ANIMAL X NUTRITIONAL REGIME INTERACTION IN POSTWEANING GROWTH TRAITS OF YOUNG BULLS

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SUMMARY
Postweaning growth performances of 1610 young bulls were recorded in both feedlot and under pasture. (Co)variance components were estimated using a multivariate restricted maximum likelikhood analysis. The pedigree file included 22472 animals. Heritability estimates for weights and gain in both phases correspond to most previously reported estimates. The genetic correlation of gain between the two phases was -0.10, suggesting a large genotype x nutritional regime interaction and a major re-ranking of animals breeding values accross environments. Results of this analysis therefore suggest the need for environment-specific breeding values for postweaning gain.
Keywords: Beef cattle, genetic correlation, genotype x environmental interaction, heritability, postweaning growth.

INTRODUCTION
Beef cattle production is practiced under a large variety of environmental conditions. In many cases, animals are selected for production in one environment, while they should produce in quite a different environment. The common practice in many beef cattle herds is then to evaluate young bulls on central testing feedlots (phase C or D of the National Beef Cattle Performance and Progeny Testing Scheme) and to select them on feedlot performance, while cows are kept and produce on pasture. Their progeny sometimes have to grow on limited forage availability.

In several studies such significant genotype x environmental interactions were obtained, resulting in re-ranking of animals (Tess *et al.*, 1979; Bertrand *et al.*, 1985, 1987; De Nise and Ray, 1987; Bradfield *et al.*, 1997). In most of these cases, halfsibs were evaluated under different environmental conditions. Most of these studies were restricted to weaning weight. This study reports on the postweaning performance and predicted breeding values of the same young bulls' performance tested under two different nutritional regimes.

MATERIALS AND METHODS
Animals. Growth performance of 1610 young bulls from a multibreed synthetic herd of approximately 4000 cows of the Johannesburg City Council were evaluated after weaning from 1988 through 1993 in both feedlot and pasture. The number of bulls varied from 215 to 363 per year. Initial and final weights were recorded for each phase and individual average daily gains (ADG) were calculated.

The bull calves were weaned at an average age of 214 days. The best calves were subsequently selected on weaning weight and conformation excellence. They were then gradually adapted to a feedlot diet consisting of a concentrate feed (12.2 MJME/kg DM) as well as hay, which were all provided *ad libitum*. The feedlot testing phase of 89 days started at the age of 263 ± 15.7 days when the young bulls weighed 270 kg on average.

After the feedlot phase, they were gradually adapted over a period of 40 days to a pasture performance test (mainly kikuyu and annual ryegrass). The pasture testing was 92 days long.

Data description. The 1610 young bulls were the progeny of 146 sires, *i.e.* an average of 11.03 progeny per sire. They varied from two sires with only one progeny each to one sire with 39 progeny tested. Most dams (1040) only had one progeny tested, while one dam had 5 progeny tested, with the average 1.24 progeny per dam.

Although the number of observations was only 1610, the complete pedigree file, which was taken from 1985, included 22472 animals. This was done in an attempt to increase the number of genetic ties and to gain in precision of estimation.

Statistical analysis. Initially a fixed models analysis, which included the fixed effects of year of test (1988 to 1993), farm (2) and age of dam and age upon entry into each testing phase as covariables (and first order interactions) were carried out. During subsequent runs non-significant ($P>0.05$) effects and interactions were removed until only those with a significant influence remained in the final models.

For the estimation of the (co)variance components and resulting h^2 and r_g parameters a multivariate REML (six traits) model was fitted using the VCE software package of Groeneveld (1995) with analytic gradients. The starting values for the (co)variance components estimation, were located in the middle of the parameter space. Optimization was done using the UNCMIN (Nash's unconstrained BFGS) optimizer on the Cholensky factor. The stopping criterion was when the estimate has changed less than 0.005 over the last six iterations, *i.e.* when the gradients approach zero.

RESULTS AND DISCUSSION

Mean ages, weights and gains in the feedlot and pasture testing phases are presented in Table 1. The young bulls gained 147 kg (1.67 kg/day) in feedlot and 56 kg (0.60 kg/day) under pasture. The faster gain in feedlot indicates a more favourable environment but is also related to the higher early potential growth rate.

Table 1. Mean ages, weights and gains in feedlot and pasture phases

	Feedlot	Pasture
Entry age (days)	261	390
Entry weight (kg)	270	428
Exit weight (kg)	417	484
Lenght of test (days)	89	92
Average daily gain (ADG) (kg)	1.67	0.60

Heritabilities and genetic correlations are presented in Table 2. Standard errors of these estimates varied from 0.003 to 0.008. The heritability estimates were almost similar across environments. Heritabilities for both weights and ADG tend to be higher than most published estimates for these traits (Woldehawariat *et al*., 1979; Koots *et al*., 1994). Contrary to what one would expect (Woldehawariat *et al*., 1979; Tess *et al*., 1984), the heritability for ADG-P is higher than for ADG-F.

The genetic correlations between weights at the start of each phase and the corresponding gains in those phases, are negative (-0.21 and -0.27 for feedlot and pasture, respectively), while the corresponding genetic correlations with weights at the end of each phase are positive (0.69 and 0.41, respectively). The smaller bulls were therefore the faster growing ones in each phase.

Table 2. Heritabilities (on diagonal) of and genetic correlations between body weight and growth traits

	Wf-I	Wf-O	ADG-F	Wp-I	Wp-O	ADG-P
Wf-I	**0.42**	0.54	-0.21	0.56	0.54	0.01
Wf-O		**0.43**	0.69	0.84	0.69	-0.14
ADG-F			**0.39**	0.44	0.34	-0.10
Wp-I				**0.41**	0.77	-0.27
Wp-O					**0.41**	0.41
ADG-P						**0.46**

where Wf-I - weight at start of feedlot phase
Wf-O - weight at end of feedlot phase
ADG-F - average daily gain in feedlot
Wp-I - weight at start of pasture phase
Wp-O - weight at end of pasture phase
ADG-P - average daily gain on pasture

The genetic correlation between ADG-F and ADG-P is small and negative (-0.10). This indicates that growth performance in feedlot is genetically independent from growth rate on pasture. It suggests an almost total re-ranking of bulls PBV's from one environment to the other. According to Falconer (1950) departure from unity of the same trait measured in two environments is an appropriate measure of genotype x environment interaction when two environments are involved. Robertson (1959) derived the relationship between genetic correlation of the same trait and genotype x environment interaction with equal heritability in two environments and concluded that a correlation of less than 0.6 is a significant deviation from unity.

Comparable studies were carried out by De Nise & Ray (1987), Theron *et al (*1994) and Bradfield *et al* (1997). In all these cases genetic independency of growth performance under different management regimes were illustrated. Theron *et al* (1994) obtained a genetic correlation for preweaning gain which does not differ significantly from unity, while those for postweaning gain were close to zero.

CONCLUSIONS

Present results, based on the evaluation of young bulls on both feedlot and pasture performance, supports the evidence that superiority of gain under *ad libitum* feeding has a different genetic basis than superiority under limited feeding. They should therefore be treated as two independent traits. Selection should be applied on performance in either feedlot or pasture, but not on average Adg over both phases as is presently the case in this herd.

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