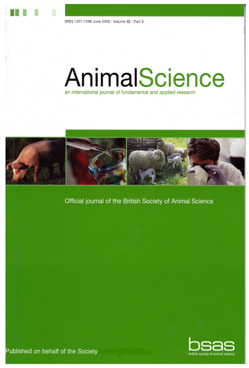

Comparative Performance of Six Holstein-Friesian × Guzera grades in Brazil 2. Traits related to the onset of the sexual function

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Animal Production / Volume 38 / Issue 02 / April 1984, pp 165 - 170
DOI: 10.1017/S0003356100002154, Published online: 02 September 2010

Anim. Prod. 1984, **38**: 165-170
0003-3561/84/23730165$02·00

COMPARATIVE PERFORMANCE OF SIX HOLSTEIN-FRIESIAN × GUZERA GRADES IN BRAZIL

2. TRAITS RELATED TO THE ONSET OF THE SEXUAL FUNCTION

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ABSTRACT

Age and weight at puberty, age at first conception and number of services per conception of 90 females at Santa Mônica Experimental Station, Valença, State of Rio de Janeiro, were studied. The females were of six red and white Holstein-Friesian (HF) × Guzera (G) grades: 1/4, 1/2, 5/8, 3/4, 7/8 and ≥ 31/32.

A model (1) including the effects of grade and season of birth resulted in the following least-squares means for the six grades in the above order (± s.e.): age at puberty, 770 (± 17), 725 (± 18), 799 (± 26), 788 (± 23), 777 (± 17) and 803 (± 24) days; weight at puberty, 309 (± 8), 334 (± 9), 316 (± 13), 311 (± 11), 303 (± 9) and 298 (± 12) kg; age at conception, 865 (± 19), 773 (± 19), 867 (± 31), 808 (± 25), 852 (± 22) and 837 (± 25) days; number of services per conception, 1·9 (± 0·2), 1·7 (± 0·2), 1·5 (± 0·3), 1·1 (± 0·2), 1·6 (± 0·2) and 1·3 (± 0·2).

A second model (2) was fitted, including the effects of season of birth, direct (g^I) breed additive effects (HF − G) and heterosis effects (h^I). g^I and h^I were estimated by the partial regression coefficient of the traits studied on, respectively, the expected HF gene frequency and the expected heterozygosity of the females. The estimates of g^I were not significantly different from zero except for age at first conception ($g^I = -102$ (s.e. 46) days) ($P < 0·05$). Heterosis effects were significant for age at puberty ($h^I = -86$ (s.e. 34) days), weight at puberty ($h^I = 44$ (s.e. 17) kg) and age at first conception ($h^I = -119$ (s.e. 37) days). These three estimates of h^I amounted, respectively to −0·106, 0·151 and −0·132 of the estimated mean of the parental breeds.

F-tests on the extra variation due to fitting model 1 after model 2 were not significant ($P < 0·05$) indicating that epistasis or other genetic effects, not included in model 2, were of little importance for the traits studied.

INTRODUCTION

CHARACTERS RELATED to the onset of sexual function have economic importance because they influence the cost of replacement of dairy females. Breed differences in age and weight at puberty have been reported (McDowell, Fletcher and Johnson, 1959; Reynolds, De Rouen and High, 1963; Wiltbank, Gregory, Swinger, Ingalls, Rothlisberger and Koch, 1966; Wiltbank, Kasson and Ingalls, 1969; Rakha, Hale and Igboeli, 1970; Laster, Glimp and Gregory, 1972; Laster, Smith and Gregory, 1976; Gregory, Laster, Cundiff, Koch and Smith, 1978; Gregory, Laster, Cundiff, Smith and Koch, 1979; Laster, Smith, Cundiff and Gregory, 1979; Stewart, Long and Cartwright, 1980), but information is scanty for tropical regions. Information on the performance of breeds and crosses, and on genetic parameters are needed to design breeding systems aimed at the economic utilization of genetic resources (Dickerson, 1973).

In this article, genetic effects on some characters related to sexual maturity are analysed, utilizing a sample of animals pertaining to a more comprehensive crossbreeding trial in the south-east region of Brazil, described by Madalena (1981).

