Growth and efficiency of young Brahman, Bonsmara and Drakensberger bulls

H.A. Kreiner, N.H. Casey,* J.G.E. van Zyl and R.J. Coertze

Department of Livestock Science, Faculty of Agriculture, University of Pretoria, Pretoria 0002, Republic of South Africa

* Author to whom correspondence should be addressed

Received 14 September 1990; accepted 12 April 1991

Growth and individual cumulative feed intakes (cumFI) of 15 Brahman, 12 Bonsmara and 14 Drakensberger bulls, randomly acquired from various herds, were recorded in a 140-day post-weaning feedlot trial. Of the linear and quadratic regressions fitted to the data of each animal, the quadratic expression showed the best fit. Average daily gain (ADG), average daily feed intake (ADFI) and average feed conversion efficiency (FCE) were obtained from differentials of the resultant equations. Corrected, pooled means of performance traits for the Brahman, Bonsmara and Drakensberger were ($P < 0{,}05$) initial mass: 211^{a}, 230^{a}, and 236^{a}; final mass: 352^{a}, 442^{b}, and 403^{b}; cumFI: 876^{a}, 1164^{b}, and 1243^{b}; ADG: $1{,}01^{a}$, $1{,}51^{b}$, and $1{,}20^{a}$; ADFI: $6{,}26^{a}$, $8{,}31^{b}$, and $8{,}88^{b}$; FCE: $6{,}36^{ab}$, $5{,}57^{a}$, and $7{,}42^{b}$. The conclusion is that a substantial genetic basis exists for variation in ADFI, gain and FCE for bulls on postweaning performance tests.

Groei en kumulatiewe voerinnames (KVI) van 15 Brahman-, 12 Bonsmara- en 14 Drakensbergerbulle, afkomstig van verskillende kuddes, is in 'n 140-dae intensiewe naspeense groeifase gemeet. Van die lineêre en kwadratiese regressies wat op die data gepas is, het die kwadratiese regressie die beste passing getoon. Gemiddelde daaglikse toename (GDT), gemiddelde daaglikse voerinname (GDVI) en gemiddelde daaglikse voeromset (GVO) is d.m.v. die differensiaal van die vergelykings bereken. Gekorrigeerde, gepoelde gemiddeldes van prestasie-eienskappe van die Brahman-, Bonsmara- en Drakensbergerbulle was ($P < 0{,}05$) aanvangsmassa: 211^{a}, 230^{a}, en 236^{a}; finale massa: 352^{a}, 442^{b}, en 403^{b}; KVI: 876^{a}, 1164^{b}, en 1243^{b}; GDT $1{,}01^{a}$, $1{,}51^{b}$, en $1{,}20^{a}$; GDVI: $6{,}26^{a}$, $8{,}31^{b}$, en $8{,}88^{b}$; GVO: $6{,}36^{ab}$, $5{,}57^{a}$, en $7{,}42^{b}$. Die gevolgtrekking is dat daar 'n aansienlike genetiese basis bestaan vir variasie in GDVI, GDT en GVO vir bulle op naspeense groeitoetse.

Keywords: Bulls, efficiency, feedlot, growth performance.

The more recent studies on postweaning gains of beef cattle have included direct measurements of feed consumption and individual feed conversion ratios. These indicate that efficiency of feed utilization varies between breeds (Smith *et al.*, 1976; Cundiff *et al.*, 1981; Chewning *et al.*, 1990). Efficiency of feed usage is not a directly measurable trait, but must be computed as a function of feed consumed, gain in body mass, body composition and time. In order to evaluate growth and efficiency reliably at any point or interval, a mathematical model is required that suitably approximates to a set of growth and intake data.

This study investigates the growth and efficiency of Brahman, Bonsmara and Drakensberger bulls in a post-weaning feedlot period using simple, suitable mathematical models to describe and analyse growth and feed conversion efficiency.

Individual growth and feed intake data were obtained from 15 Brahman, 12 Bonsmara and 14 Drakensberger bulls in a 140-day feedlot trial. The bulls were acquired at random from various herds and those of the same breed were not siblings. The animals were penned after weaning at approximately eight months of age and were fitted with neckbands holding electro-magnetic transponders, which activated an automatic feed station. An adaptation period of 21 days was allowed, after which individual daily feed intakes were recorded. The ration was similar to that used in Phase C of the Bull Performance Testing Scheme, containing 10,79 MJ ME/kg DM (Beef Cattle Performance Testing Scheme). Body mass was recorded every 14 days following overnight withdrawal of feed and water.

