

Effect of Recent Changes in the Genetic Evaluation of Dairy Cattle Production Traits in Ireland

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Introduction

The ranking of bulls for overall genetic merit in the Republic of Ireland is based on a Relative Breeding Index (RBI). This is a production index derived from the predicted differences (PD) obtained from the estimated breeding values for milk, fat and protein yields (kg) as well as protein percentage. Until recently, EBVs for milk, fat and protein yields were calculated according to the procedures described by Wiggans *et al.* (1988). Records were pre-adjusted for the effects of parity, calving age, calving period, calving interval (previous and subsequent), heterosis effect, and the level of variation within herds. The effects of management group, herd by sire interaction, permanent environment as well and the animal were included in the model. EBVs were calculated once a year based on lactation yields for cows which dry off naturally after a minimum of 150 days in milk or which were culled for other reasons after 200 days in milk. This practice of once yearly genetic evaluations and the exclusion of records in progress limited the number of cows evaluated each year, reduced the accuracy of bull evaluations and delayed the availability of progeny test results.

Two projects were commissioned by the Irish Cattle Breeding Federation (ICBF) in 1999 to address the problems leading to the above practice. These were aimed at (1) developing a method of projecting lactation records in progress (Olori and Galesloot, 1999) and (2) updating the procedure for breeding value estimation to accommodate records in progress (RIP) and facilitate more frequent evaluation (Olori and Jong de, 1999). This paper briefly describes the new genetic evaluation procedure, as introduced in February 2000, and results of a test comparing the old and new methods.

An overview of the new procedure

Production records and data pre-correction

The production record comprise of a standard 305-day yields obtained from completed and progressing lactations. The standard yield is calculated from test day records, by the method of interpolation with standard lactation curves (ISCL) (Olori and Galesloot, 1999). Records from lactations with a minimum length of 150 days are included in the analysis for breeding value estimation while records with a minimum length of 60 days are included only if the cow has been culled. Records from cows calving before 640 days in age are discarded. The 305-day yield records are pre-corrected for the effects of calving age and parity using a single factor, which adjusts for the main effects and their interaction. This adjusts the records to the equivalent of heifer cows calving at 26 months of age. The records are subsequently adjusted to a mean calving interval (previous and subsequent) of 365 days. All pre-correction factors were estimated recently from current data (Olori and Jong de, 1999).

The Model

Breeding value estimation is by Best Linear Unbiased Prediction (BLUP) with a repeatability animal model using the first 5 lactation records of each cow. A heritability of 0.35 and repeatability of 0.55 is applied for all traits (Olori and Jong de, 1999). The fixed effects in the model include calving period (17 weekly periods from January to April and 8 monthly periods from May to December) and herd-year-season (absorbed). Random effects include permanent environment and the animal as well as residual error. Unknown parents are represented by genetic groups, which depend on the breed, country of origin, birth year and selection path. A different selection path is defined for (1) male animals with both parents

unknown, (2) female animals with both parents unknown, (3) male animals with unknown sire, (4) male animals with unknown dam, (5) female animals with unknown sire and (6) female animal with unknown dam.

During the analysis, variance expansion and lactation length weighting factors are applied to records projected from lactations in progress using actual variance expansion factors (VanRaden *et al.*, 1991). Records are adjusted for heterogeneous herd variance using the method of Meuwissen *et al.* (1996). This method estimates variance within herd years with consideration for genetic variation within herd, relationship across herd-years within herd, reduction in variance in later parities due to selection and calving pattern within herd. BV estimation and correction for heterogeneous herd variance occurs simultaneously. Proofs are estimated for milk, fat and protein yield (kg) separately while BVs for percentage traits are calculated from the yield traits.

Expression and publication of proofs

Proofs are expressed as predicted differences (PDs) in kilograms. This is equivalent to ETAs obtained from EBVs after scaling to a mean of zero for the base cows, which are cows born in 1995 and having at least one lactation in the evaluation. The base cows also determine the standard error variance for re-scaling the proofs. The standard age the proofs are expressed on is 26 months at calving. Domestic proofs are published for bulls first tested in Ireland with a minimum reliability of 70% while Interbull proofs are published for all foreign bulls. Proofs are published for active cows with records having a minimum reliability of 30%. Cow proofs are published after the incorporation of foreign bull information. Publication is via the ICBF web site www.icbf.com in the months of February, May, August and November each year.

