EVALUATION OF THE PRODUCTIVE AND REPRODUCTIVE PERFORMANCE OF FRIESIAN X ZEBU AND JERSEY X ZEBU CROSSBRED CATTLE AT BUNDA COLLEGE FARM IN MALAŴI

J. W. BANDA
Bunda College of Agriculture
P. O. Box 219, Lilongwe, MALAŴI

ABSTRACT

The productive and reproductive performance of Friesian X Malaŵi Zebu (FZ) and Jersey x Malaŵi Zebu (JZ) crossbred cows at Bunda College Farm were evaluated from records kept by the farm.

The calving interval and days open were 382 ± 12 and 112 ± 14 days, respectively. Genotype, season or year of calving had no influence on these traits.

Overall means for lactation length was 326 ± 15 days, dry period 83 ± 10 days, total milk yield 2 706 ± 143.1 kg, daily milk yield 8.4 ± 0.31 kg, and 305-day corrected yield 2 516 ± 93.8 kg. Genotype did not affect any of these characters, however, there were significant seasonal and yearly variations. Parity affected all these traits.

The annual herd productivity (2 865 ± 183.4 kg of milk/cow) was affected by the year of calving and parity. Stricter control on breeding and improvements in management would improve the annual productivity of the herd even further.

INTRODUCTION

The average milk production per lactation in indigenous cattle in Africa ranges between 150 and 300 kg (Mwenya, 1992). Research has, therefore, focused on introducing exotic blood for crossing, to combine the high milk-producing ability of these breeds and the adaptation and tolerance of the indigenous breeds to the local environmental conditions.

Bunda College was established to offer training in Agriculture. The College Farm acquired Malaŵi Zebu cows, exotic Friesian and Jersey bulls, and introduced artificial insemination for a crossbreeding programme. The herd acted as a demonstration unit in dairy production to students. The dairy records kept at the farm have been analyzed in order to: 1) compare the productive and reproductive performance of half-bred Friesian x Zebu (FZ) and Jersey x Zebu (JZ) crosses kept under similar management, 2) assess the influences of year and season of calving and cow parity on performance of the two genotypes, and 3) determine relationships, if any, between productive and reproductive traits of the herd. The findings are reported in this paper.

MATERIALS AND METHODS

Bunda College Farm is located at 14°35' South, 33°50' East and is 1 200 m above sea level with an average rainfall of 855 mm per year. The average temperature is 22°C, with highest temperatures occurring between October and November, and coldest months being June and July (Figure 1). The farm has ferruginous soils with mostly open canopy woodland.

