EVALUATION OF THE EFFECTS OF ACCELERATED BODY GROWTH AND DEVELOPMENT ON THE HEALTH AND FERTILITY OF HOLSTEIN FRIESIAN FEMALES IN THE PERIOD SUBSEQUENT TO FIRST CALVING

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ABSTRACT

The variation of the body weight of the heifers at 390 days of life was 31.40 kg, and the variation of milk production per 100 days of lactation was 119.16 kg. These values indicate the variation between the heifers due to the genetic diversity that characterizes the herd of cows .

The most important element of the analysis was the significant differences regarding the chance of heifers from the 4 weight categories at the age of 390 days. For example, heifers in category C - GC1 have a chance of calving 1.22 times higher than heifers in category C - G2. Heifers in category CGC 3 and CGC 4 had the chance to perform 0.82 and 0.70 times compared to heifers in category CGC2. The average time between the calving date and the date of first insemination was 86.5 days, and the interval between the calving date and the date of second insemination was 119.8 days.

INTRODUCTION

The reproductive performance of females has a great impact on the economic situation of a cow farm. Factors affecting the reproductive performance of dairy cattle have been analyzed quite intensively by several authors (Darwash et al., 1997). The linear regression technique was mainly applied for the analysis of reproduction-related characters. A disadvantage of this technique is that it does not take into account the heifers that have a lack of information about the character considered (for example, the heifer does not have the date of conception or the date of first parturition) (Harman et al., 1996).

Several techniques allow nonlinear analysis (logistic analysis, event-time regression), being much more suitable for the analysis of reproductive characters. Event-time regression uses data on the reproductive characteristics of a cow that has only partial records of a specific character (e.g. cows that do not conceive or become pregnant at the time the data is collected for study) (Harman et al., 1996). This methodology analyzes the data when the variable result corresponds to the time elapsed from the starting point to the expected event. This time interval cannot be known because something happened before the event that does not allow further observations, as happens for example when the animal is sold.

In addition, the results obtained from the event-time analysis are given in the form of time-specific probabilities that can be included in bioeconomic models. Time-dependent covariates can be added to the analysis (Grohn et al., 1997) to measure the effects of a risk factor on the response variable, as well as the ability to model this effect over the time the animal is exposed to the risk factor.

Previous results using the linear regression technique seem to highlight that the onset of puberty and the chance of the female becoming pregnant are more correlated with body growth and development parameters (in this case body size and weight) than with chronological age (Lin et al., 1986, Moore et al., 1990).

Current research focuses on the effects of risk factors such as disease incidence, milk production or time-dependent covariates, on the calving-fertile insemination interval or on the calving-first insemination interval (Cola.M, Cola F, 2019). The toxicity of some pesticides and other pollutants directly affects the plants but also the animals that consume those plants. If not recognized and treated properly, the toxicity of these substances can lead to morbidity and mortality to animals of the livestock farms. At the same time, the quality of the raw material can be severely affected (Bonciu, 2016, 2018). Some studies (Harman et al., 1986) indicate that milk production at 60 days postpartum (p.p.) has minimal effect on gestation rate (only cows with very high milk production have a lower conception rate than other cows from the herd).

Also, in a study (Eicker et al., 1996) it was found that cows in the highest category of individual cumulative milk production at 60 days p.p. show an increase in the average calving-conception interval and a 29% increase in the number of inseminations per conception, than the cows of the lowest category.

In this study, event-time regression was used to quantify the effect of individual heifer body weight on age at first calving and the effect of individual body weight and milk production on calving-first insemination and calving-conception interval (Atkins., 2008).

MATERIAL AND METHOD

From the total herd of dairy cows from SCDA Șimnic, a genealogical line of Holstein Friesian cows with common genes from the famous STARBUCK bull (Canada) was chosen. The database includes information from cows born in 2015, 2016 and 2017 and from the pedigrees of 10 breeding bulls. Periodically new phenotypic values are recorded. It was aimed that by 2018 the basic herd (50 cows) to produce 105 F_1 products, of which 52 females and 53 males. Each group of characters is composed of indicator characters which in turn are complex phenotypes formed by physiological phenotypes.

The analysis was made using the data recorded at the level of Holstein Friesian cows from SCDA Șimnic Craiova. Included data refer to health, body growth and development performance, reproductive performance and milk production.

