Effects of Breed of Sire, Percentage of *Bos taurus* Inheritance and Season of Birth on Calving Performance of Crossbred Dairy Cattle

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ABSTRACT : Data collected from crossbred dairy cattle at the Institut Haiwan, Kluang, were used to evaluate the effects of breed of sire, percentage of *Bos taurus* inheritance and season of birth on some calving traits. Breed of sire effect was significant on age at first service ($p < 0.01$), age at first calving ($p < 0.01$) and post-partum interval to first service ($p < 0.05$) but not on calving interval ($p > 0.05$). Linear contrasts indicate that crossbred-sired cows had first service 593 days earlier and first calving 508 days earlier than purebred-sired cows. Cows sired by Friesians, however, had the earliest first service (466 days) and were among the earliest at first calving (917 days). However, the crossbred-sired cows had slightly longer post-partum interval to first service (13 days longer) and calving interval (20 days longer). Percentage of *B. taurus* inheritance affected ($p < 0.01$) all the calving traits studied. In general, the cows with 50% inheritance had the best calving performance. Season of birth had no effect ($p > 0.05$) on them.
(**Key Words**: Crossbreeding, Calving Performance, Dairy Cattle)

INTRODUCTION

Bos indicus cattle, with a few exceptions, have been found to be unsuitable for commercial milk production in a purebreeding system. Selection for milk traits within indigenous tropical breeds has also failed to produce worthwhile results, thus the need for crossbreeding with *Bos taurus* breeds (Mahadevan, 1966; Payne, 1970).

The majority of studies on crossbreeding dairy cattle have been done in temperate countries involving crosses between *Bos taurus* breeds. Therefore, it is not surprising that most of them have produced low heteroic effects in reproductive and milk traits (Hollon et al., 1967; McDowell et al., 1969; McDowell et al., 1970; McDowell et al., 1974). For some reproductive traits, breed differences due to additive effects may be more important than heterozygotic and maternal effects (Ruvuna et al., 1986). For crosses between *Bos taurus* breeds, McDowell et al. (1974) found that variation between sires within breed was greater than breed of sire effect. However, for crosses between *Bos taurus* and *Bos indicus* breeds, heterotic and breed of sire effects could prove to be more significant as differences in gene frequencies are larger.

A central issue in crossbreeding dairy cattle for tropical conditions is the optimum level of *Bos taurus* inheritance. Based on a theoretical additive-dominance model, Cunningham (1986) proposed that the optimum level is 75%. A study by Sivarajasingham and Kumar (1986) involving crosses between the Local Indian Dairy cattle and Holstein-Friesians in Malaysia indicate an optimum range of 50 to 77% of the latter breed, in a way confirming the theoretical estimation. In practice, consideration would have to be given to the severity of environmental stress, whereby the higher the stress level, the lower the percentage of *Bos taurus* inheritance should be. It is also possible that the optimum level is different for different traits, thus complicating the choice of which grade to use (Amble and Jain, 1967; Acharya, 1970).

This study seeks to determine the effects of breed of sire, percentage of *Bos taurus* inheritance and season of birth on some calving traits in crossbred dairy cattle.

MATERIALS AND METHODS

Animals and their management

The data used in this study were collected from crossbred dairy cattle at Institut Haiwan, Kluang, between 1974 and 1990. The animals were crosses between *Bos taurus* and *Bos indicus* breeds and were classified according to the percentage of *Bos taurus* inheritance that

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they contained, i. e., 25, 50, 62.5 or 75%. Three purebred sire breeds, namely Friesian (F), Gir (G) and Sahiwal (S), and three crossbred sire breeds, namely Australian-Friesian-Sahiwal (AFS), Brahman-Holstein (BH) and Sahiwal-Friesian (SF), were used.