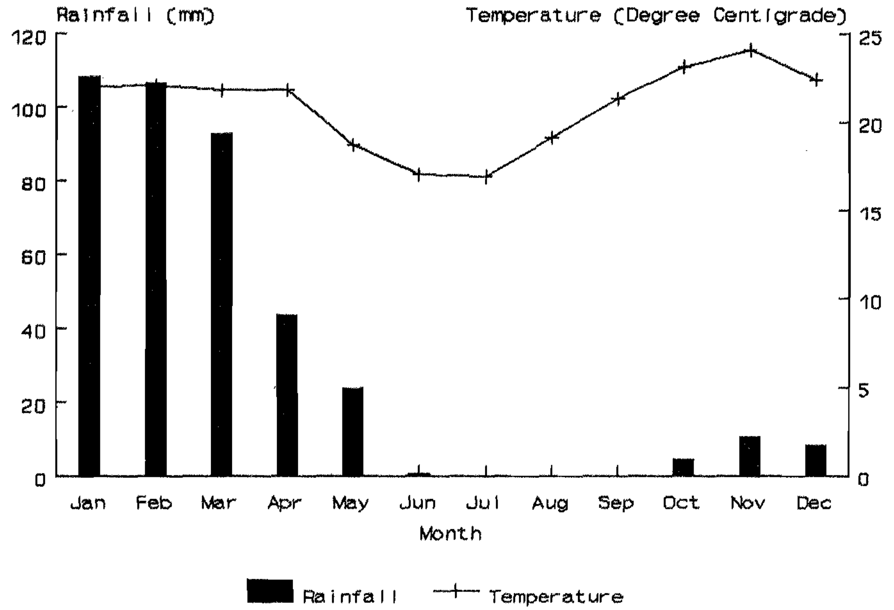

Figure 1 Long-term weather pattern for Bunda area

The Farm depends on planted Rhodes grass (*Chloris gayana*) pasture with *ad libitum* supplementation with maize silage during the dry season. During the period under study, a concentrate made up of 34.5% maize germ, 9.9% maize meal, 7.3% groundnut haulm meal, 7.3% bean hay meal, 12.3% cotton seed cake, 12.3% chicken manure, 7.4% *Leucaena* meal, 7.4% meat and bone meal, 0.8% mono-calcium phosphate and 0.8% common salt was offered to cows during milking at 1 kg per 2.5 kg milk produced. It was formulated at 91.3% dry matter (DM) to provide 20.9% crude protein (CP) and 9.87 MJ/kg DM metabolisable energy (ME).

168 (148 FZ and 20 JZ) lactation records of 60 (50 FZ and 10 JZ) crossbred cows for the period 1977 to 1981 were used after strict editing and elimination of incomplete entries. They were divided into wet (November - March) and dry (April - October) season calving. This gave a 2x5x2 factorial design for genotype, year and season of calving.

Individual parturition records were built up for each cow for each trait. Missing records for a trait were removed from the analysis of that particular trait, which resulted in unequal number of observations for the various traits.

Data collected included cow number, cow genotype, lactation number (parity), calving date, total milk yield, lactation length, and drying off dates which enable the milk yield per day, calving interval, 305-day corrected and annual milk yields, dry period and days open to be calculated.

Calving interval, days open, total milk yield, lactation length, daily milk yield, 305-day corrected milk yield, length of dry period and annual milk yield per cow were analyzed using a microcomputer version of fixed-effects-model of least squares and maximum likelihood (LSMLMW) procedures (Harvey, 1988). The fixed effects model derived was:

$$Y_{ijkl} = M + G_i + C_j + S_k + b_1(P_{ijkl} - P_{mean}) + b_2(P_{ijkl} - P_{mean})^2 + E_{ijkl}$$

where Y_{ijkl} = the trait to be analyzed
M = the overall population mean for Y_{ijkl}
G_i = the effect of the ith Genotype
C_j = the effect of the jth year of calving
S_k = the effect of the kth season of calving
b_1 = the partial linear regression coefficient of the trait on parity P_{ijkl}
b_2 = the partial quadratic regression coefficient of the trait on parity P_{ijkl}
P_{ijkl} = the effect of parity
P_{mean} = the mean parity P_{ijkl}
E_{ijkl} = the random error term associated with the observation Y_{ijkl}

The effects of genotype of cow, year of calving and season of calving, the main factors considered, were assumed fixed. Interactions were ignored after preliminary analyses showed no significant effects. Parity was used as a regression to correct for variation in ages because of insufficient data on ages of cows. The residual mean square was used as the error term to test the significance of each trait evaluated. Linear contrasts of least squares means were computed for any trait with significant effects to determine the level of significance between groups.

Relationships between productive traits (total milk yields and dry period) and reproductive traits (calving interval and days open) were determined by regression analysis using SPSS/PC+ (Norusis, 1988).

RESULTS

Reproductive Performance

Calving interval and days open were analyzed to identify the causes of variations in the reproductive performance (Table 1).

Table 1: Estimated least squares means for calving interval and days open.

Variable	Sub-class	Number of observations	Calving interval (days)	Days open
Overall mean		121	382 ± 12	112 ± 14
Genotype	Friesian crosses	107	386 ± 9	115 ± 10
	Jersey crosses	14	377 ± 21	108 ± 24
Year	1977	18	377 ± 20	107 ± 22
	1978	13	386 ± 23	116 ± 26
	1979	29	364 ± 17	94 ± 20
	1980	35	374 ± 15	104 ± 18
	1981	26	407 ± 20	137 ± 22
Season	Rainy	55	375 ± 15	105 ± 16
	Dry	66	388 ± 13	118 ± 15
Regressions	Parity linear		-14 ± 5.8	-13 ± 7.1
	Parity quadratic		0.7 ± 1.8	0.7 ± 2.3

Mean calving interval was 382 ± 12 days with a coefficient of variation of 14%. Mean days open were 112 ± 14 days. None of the factors included in the model had influence on these traits, although Friesian crosses and cows calving in the dry season tended to have longer calving intervals and longer days open.

