GENETIC PARAMETERS AND OPTIMUM LENGTH OF TEST FOR STATION-TESTED BEEF BULLS

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Summary

Bull testing and evaluation have been conducted for a long time in Ontario. Historically bulls have been weighed every 28 days over a 140-day testing period. Starting in 1996, the period of test was shortened to 112 days. This change was made based on literature results from other evaluation programs, which found that the use of 112-day test would not substantially affect the accuracy of the evaluations and would reduce housing and management costs. Using historical bull test data (146,150 weight records on 25,315 bulls from 13 breeds tested between 1988 and 2000 in Ontario), this research was conducted to quantify genetic, environmental, and phenotypic variation of weight gain and the relationship among weight gain in different periods of test, as well as to assess the optimum length of test. The calculated heritability (h^2) for gain on test increased over time, being maximum at end of test (0.38). Genetic correlations between weight gains up to different days on test were high (from 0.81, between 28 and 140-day gains on test, to 0.99, between 112 and 140-day gains on test). Genetic correlations between gain on discrete 28-day intervals were moderate to high (e.g., 0.49 and 0.99 between the last 28 days on test and the first and fourth 28 days, respectively). Correlations were determined between ranks of bulls on the basis of expected progeny differences (EPDs) for weight gain on shortened test periods and EPDs for 140-day test. For test periods shorter than 112 days, correlations substantially decreased when top bulls were considered (0.78, 0.48, and 0.25 among 1% best bulls for 84, 56, and 28-day test, respectively). For tests based on 112 days, the correlation was high, even among the 1% best bulls (0.96). Shortening the test length from 140 to 112 days while keeping the standard 28-day adjustment period, did not jeopardize the accuracy of the evaluation of growth potential for young bulls. Test lengths shorter than 112 days are not recommended, because they would provide less accurate evaluation of bulls. The lengthening of the adjustment period from 28 to 56 days, keeping 112 days on test, did not bring any advantage with respect to the evaluation of growth potential of young bulls, but would increase testing costs.

Introduction

Historically bulls have been tested in central evaluation stations in Ontario for a period of 140 days, preceded by a 28-day adjustment period. In 1996, the test period was shortened to 112 days. The advantage of a long test period is that the effect of temporary fluctuations in gain tends to be averaged out. On the other hand, a shortened period of test has the advantage of being less costly compared with the standard 140-day test.

Some important criteria, which deserve consideration when selecting alternative test periods are: the measure of growth rate in the alternative period should have a relatively satisfactory heritability; the measure of growth rate in the period should be least affected by pre-test environmental effects; and the period should be reasonably short to reduce management costs.

Random regression analysis of the performance of station-tested bulls allows the behavior of genetic and environmental effects to be studied over the test period. This information is useful to determine the optimal length of test and to assess the impact of environmental effects along the test period.

The objectives of this study were to quantify genetic, environmental, and phenotypic parameters (such as heritability), to evaluate the relationship among weight gain during different test periods, and to assess the optimum length of test for station-tested beef bulls in Ontario.

Material and Methods

Data. Consecutive weights were taken every 28 days and analyzed for bulls tested in central evaluation stations in Ontario. Bulls were submitted to an adjustment period of 28 days before the start of test. Records were analyzed only for bulls with breed composition formed by one or more of the 13 major breeds, in number of records (within brackets): (Charolais (4,900), Limousin (5,705), Red Angus (973), Simmental (3,499), Polled Hereford (3,339), Blonde D'Aquitaine (1,045), Horned Hereford (341), Maine-Anjou (238), Gelbvieh (135), Shorthorn (587), Aberdeen Angus (1,136), Shaver Beef Blend (414), Salers (282), and crossbred bulls (2,721)). The edited data set had 146,150 weight records on 25,315 bulls tested from 1988 to 2000. The weights of crossbred bulls were pre-adjusted for heterosis.

Random Regression Model. The random regression model (RR) included fixed regressions for the effects of breed (linear), starting age (cubic) and test group (cubic), and cubic random regression of the weights on days on test for weaning herd-year group (WHY) effect and for permanent environmental (PE) and additive genetic effects of the bull. Breed and residual effects were calculated for each measurement.

Comparison of Different Test Lengths. Expected progeny differences (EPDs) for weight gain on test during different days on test were compared using rank correlation between EPDs of all bulls, the first and the last 20%, and the top 5% and 1% ranked bulls.

