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Sire breed and breed genotype of dam effects in crossbreeding beef cattle in the subtropics. 2. Calving interval and cow productivity

J.G.E. van Zyl,[1] S.J. Schoeman* and R.J. Coertze

Department of Livestock Science, University of Pretoria, Pretoria, 0001 Republic of South Africa

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The influence of sire breed and breed genotype of dam on calving interval (CI) and cow productivity (CP) in Afrikaner, Hereford, Simmentaler and Bonsmara cattle, as well as in F_1, and two- and threebreed rotational crosses between Afrikaner, Hereford and Simmentaler were investigated. Cows bred to Afrikaner and Bonsmara bulls exhibited longer ($P < 0.05$) calving intervals than cows bred to Hereford and Simmentaler bulls. Cows bred to Afrikaner bulls were less ($P < 0.05$) productive than cows bred to other *Bos taurus* sires. An increase in proportion Afrikaner breeding in dam resulted in longer calving intervals and a decline in cow productivity, but these differences were not always significant. A breeding strategy for the retainment of superior performance is discussed.

Die invloed van vaderras en genotipe van moeder op kalfinterval en koeiproduktiwiteit by Afrikaner-, Hereford-, Simmentaler- en Bonsmarabeeste, asook twee- en drierasrotasiekruise tussen Afrikaner, Hereford en Simmentaler is ondersoek. Die gebruik van Afrikaner- en Bonsmarabulle het 'n langer ($P < 0.05$) kalfinterval tot gevolg as wanneer Hereford- en Simmentalerbulle gebruik word. Koeie met kalwers van Afrikanerbulle was minder ($P < 0.05$) produktief as koeie met kalwers van die ander *Bos taurus*-bulle. 'n Toename in persentasie Afrikanerteling in die koei het 'n langer kalfinterval en verlaagde produktiwiteit tot gevolg gehad, alhoewel die verskille nie altyd betekenisvol was nie. 'n Kruisteeltstrategie om prestasie op hoë vlakke te handhaaf, word bespreek.

Keywords: Calving interval, crossbreeding, dam breed genotype, productivity, sire breed.

* Author to whom correspondence should be addressed.

[1] Present address: P.O. Box 655, Bloemhof, 2660 Republic of South Africa.

Introduction

The importance of a high reproductive rate in the overall efficiency of the beef cattle enterprise has been emphasized by various authors (Harwin *et al.*, 1967; Klostermann, 1981; López de Torre & Brinks, 1990). Calving interval (CI) is one of several criteria by which reproductive performance can be evaluated (Bourdon & Brinks, 1983; Duarte-Ortuno *et al.*, 1988). Cow productivity [(365 ÷ CI) × weaning mass of calf)] gives an indication of the annual weaner mass production, and thus the expected income from the sale of weaners.

Material and Methods

Animals, environment and recording and statistical procedures have been described by Van Zyl *et al.* (1992). The CI figures do not reflect the real genetic variability in fertility of different dam breed genotypes, as rigorous culling of barren cows tend to decrease variation (Sacco *et al.*, 1990). Although calving date is regarded as a better criterium of cow fertility when a restricted breeding season is applied (Bourdon & Brinks, 1983; Lopez de Torre & Brinks, 1990), CI was used to enable the calculation of cow productivity (CP).

Low R^2 values for analyses of variation of fertility parameters are not uncommon (Hinojosa *et al.*, 1980; Bourdon & Brinks, 1983; Duarte-Ortuno *et al.*, 1988).

Results and Discussion

Analyses of variance of factors influencing CI and CP are presented in Table 1. Year, productive status of dam and day of birth within year influenced both CI and CP significantly ($P < 0.05$ or $P < 0.01$).

For each 1-kg increase in calf weaning mass, the subsequent CI was increased by 0.41 days. Cows with heifer calves were less ($P < 0.01$) productive than those with bull calves (213.65 vs. 233.58 kg). Relevant first-order interactions had a relative small, but significant ($P < 0.05$) influence (Table 1).

