtures and ready-made concentrated feeds. The mean milk yield of primiparous cows in 305-day lactation in 2016 was 7241 kg of milk.

The primiparous cows were divided into four groups depending on their age at first calving ( $\leq 24$ ,  $> 24-26$ ,  $> 26-28$ , and  $> 28$  months). Statistical calculations were conducted on the first 11 test samples from the standard 305-day lactation. Data on daily milk yield, milk content of fat, protein, lactose, milk solids and urea, somatic cell count, and the fat-to-protein ratio were obtained from RW2 record charts.

Analyses were conducted to estimate the effect of the group (age at first calving) on the milking performance of primiparous cows.

The distribution of random variables was normal. The logarithmic transformation according to Ali and Shook (1980) was used to obtain a normal distribution for somatic cell counts. Fixed effects were used for the calculations.

Statistical analyses were performed using the SAS® (2015) statistics package. Basic statistical parameters were calculated by the SAS-MEANS procedure. The ML (maximum likelihood) connecting function was used.

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The significance of the effect of experimental factors was tested by the multivariate covariance analysis using the SAS-GLM procedure, based on the following linear model:

$$y_{ijklmn} = \mu + r_i + s_j + o_k + \beta_1 w_1 + \beta_2 d_m + e_{ijklmn},$$

where:

$y_{ijklmn}$  - phenotypic value of analysed trait,

$\mu$  - population mean,

$r_i$  - fixed effect of  $i$ -th year of calving ( $i = 1, 2, \dots, 10$ ),

$s_j$  - fixed effect of  $j$ -th calving season ( $j = 1, 2, 3, 4$ ),

$o_k$  - fixed effect of  $k$ -th country of sire's origin ( $k = 1, 2, 3, 4$ ),

$\beta_1, \beta_2$  - partial coefficients of linear regression,

$w_1$  - cow's age at first calving,

$d_m$  - day in milk,

$e_{ijklmn}$  - sampling error.

Statistically non-significant effects were eliminated and calculations were repeated. For comparison of means, a series of multiple comparisons were conducted using the Tukey test. A fourfold contingency table for daily milk yield was prepared to compare the distribution of populations of cows calving for the first time at different ages and peak lactation. Significance of associations between factors was estimated using Fisher's exact test. To present the course of 305-day lactations, linear graphs were plotted showing linear trends for daily milk yield depending on age at first calving. All calculations and analyses were conducted on cows whose milk had a somatic cell count of  $\leq 300,000/\text{ml}$ .

### **RESULTS AND DISCUSSION**

Table 1 presents results concerning the daily milking performance of primiparous Jersey cows depending on their age at first calving. The statistical analysis showed a significant ( $P \leq 0,01$ ) effect of age at first calving on most of the analysed milking performance traits in primiparous cows. Dependencies were shown between age at first calving and daily milk yield, content of dry matter, fat and protein, somatic cell count (SCC) and its natural logarithm (LSCC), and the fat-to-protein ratio. A significant effect at  $P \leq 0,05$  was observed for lactose percentage and urea concentration in milk. The highest daily milk yield (21,9 kg) was recorded for cows calving within the age interval of  $> 26-28$  months, while the lowest daily milk yield was found in cows that calved at the youngest age. In terms of milk composition, the lowest contents of dry matter, fat and lactose as well as the lowest fat-to-protein ratio were found for cows calving for the first time at the age of  $> 26-28$  months. The highest percentage contents of dry matter (14,64 %), protein (3,89 %) and fat (5,10 %) in milk were recorded for cows whose age at first calving was  $> 24-26$  months.

**Table 1**

Relationships between calving age and daily milk production traits in primiparous Jersey cows