Prior to 1989, all matings were accomplished by means of artificial insemination (A. I.) using imported semen of selected sires. Since 1989, the imported semen has been supplemented with semen collected at the National Artificial Insemination Centre, Jerantut, Pahang. Cows were selected on the basis of their milk production. Cows to be inseminated were identified by external signs of oestrus such as restlessness and a red, swollen vulva. A vasectomised bull was also used in the detection of oestrus cows. When cows failed to conceive after three consecutive attempts, they were bred by natural service. The cows were milked by machine twice per day, once in the morning and again in the afternoon. At other times, they were allowed to graze pasture which consisted mainly of *Brachiaria decumbens, Panicum maximum, Paspalum* sp. and *Axonopus* sp. In addition, each cow was given a daily allowance of 1 kg of concentrate feed for every 4 kg of milk produced.

The traits studied were (i) age at first service, (ii) age at first calving, (iii) post-partum interval to first service and (iv) calving interval. The number of observations for each trait according to breed of sire, season of birth and percentage of *Bos taurus* inheritance are shown in table 1.

Table 1. Distribution of number of observations for each trait according to breed of sire, percentage of *Bos taurus* inheritance and season of birth

Main effect	Subclass	Age at first service	Age at first calving	Calving to first service interval	Calving interval
Breed of sire	Friesian	65	45	142	131
	Gir	24	32	28	26
	Sahiwal	147	218	575	568
	Australian Friesian-Sahiwal	81	85	75	67
	Brahman-Holstein	84	164	143	138
	Sahiwal-Friesian	81	64	54	34
Percentage *Bos taurus*	25	169	156	140	125
	50	258	407	803	775
	62.5	53	26	25	16
	75	2	19	49	48
Season of birth	Feb.-May	134	159	191	176
	June-Aug.	192	236	483	461
	Sept.-Nov.	98	84	108	93
	Dec.-Jan.	58	129	235	234

Statistical analysis

The mathematical model used to analyse the data contained the effects of breed of sire, season of birth and percentage of *Bos taurus* inheritance. The interactions between these effects were not included because some subclass cells had no observation. Inclusion of such interaction terms resulted in erratic degrees of freedom for the main effects in the analyses of variance.

Selected linear contrasts were constructed to compare breed means. The basic contrast compared the purebred-sired crosses with the crossbred-sired ones. The other contrasts were built up from this with the objective of making them orthogonal. The contrasts were:

(i) 1/3 (F+G+S) - 1/3 (AFS+BH+SF)
(ii) F -1/2 (G+S)
(iii) G - S
(iv) AFS - 1/2 (BH+SF)
(v) BH - SF

All analyses were performed on computer using the Statistical Analysis System (SAS, 1986) package.

RESULTS AND DISCUSSION

Age at first service

Age at first service was significantly affected ($p < 0.01$) by breed of sire and percentage of *Bos taurus*

inheritance but not affected ($p > 0.05$) by season of birth (table 2).

Least-squares means for breed of sire effect (table 3) show that Friesian-sired cows had the earliest first service at the age of 466 days while Gir-sired cows had the latest at 1,566 days. The second contrast in table 4 also indicates that Friesian-sired cows had first service more than 1,000 days earlier than Gir-sired and Sahiwal-sired cows.

Table 2. Mean squares from analyses of variance for calving traits

Source of variation	d.f.	Age at first service	Age at first calving	Calving to first service interval	Calving interval
Breed of sire	5	1,222,215.41**	729,585.64**	7,322.83*	9,149.22
Percentage *Bos taurus*	3	947,587.63**	7,496,017.72**	23,380.30**	113,864.65**
Season of birth	3	40,242.75	71,791.24	4,828.55	9,632.08
Error	a	26,906.19	65,144.24	2,577.32	12,580.91

[a] Degrees of freedom for error for age at first service, age at first calving, calving to first service interval and calving interval are 481, 607, 101.6 and 963, respectively.

* $0.01 < p < 0.05$.

