Proc. Assoc. Advmt. Anim. Breed. Genet. 18:155-158

CRITERIA FOR SELECTING AND PREDICTING HERDLIFE IN DAIRY CATTLE

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SUMMARY

In dairy production, herdlife is a highly desirable trait with a large effect on overall profitability. In Australia, the measure of herdlife is known as survival index and it is currently based on estimated breeding value (EBV) on udder depth, pin set, overall type and likeability and survival scored as survived or culled (dead) at the end of each lactation. The first objective of this study was to compare differences in survival of daughters of sires of high versus low genetic merit for a selected number of alternative selection criteria. The second objective is to report useful indicator traits that can be used to predict survival breeding value for bulls. Data of over one million cows that calved between 1990 and 2002 and EBV of over 6000 sires were used. Difference in survival of daughters of high vs. low genetic merit was the largest if bulls were categorised by their survival index or their Australian Profit Ranking (the economic index in Australia called the APR) than by their EBV for type or workability traits. Cows from sires with the highest EBVs of mammary system, overall type and likeability showed a slightly better early survival (parity 1 to 2). Late survival of cows (parity 2 to 6) from high EBV bulls for udder depth was higher than those from low EBV bulls. This study also showed that there is a potential to improve prediction of the survival index of young sires by using their EBV on type, workability and somatic cell count compared to the current survival index which is based on type and workability traits. In conclusion, farmers who want to have cows that last longer in their herd should use bulls with high survival index or high APR.

INTRODUCTION

In Australia, currently herdlife accounts for 15% of the total economic index called the Australian profit ranking (APR). The Australian Dairy Herd Improvement Scheme (ADHIS) publishes an estimated breeding value for herdlife called the survival index or ABV which is derived from estimated breeding values (EBV) for udder depth, pin set, overall type and likeability and survival scored as survived or culled (dead) at the end of each lactation. Increasing herdlife would increase the proportion of more mature, higher yielding cows in the herd, increase the opportunity for voluntary culling and reduce replacement costs. However, of all economic traits herdlife is the most difficult to measure because cows should be culled before their herdlife is actually known. The heritability of survival is also low so genetic progress is generally slower than for other dairy traits.

Thus, to improve herdlife through selection, genetic evaluation for type traits was introduced in 1980s and for young bulls, selection for herdlife largely depends on indicator traits which are mainly type traits. In most situations, estimated genetic correlations between type traits and longevity which are assumed to be linear are used to predict herdlife indirectly (Boldman et al. 1992; Vollema et al. 2000). However, few traits have a strictly linear relationship with herdlife and the role of traits with intermediate optima or traits that offer "diminishing returns" as scores increase cannot be evaluated properly using genetic correlations (e.g. Berry *et al.* 2005). Alternatively phenotypic records for indicator traits and actual survival score of cows (Berry *et al.* 2005) can be used to predict herdlife EBVs of sires. The practical application of this method in Australia is limited, because only a small proportion of cows are scored for type traits. Another option for developing prediction equations for herdlife of sires is based on EBV of sires for indicator traits and actual survival data of individual cow (Brotherstone and Hill 1991). In this way data on all sires with reliable EBV for indicator traits and all their progeny with survival score can be used and relations that are not linear can be accommodated.

Because of the historical relationship between type traits and survival, the value attached to some type traits as indirect predictors of herdlife may be greater than is necessary. The first objective of this study is to demonstrate the differences in survival of daughters of sires of high versus low genetic merit for a selected number of indicator traits. The second objective is to present an alternative method for predicting survival EBV (indirect) of bulls from their EBV on different traits and actual survival data of their progeny (cows)**.**

MATERIALS AND METHODS

Data on EBV of Holstein bulls for several traits and actual survival score of their cows were obtained from ADHIS (http://www.adhis.com.au). In the survival data, cows at the end of each lactation were scored as 1 (survived to next lactation) or 0 (culled or died). Cows that calved for the first time between 1990 and 2002 with their milk yield and survival data were included. About 1 million cows which were progeny of ~ 6000 bulls were available for analysis. Bulls selected for these analyses had a reliability of at least 60 % but the average reliability for all bulls was above 90%. The survival data of the cows were merged with the EBV of their sires for all traits.

Table 1. Number cows with survival score and number of sires with high and low genetic merit for type traits, likeability, cell count and survival, APR and ASI of their sires.

Trait	Mean[#] EBV	High genetic merit(EBV or APR) [†]			Low genetic merit(EBV or APR) [‡]		
		No. cows	No. sires	Mean EBV	No. cows	No. sires	Mean EBV
APR	12	31395	96	83	154216	1277	-64
Survival index	100	86743	274	105	272099	1060	96
ASI	9	23782	99	73	140298	1211	-55
Cell count	101	113991	1105	140	93365	991	62
Likeability	100	102098	206	103	166996	1092	96
Udder Depth	100	70128	428	113	153454	535	82
Overall type	101	100427	182	110	103419	1037	90
Mammary system	100	129202	218	109	109183	1068	90

[†]Sire and their progeny in the top 10 % for traits of interest are categorised in the high group;
[‡]Sire and their progeny in the bottom 10 % for traits of interest are categorised in the low group;
[#]Mean for all Holstein bulls in the ADHIS database of Feb. 2008 genetic evaluation.