Linear and quadratic regressions were fitted to the measured cumulative feed intake (cumFI) (y) versus days (x) and mass (y) versus days (x). Mass (y) was also regressed by linear and quadratic functions on cumulative feed intake (x). The functions used were defined as follows: linear: $y = a + bx$ and quadratic: $y = a + bx + cx^2$.

ADG, ADFI and FCE for the total feeding period were calculated by linear regressions. Analyses of variance by least-square means were carried out to quantify breed differences in growth rate, feed intake and efficiency of feed utilization on a monthly basis and for the total feeding period.

Differentials of the quadratic equations were used to calculate average daily feed intakes (ADFI), average daily gains (ADG) and feed conversion efficiency (FCE) at Days 1, 28, 56, 84, 112 and 140 of the test period. The inverse of the differential of the quadratic function relating body mass to feed intake describes feed efficiency, being the amount of feed consumed per unit gain, at any stage.

The results of the linear and quadratic regressions for each breed are given in Table 1. The coefficients of determination (r^2) indicate that the quadratic regressions most accurately described the increase in mass over the time observed. CumFI is described well by both the linear and quadratic regressions. The relationship between cumFI and mass was best described by a quadratic function in all three breeds. In both the linear and quadratic regressions the increasing variance of $\hat{y}$, as a given x moves away from the mean, results in a diminishing accuracy of the estimate, yielding either an over- or an under-estimate of $\hat{y}$. For this reason, estimates of efficiencies obtained from the differentials of the quadratic equations at Days 1 and 140 may deviate from expectation. The cumFI, mass, ADG, ADFI and FCE as calculated from the quadratic regressions at 28-day intervals are presented in Table 2.

Table 1 Pooled parameters and r^2 values of regression equations

	Linear			Quadratic			
Regression	a	b	r^2	a	b	c	r^2
Brahman							
mass : days	216,7	1,0256	0,9693	209,7	1,3471	−0,00233	0,9813
mass : cumFI	223,5	0,1593	0,9615	216,6	0,2189	−0,000093	0,9809
cumFI : days	−40,4	6,4136	0,9951	−26,4	5,7368	0,00507	0,9971
Bonsmara							
mass : days	236,7	1,5327	0,9758	228,7	1,9219	−0,00283	0,9823
mass : cumFI	250,6	0,1796	0,9701	236,9	0,2677	−0,000085	0,9911
cumFI : days	−63,4	7,8211	0,9924	−30,3	6,4429	0,01505	0,9973
Drakensberger							
mass : days	245,3	1,2089	0,9665	233,9	1,7436	−0,00380	0,9851
mass : cumFI	247,1	0,1791	0,9812	242,7	0,2240	−0,000060	0,9965
cumFI : days	−50,4	7,8211	0,9891	−11,2	5,0940	0,02762	0,9988

Table 2 Cumulative feed intake (cumFI), mass, average daily gain (ADG), average daily feed intake (ADFI) and feed conversion efficiency (FCE) of Brahman, Bonsmara and Drakensberger bulls on 140-day postweaning feedlot growth at 28-day intervals

