# COMPARISON OF BOS TAURUS-BOS INDICUS BREED CROSSES WITH STRAIGHTBRED BOS INDICUS BREEDS OF CATTLE FOR MATERNAL AND INDIVIDUAL TRAITS[1]

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## Summary

Data were analyzed to compare crossbred females produced by crossing exotic Angus and Red Poll males to indigenous Ankole, Boran and Small East African Zebu (Zebu) females with straightbred females of the Ankole, Boran and Zebu breeds at the Ruhengere Field Station in the Ankole District of Southwestern Uganda. Progeny of the straightbred and crossbred dams were by Friesian, Brown Swiss and Simmental sires. Crossbred exotic × indigenous dams were favored over straightbred indigenous dams by 13.7% (P<.01) in calf birth weight and by 14.8% (P<.01) in calf weaning weight. Crossbred cows exceeded (P<.01) straightbred cows by 61.9% (48.5 kg) in calf weight weaned per cow exposed to breeding. Crossbred cows weighed 37, 46 and 42 kg more (P<.01) than straightbred cows at parturition, weaning and cow mean weight, respectively. Angus × Boran and Red Poll × Boran crossbred dams were compared specifically with straightbred Boran dams. Exotic (Angus, Red Poll) × Boran crossbred dams exceeded straightbred Boran dams by 27.0% (P<.05) in calf crop born, by 8.3% (P<.05) in progeny birth weight and by 14.7% (P<.01) in progeny weaning weight. Weight of calf weaned per cow exposed to breeding favored (P<.01) the Angus × Boran and Red Poll × Boran crossbred dams over the straightbred Boran dams by 50.5% (50 kg). Angus × Boran and Red Poll × Boran crossbred cows weighed an average of 24, 36 and 31 kg more (P<.01) than straightbred Boran cows at parturition and weaning and in cow mean weight, respectively. Results suggest that the ¾ exotic Bos taurus progeny of the Bos taurus × Bos indicus crossbred dams were not as well adapted to the climatic and nutritive environment to which they were subjected postweaning as the ½ exotic Bos taurus-½ indigenous Bos indicus progeny of the straightbred Bos indicus dams.

(Key Words: Beef Cattle, Bos Taurus, Bos Indicus, Exotic Crosses, Breed Effects.)

## Introduction

Indigenous breeds of cattle generally possess a higher level of overall adaptation than exotic breeds to the stressful climatic, nutritive and disease-parasite environments that characterize much of the tropics. Response capability of indigenous breeds for milk and meat production traits to increased increments of production inputs is usually low. Breeds that have been selected for economic traits in temperate climatic zones may possess a high response capability for milk and meat production, but technological and economic factors may prohibit modification of natural environ-

[1] The results reported in this paper are based on research conducted by the Ministry of Animal Industry, Game and Fisheries, Government of Uganda during the period of 1964 to 1972. As employees of the Ministry, J.C.M. Trail, H.J.S. Marples and J. Kakonge and the late George Sacker supervised the conduct of this research. K. E. Gregory provided leadership for planning and for reviewing this research under the auspices of the U.S. Agency for International Development, which provided financial support for the investigations. Analyses of these data were planned jointly by J.C.M. Trail and K. E. Gregory; the analyses were conducted by J.C.M. Trail. This paper was prepared while K. E. Gregory served as a consultant to the International Livestock Centre for Africa (ILCA).

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ments of the tropics to the degree necessary to realize as high a percentage of their genetic potential as can be exploited in temperate climatic zones (Gregory et al., 1982). The most feasible approach to increasing milk and meat production in the tropics is to achieve some improvement in the natural environment and to use cattle that possess the most nearly optimum additive genetic composition contributed by both indigenous and exotic breeds for production in the improved environment. The challenge is to organize breeding systems that will optimize the simultaneous use of both additive (average breed differences) and nonadditive (heterosis) sources of genetic variation (Gregory et al., 1982). Cartwright et al. (1964) and Koger et al. (1975) have reported high levels of heterosis for both individual and maternal traits for crosses of breeds of Bos indicus with Bos taurus cattle. The purpose of this report is to provide results on a series of maternal and individual traits involving two exotic Bos taurus breeds (Angus and Red Poll), each in crosses with three indigenous Bos indicus breeds (Ankole, Boran and Zebu), compared with straightbreds of the Ankole, Boran and Zebu breeds at the Ruhengere Field Station in the Ankole District of Southwestern Uganda. A primary objective of the experiment was to determine the value of exotic Bos taurus breeds when crossed with indigenous Bos indicus breeds relative to the indigenous Bos indicus breeds as straightbreds.

