International Journal of Biological, Life and Agricultural Sciences
ISSN: 2415-6612
Vol:11, No:3, 2017

# The Effect of Cow Reproductive Traits on Lifetime Productivity and Longevity

Lāsma Cielava, Daina Jonkus, Līga Paura

***Abstract*—**The age of first calving (AFC) is one of the most important factors that have a significant impact on cow productivity in different lactations and its whole life. A belated AFC leads to reduced reproductive performance and it is one of the main reasons for reduced longevity. Cows that calved in time period from 2001-2007 and in this time finished at least four lactations were included in the database. Data were obtained from 68841 crossbred Holstein Black and White (HM), crossbred Latvian Brown (LB), and Latvian Brown genetic resources (LBGR) cows. Cows were distributed in four groups depending on age at first calving. The longest lifespan was conducted for LBGR cows, but they were also characterized with lowest lifetime milk yield and life day milk yield. HM breed cows had the shortest lifespan, but in the lifespan of 2862.2 days was obtained in average 37916.4 kg milk accordingly 13.2 kg milk in one life day. HM breed cows were also characterized with longer calving intervals (CI) in first four lactations, but LBGR cows had the shortest CI in the study group. Age at first calving significantly affected the length of CI in different lactations ($p<0.05$). HM cows that first time calved >30 months old in the fourth lactation had the longest CI in all study groups (421.4 days). The LBGR cows were characterized with the shortest CI, but there was slight increase in second and third lactation. Age at first calving had a significant impact on cows' age in each calving time. In the analysis, cow group was conducted that cows with age at first calving <24 months or in average 580.5 days at the time of fifth calving were 2156.7 days (5.9 years) old, but cows with age at first calving >30 months (932.6 days) at the time of fifth calving were 2560.9 days (7.3 years) old.

***Keywords*—**Age at first calving, calving interval, longevity, milk yield.

## I. Introduction

THE cow longevity is one of most important traits in dairy cow breeding. It is not only determined by the length of lifespan, but also with the amount of milk obtained from cows in their lifetime. Cows have potential to reach at least 15-year lifespan, but in modern dairy farming they are culled from herds before fifth to sixth lactation [1]. Lifespan can be reduced by different environmental factors, such as, injuries, different illnesses, poor milk quality [2], [3], but there also are different cow reproductive traits that can cause premature culling from herds [2]. The most common factors that have strong impact on cow longevity are the age at first calving, length of CI, and insemination count which affects the length of period from calving until first successful service, and also period from calving to first successful service determines the length of CI. For improving pregnancy rate in farm, it would be necessary to monitor cow behavior and body condition before and during heat. In ideal situation, cows get pregnant after the first insemination time, but in practice, there are some factors that prevent it from happening. In Latvia, the average pregnancy rate for one calving is 1.7.

Age at first calving not only has strong coherence with cow longevity, but it also can serve as an indicator of heifer rearing conditions. The main factor that influences age at first calving is the age at first insemination, which is strongly determined by heifer live weight and age. There is connection between the age at first calving and the cow age in the end of following lactations, which leads to fewer lactations and obtained calves in the end of cows' life [4], [5].

In Latvia, most common dairy cow breeds are HM and different step of crossbreed LB breed cows. There is very small number of purebred cows in Latvian dairy herds. The number of LB breed cows that comply the local breed requirements which are included in the National Animal resources genetic program are 100 cows [6]. The main condition to include cow into animal genetic resources is that cow has more than 50% LB breed blood, and the rest of the total blood content is from the related cow breeds (Danish Red, Angeln). Also, in National resources, genetic program does not include LB breed cows with milk yield lower than 4000 kg in 305 days of lactation and with milk fat and protein content lower than breeds average – 4.46% and 3.31%, respectively.

The aim of the study was to determine the effect of age at first calving and cow breed to the length of CI and cow longevity.

## II. Materials and Methods

### *A. Data Collection*

Data about 66423 Latvian bred dairy cows under recording were collected for study purposes. Analyzed cows were born in time period from year 2001 until 2010 and finished at least 4 full lactations. Data were collected from *Latvian Data Center* where all recording data are stored. For data analysis, crossbred HM, crossbred LB, and LBGR cows were used.