Days in	Brahman					Bonsmara					Drakensberger				
feedlot	cumFI	Mass	ADG	ADFI	FCE	cumFI	Mass	ADG	ADFI	FCE	cumFI	Mass	ADG	ADFI	FCE
1	0	211	$1,34^{a}$	$5,75^{ab}$	4,57	0	230	$1,91^{b}$	$6,47^{a}$	3,74	0	236	$1,74^{ab}$	$5,15^{b}$	4,46
28	138^{a}	246	$1,21^{a}$	$6,02^{a}$	$5,18^{a}$	162^{b}	280	$1,76^{b}$	$7,28^{b}$	$4,16^{b}$	153^{ab}	280	$1,53^{ab}$	$6,64^{a}$	$4,86^{ab}$
56	311^{a}	277^{a}	$1,09^{a}$	$6,30^{a}$	$6,21^{a}$	377^{b}	327^{b}	$1,61^{b}$	$8,11^{b}$	$4,91^{a}$	361^{ab}	320^{ab}	$1,32^{a}$	$8,19^{b}$	$5,53^{ab}$
84	491^{a}	306^{a}	$0,95^{a}$	$6,59^{a}$	$7,84^{a}$	616^{b}	370^{b}	$1,45^{b}$	$8,95^{b}$	$6,14^{b}$	611^{b}	354^{b}	$1,01^{a}$	$9,73^{b}$	$6,64^{ab}$
112	680^{a}	330^{a}	$0,82^{a}$	$6,87^{a}$	$10,82^{a}$	879^{b}	408^{b}	$1,28^{b}$	$9,79^{b}$	$8,46^{b}$	906^{b}	381^{b}	$0,89^{a}$	$11,28^{b}$	$8,67^{b}$
140	876^{a}	352^{a}	$0,69^{a}$	$7,16^{a}$	$17,87^{a}$	1164^{b}	442^{b}	$1,13^{b}$	$10,62^{b}$	$14,32^{b}$	1243^{b}	403^{b}	$0,68^{a}$	$12,83^{b}$	$13,36^{b}$

$^{a, b}$ Differing superscripts of traits in rows differ at $P < 0,05$.

The initial mass did not differ significantly ($P < 0{,}05$) between the three breeds, although the Bonsmara and Drakensberger tended to be heavier than the Brahman. The initial ADG differed ($P < 0{,}05$), with the Bonsmara having the highest, the Drakensberger intermediate and the Brahman the lowest ADG. After approximately 50 days, the ADGs of the Brahman and Drakensberger were not significantly different, but were significantly ($P < 0{,}05$) lower than that of the Bonsmara. This was true up to the end of the feeding period.

The Bonsmara had the highest ADFI at the start of the trial, with the Brahman intermediate and the Drakensberger the lowest ADFI. At day 28, ADFI of the Bonsmara was significantly ($P < 0{,}05$) higher than that of the Drakensberger as well as of the Brahman. From approximately Day 40 onwards, ADFI of the Brahman was significantly lower than that of both the Bonsmara and Drakensberger. The final mass of the Brahman was significantly ($P < 0{,}05$) lower than the final mass of Bonsmara and Drakensberger. The Bonsmara tended to be heavier than the Drakensberger, although not significantly.

The Bonsmara tended throughout the feeding period to be the most efficient feed converters (FCE). There was, however, no significant difference between the Bonsmara and Drakensberger, but the Brahman was significantly ($P < 0{,}05$) less efficient. These results support the assertions of Koch *et al.* (1963), Smith *et al.* (1976), Cundiff *et al.* (1984), Thiessen *et al.* (1985) and Brown *et al.* (1986), that the fastest growing animals are the most efficient feed converters within age-constant intervals in spite of heavier weights maintained.

The decreased efficiency of feed utilization during the feeding period observed within breed groups would suggest that the faster gaining breed groups could have been aided by leaner composition of their gain. Carcass composition was, however, impossible to determine in this trial.

Means of performance traits for the entire feeding period as calculated by linear regressions, are presented in Table 3. These analyses indicate the Bonsmara to have maintained a growth rate significantly higher than that of both the Brahman and Drakensberger breeds. Brahman had significantly lower ADFI than Bonsmara and Drakensberger. Bonsmara used significantly less feed per unit gain than Brahman and Drakensberger. Brahman tended to be more efficient than Drakensberger, but the faster growing Bonsmara tended to be more efficient feed converters than the Drakensberger and Brahman.

Table 3 Initial mass, final mass, cumulative feed intake (cumFI), average daily gain (ADG), average daily feed intake (ADFI) and feed conversion efficiency (FCE) of Brahman, Bonsmara and Drakensberger bulls as calculated by linear regressions

	Initial mass	Final mass	cumFI	ADG	ADFI	FCE
Brahman	211^{a}	352^{a}	876^{a}	1,01^{a}	6,26^{a}	6,36^{ab}
Bonsmara	230^{a}	442^{b}	1164^{b}	1,51^{b}	8,31^{b}	5,57^{a}
Drakensberger	236^{a}	403^{b}	1243^{b}	1,20^{a}	8,88^{b}	7,42^{b}

^{a,b} Differing superscripts of traits in columns differ at $P < 0{,}05$.