## Materials and Methods

Males of the Angus and Red Poll breeds each were mated to females of the Ankole, Boran and Zebu breeds at the Ruhengere Field Station in the Ankole District of Southwestern Uganda (Sacker et al., 1971; Trail et al., 1971a,b,c). Calf crops were produced from these matings in 1965, 1966 and 1967. Females were retained for evaluation of maternal traits. They were bred to produce their first calves as 3-yr-olds. Calves from these crossbred females, on which this analysis is based, were produced in 1969 and 1970 when the females were 3, 4 and 5 yr old. Straightbred Ankole, Boran and Zebu females from the same populations as the dams of the crossbred females also produced calves in this experiment in 1969 and 1970. Thus, nine breeding groups of females were included. The straightbred Ankole, Boran and Zebu females ranged in age from 3 to 10 yr when they produced calves in this experiment in 1969 and 1970. Crossbred and straightbred females were managed as one herd and were mated to the same sires when calves were produced. Calves were born during a 5-mo period from June to October in 1969 and from the beginning of January until the end of May in 1970. Conditions under which this experiment was conducted and the data collected are described in detail by Gregory et al. (1985a).

Calves born in 1969 were by Friesian and Brown Swiss sires and in 1970, calves were by Brown Swiss and Simmental sires. Matings were by a combination of artificial insemination and natural service in 1969; all matings were by artificial insemination in 1970. Within breed group, females included in this experiment were assigned to breed of sire and type of mating at random. Data on calf crop born percentage, preweaning viability percentage, overall viability percentage and weights at 12, 18 and 24 mo were available for calves born in 1969 only. Thus, cow productivity index (calf weight weaned per cow exposed to breeding) includes data on calves born in 1969 only. Data on birth weight, weaning weight and cow weight at parturition, weaning and cow mean weight were available in 1969 and 1970.

All traits were analyzed by least-squares, fixed model procedures (Harvey, 1972). The basic model, with appropriate model changes for specific traits, included the fixed effects of breed group of female (nine), cow age (3, 4, 5, 6 and 7+ yr), parity status of cow in previous year (heifer, rested or produced a calf), type of mating (artificial insemination or natural service), breed of sire of calf, year of birth of calf, sex of calf, period of birth of calf within calving season (divided into four periods of 5 wk each) and the interaction of breed group of dam with year. Based on a prior analysis, other interactions were not believed to be important.

More comparisons were made using the least-squares breed group means than there were independent degrees of freedom. Therefore, all of the comparisons are not independent, and the error rate over the entire set of comparisons may be different from that indicated by the level of probability. Tests of significance associated with the linear contrasts, although not independent, can be taken as guides as to whether the observed values could have occurred by chance. The residual mean square was used as the error term to test

the significance of the main effects, the interaction term and the linear contrasts.

### Results and Discussion

The numbers of records analyzed for the individual and maternal traits are presented in table 1 by breed group. Least-squares breed group means and average standard errors are presented in table 2. Linear contrasts constructed from the least-squares breed group effects involving exotic Bos taurus × indigenous Bos indicus crosses vs indigenous Bos indicus straightbreds are presented in table 3. Levels of significance for mean squares for breed group effects are indicated in table 3.

Data from the crossbred females included in this study were included in the report of Gregory et al. (1985a), and the straightbred females included in this study were managed as part of the same herd. Because of similarity of effects of years, age of dam, parity status, sex of calf, breed of sire of calf and period of birth within calving season for the traits analyzed, discussion of these effects is not included as part of this report. For a detailed report of these fixed effects of interest, see Gregory et al. (1985a).

