ECONOMIC VALUES OF TRAITS FOR SELECTION IN DAIRY CATTLE

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INTRODUCTION

Genetic improvement of dairy cattle *via* the use of selection indices requires a knowledge of the economic values for each of the component traits. Hazel and Lush (1942) define the economic value of a trait as the improvement in profitability resulting from a unit genetic improvement in a given trait, all other traits being held constant. This corresponds to the regression of profit on Breeding Value. The Québec milk recording programme records, on a per-cow basis, milk value and feed costs for each lactation (i.e. margin over feed costs), which leads to the idea of empirically estimating economic values of traits by regressing lifetime profitability on their Estimated Breeding Values. This approach cannot be used for 'what if' evaluations of future scenarios; however, it can provide a verification of bio-economically modeled economic values and it also has the advantage of implicitly incorporating any interactions of production with such traits as reproduction, calving interval and offsetting management factors. Thus the objectives of this study were to examine whether the economic values used for dairy cattle selection in Canada are the same for Officially supervised herds and for non-supervised Owner-Sampler herds (O/S), and whether the same economic values are appropriate for Holstein and Ayrshire breeds.

MATERIALS AND METHODS

Data. Test-day records, for the period 1980 to 1995 inclusive, for cows calving prior to 1990, were extracted from the Programme d'Analyse des Troupeaux Laitiers du Québec (PATLQ) database and lactation record margin over feed costs (gross profit) were constructed. An average (per year) insemination/breeding cost of each breeding was subtracted from the lactation gross profit to account for effects of reproductive success/conception rates and any effects of production on reproduction. Lactation gross profits were summed over all lactations of each cow to produce a 'lifetime profit' per cow, to which was added an assigned salvage value based on the last recorded weight of the cow. Lifetime profit records were then merged with Estimated Breeding Values (EBV's) obtained from the Canadian Dairy Network (CDN). Herd-year-seasons (of first calving) had to have at least 2 heifers calving for the records to be retained. There were 84654 Holstein records and 9931 Ayrshire records. Because payment for protein was only introduced in Québec in the summer of 1992 and hence only some cows received payment based on their protein value, EBV for protein was excluded from these lifetime analyses. Because of the length of time that these data cover, profits were converted to a constant 1995 dollar basis. van Arendonk (1991) has shown the need to adjust for Opportunity Cost, so each cow's lifetime profitability was reduced by an Opportunity Cost calculated as per De Haan et al (1992). A more detailed explanation of all the steps in these lifetime profit calculations is given by St-Onge (2000) in an initial study using a subset of the type and production traits.

Statistical analyses. Data were analysed separately for Holsteins and Ayrshires using SAS

PROC MIXED and fitted recording option (Official supervised vs Unofficial Owner-Sampler), EBV's and the interaction of recording option with each of the EBV's as fixed effects and herd-year-season of first calving as a random, repeated measures effect. Where the interaction between recording option and EBV was significant the main effect regression term was dropped to leave separate regression coefficients for each recording option. Correspondingly, where the interaction was not statistically significant it was dropped to leave a pooled overall regression effect.

RESULTS AND DISCUSSION

Estimates for the economic values, per unit EBV and on a standardised, relative basis, for Holsteins are shown in Table 1 and for Ayrshires in Table 2. The per unit EBV economic values are simply the regression coefficients from PROC MIXED and are in units of the respective EBV's, for example kg of milk and kg of fat.

Table 1. Economic values, per unit EBV and relative, standardised, for the Holstein breed

	Economic values per unit EBV			Economic values, relative, standardised		
Trait	O/S	Official	Pooled	O/S	Official	Pooled
Milk	.94	1.02		3.1	3.3	
Fat	25.83	21.22		3.0	2.4	
Capacity	-25.41	-6.47		-0.6	-0.2	
Herd life			97.21			0.6
Mam. System	5.66	19.98		0.1	0.5	
Feet & legs			30.55			0.6
SCC	-987.52	-745.13		-0.9	-0.7	
Udder depth			10.03			0.1
Persistency			14.52			0.2
Conformation	4.42	7.71		0.8	1.3	
Model R^2 (%) = 32.04						

For Holsteins there were some traits where the economic values were significantly different between Official and Owner-Sampler herds (milk, fat, capacity, mammary system, somatic cell count and overall conformation), whilst for the Ayrshire breed there were no significant differences for the economic values between the recording options; however, it should be noted that there were only about 10% as many Ayrshires as Holstein records, and hence the smaller sample size should be considered when interpreting these results. For Holsteins, the relative economic values of milk and fat were approximately 30%. Capacity had a negative value for both Official and Owner-Sampler herds, but a greater negative value (-.6) in Owner-Sampler herds. This negative value can be explained as follows: for 2 cows with the same genetic potential for production of milk and fat (revenue), the cow which is larger (greater capacity) will have a larger feed maintenance cost and hence will be less profitable. We are not saying that one should select to reduce cow size, nor that cows are too big; only that bigger cows *per* *se* are not warranted. They have to produce more production than their extra costs. We are simply suggesting a brake on an irrational exuberance for large size without regard to its extra costs. The small positive value for herd life is interesting in that it indicates a value for increasing herd life even for cows of equal genetic potential for production, and also over and above the adjustment for Opportunity Cost. The type traits (feet and legs, mammary stem, udder depth and overall conformation) all had small positive relative economic values. Somatic cell count had a similar, but negative, relative economic value; the sign of this is in line with what one would expect/hope, higher EBV for SCC giving a lower lifetime profit, presumably *via* it's impact on production, since there is no current per-cow value for high or low SCC (only bulk tank limits on quality). Cows with EBV's for higher persistency had greater overall lifetime profitability. For Ayrshires, the relative economic values for milk and fat yields were similar to those of Holsteins. Perhaps surprisingly the economic value of capacity (size) was positive and mammary system and persistency had negative economic values. The economic values of somatic cell count and feet and legs were similar for both Holsteins and Ayrshires. In contrast, the value of herdlife was approximately 3 times as great for Ayrshires as for Holsteins. A potential explanation for the difference in sign for the economic value of capacity between Holsteins and Ayrshires may relate to their respective diets. Moore et al (1992) noted that Holstein cows tend to receive a diet considerably higher in concentrates whereas Ayrshire cows receive diets with a greater proportion of roughage. This could therefore give an advantage to greater size in Ayrshires in as much as it might enable a sufficiently larger feed intake to sufficiently increase production to more than outway the extra maintenance feed costs.

Table 2. Economic values, per unit EBV and relative, standardised, for the Ayrshire breed

Trait	Economic values per unit EBV	Economic values relative, standardised
Milk	1.46	3.1
Fat	30.84	2.4
Capacity	40.52	0.8
Herd life	244.48	1.74
Feet & legs	35.93	0.6
Mammary System	-19.72	-0.3
Persistency	-27.49	-0.4
SCC	-662.29	-0.7
Model R^2 (%) = 33.66		

This concept, of empirically estimating economic values by regressing profit on EBV's, could be equally applied to other species, for example swine; most recording programmes for pigs provide the capability to record feed consumptions and to track groups of pigs. Thus it would be possible to use this concept at the level of the F_1 productive sow to measure her lifetime feed consumption, that of her growing and fattening offspring and then their carcase sale value and hence obtain a lifetime profit per sow. Potentially, the concept could be used to measure purebred and crossbred animals and hence obtain empirical estimates of the value of heterosis effects.

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