STUDIES ON MILK PRODUCTION AND GROWTH OF FRIESIAN × BUNAJI CROSSES : I. DAIRY PERFORMANCE

A. E. O. Malau-Aduli[1], B. Y. Abubaker, O. W. Ehoche and N. I. Dim[2]

National Animal Production Research Institute, Ahmadu Bello University, P. M. B. 1096 Zaria, Nigeria

Summary

The data analysed consisted of records on lactation length (LL), total lactation yield (TLY), estimated 305-day yield (305 DY), days dry (DDRY), age at first calving (AFC) and calving interval (CI) of 448 Friesian × Bunaji halfbreds that calved over a twenty-three year period (1967-1989) at the National Animal Production Research Institute, Shika, Nigeria. Least squares means of LL, TLY, 305DY, DDRY, AFC and CI were 250 days, 1,988 kg, 2,420 kg, 102 days, 35 months and 390 days, respectively. Parity, season and year of calving significantly affected LL, TLY ($p < 0.01$) and 350DY ($p < 0.05$), but not CI. DDRY was affected by season of calving only ($p < 0.05$).

It was therefore concluded that the Shika Friesian × Bunaji crossbreeding programme was successful and beneficial in that the F_1 crosses calved at a younger age, produced twice as much milk, had longer lactations and slightly shorter calving intervals than the indigenous Bunaji.

(**Key Words** : Dairy Performance, Friesian × Bunaji, Crossbreeding)

Introduction

The genetic potential for milk of most indigenous cattle in the tropics is less than for breeds supporting the infrastructure of dairying in temperate countries (Morales et al., 1989). Therefore, the fastest way to improve the dairy potential of tropical cattle is to introduce inheritance from *Bos taurus* dairy breeds (Syrstad, 1988).

Although germplasms of European origin have high milk potential, fitness is relatively less in tropical environments because of insufficient and costly feed supplies, disease and parasite challenges and narrow margins between input costs and output prices (McDowell, 1985). Natural selection over hundreds of generations on the other hand, has provided indigenous tropical cattle with a high level of heat tolerance, some resistance to many tropical diseases and the ability to survive long periods of feed and water shortage. Crossbreeding has therefore been exploited as an efficient tool of blending the adaptability of tropical cattle with the high milking potentials of exotic breeds for increased milk production.

A crossbreeding programme involving the Bunaji (also known as White Fulani) and the Friesian commenced at Shika, Nigeria in 1964 with the objective of improving the milk yield of the indigenous Bunaji. The dairy performance of the crosses during the early phases of the programme up to 1978 was reported by Buvanendran et al. (1981). The objective of this paper is to present a fuller, up-to-date report on the dairy performance of half Friesian × Bunaji crosses at Shika during the period 1967 to 1989.

Materials and Methods

The data utilized for this study originated from the dairy herd of the National Animal Production Research Institute, Shika, Nigeria. Details of the establishment of this herd have been described in a previous study by Olayiwole et al. (1973).

Located between latitude 11° N and longitude 12° E at an altitude of 640 m above sea level, Shika lies within the Guinea savannah zone where the average annual rainfall is 1,100 mm, most of which falls during May to October. Peak rainfall occurs in the months of June to September (wet season) when the relative humidity and

[1] Address reprint requests to Dr. A. E. O. Malau-Aduli, Department of Animal Science, University of Adelaide, Waite Agricultural Research Institute, Glen, Osmond, S. A. 5064, Australia.

[2] Department of Animal Science, Ahmadu Bello University, P. M. B. 1044 Zaria, Nigeria.

Received November 7, 1995
Accepted March 28, 1996

daily temperature average 72% and 25℃ respectively. Following the rainy season is a period of dry, cool weather called the 'harmattan' which marks the onset of the dry season. This period extends from mid-October to January. The dry season (February to May) is characterised by very hot weather conditions. At this period, daily temperatures range from 21℃ to 36℃, while mean relative humidity is 21% (Buvanendran et al., 1981).

The Bunaji cattle were introduced to Shika for the first time in 1928, and their population was progressively increased through pure breeding as well as by transfer of cows from other out-stations. Matings were designed to increase their numbers while avoiding deliberate inbreeding. Crossbreeding of the Bunaji with Friesian by means of artificial insemination, commenced in 1964 using bulls imported from the United Kingdom. A programme of upgrading was adopted. The mating plan and number of parents in each generation has been reported by Buvanendran et al. (1981). Some locally bred Friesian bulls were also used for artificial insemination in subsequent generations.

