CROSSBREEDING INFLUENCE OF DAIRY BREEDS CATTLE ON AVERAGE OF LACTATION LENGTH AND ON AVERAGE OF PRODUCTIVITY

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Abstract. This paper provides records of average milk production, and average lactations length of 1849 pure Holstein cows, 240 Danish Red cows, 455 Red Holstein cows, 155 Swedish Red cows, 113 crosses of Holstein cows with Danish Red sires (HxDR), 325 and crosses of Holstein cows with Swedish Red sires (HxSR), 150 crossbreds of Holstein cows with Red Holstein sires (HxRH) (total 7939 lactations records). Productivity performance of crossbred cows was worse than that of the purebred cows. The highest average milk yield (kg), fat (kg) and protein (kg) were determined in the purebred Holstein and purebred Red cows. Significant differences in milk yield (kg), fat (kg) and protein (kg) between the purebreds and crossbreds were obtained ($p<0.001$). Also the yield of recalculated milk was higher in purebred cows compared with the crossbreds; the differences were statistically significant ($p<0.001$). However, crossbreds HxDR and HxSR have distinguished higher milk fat percentage, than Holstein animals. This trait was higher by 2.3 % in the HxDR crossbreds ($p<0.01$) and by 2.0 % in the HxSR crossbreds ($p<0.05$) than pure Holstein cows.

The obtained results showed that crossing had no positive effect on average productivity and average lactation length (days) if compared with the purebred cows. According to assay data we could to affirm that hybridization is not applicable for optimization of lactation length and productivity of cows.

Keywords: crossbreeding, milk production, lactation, cattle.

PIENINIŲ VEISLIŲ GALVIJŲ KRYŽMINIMO ĮTAKA VIDUTINIAM PRODUKTYVUMUI IR VIDUTINEI LAKTACIJOS TRUKMEI

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Santrauka. Straipsnyje pateikti Lietuvoje veisiamų pieninių veislių galvijų ir jų mišrūnų duomenys apie vidutinį produktyvumą ir vidutinę laktacijos trukmę. Tyrimams atrinktos 1849 grynaveislės holšteinų karvės, 240 Danijos žalųjų, 455 holšteinų žalmargės, 155 Švedijos žalmargės karvės ir 113 holšteinų bei Danijos žalųjų (HxDŽ), 325 holšteinai bei Švedijos žalmargės (HxŠŽ), 150 holšteinų bei žalmargių holšteinų (HxŽH) mišrūnių (iš viso 7939 laktacijų duomenys).

Visų mišrūnių karvių produktyvumo rodikliai buvo prastesni nei grynaveislių. Palyginti su mišrūnėmis vidutiniškai daugiausia baltymingumo ir riebiausio pieno (kg) davė grynaveislės holšteinų bei grynaveislės žalosios karvės. Tarp šių grupių gauti statistiškai reikšmingi pieno, riebalų ir baltymų (kg) kiekio skirtumai ($p<0,001$). Pagal bazinį pieno kiekį geresnėmis savybėmis taip pat pasižymėjo grynaveislės karvės nei mišrūnės; skirtumai buvo statistiškai reikšmingi ($p<0,001$). Tačiau mišrūnių HxDŽ ir HxŠŽ pienas buvo riebesnis, nei Holšteino veislės karvių. Šis rodiklis 2,3 proc. ($p<0,01$) didesnis HxDŽ ir 2,0 proc. ($p<0,05$) HxŠŽ mišrūnių palyginti su grynaveislėmis holšteinų karvėmis.

Pagal tyrimo rezultatus galima teigti, kad kryžminimas neturėjo teigiamos įtakos vidutinei laktacijos trukmei bei vidutiniam produktyvumui, todėl, norint optimizuoti karvių laktacijos trukmę ir produktyvumą, mišrinimas netinka.

Raktažodžiai: kryžminimas, pieno produkcija, laktacija, galvijai.

Introduction. The milk production and reproduction are major factors affecting the efficiency and profitability of dairy industry. In the last several years, farmers have been increasingly interested in crossbreeding. The performance of crossbreeding depends on many factors. Breeds selection and compatibility for the crossing and crossbreds feeding and housing conditions affect the manifestation degree of heterosis (Bryant et al., 2007; Thompson et al., 2000; Lesmeister at al, 2000). If breeds are wrongly selected for the crossbreeding or crossbreeds are poorly fed, their milk production indicators can be worse than those of purebred animals. A. F. Freitas et al. (1998) reported that crossbreeding is without loss of milk production if sires of high genetic value are used.