Survival of cows from low versus high genetic merit. To demonstrate differences in survival ability between progeny of extreme group of sires, cows from the top 10% of the sires were classified as high EBV or APR (referred hereafter as high genetic merit) group and cows from the bottom 10% of sires were classified as low EBVs or APR (referred as low genetic merit) for traits of interest. The number of cows and their sires (with mean) for high versus low genetic merit group is shown in Table 1. Survival of cows in the first 5 parities from sires with high versus low genetic merit for type traits, likeability, cell count, survival index, Australian Selection Index (ASI, calculated from EBV on protein, fat and milk yield) and APR was determined. The y-variable was survival score of cows recorded as 1 or 0 at the end of each parity and the model used to determine difference between the high and low genetic merit included herd-year-season of calving (HYS), age at calving (AFC) and month of calving of the cows. As the objective of these analyses was to point to farmers useful selection criteria for herdlife, the y-variable was survival unadjusted for milk yield.

Indirect predictors of survival. The second set of analyses were performed to derive prediction equations for survival from EBVs for type, workability and cell count and the actual survival record of their progeny. This involved several regression analyses fitting EBV of bulls for predictor traits (as covariate) and HYS, AFC and month of calving of cow. Non-linear relationships (i.e. regressions) were tested by fitting linear and quadratic component of the indicator traits. As the objective when selecting for survival was to reduce involuntarily culling, the y-variable (survival to next lactation) was adjusted for relative production of cows by fitting production index as a covariate in the same model. Finally all EBVs of the predictor traits which had significant (P<0.05) effect on survival when fitted individually were included in the model to get the best possible equation that predicts early survival (from first to second) and late survival (second to sixth parity). As the results of these analyses, two prediction equations one for early and another for late survival were developed.

RESULTS AND DISCUSSION

Survival of cows from low versus high genetic merit. As expected difference in survival score at the end of each lactation between progeny from high and low genetic merit was the largest when sires were categorised based on survival index (Table 2) followed by APR. The survival scores of cows with high sire EBV for mammary system were not statistically different from those with low sire EBV (results not tabulated). In the case of overall type, the difference was significant (P<0.05) in survival from first to second parity (Table 2) only. In the case of likeability, differences were only significant in the first 3 parities. All other differences between low and high genetic merit sires shown in Table 2 were statistically significant (P<0.05).

Table 2. Survival of cows at the end of each parity (%) from sires with high and low genetic merit for survival index, cell count, likeability and udder depth.

Par.	APR		Survival index		Cell count		Likeability		Udder depth		Overall type	
	Top	Last	Top	Last	Top	Last	Top	Last	Top	Last	Top	Last
1	85	80	86	79	82	80	85	80	83	81	85	83
2	84	79	85	78	82	79	83	80	82	80	83	83
3	81	77	83	76	80	77	80	78	81	78	81	80
4	79	73	79	72	77	72	76	75	76	73	76	76
5	76	67	75	66	71	67	70	70	71	67	74	72

Difference between survival score of cows from high vs. low EBV sires increased with increase in parity when sires were categorised by their EBV for udder depth (Table 2). In the case of likeability, ASI (results not tabulated) and overall type, for which voluntary culling is practiced, differences between progeny of low and high EBV sires were larger in the first parity (early survival) than in later parities. Among the currently used predictors in survival index, udder depth followed by likeability were the most important traits associated with differences in survival of cows from high EBV versus low EBV sires were observed (Table 2). The results show the consequence of selecting the top or bottom bulls for a number of traits on the longevity of their progeny. Type traits like overall type and mammary system which are highly valued by some farmers are not necessarily good at predicting survival of cows.

Indirect predictors of survival. EBV on udder depth, overall type, likeability, somatic cell count, pin set and milking speed had positive effect on early survival (parity 1 to 2) whereas the effect of angularity and foot angle was negative. These traits can be used as indirect predictors of early survival. Survival in later parities were positively affected by EBV on udder depth, overall type, likeability, somatic cell count, pin set and teat length and negatively affected by rear attachment height and angularity. In addition in both early and late survival, the relationship between body depth EBV and actual survival was non-linear where cows from intermediate sires have a better survival than cows from high or low EBV bulls and these effects were also considered when deriving the two prediction equations, one for early and one for late survival. These two equations can be combined to predicted survival BV for a bull.

The simple correlation between the official survival index from ADHIS and the indirectly predicted survival value calculated using the equations from the current study for bulls that had over 100 progeny that calved after 2002 for the first time was 0.76 and 0.81, when the equation from early and late survival were used for prediction, respectively. The corresponding correlation value when the ADHIS equation based on overall type, udder depth, pin set and likeability was applied was slightly lower at 0.61.This shows that there is a potential to improve the prediction of the survival index of young bulls by using their EBV on type, workability and somatic cell count. However, selection against angularity may not be popular so farmers need to be convinced about the usefulness of the set of predictors suggested,

In conclusion, the largest difference in survival of daughters was observed if bulls were categorised by their survival index or their APR into low and high genetic merit group than by their EBV for type or workability traits. The value of individual type traits such as overall type and mammary system in predicting survival is rather small. The study also showed that there is a potential to improve prediction of survival of bulls by using separate equations based on combination of type, workability and somatic cell for predicting early and late survival. However, before these prediction equations are recommended for wider use extensive validation and then extension work to convince the industry on the value of selecting against some type traits such as angularity to improve herdlife is necessary.

ACKNOWLEDGEMENTS

This research is funded by Dairy Australia and Victorian Department of Primary Industries. We thank ADHIS for providing the data and Dr Kevin Beard for data extraction.

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