*Exotic-Indigenous Crosses vs Indigenous Straightbreds.* The linear contrasts (table 3) between the exotic crosses and indigenous breed groups include all of the heterosis for maternal traits ($H^M = 1$) for crosses of these breeds, plus one-half of the additive maternal genetic effects ($G^M = .5$) and one-fourth of the additive direct genetic effects ($G^I = .25$) expressed in progeny. For individual traits (cow parturition weight, cow weaning weight, cow mean weight and cow weight change), the linear contrasts between the exotic crosses and indigenous breed groups include all of the individual heterosis for these traits ($H^I = 1$), plus one-half of the additive direct genetic effects ($G^I = .5$). Progeny of both crossbred and straightbred dams were by the same Friesian, Brown Swiss and Simmental sires.

The mean square for breed group of dam was significant in the analysis of variance for calf crop born percentage (table 3). Linear contrasts were significant and in favor of the Angus × Boran and the Red Poll × Boran dams for calf crop born percentage (table 3).

Breed group of dam had significant effects on birth weight and weaning weight in the analyses of variance. Linear contrasts were

TABLE 1. NUMBER OF OBSERVATIONS FOR EACH TRAIT BY BREED GROUP OF FEMALE

| Trait | Sire breed: | Angus | | | Red Poll | | | Ankole | Boran | Zebu |
|---|---|---|---|---|---|---|---|---|---|---|
| | Dam breed: | Ankole | Boran | Zebu | Ankole | Boran | Zebu | Ankole | Boran | Zebu |
| Maternal | | | | | | | | | | |
| Calf crop born (%) | | 18 | 29 | 23 | 15 | 36 | 24 | 101 | 106 | 97 |
| Preweaning and overall viability (%) | | 15 | 28 | 20 | 13 | 34 | 18 | 70 | 73 | 65 |
| Birth and weaning weight (kg) | | 25 | 43 | 42 | 21 | 43 | 26 | 80 | 162 | 78 |
| 12-, 18- and 24-mo weight (kg) | | 12 | 26 | 17 | 11 | 27 | 16 | 60 | 65 | 57 |
| Cow productivity index (kg) | | 18 | 29 | 23 | 15 | 36 | 24 | 101 | 106 | 97 |
| Individual | | | | | | | | | | |
| Cow parturition weight, cow weaning weight, cow mean weight and cow weight change (kg) | | 25 | 43 | 42 | 21 | 43 | 26 | 80 | 162 | 78 |

TABLE 2. LEAST-SQUARES MEANS AND AVERAGE STANDARD ERRORS OF CROSSES AND STRAIGHTBREDS FOR INDIVIDUAL AND MATERNAL TRAITS

| Trait | Sire breed: / Dam breed: | Mean | Angus | | | Red Poll | | | Ankole | Boran | Zebu | Average standard error |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Ankole | Boran | Zebu | Ankole | Boran | Zebu | Ankole | Boran | Zebu | |
| Calf crop born, % | | 83.6 | 82 | 100 | 89 | 86 | 100 | 78 | 72 | 73 | 68 | 8.7 |
| Preweaning viability, % | | 91.7 | 84 | 98 | 103 | 98 | 91 | 92 | 81 | 92 | 85 | 7.2 |
| Overall viability, % | | 89.5 | 87 | 99 | 91 | 92 | 86 | 94 | 80 | 92 | 84 | 8.1 |
| Birth weight, kg | | 29.0 | 30.0 | 30.0 | 28.2 | 32.6 | 31.9 | 28.7 | 28.0 | 28.6 | 23.2 | .6 |
| Weaning weight, kg | | 171 | 176 | 193 | 171 | 176 | 190 | 171 | 156 | 167 | 146 | 3.8 |
| 12-mo weight, kg | | 171 | 180 | 189 | 167 | 180 | 183 | 161 | 162 | 173 | 149 | 5.3 |
| 18-mo weight, kg | | 230 | 236 | 242 | 223 | 242 | 238 | 216 | 225 | 238 | 208 | 6.0 |
| 24-mo weight, kg | | 271 | 274 | 279 | 263 | 285 | 279 | 254 | 272 | 286 | 247 | 7.0 |
| Cow productivity index, kg[a] | | 111 | 107 | 157 | 129 | 125 | 141 | 102 | 69 | 99 | 67 | 14.0 |
| Cow parturition weight, kg | | 345 | 365 | 373 | 345 | 380 | 365 | 319 | 347 | 345 | 270 | 6.2 |
| Cow weaning weight, kg | | 325 | 352 | 353 | 321 | 361 | 346 | 308 | 323 | 313 | 248 | 5.7 |
| Cow mean weight, kg | | 336 | 359 | 364 | 333 | 371 | 356 | 314 | 335 | 329 | 259 | 5.5 |
| Cow weight change, kg | | −21 | −13 | −20 | −24 | −20 | −20 | −12 | −24 | −31 | −22 | 4.3 |

[a]Calf weight weaned per cow exposed to breeding.