Traits	Significance of effect	Age at first calving (months)							
		≤ 24		> 24–26		> 26–28		> 28	
		N = 300		N = 794		N = 440		N = 213	
	$\bar{x}$	SD	$\bar{x}$	SD	$\bar{x}$	SD	$\bar{x}$	SD	
Milk (kg)	**	19,8 <sup>A</sup>	3,9	20,8 <sup>BC</sup>	4,0	21,9 <sup>BD</sup>	4,9	21,5 <sup>B</sup>	4,9
Fat (%)	**	5,02 <sup>B</sup>	0,72	5,10 <sup>B</sup>	0,77	4,89 <sup>A</sup>	0,77	5,02 <sup>B</sup>	0,76
Protein (%)	**	3,88 <sup>A</sup>	0,41	3,98 <sup>B</sup>	0,43	3,93	0,43	3,90 <sup>A</sup>	0,44
Lactose (%)	*	4,90 <sup>a</sup>	0,15	4,89 <sup>a</sup>	0,15	4,86 <sup>b</sup>	0,15	4,88	0,16
Total solid (%)	**	14,43 <sup>B</sup>	0,95	14,64 <sup>A</sup>	1,02	14,37 <sup>B</sup>	1,04	14,49 <sup>B</sup>	1,00
Somatic cell count (1000/ml)	**	113 <sup>Aa</sup>	70	124 <sup>b</sup>	67	132 <sup>B</sup>	71	127 <sup>B</sup>	70
LSCC (1000/ml)	**	11,42 <sup>A</sup>	0,70	11,56 <sup>B</sup>	0,61	11,63 <sup>B</sup>	0,61	11,58 <sup>B</sup>	0,62
Urea (mg/l)	*	218 <sup>a</sup>	74	234 <sup>b</sup>	70	243 <sup>b</sup>	6	237 <sup>b</sup>	72
Fat/Protein	**	1,30 <sup>A</sup>	0,16	1,28 <sup>AC</sup>	0,15	1,25 <sup>B</sup>	0,16	1,29 <sup>ABC</sup>	0,18

Significance of effect: \*\* - highly significant ( $P \leq 0,01$ ); \* - significant ( $P \leq 0,05$ ).Means denoted with different letters (in rows) differ statistically: A, B, C - highly significantly ( $P \leq 0,01$ ); a, b, c - significantly ( $P \leq 0,05$ ).

Somatic cell counts and urea content in the milk of all analysed groups of cows fell within the assumed standard limits. However, the lowest LSCC (11,42) and urea level (218 mg/l) were recorded in the milk of cows calving before the age of 24 months. Those cows differed in these traits from all other groups at  $P \leq 0,01$  and  $P \leq 0,05$ , respectively. Analyses of results presented by other authors concerning fluctuations in age at first calving in dairy cows indicate a downward trend in this parameter, which is probably associated with performance traits and the profitability of raw milk production. Hutchison et al. (2017), in a study of a large population of cows of three breeds, found that a younger age at first calving was correlated with better fertility and higher milk yield. The authors showed that milk production throughout the animals' life is maximized when the age at first calving ranges from 21 to 22 months in the case of Holstein and Brown Swiss cows and from 20 to 21 months in the case of the Jersey breed. Zavadilová and Štípková (2013), in a study of Czech Holstein cows, showed that animals with the oldest age at first calving (33–46 months) were less fertile in their first lactation and had a shorter productive life. The results of a study by Mohd et al. (2013) indicate that earlier artificial insemination of heifers, even if their development is adequate, reduces their milking performance. For this reason the decision to undertake this procedure should take into consideration current economic conditions. The authors suggested that lowering the age at first calving may have a negative effect on the level of milk production in primiparous cows. A similar opinion was expressed by Meyer et al. (2004), who also stated that milk yields in successive lactations are not associated with the cows' age at first calving. According to Novaković et al. (2011), however, age at first calving in cows influences not only their milk yields in the first lactation, but

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also their lifetime productivity. A similar opinion was presented by Nilforooshan and Edriss (2004), whose research confirmed that an earlier age at first calving favourably influenced milk yield and the length of productive life. Haworth et al. (2008) showed that in the case of Holstein cows there is a positive relationship between age at first calving and longevity in animals with an average daily milk yield below 30 litres in the first lactation. According to Pirlo et al. (2000), Weerasinghe et al. (2007-2008) and Kertz (2005), the optimal age at first calving for Holstein cows is 23–24 months, while calving at a later age results in economic losses. In contrast, Sung et al. (2016) showed that Holstein cows from Korea aged 24–28 months at first calving had higher productive performance owing to an increased lifetime milk yield and a decreased culling rate. On the other hand, Eastham et al. (2018) showed that in Holstein-Friesian populations a lower age at first calving (21 months) improved the health status of the mammary gland and reproduction indexes while extending the productive life of cows.