† Project IICA/EMBRAPA.

MATERIAL AND METHODS

Animals and management

Data on 90 females, of six red and white Holstein-Friesian (HF) × Guzera (G) grades, were studied. Throughout this paper, grade means the expected fraction of HF genes, the implicit complement adding up to 1 coming from the G breed. The six grades were: 1/4, 1/2, 5/8, 3/4, 7/8 and ≥ 31/32 or HF. Animals of these six grades were contemporary. The halfbreds were F_1 out of G dams and HF sires. The 1/4 and 3/4 were first backcrosses of F_1 dams to, respectively, G and HF sires. The 7/8 were second backcrosses to HF sires, and the 5/8 were obtained by mating 5/8 dams to 5/8 sires. The 1/4 were sired by five G bulls, the 5/8 by one 5/8 bull and the other four grades were sired by six HF bulls. The crossbred (5/8) sire was from the same herd as the 5/8 dams. G and HF sires were from commercial artificial insemination companies. Further information on the genetic background of the cattle used was given by Lemos, Teodoro, Barbosa, Freitas and Madalena (1984).

The females were reared at Santa Mônica Experimental Station, Municipality of Valença, State of Rio de Janeiro. Climatic data were presented by Lemos *et al.* (1984). Calves were artificially reared, receiving 4 l whole milk per head per day up to 4 months of age. A concentrate ration (composition (g/kg) 410 ground maize, 540 cottonseed meal, 30 molasses, 20 mineral mix) was offered in collective feeders, limited to a maximum average daily consumption of 2 kg per head per day, up to 6 months of age. The mineral mix was composed (g/kg) of 800 bone-meal, 198·1 salt, 1·2 $CuSO_4$, 0·1 $CoSO_4$, 0·5 ZnO and 0·1 KI. The calves were kept in paddocks of Bermuda grass (*Cynodon dactylon* L.) until 6 months old and were also offered chopped elephant grass (*Pennisetum purpureum* Schum.). After 6 months of age the heifers were kept on native pastures, mainly molasses grass (*Melinis minutiflora* Beauv.). During the dry season and other periods of forage shortage they were given chopped elephant grass plus 1 to 2 kg of commercial concentrates (160 g crude protein and 620 or more g total digestible nutrients per kg) per head daily. The mineral mix was permanently available *ad libitum* in the paddocks.

After 12 months of age, the heifers were checked twice a day for oestrus, with the help of teaser bulls equipped with chin-ball devices. The heifers were weighed after 15 to 20 h fasting following detection of first oestrus (puberty) and inseminated for the first time at their second detected oestrus. For the analyses of traits involving conception, only data from heifers requiring up to three services were included. Frozen semen (French pailletes) of fifteen crossbred European × zebu bulls was used, being assigned at random to heifers within grades.

Statistical analysis

Data were analysed by least-squares techniques using the computer program of Harvey (1972). Data were grouped into two classes according to season of birth (May to September 1977 and December 1977 to February 1978). These two seasons resulted from an interruption of artificial insemination due to an outbreak of foot and mouth disease in the previous year and were considered only to reduce residual variation. Two models were used:

$$Y_{ijk} = M + G_i + B_j + e_{ijk} \qquad \text{(model 1)}$$

where Y_{ijk} represents one of the traits studied (age and weight at puberty, age at conception and number of services per conception) for the kth female of the ith grade ($i = 1, \ldots, 6$) and the jth season of birth ($j = 1,2$). Sire within grade and grade × season of birth interactions were not significant in preliminary analyses ($P > 0{\cdot}05$), and were not considered thereafter. Contrasts were tested by the method of Scheffé (1959).

