

## The relationship between linear type traits and stayability of Czech Fleckvieh cows

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**ABSTRACT:** The relationship between linear type traits and stayability was analyzed in 34 492 Czech Fleckvieh cows. Pearson correlation coefficients were calculated between linear type traits and stayability of cows. The observed correlations were  $r = -0.04$  for stature,  $r = -0.08$  for muscularity,  $r = -0.14$  for rump angle,  $r = -0.03$  for rump width,  $r = -0.01$  for rear legs set and  $r = -0.18$  for foot angle. The following correlations were found for udder traits:  $r = 0.18$  for fore udder,  $r = 0.12$  for rear udder,  $r = 0.16$  for central ligament,  $r = -0.06$  for teat placement,  $r = 0.06$  for teat length and  $r = 0.18$  for udder depth. Udder traits can be used for predicting the longevity of cows.

**Keywords:** cattle; stayability; type traits; correlation

Considerable changes have occurred in cattle breeding, particularly in countries with a regulated milk production. This fact can be demonstrated by the development of selection indexes and weights of different components in the total index (Šafus et al., 2005). The main emphasis is put on non-production but also on economically important characteristics such as health traits of animals and the length of their productive life. Within the system of dairy cattle breeding, longevity has its important economic value (Essl, 1998). As reported by a number of authors, heritability of longevity is very low (Vollema and Groen, 1998; Settar and Weller, 1999; Vukasinovic et al., 2001; Essl and Voith, 2002; Tsuruta et al., 2005). Therefore, selection appears to be more efficient when a combination of more hereditary traits and characteristics determining longevity is used. Neuenschwander et al. (2005) reported that the results of linear type trait classification could be used as indicators of longevity.

The study of relationships between animal longevity and other characteristics and traits is still very current. In this respect, type traits are particularly important. Linear type scoring systems are a part of animal evaluations in most countries

with a developed dairy industry (Mark, 2004). Such systems are means of achieving a higher efficiency in dairy herds as they allow to use more accurate selection for economically important characteristics and traits. Efficient selection for longevity is, however, rather difficult because of the fact that in real time it is not possible to obtain estimated breeding values of sires on the basis of direct longevity of their daughters. These values have to be predicted indirectly. Selection can therefore be realized indirectly through type traits which are correlated to longevity.

According to a number of authors, the relationship between longevity and some type traits is evident. Vollema and Groen (1997) found a non-linear relationship between udder depth, central ligament, teat placement, and foot angle. Similar conclusions were reported by Vukasinovic et al. (1994, 2002), Cruickshank et al. (2002), Zedníková et al. (2002) and Tsuruta et al. (2005). Sölkner and Petschina (1999) and Strapák et al. (2005) confirmed significant correlations between longevity and udder traits.

A possible use of indirect information to predict breeding values for longevity appears to be highly

efficient. However, it is not possible to perceive longevity of cows as the sole breeding goal. It only yields the required economic results in association with the high efficiency of animals. The present study brings together relationships between selected linear type traits and the longevity of Czech Fleckvieh cows and provides further background for including these traits in the total selection index.

## MATERIAL AND METHODS

First-parity Czech Fleckvieh cows with their first calvings in the period from 1998 to 2000 were included in the data set. It contained a total of 34 492 cows with their type evaluated after the first calving. The following type traits were scored:

Trait	1 Point	9 Points
Stature	short	tall
Muscularity	poor	excellent
Rump angle	high pins	extreme slope
Rump width	narrow	wide
Rear legs side view	straight	sickled
Foot angle	very low	very steep
Fore udder	short	long
Rear udder	low attached	high attached
Rear udder height	low	high
Central ligament	indistinct	deep
Udder depth	deep	shallow
Front teat placement	wide	narrow
Teat length	short	long

In addition, the age of cows at culling was recorded and longevity expressed as survival time was calculated as the period from birth to culling.

The data set was classified into groups based on survival time as follows:

Group 1 survival time less than 36 months

Group 2 survival time from 36.1 to 48 months

Group 3 survival time from 48.1 to 60 months

Group 4 survival time from 60.1 to 72 months

Group 5 survival time more than 72.1 months.

To emphasize tendencies between type traits and the survival time of cows, three groups were set up for each trait as follows:

Group 1 score 1 to 3 points

Group 2 score 4 to 6 points

Group 3 score 7 to 9 points.