Results and Discussion

Genetic Parameters. Figure 1 presents the calculated heritability (h^2) for weight gain up to different days on test (28, 56, 84, 112, and 140 days). h^2 increased with the length of test, being minimum for 28 days on test and maximum for 140 days (from 0.14 to 0.38). The h^2 for 112-day test was slightly smaller than for 140-day test (0.35 vs 0.38, respectively).

The contribution of PE effect to the total variation observed in the weight gain on test (p^2) ranged from 36% at 28 days on test to 49% at the end of test, indicating the importance of this sort of environmental effect on the performance of bulls.

The contribution of WHY effect to the total variation observed in the weight gain on test (w^2) varied between 7.0% and 8.5% during the test period, indicating that the pre-test adjustment period was not able to completely remove from the weight gain on test all pre-test environmental effects associated with weaning herd-year environment. This WHY effect is currently not included in the bull evaluation model. However, the amount of variation of weight gain associated with WHY found in this study, indicates the importance of further investigations on this effect.

Correlations. Table 1 shows the genetic (r_G) correlations, environmental correlations (due to permanent environment (r_P) and weaning herd-year effects (r_W)), and phenotypic correlations (r_{PH}) among the weight gains in a range of possible days on test (28, 56, 84, 112, and 140 days). In general, all correlations decreased as difference in days on test increased. Genetic correlations between weight gain up to 84 and 112 days on test and gain up to 140 days were high (0.97 and 0.99, respectively). However, h^2 estimates for 84 and 112-day test were 18% and 8% lower than for 140-day test, respectively. In addition, w^2 for 84 and 112-day test were 15% and 8% higher than for 140-day test. These results indicate that shortening the period of test to less than 112 days could substantially reduce the accuracy of the genetic evaluation of the bulls.

Genetic correlations between weight gain on different discrete 28-day intervals were estimated. The first 28 days on test had the smallest correlation with other periods of test (0.90, 0.70, 0.55, and 0.49 with 28-56, 56-84, 84-112, and 112-140 day intervals, respectively). The last three periods of test (56-84, 84-112, and 112-140 days) were highly genetically correlated (all $r_G > 0.95$). These results indicate that performance during the first 56 days on test (especially the first 28 days) is partially controlled by different genes, when compared with the performance during the last 84 days on test. Compensatory gain has been attributed to be the main reason for the low phenotypic correlation between performance at beginning of test and the rest of test.

Consideration could be given to lengthening the adjustment period and shortening the length of test from 140 to 112 days, because the bulls' performances in the first 28 days of test are poorly related to performances during the last 112 days on test. This alternative was assessed by calculating the genetic correlation between gain in the last 112 days (L112) on test (from 28 to 140 days) and gain on 112 days (from 0 to 112 days) and 140 days on test. Correlations obtained were 0.96 and 0.98, respectively (Table 1). Therefore, L112 and 112-day gain were similarly genetically correlated with 140-day gain. L112 and 112-day gain were also similarly heritable ($h^2 = 0.33$ vs 0.35, respectively) and likewise affected by PE effects ($p^2 = 0.49$ vs 0.48, respectively). L112 was only slightly less influenced by WHY effects than 112-day gain ($w^2 = 0.06$ vs 0.08, respectively). These results showed that there is no advantage of using the weight gain on the last 112 days over the gain on the first 112 days on test for genetic evaluation of growth potential of young bulls.

Expected Progeny Differences. Table 2 presents correlations between ranks of bulls on the basis of EPDs for weight gain on shortened test periods and EPDs for 140-day test. For test periods shorter than 112 days, correlations decreased substantially when top bulls were considered (0.78, 0.48, and 0.25 among 1% best bulls for 84, 56, and 28-day test, respectively). For tests based on 112-day gain, the correlation was high, even among the 1% best bulls (0.96). EPDs for L112 and for 112-day gain were similarly correlated with 140-day EPDs, which reinforces that there is no advantage of using the last 112 days on test over the first 112 days for genetic evaluation of the bulls.

Conclusions

Heritability of weight gain on test increased with length of test. However, the difference between the heritability of weight gain on 112-day and 140-day test was small (35% vs 38%).

The comparison of different testing periods showed that weight gains on 112-day test were highly genetically correlated with weight gains on 140-day test, and bull EPDs based on 112-day test were highly correlated with those based on 140-day test, even among top bulls.

