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Lifetime milk productivity and quality in farms with different housing and feeding systems

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Abstract. Housing and feeding systems in farms are main factors that affects cow milk productivity and its quality. The largest proportion of Latvian farms are small farms with tie stall housing system and grazing in summer. The aim of our study was to determine to what extent different housing and feeding systems affect the milk productivity, quality and cow longevity characterizing traits of Latvian dairy cows. In study we analysed 3,179 Holstein Black and White (HBW) and Latvian Brown (LB) breed cows from which 2,383 were located in 2 farms with loose housing system and TMR feeding and 796 cows were located in 8 small farms with tie stall housing system and different feed in summer and winter periods. The average daily milk yield significantly higher ($p < 0.05$) were in farms with loose housing system – 23.53 kg ECM, but in farms with Tie stall housing system was obtained 18.46 kg ECM per day. HBW breed cows characterized with lower somatic cell count in milk than Latvian brown in both housing systems. The highest somatic cell count in milk was obtained from third lactation LB breed cows in Tie stall housing system (249.11 thous. in $1mL^{-1}$ milk) and the lowest from HBW cows in loose housing system (127.57 thous. in $1mL^{-1}$ milk). Cows in smaller farms characterized with longer lifespan – 2,098.7 and 1,890 days for large farms, but lifetime milk productivity was significantly higher in farms with loose housing system where was obtained 21,315.9 kg ECM whereas in Tie stall system farms average life productivity was 19,740.2 kg ECM.

Key words: Housing systems, milk productivity, milk quality, longevity.

INTRODUCTION

Housing and feeding systems in farms are main factors that affects cow milk productivity and its quality. With the increased level of dairy farm modernization, there also comes higher milk productivity, but with the cost of poorer udder health and shorter lifespan (Weigel, et al., 2003). The larger proportion of Latvian dairy cows are keeping in small and medium size farms and in those farms the most often are tie stall housing system with grazing cows in pasture period. Tie stall housing farms with grazing system characterizes with lower fed quality and unbalanced rations that leads to significant decrease of milk productivity (Beever et al., 2000). One of the greatest problems connected with cow feeding in tie stall housing farms is pasture. There are not one fully precise technology that can detect and measure amount and quality of consumed grass.

That leads farmers to compile rations by using estimated measurements (Oudshoorn et al., 2011).

Dairy cow longevity is one of the most important traits in dairy farming. The length of cow lifespan can depend from different environmental conditions that varies in different farms (Vukasinovic, et al., 1997; Buenger, et al., 2001). The indicator of environmental conditions in each farm can be evaluated by the housing system used in given farm. Housing system determines not only farms welfare conditions, but also it serves as indicator of used feeding and milking systems (Krohn & Munksgaard, 1993; Corazzin et al., 2010). In farms with loose housing system feed rations are well balanced and fed as totally mixed ration (TMR) that leads to better consumption rates and more effective use of nutrients (Bunger et al., 2001).

In farms with more than 100 cows usually applied loose housing system with milking in milking parlours, but in smaller farms (up to 50 cows) most commonly used Tie stall housing system with grazing in summer period and milking in milk line (Popescu et al., 2010; Oudshoorn et al., 2012).

In intensive dairy farming system the main emphasis is put on higher milk productivity and better milk quality. However with the intensive farming strategies and high milk productivity also comes shortened average lifespan (Bielfieldt et al., 2006). On the other hand cows that are kept in Tie stall housing system usually characterizes with longer lifespan, but lower lifetime milk productivity and poorer milk quality than cows kept in loose housing farms (Smulski et al., 2011).

The aim of our study was to evaluate the milk productivity, quality and cow longevity characterizing traits of Latvian dairy cows in different housing systems.

MATERIALS AND METHODS

For study purposes was used data about 3,179 Holstein Black and White (HBW) and Latvian Brown (LB) breed cows – 2,383 cows were located within two farms with loose housing system and 796 cows were located in eight small farms with tie stall housing system and grazing in pastures.

In study were analysed data about cows that were born in time period from year 2007 to 2014 and concluded at least one full lactation. Farms were located in the central part of Latvia.

In farms with loose housing system cows were secured with optimal welfare conditions, and milking was organized in milking parlours. Feed rations in those farms are compiled periodically and distributed as Totally Mixed Ration (TMR), whereas in small farms with grazing system cows are milked in milk lines located in tie stall farm, feed ration differs in winter and summer periods. In analysed tie stall housing farms feed rations are not balanced and in grazing periods there are used pasture feeding with additional fodder in ration.

For study purposes from Latvian Agricultural Data Centre were collected data about:

- dates of cow birth, first calving and culling dates,
- milk yield, milk fat and protein content in full lactation,
- milk quality in first three lactations.