The animals were raised during the rainy season on paddock-sown pastures, while hay or silage supplemented with concentrate mixture of undelinted cottonseed cake, maize or guinea corn were offered during the dry season at 3.5 kg/day when animals were housed in open sheds. They had access to water and salt-lick at all times. Regular spraying against ticks was observed, while vaccination was carried out against contagious diseases, namely anthrax and contagious bovine pleuropneumonia (CBPP). Calves were separated from their dams three days after birth and bucket-fed until three months of age when they were weaned. The cows were machine-milked in the morning and evening daily.

Records on animals with uncertain dates of birth, calving or parentage were excluded, so that out of a total of 1,124 records, the data utilised consisted of 840 records on lactation length (LL), total lactation yield (TLY), estimated 305-day yield (305DY), days dry (DDRY), calving interval (CI) and age at first calving (AFC) of half Friesian × Bunaji cows that calved over a twenty three-year period (1967-1989). 305-day yield was estimated using the procedure of Malau-Aduli and Abubakar (1992).

The data were analysed by least squares procedures using SYSTAT (1988). Dairy performance traits were analysed using the following statistical model :

$$Y_{ijkl} = \mu + YC_i + SC_j + P_k + E_{ijkl}$$

Where Y_{ijkl} = the observation on the l^{th} cow of the k^{th} parity within the j^{th} season of the i^{th} year group

μ = the overall mean

YC_i = fixed effect of the i^{th} year group (i = 1, 5)

SC_j = fixed effect of the j^{th} calving season (j = 1, 3)

P_k = fixed effect of the k^{th} parity (k = 1, 7)

E_{ijkl} = random error associated with each record with a mean of 0 and variance σ_e^2

Season of calving was classified as dry (February to May), wet (June to September) or harmattan (October to January), while parities above six were coded as > 6 and year of calving was grouped into five : 1967-1971, 1972-1976, 1977-1981, 1982-1986 and 1987-1989.

Results and Discussion

Lactation length (LL)

Least squares analysis of variance shown in table 1 reveals that LL was highly ($p < 0.01$) affected by calving season, year and parity. Hayatnagarkar et al. (1990) have reported similar observation in Friesian crossbred cows under rural production management.

Overall, LL averaged 250 ± 4.8 days (tables 2, 3 and 4). This was slightly higher than the 247 days reported by Dettmers and Laseinde-Olotu (1978) for Friesian × Bunaji F_1 cows in herds at Agege, but lower than the 271 days obtained by Sohael (1984) at Vom. Buvanendran et al. (1981) reported an average lactation length of 244 days at Shika from a subset of the data used in the current

TABLE 1. LEAST SQUARES ANALYSIS OF VARIANCE FOR FACTORS AFFECTING DAIRY TRAITS*

Source	d.f.	Mean squares			DDRY	AFC	CI
		LL	TLY	305DY			
SOC	2	112,092[b]	38,374,817[b]	31,791,179[a]	107,466[a]	2,133	134,610
YOC	4	137,311[b]	13,010,351[b]	11,663,332[b]	12,523	11,234[a]	158,237
POC	6	11,180[b]	1,704,923[b]	1,675,904[b]	11,791[a]	2,187	141,652
ERROR	435	5,093	1,110,382	999,942	12,439	2,032	156,240

* a = $p < 0.05$ b = $p < 0.01$.

LL = Lactation length, TLY = Total lactation yield, 305DY = Estimated 305-day yield, DDRY = Days dry, AFC = Age at first calving, CI = Calving interval, SOC = Season of calving, YOC = Year of calving, POC = Parity.

analysis. In all cases, the mean LL of 250 days obtained in this study was higher than those of pure Bunaji at Vom, Agege and Shika, an indication that crossbreeding Bunaji with Friesian had a beneficial effect on LL since on the average, longer LL means more milk yield.

TABLE 2. LEAST SQUARES MEANS (LSM) ± S.E. OF DAIRY TRAITS ACROSS SEASONS OF CALVING

	LL (days)	TLY (kg)	305DY (kg)	DDRY (days)	AFC (months)	CI (days)
Overall mean	250 ± 5	1,988 ± 108	2,420 ± 93	102 ± 2	35 ± 2	390 ± 3
No. of records	(840)	(840)	(840)	(619)	(448)	(619)
Season of calving						
Dry	215[a]	1,520[a]	2,154[a]	122[a]	34	370
Wet	288[b]	2,516[b]	2,659[b]	90[b]	36	398
Harmattan	248[c]	1,930[c]	2,449[c]	104[c]	37	396

Means within columns with different superscripts significantly differ ($p < 0.05$).
LL = Lactation length, TLY = Total lactation yield, 305DY = Estimated 305-day yield, DDRY = Days dry, AFC = Age at first calving, CI = Calving interval, SOC = Season of calving, YOC = Year of calving, POC = Parity.