Frisch & Vercoe (1977) found that Brahman-cross steers had a lower voluntary food intake per kilogram live mass, as well as a lower fasting metabolism per kilogram live mass, compared to *Bos taurus* steers. Furthermore, *Bos indicus* breeds show a better growth rate on roughage than *Bos taurus* breeds (Frisch, 1976). The conclusion drawn by Frisch & Vercoe (1977) was that *Bos indicus* breeds, having evolved under poor nutritional conditions, have a low fasting metabolism and a comparatively low growth rate under optimal conditions. This may well apply to the Drakensberger breed, although more detailed research would be required.

Monteiro (1975) suggested that the different efficiencies over a same age interval found in breed groups most likely correspond to breed characteristics of size, degree of maturity, and to breed differences in some intrinsic appetite parameters. Brown *et al.* (1986) suggested that the feed intake and gain differences between breeds were more likely the result of appetite and feed capacity than intrinsic efficiency or composition of gains. Chewning *et al.* (1990) concluded that differences do exist between breeds in ADG, feed efficiency and daily feed intake, which are important parameters for cattle producers to make sound economic decisions. The conclusion drawn from these results is that a substantial genetic basis exists for variation in feed consumption, gain and the ratio of gain to feed (efficiency) for bulls on postweaning performance tests.

Acknowledgements

The authors acknowledge Prof. H.T. Groeneveldt, Department of Statistics, University of Pretoria, for his assistance with the statistical analyses.

References

BEEF CATTLE PERFORMANCE TESTING SCHEME. Administered by the Director, Animal and Dairy Science Research Institute, Department of Agricultural Development. Private Bag X2, Irene 1675, Republic of South Africa.

BROWN, C.J., JOHNSON, Z. & BROWN, A.A., 1986. Some genetic aspects of feed intake, gain and feed conversion of young bulls on postweaning gain test. In *Proceedings, 3rd World Congress on Genetics applied to Livestock Production (Madrid)* XI: 291—294.

CHEWNING, J.J., BROWN, A.H. (Jr.), JOHNSON, Z.B. & BROWN, C.J., 1990. Breed means for average daily gain, feed conversion and intake of beef bulls during postweaning feedlot performance tests. *J. Anim. Sci.* 68, 1500.

CUNDIFF, L.V., KOCH, R.M., GREGORY, K.E. & SMITH, G.M., 1981. Characterization of biological types of cattle — cycle II. IV Postweaning growth and feed efficiency of steers. *J. Anim. Sci.* 53, 332.

CUNDIFF, L.V., KOCH, R.M. & GREGORY, K.E., 1984. Characterization of biological types of cattle — cycle III. IV Postweaning growth and efficiency. *J. Anim. Sci.* 58, 312.

FRISCH, J.E., 1976. A model for reasons for breed differences in growth rate of cattle in the tropics. *Proc. Aust. Soc. Anim. Prod.* 11, 85.

FRISCH, J.E. & VERCOE, J.E., 1977. Food intake, eating rate, weight gains, metabolic rate and efficiency of feed utilization in *Bos taurus* and *Bos indicus* crossbred cattle. *Anim. Prod.* 25, 343.

KOCH, R.M., SWIGERS, L.M., CHAMBERS, D. & GREGORY, K.E., 1963. Efficiency of feed use in beef cattle. *J. Anim. Sci.* 22, 486.

MONTEIRO, L.S., 1975. Food efficiency in relation to estimated growth of body components in cattle. *Anim. Prod.* 20, 315.

SMITH, G.M., FITZHUGH, H.A.(Jr.), CUNDIFF, L.V., CARTWRIGHT, T.C. & GREGORY, K.E., 1976. A genetic analysis of maturing patterns in straightbred and crossbred Hereford, Angus and Shorthorn cattle. *J. Anim. Sci.* 21, 588.

THIESSEN, R.B., TAYLOR, St.C.S. & MURRAY, J., 1985. Multibred comparisons of British cattle. Variation in relative growth rate, relative food intake and food conversion efficiency. *Anim. Prod.* 41, 193.