The lifespan, length of productive life and count of milking days were calculated as well as milk productivity in life, one life day, one productive life day and one milking day.

To characterize milk productivity were calculated energy corrected milk (ECM) by formula:

$$ECM = milk\ yield \times \frac{[(0.383 \times fat, \%) + (0.242 \times protein, \%) + 0.783]}{3.14} \quad (1)$$

Data in tables are represented as mean ± standard error. The factor of farm impact on cow longevity and productivity traits was determined by analysis of variance. Pairwise comparisons between farms occurred by using Bonferroni test. Significant differences *(P < 0.05*) in the tables were marked with different superscripted letters of the alphabet (A, B). The mathematical processing was performed using the SPSS program package.

RESULTS AND DISCUSSION

The length of dairy cow lifespan indicates of its effectiveness in herd, but length of productive life and count of milking days is one of the economically most important longevity traits.

In our study group with longest lifespan – 2,098.7 days (5.7 years) – characterized cows that were kept in tie stall housing system (Table 1).

Table 1. Average longevity traits in loose and tie stall housing systems

Longevity trait, days	Loose housing	Tie stall housing	Difference
Lifespan	1,890 ± 14.2	2,099 ± 27.9	208*
Length of productive life	1,059 ± 13.9	1,250 ± 27.4	191*
Milking days	876 ± 11.8	1,037 ± 23.2	161*
Age at first calving	832 ± 8.5	848 ± 7.6	16*

* – traits signed with asterisks shows significant differences between traits in different housing systems.

Cows that were kept in loose housing system characterized not only with significantly ($p < 0.05$) shorter lifespan (1,890.7 days), but also with shorter productive life and lesser milking days (accordingly 1,058.8 and 875.9 days) in their life. Also cows in loose housing system characterized with earlier age at first calving – 831.9 days (27.7 months), whereas cows in tie stall housing system first time calved 16.5 days older that indicates of better heifer rearing conditions in farms with loose housing system.

Milk productivity, obtained from one cow in its lifetime, is one of most important economic indicators – it shows the balance of invested and yielded financial resources in cows rearing and maintenance period. The average lifetime productivity significantly *(P < 0.05*) higher (21,315.9 kg ECM) was obtained from cows that was located in farms with loose housing system (Table 2).

Table 2. Average lifetime and life day milk productivity in different housing systems

Milk productivity traits, kg ECM	Loose housing (N = 2383)	Tie stall housing (N = 796)	Difference
Lifetime milk productivity	21,315.9 ± 296.49	19,740.2 ± 584.96	1,575.7*
Life day milk productivity	10.2 ± 0.08	8.6 ± 0.17	1.6*
Productive life day milk productivity	19.3 ± 0.11	15.3 ± 0.22	4.0*
Milking day milk productivity	23.5 ± 0.11	18.5 ± 0.22	5.0*

* – traits signed with asterisks shows significant differences between traits in different housing systems.

Cows that were located in loose housing farms characterized with higher milk productivity in one life day (10.2 kg ECM), one productive life day (19.3 kg ECM) and one milking day (23.5 kg ECM) than cows in tie stall housing systems. This tendency is mainly explained with rapid changes of feed ration and the fact that in small farms ration is not balanced and there is little knowledge about amounts of feed consumed (Krisstensen, et al., 2005; Van Calker et al., 2005; Meyer, 2007).

HBW breed cows characterizes with shorter lifespan, length of productive life and lower number of milking days, whereas LB and other red breed group cows has a potential for extended longevity traits (Parna, et al., 2006). This tendency was confirmed in our previous studies in LB and HBW breed cow populations (Cielava, Jonkus & Paura, 2014). Average lifespan for HBW breed cows were 1,826.4 days in loose housing system, but in Tie stall housing system it was 194 days longer (Table 3).

Table 3. Longevity traits for different breed cows in loose and tie stall housing systems

Longevity trait, days	Loose housing	Tie stall housing
Holstein Black and White (HBW)	N = 1,620	N = 796
Lifespan	$1,826 \pm 24.7^{A}$*	$2,020 \pm 43.9^{A}$*
Length of productive life	$1,023 \pm 24.3^{A}$*	$1,205 \pm 43.1^{A}$*
Milking days	880 ± 20.6*	$1,021 \pm 36.5^{A}$*
Age at first calving	803 ± 10.4^{A}*	815 ± 12.9^{A}*
Latvian brown (LB)	N = 763	N = 354
Lifespan	$1,910 \pm 17.3^{B}$*	$2,103 \pm 36.3^{B}$*
Length of productive life	$1,076 \pm 16.9^{B}$*	$1,282 \pm 35.6^{B}$*
Milking days	874 ± 14.4*	$1,050 \pm 30.2^{B}$*
Age at first calving	834 ± 11.3^{B}*	821 ± 21.4^{B}*

* – traits signed with asterisks shows significant differences between traits in different housing systems; $^{A;B}$ – traits with different superscriptions shows significant differences between breeds.

