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THE COMPARATIVE PERFORMANCE OF HOLSTEIN FRIESIAN AND BROWN SWISS BREEDS IN CROSSES WITH TROPICAL CATTLE: A REVIEW OF THE LITERATURE.

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The comparative performance of Holstein Friesian and Brown Swiss crosses with zebu and criollo cattle in the tropics and subtropics is reviewed, using data from 14 sources in India, Latin America and the southern USA. No evidence of differences between breed groups was found for abortion rate, stillbirth rate or herd life in cows. Statistically significant differences in favour of the Holstein crosses amounted to 37-130% in calf and heifer survival, 4-28% in body weight at different ages, 8-9% in age at first calving, 6-13% in reproductive traits and 8-49% for milk yield. The only significant differences in favour of the Brown Swiss crosses amounted to 4-14% for milk yield, but in part of the data European breed was confounded with grade of European breed inheritance. Overall, 88% of the significant differences for performance traits were in favour of the Holstein crosses. More information is required on stabilised crossbred populations, especially under grazing conditions. Meanwhile, the use of the Holstein Friesian in preference to the Brown Swiss seems amply justified for crossbreeding programmes in the tropics.

Key words: Holstein Friesian crosses, Brown Swiss crosses, pre-natal survival, post-natal survival, growth, reproduction, milk yield, tropics.

The important role of European x zebu/criollo cattle for milk and dual purpose production using the resources commonly available in the tropics is widely recognised (Mason 1974; FAO 1979). However, relatively little information is available on how to form crossbred populations which will produce most efficiently. Usually, the mating system involves the use of European breed bulls, or bulls with European inheritance, on zebu or criollo cows and one of the first decisions which has to be made concerns the European breed to use. The breeds most widely available for crossbreeding programmes in Latin America are the Holstein Friesian and the Brown Swiss, and the purpose of this paper is to collect available evidence on their comparative performance in crosses with native cattle in the tropics and subtropics.

Results

The results shown in Tables 1 to 4 refer, respectively, to survival, growth, reproductive and productive characters of Holstein Friesian (HFx) and Brown Swiss (BSx) crossbreds. The European breeds were mainly of North American origin, although semen of British Friesian bulls was used at Haringhata, India. The tropical breed or type involved is indicated in the Tables and, within characters, the results are grouped according to level of European breed inheritance.

Survival. Table 1 summarises information on abortions, stillbirths, post-natal death and culling rates and on herd life in cows. The data are taken from experiment stations in Louisiana and India and from a commercial farm in the Venezuelan lowlands, in all cases reflecting relatively intensive systems of management and artificial rearing of the calves.

Table 1 Abortions, stillbirths, post-natal losses from death or involuntary culling, and herd life in cows

Trait	n[a]	Crosses: Holstein Friesian	Crosses: Brown Swiss	P[b]	Grade of European breed inheritance	Tropical breed/ type	Reference
Abortions (%)							
1st gestation	224	1.0	0.8	NS	≥75%	Red Sindhi	1a
2nd gestation	161	4.9	3.6	NS	≥75%	Red Sindhi	1a
Stillbirths (%)							
All gestations	1350	2.3	2.8	NS	≥50%	Zebu/Criollo	2a
1st gestation	224	6.9	6.7	NS	≥75%	Red Sindhi	1a
2nd gestation	161	4.9	5.6	NS	≥75%	Red Sindhi	1a
Death (D) and involuntary culling(C)(%);							
Calves							
Age undefined (D)	(219)	6.7	8.1	--	F_1	Hariana	3a
0-3 months (D)	(693)	8.5	11.5	--	F_1	Hariana	4
3-12 months (D)	(693)	2.3	6.7	--	F_1	Hariana	4
0-9 months (D+C)	1656	13.4	18.4	.01	≥50%	Zebu/Criollo	2a
0-3 months (D+C)	305	5.3	12.2	.05	≥75%	Red Sindhi	1a
3-15 months (D+C)	(305)	3.7	5.2	.05	≥75%	Red Sindhi	1a
Heifers							
12-28 months (D)	(693)	1.1	3.1	--	F_1	Hariana	4
9 months -1st calving (D+C)	665	9.2	10.9	NS	≥50%	Zebu/Criollo	2a
Service-1st calving (D+C)	1958	22.5	30.8	.01	≥50%	Zebu/Criollo	2b
15 months-1st calving (D+C)	(305)	10.7	8.2	NS	≥75%	Red Sindhi	1a
Cows							
1st-2nd calving	1575	29.0	27.0	NS	≥50%	Zebu/Criollo	2b
2nd-3rd calving	(305)	22.4	25.6	NS	≥75%	Red Sindhi	1a
Herd life in cows							
Calvings/lifetime	577	2.6	2.7	NS	≥50%	Zebu/Criollo	2b

In this and the following tables:

[a] Number of observations. Figures in parenthesis are approximate. [b]P shows statistical significance of the difference.

