Performance of Boran and Crossbred Cattle for Beef Production Under Ranching Conditions in Tanzania. 2. Weight at Slaughter and Carcass Measurements

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Abstract

Steers reared in a beef cattle crossbreeding experiment carried out in two ranches in central Tanzania were slaughtered at an average age slightly above four years. The genetic groups represented were purebred Boran and crosses out of Boran cows mated to bulls of 12 exotic breeds. The steers were weighed prior to slaughter, and the carcasses were weighed and measured. A joint of the tenth rib was dissected into lean, fat and bone, and each fraction weighed. Various fractions of internal organs were also recorded separately. Crossbred steers yielded on average about 14 percent heavier carcasses than pure Boran. Among the crosses no significant differences in carcass weight according to breed of sire were observed. The heaviest carcasses were from steers sired by Chianina bulls. Carcasses of Boran steers were shorter and had more fat and slightly less bone on the 10th rib joint than carcasses of crosses. Steers sired by British beef or Simmental bulls were fatter than steers by Limousin or Piedmont bulls. Piedmont crosses were the lowest in both subcutaneous (10th rib) and internal (heart and kidney) fat, and had the highest amount of lean in the 10th rib joint. Research on beef crossbreeding in Tanzania should be directed more towards viability and reproductive performance rather than carcass quality.

Keywords: Crossbreeding, Boran, *Bos taurus*, beef, carcass measurements

Introduction

In most meat markets, the value of an animal for slaughter is determined by the weight of the carcass and its quality. Carcass weight can be recorded accurately and objectively, while quality of a carcass is a complex and composite trait, with many aspects, which cannot easily be recorded by any kind of measurement. Moreover, meat quality means different things in different markets and to different consumers.

In Tanzania, beef is sold at a fixed price regardless of joint or quality. Consequently, carcasses are usually not graded or jointed by the butcher. Nevertheless, an investigation on the choice of breeds and breeding for commercial beef production is not complete without an assessment on the yield and composition of edible beef from the various breed types.

Materials and Methods

Management of animals and breeds used

A description of the breeding, feeding and management of the experimental animals, as well as the environmental conditions on the two ranches (Kongwa and Mkata, both in central Tanzania) in which the animals were kept, has been given in part I of this study (Mchau *et al.*, 2006).

The steers reared in the experiment were slaughtered at an age of about four years, which is the age at which Borans are considered to be

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ready for slaughter under ranching conditions in Tanzania. In addition to the ten genetic groups reported in part I (straightbred Boran and first crosses between Boran cows and Hereford, Angus, South Devon, Limousin, Simmental, Friesian, Charolais, Chianina and Brown Swiss bulls), three sire breeds introduced into the experiment at a later stage, namely Piedmont (a *Bos taurus* breed), Brahman *(Bos indicus)*, and Santa Gertrudis (an *indicus x taurus* composite) were also represented. A few of the steers (less than 30) were out of crossbred dams.

Slaughter procedure and measurements taken

Steers from both ranches were slaughtered together in a modern abattoir at Kongwa ranch. This involved trucking by rail from Mkata to Kongwa, some six hours. On arrival to Kongwa, the steers were rested for several days before they were slaughtered. Slaughter took place in the dry season, mainly in June, July, and August. The steers were starved overnight with access to water and were weighed the following morning just before slaughter.

Slaughter was carried out by ranch personnel, while cutting, dissection and measurement of sample joints was carried out by technicians from a nearby livestock research institute. As the carcasses were weighed after a 24-hour stay at room temperature (upon arrival of the technicians), a certain amount of shrinkage occurred. The carcasses were sawed into two halves along the vertebral column and sternum, and the left half was used for further measurement and jointing. Sample joint dissections were carried out on specimens that had been chilled for at least 24 hours. The following measurements were taken: (i) Carcass weight (ii) Carcass length - from the cranial margin of the first rib to the caudal end of the pubic symphysis (iii) Maximum thigh girth (iv) On the 10th rib: thickness of fat layer, eye muscle area, weights of bone, fat and lean (v) On the heart: weight of lean, coronary fat and pericardial fat (vi) Kidney weight and (vii) Weight of perirenal fat.

Data handling and analysis

Raw data was in a number of sources. All sources were used in order to complement each other. However, many problems were encountered in extracting the data. Due to inconsistencies and uncertainty as to the accuracy of the records, the final data set was edited to include 372 carcasses. Even in this edited file some important information was missing, thus making the number of observations for the various traits quite variable. Results on the eye muscle area and 10th rib fat thickness are not reported because too many records were missing and/or the data were considered unreliable.

