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Relationships between bodyweight, milk yield, and longevity of Estonian test cows

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Introduction

Dairy cattle breeding goals have placed great emphasis on production traits over the last several decades. It has been tremendous genetic improvement of the potential production. At the same time reproduction, health and durability have been declined (Derikx, 2002).

It is well documented that length of animal's productive life affects her profitability as well as dairy farm production efficiency through increasing proportion of high yielding cows, decreasing replacement costs, and more opportunity for voluntary culling (Brotherstone et al, 1998). Ducrocq (1994) defined the length of productive life as the number of days from first calving to death or culling.

Longevity is one of the most important components of dairy cow profitability. The economic advantage of longevity lies primarily in retaining productive, healthy and trouble free cows as long as possible (Ducrocq *et al.,* 1988).
Maximizing longevity in dairy cows is important because a cow returns profit to the operation only after income from her milk production during the first several lactations exceeds her rearing, maintenance, and feed costs (Bascom et al., 1998).

Material and Methods

Analyses based on data of Põlula Experimental Farm, where an experiment was conducted using the cows of the Estonian Native (EN), Estonian Red (ER), Estonian Holstein, and Red-and-White Holstein (RH) breeds to establish the maximum milk productivity. The groups were arranged in five trial groups according to breed. Black-and-White Holstein cows were divided between two groups by breeding value. From bodyweight analysis EN group has been excluded because of small number of cows. The cows were kept tethered and fed energy and protein rich total mixed ration *ad libitum,* and in summer they grazed half a day in pastures. The cows were milked three times a day with pipeline system.

Statistical models were developed to study the effect of factor (group, reason of culling) on trait (longevity, production per life and per day of life). Bonferroni t-Test was used to identify statistical significance between group averages.

Results

In three test groups, except RH-group (Table 1), were found statistically reliable relationships between milk production and body weight. In that case the effect of bodyweight was parabolic (nonlinear), where with increasing milk production the bodyweight increased. At a certain level the milk production started to decrease. It was established that the optimal bodyweight of Estonian Holsteins was 610...650 kg, and that of Estonian Red was 580...640 kg. In RH group, however, milk production increased linearly with increasing body weight ($P>0.05$). Milk fat and protein yields had similar tendencies, although in some cases not statistically proved.

Table 1. Optimal bodyweight and impact on milk yield of test cows

Group	Optimal bodyweight	Impact of bodyweight on (P)			
		milk	fat	protein	f + p
ER	580…640	<0.05	<0.05	<0.05	<0.05
RH	>660	ns*	ns	ns	ns
EH	610…650	<0.05	<0.001	ns	<0.01
EHt	610…650	<0.05	ns	<0.05	ns
Average	600…650	<0.01	<0.01	<0.01	<0.01

*) ns – not significant, P>0.05;

The basic aim of the experiment was to investigate the maximum milk yield of cows of four different genetic origins. Based on the test results over a 4-year period, the test groups were arranged by 305-day milk yield as follows: EH>EHt>RH>ER>EN. High culling rate was observed in high-producing groups; therefore it was important to analyze longevity, milk production per life and per productive life of culled cows (Table 2).

Table 2. Milk production of cows culled from test groups

Item	**Test groups**					Mean	P
	EHt	EH	RH	ER	EN		
Cows	25	34	25	22	6	112	x
Lifetime production, kg							
Days of life	1301	1311	1489	1513	1193	1382	x
Milk	13 394	12 403	14 977	16 008	6055	13 567	ns
Fat	504	443	531	617	297	503	ns
Protein	451	408	514	564	229	462	ns
Fat + Protein	955	852	1045	1180	526	965	ns
Production per day of life, kg							
Milk	8.8	8.2	9.2	9.7	5.0	8.7	x
Fat	0.3	0.3	0.3	0.4	0.2	0.3	x
Protein	0.3	0.3	0.3	0.3	0.2	0.3	x
Fat + Protein	0.6	0.6	0.6	0.7	0.4	0.6	x
Production per day of productive life, kg							
Productive life, day	518	501	612	678	382	558	ns
Milk	26.8	24.8	25.5	23.8	15.8	24.7	<0.001
Fat	1.0	0.9	0.9	0.9	0.8	0.9	ns
Protein	0.9	0.8	0.9	0.8	0.6	0.8	<0.001
Fat + Protein	1.9	1.7	1.8	1.8	1.3	1.8	<0.01

x) Not analyzed statistically;