** $p < 0.01$.

Table 3. Least-squares means and their standard errors for calving traits according to breed of sire and percentage *Bos taurus* inheritance subclasses

Main effect	Subclass	Age at first service	Age at first calving	Calving to first service interval	Calving interval
		days			
Breed of sire	Friesian	465.84± 39.76	917.11±42.83	85.10± 4.98	446.47±12.35
	Gir	1,565.74± 78.03	1,734.01±58.85	82.33±11.25	434.68±26.24
	Sahiwal	1,445.74± 70.10	1,782.67±34.46	83.25± 4.47	455.28±10.78
	Australian Friesian-Sahiwal	502.02± 42.31	920.66±37.27	101.93± 6.91	471.33±16.27
	Brahman-Holstein	712.86± 41.51	1,075.81±32.45	98.56± 5.60	467.43±12.88
	Sahiwal-Friesian	484.14± 42.15	914.31±40.56	89.09± 7.72	456.42±21.57
Percentage *Bos taurus*	25	211.41± 57.14	613.38±33.11	94.98± 5.14	441.22±11.96
	50	1,068.08± 29.26	1,309.76±17.68	76.31± 2.93	408.45± 7.05
	62.5	1,084.10± 40.32	1,340.99±52.48	76.41±10.61	481.66±29.07
	75	1,087.32±122.24	1,632.25±74.43	112.47± 8.91	489.73±20.25

Table 4. Selected linear contrasts among breed of sire means for calving traits

Contrast	Age at first service	Age at first calving	Calving to first service interval	Calving interval
	days			
1/3 (F+G+S)- 1/3 (AFS+BH+SF)	592.76±57.62**	507.67±34.51**	−12.97± 5.57*	−19.58±13.29
F-1/2 (G+S)	−1,039.91±89.39**	−841.23±64.98**	2.32± 8.20	1.50±18.99
G - S	119.99±36.82**	−48.66±51.02	−0.92±10.73	−20.60±24.95
AFS - 1/2 (BH+SF)	−96.47±22.31**	−74.40±33.76*	8.10± 7.15	9.41±17.46
BH - SF	228.72±25.63**	161.50±37.99**	9.46± 8.14	11.00±21.61

Breeds of sire are: F=Friesian, G=Gir, S=Sahiwal, AFS=Australian Friesian-Sahiwal, BH=Brahman-Holstein and SF=Sahiwal-Friesian.

* $0.01 < p < 0.05$.

** $p < 0.01$.

Among the crossbred-sired cows, those sired by SF had the earliest first service (table 3). Although no contrast was formed to compare the AFS- and SF-sired cows, the age at first service for the two groups were quite similar (502 and 484 days, respectively), this similarity being perhaps due to their close genetic origin. Even though Friesian-sired cows had the earliest service, the linear contrast comparing cows sired by purebreds (Friesian, Gir and Sahiwal) with those sired by crossbreds (AFS, BH and SF) indicate that, on average, the latter group had significantly earlier ($p < 0.01$) first services (table 4).

The least-squares means in table 3 also show that age at first service increased with percentage of *Bos taurus* inheritance. However, it is difficult to interprete the significance of this effect because, within any particular group, say the 50%, the number of breeds involved could have been two, three or more, or it could have involved repeated use of a particular breed.

The lack of significance of the season of birth effect imply that seasonal variation in rainfall alone, as is normally the case in Malaysia, was not sufficiently large to have a significant effect on age at first service.

Age at first calving

Age at first calving was significantly affected ($p < 0.01$) by breed of sire and percentage of *Bos taurus* inheritance but not by season of birth (table 2).

Least-squares means for breed of sire effect (table 3) show that Friesian-sired cows had the earliest first calving (917 days) consistent with their early age at first service. The Sahiwal-sired and Gir-sired cows took the longest to have their first calves (1,734 and 1,782 days, respectively). This is consistent with the observation of Camoens (1980) that temperate breeds of cattle tend to calve earlier than their tropical counterparts.

The linear contrast comparing purebred-sired cows with the crossbred-sired ones shows that the latter group calved, on average, 507 days earlier (table 4). Among the purebred-sired cows, the Friesian-sired group calved, on average, 841 days earlier than the Gir-sired and Sahiwal-sired groups ($p < 0.01$). Thus, even though Friesian-sired cows were the earliest calvers, the overall performance of the purebred-sired group were offset by the long time the Gir-sired and Sahiwal-sired cows took to calve. The difference between Gir-sired and Sahiwal-sired cows was not significant. Among the crossbred-sired cows, the AFS-sired group calved earlier, on average, than BH- and SF-sired groups ($p < 0.05$). BH-sired cows calved later than SF-sired cows ($p < 0.01$). Although no contrast was constructed to compare the AFS- and SF-sired cows for this trait, it is obvious from table 3 that they calved at about the same age (920 and 914 kg, respectively). Again, this reflects their similar genetic origin.