In database, the following data about cow were included;
- breed;
- age at first calving;
- length of CI;
- date of birth and culling;
- individual milk yield data in each lactation.

The cow lifespan was calculated from the date of birth and culling. From individual milk yield, data in each lactation were calculated lifetime milk yield.

Lāsma Cielava is a PhD Candidate in Latvia University of Agriculture, Latvia (e-mail: lasma.cielava@llu.lv).

*B. Data Distribution*

To evaluate the influence of first calving age on cow lifespan, lifetime milk productivity, and length of CI, cows were distributed in different groups according to age at first calving.

TABLE I
THE NUMBER OF COWS OF COWS IN EACH STUDY GROUP

| Analyzed trait | Cow breed | | |
|---|---|---|---|
| | HM | LB | LBGR |
| Breed | 27634 | 38336 | 453 |
| Age at first calving | | | |
| <24 months | 252 | 379 | 7 |
| 24 – 27 months | 4152 | 5354 | 73 |
| 27 – 30 months | 13710 | 17866 | 246 |
| >30 months | 9520 | 14737 | 127 |

*C. Statistical Analysis*

For mathematical processing, IBM SPSS 20 program packages were used.

*One way ANOVA* with *Bonfferoni PostHoc* test was used to characterize differences between analyzed groups with different ages at first calving

Significant differences ($p<0.05$) in the tables were marked with different superscripted letters of alphabet (A, B, C, etc.).

## III. RESULTS

HM cows characterized not only with significantly higher ($p<0.05$) milk yield in one life day (13.2 kg) and in lifetime (37 916.4 kg), but also with the shortest lifespan (2862.2 days). The LBGR cows were characterized with the lowest life day productivity (10.4 kg), but the average lifespan in this group was more than 500 days longer than in LB and HM cow groups.

TABLE II
MILK YIELD AND LIFESPAN OF DIFFERENT BREED COWS

| Breed | Lifespan, days | Lifetime milk yield, kg | Life day milk yield, kg |
|---|---|---|---|
| HM* | $2862.2\pm3.48^{A}$ | $37916.4\pm72.32^{A}$ | $13.2\pm0.03^{A}$ |
| LB* | $2966.2\pm2.94^{B}$ | $34407.9\pm49.74^{B}$ | $11.6\pm0.02^{B}$ |
| LBGR* | $3393.1\pm28.52^{C}$ | $35188.6\pm318.00^{C}$ | $10.4\pm0.11^{C}$ |

$^{A;B;C}$ – the values with different superscriptions varies significantly between different breeds ($p<0.05$).

The LB breed cows were characterized with significantly ($p<0.05$) lowest lifetime milk yield, whereas the average lifespan was longer than that of HM breed cows, and the life day milk yield was higher than that of cows of local genetic resources.

The length of CI in study group varied not only within different lactations, but also between the analyzed breeds. For HM breed cows, significantly longer CIs in first lactation (CI1) were conducted, and it had tendency to increase; in fourth lactation, it was 415.3 days long (CI4). LBGR cows were characterized with the shortest CI in all study groups and it remains the tendency to observe longest C until the fourth lactation.

For LB breed cows, there are no significant differences between length of CI from first to third lactations (C1, C2, C3), but in the fourth lactation, it increased significantly ($p<0.05$) and reached 401.6 days.