**Table 2**

Distribution of the lactation peak for daily milk yield in primiparous Jersey cows calving at different ages

Age at first calving (months)		Peak of lactation (days)				$\Sigma$
		$\leq 30$	31–60	61–90	$> 90$	
$\leq 24$	N	9	16	9	9	43
	% <sup>1</sup>	20,93	37,21	20,93	20,93	
	% <sup>2</sup>	15,79	16,33	17,65	16,36	
$> 24-26$	N	26	38	27	24	115
	% <sup>1</sup>	22,61	33,04	23,48	20,87	
	% <sup>2</sup>	45,61	38,78	52,94	43,64	
$> 26-28$	N	14	32	4	17	67
	% <sup>1</sup>	20,90	47,76	5,97	25,37	
	% <sup>2</sup>	24,56	32,65	7,84	30,91	
$> 28$	N	8	12	11	5	36
	% <sup>1</sup>	22,22	33,33	30,56	13,89	
	% <sup>2</sup>	14,04	12,24	21,57	9,09	
$\Sigma$	N	57	98	51	55	261
		Parameter			Value	P
		Fisher test			-	0,0850
		V <sub>Cramer</sub>			0,1323	-
		r <sub>p</sub>			0,0137	0,4832
		r <sub>k</sub>			0,0138	0,4937

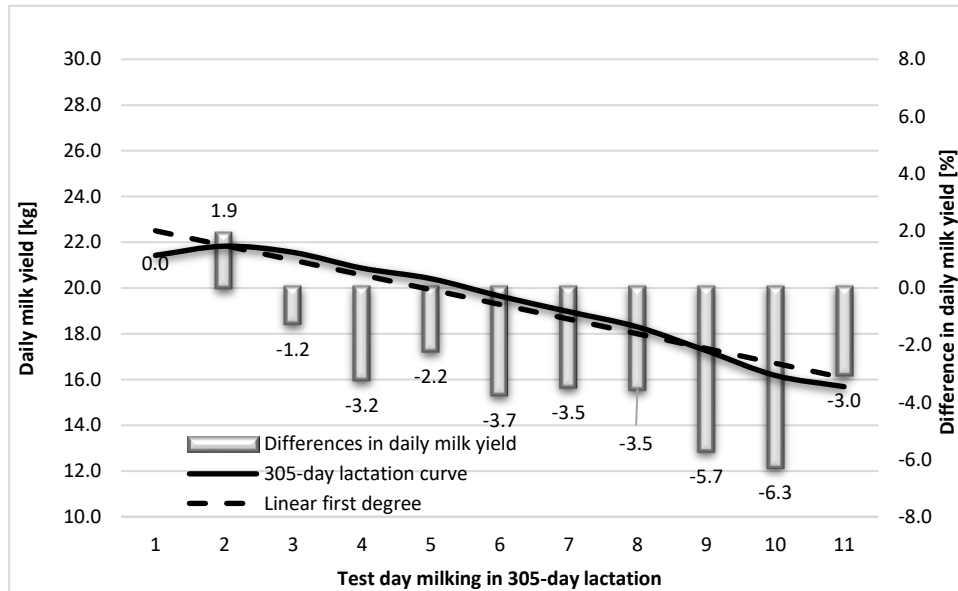
%<sup>1</sup> - % in row, %<sup>2</sup> - % in column

r<sub>p</sub> - phenotypic correlation, r<sub>k</sub> - canonical correlation

Table 2 presents the relationships between the distribution of peak lactation and age at first calving in primiparous Jersey cows. The statistical analysis showed no significant effect of age at first calving on the date of the highest daily milk yield during lactation. Primiparous Jersey cows in all analysed groups (age at first calving) had their peak lactation from day 31 to day 60 of lactation. However, the highest share (47,76%) of peak lactation in this time interval was recorded in the group of primiparous cows calving at the age of  $> 26-28$  months.