Statistical analyses were performed using the multifactorial analysis of variance (Rasch and Mašata, 2006) and the procedures CORR and GLM of the statistical programme SAS (SAS Institute, Inc., 2001). The following basic model with fixed effects was chosen:

$$Y_{ijk} = \mu + HYS_i + B_j + C_k + \beta x_1 + e_{ijklm}$$

where:  $\mu$  = mean value

$HYS_i$  = effect of herd, year, and season of first parturition  $i$

$B_j$  = effect of classifier  $j$

$C_k$  = alternative effect

$\beta x_1$  = regression on age at first parturition

$e_{ijklm}$  = residual error

The following effects were alternatively included into the basic model:

- effect of the level of linear type traits
- effect of the level of cow survival

## RESULTS AND DISCUSSION

The relationships between recorded type traits and stayability of cows are given in Table 1. The highest Pearson correlation coefficients between stayability and linear type traits were  $r = -0.14$  for rump angle,  $r = 0.08$  for foot angle,  $r = -0.08$  for muscularity, and  $r = -0.04$  for stature. Tsuruta et al. (2005) reported the following genetic correlations between productive life and type traits for Holstein

Table 1. Pearson correlation coefficients ( $r$ ) between type traits and stayability of Czech Fleckvieh cows

Trait	$n$	$r$	Statistical signification
Stature	34 492	-0.04	$P < 0.05$
Muscularity	34 492	-0.08	$P < 0.01$
Rump angle	34 492	-0.14	$P < 0.001$
Rump width	34 492	-0.03	
Rear legs set	34 492	0.01	
Foot angle	34 492	-0.08	$P < 0.01$

Table 2. Pearson correlation coefficients ( $r$ ) between udder traits and stayability of Czech Fleckvieh cows

Udder trait	$n$	$r$	Statistical signification
Fore udder	34 492	0.18	$P < 0.001$
Rear udder	34 492	0.12	$P < 0.001$
Central ligament	34 492	0.16	$P < 0.01$
Udder depth	34 492	0.18	$P < 0.001$
Teat placement	34 492	-0.06	$P < 0.01$
Teat length	34 492	0.06	$P < 0.01$

Table 3. Stayability of Czech Fleckvieh cows in relation to type traits

Type trait	Evaluation level		Stayability in months		Statistical signification of differences
	class	$n$	mean	S.E.	
Stature	1	4 620	53.31	0.20	1:3, 2:3
	2	24 946	53.00	0.15	
	3	4 926	52.56	0.20	
Muscularity	1	2 695	53.19	0.24	1:3, 2:3
	2	29 883	53.14	0.15	
	3	1 914	52.05	0.27	
Rump angle	1	250	54.01	0.66	1:3, 2:3
	2	28 561	53.06	0.15	
	3	5 681	52.56	0.19	
Foot angle	1	4 162	52.47	0.21	1:2
	2	26 953	53.10	0.15	
	3	3 377	52.80	0.22	

Table 4. Stayability of Czech Fleckvieh cows in relation to udder traits

Udder trait	Evaluation level		Stayability in months		Statistical signification of differences
	class	$n$	mean	S.E.	
Fore udder	1	273	48.35	0.63	1:2; 3, 2:3
	2	18 014	52.48	0.15	
	3	16 205	53.72	0.16	
Rear udder	1	1 655	50.58	0.29	1:2; 3
	2	30 248	53.09	0.15	
	3	2 589	53.60	0.25	
Central ligament	1	15 530	52.23	0.16	1:2; 3
	2	17 857	53.57	0.16	
	3	1 105	54.29	0.34	
Udder depth	1	1 952	51.61	0.26	1:2; 3
	2	29 070	53.02	0.15	
	3	3 470	53.50	0.29	
Teat placement	1	4 195	53.44	0.26	1:3
	2	29 764	53.87	0.15	
	3	533	52.15	0.48	
Teat length	1	2 180	50.13	0.37	1:2; 3, 2:3
	2	17 379	53.31	0.15	
	3	14 933	52.68	0.16	

Table 5. Average type traits score according to cows' stayability

Type trait	Stayability in months			Trait score		Statistical signification of differences
	cows group	<i>n</i>	mean	S.E.		
Stature	1	< 36	2 145	4.98	0.03	
	2	36.1–48	9 598	5.00	0.02	
	3	48.1–60	12 263	4.97	0.02	
	4	60.1–72	7 671	4.92	0.02	
	5	> 72.1	2 721	4.90	0.03	
Muscularity	1	< 36	2 145	4.95	0.02	
	2	36.1–48	9 598	4.96	0.02	
	3	48.1–60	12 263	4.97	0.02	5:1; 2; 3; 4
	4	60.1–72	7 671	4.96	0.02	
	5	> 72.1	2 721	4.85	0.02	
Rump angle	1	< 36	2 145	5.72	0.02	
	2	36.1–48	9 598	5.69	0.01	
	3	48.1–60	12 263	5.69	0.01	1:5
	4	60.1–72	7 671	5.66	0.01	
	5	> 72.1	2 721	5.62	0.01	

