REPRODUCTION AND CALF GROWTH IN BRAHMAN CROSSBRED AND SOUTH EAST ASIAN CATTLE IN PAPUA NEW GUINEA

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Summary

Reproduction and growth to weaning were compared for Brahman crossbred (BX) and a local strain of South-East Asian cattle, "Javanese Zebu" (JZ) and their reciprocal crosses at "Erap" in the humid equatorial lowlands of Papua New Guinea. Forty heifers of each breed were mated continuously, half to bulls of each breed, for five years. BX calved first at 35 months while JZ calved at 31 months. Subsequent calving intervals were very short, at 370 and 341 days. JZ cows weighed about two thirds of the BX cattle at each stage of reproduction. Birth weights and growth to weaning were : BX 35 kg and 0.68 kg/d ; BX male × JZ female 29.3 kg and 0.53 kg/d ; JZ male × BX female 30.8 kg and 0.61 kg/d ; JZ 25 kg and 0.50 kg/d. The combination of small cow size, short calving interval and rapid calf growth resulted in the BX male × JZ female being the most efficient producer, in kg of calf weaned per cow mated per year while the reciprocal cross was the least efficient ; both straight-breds were equal and intermediate. These data show that indigenous equatorial cattle may not be inferior under good grazing conditions. For all traits, breed interactions (heterosis) was small and non-significant.

(**Key Words** : Tropical Cattle, Calving Interval, Weaning Weight)

Introduction

The small tropical type of cattle known locally as "Javanese Zebu" (JZ) were imported to Papua New Guinea from Java, Sumatra and Thailand by German missionaries before 1900 (Purdy, 1972). During World War II, some of these cattle survived by becoming feral and were recaptured to found new herds in the East Sepik, Madang and New Ireland Provinces. Shorthorn and Aberdeen Angus cattle were imported from Australia, followed by Africaners and Brahmans. By the mid- 1970's, most lowlands cattle were 1/2 - 3/4 Brahman (with some Africander) and 1/4 1/2 *Bos taurus*, i. e. similar to herds run in the sub- tropical and tropical regions of northern Australia. Little information is available on performance of these Australian cattle in the humid equatorial lowlands compared to cattle such as the JZ which originated there. This paper compares the reproductive performance of cows and preweaning growth of calves of Brahman crossbreds (BX) and Javanese Zebu (JZ) in pure breeds and in reciprocal crosses, from 1977 to 1982, in Papua New Guinea.

Materials and Methods

The Pastoral Research Centre, 'Erap', and its herd of Brahmancrossgbred (BX) cattle were described in detail in a previous paper (Holmes et al., submitted for publication, Asian-Austraiasian J. Animal Science, 1991). The climate is uniformly hot, with two wet seasons ; the light soils support Dichanthium, Imperata and Cenchrus ciliaris pastures, with little legume ; the BX cattle are about 9/16 Brahman, 1/16 Afrikaner and 3/8 Shorthorn.

In 1974, accumulation of JZ cattle (Holmes, 1977) commenced with purchase of one bull and 24 females of all ages from Roman Catholic Missions in the lower Sepik River area, 33 heifers and 4 bulls from coconut plantations near

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Madang, and 25 heifers and 2 bulls from plantations in New Ireland.

In June 1977, 20 BX and 20 JZ heifers were mated to a 3-year-old BX bull, and an identical group to a JZ bull, to produce straightbred and reciprocal cross calves. Mating to the same breed of bull continued until 1982. Sires selected from the station herds replaced existing bulls in 1979 and 1981. Based on previous experience, BX heifers were mated when they reached 300 kg, JZ at 200 kg. Cows and calves were weighed each month and newborn calves were ear-tagged and weighed at birth. Males were not castrated until weaning at approximately 7 1/2 months. In 1980 a change in station function necessitated a reduction in numbers to about 14 in each group, and weighing was not carried out as regularly during 1980-81. The trial terminated in October 1982, when the better breeders in each group had weaned their fifth calf.