Table 1 Analysis of variance for calving interval and cow productivity

	CI		CP	
Source	df	F	df	F
Year	12	2.19**	11	3.30**
Productive status	2	4.30*	2	3.40*
Breed of sire	3	5.92**	3	18.21
Breed genotype of dam	13	3.01**	13	2.45**
Sex of calf	–	–	1	74.61**
Age of dam	–	–	2	NS[a]
Weaning mass of previous calf	1	23.58**	–	–
Day of birth (year)	26	4.90**	24	4.90**
Breed of sire × productive status	6	2.19*	–	–
Breed of sire × sex of calf	–	–	3	2.73*
Year × age of dam	–	–	22	4.03*
Breed genotype of dam × age of dam	–	–	26	4.11*
Error	2134		2080	
R^2 Model	8.30		42.65	

[a] Non-significant.

** $P < 0.01$; * $P < 0.05$.

Breed of sire

Cows running with Afrikaner and Bonsmara bulls exhibited significantly ($P < 0.05$) longer calving intervals than cows which were with Hereford and Simmentaler bulls (Table 2). Cows rearing calves sired by Simmentaler bulls were more ($P < 0.05$) productive than those with calves sired by Afrikaners and Bonsmaras. Cows raising progeny by Hereford sires were more ($P < 0.05$) productive than those with Afrikaner-sired progeny (Table 2).

Table 2 Least squares means for calving interval (CI) and cow productivity (CP) by breed of sire of calf

Breed of sire	CI		CP	
	n	Days ± *SE**	n	kg ± *SE**
Afrikaner	802	407.46 ± 8.20^{a}	802	202.43 ± 6.26^{a}
Hereford	670	376.76 ± 9.22^{b}	670	223.34 ± 6.36^{bc}
Bonsmara	286	418.57 ± 41.85^{a}	286	227.22 ± 16.64^{ac}
Simmentaler	440	342.93 ± 16.36^{b}	440	241.47 ± 8.40^{b}

* Least squares means with different superscripts differ significantly ($P < 0.05$).

Little information regarding the reproductive capabilities of Sanga type *Bos indicus* bulls is available, while these characteristics are well researched in Zebu type *Bos indicus* (Brahman). Several authors (Seebeck, 1973; Crockett *et al.*, 1978; Reynolds *et al.*, 1979; Bailey & Moore, 1980) found the reproductive ability of Brahman bulls inferior to that of *Bos taurus* breeds, or even that of Afrikaners (Chenowith & Osborne, 1975). However, Neville *et al.* (1988) failed to show a difference in conception rate of cows bred to Angus and Brahman bulls.

The fact that Bonsmara and Afrikaner bulls took longer ($P < 0.05$) to get their allotment of cows in calve compared to Hereford and Simmentaler bulls (Table 2), indicate that their mating characteristics and behaviour may be similar to that of Zebu bulls. Keeping in mind that relatively few (20) females were assigned per bull, and that bulls underwent some breeding soundness evaluations prior to the breeding season, the sire breed effects might have been more pronounced if 30 or 40 females had been assigned per bull.

Although the heritability of bull fertility is low ($h^2 = 0.08$; Mackinnon *et al.*, 1990), the variation in fertility in Sanga type pure and synthetic breeds may be similar to that in Zebu populations (Seebeck, 1973; Cartwright, 1980), and thus afford opportunities for improving Sanga type bull fertility by selection.

Breeding soundness evaluations used included physical examination and semen evaluation prior to the start of the breeding season. This is invaluable to ensure acceptable fertilization rates and may improve overall fertility (Cartwright, 1980). Under commercial conditions, multisire breeding may be advantageous since large individual differences in fertilization rates have been demonstrated (Marincowitz, 1975; Neville *et al.*, 1988).