General Linear Models (GLM) procedures of Statistical Analysis System (SAS, 1985) were employed for data analysis. The genetic effects studied were type of breeding (purebred Boran or crossbred) and breed of sire (if crossbred). Environmental factors considered were effects of ranch and slaughter occasion. Thus the statistical model included four fixed effects: type of breeding, breed of sire (nested within type of breeding), ranch and slaughter occasion. This model was applied to all traits. In the analysis of slaughter and carcass weights, age at slaughter was included in the model as a covariate, while all other traits were analysed with carcass weight as covariate. Phenotypic correlation coefficients between traits were computed from residual sums of squares and crossproducts after elimination of the fixed effects considered, but not the effect of the covariate.

Results

The least squares means and their standard errors for the various traits analysed are presented in Tables 1,2 and 3.

Slaughter and carcass weights

Actual age of the steers at slaughter exceeded four years by 2.5 months on average. The mean live weight at slaughter was 478.5 kg and mean carcass weight of 245.3 kg, with standard deviations of 54.0 and 27.8 kg, respectively (computed from residual mean squares). Slaughter occasion was the most important source of variation in both traits, accounting for more than 20 percent of total sum of squares. Also the effects of ranch and age were highly (P <0.001) significant. Type of breeding (Boran *vs.* crossbreds) had a highly significant effect on both traits, the crosses (pooled over sire breeds) were 13 to 14 percent heavier than pure Boran (Table 1). The various crossbred groups (breed of sire) did, however, not differ significantly, although the range of means was about 12 percent of the overall mean.

Table 1: Least squares means and standard errors (S.E.) of weight at slaughter, carcass weight, carcass length, and thigh girth for various classes

Subclass	Slaughter weight (kg)		Carcass weight (cm)		Carcass length (cm)		Thigh girth(cm)	
	Mean	S.E.	Mean	S.E.	Mean	S.E.	Mean	S.E.
Type of breeding								
Pure (Boran)	450	14	229	8	122.4	1.6	105.2	1.4
Crosses	509	11	262	7	129.1	1.3	110.0	1.1
Breed of sire								
Hereford	499	19	257	10	127.6	1.9	108.8	1.7
Angus	498	17	257	9	128.0	1.8	108.1	1.6
S.Devon	507	17	256	9	128.5	1.7	109.5	1.6
Limousin	484	18	258	10	125.4	1.9	109.0	1.7
Simmental	501	21	266	11	127.1	1.1	109.4	1.8
Friesian	515	19	261	10	131.4	2.0	110.6	1.8
Charolais	519	20	271	11	130.2	2.1	112.9	1.9
Chianina	518	19	280	10	129.9	2.0	111.5	1.8
B. Swiss	493	18	258	10	131.3	1.8	109.3	1.6
Piedmont	517	21	262	12	130.2	2.4	112.6	2.2
Brahman	543	21	270	12	130.2	2.3	111.0	2.1
S.Gertrudis	513	22	247	13	128.9	2.5	107.5	2.2
Ranch								
Kongwa	513	12	257	7	128.0	1.3	110.3	1.2
Mkata	446	15	233	9	123.5	1.6	104.9	1.5

Carcass length and thigh girth

For these traits the covariate (carcass weight) was the most important source of variation, followed by slaughter occasion. Type of breeding had a significant effect on both traits, while only carcass length was significantly affected by breed of sire (among the crossbreds). All crosses had longer carcasses than pure Boran. Among crosses, Friesian and Brown Swiss crosses had the longest carcasses, Limousin crosses the shortest (Table 1). Widest thigh girth was recorded among Charolais (112.9 cm) and Piedmont (112.6 cm) steers while S. Gertrudis crosses had thinnest (107.5 cm).

Tenth rib lean, fat and bone

Mean weights of lean, fat, and bone tissues of the tenth rib joint were 1322, 639, and 436 g, respectively.

The variation among slaughter occasions was highly ($P<0.001$) significant for all the three traits and accounted for 9 to 17 percent of total sum of squares. The influence of the covariate (carcass weight) was also highly significant ($P<0.01$), while the difference between ranches was unimportant.

