UNIVERSITY OF LIFE SCIENCES
"KING MIHAI I" FROM Timisoara
Multidisciplinary Conference on Sustainable Development
30-31 May 2024

ANALYSIS OF LONGEVITY TRAITS IN HOLSTEIN FRIESIAN COWS

Constantin Găvan
Agriculture Research and Development Station Șimnic, Craiova, Șoseau Bălcești, no. 54, 200721, Dolj, Romania.

Abstract: *Survival rate (SR) number of parities and length of productive herd life (LPHL) were evaluated for Holstein Friesian cows that calved beginning January 1, 2000 through May 2021 in a research dairy farm. A total of 870 lactation records were examined. Average Survival Rates (SRs) were 75.8% to parity 2, 49.7% to parity 3, 37.3% to parity 4, 18.6% to parity 5, 11% to parity 6, 6.3% to parity 7 and 3.3% to parity 8. A change for a better survival rate of cows over the span, years 2011-2021 compared with 2000-2010 was found to parity 2 and to parity 3 (significant differences). For the rest of parities (to 4, to 5, to 6, to 7 and to 8) the differences were non-significant. Average number of parities over the spam years 2000 to 2015 was 2.81. Linear regression of average of parities on year of first calving was positive (R=0.2786) and this means that was a weak direct relationship between variables. A change in the year of first calving with 1 impacted a change in the number of parities with 0.006. Average productive herd life (months) over the span years 2000 to 2015 was 33.86. Linear regression of average LPHL by year of first calving was positive (R=0.6513) and this means that was a strong direct relationship between variables. A change in the year of first calving with 1, impacted a change in the number of parities with 0.1889. The results of this study can give important information for economic studies on dairy herd management*

• Introduction

A dairy cow is biological capable of a life span of 20 years [1]. Reduced welfare of dairy cows, as a results of human intervention caused a shortened of life spam during the industrial revolution. Average time in the herds reported in 2008, 2009 years ranges between 4.5 and 5.5 years or 2.5 and 3.5 lactations [2, 3, 4].
The longevity of dairy cows is a complex trait with low heritability value and it is influenced by several inherent and external factors [5, 6, 7].
For breeding longevity traits in dairy cattle it is necessary to select the traits of longevity which determines superior economic performance of dairy herd [8, 9].
After calving a cow must become to be profitable once she get to a point when the cost during rearing is repaid. This point is specific for each cow and is determined by many factors like age at first calving, milk yield and length of the dry period [11].
In Netherlands rearing costs of a heifer are on average between 1423 euro and 1715 euro [12].
Increasing the length of productive life is a potential option to improve the profitability of the dairy activity [13].
The analysis of longevity in dairy cows has been a top research topic in the recent years, with special attention to the selection of methods precisely determining the relationship between variables [14, 15, 16].
The main purpose of this study was to provide new information about survival rate, number of parities and length of productive life for Holstein Friesian cows from a research farm and to determine if those longevity trait has changed over time (2000 through 2021).

• Material and method

Data for this report were lactations records from Agricultural Research and Development Station (ARDS) Șimnic-Craiova, Romania, enrolled in the National Association Dairy Herd Improvement Program. The research dairy farm is located in the South-West region (Oltenia, 182 m above sea level, 44°19' N, 23°8' E). The initial dairy herd was imported from Denmark (1977-1978) as Danish Black and White (DBW) dairy cattle. Today the most genes from the original DBW cattle have been replaced by Holstein-Friesian genes, and the herd is enrolled in Dairy Herd Improvement testing.
For this report only records of cows that calved between 2000 and 2021were used.
Survival rate (SR) subsequent calving was evaluated (percentage) as the number of cows that calved a second, third, fourth, fifth, sixth, seventh and eighth time divided by the total number of cows that calved for the first time.
Mortality and culling rate were evaluated as the number of cows that died or culled after the first calving to the end of 8th parity divided by total number of cows included in the first calving in each year (2000 to 2021).
Length of productive life (LPL) was defined as the time a cow was in the herd and was evaluated as the number of days between first calving date and culling or death date.
For parity 8, cows were assumed to have survived for 1 year (365.26 days).
All data were entered into Microsoft Excel computer program 2007. Stata version 14 was used to summarize the data, and descriptive statistic was used to express the results.
A linear regression model was used to describe the relationship between the dependent variables (parity number or LPL) and independent variables (year of first calving), and to estimate the effect of each independent variable on the dependent variables. For this analysis an online calculator was used (www.statskindom.com/linear-regression-calculator) [17].

• Results and discussions

Table 1. Survival rates to parities 2nd through 8th by year of first calving.