Figures 1–4 present curves for daily milk yields in the first lactation, with the first-order linear trend established for Jersey cows depending on groups distinguished by age at first calving. Cows calving before 24 months of age (Fig. 1) had relatively gentle, stable lactation curves plotted for daily

milk yields, characterized by a gradual decreasing trend from month to month (max. 10%). Peak lactation was observed around day 60 of lactation. Daily milk yield in that period was 28,8 kg. Figure 2 presents lactation curves for daily milk yields in cows calving in the period between > 24 and ≤ 26 months of age. Monthly reductions in yields for that group are not as uniform as in the case of cows calving before the age of 24 months. Peak lactation in primiparous cows was observed at about 60 days after calving, while milk yield in that period was higher than in cows calving for the first time at ≤ 24 months of age. However, the lactation curve for milk yield is more irregular than in the group of animals calving earlier. Cows calving in the age interval between > 26 and 28 months of age (Fig. 3) had much higher milk yields at peak lactation than animals with a younger age at first calving. However, the milk yield of primiparous cows in that group decreased more rapidly and was lower by the end of lactation. Those cows started lactation with a fairly high production plateau, while the curve for daily milk yield was somewhat irregular, and peak lactation occurred at about day 60 of lactation (Fig. 3). Figure 4 presents the course of daily milk yields in Jersey cows calving for the first time after 28 months of age. Peak lactation in those cows was observed from day 60 to even day 120 of lactation, while daily milk yields at that time were relatively high (a high increase in relation to the initial yield). Towards the end of lactation milk yields increased. The curve plotted for daily milk yield was highly irregular and unstable, characterized by rapid drops and increases in daily milk yield; however, with progressing lactation a general downward trend was recorded for milk yields. The reduction in milk yield from month to month frequently exceeded 10%.



**Fig. 1.** Curve for daily milk yield in 305-day lactation with linear trend and differences in daily milk yield in primiparous Jersey cows calving at ≤ 24 months of age

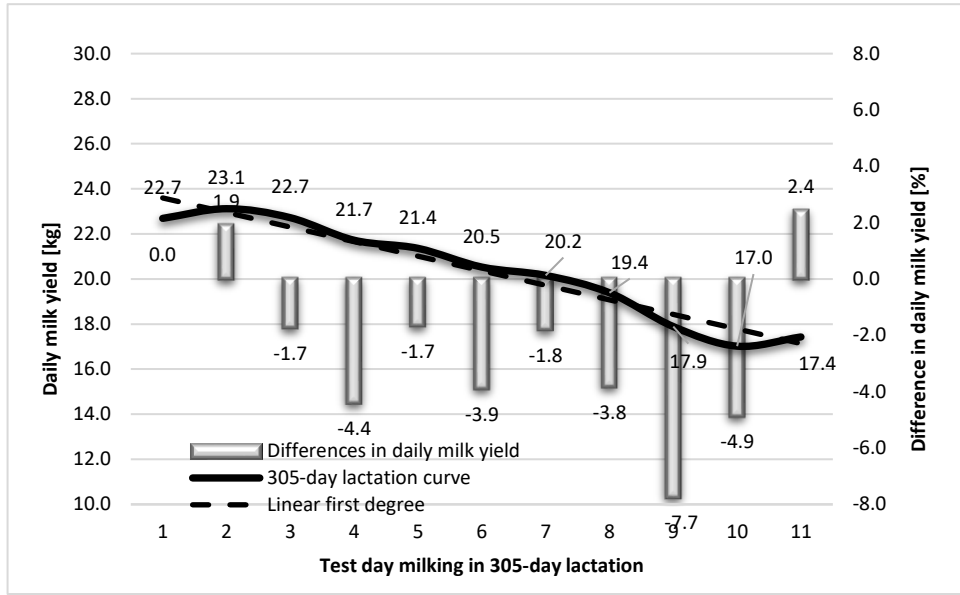


Fig. 2. Curve for daily milk yield in 305-day lactation with linear trend and differences in daily milk yield in primiparous Jersey cows calving at > 24–26 months of age