Using multiple regression (Robison, McDaniel and Rincón, 1981), estimates were obtained of direct breed additive (g^I) and heterosis (h^l) effects, according to the following model:

$$Y_{ijk} = b_0 + g^l q_i^l + h^l z_i^l + B_j + e_{ijk} \qquad \text{(model 2)}$$

where Y and B have the same meaning as above, and q_i^l and z_i^l represent, respectively, the expected HF gene frequency and the expected heterozygosity of an individual of the ith grade. Assuming independent loci, $z^l = u(1 - v) + v(1 - u)$, where u and v represent, respectively, the HF grade of each progenitor of the individual. Table 1 shows the value of q and z for each grade. Heterosis effects were also expressed as a proportion of the estimated parental average and confidence limits for this ratio were calculated following Gianola (1980). The goodness of fit of model 2 was assessed by F-tests on the extra m.s. due to fitting model 1 after model 2 against the residual m.s. under model 1.

TABLE 1

Holstein-Friesian grade of heifers and parents, and expected heifer heterozygosity

Holstein-Friesian Grade of						
Heifer (q)	1/4	1/2	5/8	3/4	7/8	1
Sire (u)	0	1	5/8	1	1	1
Dams (v)	1/2	0	5/8	1/2	3/4	1
Expected Heterozygosity of heifer(z)	1/2	1	30/64	1/2	1/4	0

RESULTS

Heifers born during the second birth period had ages at puberty and conception, respectively, 59 (s.e. 18) and 86 (s.e. 20) days shorter than heifers born during the first period. As birth periods resulted purely from circumstantial reasons, their effects will not be discussed further.

Grade effects under model 1 were significant for age at conception ($P < 0{\cdot}05$), and approached significance for age at puberty and number of services per conception ($P = 0{\cdot}08$). Least-square means for model 1 are, however, shown in Table 2 for all characters because some significant genetic effects were indicated by the analysis under model 2 (Table 4). F_1 females were younger and heavier at puberty than the 1/4 and HF. Females of the other grades were intermediate between F_1 and HF in age and weight at puberty. The trend of grade effects for age at conception approximately paralleled grade effects for age at puberty, but HF and 3/4 ranked relatively better, as they required less services per conception (Table 2).

Two females (grades 1/4 and HF) did not show oestrus up to age 36 months, and were culled. Fourteen females contributed to puberty but not to conception data: two (grades 1/4 and 5/8) did not show a second oestrus; four (one 1/4 and three 5/8) were not

TABLE 2

Number of heifers and least-square means (LSM), with standard errors, for reproduction traits

	Age at puberty (days)			Weight at puberty (kg)			Age at conception (days)			No. services/ conception		
	No.	LSM	s.e.	No.	LSM	s.e.	No.	LSM	s.e.	No.	LSM	s.e.
Mean	90	777	9	90	312	5	76	833	10	76	1·5	0·1
Holstein-Friesian grade												
1/4	21	770	17	21	309	8	17	865[a]†	19	17	1·9	0·2
1/2	18	725	18	18	334	9	17	773[b]	19	17	1·7	0·2
5/8	9	799	26	9	316	13	7	867[ab]	31	7	1·5	0·3
3/4	12	788	23	12	311	11	11	808[ab]	25	11	1·1	0·2
7/8	20	777	17	20	303	9	14	852[ab]	22	14	1·6	0·2
HF	10	803	24	10	298	12	10	837[ab]	25	10	1·3	0·2

† a, b: means with different superscripts differ significantly ($P < 0{\cdot}05$).

TABLE 3

Summary of statistics for models 1 and 2

	Age at puberty	Weight at puberty	Age at conception	No. services/ conception
Model 1				
Total reduction				
m.s.	25 984	2202	40 591	0·987
d.f.	6	6	6	6
Residual				
m.s.	5 823	1435	6 259	0·555
d.f.	83	83	69	69
R^2	0·24	0·10	0·36	0·13
Model 2				
Total reduction				
m.s.	49 272	4160	70 484	1·291
d.f.	3	3	3	3
Residual				
m.s.	5 714	1394	6 444	0·560
d.f.	86	86	72	72
R^2	0·23	0·09	0·31	0·09
Extra variation due to fitting model 1 after model 2				
m.s.	2 697	244	10 699	0·675
d.f.	3	3	3	3
F	0·46NS	0·17NS	1·71NS	1·22NS