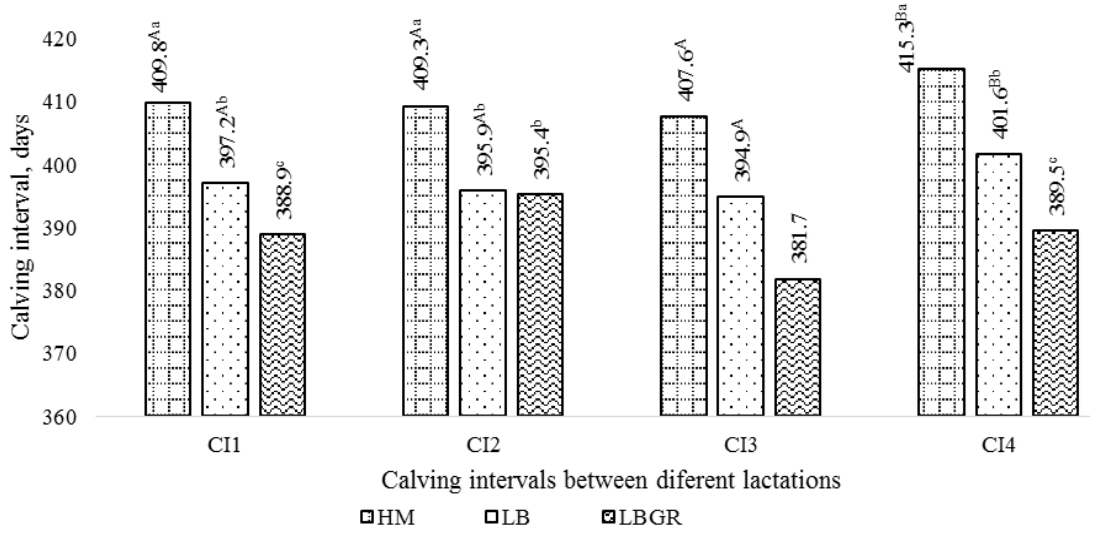


Fig. 1 CIs between different lactations for analyzed cow breeds. CI1 – CI in 1st lactation; CI2 – CI in 2nd lactation; CI3 – CI in 3rd lactation; CI4 – CI in 4th lactation. $^{A;B;C}$ – traits with different capital superscriptions has significant differences between one breeds different lactations ($p<0.05$). $^{abc}$ – traits with different subscriptions has significant differences between breeds ($p<0.05$)

Age at first calving significantly determines length of CI. As age at first calving increases, also does CI in first and later lactations.

The longest (421.4 days) CI was conducted for HM breed cows in the fourth lactation, for cows with age at first calving >30 months. HM breed cows were also characterized with longer CI between all breeds and ages at first calving groups.

In the second, third, and fourth lactations for LBGR cows, longer CI were conducted in group where cows younger than 24 months first time calved. LB breed cows were characterized with shorter CI in all lactations and AFC groups than in HM breed group and longer in comparison with LBGR breed cows.