References:

1 Iberia Livestock Expt. Stn., Jeanerette, La., USA. The sample included crosses between European breeds. 1a: Hollon and Branton (1975); 1b: Hollon *et al.* (1972); Hollon *et al.* (1969); 1d: Hollon *et al.* (1967).

2 Intensive commercial farm, lowlands, west-central Venezuela. 2a: Vaccaro and Vaccaro (1981); 2b: Cardozo and Vaccaro (1983a); 2c: Vaccaro and Vaccaro (1982); 2d: Cardozo and Vaccaro (1983b).

[3] Hissar Exp. Stn., Haryana, India. 3a: Katpatal (1977); 3b: Katpatal (1979).

[4] Haringhata Exp. Stn., W. B., India. Katpatal (1977).

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[11] Seven commercial farms, south of Lake Maracaibo, Venezuela. Contreras *et al.* (1978).

[12] Six commercial farms, Parijá, Venezuela. Cerrada *et al.* (1978).

[13] Thirty-one commercial farms, south of Lake Maracaibo, Venezuela. 13a: Rodríguez *et al.* (1974); 13b: Rodríguez *et al.* (1978).

[14] Experiment stations, Zulia, Venezuela. Rodríguez and Rincón (1971).

[15] Jalapur Exp. stations, M.P., India, Katpatal (1979)

There was no evidence of differences between the HFx and BSx with respect to abortion or stillbirth rates, but the data refer exclusively to high grade crosses. The calf losses were consistently higher in the BSx, whatever the level of European breed inheritance. In two of the studies, the loss of BSx calves was over double that of the HFx. Taking the data altogether and weighting according to the number of observations, the BSx losses were 48% greater. The difference was attributed to higher incidences of pneumonia (14.0 *vs* 6.8%) and diarrhea (53.1 *vs* 30.3%) in the BSx calves in the Louisiana study (Hollon and Branton, 1975).

The same tendency continued in heifers in three of the four studies considered. The difference was, however, of statistical significance only in the Venezuelan case, where it was of considerable economic importance. Most of the losses were due to reproductive causes, possibly related to excessive body weights at first service (Cardozo and Vaccaro 1983a), and it is of interest that Hollon and Branton (1975) also observed a higher incidence of anoestrous in BSx heifers in Louisiana (38.2 *vs* 24.5%).

The differences between HFx and BSx animals in survival after first calving were neither consistent nor significant.

Growth. Information of body weights at different ages, ages at first oestrus and at first calving is presented in Table 2. The data are taken from the sources mentioned above and, in addition, from extensive, dual purpose herds in the Colombian lowlands where calves are reared by their dams (Schellenberg 1983).

The birth weights of the HFx and BSx F_1 calves where very similar, except in the case of the Gir crosses, and also similar in the high grade crosses in Louisiana. However, in all the F_1 groups, the HFx weighed more than the BSx at 6 as well as at 18 months of age, with differences amounting to between 4 and 25%. The same tendency was evident in the high grade cross calves, although the difference did not reach significance at 18 months of age. In Schellenberg's (1983) study, the 4% difference in favour of the HFx at 10 months of age was not significant, possibly suggesting that the disadvantage of the BSx is less marked when the calves

Table 2 Body weights, age at first oestrous and age at first calving

Trait	n	Crosses Holstein Friesian	Brown Swiss	P	Grade of European breed inheritance	Tropical breed/type	Reference
Body Weight (kg)							
At birth	659	25.3	25.6	NS	F_1	Hariana	3b, 5b
	334	26.5	20.7	.01	F_1	Gir	6
	335	27.2	27.2	NS	F_1	Ongole	7
	230	34.5	35.7	NS	$\geq$75%	Red Sindhi	1b
At:							
6 months	400	101.2	93.8	.01	F_1	Hariana	3b, 5b
	303	109.1	87.1	.01	F_1	Gir	6
	285	86.0	83.1	.05	F_1	Ongole	7
	(230)	145.4	135.8	.01	$\geq$75%	Red Sindhi	1b
10 months	255	134	128	NS	$\leq$25%	Zebú/Criollo	9
18 months	276	250.8	217.7	.01	F_1	Hariana	3b, 5b
	247	317.4	278.9	.01	F_1	Gir	6
	138	217.6	200.2	.01	F_1	Ongole	7
	(230)	330.9	323.8	NS	$\geq$75%	Red Sindhi	1b
During 1st lactation	128	425	442	NS	$\geq$75%	Red Sindhi	1c
Adult cow	687	382	366	.01	$\leq$25%	Zebu/Criollo	9
Age at 1st oestrous (months)	79	20.9	22.6	--	F_1	Hariana	5a
	118	18.4	19.4	--	F_1	Hariana	3a
	114	24.6	25.6	--	F_1	Hariana	4
Age at 1st calving (months)	158	31.6	34.2	.01	F_1	Hariana	3b
	188	35.6	35.0	NS	F_1	Hariana	5b
	174	33.0	33.4	NS	F_1	Ongole	7
	62	31.0	35.0	NS	F_1	Criollo	10
	996	32.7	35.6	NS	F_1	Criollo	2c