The least-squares means in table 3 show that age at first calving increased with percentage of *Bos taurus* inheritance. This trend is consistent with that for age at first service.

Post-partum interval to first service

The interval from calving to first service was affected by breed of sire ($p < 0.05$) and percentage of *Bos taurus* inheritance ($p < 0.01$) but not by season of birth (table 2).

The least-squares means (table 3) show that the purebred-sired groups had very similar intervals to first service. Non-significant linear contrasts comparing among the purebred-sired groups attest to this similarity (table 4). The only significant contrast was the one comparing the purebred-sired cows with the crossbred-sired ones ($p < 0.05$). Garcia et al. (1990) reported that Zebu-sired cows had longer intervals to first service than those sired by temperate breeds. However, this finding is not supported by the present study where Friesian-sired cows did not differ significantly from Gir- and Sahiwal-sired cows.

Post-partum interval to first service is largely influenced by the ability of cows to commence regular oestrus cycles soon after calving. In this study, cows with 50 and 62.5% *Bos taurus* inheritance had the shortest intervals to first service (76 days for both) (table 3). Cows with 75% *Bos taurus* inheritance took the longest to get into first post-partum service. Evidently, increase in *Bos taurus* inheritance above 62.5% resulted in cattle that were less tolerant of the heat and high humidity of this region. Heat stress is known to delay return to oestrus (Ali et al., 1983).

Calving interval

Breed of sire and season of birth did not affect ($p > 0.05$) calving interval (table 2). However, percentage of *Bos taurus* inheritance had a significant effect on it ($p < 0.01$).

The least-squares means (table 3) attest to the lack of significance of the breed of sire effect. The calving intervals of cows in this study ranged from 435 days (Gir-sired) to 471 days (AFS-sired). A calving interval within this range (438 days) was reported by Kumar and Cheah (1987) for Sahiwal × *Bos taurus* cows. The selected linear contrasts (table 4) are all not significant, although the purebred-sired vs. crossbred-sired contrast and the Gir-sired vs. Sahiwal-sired contrast were quite substantial (−20 and −21 days, respectively).

Calving intervals were lowest (408 days) in cows with

50% *Bos taurus* inheritance. Similarly, Mbap and Ngere (1990) reported that calving intervals were lowest in cows with 50% Friesian inheritance and increased with percentage of this breed.

CONCLUSIONS

Breed of sire affected calving traits, except for calving interval. Of the groups, the Fiesian-sired cows had early first calving as well as short post-partum intervals to first service and calving intervals. The Gir- and Sahiwal-sired cows also had short post-partum to first service and calving intervals but they took too long to have their first service and first calving, i. e., about 4 and 5 years, respectively. Crossbred-sired cows were better than Gir- and Sahiwal-sired cows in having earlier first service and calving but took slightly longer to get into first post-partum service and to calve again.

Content of *Bos taurus* inheritance had significant effects on all calving traits studied. Generally, ages at first service and calving increased with increase in *Bos taurus* inheritance. On the basis of these two traits, the 25% cows had the best performance. However, post-partum interval to first service and calving interval did not follow a similar trend. In these traits, the 50% cows had the shortest intervals. When all traits are considered, the authors feel that the 50% cows generally had the best calving performance followed by the 25% animals. The upper limit of *Bos taurus* inheritance is perhaps 62.5%. The 75% animals had the worst calving performance.

Season of calving did not affect any of the traits. This can be attributed to the fact that seasonal variation in Malaysia, as in most tropical countries, is limited to differences in the amount of rainfall. The results of the present study imply that this variation is insufficient to have a significant impact on calving performance.

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