Cow traits analysed using least-squares procedures (Harvey 1975) were cow weight at conception (CCWT) (defined as 285 days prior to birth), cow weight prior to calving (PCWT), minimum cow weight during lactation (CMWT), cow weight at weaning of calf (CWWT) and calving interval (CI). The least squares model fitted to the data included the fixed effects of breed of cow, parity, cow breed × parity, and sex and breed of calf (or of previous calf for analysis of CCWT and CI). Non-significant terms were dropped from the model for the final analyses. Repeatabilities of cow traits and calf weights (considered as a trait of the cow) were estimated

TABLE 1. LEAST SQUARES BREED AND PARITY MEANS OF WEIGHTS AND INTERVALS DURING CALVING CYCLES IN BX AND JZ COWS AND CALF PRE-WEANING WEIGHTS

Trait	Breed	Parity				
		1	2	3	4	5
Cow Traits						
Weight (kg) at:						
Conception (CCWT)	BX	333	368	404	448	428
	JZ	217	262	276	279	292
Pre-calving (PCWT)	BX	424	455	471	487	486
	JZ	293	306	309	333	322
Minimum during lactation (CMWT)	BX	363	392	396	406	375
	JZ	241	270	274	284	253
Weaning of calf (CWWT)	BX	380	413	424	431	397
	JZ	277	294	273	312	278
Calving interval (days) (CI)	BX	1078	389	357	365	370
	JZ	944*	370	338	346	351
Calf Traits						
Birth weight (BWT)		31.3	31.9	31.3	28.4	27.4
Birth weight/cow pre-calving weight (%) (BWT/PCWT)		8.7	9.0	8.8	8.0	6.6
Ave. daily gain (ADG) (kg/day)		0.58	0.64	0.60	0.52	0.50
Weaning weight/cow weight at weaning (%) (WWT/CWWT)		50	52	49	40	45

* Time between birth of cow and birth of first calf.

from the ratio of the between- and within- cow variance components, estimated within each breed of cow and pooled to give a combined estimate. Calf weights used in the variance component analyses were corrected for the fixed effects of sex and dam age using multiplicative adjustment factors from the Australian National Beef Recording Scheme (NBRS).

Calf traits analysed were calf birth weight (BWT), BWT as a proportion of pre-calving weight of cow (BWT/PCWT), average daily gain from birth to weaning (ADG), and weaning weight as a proportion of cow weight at weaning (WWT/CWWT). The model used to analyse these traits included the effects of sire breed, dam breed, sex, parity, dam breed × parity and dam breed × sire breed (equivalent to calf breed). Maternal effects were calculated as the difference between sire and dam breed effects divided by the overall mean. Heterosis was calculated as the difference between the mean of the crossbred calves' performance and the mean of the straightbred calves' performance expressed as a proportion of the straight-bred calves' performance.

Theoretically, a term for individual cow should have been included in the model because each cow contributed up to five records. However, limitation on size of the model prevented removal of these effects. For the purposes of testing for significance, the error variance was assumed to be an adequate estimate of the true error variance and the error degrees of freedom were adjusted for the number of cows.

Results

JZ cows weighed on average only 68% (62-75%) of the weight of the BX cows at all stages of the five calving cycles (table 1) and these breed differences were highly significant ($p < 0.001$). In both breeds cow weights increased to the third parity when they reached a plateau (figure 1). Parity effects were highly significant ($p < 0.001$) for all cow weight traits.

Both breeds of cow exhibited extremely high fertility throughout the study; the CI of the reputedly lowly fertile BX was equivalent to a calving percentage of 98% while the JZ rate was 104%. JZ bred for the first time on average 134 days earlier than BX cows (table 1). Calving

