Relationship between type traits and longevity in Austrian Simmental cattle

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Abstract

The economic value of type traits in cattle is often seen in their effect on improvement of functional stability of cows. The relationship of various type traits obtained from a linear scoring system with the length of productive life of dairy cows of the Austrian Simmental breed was examined. A Cox survival model was used including the time-dependent effects of year-season, stage of lactation, level of milk yield, fat percent and protein percent relative to herd mates and, alternatively, one of the time-independent effects of 24 type traits. Type traits a were corrected for effects like classifier, stage of lactation and herd and fit as regressions with a linear and quadratic component. The data set consisted of a total of 5360 individuals. Of the 24 type traits, 12 showed a significant positive linear effect on length of productive life, one trait, muscularity of the front part of the body showed a significant negative effect. The largest positive effect was found for udder score. Quadratic terms were significant 6 times, and the signs of the quadratic regression coefficients indicated in all instances that more extreme expressions of a type trait have a negative effect on longevity.

Results on the effect of type traits on longevity have to be viewed with caution because in many instances it might not be functional deficiencies but instead voluntary culling by the farmer for type that reduces the lifetime of cows.

1. Introduction

Linear scoring of type traits is carried out routinely for the total population or for groups of offspring of test bulls in many breeds and many countries. One reason for characterising offspring morphologically is to present a "picture" of the type of cow a breeder might expect when using semen of a particular sire. Another reason is to detect obvious deficiencies in the body conformation of animals which result in severe problems to cope with their environment (e.g. leg problems) or present troubles to the farmer (e.g. milking of cows with very loose udders or extreme positioning of teats). These deficiencies have an obvious correlation with the herd life of a cow and therefore a large number of studies have been carried out about the use of conformation traits as early indicators for longevity of dairy cows (e.g. Keller and Allaire, 1987, Brotherstone and Hill, 1991, Dekkers et al., 1994, Veerkamp et al., 1995 Vukasinovic et al., 1995). The dependent variable in these studies is somewhat problematic statistically as many of the observations for longevity are incomplete, i.e. cows are still alive at the point in time when the study is carried out. Different approaches have been taken to avoid the problem, like definition of opportunity groups (alive or not alive at a certain predefined age, Everett et al., 1976) or length of productve life observed at a fixed age boundary (Vukasinovic at al., 1995).

In the current study, the phenotypic relationships between type traits and length of productive life are analysed by survival analysis methods (Ducrocq and Sölkner, 1998). Polynomial regression of length of productive life on the various type traits while including other systematic effects in the model is used to investigate precence and the (non)linearity of such relationships.

2. Data and methods

Data on type traits were available for a total of 5360 Simmental cows in the region of Lower Austria. Data were from offspring of test bulls recorded from January 1987 to September 1996. The recording followed a procedure outlined by Gottschalk (1987) which included 4 main traits (frame, muscularity, form and udder) scored subjectively from 1 (very bad) to 9 (excellent). 20 traits were scored in a descriptive manner with biological extremes decribing the ends of the scale (e.g. for length 1 is very short and 9 is very long). Before analysing the relationship between these traits and longevity, they were precorrected for effects influencing them. Effects considered were classifier, year, month, time of the day, stage of lactation, age and average milk production of the herd in the year of scoring. The last effect was included as a substitue for a herd-year effect which could not be fitted due to very low frequencies of observations in herd-year classes. Two-way interactions between classifier, year, month and time of day were fitted where appropriate. The other effects were fitted as linear and quadratic regressions where significant.

The analysis of the effect of type traits on length of productive life was carried out with a Cox model, which is a standard model in survival analysis (e.g. Cox and Oakes, 1984, Collet, 1994). The following model was supposed:

$$h(t,z) = h_0 \exp(YS_i + LST_j + M_k + F_l + P_m + b_1 TT + b_2 TT^2)$$

where

$h(t,z)$ = hazard function for an animal with vector of covariates z at time t

h_0 = baseline hazard function (unspecified in the Cox model)

YS_i = year-season effect (2 seasons per year, january-june, july-december)

LST_j = lactation x stage of lactation effect (lactations 1 –5 and higher, 3 stages within lact.)

M_k = Milk yield of a cow relative to her herd mates (7 classes)

F_l = Fat content of a cow relative to her herd mates (6 classes)

P_l = Protein content of a cow relative to her herd mates (6 classes)

b_1, b_2 = linear and quadratic regression coefficients

TT = type trait

All effects except *TT* are time dependent, *M*, *F* and *P* change each lactation. Only one type trait was included at one time. This has to be kept in mind when interpreting the effects.

3. Results and discussion

The influence of the systematic effects other than type traits was similar as found in other studies before (Egger-Danner, 1993, Ducrocq, 1994) and will not be discussed here. The regressions of length of productive life (more precisely of the hazard of being culled) on type traits are presented in Table 1. For the interpretation of the regression coefficients in Table 1 one has to keep in mind that the dependent variable is the risk to be culled. Positive signs of the regression coefficients mean that the risk is increased, i.e. the longevity of an animal is reduced. Regression coefficients with negative signs mean that longevity is increased.