are suckled naturally. On the other hand, the grade of European inheritance in this case was very low. McDowell (1982) attributed the poor growth rate of Brown Swiss pure and crossbred young stock in the USA to their greater health problems, which were also evident in the present study, judging by the comparatively high death rates, and demonstrated their long term effects: BSx cows which had been treated for disease as calves produced 770 kg less milk than those which had not been treated.

Very few data are available describing adult cow weights. While no difference was observed in the high grade crosses in Louisiana, in low grade crosses under extensive conditions in Colombia, the HFx cattle weighed 4% ($P < .01$) more than the BSx.

With regard to age at first oestrous, the data derived from the F_1 crosses in India were not subjected to statistical analysis, but the difference of one month in favour of the HFx was consistent.

Significant differences in age at first calving were not always observed in the F_1 groups, but in three of the four studies included, the HFx heifers calved earlier than the BSx, with a difference of 2.6 months ($P < .01$) in one case. A similar difference of 2.9 months ($P < .05$) was found in HFx heifers of ≥ 50% Eurepean breeding in Venezuela.

Reproduction. In addition to the sources already included, information on reproduction is taken from the regions of Perijá and south of Lake Maracaibo, Venezuela. Data from between 6 and 31 commercial farms are included in each study. The predominating system of production is to keep the cows on pastures without supplementation, to milk with the calves present and to use natural mating.

In general, the results in Table 3 show very small differences between HFx and BSx females, irrespective of type of crossbred or production system. The only significant differences were in favour of the HFx. However, one of these refers to a difference of only seven days in the interval between calving and first *post partum* oestrus, and was thus of little practical importance. The other case refers to a considerable difference in calving interval, 1.8 months, in dual purpose cattle in Colombia. The milk yields and weaning weights of the two groups of cows were similar (Tables 2 and 4), and no obvious explanation for the

Table 3 Reproduction in females and males

Trait	n	Crosses: Holstein Friesian	Crosses: Brown Swiss	P	Grade of European breed inheritance	Tropical bread/type	Reference
Females:							
Interval calving-1st oestrous (days)	338	48	47	NS	≥75%	Red Sindhi	1d
Interval calving-conception (days)	338	115	122	.01	≥75%	Red Sindhi	1d
Conception to 1st service (%)	266	47	51	--	F_1	Hariana	4
Birth rate (%)	201	71.9	67.7	--	F_1	Criollo	10
Calving interval (days)	507	421	474	.01	≤25%	Zebu/Criollo	9
	214	410	399	NS	F_1	Hariana	5b
	323	403	396	NS	F_1	Hariana	3b
	198	461	471	--	F_1	Hariana	4
1st-2nd calvings	625	432	439	NS	≥50%	Zebu/Criollo	2c
2nd-3rd calvings	297	441	445	NS	≥50%	Zebu/Criollo	2c
	338	401	398	NS	≥75%	Red Sindhi	1d
	(1349)	418	397	NS	*	Zebu/Criollo	11
	(2351)	422	445	--	*	Zebu/Criollo	12
	217	386	399	NS	*	Zebu/Criollo	13a
	608	424	443	NS	*	Zebu/Criollo	13b
Males:							
Conception to 1st service (%)	113	44	31	--	F_1	Hariana	4
Conception (%)	409	33	30	--	F_1	Hariana	4

* Undefined.