LB breed cows had the highest milking day count (1,050.1 days) in study group, but in the same time from them was obtained the lowest amount of energy corrected milk per one life (8.2 kg ECM), productive life (14.4 kg ECM) and milking day (17.4 kg ECM) (Table 4).

Lifetime milk productivity for HBW and LB cows were higher in loose housing system, but cows that were kept in tie stall farms and grazed in summer period characterized with significantly lower milk productivity traits. It could be explained with problem that in the tie stall farms feed rations are usually unbalanced because There are not regulary compted a forage analysis which can lead to decreased milk productivity (Bargo et al., 2002).

Table 4. Lifetime milk productivity traits in loose and tie stall housing systems from different cow breeds

Milk productivity traits, kg ECM	Loose housing	Tie stall housing
Holstein Black and White (HBW)	N = 1620	N = 796
Lifetime milk productivity	21,066.1 ± 517.96^{A}*	19,707.9 ± 919.33^{A}*
Life day milk productivity	10.7 ± 0.15	9.1 ± 0.27 ^{A}
Productive life day milk productivity	20.5 ± 0.19 ^{A}*	16.6 ± 0.34 ^{A}*
Milking day milk productivity	23.8 ± 0.19 ^{A}*	19.2 ± 0.33 *
Latvian brown (LB)	N = 763	N = 354
Lifetime milk productivity	20,458.0 ± 361.96^{B}*	18,754.6 ± 760.22^{B}*
Life day milk productivity	9.9 ± 0.11 *	8.2 ± 0.22 ^{B}*
Productive life day milk productivity	18.7 ± 0.13 ^{B}*	14.4 ± 0.28 ^{B}*
Milking day milk productivity	22.8 ± 0.13 ^{B}*	17.4 ± 0.28 *

* – traits signed with asterisks shows significant differences between traits in different housing systems; $^{A;B}$ – traits with different superscriptions shows significant differences between breeds.

The somatic cell count (SCC) is one of the main indicators of the milk quality. SCC has tendency to increase in the milk of the older cows (Pösö & Mäntysaari 1996; Regula et al., 2004; Mdgela et al., 2009). In different study's authors found the connection between increased SCC in milk and in lowered cow milk productivity (Juozaitiene, et al., 2006; Sasaki, 2013; Cinar et al., 2015). Milk quality in the first three lactations is shown in Table 5.

Table 5. Somatic cell count in milk for HBW and LB cows kept in different housing systems

Somatic cell count, thous. in 1mL^{-1}	N	Loose housing	N	Tie stall housing
HBW				
First lactation	1,620	127 ± 8.1	442	130 ± 14.1 ^{A}
Second lactation	1,134	184 ± 10.7^{A}	306	184 ± 18.7
Third lactation	849	161 ± 13.2 ^{A}*	159	224 ± 22.9 ^{A}*
LB				
First lactation	763	131 ± 10.8 *	354	148 ± 16.2 ^{B}*
Second lactation	486	147 ± 14.4 ^{B}*	237	198 ± 21.6*
Third lactation	403	139 ± 17.6 ^{B}*	170	249 ± 26.5 ^{B}*

* – traits signed with asterisks shows significant differences between traits in different housing systems; $^{A;B}$ – traits with different superscriptions shows significant differences between breeds.

HBW breed cows characterized with lower somatic cell count in the milk than LB in both housing systems. The highest somatic cell count in milk was obtained from third lactation LB breed cows in tie stall housing system (249.11 thous. in 1mL^{-1} milk) and the lowest from HBW cows in loose housing system (127.57 thous. in 1mL^{-1} milk).

CONCLUSIONS

Housing system not only refers to the way that cows are located in farm, but also it is main indicator of feeding and milking conditions. In loose housing system cows characterized with shorter lifespan, but average lifetime and daily milk production was higher in those farms. On the other hand in tie stall housing farms cows characterized with lower productivity, and lower culling rates, which indirectly points of better health situation in this housing groups. In tie stall housing farms there are high potential of

improvement in milk productivity and also quality aspect, and as one of main steps in this direction could be rationalized and balanced feeding. The tendency showed that Holstein Black and White cows had higher milk productivity than Latvian Brown cows, but their productivity is strongly dependant from the housing conditions. As Latvian Brown breed cows have better adaptability to rapid environment changes they are more suitable for grazing system and tie stall housing than Holstein Black and White breed cows.

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