TABLE 4

Estimates of breed additive and heterosis effects, with standard errors

	Age at puberty (days)		Weight at puberty (kg)		Age at conception (days)		No. services/ conception	
	Mean	s.e.	Mean	s.e.	Mean	s.e.	Mean	s.e.
g^I (HF-G)								
Actual units	−17NS	40	12NS	20	−102*	46	−0·74NS	0·43
h^I								
Actual units	−86**	34	44**	17	−119**	37	0·13NS	0·35
h^I								
Proportion of parental mean	−0·106		0·151		−0·132		—	
0·95 confidence intervals	−0·201 to −0·022		0·039 to 0·279		−0·390 to −0·219		—	

inseminated because of uterine infection; and eight (two 1/4, one 1/2, one 5/8, one 3/4 and three 7/8) required more than three services per conception and were eliminated to simulate the culling practice considered appropriate for well managed herds in the region.

As may be seen from the F-ratios and from the coefficients of determination (Table 3), model 2 fitted the data nearly as well as model 1 for the three traits that were significantly affected by genetic effects, i.e. age and weight at puberty, and age at conception. Estimates of breed additive and heterosis effects are presented in Table 4. The g^I effect was significant only for age at conception (HF − G = −102 (s.e. 46 days)) ($P < 0{\cdot}05$). Heterosis reduced age at puberty and age at conception, and increased weight at puberty, having a small and non-significant effect on the number of services per conception.

DISCUSSION

The better performance of F_1 heifers may be a consequence of the environment for this study, in which average weight/average age at puberty was 0·40 kg/day. Stewart *et al.* (1980) reported Holstein heifers to be younger at puberty than Holstein × Brahman F_1, and these younger than Brahmans, in two groups with average weight/age of 0·80 and 0·65 kg/day, respectively. McDowell *et al.* (1959) reported that Jersey heifers reached puberty at a younger age than F_1 Jersey × Red Sindhi crosses at one location, while no significant differences were found at a second location where performance was poorer. Wiltbank *et. al.* (1969) found a significant interaction between heterosis and feeding level for age at puberty in Hereford × Angus crosses. Heterosis was present on a low feeding level and absent on a high one. Results in the present study support published evidence indicating increased importance of heterosis for age at puberty under adverse environments (Barlow, 1981).

Positive heterosis for weight at puberty was reported by Gregory *et al.* (1978) and Stewart *et al.* (1980). Wiltbank *et al.* (1966) found no differences between crossbreds and purebreds, while Wiltbank *et al.* (1969) reported crossbreds to be heavier at puberty than purebreds on the high feeding level but lighter on the low feeding level.

In tropical environments under poor management conditions, crossbreeding of *Bos taurus* and *B. indicus* offers a means of reducing age at first calving, because of the heterosis present in age at puberty and age at first conception. At the same farm where this study was undertaken, but under poorer management, the advantage of crossbreds over pure European heifers was more marked, age at first calving for Holstein-Friesian and F_1 Holstein-Friesian × Gir females being, respectively, 1368 and 1202 days (Freitas, Madalena and Martinez, 1980). However, under more favourable environments, purebred *B. taurus* have shown better performance (McDowell *et al.*, 1959; Gregory *et al.*, 1979; Stewart *et al.* 1980).

Sheridan (1981) suggested epistasis to be an important cause of heterosis in domestic animals. However, in the present study, breed additive and heterozygosis effects accounted for most of the variation between grades, indicating that epistasis or other genetic effects not included in model 2 had negligible influence on the traits under consideration.

ACKNOWLEDGMENTS

The authors acknowledge the technical assistance of Mr A. T. de Campos and Mr J. D. Nogueira, and the statistical advice of Dr Carmen S. Pereira.

REFERENCES

Barlow, R. 1981. Experimental evidence for interaction between heterosis and environment in animals. *Anim. Breed. Abstr.* **49:** 715-737.

Dickerson, G. E. 1973. Inbreeding and heterosis in animals. *Proc. Anim. Breed. Genet. Symp. in Honor of Dr J. L. Lush,* pp. 54-57. American Society of Animal Science, Champaign, Ill.