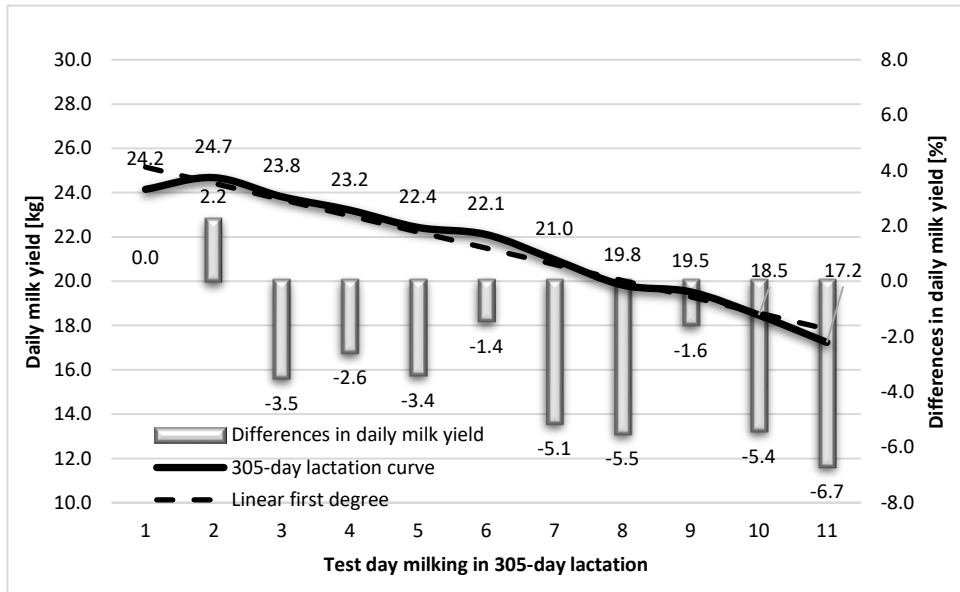
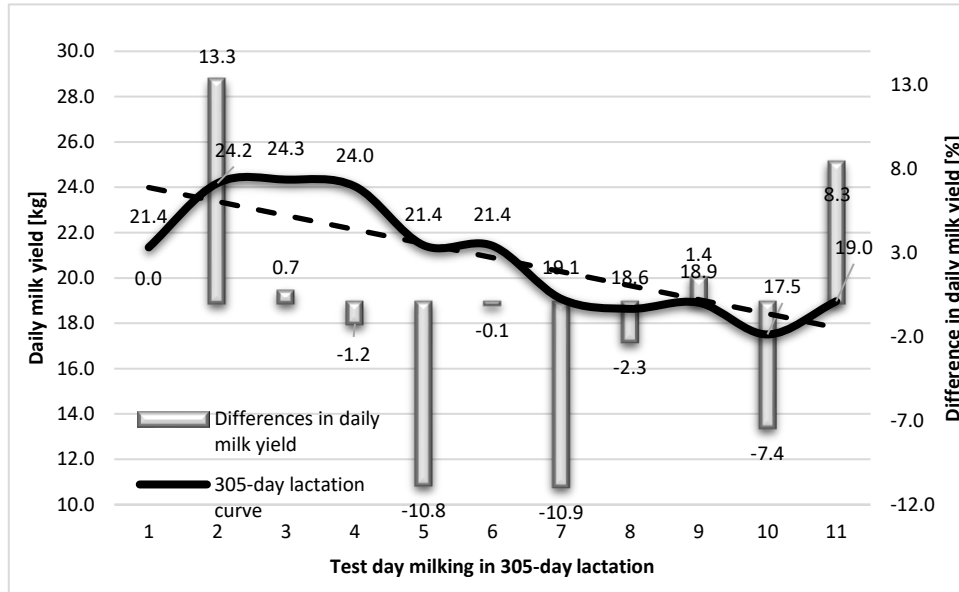


Fig. 3. Curve for daily milk yield in 305-day lactation with linear trend and differences in daily milk yield in primiparous Jersey cows calving at > 26–28 months of age



**Fig. 4.** Curve for daily milk yield in 305-day lactation with linear trend and differences in daily milk yield in primiparous Jersey cows calving at > 28 months of age

In view of the literature results presented on the subject, the data obtained in this study should be considered preliminary. However, they indicate that a younger age at first calving is associated with a lower somatic cell count in milk and a more favourable curve for daily milk yield. The results of this study may also suggest that Jersey cows calving at a younger age (up to 24 months) have a longer productive life and thus more favourable performance traits.

### CONCLUSIONS

Primiparous Jersey cows calving at the age of > 26–28 months had the highest milk yields. In terms of content of basic milk constituents, the most advantageous age at first calving was > 24–26 months of age.

Milk produced by cows calving at the youngest age ( $\leq 24$  months) had the lowest somatic cell counts and the lowest urea content.

The peak of lactation most commonly occurred between 31 and 60 days after calving, irrespective of the age at first calving.

The most stable lactation curve plotted for daily milk yield was found for primiparous Jersey cows calving no later than 24 months of age.

Research should be continued to assess the effect of the age at first calving on the lifetime productivity of cows.



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