Productive performance

Total milk yield and lactation length.

Least squares means for total milk yield and lactation length are given in Table 2. The mean total milk yield was 2 706 ± 143.1 kg (CV = 35%). Year and season of calving and parity had a significant effect on the total milk yield, but genotype had no effect. Milk yield increased by 14.1% from 1977 to 1978, thereafter yield decreased significantly ($p < 0.01$) by 9 - 10 % (average 359 kg/year) reaching the lowest values in 1981. Cows calving in the dry season produced 20.0% more ($p < 0.001$) milk than those calvin in the wet season. There was a significant ($p < 0.01$) linear increase in milk yield with parity.

The mean lactation length was 326 ± 15 days (CV = 30%). Only season of calving and parity significantly influenced length of lactation. Genotype and year of calving did not. Cows calving in dry season were milked significantly ($p < 0.05$) longer than those calving in the rainy season. Lactation length linearly increased ($p < 0.01$) with increasing parity.

Table 2: Estimated least squares means for total milk yield and lactation length.

Variable	Sub-class	Number of observations	Total yield (kg)	lactation length (days)
Overall mean		168	2 706 ± 143	326 ± 15
Genotype	Friesian crosses	148	2 709 ± 105	315 ± 11
	Jersey crosses	20	2 703 ± 238	336 ± 25
Year	1977	23	2 753 ± 220[b]	344 ± 23
	1978	33	3 142 ± 222[d]	307 ± 20
	1979	42	2 931 ± 195[c]	325 ± 19
	1980	43	2 640 ± 183[b]	313 ± 24
	1981	27	2 066 ± 232[a]	340 ± 18
Season	Rainy	76	2 461 ± 168[a]	310 ± 18[a]
	Dry	92	2 952 ± 155[b]	341 ± 16[b]
Regressions	Parity linear		150.1 ± 65***	20.7 ± 7**
	Parity quadratic		-44.7 ± 31	5.7 ± 3

Means within variable groups with different superscripts differ significantly ($p < 0.05$).
Significance of regression coefficients from a value of zero * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$.

Daily and 305-day milk yield and dry period

The mean daily and 305-day milk yields were 8.4 ± 0.31 and 2 516 ± 93.8 kg respectively (Table 3) with a 25% coefficient of variation (CV). Year, season of calving, and lactation number exerted significant influences on these two traits. There were no differences between Friesian and Jersey crosses. The daily and 305-day milk yield increased by 1.6 and 535 kg, respectively, between 1977 and 1978. Thereafter they decreased at a rate of 1.3 and 399 kg/year respectively, and the lowest ($p < 0.001$) was reached in 1981. Cows that calved in the dry season produced 8.6 - 8.8% more ($p < 0.05$) milk than those that calved in the rainy season.

Mean dry period observed was 83 ± 10 days (CV = 50%). None of the main factors included in the model influenced this trait. There was a significant ($p < 0.05$) linear increase in dry period as the parity of cows increased.

Table 3: Estimated least squares means for daily milk yield, 305-Day milk yield and dry period.

Variable	Sub-class	Observ-ations	Daily Milk yield (kg)	305-day yield (kg)	Dry period (days)
Overall mean		168	8.4 ± 0.31	2 516 ± 94	83 ± 10
Genotype	Friesian	148	8.7 ± 0.23	2 585 ± 69	90 ± 8
	Jersey	20	8.2 ± 0.51	2 448 ± 156	75 ± 17
Year	1977	23	8.5 ± 0.48[b]	2 489 ± 144[b]	73 ± 17
	1978	33	10.1 ± 0.48[d]	3 024 ± 146[d]	99 ± 20
	1979	42	9.0 ± 0.42[c]	2 698 ± 128[c]	74 ± 14
	1980	43	8.2 ± 0.40[c]	2 539 ± 120[c]	77 ± 12
	1981	27	6.3 ± 0.50[a]	1 828 ± 152[a]	91 ± 17
Season	Rainy	76	8.1 ± 0.36[a]	2 410 ± 110[a]	78 ± 13
	Dry	92	8.8 ± 0.34[b]	2 621 ± 102[b]	88 ± 11
Regressions	Parity linear		0.83±0.14***	247.6±43***	-12 ± 4.9*
	Parity quadratic		-0.28±0.07***	-67.9±21***	1 ± 1.5

Means within variable groups with different superscripts differ significantly ($p < 0.05$).
Significance of regression coefficients from a value of zero * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$.

