Calculation of the Economic Weight for Somatic Cell Count for Inclusion in the New Zealand Dairy Cattle Breeding Objective

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1. Introduction

In New Zealand (NZ) we are currently in the process of developing somatic cell count (SCC) breeding values for the dairy industry. The decision on whether to include SCC as a seventh trait in NZ's national breeding objective, Breeding Worth (BW), depends on the economic value (EV) of SCC. The SCC can affect profitability indirectly through culling and directly through factors like treatment for udder infection and penalties imposed on milk with high SCC. The purpose of this study was to determine the EV of the direct effect of SCC on profitability. This was done by determining the association between SCC and each of five factors that have an impact on farm profitability: need for dry cow therapy, incidence of clinical mastitis, penalties for milk with high SCC, lost days in milk due to early drying off, and probability of inhibitory substances in milk.

The New Zealand (NZ) dairy industry is based on a pastoral system where calving is concentrated in July and August so that peak milk production coincides with peak grass growth. Each season, which starts in June and finishes in May, is referred to by the year the calving occurred. Herd testing for milk, fat, protein and SCC is generally done bimonthly so that most cows are tested between three to four times per season. The days in milk (DIM) at the last herd test is approximately 220. For genetic evaluation the records are extended to 270 DIM. Routine recording of mastitis is not part of the NZ milk recording system.

2. Materials and Methods

2.1. Calculation of Economic Value

The economic weight for each trait in the NZ national breeding objective represents the net income (in NZ dollars), per unit of expression, per 4.5 tonne (t) of dry matter (DM) (the average intake of the base cow) from breeding replacements (Harris, 1998). Income and costs were derived for the average NZ farm (currently 270 cows) using average proportions of cows in the herd aged two to nine years at calving. For this study, the association between each of the five factors investigated and SCC was calculated for the base (current) SCC levels. The direct costs for the average farm were calculated using price information for the industry. By way of illustration, each SCC reading (either individual cow or bulk tank, see below) was deviated from -10% to +10% of its base value and the cost associated with each percentage change in SCC was calculated for the average farm. The contribution of each of the five factors to the EV of SCC was calculated as the difference in the net income per 4.5 t of DM for a percentage change in SCC. Because the breeding values are calculated using log transformed data, the final EV is expressed in dollars per 4.5 t of DM per log SCC.

2.2. Data

The SCC data were either individual cow SCC (ICSCC) records or bulk tank SCC (BTSCC) readings. ICSCC were obtained from herd test (HT) data. HT data from season 1998 collected on 831,056 cows that averaged 3.3 herd tests was used for this study. Data on bulk tank (BT) shipments from 6338 farms in season 2000 were obtained from New Zealand Milk Products. The data contained information on consignment date, quantity of milk shipped, BTSCC reading, and results of tests for inhibitory substances in the milk. The average number of farm pickups was 224 (range: 95 to 310). The average consignment length (CL) (number of days between first and last consignment within a herd) was 284 days (range 183 to 320). Demerit points are given to shipments of bulk milk that have a high SCC or contain inhibitory substances. Each demerit point results in a 5% penalty that is applied to the volume of milk of the penalised consignment. Costs associated with demerits points were based on a payment of 29 cents per litre of milk.

2.3. Dry Cow Therapy

Dry cow therapy (DCT) is recommended when the ICSCC exceeds a specified threshold at any herd test in the preceding lactation (Anonymous, 2003). The ICSCC thresholds are 120,000 cells/ml for first lactation cows and 150,000 cells/ml for older cows. The objective of this analysis was to obtain a prediction of the requirement for DCT as a function of ICSCC during the preceding lactation. The HT data were used for this analysis. The prediction was developed as a function of days in milk (DIM) using parametric survival analysis assuming a Weibull distribution. The only predictor in the model was age of cow at calving, modelled as a classification variable. The 'event' was the first occurrence of exceeding the threshold for DCT during the lactation. Survival was defined as not exceeding the threshold for DCT. HT information collected from 10 to 270 DIM was included in this study. If the cow did not exceed the threshold by 270 DIM, the record was considered to be censored at the time of her last herd test. The cost of DCT, attributed to antibiotics and labour, was $16.00 per cow.

2.4. Clinical Mastitis

Episodes of clinical mastitis (CM) are associated with elevated ICSCCs. Thresholds of test day ICSCC from which a case of CM might be inferred can be constructed. For this analysis, thresholds were inferred by calculating the percentile of the ICSCC that resulted in the incidence rate reported in the NZ dairy industry (McDougall, 2002). The incidence rate, reported by month, was 13.03% over nine months. The lactation was divided into four 60-day intervals and one 30-day interval thus representing the 270-day lactation using 5 discrete categories to represent stage of lactation. The incidence of CM in the first 60-day interval was taken as that reported for the first two months of the season (July and August) and so on with the last category of 30 days corresponding to incidence rate reported for March. Separate thresholds were determined within each age. The cost associated with a case of CM was $54 per cow, which includes labour, discarded milk and antibiotics.

2.5. Penalty for high SCC Milk

One cost associated with high SCC is the penalty imposed by dairy companies when the BTSCC exceeds specified thresholds. In NZ, demerit points are assigned starting at 400,000 cells per ml of milk. The financial impact of these penalties were calculated using the BT data.