Weight gains in the last 112 days on test were also highly genetically correlated with weight gains on 140-day test, yielding bull EPDs as correlated with 140-day gain EPDs being similar to EPDs based on 112-day test. However, the use of the last 112-day on test implies that a 28 days longer adaptation period would be applied without bringing any advantage over the 112-day test with a 28-day adaptation period currently used in the test stations in Ontario.

Significance to Industry

Bull performance and ranking of bull EPDs for weight gain were very similar whether measured after 112 or 140 days on test, even though the performance in the first 56 days was poorly related with the performance during the last 84 days on test. The use of 112-day test instead of 140-day test, keeping a standard adaptation period of 28 days, as currently applied in Ontario, does not jeopardize the accuracy of the evaluation of growth potential of young bulls.

The lengthening of the adjustment period from 28 to 56 days, keeping the test period equal to 112 days, does not bring any advantage with respect to the evaluation of growth potential of young bulls, but would increase housing and management costs.

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Figure 1. Variance ratio with respect to total variance for additive genetic (h^2-heritability), permanent environmental (p^2), and weaning herd-year (w^2) effects on weight gain up to different days on test (28, 56, 84, 112, and 140).

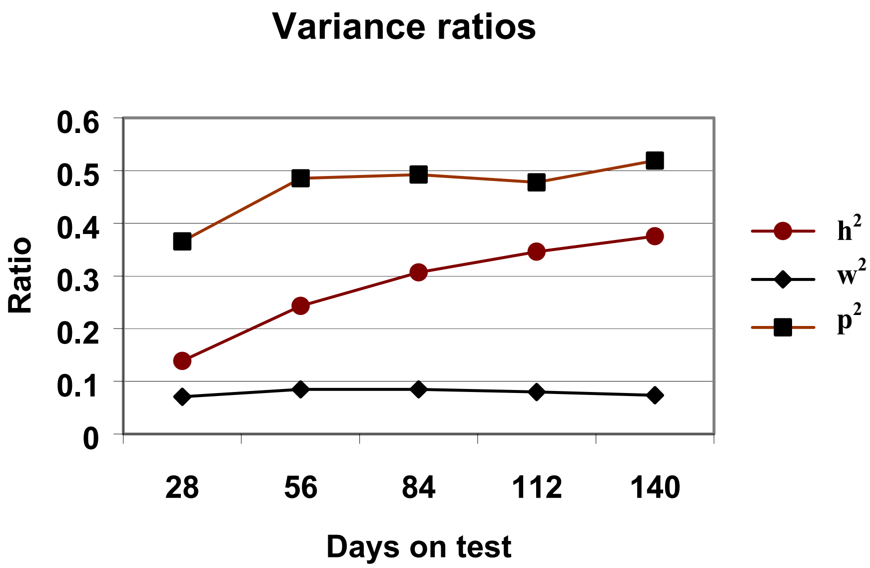

Table 1. Additive genetic (G), permanent environmental (PE), weaning herd-year (WHY), and phenotypic (PH) correlations between weight gain up to different days (28, 56, 84, 112, and 140) on test.

Days on test: measure 1	Days on test: measure 2	Correlations			
		r_G	r_{PE}	r_{WHY}	r_{PH}
28	56	0.977	0.960	0.938	0.686
	84	0.921	0.851	0.781	0.635
	112	0.857	0.720	0.658	0.557
	140	0.807	0.590	0.651	0.505
56	84	0.983	0.962	0.948	0.835
	112	0.947	0.868	0.867	0.778
	140	0.913	0.722	0.812	0.714
84	112	0.990	0.965	0.976	0.882
	140	0.972	0.840	0.900	0.835
112	140	0.995	0.943	0.953	0.909
L112[1]	112	0.962	0.823	0.862	0.783
	140	0.983	0.944	0.924	0.920

[1]Weight gain on the last 112 days on test (from 28 to 140 days)

Table 2. Correlation between ranks of bulls on the basis of EPDs estimated by random regression model for weight gain up to 140-day test and EPD's for different shortened days on test (28, 56, 84, 112 and L112).

	Bulls' EPDs				
Weight gain up to	All	20% best	20% worst	5% best	1% best
28 days on test	0.919	0.710	0.691	0.590	0.253
56 days on test	0.968	0.843	0.830	0.756	0.480
84 days on test	0.990	0.940	0.932	0.899	0.775
112 days on test	0.998	0.989	0.987	0.979	0.960
L112[1]	0.998	0.984	0.982	0.972	0.945

[1]Last 112 days on test (from 28 to 140 days)