Phenotypic relationships between type traits and longevity in New Zealand dairy cattle.

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Introduction

Short herdlife is a larger contributing factor to reduced profitability in dairy herds. The reduced profitability manifests itself through, amongst others, higher replacement costs which are spread out over a shorter time horizon and the inability of a large proportion of cows to reach mature milk yield. Some physical characteristics of an animal are reported to be associated, at both a phenotypic and genetic level, with longevity (Short and Lawlor, 1992; Larroque and Ducrocq, 2001; Schneider et al., 2003). However, most studies are undertaken within dairy production systems that incorporate housing of the cows for a large proportion of the annual production cycle. Also, fewer studies have investigated the relationship between individual cow management traits and eventual/predicted longevity. Additionally, because of the nature of data recording for type traits, phenotypic relationships between type and survival are generally restricted to be within pedigree registered herds which may practice active culling on type thereby biasing subsequent results.

Hence, the objective of the present study was to quantify the relationships between individual type traits and longevity in commercial New Zealand dairy herds where cows generally remain outdoors continuously and are fed primarily grazed grass.

Materials and Methods

Data were extracted from the New Zealand national database on 15th March 2004 on all primiparous cows that were type classified throughout the years 1987 and 2003. In New Zealand, 17 type traits are assessed on a scale of 1 to 9; 4 traits are scored by the dairy farmer (adaptability to the milking routine, speed of milking, temperament and overall farmer opinion) and the remaining 13 by industry trained classifiers primarily from the breed societies (stature, capacity, rump angle, rump width, legs, live-weight, udder support, fore udder attachment, rear udder height, front teat placement, rear teat placement and two composite traits udder overall and dairy conformation). All type traits are described in more detail by Cue et al. (1996). Only the first classification record per cow was retained. The type traits (following re-scaling using the Snell transformation) were pre-adjusted for age at first calving, nested within breed, and stage of lactation at classification. Residuals were standardised within contemporary group of herd-year-season and were subsequently transformed to a qualitative variable with 20 classes: intervals of 0.2 SD between ±1SD, subsequent intervals of 0.5 SD to ±3SD, and two final classes of >|3SD|.

Spring calving cows were considered to be right censored if an official record was available on the cow after the 1st June 2003 and the cow subsequently did not die or was not culled; spring calving cows were cows that calved in the last six months of the year. Similar censoring criteria were applied for autumn calving cows except that the cow had to have an official record after the 1st January 2003; autumn calving cows were cows that calved in the first six months of the year. Animals culled due to low production or moved into unrecorded herds were treated as censored at the time of culling or sale.

Breed was classified as Holstein-Friesian, Jersey or Holstein-Friesian X Jersey crossbreds. Herd-year contemporary groups were created for each cow at each calving. Contemporary groups with less than four non-censored records were removed and the record was coded as censored at the time when the cow entered that contemporary group. Lactation yield deviations for milk, fat and protein (Johnson, 1996) were extracted from the national database for each cow-lactation and were subsequently standardised within contemporary group and converted to a qualitative variable with 20 classes as performed for the type traits. Production values for milk volume, protein yield, fat yield, and live-weight (Harris et al., 1996) were extracted from the animal evaluation database for each individual cow and was divided into deciles.

A qualitative variable (i.e., calving period) with six classes representing intervals of 15 days from the start of the calving season was generated for each herd-year. Each cow received a record for this variable based on her most recent calving. Proportion of genes of each breed and heterosis between crosses was converted to a quantitative variable with 11 levels: 0% and 10 subsequent levels each representing 10 percentage units increments.

Cows that had no information on a type trait were assigned into a separate class for each trait. In total 259,280 cows were included in the analysis. All analyses were undertaken using a proportional hazards Cox model in “The Survival Kit V3.0” (Ducrocq and Solkner, 1998). The hazard function was defined as the baseline hazard function, stratified by breed, times the exponent of the solutions for contemporary group (class variable; time dependent), age at first calving (time independent), heterosis (class variable; time independent), proportion of genes of each breed (class variable; time independent), calving period (class variable; time independent), type trait (class variable; time independent), cow pedigree status (class variable, time independent), production value (class variable; time independent), and lactation deviation (class variable; time dependent). The production values and lactation deviation explanatory variables were only included in the analysis of functional longevity; longevity prior to adjusting for production values and lactation deviation is termed true longevity herein. The significance of effects in the model was tested using the likelihood ratio test between nested models.

Results and Discussion

All type traits had a significant ($P<0.001$) effect on the change in log likelihood (Figure 1). Farmer opinion of the cow in first lactation (scored on average between 90-100 days of lactation) relative to her contemporaries was the most influential of all the type traits on true and functional longevity. The importance of farmer opinion, relative to other type traits, diminished following adjustment of longevity for the relative milk production of the cow. Previous analysis in New Zealand revealed heritability estimates of 0.12 to 0.36 for farmer opinion and moderate to strong genetic correlations between farmer opinion and survival (Cue et al., 1996). The influence of the other farmer scored traits on longevity was similar to those of the classifier scored traits. The two composite traits (udder overall and dairy conformation) also had a large influence on true and functional longevity.