For the main traits, size and muscularity do not have a significant effect on longevity. Cows ranked higher for form or udder have a decreased culling risk (increased longevity). For udder, the quadratic regression coefficient is also significant, and its sign is positive. In general a positive sign of the quadratic coefficient means that extreme values will have a negative impact on longevity, in the case of the udder score this has the effect that cows being ranked one standard deviation above the mean are expected to live about as long as cows ranked two standard deviations above the mean (see Figure 1 for graphical representation of expected lengths of productive life based on the regression coefficients).

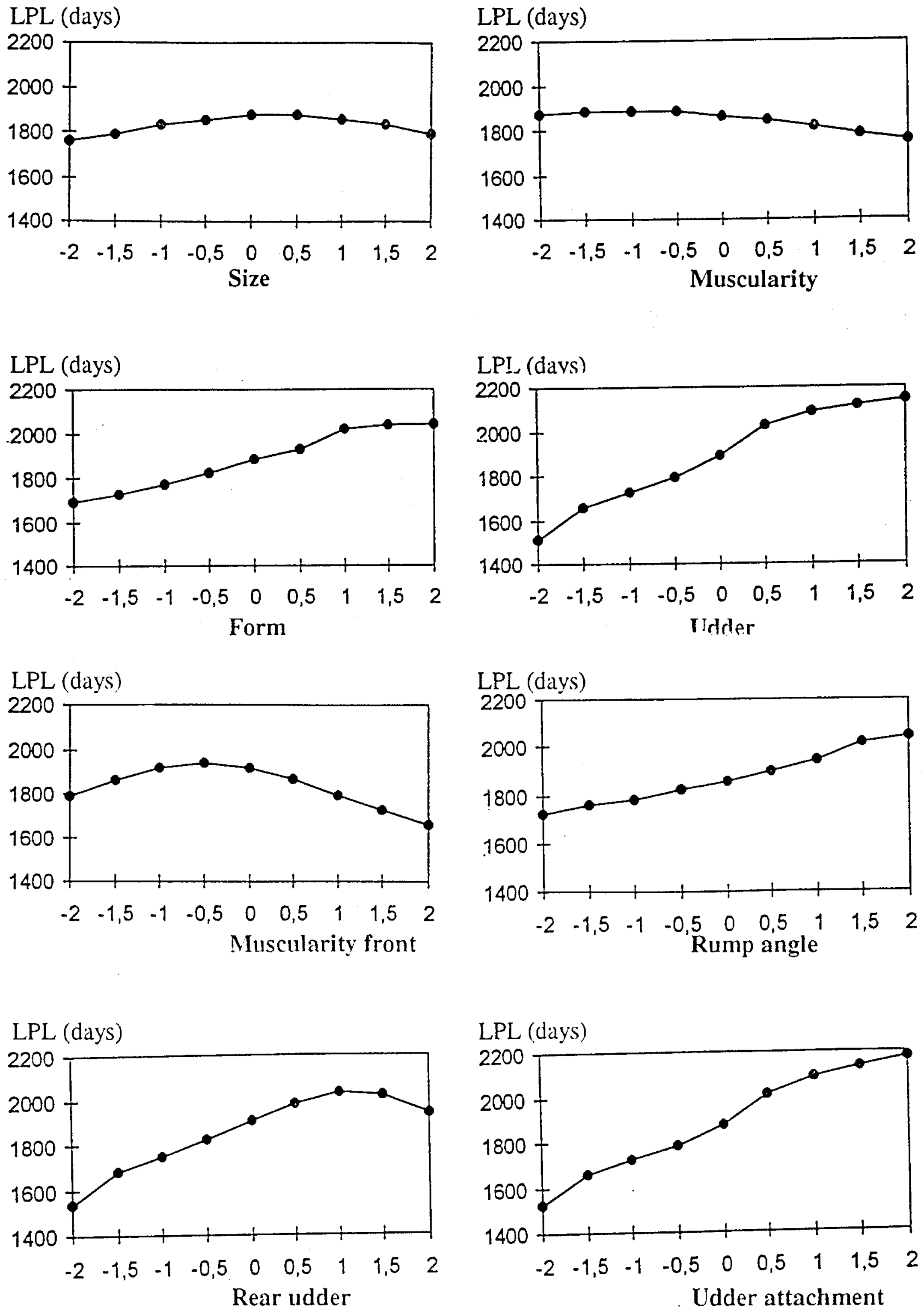
None of the individual size traits has an effect on longevity whereas muscularity of the front part of the body has a negative effect which is more pronounced for extremely muscular types (see Figure 1). About half of the form traits and all of the udder trats have a significant effect on longevity. Higher scores for the udder traits are associated with higher longevity which is due to the definition of classes. Code 9 is in the case of udder always associated with good quality of the udder (e.g. for teat placement code 9 is defined as very correct placement).

In all six cases where the quadratic regression coefficient is significant, its sign is positive. This means that extreme expressions of a trait tend to decrease longevity, or in some cases that no further increase of longevity is to be expected when the trait is approaching the ideal standard (for traits where code 9 is identical with the defined optimum).