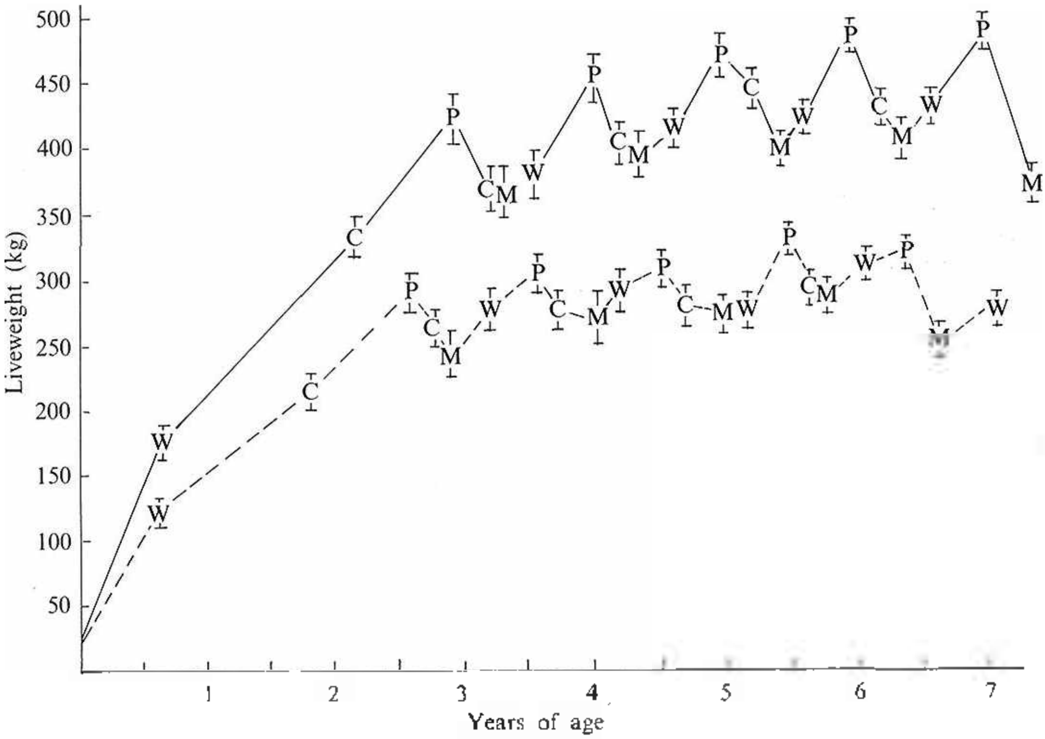

Figure 1. Liveweight of BX (——) and JZ (– – –) cows from birth to weaning of 5th calf. W = weaning, C = conception, P = parturition, M = minimum weight during lactation (+ S.E.).

intervals (CI) of JZ at each parity were consistently 19 days shorter ($p < 0.05$) than those of BX cows. The combined effect was that JZ calves at the 5th parity were born on average approximately 7 months earlier than BX calves. Heifers suckling their first calves had the longest calving intervals. Repeatabilities of all traits were similar in the two breeds so that only the pooled values are given in table 2. Of the cow weights CWWT and CMWT had highest repeatabilities. Repeatabilities of calf traits were low.

BX × BX calves were 10.1 kg heavier ($p < 0.001$) than JZ × JZ calves at birth. BX sired calves, irrespective of dam breed, were 4.3 kg heavier than JZ sired calves, and calves from BX dams were 5.2 kg ($p < 0.01$) heavier than calves from JZ dams (table 3). This corresponds to a maternal effect on birth weight of 30%. In contrast, the differences due to breed of sire and breed of dam in the ratio of calf birth weight

TABLE 2. REPEATABILITY (± S.E.) OF WEIGHTS DURING A CALVING CYCLE, CALVING INTERVAL, AND CALF PRE-WEANING GROWTH TRAITS IN A HERD OF JZ AND BX COWS

Trait		Repeatability (± S.E.)
Cows		
	Weight at conception	0.21 (± 0.10)***
	Weight before calving	0.19 (± 0.11)*
	Weight at weaning of calf	0.48 (± 0.10)***
	Minimum weight during lactation	0.44 (± 0.10)***
	Calving interval	0.27 (± 0.08)**
Calves		
	Birth weight	0.12 (± 0.06)*
	Birth weight/cow weight before calving	0.01 (+ 0.12)
	Average daily gain	0.15 (± 0.09)*
	Weaning weight/cow weight at weaning	0.14 (± 0.12)

TABLE 3. LEAST SQUARES MEANS FOR BIRTH WEIGHT, BIRTH WEIGHT AS A PROPORTION OF COW PRE-CALVING WEIGHT, AVERAGE DAILY GAIN TO WEANING AND ADJUSTED WEANING WEIGHT AS A PROPORTION OF DAM WEIGHT AT WEANING FOR BX × BX, JZ × JZ, BX × JZ AND JZ × BX

