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UPDATES TO THE NEW ZEALAND NATIONAL BREEDING OBJECTIVE FOR DAIRY CATTLE

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SUMMARY

The National Breeding Objective for dairy cattle in New Zealand expressed as a genetic selection index called Breeding Worth (BW), assesses sire and cow genetic merit now and sets the direction for the New Zealand cow of the future. A major review of the calculations of the economic weightings that underpin the index has recently been undertaken. A modified approach to the costing of feed had only a modest impact on existing traits in the index, but opens up opportunities to calculate economic values for traits which shift feed requirements from one season to another. Such traits include autumn body condition score and lactation persistency. A further major change to the index related to assumptions about the farmer response to shifts in herd genetic merit for survival. Historically, lower survival was assumed to result in lower voluntary culling, whereas the new model assumes that lower survival will lead to an increased requirement to breed replacement heifers. As a consequence, the economic values for residual survival, fertility, and to a lesser extent somatic cell score have increased substantially. These changes have been generally well received in the industry and have led to noticeable impacts on rankings of AI sires.

INTRODUCTION

The New Zealand dairy industry is supported by a co-ordinated, integrated and comprehensive data recording and genetic evaluation system. New Zealand dairy farmers rely on independent evaluations encapsulated in the breeding worth (BW) of sires The National Breeding Objective which is to "identify animals whose progeny will be the most efficient converters of feed into farm profit" is expressed as Breeding Worth (BW) and is managed by New Zealand Animal Evaluation Limited (NZAEL) a subsidiary of DairyNZ. This paper describes the outcomes of a major review and development of the economic models to calculate economic values, as well as the practical implications for sire rankings and farmer selection decisions.

METHODS

A completely new set of models was developed for computing economic values used in the BW formulation. For milk yield traits, largely similar sets of assumptions and equations were used as in the previous model (Harris 1998). The cost of feed was modelled quite differently in the new approach (i.e. based on the models described by Chapman *et al.* (2012) for ranking forages), but despite this, new economic values for milk component yield and milk volume traits were very similar to those from the historic model. For as many inputs as practical, five year rolling averages of historic values were used as the model inputs. This was particularly relevant for the assumption about the relative value of protein versus fat, where this ratio has been highly variable over time, and the five year average avoided too much impact of very old and less relevant payments, while still evening out some short term fluctuations. In order to keep the economic values in strict concordance with the philosophy of improving the efficient conversion of feed into profit, a rescaling methodology was applied to all of the economic values affecting per animal feed requirements. Any trait that increased the amount of feed required per cow on the home farm (commonly referred to as the milking platform) received a penalty under the assumption of a proportional reduction in stocking rate and therefore a loss of per cow profitability. There were three components to the economic value of milk volume which accounted for the volume charges associated with milk collection under the Fonterra payment system including a net effect of a peak season supply premium, the feed costs associated with milk lactose content which is very closely linked to milk volume, and an adjustment for the fact that high milk yielding cows have higher mastitis.

The economic value of live weight was computed using methodology that we had previously applied in breeding objective developments for many other livestock farming systems (e.g. Amer *et al.* 2001). Four independent components of the live weight economic value were calculated, each with separate discounted genetics expressions coefficients (e.g. Berry *et al.* 2006) to account for different timing and frequency of trait expression. The four live weight economic value components were bobby calf revenue, heifer rearing costs, annual cow maintenance feed requirements, and cull cow carcase value. Pricing schemes for bobby calf and cull cow values took account of both average per kg payment values, but also price premiums for heavier weight bands. Feed costs for heifer replacements used opportunity costs of feed on sheep and beef farms assuming contract heifer rearing costs off the home farm that would be directly proportional to the feed requirements of the animals. Similarly, dry cow feed costs assumed that all dry cows in the South Island would be fed on support blocks with lower opportunity costs of feed than occur on the milking platform.

The rationale for the economic value of Cow Survival was changed with a new assumption that lower survival would result in higher herd replacement heifer costs, and a higher proportion of younger cows in the herd which tend to be less profitable than mature cows due to lower milk yields. The previous rationale was that lower survival would result in less voluntary culling.

The somatic cell score economic value had three components, namely, a bulk tank penalty associated with milk processor charges when bulk tank average cell counts exceed thresholds which invoke price penalties, an account for the relationship between somatic cell score and cow survival, and a further relationship in the link between higher somatic cell counts in individual cows and their incidence of mastitis. Bulk tank penalties were modelled using aggregations of whole herd test results for somatic cell count to generate a distribution of bulk tank readings by region and farm. A certain proportion of farms capture price penalties which can be then translated into an average price penalty per litre of milk under this base level of somatic cell count. The same calculation was then undertaken to work out what the average price penalty per litre would be if all cows increased their somatic cell score by a single unit. The impact of somatic cell score on cow survival was quantified using a genetic regression coefficient derived from variance component estimates available from the New Zealand national genetic evaluation system. A corresponding genetic regression coefficient for clinical mastitis on somatic cell score was derived using a combination of values available in New Zealand, and values from the international literature, as no genetic evaluation currently exists for mastitis in the New Zealand system.