TABLE 3. LEAST SQUARES MEANS (LSM) ± S.E. OF DAIRY TRAITS* ACROSS PARITIES

	LL (days)	TLY (kg)	305DY (kg)	DDRY (days)	AFC (months)	CI (days)
Overall mean	250 ± 5	1,988 ± 108	2,420 ± 93	102 ± 2	35 ± 2	390 ± 3
No. of records	(840)	(840)	(840)	(619)	(448)	(619)
Parity						
1	264[a]	1,715[a]	1,982[a]	–	39	–
2	284[b]	2,088[b]	2,243[b]	109[a]	–	390
3	298[c]	2,163[c]	2,410[c]	82[b]	–	390
4	306[d]	2,339[d]	2,801[d]	73[c]	–	395
5	220[e]	2,064[b]	2,331[e]	99[d]	–	383
6	197[f]	1,981[e]	2,591[f]	123[e]	–	382
> 6	190[f]	1,572[f]	2,786[g]	128[e]	–	392

* Abbreviations for dairy traits same as in tables 1 and 2.
Means within columns with different superscripts significantly differ ($p < 0.05$).

TABLE 4. LEAST SQUARES MEANS (LSM) ± S.E. OF DAIRY TRAITS* ACROSS 5-YEARLY INTERVALS OF CALVING

	LL (days)	TLY (kg)	305DY (kg)	DDRY (days)	AFC (months)	CI (days)
Overall mean	250 ± 5	1,988 ± 108	2,420 ± 93	102 ± 2	35 ± 2	390 ± 3
No. of records	(840)	(840)	(840)	(619)	(448)	(619)
Year of calving						
1967-1971	230[a]	1,966[a]	2,303[a]	89	26[a]	386
1972-1976	277[b]	2,416[b]	2,715[b]	100	35[b]	394
1977-1981	264[c]	1,831[c]	2,418[c]	116	36[b]	389
1982-1986	241[d]	1,821[c]	2,465[d]	101	38[c]	396
1987-1989	238[d]	1,876[d]	2,199[e]	104	40[d]	385

* Abbreviations for dairy traits same as in tables 1 and 2.
Means within columns with different superscripts significantly differ ($p < 0.05$).

Across seasons of calving (table 2), the longest LL of 288 days was obtained during the wet season as compared to 215 days recorded during the dry season. Since the wet season is a period of abundant pasture availability, it is expected that grazing cows would meet a large part of their nutritional requirements for milk synthesis more than those calving during the dry season when forage is scarce.

Table 3 shows that across parities, LL was longest during the fourth parity and shortest for parities greater than six. Similar findings under tropical management conditions have been reported by Mudgal et al. (1990) and Singh and Tomar (1991) in Red Sahiwal and Karan Fries cows, respectively. Across groups of years of calving (table 4), 1972-1976 recorded the highest LL of 277 days compared to 230 days obtained in 1967-1971. Differences between years might be due to management or climatic factors.

Total lactation yield (TLY)

Least squares analysis of variance shown in table 1 reveals that TLY was highly ($p < 0.01$) affected by calving season, year and parity. This is in agreement with the reports of Mbap and Ngere (1991).

Overall, TLY averaged 1,988 ± 108.1 kg (tables 2, 3 and 4). This exceeded the 880 and 837 kg reported for Bunaji at Agege and Vom (Dettmers and Laseinde-Olotu, 1978 and Sohael, 1984, respectively). Buvanendran et al. (1981) obtained a mean milk yield of 1,684 kg in F_1 Friesian × Bunaji cows at Shika, while Sohael (1984) and Laseinde (1979) reported average milk yields of 1,692 and 1,329 kg for the same breed at Vom and Agege respectively. The beneficial effect of crossbreeding has no doubt been reflected in the milk yield of the halfbreds compared to pure Bunaji.

Across seasons of calving (table 2), the highest TLY of 2,516 kg was obtained during the wet season as compared to the dry season yield of 1,520 kg. A similar seasonal influence on the milk yield of Friesian × Bunaji cows has been reported by Alhassan et al. (1985). The trend observed in this study conforms to expectation because the wet season is the time of abundant pasture availability when grazing cows exhibit high yields. The explanation for the intermediacy of results for calving during the harmattan season lies in the fact that crop residues abound since it is the post-harvest period. This, coupled with concentrate supplementation, leads to higher yields than those of dry season calvings, but lower than wet season calvings.