Records of body weight, reproductive events, daily milk production and herd characteristics were recorded in the software databases.

Body weight records were made at fixed dates, at 2 months interval, using simple regression with an independent variable (chest circumference; body weight = $\alpha + \beta$ (PT).

Data on milk production and reproductive performance was recorded by the research team.

Defining characters and editing data

For the analysis of age at the first calving, the heifers had to have registered body weight at 390 days of age.

Heifers without registered body weight and heifers reformed before 390 days were not included in this analysis. Under these conditions, the starting point of the measurement period was 390 days of life and not from the date of birth.

The calving-first insemination interval is the period between the date of the first calving and the date of the first insemination (pp). The calving-conception interval is the period between the date of the first calving and the date of the fertile insemination p.p. The gestation was confirmed by the date of calving. The body weight at 390 days of life and milk production at 100 days of lactation were obtained by linear interpolation using individual observations.

Heifers must have at least two records of body weight between 9 and 17 months of age. To calculate milk production per 100 days of lactation, primiparous animals must have at least one record of milk production on the control day in the period 5-50 days p.p., one in the period 50-100 days and one in the period 100-150 days p.p. (a total of 3 records in the first 150 days after calving).

Heifers according to body weight at 390 days of age were divided into 4 categories. Heifers in the highest CGC category 1 (body weight category 1) had a body weight with at least a standard deviation higher than average. The heifers in the lowest category (CGC 4) had a body weight of more than one standard deviation below average. Heifers in CGC 2 and CGC 3 categories were above and below average, respectively, but with deviations lower than a standard deviation from the average.

The categories of heifers after milk production at 100 days of lactation (C.PL) were established in a similar way to the weight categories, namely:

Heifers (C.PL 1) were the heifers that at 100 days of lactation milk production was higher by a standard deviation from the average. C.PL 4 heifers were heifers with more than one standard deviation below average, and C.PL 2 and C.PL 3 heifers had above and below average, respectively, but with deviations smaller than a standard deviation from the average.

Semiparametric model C_{ox} was as follows:

$$\lambda\ (t; x) = \lambda_0(t)e^{(x'\beta)} \text{ equation [1]}$$

where:

λ (t; x) = the "hazard" event for a heifer at time t with covariates x;

λ_0 = baseline of the "hazard" function describing the "hazard" of an event for a hypothetical situation when all covariate values are set to zero;

$e^{(x'\beta)}$ = term specific to individuals with x covariates that are always positive and act multiplicatively on the baseline of the "hazard" function

The model is semiparametric because it does not require the specification of a distribution for the "hazard" function. The effect of covariates on time-events is in parametric form.

To determine the covariates, x was defined as follows:

C.GC g = fixed effect of the weight category g of the heifer (g = 1 - at 4);

C-PL e = fixed effect of the heifer milk production category L (l = 1 to 4).

RESULTS AND DISCUSSIONS

<u>Age at first calving</u>

The mean age at first calving was 747.5 days ± 40.38 days standard deviation.

The mean body weight of the calves at 390 days of age was 292.95 kg ± 12.63 kg standard deviation.

The categories of body weight at the age of 390 days and the categories of milk production at 100 days of lactation are presented in Table 1.

The variation of the body weight of the heifers at 390 days of life was 31.40 kg, and the variation of milk production at 100 days of lactation was 119.16 Kg. These values indicate the variation between heifers due to the genetic diversity that characterizes the herd of cows from SCDA Șiminic.

The most important element of the analysis was the significant differences in the present chance of calving of heifers within the 4 weight categories at the age of 390 days. For example, heifers from category C - GC1 have a 1.22 times higher chance of calving than heifers from category C - G2 (table 2.).

1-Regression parameter of the survival function.
2-Standard error of the difference between β in each category and the largest category.
3-The hazard ratio at the level of the body weight factor is relative to the hazard for the largest category that was set to 1.0.