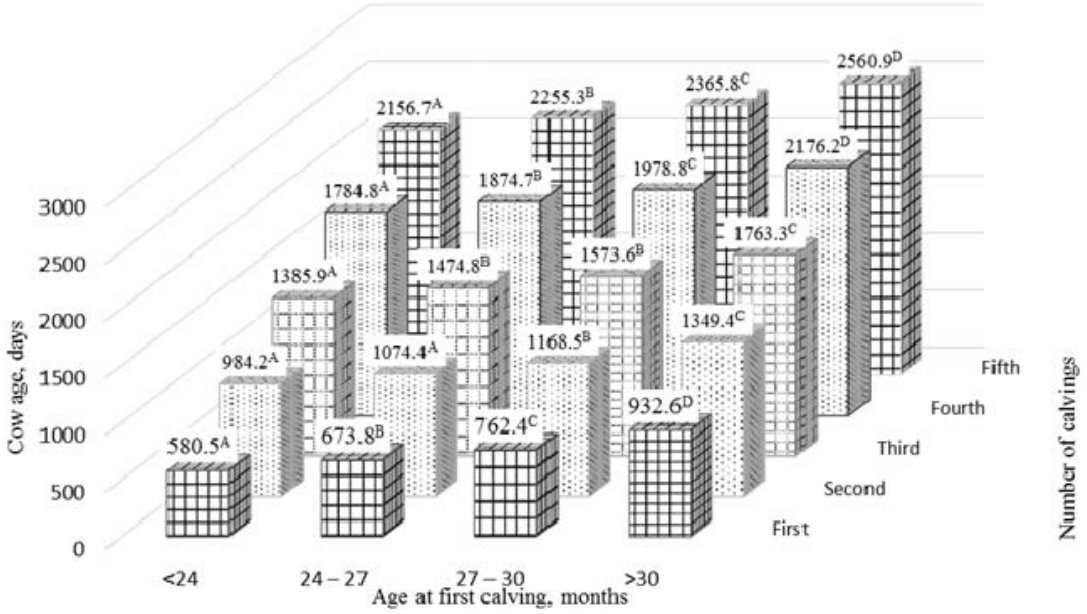


Fig. 2 Cow age in the beginning of different lactations depending from age at first calving. [A;B;C;] – traits with different capital superscriptions shows significant differences between groups ($p<0.05$)

TABLE III
THE LENGTH OF CI IN DEPENDENCE FROM AGE AT FIRST CALVING AND COW BREED

| Age at first calving | HM | LB | LBGR |
|---|---|---|---|
| 1st lactation | | | |
| <24 months | 398.8±4.75[Aa] | 397.5±4.16[Aa] | 384.7±4.11[Ab] |
| 24 – 27 months | 400.8±1.15[Ba] | 390.4±0.95[ABb] | 390.4±8.25[ABb] |
| 27 – 30 months | 408.4±0.70[Ca] | 394.3±0.58[Ab] | 382.7±4.64[Ac] |
| >30 months | 415.2±0.90[Da] | 403.8±0.65[Bb] | 400.4±6.50[Bb] |
| 2nd lactation | | | |
| <24 months | 392.4±5.03[Aa] | 397.8±4.19[ABb] | 414.4±7.33[Ac] |
| 24 – 27 months | 401.1±1.18[Ba] | 389.9±0.99[Ab] | 392.9±10.02[Bb] |
| 27 – 30 months | 407.5±0.68[Ca] | 393.3±0.55[ABb] | 393.7±4.57[Bb] |
| >30 months | 415.3±0.84[Da] | 401.8±0.64[Bb] | 398.8±7.34[Bc] |
| 3rd lactation | | | |
| <24 months | 394.8±5.02[Aab] | 389.9±5.16[Aa] | 408.8±3.48[Ab] |
| 24 – 27 months | 398.7±1.28[Ba] | 388.7±1.09[Ab] | 360.1±7.32[Bc] |
| 27 – 30 months | 407.2±0.75[Ca] | 393.2±0.61[Ab] | 382.1±4.97 [Bc] |
| >30 months | 411.8±0.98[Da] | 400.1±0.71[Bb] | 391.6±6.52 [ABc] |
| 4th lactation | | | |
| <24 months | 392.6±6.65[Aa] | 391.6±4.45[Aa] | 398.1±5.82[Ab] |
| 24 – 27 months | 406.2±1.72[Ba] | 394.9±1.36[Aab] | 386.3±5.19[Bb] |
| 27 – 30 months | 413.0±1.01[Ba] | 399.9±0.79[Bb] | 386.7±4.65 [Bc] |
| >30 months | 421.4±0.74[Ca] | 407.0±0.97[Bb] | 396.3±6.48[Ac] |

[A;B;C;D] – traits with different capital superscriptions have significant differences ($p<0.05$) between AFC in each lactation.
[a;b;c] – traits with different superscriptions have significant differences ($p<0.05$) between cow breeds in each first calving age group.

Age at first calving is the trait that not only affects cow productivity, but also shows influence on cows calving age at different life periods. Cows with age at first calving <24 months in the beginning of fifth lactation was 2156.7 days old (5.9 years), but cows that first time calved after age of 30 months started the fifth lactation at the age of 2560.9 days (7.3 years). The similar tendency runs through all calving times showing that AFC is one of most important factors that affects the cows' future productivity and longevity traits.

