Heterosis effects on weight traits in South African beef breeds

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AIM OF THE STUDY

The aim of the study was to characterize and quantify heterosis in South African beef cattle, using results of weight traits in 24 crossbred genotypes and five pure breeds obtained from the Vaalharts research station in South Africa.

MATERIALS AND METHODS

The data were least squares means and standard errors from the thesis of Els (1988). Five purebred sire lines; Afrikaner (A), Brahman (B), Charolais (C), Hereford (H) and Simmentaler (S) were evaluated in crosses with the A as dam line as well as their F1 female progeny (Table 1).

Table 1. Sire and dam lines and their 29 progeny genotypes used in the study of Els (1988)

Dam	Sire lines				
lines	A	B	C	H	S
B		BB			
C			CC		
H				HH	
S					SS
A	AA	BA	CA	HA	SA
BA	ABA	BBA	CBA	HBA	SBA
CA	ACA	BCA	CCA	HCA	SCA
SA	ASA	BSA	CSA	HSA	SSA

The least squares mean of each trait was equated to its expectation, following Dickerson (1963) and the resulting set of equations was solved by weighted least squares, wherein the weight given to each mean was the reciprocal of its standard error. Constraints were imposed such that $G_A^I = G_A^M = 0$. The model was:

$$\bar{Y} = G_0 + \beta_1 G^I + \beta_2 G^M + \beta_3 H^I + \beta_4 H^M + \varepsilon$$

The intercept (G_0) estimated the breed mean of A. The G^I and G^M were vectors of breed-specific individual (I) and maternal (M) fractional contributions to the least squares mean for each breed group. The H^I and H^M were vectors of breed-specific individual and maternal fractions of heterosis, assumed proportional to expected heterozygosity. The β_i were vectors of genetic effects to be estimated. Finally, the ε represent lack-of-fit of the breed group means to the proposed genetic model (not estimated). Each trait was analyzed separately.

RESULTS AND DISCUSSION

The breed-specific heterosis effects were estimated from relatively small amounts of data. Thus, they were pooled to derive inter-species estimates (Table 2). Individual heterosis was estimated to be slightly greater for indicus x taurus than for indicus x taurus afrikanus, but substantially greater than for either taurus x taurus afrikanus or taurus x taurus. Estimates of maternal heterosis were consistently greater for taurus x taurus afrikanus than for indicus x taurus afrikanus. It should be noted that the data do not contain crosses in which there would be full expression of heterosis for either indicus x taurus or taurus x taurus. Thus, estimates for these species combinations are less precise than for the other species combinations.

Table 2. Estimates of inter-species average heterosis effects (%) for body weight at various ages in two- and three-breed crosses

Individual heterosis	**Birth weight**	**Weaning weight**	**19 month heifer weight**	**Cow weight at partus**
indicus x taurus afrikanus	13.9	8.0	12.0	4.1
indicus x taurus	21.4	16.1	17.8	12.0
taurus x taurus afrikanus	3.3	2.6	4.4	13.8
taurus x taurus	-9.3	5.2	3.2	1.7
Maternal heterosis				
indicus x taurus afrikanus	-7.0	3.0	-5.3	-2.4
taurus x taurus afrikanus	8.7	10.7	8.4	4.7

taurus afrikanus was represented by the Afrikaner breed; taurus was represented by Simmentaler, Charolais, and Hereford; and indicus was represented by Brahman.

CONCLUSION

The estimated individual heterosis effects were, on average, substantial and positive at all ages. There magnitude varied depending on the contributing species. Likewise, the estimated maternal heterosis effects were also, on average, positive. However, the magnitude of the estimated maternal heterosis effects appeared less than that of the estimated individual heterosis effects. The observation of relatively small maternal heterosis effects may possibly be explained by the relatively harsh environment of the Vaalharts research station resulting in an environmental limitation on expression of milk production. These data support the use of crossbreeding in commercial beef production in South Africa.

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