Comparison Between the Old and New Methods

Three separate evaluations were conducted, aimed at comparing the effects of the new evaluation method and new measure of production on bull proofs. Proofs calculated

with the old method based on complete lactation yields served as control. The first evaluation applied the new method and evaluated 305-day yields realised or projected from all lactation records (Run 1; New data, new method). The second run applied the new method on complete lactation yields (Run2: old data new method) while the third run applied the old method on complete lactation yields (Run3: old data old method). Breeding values were estimated using a repeatability animal model with records from the first 5 lactations. Cows born in 1990 calving in 1995 served as the base for the expression of the EBVs in this test run. The data used comprised about 0.5M records from 0.25M cows calving between 1993 and 1998 in 5,224 herds. The full pedigree included about 14000 bulls.

A comparison between runs 1 and 2 shows the effect of data type on estimates obtained with the new method. A comparison between 2 and 3 showed the effect of evaluation method when the same old data type was used. A comparison between run 1 and 3 show the effect of both data type and evaluation method on estimates. This represents the critical change that was experience following the application of the new method using projected and realised 305-day yields in the national evaluation in Ireland. Comparison between the methods was based on the bull proofs of 450 progeny tested bulls born since 1980 with at least 50 daughters in 10 herds.

Results and Discussion

Bull proofs obtained with the new methods from the different data types (Run 1 vs 2) were not significantly different ($P < 0.05$). Correlation between EBVs average 0.98 for all traits suggesting no effect of data type. Olori and Galeslout (1999) have shown that, for lactations that dry up naturally, realised 305-day yields obtained by interpolation with standard lactation curves (ISCL) method were not significantly different from the lactation yields. The data used in this study were mostly from completed lactation. The effect of data would be more significant if a high proportion of short RIPs are projected and included in the analysis.

Table 1 shows the mean and standard deviation (SD) of PDs for all traits from runs 1 and 3. These were both lower under the new method, however the coefficient of variation indicate higher variation among the proofs from the new method compared to the old method (e.g. CV=120 Vs 85% for protein kg). This indicates that the reduction in variance was due to the reduction in proofs and not an indication of less variation within the bull population.

Differences in protein proofs (New – Old) ranged between –10 and +4 with a mean of –3.37±2.13. The standard deviation of the differences in proofs was 69, 2.39kg for milk and protein yields respectively and 3.6 for the RBI. Figure 1 shows a plot of the deviation of the old protein proof from the new against the old proof. For poor bulls (old proof ≤ 0kg), the deviation of old proofs from new were randomly distributed about zero. For above average bulls, the deviation were mostly negative suggesting that most had new proofs less than the old proofs. However there was no significant trend implying that the new method was not biased against previously high profile bulls. This trend was similar for all traits and the breeding index (RBI). This shows that overall reduction in proof was due to a proper accounting for some other non-genetic factor (s) by the new method of evaluation.

One main difference between the methods is the way in which correction was made for heterogeneous herd variance. The new method estimate within herd year variance with consideration for breed, genetic variation, relationship across herd years and reduction in variance in later parities (Meuwissen *et al.*, 1996; Jong, 1997). In effect, adjustment under the new method was made for residual within herd year variance simultaneously with BV estimation. The proofs of bulls in herds with high residual herd variance will be adjusted differently from those in herds with low within herd residual variance even though total within herd variance may be the same under the old method. Accurate correction for heterogeneous within herd variance has been known to cause a reduction in the proofs of foreign bulls with second crop daughters used in high variance herds similar to the reduction observed here.

The new method applied new pre-correction factors calculated recently (Olori and Jong, 1999), which takes current practices and conditions into account compared to historical factors applied under the old method. Also the effect of calving period was included in the model with the new method resulting in more accurate correction while the old method applied pre-correction factors for this effect calculated.

The correlation between PDs from the old and new methods averaged 0.97 for the 3 yield traits and was 0.96 for the RBI (Table 1). Change in rank for the 450 bulls based on RBI ranged from –132 to +117 with a standard deviation of 36 places. Generally, there was no trend relating change in rank to the old RBI or rank. However, most of the bulls that gained places had old proofs less than 120. This indicates that more medium and lower index bulls (consistent with home bred bulls) gained rank with the new method.