The superior ($P < 0.05$) productivity of cows rearing progeny by the *Bos taurus* sire breeds would, in part, be due to heterosis in the calf as well as a positive additive contribution by the *Bos taurus* sires. Sanga type sires have little, or even a negative additive influence on the growth performance of their progeny (Mentz, 1977; Tawonezvi *et al.*, 1988). Heterosis estimates were not calculated but reported by Schoeman *et al.* (1992).

The shorter CI of cows and high weaning mass of calves (Van Zyl *et al.*, 1992) sired by Simmentalers accounted for the superior ($P < 0.05$) productivity of cows by these sires compared to cows running with Afrikaner and Bonsmara bulls. Herefords were superior to Afrikaners ($P < 0.05$), but not to Simmentalers and Bonsmaras (Table 2). Both these *Bos taurus* breeds, and possibly others (Scholtz *et al.*, 1990) could be considered as possible sire breeds in initial crosses with indigenous females. Although Brahman sires increased the productivity of Afrikaner cows by virtue of increased weaning mass (Mentz *et al.*, 1979), subsequent generations of these crosses have shown a lapse in fertility (Seebeck, 1973; Mackinnon *et al.*, 1990). Initial crosses of Afrikaners with other *Bos taurus* breeds have maintained high levels of fertility (Seebeck, 1973) and productivity (Mentz, 1977) in later generations.

Breed genotype of dam

Very few significant ($P < 0.05$) differences in CI that can be attributed to breed genotype of dam have been observed (Table 3), probably due to the removal of cows failing to conceive two years in succession. Some general tendencies in CI related to breed genotype of dam can, however, be deduced (Table 3; Figures 1 and 2). Cows with less than 50% Afrikaner breeding (purebred Simmentaler excluded) had shorter calving intervals than those with more than 50% Afrikaner breeding (Figure 1). Cows sired by the other *Bos taurus* breeds had shorter calving intervals than those sired by Afrikaners (Figure 2). Afrikaner cows are known to be prone to lactational anestrus (Harwin *et al.*, 1967), as are Zebu cows (Madalena & Hinojosa, 1976; Cartwright, 1980). Other Sanga types, however, have been found to be highly fertile (Light *et al.*, 1982; Tawonezvi *et al.*, 1988; Schoeman, 1989). *Bos taurus* × Afrikaner crossbreds are inherently highly fertile (Seebeck, 1973; Mentz, 1977; Mackinnon *et al.*, 1990) and the

Table 3 Least squares means for calving interval (CI) and cow productivity (CP) by breed genotype of dam

Breed genotype of dam	CI		CP	
	n	Days ± *SE**	n	kg ± *SE**
Afrikaner	311	401.30 ± 13.74^{abcd}	311	204.00 ± 5.22^{ab}
Hereford	331	389.56 ± 14.22^{abcd}	331	190.90 ± 5.27^{a}
Bonsmara	290	374.78 ± 33.53^{abd}	290	206.98 ± 12.59^{abc}
Simmentaler	306	409.22 ± 19.62^{abcd}	306	221.14 ± 7.53^{b}
1/2H 1/2A	91	376.70 ± 16.62^{abcd}	91	229.04 ± 6.24^{cdef}
1/2S 1/2A	326	380.72 ± 13.82^{abcd}	326	235.73 ± 5.0^{ef}
3/4A 1/4H	101	395.63 ± 15.65^{c}	101	214.70 ± 6.13^{bd}
3/4A 1/4S	83	426.07 ± 21.35^{bc}	83	208.69 ± 8.29^{abc}
1/2H 1/4S 1/4A	107	353.09 ± 15.95^{abcd}	107	239.54 ± 6.03^{cef}
5/8H 3/8A	63	351.17 ± 17.36^{abcd}	63	242.22 ± 13.27^{cef}
5/8S 3/8A	79	363.23 ± 16.69^{abcd}	79	227.57 ± 10.49^{bf}
5/8A 1/4H 1/8S	66	368.84 ± 17.10^{ad}	66	254.70 ± 8.86^{ef}
11/16A 5/16H	18	394.86 ± 24.44^{abcd}	18	188.78 ± 61.91**
11/16A 5/16S	26	424.79 ± 25.73^{abcd}	26	266.64 ± 45.76**

* Least squares means with at least one common superscript in column, do not differ significantly ($P > 0.05$).