## IV. DISCUSSION

Age at first calving not only affects cow productivity and lifespan [5], but also can affect the future reproductive performance [7], [8]. In the previous studies, it was determined that the optimal first calving age for reaching maximal lifetime and daily production levels and also for keeping cows in herds for as long as possible, is 24 – 27 months [9], [10]. The previous reports indicate that cows that calved first time at a relatively young age have longer lifespan and productive life, but lifetime productivity and productivity in one day and in one productive day for those cows were significantly lower than for cows that first time calved at age of 24 -27 months. In our previous studies, it was observed that cows calved first time at age of 30 months and older had longer lifespan, but their productive life was significantly shorter than for cows from the other AFC groups and those cows had serious problems with insemination [11].

Cow lifespan and lifetime productivity vary between different breeds. Red breed cows were usually characterized with longer lifespan and better milk dry matter content, but HM breed cows were characterized with higher milk productivity in life and in one life day. HM cows in dairy

herds are more economically beneficial [12], [13]. Local breeds and their genetic resources are more sustainable for local weather and feeding conditions, and it results in longer lifespan. Unfortunately, local breeds (included LBGR) are not as productive as HM breed cows [14], [15]. Our study showed similar tendencies that HM breed cows had larger lifetime and life day milk yield, but red breed group cows characterized with longer lifespan.

There are strong correlations between cow reproductive traits, in this case, age at first calving have significant influence of the length of CI not only in first, but also in later lactations [15], [16]. Cows with later first calving each consecutive time calved in older age than cows which first time calved before age of 24 months [17], [18], [20]. In our study after fifth calving time cows who first time calved <24 months was 1.4 years younger than cows with age at first calving >30 months. The length of CI also depends on the cow breed and the level of milk productivity [19]. Black and white breed cows naturally are more productive than red breed group cows, and thereby, there occur problems with energy balance and low conception rate. In our study, it also was proven that HM breed cow CI in first lactation was for 12.6 days longer than for LB breed cows and for 20.1 day longer than for LBGR cows.

One of the possible reasons for the lengthened CI might be problems with heifer and cow insemination, which can occur because farmers wrongly determined heifer live weight and body condition before first insemination (heifers were too heavy for first insemination) or in farm level, and there could be problems with heifer rearing process and herd management [19], [21].

## V. Conclusion

Age at first calving have significant influence ($p<0.05$) on the length of CI. In fifth lactation, there is 1.4-year difference between age of cows with AFC <24 months and age of >30 months.

There is a need to continue studies about the interaction between different cow reproductive traits and cow longevity to determine to what extent they affect not only cow lifespan, but also cow milk productivity.

## Acknowledgment

The investigation is supported by VPP 2014-2017 AgroBioRes Project No. 3 LIVESTOCK.

## References

[1] C.Y. Lin, A.J. McAllister, T.R. Batra, A.J. Lee, G.L. Roy, J.A. Vesely, J.M.., Wauthy, K.A. Winter, "Effects of early and late breeding of heifers on multiple lactation performance of dairy cows," *Journal of Dairy Science*, vol. 71, pp. 2735-2743. 1988.

[2] J. Hultgren, C. Svensson, "Heifer rearing con-ditions affect length of productive life in Swedish dairy cows," *Preventative Veterinary Medicine*, vol. 89, pp. 255-264. 2009.

[3] R.D. Evans, M. Wallace, D.J. Garrick, P. Dillon, D.P. Berry, V. Olori, "Effects of calving age, breed fraction and month of calving on calving interval and survival across parities in Irish spring-calving dairy cows," *Livestock Science*, vol. 100, pp. 216-230. 2006.

[4] J. S. Cooke, Z. Cheng, N. E. Bourne, D. C. Wathes, "Association between growth rates, age at first calving and subsequent fertility, milk production and survival in Holstein-Friesian heifers," *Open J. of Animal Sc.,* vol.3, no.1, pp. 1 – 12, 2013.

[5] Z. Riecka, J. Candrák, "Analysis of relationship between production and reproduction traits of Holstein cattle population in the Slovak Republic," *Animal Science and Biotechnologies,* vol 44, no 1, pp. 332 – 336, 2011.

[6] Consultative Committee of Farm Animal Genetic Resources, State of the Animal Genetic Resources of Latvia, Ministry of Agriculture of Latvia, Rīga, pp.49. 2003.