Weight of fat at the 10th rib differed significantly between the two types of breeding, pure Borans had nearly 12 percent more fat than the crossbreds (Table 2). Crosses sired by Simmental or by British beef bulls had significantly more fat than crosses by Limousin or Piedmont bulls. Piedmont crosses were the highest in weight of lean tissue (1498 g) and among the lowest in weight of bone (428 g). The highest weight of bone (533 g) was recorded in the Santa Gertrudis crosses.

Table 2: Least squares means and standard errors (S.E.) of weight (in g) of lean, fat, and bone of tenth rib joint

Class	Lean		Fat		Bone	
	Mean	S.E.	Mean	S.E.	Mean	S.E.
Type of breeding						
Pure Boran	1322	55	692	43	418	18
Crosses	1322	37	585	29	454	12
Breed of sire						
Hereford	1319	75	677	59	438	24
Angus	1265	68	688	53	436	22
S. Devon	1414	68	662	53	468	22
Limousin	1409	72	456	57	454	23
Simmental	1204	92	704	72	445	30
Friesian	1323	73	624	57	473	24
Charolais	1344	79	601	62	439	26
Chianina	1409	77	542	61	451	25
B. Swiss	1224	77	643	60	466	25
Piedmont	1498	82	417	64	428	27
Brahman	1171	82	528	64	421	27
S. Gertrudis	1285	93	476	73	533	30
Ranch						
Kongwa	1319	46	614	36	435	15
Mkata	1325	55	663	43	437	18

Weight of internal organs

Variation among slaughter occasions was again highly significant for all traits recorded, and so was the influence of the covariate. The difference between the two types of breeding was in general small. Significant variation among sire breeds was observed with respect to heart coronary fat and perirenal fat only, and with a few exceptions the breeds ranked similarly in the two traits (Table 3). The crosses by British beef breeds and Brahman ranked among the highest in both traits, while Piedmont crosses again were the lowest.

Correlation between traits

Coefficients of correlation between various carcass traits are entered in Table 4. Carcass weight was significantly correlated to all other traits, with coefficients ranging from 0.17 (heart coronary fat) to 0.62 (carcass length). Most other coefficients were low or moderately high, and could probably be ascribed mainly to the association between carcass weight and the traits in question.

Table 3: Least squares means and standard errors (SE) of weights (in g) of heart lean, pericardial fat, coronary fat, kidney lean, and kidney perirenal fat

Class	Heart lean		Heart pericardial		Heart coronary fat		Kidney lean fat		Kidney perirenal fat	
	Mean	SE	Mean	SE	Mean	SE	Mean	SE	Mean	SE
Type of breeding										
Pure Boran	1260	47	535	56	295	17	742	28	2362	163
Crosses	1305	32	534	34	296	12	769	19	2089	110
Breed of sire										
Hereford	1265	63	563	66	293	23	741	38	2230	221
Angus	1318	58	501	61	329	21	751	35	2360	204
S. Devon	1296	57	574	61	333	21	753	35	2566	201
Limousin	1204	62	461	64	285	22	737	37	1928	213
Simmental	1373	76	584	72	299	28	801	47	2143	272
Friesian	1305	61	563	64	288	22	787	37	2209	214
Charolais	1209	65	463	67	297	24	757	39	1773	233
Chianina	1392	66	516	71	295	24	757	39	2037	228
B.Swiss	1370	66	530	77	362	24	798	39	2070	226
Piedmont	1259	71	416	107	182	26	744	42	1376	242
Brahman	1273	71	707	92	308	26	772	42	2622	243
S.Gertrudis	1393	80	529	113	281	29	875	47	1753	275
Ranch										
Kongwa	1299	39	587	41	294	14	725	24	2152	136
Mkata	1266	48	481	53	297	17	786	28	2298	162

Table 4: Correlations coefficients* (in percent) between various carcass traits

	Carc. wt	Carc. lth	Thigh girth	Tenth rib Lean	Fat	Bone	Heart Lean	Per.	Cor.	Kidney lean
Carcass length	62									
Thigh girth	52	50								
10th rib lean	36	37	36							
10th rib fat	24	22	16	3						
10th rib bone	28	38	32	38	28					
Heart lean	35	43	35	19	19	24				
Heart pericard.fat	19	17	17	10	11	4	28			
Heart coronary fat	17	19	20	22	5	9	17	25		
Kidney lean	27	30	28	11	19	20	38	19	12	
Kidney perir. fat	33	23	10	9	25	19	29	34	11	22

Numbers of observations ranged from 244 to 322

*Numerical values of $r > 0.12$ are statistically significant at $P < 0.05$

Discussion

The superiority of the crossbreds over the pure Borans in weight at slaughter was about equal to their superiority in weight at three years as reported in Part I (about 12 percent, Mchau *et al.*, 2006). A similar difference was obtained also in carcass weight, indicating that dressing percentages did not differ much between the two groups. The average dressing percentage, 51.3, was similar to that reported by Trail *et al.*(1971) for Boran, Angus, and Red Poll crosses in Uganda.