TABLE 3. LINEAR CONTRASTS OF EXOTIC X INDIGENOUS CROSSBREDS VS INDIGENOUS STRAIGHTBREDS FOR INDIVIDUAL AND MATERNAL TRAITS

| Trait | (Angus X Ankole)-Ankole | (Angus X Boran)-Boran | (Angus X Zebu)-Zebu | (Angus crosses)-Indigenous | (Red Poll X Ankole)-Ankole | (Red Poll X Boran)-Boran | (Red Poll X Zebu)-Zebu | (Red Poll crosses)-Indigenous | (Exotic crosses)-Indigenous | Significance[a] |
|---|---|---|---|---|---|---|---|---|---|---|
| Calf crop born, % | 10 | 27* | 21 | 19.7 | 14 | 27** | 10 | 17.7 | 18.7 | * |
| Preweaning viability, % | 3 | 6 | 18 | 9 | 7 | −1 | 7 | 7.7 | 8.4 | NS[c] |
| Overall viability, % | 7 | 7 | 7 | 7 | 12 | −6 | 10 | 5.3 | 6.2 | NS |
| Birth weight, kg | 2.0* | 1.4* | 5.0* | 2.8** | 4.6** | 3.3** | 5.5* | 4.5* | 3.7** | ** |
| Weaning weight, kg | 20** | 26** | 25** | 23.7** | 20** | 23** | 25** | 22.7** | 23.2** | ** |
| 12-mo weight, kg | 18* | 16* | 18* | 17.3* | 18* | 10 | 12 | 13.3 | 15.3* | ** |
| 18-mo weight, kg | 11 | 4 | 15 | 10 | 17 | 0 | 8 | 8.3 | 9.2 | ** |
| 24-mo weight, kg | 2 | −7 | 16 | 3.7 | 13 | −7 | 7 | 4.3 | 4 | ** |
| Cow productivity index, kg[b] | 38 | 58** | 62** | 52.7** | 56** | 42** | 35 | 44.3** | 48.5** | ** |
| Cow parturition weight, kg | 18* | 28** | 75** | 40** | 33** | 20** | 49** | 34** | 37** | ** |
| Cow weaning weight, kg | 29** | 40** | 73** | 47** | 38** | 33** | 60** | 44** | 46** | ** |
| Cow mean weight, kg | 24** | 35** | 74** | 44** | 36** | 27** | 55** | 39** | 42** | ** |
| Cow weight change, kg | 11 | 11 | −2 | 6.7 | 4 | 11 | 10 | 8.3 | 7.5 | ** |

[a]For mean square for breed group effect.

[b]Calf weight weaned per cow exposed to breeding.

[c]NS = Not significant.

*P<.05.

**P<.01.

significant and favored crossbred dams over straightbred dams in birth and weaning weight of calves. Calves with crossbred dams weighed 3.7 kg (13.7%) more (P<.01) at birth than calves with straightbred dams. Calves with crossbred dams weighed 23.2 kg (14.8%) more (P<.01) at weaning than calves with straightbred dams.

Breed group of dam had a significant effect on 12-mo weight in the analysis of variance. The linear contrasts involving 12-mo weight were significant for all Angus crosses; among the Red Poll crosses the linear contrast was significant only for the Red Poll × Ankole crossbred group. Nevertheless, the progeny of crossbred dams weighed an average of 15.3 kg more (P<.05) at 12 mo than the progeny of straightbred dams. There was a compensation, however, of 7.9 kg between weaning (9 mo) and 12-mo weight in favor of the progeny of straightbred dams.