[7] J.F. Ettema, J.E.P. Santos, "Impact of age at calving on lactation, reproduction, health, and income in first-parity Holsteins on commercial farms," *Journal of Dairy Science*, vol. 87, pp. 2730-2742. 2004.

[8] M.A. Nilforooshan, M.A. Edriss, "Effect of age at first calving on some productivity and longevity traits in Iranian Holsteins of the Isfahan province," *Journal of Dairy Science*, vol. 87, pp. 2130-2135. 2004.

[9] G. Pirlo, F. Miglior, M. Speroni, "Effect of age at first calving on production traits and on difference be-tween milk returns and rearing costs in Italian Holsteins," *Journal of Dairy Science*, vol. 83, pp. 606-608. 2000.

[10] J.S. Brickell, N. Bourne, M.M. McGowan, D.C. Wathes, "Effect of growth and development during the rearing period on the subsequent fertility of nulliparous Holstein-Friesian heifers," *Theriogenology*, vol. 72, pp. 408-416. 2009.

[11] L. Cielava, D. Jonkus "First Calving Age Effect on the Longevity of Cows and Milk Productivity," *Ražas svētki Vecaucē – 2013,* nov. 2013.

[12] Y. Grohn P.J. Rajala-Schultz, "Epidemiology of reproductive performance in dairy cows" *Animal Reproduction Science*. vol. 60–61. pp. 605–614. 2000.

[13] P.R. Tozer, A.J. Heinrichs,) "What affects the costs of raising replacement dairy heifers: A multiple- component analysis," *Journal of Dairy Science*, vol. 84, pp. 1836- 1844. 2001.

[14] M.C.M. Mourits, D.T. Galligan, A.A. Dijkhuizen, R.B.M. Huirne, R.B.M. "Optimization of dairy heifer man-agement decisions based on production conditions of Pennsylvania," *Journal of Dairy Science*, vol. 83, pp. 1989-1997. 2000.

[15] M. Janžekovič, M. Ocepek, T. Virk, D. Škorjanc, "Comparison of longevity and production traits of Holstein and Simmental cows of different origin in Slovenia," *Mljekarstvo,* vol. 59. no. 4. pp. 336 – 342. 2009.

[16] A. Chegini, A.A. Shadparvar N. Ghavi Hossein-Zadeh, "Genetic trends for milk yield, persistency of milk yield, somatic cell count and calving interval in Holstein dairy cows of Iran," Iranian J. of App. Animal Sc. vol. 3, pp. 503 – 508. 2013.

[17] L. Šernienė, A. Kabašinskienė, "Analysis of reproductive performance, milk composition and quality of indigenous cows: Lithuanian Light Gray and White Backed," *Vet Med Zoot,* vol. 72, no. 94, pp. 30 – 36. 2015.

[18] A.P. Gulinski B. Giersz G. Niedziałek K Młynek, "First age calving and its importance for milk productivity of primiparous cows remaining in eastern Mazovia farms from years 1977-2000," *Acta Scientiarum Polonorum Zootechnica*. vol. 2. pp. 31–41. 2003.

[19] A. Chegini, A.A. Shadparvar, N. Ghavi Hossein-Zadeh, "Genetic parameter estimates for lactation curve parameters, milk yield, age at first calving, calving interval and somatic cell count in Holstein cows" *Iranian J. of App. Animal Sc.* vol. 5. no. 1. pp. 61 – 67. 2014.

[20] D.P. Berry A.R. Cromie, "Associations between age at first calving and subsequent performance in Irish spring calving Holstein-Friesian dairy cows," *Livest. Sci.* vol. 123, pp. 44-54. 2009.

[21] J. Miciński, M. Maršálek, J. Pogorzelska, A. Vrbová, W. Sobotka, G. Zwierzchowski, P. Matusevičius, "The comperative analysis of milk performance in Czech Pied cattle rised in the Czech Republic versus Polish Holstein – Friesian, Simental and Czech Pied cattle rised in Polland," *Vet Med Zoot.* vol. 67. no. 89. pp. 75 – 80. 2014.