Holstein breed is worldwide used in other breeds for increase of milk yield (Garcia-Peniche et al., 2005).

Holstein breed is resistant to climate changes and its productivity traits are steadily transferred to the offsprings when crossbred with other breeds (Heins et al., 2008; Dechow et. al., 2007; VanRaden and Sanders, 2003; Lesmeister et al., 2000). Therefore, Lithuania has already launched a crossbreeding programme of Holstein cows with bulls of other unrelated breeds that started a few years ago. Thus, Holstein breed cow owners have paid special attention not only to milk production, but also to cow health, early maturity, fertility, and longevity improvements (Harris and Winkelman, 2000). When, the storage conditions are unfavourable for realization of the genetic potential of crosses, the influence of crossbreeding on the milk production may be low or absent altogether. Various researchers agree that some of the hybrids have a better economic value for the light calving, calf viability, and cows' fertility. But views about milk yield and composition are contradictory (Petraškienė et al., 2011). Favourable heterosis for yield was completely counteracted by recombination in future generations of Red Danish, Finnish Ayrshire, Danish Friesian, and Holstein Friesian crosses (Pedersen and Christensen, 1989). Unfavourable recombination for yield has been reported for crosses among European Friesian and Holstein Friesian (Wall et al., 2005).

Also, milk production largely depends on the cow's age. The changes in milk production over time, very much depend on the cow's reproductive activities and feeding conditions. Reproductive activity is a significant factor in maintaining stable productivity throughout the life of the cows. The optimal duration of lactation is 305 days and the dry period lasts for 60 days. Assessing the productivity of dairy cows, the mentioned figures are taken as a standard in many countries around the world. Špakauskiene J. (2002) reported, that under normal conditions of use, cows' milk yield increases up to 5–6 lactation (until 6–8 years of age), depending on variety and speed of maturation, then 2–3 lactation are nearly equal. Opinions of various authors on milk fat and milk yield are contardictory. Milk fat and protein amount may vary due to age. (Špakauskienė, 2002; Bižokas et al., 2002; Pauliukas and Masiulienė, 2001).

The aim of this study was to estimate the effect of the dairy cattle crossbreeding on average productivity, and average lactation length in Lithuania.

Materials and Methods. Records of average milk production, and average lactation length of 1849 pure Holstein cows, 240 Danish Red cows, 455 Red Holstein cows, 155 Swedish Red cows, 113 crosses of Holstein cows with Danish Red sires (HxDR), 325 and crosses of Holstein cows with Swedish Red sires (HxSR), 150 crossbreds of Holstein cows with Red Holstein sires (HxRH) were used for this study (total of 7939 lactation records). Both purebred and crossbred cows were kept under the same feeding, maintenance and climatic conditions; they were taken from the same Lithuanian farms (in total 254 farms) in order to avoid the influence of particular conditions and managerial decisions of different farms. Cows were first calved after 01.01.2003. The lactation production was obtained from the Lithuanian State Enterprise "Agriculture Information and Rural Business Centre".

The data on milk, fat, protein yield, fat and protein percentage were used. Recalculated milk yield was provided for comparison. Milk yield was recalculated by formula (this formula is used by the milk shoppers):

Recalculated milk yield = M (1 + (Fpr – 3.4) 0.178 + (Ppr – 3) 0.267),

Where, M – milk yield, Fpr – fat percentage, Ppr – protein percentage.

The mean (X) and the standard error (mx), and the standard deviation (SD) were calculated for each trait. The reliability (p) of the difference between the arithmetic means of the two groups was determined by Student's (t) criteria.

Results and discussion. The average productivity and average lactation length of pure dairy cattle breeds and their crosses were compared (Tables 1 and 2). We analyzed crossbreeding effectiveness and heterosis effects on average productivity and average lactation length of first-generation crossbred. Experiments showed that the average productivity was higher in pure bred cows. The highest average amounts according to the milk yield (kg), fat (kg) and protein (kg) were determined in the purebred Holstein cows, if compared with purebred Red and crossbred cows. Our results were consistent with the results obtained by other authors (Weigel and Barlass, 2003). Milk yield is the main advantage of Holstein breed. Similar results also have been obtained by other scientists (VanRaden et al., 2007). According to them, the milk yield (31.5 kg/d) of purebred Holstein cows was higher than that of any other breed or crossbreed. Crossbred cows also had lower average milk yield (kg), fat (kg) and protein (kg) than the purebred Danish Red, Red Holstein and Swedish Red cows.