The average lifetime of culled cows was 1382 days, of which productive life was 558 days (40.4%), i.e. rearing constituted about 60% of lifetime. The longest life and productive life had the cows of ER and RH groups, and equally shorter the cows of two black-and white Holstein (EHt, EH) groups. Due to intensive usage the shortest period to culling had the cows from Estonian Native group.

Total lifetime production and average production per day (ER>RH>EHt>EH>EK) depended mostly on length of lifetime and productive period (ER>RH>EHt>EH>EK), than average production per productive day EHt>RH>EH>ER>EK.

Over the last decades in Estonia the major culling reasons have been udder diseases and fertility problems, somewhat less metabolic disorders and feet diseases (65…71% of culled cows). Even 84.8% of cows, were culled from test farm, although the objective of test did not allow culling of cows due to low milk production (Table 3).

Table 3. Milk yield of cows by culling reason

Item	Culling reason					Mean/ total	P
	udder	fertility	metabolism	feet	other		
Cows	41	22	13	19	17	112	x
Lifetime production, kg							
Days of life	1261	1397	1758	1556	1169	1382	x
Milk	11 221	12 993	22 454	16 839	9514	13 567	x
Fat	408	503	804	631	358	503	x
Protein	384	454	750	565	326	462	x
Fat + Protein	792	957	1554	1196	684	965	x
Production per day of life, kg							
Milk	8.0	8.7	11.9	9.5	6.9	8.7	<0.05
Fat	0.3	0.3	0.4	0.4	0.3	0.3	<0.05
Protein	0.3	0.3	0.4	0.3	0.2	0.3	<0.05
Fat + Protein	0.6	0.6	0.8	0.7	0.5	0.6	<0.05
Production per day of productive life, kg							
Productive life, day	456	571	890	714	357	558	<0.05
Milk	24.9	23.0	25.3	24.5	26.3	24.7	ns
Fat	0.9	0.9	0.9	1.0	1.0	0.9	ns
Protein	0.8	0.8	0.9	0.8	0.9	0.8	ns
Fat + Protein	1.8	1.7	1.8	1.8	1.9	1.8	ns

From all test groups the longest life and productive period had the cows culled for metabolic diseases, followed by those culled for feet disorders, whose life was 202 days and productive period 176 days shorter. Concurrently the cows culled because of udder diseases had shortest life and productive life, only 136 and 115 days longer stayed in herd the cows with fertility problems.

Particularly large differences were found in total lifetime milk production and production per day of life, whereas the highest lifetime production had the cows culled because of metabolic disorders and feet diseases. By culling reason there were no large differences found in production per day of productive life. The length of production period was conclusive.

Discussion

We have proved previously, that during the productive period it was economically effective to keep in the herd cows with higher productivity, because costs per one kilo of milk were lower (Voore, Saveli, 2004). In that study the rearing costs were not taken into account. In this investigation average productions per productive life proved to be comparatively similar,

both as average of test groups (except EK-group) and as grouped by culling reasons. Apparently economical effectiveness would be analogous.

Taking into consideration the productive and rearing period or life period, there were big differences in milk yield figures. The groups with longer productive life (ER and RH) produced 1500…3500 kg more milk per lifetime or 0.5…1.5 kg per day of life, respectively. Such large differences resulted from ratio of rearing period to productive period (60:40) of the test cows.

Analysis of culling reasons indicated, that most early, already in second year of production the problems in functions of udder and reproductive organs appeared. There were no ageing changes, only the influence of environmental factors might be possible. The implementation of disease prevention is therefore necessary. We found that longevity can be improved if management factors with a high impact on feet and legs, reproduction, and mastitis are identified and corrective measures are taken.

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