The lack of significant differences in slaughter and carcass weights between sire breeds (among the crosses) should probably be ascribed to the rather small numbers and therefore large sampling errors. However, the ranking is as might be expected, with Chianina on the top, followed by Charolais and Brahman (cf. review by Liboriussen, 1982).

The other traits which showed a significant difference between pure Borans and their crosses were carcass length, thigh girth, and records on fat at tenth rib and perirenal fat. The two former traits reflect anatomic differences between the groups, while the two latter indicate a greater ability of the Boran to store energy reserves. This ability might be a valuable property for animals which have to cope with long periods of feed scarcity.

Carcass length and fatness were the only traits showing important differences between breeds of sire. The results are in agreement with many previous studies (*e.g.* Koch et al., 1976; Berg 1982) in showing that bulls of the British beef breeds sire progenies which produce slightly shorter and fatter carcasses than bulls of the large-frame beef breeds originating in continental Europe (Charolais, Chianina, Piedmont). The leanest carcasses were those from Limousin and Piedmont crosses. Extreme leanness of Piedmont crosses was confirmed in a large scale experiment in which progenies of Piedmont, Limousin and Hereford bulls were compared (MacNail *et al.*, 2001). Pure Boran steers had about 8 percent less bone on the 10^{th} rib joint than the average of the crossbred groups. If this is applied to the bone mass of the whole carcass, the difference would amount to about 1 percent of the carcass weight (assuming 12 – 13 percent of bone in the carcass). The superiority of crossbreds over Boran in the carcass yield should therefore be reduced by this amount. The large amount of bone recorded on the Santa Gertrudis crosses is consistent with findings reported by Strydon *et al.* (2000).

Conclusions

Because of the limited amount of data, the results presented in this paper are not very precise, as shown by the rather large standard errors. Further, many aspects of carcass quality like tenderness, juiciness and palatability, have not at all been considered. For the time being quality of beef is getting more emphasis for lucrative markets and should be considered in beef crossbreeding in Tanzania. In addition, research should be directed towards other aspects, like viability and reproductive performance, besides growth rate.

References

Berg, R. T. 1982. Genetic and environmental factors influencing growth of muscle and fat tissue.2nd World Congress on genetics applied to livestock production. Madrid, 4-8 October, 1982. Vol.V, pp. 245-251.

Koch, R.M., Dikeman, M.E., Allen, D.M., May, M., Crouse, J.D., and Campion, D.R. 1976.Characterization of biological types of cattle. III. Carcass compositiont quality and palatability. J. Anim. Sci. 43(1): 48-62.

Liboriussen, T. 1982. Comparison on paternal strains used in crossing and their interest for increasing production in dairy herds. 2nd World Congress on genetics applied to livestock production. Madrid, 4-8 October 1982. Vol V, pp. 469-481.

MacNail, M.D., Short, R.E. and Grings, E.E. 2001. Characterisation of topcross progenies from Hereford, Limousin and Piedmontese sires. J. Anim. Sci. 79(7): 1751 – 1756.

Mchau, K.W., Syrstad, O. and Kifaro, G.C. 2006. Performance of Boran and crossbred cattle for beef production under ranch conditions in Tanzania: 1. Gestation length and growth to 36 months. Tanzania J.of Agric. Sci. 7(2):67-74

SAS Institute Ins. 1985. SAS User's guide: Statistics.5 Edition. Cary NC. USA. 956 pp.

Strydon, R.T., Naude, R.T., Scholtz, M.M. and van Wyk, J.B. 2000. Characterization of indigenous African cattle breeds in relation to carcass characteristics. Anim. Sci. 70: 241 – 252.

Trail, J.C.M., Sacker, G.D., and Marples, H.J.S. 1971. Crossbreeding beef cattle in Western Uganda. 5. Growth and carcass evaluation of castrated males.Anim. Prod. 13: 171-184.