Table 1: Means and standard deviations of the type traits and linear and quadratic regression coefficients from the Cox model.

Type trait	Mean	St.Dev.	Regression coefficient	
			linear	Quadratic
Main traits				
Size	6.48	1.21	-.009	.014
Muscularity	5.81	0.90	.029	.015
Form	6.16	0.99	**-.074*****	.016
Udder	6.15	0.99	**-.132*****	**.026***
Size traits				
Height	6.62	1.37	-.007	.008
Length	6.53	1.22	.002	.013
Width	6.06	1.01	.038	.014
Depth	6.53	1.00	-.008	.016
Muscularity traits				
Front	5.63	0.88	**.051***	**.059*****
Mid+Rear	5.86	0.93	.025	.024
Form traits				
Shoulder	6.37	0.99	.000	-.001
Back	6.67	1.02	-.011	-.017
Rump angle	6.43	1.03	**-.055****	.003
Angularity of joint I	7.48	1.06	-.007	.020
Angularity of joint II	6.89	1.28	**-.024****	**.018***
Expression of joint	6.43	0.97	**-.081*****	**.034***
Ankle	6.25	1.12	**-.063*****	-.004
Hoof angle	5.76	0.95	**-.081*****	-.008
Spreading of claws	6.35	0.91	-.033	.013
Udder traits				
Fore udder	6.28	0.88	**-.133*****	**.039***
Rear udder	6.38	0.85	**-.111*****	**.059****
Udder attachment	6.58	0.85	**-.160*****	.024
Teat length	6.53	1.04	**-.056****	.015
Teat placement	6.54	1.10	**-.058****	.014

Figure 1: Graphical representation of the effect of the four main type traits and selected individual traits on length of productive life (LPL). For improved comparability, type traits (x-axis) are standardised with mean of 0 and standard deviation of 1.



4. Conclusions

The results of the study indicate that there is a rather strong phenotypic relationship between some type traits (especially udder traits and some form traits) and length of productive life. Normally they are in the expected direction and when the relationship is nonlinear the curves show also trends that are well interpretable. The probably least expected results is the clear optimum for cows with average or below average muscularity in the front part of the body. As the effect of milk production of a cow relative to the herd mean is in the model this cannot be interpreted as a result of highly muscular cows yielding less milk and therefore being culled for reasons of low milk yield. As the other muscularity scores show the same trend (although not significant) this seems to be some indication for a biological antagonism between muscularity and longevity.

In general one has to be careful though, not to interpret the relationships between type traits and longevity to be caused by biological facts like physiological or functional stability (Brotherstone and Hill, 1991, Essl, 1998). Especially for type traits connected with the udder there is probably also quite strong voluntary culling by farmers who do not want cows with “bad” udders even if no functional deficiency is connected with certain undesired states.

5. References

Brotherstone, S. and W.G. Hill (1991): Dairy herd life in relation to linear type traits and production. 1. Phenotypic and genetic analysis in pedigree type classified herds. 2. Genetic analysis for pedigree and non-pedigree cows. *Anim. Prod.*, 53, 279-287, 289-297.

Collet, D. (1994): Modelling survival data in medical research. Chapman & Hall, London

Cox, D.R. and D. Oakes (1984*): Analysis of survival data*. Chapman and Hall, London.

Dekkers, J.C.M., L.K. Jairath and B.H. Lawrence (1994): Relationships between sire genetic evaluations for conformation and functional herd life of daughters. *J. Dairy Sci*., 77, 844-854.

Ducrocq, V. (1996): Statistical analysis of length of productive life of dairy cows of the Normande breed. *J. Dairy Sci*., 77, 855-863.

Ducrocq, V.P. and J. Sölkner (1998): „The Survival Kit V3.0“, a package for large analyses of survival data. *Proceedings of the 6th World Congress of Genetics Applied to Livestock Production*, Armidale, Australia, 27, 447-448.

Egger-Danner, C. (1993): Zuchtwertschätzung für Merkmale der Langlebigkeit beim Rind mit Methoden der Lebensdaueranalyse. *Doctoral thesis*, Univ. of Agriculture, Vienna.

Essl, A., 1998: Longevity in dairy cattle breeding: a review. *Livest. Prod. Sci*. 57: 79-89.

Everett, R.W., J.R. Keown and E.E. Clapp (1976a): Relationships among type, production and stayability in Holstein sire evolution. *J. Dairy Sci*., 59, 1505-1510.

Gottschalk, A. (1987): Bewertungssystem ’87. *Tierzüchter* 39, 466-468.

Keller, D.S. and F.R. Allaire (1987): Relationships of first lactation milk and type traits to cow survival and sire index for discounted total milk. *J. Dairy Sci*., 70, 2116-2126.

Veerkamp, R.F., W.G. Hill, A.W. Stott, S. Brotherstone and G. Simm (1995): Selection for longevity and yield in dairy cows using transmitting abilities for type and yield. *Anim. Sci*., 61, 189-197.

Vukasinovic, N., J. Moll and N. Künzi (1995): Genetic reletionships among longevity, milk production, and type traits in Swiss Brown cattle. *Livest. Prod. Sci*., 41, 11-18.