Purebred Holstein cow also was longer average lactation length, compared with crossbred and purebred Red cows.

Table 1. **Statistical analysis of average productivity, and average of lactation length of purebreed cows**

Trait	Holstein, n=1849	Danish Red, n=240	Red Holstein, n=455	Swedish Red, n=155
Milk yield kg	7484.94 ± 36.41	6386.17 ± 72.07	7272.06 ± 72.47	6905.60 ± 111.13
Fat yield kg	316.93 ± 1.65	279.76 ± 3.36	305.18 ± 3.03	300.11 ± 5.29
Fat percentage %	4.25 ± 0.01	4.39 ± 0.03	4.23 ± 0.02	4.35 ± 0.04
Protein yield kg	249.40 ± 1.17	221.64 ± 2.49	240.80 ± 2.23	236.56 ± 3.83
Protein percentage %	3.34 ± 0.005	3.48 ± 0.01	3.33 ± 0.01	3.43 ± 0.02
Recalculated milk yield kg	9259.80 ± 45.01	8303.38 ± 87.80	8907.54 ± 82.14	8853.15 ± 147.77
Average of lactation length days	398.00 ± 2.30	377.39 ± 5.08	377.58 ± 3.87	355.14 ± 5.16

Table 2. **Statistical analysis of average productivity and average of lactation length of crossbred cows**

Trait	All crossbreeds cows, n=592	HxDR, n=113	HxRH, n=150	HxSR, n=329
Milk yield kg	6106.51 ± 49.41	5980.99 ± 112.11	6414.81 ± 131.03	6118.45 ± 61.24
Fat yield kg	264.03 ± 2.38	259.86 ± 5.38	271.07 ± 6.08	264.42 ± 2.96
Fat percentage %	4.33 ± 0.02	4.35 ± 0.04	4.23 ± 0.04	4.33 ± 0.03
Protein yield kg	203.99 ± 1.71	201.34 ± 3.81	211.22 ± 4.49	205.49 ± 2.17
Protein percentage %	3.34 ± 0.01	3.37 ± 0.02	3.29 ± 0.02	3.36 ± 0.01
Recalculated milk yield kg	7665.78 ± 66.54	7571.64 ± 150.48	7858.86 ± 170.86	7708.05 ± 84.66
Average of lactation length days	366.43 ± 3.25	354.93 ± 5.91	395.65 ± 9.01	356.14 ± 3.85

The differences between Holstein cows and crossbreeds are presented in Table 3. The purebred Holstein cows were superior to crossbreds. Significant differences for milk yield (kg), fat (kg) and protein (kg) were obtained between Holstein cows and all crossbreds ($p<0.001$). The results on milk production by pure Holstein cows obtained in this study are similar to those reported by Heins et al. (2006), who have found that pure Holstein cows produced more milk. Also the yield of recalculated milk was higher in pure Holstein cows, as compared with the all crossbreds; the differences were statistically significant ($p<0.001$). Recalculated milk yield is a very important economical rate of the herd.

However, crossbreds HxDR and HxSR have distinguished higher milk fat percentage, than Holstein animals. This trait was higher by 2.3 % in the HxDR crossbreds ($p<0.01$) and by 2.0 % in the HxSR crossbreds ($p<0.05$) than in pure Holstein cows. Except, of crossbred HxRH fat of milk percent was obtained less than the purebred Holstein, but the difference was statistically insignificant. Milk protein percentage differed statistically significantly only between crossbreds HxRH and purebred Holstein. This difference was 1.6 % ($p<0.01$). Similar results were obtained by scientists VanRaden and Sanders (2003), they maintained, that the fat and protein amounts of crossbreds were similar or slightly higher than in pure Holstein cows.

The purebred Holsteins in comparison with crossbred cows according the average of lactation length (days) were superior to the crossbred animals. According to this trait, statistically significant differences were obtained between purebred Holstein and crossbreds HxDR 12.1 % ($p<0.01$) and HxSR 11.8 % ($p<0.05$).