Table 4 Milk yield and composition

Trait	n	Crosses: Holstein Friesian	Crosses: Brown Swiss	P	Grade of European breed inheritance	Tropical breed/type	Reference
Milk yield/lactation (kg)	154	720	730		≤25%	Zebu/Criollo	9
1st-3rd lactation	304	2185	1379	--	F_1	Hariana	4
1st lactation	153	2625	2248	.01	F_1	Hariana	3b
1st lactation	100	.835	1434	.01	F_1	Hariana	5b
1st lactation	149	329	2236	.01	F_1	Gir	6
1st lactation	84	.391	1975	.01	F_1	Gir	8
1st lactation	57	2477	1927	.01	F_1	Ongole	7
All lactations	240	2000	1318	--	F_1	Criollo	10
All lactations	94	1816	1705	NS	F_1	Criollo	14
All lactations	3002	3409	3148	.01	≥50%	Zebu/Criollo	2d
All lactations	128	4104	4080	NS	≥75%	Red Sindhi	1c
All lactations	464	1457	1664	.05	*	Zebu/Criollo	13a
	1063	1486	1689	.05	*	Zebu/Criollo	13b
	(2351)	2022	1970	NS	*	Zebu/Criollo	12
Milk yield/day (kg)	2364	2.7	2.8	.05	≤25%	Zebu/Criollo	9
Butterfat %	—	4.5	4.6	—	F_1	Hariana	3b, 5b
	—	3.9	4.0	—	F_1	Ongole	7
	128	3.8	3.8	NS	≥75%	Red Sindhi	1c
Solids-not-fat %	—	8.7	8.7	—	F_1	Hariana	3b, 5b
	—	8.5	8.8	—	F_1	Ongole	7
	128	8.8	9.0	NS	≥75%	Red Sindhi	1c

* Undefined

difference in fertility is apparent.

There is little available information on the fertility of crossbred males. The data included in Table 3 refer to artificial insemination and Katpatal (1977) concluded that the HFx were somewhat superior to the BSx. Although the results were not analysed statistically, they may serve as a reference for future studies.

Milk production. Data on milk yields and composition from the same sources are summarised in Table 4. In the F_1 groups, the yields of the HFx were consistently higher than those of the BSx. If the differences are weighted according to the numbers of observations, the superiority of the HFx reached 24% in the crosses with zebu and 34% in the crosses with criollo cattle. Although limitations of numbers and statistical design do not permit exact conclusions, these results give a general idea of the size of the difference between the two paternal breeds in the first crossbred generation. At Haringhata, where the HFx produced 58% more than the BSx in the first three lactations, the HFx included a sample of daughters of

British Friesian sires of mediocre genetic quality (mean predicted difference: + 19 kg milk), compared with the North American Brown Swiss sires (+ 207 kg milk) (Katpatal 1977). Even so, the HFx in this sample produced 4% more milk in the first lactation.

With higher grade crosses, a difference of 8% in yield was found in favour of the HFx cattle in an intensive production system in the Venezuelan lowlands. With mean yields above 4 000 kg milk per lactation in Louisiana, there was no difference between HFx and BSx females, but the total number of cattle was small.

In the case of the crossbreds of low or undefined levels of European inheritance, used in more extensive systems, the results seems contradictory. Either the HFx and BSx groups produced similar amounts of milk, or the difference was in favour of the BSx. However, in the study of Rodríguez et al (1974, 1978), the superiority of the BSx was attributed to their higher levels of European breed inheritance (Rodríguez et al 1974). In Schellenberg's (1983) study, the difference of 0.1 kg milk/day in low grade crosses was of little practical importance and was not apparent when the lactation yields were considered as a whole.

With regard to milk composition, the limited information available suggests a slight advantage for the BSx in the first generation, both for fat and solids-not-fat percentage. The same tendency in solids-not-fat was observed in the high grade crosses in Louisiana.

Discussion

The outstanding aspect of the results presented is the consistency of the superiority of the HFx animals. The differences in calf survival, growth and milk yield would be of considerable economic significance both in milk and dual purpose production systems. In other traits, the differences were of minor practical importance, or non-existent. It is possible that the BSx may prove superior in milk solids percentages, but this has not been demonstrated statistically, and the difference was, in any case, small.

These conclusions agree closely with those obtained in comparisons between pure and crossbred Holsteins and Brown Swiss in inter-breed crossing experiments carried out in the United States (McDowell 1982). Another advantage of the Holstein Friesian is the variety and superior genetic quality of the sires available in the international market. In the USA in 1983, the number of bulls active in artificial insemination with positive progeny tests and with predicted differences above 1 500 lb milk were 616 and 274 in the Holstein and 51 and 19 in the Brown Swiss breeds, respectively (USDA DHIA, 1983). The difference in availability of semen of high genetic quality is also reflected in its price.

Nevertheless, it is important to point out that the majority of the studies included in this review refer to animals kept in confinement. There is relatively little information available on comparative performance in more extensive production systems and, in part of that available, European breed is confounded with grade of crossbred. In addition, most of the results refer to first generation crosses or to systems of grading up to the European breeds. It is possible that they are thus not applicable to established crossbred populations of intermediate grades of European breeding, such as are indicated for use in grazing systems in parge parts of the Latin American tropics. It is urgently necessary to generate reliable information in this area. Meanwhile, where equal opportunity exists to choose between the two European breeds for tropical crossbreeding programmes, the choice of the Holstein Friesian seems justified.

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