Freitas, A. F., Madalena, F. E. and Martinez, M. L. 1980. [Age at first calving and calving interval of Holstein-Friesian and crossbred Holstein-Friesian : Gir cows.] *Pesq. Agrop. Bras., Brasília* **15:** 101-105.

Gianola, D. 1980. Confidence intervals for ratios of linear functions of mixed models with reference to animal breeding data. *J. Anim. Sci.* **50:** 1051-1056.

Gregory, K. E., Laster, D. B., Cundiff, L. V., Koch, R. M. and Smith, G. M. 1978. Heterosis and breed maternal and transmitted effects in beef cattle. II. Growth rate and puberty in females. *J. Anim. Sci.* **47:** 1042-1053.

Gregory, K. E., Laster, D. B., Cundiff, L. V., Smith, G. M. and Koch, R. M. 1979. Characterization of biological types of cattle — Cycle III. II. Growth rate and puberty in females. *J. Anim. Sci.* **49:** 461-471.

Harvey, W. R. 1972. User's guide for least squares and maximum likelihood general purpose program. Ohio State University, Columbus (Mimeograph).

Laster, D. B., Glimp, H. A. and Gregory, K. E. 1972. Age and weight at puberty and conception in different breeds and breed-crosses of beef heifers. *J. Anim. Sci.* **34:** 1031-1036.

Laster, D. B., Smith, G. M., Cundiff, L V. and Gregory, K. E. 1979. Characterization of biological types of cattle (Cycle II). II. Postweaning growth and puberty of heifers. *J. Anim. Sci.* **48:** 500-508.

Laster, D. B., Smith, G. M. and Gregory, K. E. 1976. Characterization of biological types of cattle. IV. Postweaning growth and puberty of heifers. *J. Anim. Sci.* **43:** 63-70

LEMOS, A. M., TEODORO, R. L., BARBOSA, R. T., FREITAS, A. F. and MADALENA, F. E. 1984. Comparative performance of six Holstein-Friesian × Guzera grades in Brazil. 1. Gestation length and birth weight. *Anim. Prod.* **38:** 157-164.

MCDOWELL, R. E., FLETCHER, J. L. and JOHNSON, J. C. 1959. Gestation length, birth weight and age at first calving of crossbred cattle with varying amounts of Red Sindhi and Jersey breeding. *J. Anim. Sci.* **18:** 1430-1437.

MADALENA, F. E. 1981. Crossbreeding strategies for dairy cattle in Brazil. *Wld Anim. Rev.* **38:** 23-30.

RAKHA, A. M., HALE, D. and IGBOELI, G. 1970. The age of puberty in local breeds of cattle in Central Africa. *J. Reprod. & Fert.* **22:** 369-370.

REYNOLDS, W. L., DE ROUEN, T. M. and HIGH, J. W., JR. 1963. The age and weight at puberty of Angus, Braman and Zebu cross heifers. *J. Anim. Sci.* **22:** 243-244 (Abstr.).

ROBISON, O. W., MCDANIEL, B. T. and RINCÓN, E. M. 1981. Estimation of direct and maternal additive and heterotic effects from crossbreeding experiments in animals. *J. Anim. Sci.* **52:** 44-50.

SCHEFFÉ, H. 1959. *The Analysis of Variance.* Wiley, New York.

SHERIDAN, A. K. 1981. Crossbreeding and heterosis. *Anim. Breed. Abstr.* **49:** 131-144.

STEWART, T. S., LONG, C. R. and CARTWRIGHT, T. C. 1980. Characterization of cattle of a five-breed diallel. III. Puberty in bulls and heifers. *J. Anim. Sci.* **50:** 808-820.

WILTBANK, J. N., GREGORY, K. E., SWIGER, L. A., INGALLS, J. E., ROTHLISBERGER, J. A. and KOCH, R. M. 1966. Effects of heterosis on age and weight at puberty in beef heifers. *J. Anim. Sci.* **25:** 744-751.

WILTBANK, J. N., KASSON, C. W. and INGALLS, J. E. 1969. Puberty in crossbred and straightbred beef heifers on two levels of feed. *J. Anim. Sci.* **29:** 602-605.

(*Received* 18 *November* 1982—*Accepted* 20 *July* 1983)