cattle:  $r_g = -0.12$  for stature,  $r_g = 0.15$  for foot angle, and  $r_g = 0.03$  for rump angle. Vukasinovic et al. (2002) estimated genetic correlations between longevity and linear type traits in Swiss Simmental cattle:  $r_g = 0.08$  for stature,  $r_g = -0.04$  for rump angle,  $r_g = -0.10$  for foot angle,  $r_g = -0.12$  for rear legs set, and  $r_g = 0.01$  for muscularity. These values generally correspond to our results. Similar parameters between longevity and type traits were confirmed by Zedníková et al. (2002). The estimated correlations were  $r = 0.06$  for muscularity,  $r = 0.02$  for rump angle,  $r = 0.02$  for foot angle,  $r = -0.03$  for stature and  $r = -0.05$  for rump width. Strapák et al. (2005) reported similar correlations between stayability of cows and their stature ( $r = 0.05$ ) and muscularity ( $r = -0.06$ ). The estimated correlation for rump angle was  $r = 0.10$  and for foot angle  $r = 0.05$ .

The correlations between stayability and udder traits are presented in Table 2. It is evident that the most significant relationships were estimated for fore udder ( $r = 0.18$ ), udder depth ( $r = 0.18$ ), central ligament ( $r = 0.16$ ), and rear udder ( $r = 0.12$ ). Vukasinovic et al. (2002) reported slightly higher genetic correlations between longevity and fore udder  $r_g = 0.32$  and udder depth  $r_g = 0.36$ , lower correlation for rear udder  $r_g = -0.04$ , and the correlation for central ligament  $r_g = 0.16$  corresponding to our estimate. Similar correlations were reported by Zedníková et al. (2002) between udder traits

and stayability of Czech Fleckvieh cows. Their estimates were  $r = 0.11$  for fore udder and  $r = 0.18$  for rear udder. Our results were also confirmed by Strapák et al. (2005) in Bavarian Fleckvieh. The estimated correlations between longevity and udder traits were  $r = 0.17$  for fore udder,  $r = 0.17$  for rear udder, and  $r = 0.19$  for central ligament.

The average survival times in months in the groups set up according to the score level of different traits are shown in Table 3. The average survival time tended to decrease with increasing scores for stature, muscularity, and rump angle. The differences between group 1 and group 3 were 0.75, 1.14, and 1.45 months for stature, muscularity and rump angle, respectively. The longest survival time, 53.10 months, was found in group 2 (score from 4 to 6 points) for foot angle.

Similar parameters for udder traits are given in Table 4. The results indicate a positive relationship between stayability and udder traits. The differences between group 1 and group 3 were 5.37, 3.02, 2.06, and 1.89 for fore udder, rear udder, central ligament and udder depth, respectively. The highest survival time was recorded in group 2, i.e. in cows scored from 4 to 6 points, for teat placement and length.

The average type trait scores in the groups according to survival time are presented in Table 5. The differences are not statistically significant for



Table 6. Average udder traits score according to cows' stayability

Type trait	Stayability in months			Trait score		Statistical signification of differences
	cows group	<i>n</i>	mean	S.E.		
Fore udder	1	< 36	2 145	4.91	0.02	
	2	36.1–48	9 598	5.18	0.02	
	3	48.1–60	12 263	5.22	0.02	1:2; 3; 4; 5, 2:4; 5
	4	60.1–72	7 671	5.28	0.02	
	5	> 72.1	2 721	5.29	0.02	
Rear udder	1	< 36	2 145	6.02	0.02	
	2	36.1–48	9 598	6.26	0.02	
	3	48.1–60	12 263	6.31	0.02	1:2; 3; 4; 5, 2:4; 5, 3:4; 5
	4	60.1–72	7 671	6.39	0.02	
	5	> 72.1	2 721	6.40	0.05	
Central ligament	1	< 36	2 145	3.49	0.04	
	2	36.1–48	9 598	3.77	0.03	
	3	48.1–60	12 263	3.83	0.02	1:2; 3; 4; 5, 2:4; 5, 3:4; 5
	4	60.1–72	7 671	3.96	0.03	
	5	> 72.1	2 721	4.14	0.04	

stature. The group with the longest survival time received the lowest average score for muscularity (4.85 points), while the average scores in the other groups were rather similar and ranged from 4.95 to 4.97 points. The greatest difference between different groups for rump angle was only 0.10 points.

Longer survival times of cows are associated with a steady increase of udder traits score (Table 6). Maximum differences between groups 1 and 5 are 0.38, 0.38, and 0.65 points for fore udder, rear udder, and central ligament, respectively.

## CONCLUSION

Positive relationships between stayability of Czech Fleckvieh cows and recorded linear type traits were found particularly for udder traits. Fore udder, rear udder, central ligament, and udder depth appear to be potential indicators of cow longevity. It is necessary to test these traits regularly so that they can be used as important selection criteria for the improvement of Czech Fleckvieh longevity.

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