Table 1

Mean and standard deviation of calves' body weight at 390 days of age and their milk production at 100 days of lactation and by categories

Specification	n	x* Kg	± DS** Kg
The average weight of calves at 390 days of age	22	292.95	12.63
C - GC 1	8	307.20	1.38
C - GC 2	4	296.50	1,91
C - GC 3	5	285.80	2.86
C - GC 4	5	275.80	2.86
Average milk production at 100 days of lactation:	22	3361.86	47.73
C - PL1	6	3425.16	6.64
C - PL 2	3	3386.00	19.69
C - PL 3	9	3336.44	18.32
C - PL 4	4	3306.00	5.16

* - Average ** - Standard deviation

Heifers in the CGC 3 and CGC 4 category had the chance to give birth 0.82 and 0.70 times compared to the heifers in the CGC_2 category (Table 2). This shows that the body weight of heifers has an effect on a heifer's chance of having a subsequent parturition.

Table 2.

Estimates of hazard ratios for first calving age for body weight categories at 390 days of heifer life

Factor	Category	β [1]	ESD [2]	Proportion of hazard [3]
Body weight of the heifers	CGC 1	0.16	0.06	1.22
	GCC 2	0.00	0.00	1.00
	CGC 3	-0.08	0.17	0.82
	CGC 4	0.21	0.06	0.70

<u>The calving-first insemination c interval and the calving-conception interval</u>

The average interval between the date of farrowing and the date of first insemination was 86.5 days, and the interval between the date of calving and the date of fertile insemination was 119.8 days.

For heifers in the 4 weight categories at the age of 390 days, the hazard proportions tended to be linear for the calving interval and the first insemination, but insignificant (Table 3). Proportions indicate that heifers with a higher body weight at 390 days of age were more likely to be inseminated after the first calving compared to heifers in the other categories (Table 3). For the calving-conception interval, the estimates did not have the same linear trend and were statistically insignificant.

Table 3

Estimates of hazard ratios for body weight categories and milk production categories for the calving-first insemination interval and the calving-conception interval

Factor	Category	Calving-first insemination interval			Calving – conception interval		
		β [1]	**ESD [2]**	**PH [3]**	**β [1]**	**ESD [2]**	**PH [3]**
Body weight of heifers at 390 days of age	C-GC $_1$	0,07	0,08	1,07	0,10	0,08	1,11
	C-GC $_2$	0,00	0,00	1,00	0,00	0,00	1,00
	C-GC $_3$	-0,02	0,06	0,98	0,08	0,07	1,10
	C-GC $_4$	-0,07	0,08	0,92	0,10	0,09	1,12
Milk production of heifers at 100 days p.p.	C-GC $_1$	-0,13	0,08	0,88	-0,09	0,08	0,92
	C-GC $_2$	-0,00	0,00	1,00	0,00	0,00	1,00
	C-GC $_3$	-0,09	0,06	0,93	-0,05	0,06	0,95
	C-GC $_4$	-0,35	0,08	0,70	-0,24	0,07	0,80

1. Survival function regression parameter.
2. Standard error of the difference between β in each category and the largest category.
3. Proportion of hazard to body weight factors and milk production is relative to the hazard for the largest category that was set at 1.0.

The estimated hazard ratios for the milk production categories show a non-linear effect on the calving-conception interval. The heifers in the first 3 categories had a similar probability of being inseminated after calving or becoming pregnant. The chance was much lower for the heifers in the lowest category. In theory, cows with high milk production are expected to have a longer interval from calving to conception due to the negative effect of milk production on energy balance and reproductive performance.

This analysis does not support this idea, as heifers in the highest category of milk production (CPL_1) showed a slight decrease in the chances of insemination and becoming pregnant compared to CPL_2 and CPL_3 categories. The chances of being inseminated and becoming pregnant were the lowest for heifers in the lowest category of milk production (CPL_4). This may be due to an unidentified managerial practice other than the result of a genetic factor.

CONCLUSIONS

There was a significant effect of the individual body weight of the heifers at the age of 390 days on the age at first calving. An increase in body weight increases the likelihood that the heifer will reach the first calving.

The body weight of heifers at the age of 390 days has no impact on the first calving-insemination interval, but seems to have an effect on the calving-conception interval. However, further research is needed to identify management practices that could lead to some aspects, both before and after insemination.

Milk production after the first calving seems to have a nonlinear effect on the calving-conception interval.

Heifers with high milk production had a slight decrease in the chance of being inseminated, however managerial practices seem to be much more important in the situation analyzed because heifers with the lowest milk production had the least chance of being inseminated and become pregnant.

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