Trait	Mean (± S.E.)	Breed of Dam	Breed of Sire BX	JZ	Both
Birth weight (kg)	30.1 (± 0.7)	BX	35.1	30.8	33.0
		JZ	29.3	25.0	27.2
		Both	32.2	27.9	
Calf birth wt/cow pre-calving wt (%)	8.0 (± 0.3)	BX	7.8	6.7	7.3
		JZ	9.3	8.3	8.8
		Both	8.6	7.5	
Pre-weaning ADG (kg)	0.57 (± 0.01)	BX	0.68	0.61	0.65
		JZ	0.53	0.46	0.50
		Both	0.61	0.54	
Calf weaning wt/cow wt at weaning (%)	47 (± 1)	BX	47	43	45
		JZ	52	47	50
		Both	50	45	

to dam pre-calving weight (BWT/PCWT) were generally small (table 3), and only the difference due to breed of dam was significant ($p < 0.05$). The maternal effect for BWT/PCWT was 8% in favour of the JZ dam. Growth rates to weaning (ADG) of BX × BX calves were 0.22 kg/d (49%) higher than those of JZ × JZ, and calves by BX sires and dams grew 13 and 30% faster ($p < 0.001$) than those by JZ sires and dams respectively. The maternal effect on ADG was 13%. The ratios of calf weaning weight to cow weight at weaning (WWT/CWWT) from BX × BX and JZ × JZ were identical, but lower for calves from JZ than BX sires ($p < 0.01$). In contrast, JZ dams produced relatively larger calves than BX dams ($p < 0.01$) corresponding to a maternal effect of 18%.

There were parity effects on BWT/PCWT ($p < 0.05$) but not on BWT. Both ADG and WWT/CWWT were affected by parity where calves from 2nd parity cows grew fastest ($p < 0.001$, table 1). For all traits there was no sire breed × dam breed interaction thus heterosis effects were small and insignificant.

Discussion

The relatively constant ratio of weight of JZ cows to BX cows over five calving cycles indicates that the JZ perform simply as a scaled-down version of the BX. Repeatability of calving interval tended to be higher than in other studies (Plasse et al., 1966; Wilson and Willis, 1974) but in both of those studies fixed mating periods were used which tends to introduce a downward bias in repeatability estimates (Baily et al., 1985; Bourdon and Brinks, 1983). Our estimate was similar to that for day of birth (0.31) reported by Seifert et al., (1982) in Africander crossbreds in the coastal sub-tropics of Central Queenslnad.

Although sire breed significantly influenced calf birth weight and calf growth rate, it had no effect on dam weight or on calving interval within breed of cow. Larger calves therefore did not adversely affect cow weight or reproduction by their greater demand for milk.

Performance of cows over the five year period in terms of total weight of calf produced and efficiency of calf production is recorded in table 4. The efficiency of weaner production, calculated per kg of cow weight, was higher for BX bulls than JZ bulls, and higher for JZ cows than BX cows. Thus the best mating was BX bull × JZ cow which was estimated to be 27% more efficient than a straight BX × BX mating. This estimate may be biased in favour of the smaller breed since the maintenance requirements of smaller cattle are usually higher than larger cattle per kg live weight. The basal metabolic rate of BX steers is 20% below that of Bos taurus steers in a warm climate (Vercoe and Frisch, 1977). Since no data are available for BX cows or any JZ cattle, unsubstantiated assumptions regarding requirements for maintenance, lactation and growth must be made to calculate their energetic efficiency. For cattle of these sizes, if ARC (1980) tables are used, the maintenance requirements of JZ cattle would appear to be about 12% higher per kg live weight than BX. This could eliminate any apparent advantage of JZ × JZ

TABLE 4. RELATIVE EFFICIENCY OF PRODUCTION OF WEIGHT OF WEANER BY BX, JZ AND RECIPROCAL CROSSES, PER KG OF DAM AND PER MJ ME (ARC 1981) FOR MAINTENANCE. "TIME" IS THE INTERVAL FROM WEANING OF DAM TO WEANING OF HER FIFTH CALF: COW WEIGHT IS THE MEAN WEIGHT AT WEANING OVER THIS INTERVAL.