Even though the effects of breed group of dam were significant in the analysis of variance on weight both at 18 and at 24 mo, none of the linear contrasts was significant for weight at either of these ages. The progeny of crossbred dams weighed 9.2 and 4.0 kg more than the progeny of straightbred dams at 18 and at 24 mo, respectively. The 23.2-kg advantage at weaning in favor of the progeny with crossbred dams over straightbred dams was the result of the combined effects of additive maternal genetic effects, additive direct genetic effects and maternal heterosis (Gregory et al., 1985a,b). There was compensation for most of the preweaning effects during the 15 mo subsequent to weaning. Weight gains during this 15-mo period averaged only 220 g/d. We believe that the primary factor involved in explaining the reversal between preweaning and postweaning rate of gain of the progeny of exotic × indigenous crossbred and indigenous straightbred dams is that the progeny of the crossbred dams were ¾ Bos taurus breed composition and the progeny of straightbred dams were only ½ Bos taurus breed composition. Calves on which postweaning growth data were available were by Friesian and Brown Swiss sires. Thus, progeny of both exotic × indigenous crossbred and indigenous straightbred dams reflect maximum heterosis for individual traits ($H^I$ = 1). We believe that the ¾ Bos taurus progeny were likely less well adapted than the ½ Bos taurus progeny to the climatic and nutritive environment to which they were subjected after removal from their more favorable preweaning environment. Thus, their growth rate was less, even though their additive direct genetic effects for growth may have been greater in a more favorable climatic and nutritive environment.

The heavier weaning weight of progeny of crossbred dams suggests that the exotic × indigenous crossbred cows were at least equal to the indigenous straightbred cows in overall adaptation to the environment. This suggestion is supported further by the higher reproduction rate of the exotic × indigenous crossbred cows than the indigenous straightbred cows.

The effects of breed group of cow were significant in the analysis of variance for cow productivity index. Cow productivity index is calf weight weaned per cow exposed to breeding. Cows that were exposed to breeding and failed to wean a calf were recorded a zero for this trait. Thus, standard errors for this trait were large (table 2). Linear contrasts were significant for the index for all except one of the breed group comparisons; this linear contrast approached significance. Crossbred dams exceeded (P<.01) straightbred dams by 48.5 kg (61.9%) in calf weight weaned per cow exposed to breeding.

The effects of breed group of cow were significant in the analysis of variance for cow parturition weight, cow weaning weight, cow mean weight and cow weight change from parturition to weaning. Crossbred cows weighed 37, 46 and 42 kg more (P<.01) than straightbred cows at parturition, weaning and cow mean weight, respectively. Even though significant for the effects of cow breed group in the analysis of variance, none of the linear contrasts was significant for cow weight loss between parturition and weaning.

*Exotic × Boran Crosses vs Boran Straightbreds.* Because the Boran is recognized as the only improved indigenous breed used for beef production in East Africa and was considered a standard of comparison or a control when this experiment was planned, it is appropriate to focus specifically on comparisons of exotic × Boran crossbred dams with straightbred Boran dams for the traits evaluated. Linear contrasts constructed from least-squares breed group effects for Angus × Boran vs Boran and Red Poll × Boran vs Boran are presented in table 3. Again, these linear contrasts between the mean of the Angus and Red Poll breeds compared with the Boran breed include all of the hetero-

sis for maternal traits ($H^M$ = 1) between the Angus and Red Poll breeds in crosses with the Boran breed, plus one-half of the additive maternal genetic effects ($G^M$ = .5) and one-fourth of the additive direct genetic effects ($G^I$ = .25) expressed in progeny. For the individual traits (cow weights), the linear contrasts between the Angus and Boran breeds and the Red Poll and the Boran breeds include all of the individual heterosis ($H^I$ = 1) for these traits, plus one-half of the additive direct genetic effects ($G^I$ = .5).

For calf crop born percentage, Angus × Boran and Red Poll × Boran crossbred dams exceeded Boran straightbred females by an average of 27% ($P<.05$). For preweaning and overall viability percentage, the means of the progeny of the exotic × Boran crossbred dams and the progeny of straightbred Boran dams did not differ ($P>.05$).