Table 3. **Comparison of average performance between Holstein cows and crossbreeds cows**

Trait	Difference between Holstein cows and crossbreeds:		
	HxDR	HxRH	HxSR
Milk yield kg	$1503.94 \pm 117.9^{***}$	$1070.13 \pm 136.0^{***}$	$1366.49 \pm 71.2^{***}$
Fat yield kg	$57.07 \pm 5.6^{***}$	$45.85 \pm 6.3^{***}$	$52.51 \pm 3.4^{***}$
Fat percentage %	$0.10 \pm 0.04^{**}$	$0.04 \pm 0.02^{¯}$	$0.08 \pm 0.03^{*}$
Protein yield kg	$46.06 \pm 4.0^{***}$	$38.18 \pm 4.6^{***}$	$-43.90 \pm 2.5^{***}$
Protein percentage %	$0.03 \pm 0.02^{¯}$	$0.05 \pm 0.02^{**}$	$0.02 \pm 0.01^{¯}$
Recalculated milk yield kg	$1688.16 \pm 157.1^{***}$	$1402.94 \pm 176.6^{***}$	$1551.75 \pm 95.9^{***}$
Average of lactation length days	$43.08 \pm 6.30^{**}$	$2.36 \pm 0.00^{¯}$	$41.87 \pm 4.50^{*}$

*** – $p<0.001$, ** – $p<0.005$, * – $p<0.01$, ¯ – $p>0.05$

Table 4. **Comparison of average performance between pure red cows and crossbreeds cows**

Trait	Difference between:		
	Danish Red and HxDR	Red Holstein and HxRH	Swedish Red and HxSR
Milk yield kg	$405.17 \pm 133.3^{**}$	$857.25 \pm 149.70^{***}$	$787.15 \pm 126.90^{***}$
Fat yield kg	$19.90 \pm 6.3^{**}$	$34.10 \pm 6.80^{***}$	$35.69 \pm 6.10^{***}$
Fat percentage %	$0.4 \pm 0.0^{¯}$	$0.0014 \pm 0.00^{¯}$	$0.01 \pm 0.00^{¯}$
Protein yield kg	$20.30 \pm 4.6^{***}$	$29.58 \pm 5.00^{***}$	$31.07 \pm 4.40^{***}$
Protein percentage %	$0.10 \pm 0.00^{***}$	$0.04 \pm 0.00^{\wedge}$	$0.07 \pm 0.00^{***}$
Recalculated milk yield kg	$731.74 \pm 177.4^{***}$	$1048.67 \pm 189.50^{***}$	$1145.10 \pm 170.30^{***}$
Average of lactation length days	$22.46 \pm 7.8^{¯}$	$18.07 \pm 9.8^{¯}$	$0.99 \pm 0.0^{¯}$

*** – $p<0.001$, ** – $p<0.005$, * – $p<0.01$, ¯ – $p>0.05$

The experiment showed that the crossing had no positive effect on milk production in comparison with the purebred Danish Red, Red Holstein and Swedish Red cows and the crossbred cows. The purebred Red cows were superior according the milk production (Table 4). Milk yield (kg), fat (kg) and protein (kg) of crossbreds were less, than those of the purebred red cows. The differences were statistically significant ($p<0.01$; $p<0.001$). According to milk fat (%), a statistically insignificant difference was found between crossbred cows compared with purebred Red cows. Protein content (%) of milk was by 3.02 % higher in the purebred Danish Red cows than in crossbreds HxDR and by 2.1 % higher in the purebred Swedish Red than in crossbreds HxSR. The differences were statistically significant ($p<0.001$). Similarly, the yield of recalculated milk was higher in pure Red cows, as compared with the crossbreds, and the differences were statistically significant ($p<0.001$).

By comparison of average lactation length in days in the crossbred cows and in the purebred Red cows, statistically significant differences were not obtained.

In surveys of many authors, a significant loss in milk production by crossbreeding of dairy cattle has been clearly demonstrated. However crossbreeding improved the health, fertility, survival, and profitability of dairy cows and heifers (Weigel at al, 2003; Heins at al, 2008; Heins at al, 2006).

Conclusions.

1. According to the obtained results, the productivity performance of crossbred cows is worse than that of the purebred cows. The highest average amounts according to the milk yield (kg), fat (kg) and protein (kg) were determined in the purebred Holstein cows and purebred Red compared with crossbred cows. Significant differences for milk yield kg, fat kg and protein kg were obtained ($p<0.001$). Also the yield of recalculated milk was higher in purebred cows compared with the all crossbreds; and the differences were statistically significant ($p<0.001$).

2. Comparison of purebred cows and crossbreds showed that the crossing had no positive effect on the average lactation length (days). The differences in average lactation length between crossbred and purebred cows were low and statistically insignificant.

3. According to assay data, we could to affirm that hybridization is not applicable for optimization of lactation length and cow productivity. Therefore, crossbreeding of dairy cattle may be used if the goals are not only milk production but also fertility, wellness and longevity improvement.

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