2.6. Lost Days in Milk

With seasonal calving, the BTSCC lactation curve closely resembles that of the individual cow's lactation curve. Therefore, towards the end of the season, the BTSCC may approach the threshold at which a penalty is applied. To avoid the penalty, farmers dry off the entire herd when the BTSCC is near threshold for the penalty, thus decreasing the CL of the herd. The shortened CL reduces the amount of milk sold by the farm. The purpose of this work was to determine the association between the end-of-season (EOS) BTSCC and the CL and to estimate the amount of milk that was not shipped (sold) in cases where the period was deemed to be shortened by high BTSCC. The BT data were used to study this relationship. EOS was defined as the last 21 days of the consignment period within each farm. The effect of EOS BTSCC on CL was determined using linear regression. No information was available on the farm's feed supply at the end of season, or on per-cow yield and condition score at that time. These factors affect drying off decisions. Consequently a proxy for these factors, to be used as a predictor in the model, was constructed. The proxy was the ratio of average daily milk production at EOS to average daily milk production during the peak of the season (last 11 days of October). In order to quantify the lost milk, an estimate of the bulk milk lactation curve is needed. The curve was estimated by fitting a cubic smoothing spline on day of consignment.

2.7. Inhibitory Substances

Treating udder infections involves infusion of the infected quarters with antibiotics. In order to prevent contamination of the milk supply with inhibitory substances, there is a withholding period for the milk of cows that have been treated with antibiotics. On occasion, milk from recently treated cows is inadvertently added to the bulk tank. Because an elevated ICSCC is a sign of udder infection, it is plausible that there is an association between the BTSCC and the presence of an inhibitory substance in the milk as a result of treating the infection. The objective of this analysis was to develop a predictive relationship between BTSCC and the presence inhibitory in the milk. The BT data were used. The bulk tank somatic cell score (BTSCS) was calculated as the log transformed (base 10) BTSCC. The farm level BTSCS was calculated as the mean BTSCS weighted for the volume of milk shipped in each consignment. The presence of an inhibitory substance in the milk was coded as a binary variable, being 1 if a farm recorded any positive result throughout the season and 0 otherwise. The effect of BTSCS and CL on the probability of an inhibitory substance in the milk was estimated using logistic regression. CL was also included as a predictor in the model.

3. Results and Discussion

3.1. Dry Cow Therapy

By 270 DIM, 49% of cows were uncensored (i.e. had an ICSCC that exceeded the threshold indicating the need for DCT). Two-year-old cows had the lowest incidence of uncensored data (40%) and 9-year-old cows had the highest incidence of uncensored data (70%). The probability of reaching the threshold for DCT increased with increasing DIM. The probability of not needing DCT by 220 DIM (average DIM at last herd test) ranged from 56% for 2 year olds to 23% in the 9 year olds. The cost of DCT on the average farm was calculated to be $2300.

3.2. Clinical Mastitis

The inferred thresholds increased with increasing age and stage of lactation. In the 2-year-old cows, the thresholds ranged from 248 in the first 60-day period to 1583 in the last 30-day period of the lactation. Analogous thresholds were 286 and 1997 for the 4-year-old cows and 524 and 2862 for the 6-year-old cows. The cost of treating CM on the average 270-cow farm was $1833.

3.3 Penalty for high SCC Milk

The average penalty for high SCC in the BT data was $158 (range $0 to $18,000).

3.4 Lost Days in Milk

The fitted curve of CL was obtained using the estimates of the linear regression equation. The relationship showed that when EOS BTSCS exceeded 5.36 (a BTSCC of 229,000), increasing EOS BTSCS is associated with a decreased CL. A total of 4854 herds had an EOS BTSCS that exceeded this level. The predicted CL at an EOS BTSCS of 5.36 was 285.3. The predicted average loss in CL over all 6338 herds was 0.96 days. The predicted values of the bulk milk lactation curve obtained from the cubic spline were used to calculate the lost milk production associated with decreased CL. The volume was approximated by the trapezium defined by the milk production at a CL of 285.3 and the reduced CL. The average lost milk over all 6338 farms was 1556 litres, which is 0.15% of the average farm production.

3.5 Inhibitory Substances

The analysis revealed that there was positive relationship between average weighted BTSCS and the probability of incurring a positive test for inhibitory substances in the milk.

3.6 Economic Value

Table 1 contains the difference in net income for each factor per 4.5 t DM between a 10% increase and a 10% decrease in SCC. The relative contribution of each factor to the EV for SCC is also shown. The costs associated with clinical mastitis had the highest relative contribution to the EV and the penalties associated with the presence of inhibitory substances in milk had the lowest relative contribution. The EV of SCC was -$52.9/log SCC (SCS). The relative effective weight of SCS in New Zealand's Breeding Worth (total merit index) is likely to be approximately 5% based on the relationships investigated in this study.

Table 1. Difference in net income between a 10% increase and a 10% decrease in the SCC.

Factor	$[1]	%[2]
Dry cow therapy	1.18	24.5
Clinical mastitis	1.59	33.0
Penalties for SCC	1.06	22.0
Lost days in milk	0.86	17.9
Inhibitory substances	0.13	2.6

[1] Per 4.5 t DM
[2] relative contribution (%)

4. Conclusions

The study has shown that the economic weight of SCC is of sufficient magnitude to warrant inclusion in the national breeding objective.

References

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