Annual milk yield per cow

The mean annual milk yield per cow (Table 4) was 2 865 ± 183.4 kg. It was affected by year of calving ($p < 0.05$) and lactation number ($p < 0.01$), but not genotype. The annual yield increased to a maximum (3 317 ± 265 kg) in 1979, thereafter it decreased to reach the lowest levels (2 097 ± 306 kg) in 1981. No differences in annual milk yield were observed between rainy and dry season. A linear increase ($p < 0.01$) in annual yield per cow was observed with increasing parity of the cows.

Table 4: Estimated least squares means for annual milk yield per cow

Main effect	Sub-class	No. of observations	Mean (kg)	Se
Overall mean		104	2 865	183.4
Genotype	Friesian crosses	91	2 840	146.9
	Jersey crosses	13	2 890	314.0
Year of calving	1977	17	2 901[b]	287.4
	1978	9	3 164[c]	377.2
	1979	26	3 317[d]	265.3
	1980	31	2 845[b]	241.3
	1981	21	2 097[a]	306.0
Season of calving	Rainy	48	2 741	224.3
	Dry	56	2 989	207.4
Regressions	Parity linear	256**	98.9	
	Parity quadratic	-57	31.1	

Means within variable groups bearing different superscripts are significant ($p < 0.05$).
Significance of regression coefficients from a value of zero; ** $p < 0.01$

Relationships among productive and reproductive traits

Simple linear regression equations and their relevant correlation coefficients are summarised in Table 5.

Total milk yield was correlated significantly and positively with lactation length ($r = 0.68$, $p < 0.001$) and days open ($r = 0.24$, $p < 0.05$). Annual milk yield was also correlated significantly and positively with dry period ($r = 0.61$, $p < 0.001$) as well as days open ($r= 0.29$, $p < 0.01$). Calving interval was correlated significantly and positively with dry period ($r = 0.72$), $p < 0.001$) and days open ($r = 1.00$, $p < 0.001$). From the regression analysis, total milk yield increased by 8.90, 2.34, 2.61 and 2.35 kg for each additional day of lactation, calving interval, dry period and days open, respectively.

Table 5: Relationships among productive and reproductive characters.

Dependent (Y)	Independent (X)	Regression Equation (Y=a+bX)	Standard error (Se) of b.	Correlation Coefficient (r)
Total Milk Yield	Lactation length	-69.3+8.90X	1.06	0.68***
Total Milk Yield	Calving interval	1 481+2.34X	1.06	0.23*
Total Milk Yield	Days dry	2 758-2.61X	1.01	0.27**
Total Milk Yield	Days open	2 112+2.35X	1.06	0.24*
Annual Milk Yield	Days dry	2 930-5.56X	0.78	0.61***
Annual Milk Yield	Days open	2 598-2.68X	0.98	0.29**
Calving interval	Dry period	318.9+0.70X	0.073	0.72***
Calving interval	Days open	270+1.00X	0.001	1.00***

Significance from a value of Zero: * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

DISCUSSION

Experiences of crossbreeding work throughout the tropics have revealed that exotic inheritance of around 50% is the most ideal for growth, reproduction and milk production (McDowell, 1984; Bhat and Taneja, 1987). Milk yields of higher crosses fall short of theoretical expectations. It is with this background that only cows with 50% of the exotic blood were selected for analysis in the present study.