Figure 2 shows the mean protein PD of bulls by birth year obtained from the old and new systems. Estimates for the new method were generally less than corresponding estimates for the old method. The linear trends indicate a difference of 0.11kg/year in the annual rate of increase ($b=0.46$ & 0.35 for old and new trend respectively), which is less than $1/10^{\text{th}}$ of the SD of the old protein proof. The figure also shows a downward trend for the variance of the proofs, which was more rapid for the old method ($b=-0.18\text{kg}$) compared to the new ($b=-0.08\text{kg}$). Based on this trend, standard deviation of bull PDs estimated with the old method reduced by 28% between 1980 and 1993 which is about twice the reduction based on estimates from the new method (15%). The rate of decline under the new method is more consistent with the trend observed in other countries (Doormaal *et al.*, 1999).

Conclusion

The difference in the proofs produced by the new and old genetic evaluation methods are mostly due to the difference in pre-correction factors, terms in the model and correction for

heterogeneous herd variance. There was no systematic bias but an overall reduction in proofs was observed which caused a reduction in the variance hence narrowing the distribution of proofs from the new system compared to the old.

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Table 1. Summary of EPDs and RBI from old (old data, old method) and new (new data, new method) genetic evaluation methods based on 450 progeny tested bulls with at least 50 daughters in 10 herds in Ireland

	New Method		Old Method		Difference (Old-New)	Correlation
Variable	Mean	SD	Mean	SD	Mean \pm SD	Old/new
Milk (kg)	195	248	296	276	-101.3 \pm 69.3	0.97
Fat (kg)	6.74	7.99	9.58	8.43	-2.84 \pm 2.39	0.96
Protein (kg)	5.79	6.97	9.17	7.88	-3.37 \pm 2.13	0.97
Fat %	-0.009	0.138	-0.023	0.125	0.014 \pm 0.026	0.99
Protein %	-0.011	0.066	-0.007	0.059	-0.004 \pm 0.013	0.98
RBI	108	12.1	114	12.8	-5.4 \pm 3.6	0.96

Figure 1. Change in protein EPD (kg) with the introduction of the new method by the EPD under the old method for 450 progeny tested bulls born since 1980.

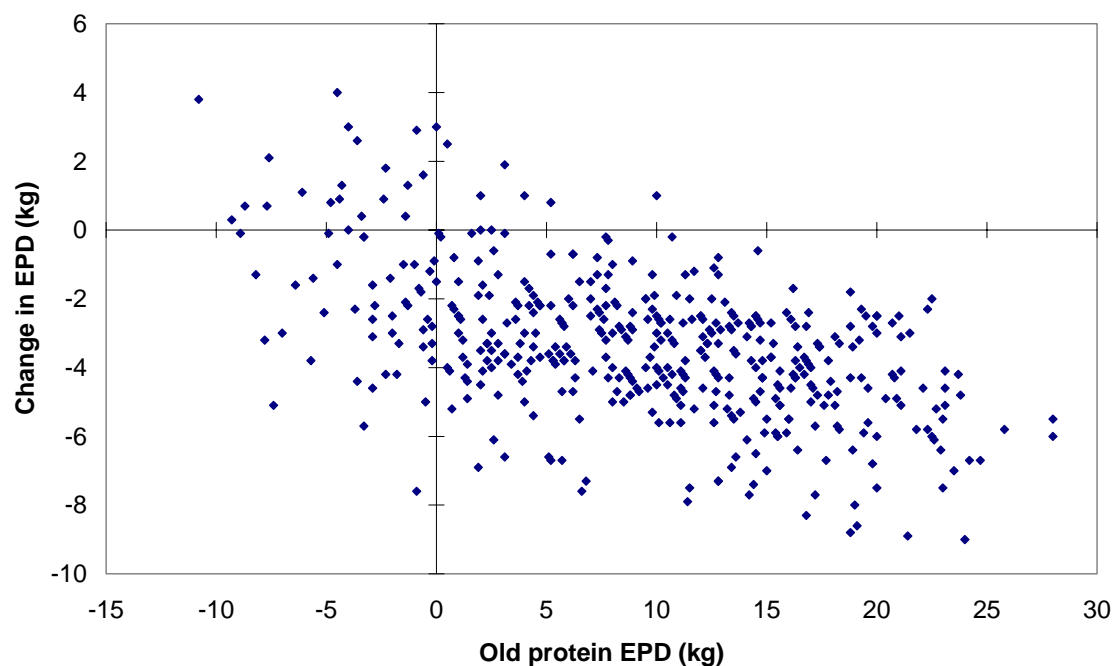


Figure 2. Mean and standard deviation of protein EPD of progeny tested bulls born since 1980 estimated with the old and new method plotted by birth year with.