** Unreliable least squares means owing to too few observations.

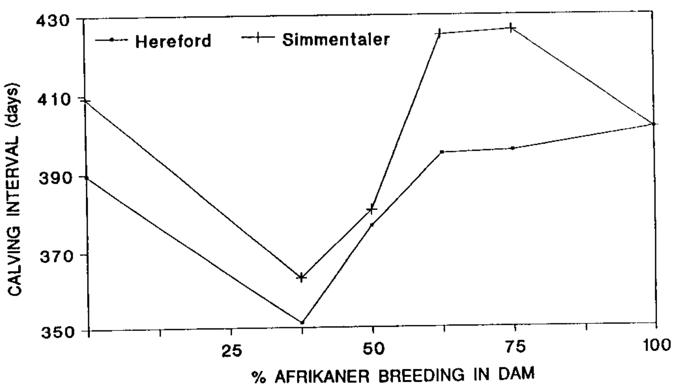

Figure 1 Influence of % Afrikaner breeding in dam on calving interval.

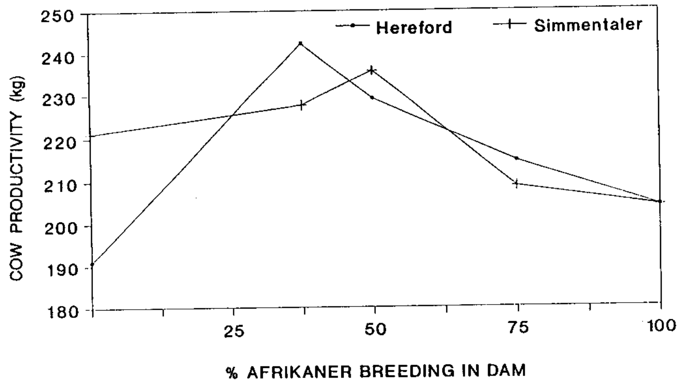

Figure 3 Influence of % Afrikaner breeding in dam on cow productivity.

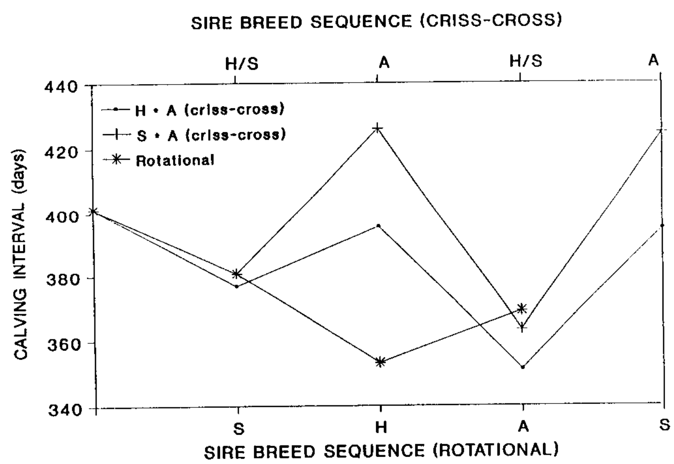

Figure 2 Variation in calving interval with sire breed of dam.

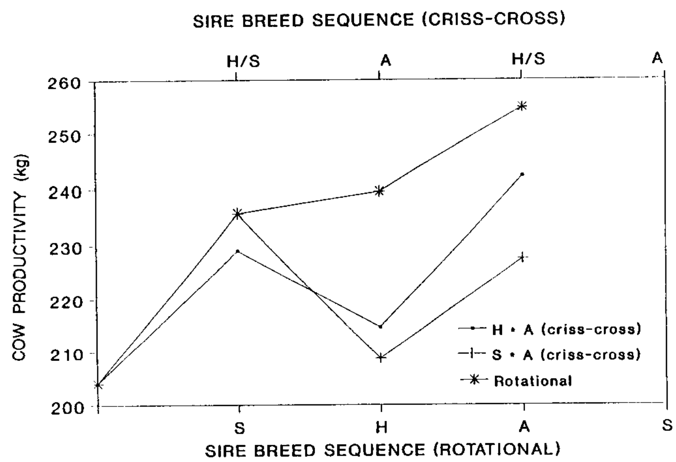

Figure 4 Variation in cow productivity with sire breed of dam.