The observed mean calving intervals of 386 and 377 days for Friesian and Jersey crosses respectively are less than those of crosses of *Bos taurus* and *Bos indicus* cattle recorded by McDowell (1984), Kiwuwa, et al. (1983), Agyemang and Nkhonjera (1986), and Cunningham and Syrstad (1987) in Africa. Days open for Friesian crosses (115) and for Jersey crosses (108) are less than those reported by Igboeli (1973), Katyega (1988), and Chaudhari, Deshmukh and Deshpande (1995). Since service period determines the length of the calving interval, there is need to reduce days open to 85 days by breeding cows as early as 60 days *post-partum*, when involution of uteri is completed. Jersey crosses have been reputed for their better reproductive efficiency (Bhat and Taneja, 1987) as opposed to Friesian crosses. Both genotypes showed no differences in reproductive efficiency in this study. Lack of differences in lactational performance between Friesian and Jersey crosses was also observed in Ethiopia by Kiwuwa *et al.* (1983).

Although no differences were observed in all reproductive and productive traits between Friesian and Jersey crosses, other workers have observed that Friesian crosses have higher values of total and daily milk yields and lactation length than Jersey crosses (Mangurkar, Gokhale and Hayes, 1984; Cunningham and Syrstad, 1987). Generally, milk yields obtained in the present study are much higher than those reported by Mangurkar *et al.* (1984), McDowell (1984), Alba and Kennedy (1985), Cunningham and Syrstad (1987), Katyega (1988), and Deshmukh, Chaudhari and Deshpande (1995).

It is interesting that milk yield dropped between 1978 and 1980, with a sharp fall from 1980 to 1981. The poor performance in 1981 was due to the cows response to feed shortages resulting from drought which occurred during this year. This was observed in cows kept on other livestock farms in Malawi (Agyemang and Nkhonjera, 1986).

The highest annual milk yield was obtained in 1979 and it coincided with the shortest calving interval. Within limits, a relationship exists between calving interval and milk yield. Total milk yield is positively correlated with lactation length, calving interval, dry period and days open. Lengthening lactation period, calving interval and days open are not practical ways of increasing yields. Shortening the dry period to the recommended 60 days and shortening days open to 85 days would improve the annual milk yield as indicated by the regression coefficients of the relationship between annual milk yield with days dry and days open. The significant relationships between calving interval and dry period and days open imply that calving interval could be shortened by improving breeding management through decreasing breeding time from 112 days to 60 days.

That cows which calved in the dry produced more milk than those calving in the rainy season is contrary to expectations. However, this phenomenon has been widely observed in cattle and small ruminants (Kabuga and Agyemang, 1984; Karua, 1989; Banda, 1992). The season by year interactions showed no significance, meaning that the animals which calved during the dry season were consistently better than their counterparts. Two explanations could be offered for the difference. Cows which calved during the dry season were given controlled feed of silage and concentrate which probably allowed high initial milk yield and a more persistent production resulting in more yield than those which calved during the rainy season, while the wet season calving cows were released out to and relied mainly on pasture. Although they may also have been given concentrate, the combined effect of climate, rapid grass growth and decline in nutritive value contribute to low yields (Kabuga and Agyemang, 1984). Cows calving during the wet season may have suffered high incidence of external parasites and worm infestations leading to reduced milk yield.

As there were differences in lactation lengths between cows calving during the dry and wet seasons, it may be assumed this could also influence differences in annual yields.

Varying milk outputs over different lactation lengths makes it difficult to compare animal performance directly using individual traits of lactation milk yield, lactation length, dry period and calving interval (Kiwuwa, Trail, Kurtu, Getachew, Anderson and Durkin, 1983). To overcome this problem, the productive and reproductive performance described above were combined in form of annual milk yield per cow. The annual milk yield was calculated as total lactation milk yield divided by calving interval (days) x 365.

Parity affected milk yield and other lactation traits. As parity advanced, total milk yield, lactation length and dry period increased linearly while daily and 305-day milk yields increased quadratically. An increasing trend in milk yield with advancement in parity has been observed (Agyemang and Nkhonjera, 1986; (Kiwuwa *et al.*, 1983) and is universally accepted. Cows show better milk secretion as they get older. Martinez, Ramirez and Combrellas (1982) showed a linear increase in milk yield up to the fourth parity.

The study has confirmed that Friesian and Jersey half crosses have similar lactational performance in the tropics. Any management practices that will reduce the dry period to the recommended 60 days and days open to recommended 60-85 days might further improve the productivity of dairy cattle.

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