Year of first calving	to 2nd %	to 3rd %	to 4th %	to 5th %	to 6th %	to 7th %	7th to 8th %
2000	73.6	55.2	39.4	18.4	13.1	5.2	2.6
2001	72.5	50	40	20.2	12.5	7.5	5
2002	73.1	46.3	34.1	17	12.2	7.3	4.8
2003	71.8	46.1	33.3	15.4	10.2	7.7	2.5
2004	71	47.3	34.2	15.8	10.5	7.9	2.6
2005	70	47.5	35	17.5	7.5	5	2.5
2006	71.8	48.7	35.9	17.9	10.2	5.1	2.6
2007	76.9	51.3	38.4	20.5	12.8	7.7	5.1
2008	78.9	50	36.8	18.4	10.5	5.3	2.6
2009	77.5	45	40	22.5	10	5	2.5
2010	73.2	43.9	31.7	17.1	7.3	4.9	2.4
2011	83.8	51.3	35.1	16.2	8.1	5.4	2.7
2012	84.2	52.6	42.1	23.7	13.1	7.9	5.3
2013	77.5	50	37.5	17.5	10	5	2.5
2014	75	47.5	40	20	12.5	7.5	5
2015	79.5	53.8	35.9	15.4	7.7	5.1	2.6
2016	73.2	48.8	36.6	19.5	14.6	7.3	
2017	77.5	52.5	40	20	15		
2018	75	50.5	40	20			
2019	76.9	53.8	41				
2020	76.2	52.4					
2021	78						
Average	75.8	49.7	37.3	18.6	11	6.3	3.3
S.E.*	0.8	0.7	0.6	0.5	0.5	0.3	0.3

Table 2. Average survival rates by parity subgroups (a and b), and the difference between them.

Parity (category)	Years of first calving	Average survival rate		Difference		95% CI	t – statistic	p-value
		%	SD	%	SE			
1 to 2 (a)	2000-2010	73.66	2.86					
1 to 2 (b)	2011-2021	77.89	3.46	+4.20	1.35	1.40-7.05	3.125	0.0053
2 to 3 (a)	2000-2010	48.3	3.21					
2 to 3 (b)	2011-2020	51.32	2.10	+3.02	1.19	0.51-5.5	2.520	0.0208
3 to 4 (a)	2000-2009	36.71	2.58					
3 to 4 (b)	2010-2019	37.99	3.2	+1.28	1.30	-1.45-4.01	0.985	0.337
4 to 5 (a)	2000-2009	18.36	2.19					
4 to 5 (b)	2010-2018	18.82	2.54	+0.46	1.08	-1.83-2.75	0.424	0.677
5 to 6 (a)	2000-2008	11.05	1.78					
5 to 6 (b)	2009-2017	10.92	2.97	-0.13	1.15	-2.57-2.31	-0.113	0.911
6 to 7 (a)	2000-2007	6.67	1.32					
6 to 7 (b)	2008-2016	5.93	1.24	-0.74	0.62	-2.06-0.58	-1.192	0.252
7 to 8 (a)	2000-2007	3.46	1.25					
7 to 8 (b)	2008-2015	3.20	1.21	-0.26	0.61	-1.58-1.06	-0.423	0.679

Table 4. Results of linear regression analysis of mean number of parities (a), and mean productive herd life (b) on year of first calving.

	Regression ANOVA	Source	DF*	Sum of square	Mean square	F statistic	P value
		Regression	1	0.01372	0.01372	1.1782	0.2961
		Residual	14	0.1631	0.01165		
		Total	15	0.1768	0.01179		
a	Linear regression reported in APA style	R^2 = 0.078, F = 1.18, p = 0.296 β = 0.0064 p = 0.296 α = 2.7 p<0.001, slope b1 = 0.06353 CI**(0.062-0.0989)					
	Regression (ANOVA)	Source	DF	Sum of square	Mean square	F statistic	P value
		Regression	1	12.1357	12.1357	10.3161	0.006271
		Residual	14	16.4694	1.1764		
		Total	15	28.6051	1.907		
b	Linear regression reported in APA style	R^2 = 0.42, F = 10.32, p = 0.006, β = 0.19 p = 0.006 α = 32.25 p<0.001, slope b1 = 0.1889 CI(0.063-0.3151)					

Survival rate are dependent on many economic factors. For a long-term breeding strategies in dairy cows, it is necessary to evaluate the changes over time of longevity traits, and then using simple methods, to calculate the economic value of herd life. In this study we estimated the survival rate, number of parties and length of productive life in a herd of Holstein Friesian cows with first calving between 2000 and 2021.
Short longevity shows that cows are not expressing their maximum potential for milk production and profitability. Also if more cows in first and second lactation are culled (increased culling rate) will decrease cow longevity and reduces the profitability of the herd. In the initial third of the first lactation cows are culled due to low milk production and mil ability while in the second lactation cows are culled due to the incidence of metabolic and other diseases (Heise et al., 2016) [23].
Higher risk of culling due to failure to reproduce is observed in the final third of lactation for cows in the first and second lactation.
A greater proportion of mature cows as a results of increased longevity would reduce the number of replacement heifers, because mature cows have a relatively higher milk yield compared to young animals. This approach is relevant under a supply management system where profitability is associated with increased efficiency of using the resources available rather than increasing milk production.
The commercialization of extra heifers should be an additional source of income.

• Conclusions

Using the recommended methodology to measure longevity of dairy cows, our study shows that Holstein Friesian cow longevity has increased over time between 2000 through 2021.
The results of this study can give important information for economic studies on dairy herd management.

Acknowledgement: The research leading to these results has received funding from ARDS Simnic-CRAIOVA. The authors have not stated any conflicts of interest.