The three components which made up the final economic weight for fertility accounted for lost milk due to late calving, reduced survival due to culling on poor fertility, and lost premium value on heifer calves bred by AI. While late calving cows tend to have a truncated lactation curve when it is assumed that the whole herd is dried off on a constant date, the shape of the lactation curve is also influenced by calving date, with earlier calving cows tending to have a lower peak than late calving cows. The effect of poor fertility on reduced survival was quantified using a genetic regression coefficient derived from variance component estimates available from the New Zealand national genetic evaluation system. Cows that calve earlier also have a greater chance than their later calving counterparts of producing high value replacements or high value beef calves that can then be sold. There is currently a market price differential between recorded, artificially bred (AB) heifer calves, and those that are unrecorded reflecting the superior genetic merit and scarcity value of recorded AB calves. This differential equates to a range between $350 to $400 per calf. Discounted genetic expressions coefficients were used to combine component economic values expressed in different animal classes (replacements, lactating cows vs cull cows) into a per lactating cow basis.

RESULTS

The results from the new model and corresponding assumptions led to a set of economic values for the Breeding Worth calculation as shown in Table 1. Milk protein has a much higher relative economic value than fat, reflecting both the relative price of fat in the market, and also the higher feed costs associated with the relatively energy dense milk fat component. While in absolute terms, the penalty for milk volume appears modest, this trait has a very high genetic standard deviation because of its units (litres), and in practice has a significant influence on bull and breed rankings. The feed cost associated with the lactose component of milk volume is a major contributor to the penalty, although volume charges applied by milk processors to cover trucking and processing costs of raw milk were also significant.

Both higher maintenance costs for the herd, and higher heifer rearing costs associated with increased live weight breeding value contributed in roughly equal proportions to the live weight breeding value. The higher revenues from bobby calf and cull cow sales only offset approximately 25% of the feed costs for larger cows and heifers.

The economic value of cow survival ($0.148 per day of average herd life in Table 1) represents a substantial increase on the economic value used previously ($0.048 per day). This further resulted in a modest increase in the economic value of somatic cell score, and a substantial increase in the economic value of fertility, as the impact of fertility on cow survival is a significant component of the overall economic value of fertility, whereas bulk tank penalties are a significant component of the economic value of somatic cell score.

In summary, the economic values for milk protein, milk volume and live weight have all changed by less than 3%. The economic value of milk fat has dropped by 7% while the economic values of survival, somatic cell score, and fertility have increased in magnitude by 200%, 20% and 135% respectively.

IMPLICATIONS

The correlation across all bulls with a minimum reliability for the index of 75% was 0.974 between the new index and the index used in 2012. The new index had moderate positive effects on breed averages (BW Reliability > 75%) for Jersey (+$9.20) and Kiwi Cross (+$5.00), but resulted in a lower average BW for Friesian (-$12.40), Aryshire (-$10.06) and Other (-$19.20) largely due to the increased emphasis on fertility. The new index also changed the breed representation in the top 100 bulls, 41 were Friesian (previously 45), 28 were Jersey (previously 23) and 31 were Kiwi Cross (previously 32). While the correlations between the new index and the old index appear high, significant shifts in rankings among the top AI bulls have been observed in practice. In particular, some bulls which are favourable for high production and live weight but weaker for fertility and survival have dropped substantially in their ranking. In general, there has been a high level of industry acceptance of the new index.

Table 1. Summary table detailing the calculation of economic weights for the new national breeding objective for the New Zealand dairy industry[1]

Trait (units)	Economic value ($/unit change)	Genetic regression	Discounted genetic expressions	Component economic weight ($/unit change)	Aggregated economic weight ($/unit change)	2012 BW
Milk Fat (kg)	**1.79**	**1.00**	**1.00**	**1.79**	**1.79**	**1.92**
Milk Protein (kg)	**8.63**	**1.00**	**1.00**	**8.63**	**8.63**	**8.69**
Milk Volume (litres)					**-0.091**	**-0.094**
Volume charge component	-0.038	1.00	1.00	-0.038		
Lactose feed cost component	-1.032	0.049	1.00	-0.051		
Mastitis component	-86.32	0.00002618	1.00	-0.002		
Live weight (kg)					**-1.52**	**-1.48**
Cow maintenance component	-1.16	1.00	1.00	-1.16		
Bobby calf value component	0.34	1.00	0.67	0.23		
Heifer replacement feed costs	-3.17	1.00	0.27	-0.86		
Cull cow carcase value component	1.51	1.00	0.18	0.27		
Cow Survival (days of average herd age)	**0.82**	**1.00**	**0.18**	**0.148**	**0.148**	**0.048**
Somatic cell score (log cells/ml)					**-38.57**	**-31.46**
Bulk tank penalty	-24.03	1.00	1.00	-24.03		
Survival component	0.82	-65.129	0.18	-9.62		
Mastitis component	-86.32	0.057	1.00	-4.92		
Fertility (% calving in first 42 days)					**7.35**	**3.12**
Lost milk component	1.84	1.00	1.00	1.84		
Survival component	0.82	27.847	0.18	4.11		
AB heifer calf premium component	1.41	1.00	1.00	1.41		

[1]Economic values give the change in dairy farm gross margins per industry average animal that expresses the trait. Bold font traits reflect traits for which economic weighting get applied in the index. Normal font traits are component traits for which economic values have been calculated for convenience, but their impact on the NBO comes either through aggregation of components or through their genetic relationship with other traits. Genetic regressions are of component traits on profit traits and explicitly account for the genetic relationships between the traits that capture the final weighting in the index and component traits. Discounted genetic expressions coefficients account for the fact that the expressions of some traits and their components comes with different timing and frequency of expression and this needs to be accounted for in the index formulation.

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