shorter CI of Bonsmara cows (Table 3) indicates that selection against low fertility in Afrikaner crosses would be beneficial, despite the low ($h^2 = 0.11$; Mackinon *et al.*, 1990) cow fertility heritability estimate. Selection for fertility under sub-optimal conditions has yielded higher h^2 values ($h^2 > 0.20$; Deese & Koger, 1967; Seebeck, 1973). Selection for calving date would be appropriate with restricted breeding seasons (Bourdon & Brinks, 1983; López de Torre & Brinks, 1990), and should be possible in Afrikaner type herds, due to their calving pattern (Harwin *et al.*, 1967).

Breed genotype of dam influenced CP significantly ($P < 0.01$; Table 1). Hereford cows were least ($P < 0.05$) productive, mainly due to a lack of milk production in summer (Reyneke & Bonsma, 1964). Amongst crossbreds, 1/2S 1/2A, 5/8H 3/8A and 5/8A 1/4H 1/8S cows were the most productive (Table 3). With the exception of 5/8A 1/4H 1/8S, cows of predominant (> 50%) Afrikaner breeding (Afrikaner, Bonsmara, 3/4A 1/4H, 3/4A 1/4S) were less productive than other crossbreds (Figure 3). These cows (except Bonsmaras) all had Afrikaner sires. The influence of sire breed of dam on CP is shown in Figure 4. The decline in CP with the use of Afrikaner sires would be unacceptable to many livestock producers.

It is clear from Figures 1 to 4 that the optimum percentage Afrikaner breeding would be somewhere between 25 to less than 50%. This requirement should therefore be incorporated in the design of a crossbreeding system. A further requirement under ranching conditions would be self-sufficiency with regard to replacement females. A possible crossbreeding system could start with F_1 *Bos taurus* × *Bos indicus* or Afrikaner females bred to a *Bos taurus* sire breed. The progeny could then be bred alternatively to a synthetic *Bos taurus* × *Bos indicus* or. Afrikaner (e.g. Bonsmara, Beefmaster) and *Bos taurus* sires. Crossbred sires could be utilized as well. This would maintain the required proportion *Bos indicus* or Afrikaner breeding for several generations.

Furthermore, a two-breed rotational system is fairly simple to manage and poses fewer requirements than a more sophisticated system to ranch infrastructure. Such a system is not unlike that advocated by Light *et al.* (1982) for Botswana. An interesting feature of the rotational crossbreeding system is the absence of a decline in productivity with the use of Afrikaner sires in the last crossing, which is contrary to the effect of Afrikaner sires on other dam breed genotypes. Under favourable conditions such a breeding system may well be superior to criss-cross breeding in the long term, provided that correct breed choices are exercised, as shown by Franke (1990).

It should be emphasized that proportion *Bos indicus* or Afrikaner inclusion will vary according to environmental requirements, with more extreme conditions warranting a larger proportion. Periodic rotational crossing (Bennett, 1987) further simplifies a crossbreeding system while retaining a large proportion of the heterosis generated in conventional crossbreeding systems.

Conclusion

Cow productivity, as measured by annual weaning mass produced per cow bred, can be improved by crossbreeding in subtropical conditions. Optimum percentage Afrikaner breeding for maximum productivity in cows is between 25 and 50%, and Afrikaner bulls should preferably not be considered as sires. A criss-cross breeding system, utilizing synthetic part-*Bos indicus* or part-Afrikaner and *Bos taurus* sires, will in theory, be effective in maintaining efficiency at a high level.

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