Exotic × Boran crossbred dams produced calves that averaged 2.4 kg (8.4%) heavier ($P<.05$) at birth and 24.5 kg (14.7%) heavier ($P<.01$) at weaning than straightbred Boran dams. Even though the progeny of exotic × Boran crossbred dams averaged 13 kg heavier ($P<.05$) at 12 mo, the difference was only 2.0 kg at 18 mo, and at 24 mo the progeny of the straightbred Boran dams were 7.0 kg heavier ($P>.05$) than the progeny of the exotic × Boran crossbred dams. Weight of calf weaned per cow exposed to breeding favored ($P<.01$) the exotic × Boran crossbred dams over the straightbred Boran dams by 50 kg (50.5%).

Exotic × Boran crossbred cows weighed an average of 24, 36 and 31 kg more ($P<.01$) than straightbred Boran cows at parturition, weaning and cow mean weight, respectively.

*General Discussion*

The generally higher reproductive rate of progeny with greater viability along with greatly superior maternal performance indicate that the exotic × indigenous crossbred dams were at least equal to indigenous straightbred dams in overall adaptation to the production environment. The environment to which progeny were exposed from weaning at 9 mo to an age of 24 mo supported a gain of only 220 g/d. During this 15-mo period, the progeny of indigenous straightbred dams grew significantly faster than the progeny of crossbred dams so that differences in favor of progeny of crossbred dams were only 4.0 kg in 24-mo weight. The progeny of straightbred Boran dams were actually 7.0 kg heavier at 24 mo than the progeny of the exotic × Boran crossbred dams. The relatively favorable results for the exotic × indigenous crossbred dams for maternal traits and the relatively unfavorable postweaning growth rate of their progeny from weaning at 9 mo to 24 mo suggests that the ½ exotic Bos taurus crossbred cows were relatively better adapted to the production environment than their ¾ exotic Bos taurus progeny. Progeny on which postweaning data were available were by Friesian and Brown Swiss sires. Because of differences in exotic × indigenous additive genetic (breed) composition between the progeny of crossbred and straightbred dams, the postweaning environment was likely relatively more favorable to the progeny of indigenous straightbred cows. Trail et al. (1971b) presented results that showed that $F_1$ Angus × Boran and Red Poll × Boran crossbreds exceeded straightbred Boran in postweaning growth rate to 24 mo.

**Literature Cited**

Cartwright, T. C., G. F. Ellis, Jr., W. E. Kruse and E. K. Crouch. 1964. Hybrid vigor in Brahman-Hereford crosses. Texas Agr. Exp. Sta. Tech. Monogr. 1.

Gregory, K. E., J.C.M. Trail, R. M. Koch and L. V. Cundiff. 1982. Heterosis, crossbreeding and composite breed utilization in the tropics. Proc. 2nd World Congress on Genetics Applied to Livestock Production VI:279.

Gregory, K. E., J.C.M. Trail, H.J.S. Marples and J. Kakonge. 1985a. Characterization of breeds of Bos indicus and Bos taurus cattle for maternal and individual traits. J. Anim. Sci. 60:1165.

Gregory, K. E., J.C.M. Trail, H.J.S. Marples and J. Kakonge. 1985b. Heterosis and breed effects on maternal and individual traits of Bos indicus breeds of cattle. J. Anim. Sci. 60:1175.

Harvey, W. R. 1972. Program write-up for least squares and maximum likelihood general purpose program. The Ohio State Univ., Columbus (Mimeo.).

Koger, M., F. M. Peacock, W. G. Kirk and J. R. Crockett. 1975. Heterosis effects on weaning performance of Brahman-Shorthorn calves. J. Anim. Sci. 40:826.

Sacker, G. D., J.C.M. Trail and I. L. Fisher. 1971. Crossbreeding beef cattle in western Uganda. 2. Environmental influences on body weight. Anim. Prod. 13:143.

Trail, J.C.M., G. D. Sacker and I. L. Fisher. 1971a. Crossbreeding beef cattle in western Uganda. 1. Performance of Ankole, Boran and Zebu cows. Anim. Prod. 13:127.

Trail, J.C.M., G. D. Sacker and I. L. Fisher. 1971b. Crossbreeding beef cattle in western Uganda. 3. Genetic analysis of body weight. Anim. Prod. 13:153.

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