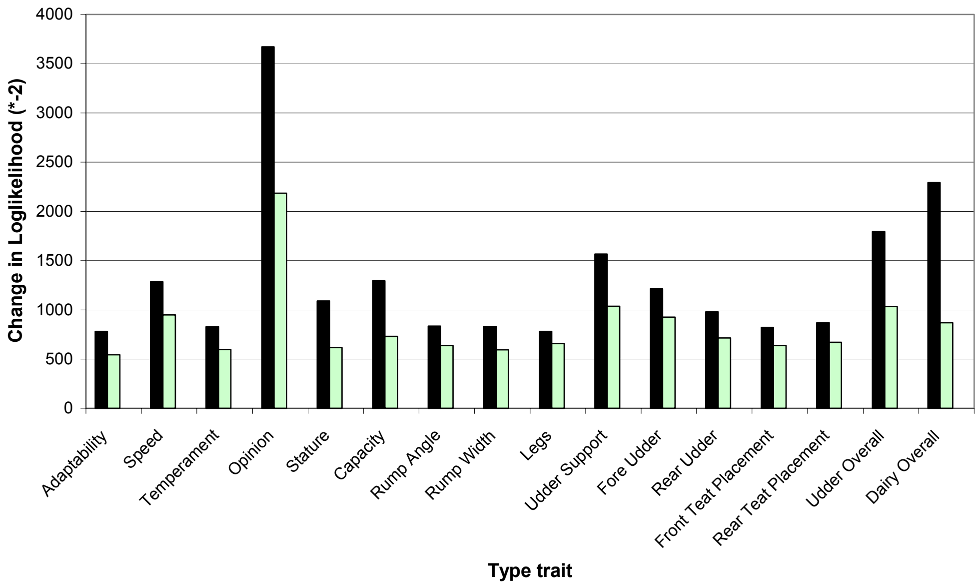

Figure 1. *Contribution of each type trait to the change in log-likelihood for true (■) and functional (□) longevity.*

Of the individual type traits describing the physical characteristics of the cow, the udder related traits had the largest effect on functional longevity agreeing with previous international studies (Short and Lawlor, 1992; Schneider et al., 2003). Of the individual udder traits investigated in the present study, udder support had the largest influence on true and functional longevity. Udder support is sometimes referred to as median suspensory (Schneider et al., 2003), suspensory ligament (Vollema et al., 2000) or udder cleft (Larroque and Ducrocq, 2001) although in New Zealand udder support, also includes an element of udder depth relative to the hocks. Udder support has also been shown in other international studies (Vollema et al., 2000; Larroque and Ducrocq, 2001; Schneider et al., 2003) to be one of the most important udder traits in relation to true and functional longevity along with udder texture. These results suggest that cows with healthy udders are better able to withstand the stress of milk production and remain healthy and fertile thereby persisting in the herd longer. The low relative importance of legs as an indicator of longevity agrees with Larroque and Ducrocq (2001).

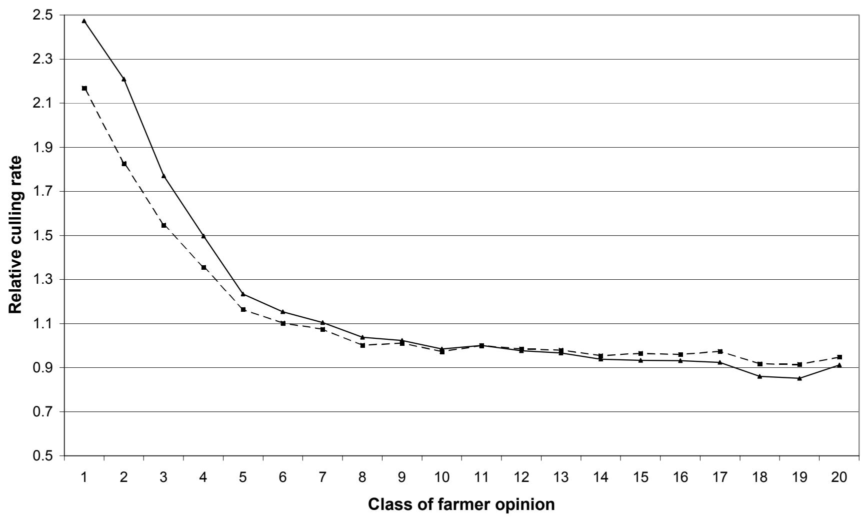

Figure 7. *Relative culling rate across different classes of farmer opinion for true (—▲—) and functional (--■--) longevity.*

The risk of culling for different classes of farmer opinion is shown in Figure 2. This figure is typical of all farmer scored type traits with an observed pattern of diminishing returns as the score increased. Cows in the strongly undesirable classes (>2 SD below the mean) were at a higher risk of being culled compared to cows of intermediate scores, but cows with high scores appeared to confer no additional advantage in their ability to avoid voluntary and involuntary culling.

Based on the relative culling rates for udder overall, cows with a high probability of being culled tended to exhibit lower scores corroborating previous international results on mammary traits (Schneider et al., 2003); similar trends were observed for stature, udder support, fore udder attachment, rear udder height, and dairy conformation. Legs showed an opposite trend with high scoring cows (i.e., more sickled legs) being at greater risk of being culled; this trend was obvious for both true longevity and functional longevity. Legs measured in New Zealand is a similar trait to rear legs, side view or rear legs set reported in some studies (Short and Lawlor, 1992; Larroque and Ducrocq, 2001; Schneider et al., 2003). Capacity, rump angle, rump width and front and rear teat placement exhibited an intermediate optimum with an increased risk of being culled in cows at both extremes.

Conclusions

Farmer opinion of the cow was the most influential of the type traits on true and functional longevity. Previous genetic analysis by others (Cue et al., 1996) suggest a moderate genetic background to the traits with moderate genetic associations with survival. Of the individual type traits describing the physical characteristics of the cow, the udder related traits had the largest effect on functional longevity.

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