Breed		Total wt. 5 calves/ cow	Time to produce 5 calves (yr.)	Mean cow wt.	kg calf per kg cow per year.	Relative efficiency : (BXBX = 100%)	
						per kg cow weight (%)	per MJ ME for maintenance
BX	BX	953	7.0	383	0.355	100	100
	JZ	755	6.4	261	0.451	127	113
JZ	BX	850	7.0	383	0.317	89	89
	JZ	652	6.4	261	0.389	110	98

over BX × BX cattle (table 4). The advantage of BX × JZ mating over BX × BX is reduced from 27% to about 13%.

Repeatability was high for cow weights during lactation (CMWT) but low for weights at conception (CCWT) and calving (PCWT) when nutritional stress was lower. This indicates that, while cows may gain a variable amount of weight during pregnancy, depending upon the season, they lose weight to a repeatable minimum during lactation. Minimum weight is limited by frame size, and is therefore to some extent buffered against seasonal changes and the cows' milk production. On the other hand, repeatabilities of calf weights were low suggesting that energy expended by the cow for foetal growth and milk production is less buffered against seasonal effects. It would appear from this that, within these breeds, calf growth and survival is a secondary consideration after cow maintenance. Seifert et al. (1982) found repeatabilities of calf pre-weaning growth rates of a similar magnitude and suggested that estimates in tropical herds tended to be lower than in temperate herds (e. g. Turner and Shrode,1986).

Between breeds, calf weights at birth were not a simple proportion of cow weights. Irrespective of size, JZ cows bore and weaned relatively larger calves than BX cows. Smaller breeds generally have relatively higher birth weight; Taylor and Murray (1987) found the relationship

: Calf wt = .197 dam $wt^{0.83}$,

using data from over 200 breeds.

Calf growth rate increased from first to second parity, then declined to the third and subsequent parities in parallel with the rainfall. This is in contrast with the expected pattern for cattle where calf pre-weaning growth rate would increase with age of cow up to about 5 years of age.

In our experiment JZ and BX heifers conceived first at approximately 220 and 320 kg, calved at 290 and 429 kg, lost 5 and 11% of their body weight during lactation and had calving intervals of 341 and 370 days respectively. The mating weights for heifers of both breeds appeared appropriate as indicated by the continued growth and rapid rebreeding after parturition. Under harsh conditions of the Sepik plains of Papua New Guinea, BX grew at 0.35 kg/d, calved at 300 kg, for the first time, lost 30% of their body weight during lactation and had calving intervals of 28 months, while JZ grew at 0.50 kg/d and had calving intervals of 15 months (Holmes, 1977). Couchman (1983) has shown that in the Papua New Guinea Highlands, BX heifers mated at 250-300 kg live weight calved at 415 kg, lost 19% of body weight by 126 days and had calving intervals of 402 days. However, heifers that conceived at light weights had prolonged calving intervals (> 500 days) which would explain the better performance in our study where heifers were on average heavier when first mated. Rudder et al. (1985) in Central Queensland found that critical weights for various age groups of Africander and Brahman cross breeders differed. They also found that the live weight required to achieve a first conception rate of at least 80% in BX heifers was greater than 325 kg and was greater than 375 kg for maximum conception rates in lactating cows. The year round good nutrition and relatively benign environment at Erap therefore allowed the BX to achieve high reproductive rates when compared to reports from other tropical environments.

Size and fatness of carcass are important components of profitability of beef production. At the same degree of fatness, JZ steers yield about 90% of the carcass weight of the BX, despite the small size of the cows (Holmes, 1985). However, at these high reproduction rates, sale of females is of considerable importance. In developing countries marketing a large carcase can present problems so that small carcasses such as the JZ may be preferred. Even in these countries, unit cost of slaughtering may favour larger animals.

We conclude that crossbreeding BX and JZ to produce F1 cattle is unlikely to be advantageous in P. N. G. unless greater advantages are shown than found here. The BX cattle at Erap have high fertility and good growth rates. JZ cattle are smaller and more fertile than BX, but this advantage is smaller under good conditions and their energetic efficiency is unlikely to be significantly greater. Under harsh, humid equatorial lowlands conditions JZ are superior and their contribution to beef production in Papua New Guinea probably lies in these areas.

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