Table 3 shows that across parities, there was a trend of increasing milk yield as parity increased, until the fourth parity was attained. Thereafter, it declined. Licitra et al. (1990) reported that the yields of Modicana and Holstein cows increased with parity, while Adeneye and Adebanjo (1978) reported that the milk production of Friesian cattle in Western Nigeria was highest during the fourth lactation. The present study confirms their findings. The most likely reason for this observation is that when most heifers calve for the first time, they are still growing; their physiological and anatomical structures for milk secretion are not yet fully developed. With an increase in age, there is a corresponding linear relationship with yield until a certain stage, beyond which an inverse relationship takes over (Morales et al., 1989). This stage for the Friesian × Bunaji crosses as shown by the result of this study, is the fourth parity. Across groups of years of calving (table 4), the longest lactation lengths were recorded for lactations initiated in 1972-1976 and also had the highest milk yield of 2,416 kg.

Estimated 305-day yield (305DY)

Least squares analysis of variance shown in table 1 reveals that 305DY was significantly affected by calving season ($p < 0.01$) year and parity ($p < 0.05$). A similar observation has been reported by Kafidi et al. (1991).

Overall, 305DY averaged 2,420 ± 93.3 kg (tables 2, 3 and 4). In their evaluation of lactations in Black Pied dairy cows under similar tropical feeding and management in Nigeria, Sada and Hoffmeisterova (1990) reported a 305-day yield of 2,724 kg. The disparity between these values could be attributable to breed differences, as well as the fact that while the former was estimated, the latter was an actual performance. However, the value obtained in this study is in close agreement with the 305DY of 2, 433 kg reported by Morales et al. (1989) and 2,471 kg reported by Madalena et al. (1978) in Carora and Friesian × Gir cows, under tropical management conditions in Venezuela and Mexico, respectively.

Across seasons of calving (table 2), the highest 305DY of 2,659 kg was obtained during the wet season. This was expected given the advantage of feed availability which could result in higher lactation yields. Table 3 shows that the fourth parity lactation recorded the highest value of 2,801 kg. This conforms to expectation since the mean lactation length exceeded the standard 305 days. Yearly fluctuations in climatic and management factors are the likely causes of the differences observed across years of calving in which 1972-1976 recorded the highest yield of 2,715 kg compared to 1987-1989 with the least value (table 4).

Days dry (DDRY)

Table 1 shows that DDRY was significantly ($p <$

0.05) affected by calving season and parity. The non-significant effect of year of calving on DDRY observed in this study agrees with the reports of Moon and Kim (1989) and Reddy and Nagarcenkar (1990) in Holstein and milch cows, respectively.

Overall, DDRY averaged 102 ± 2.5 days (tables 2, 3 and 4). This value is in close agreement with the mean values of 101 and 111 days reported for Friesian × Ongole and Brown Swiss × Ongole cows, respectively (Kumar et al., 1990). It was however less than the 150 days reported for White Fulani cows by Lecky (1951). The implication is that crossbreeding the White Fulani with Friesian led to a marked decrease in the dry period length of the crossbreds, hence a longer lactation duration.

Across seasons of calving (table 2), the dry season recorded the longest dry period of 122 days as compared to the shortest (90 days) during the wet season. This follows the expected pattern that the longer the duration of a cow's lactation, the shorter her dry period, and vice-versa. Since cows calving in the dry season had shorter lactation lengths, it is expected that their DDRY should be the longest. Table 3 shows that across parities, DDRY was shortest (73 days) for cows in their fourth parity, and longest (128 days) for parities greater than six. A similar observation has been reported in Gir cows by Odedra et al. (1978). With an increase in parity, there is a corresponding increase in age of the cow and a concomitant decline in lactation duration, hence a longer dry period.

Age at first calving (AFC)

Least squares analysis of variance shown in table 1 reveals that only year of calving significantly ($p < 0.05$) affected AFC. Buvanendran et al. (1981) also reported that neither calving season nor parity affected the AFC of Friesian × White Fulani crossbred cows.

The overall mean AFC of 35 ± 2.3 months obtained in this study (tables 2, 3 and 4) falls within the reported range of values of 33.9 months for cows at the same station at Shika (Buvanendran et al., 1981), 40.1 months observed at Agege (Dettmers and Laseinde-Olotu, 1978) and 30.9 months at Vom (Sohael, 1984). It was however much shorter than the 60 months reported in pure Bunaji under traditional management in Northern Nigeria by Voh and Otchere (1989). This is not entirely contrary to expectation since under traditional management, heifers mature slowly and attain breeding status much later than their counterparts managed in research farms.

Across seasons of calving (table 2), differences in AFC were statistically non-significant, a trend similarly reported by Hayatnagarkar et al. (1990). Table 4 shows that animals that calved from 1967-1971 were the youngest first calvers (26 months), compared to those born in 1987-1989 whose AFC averaged 40 months. Under tropical management conditions, the attainment of an early age at first calving demands an improvement in the level of husbandry. The results of this study show that this appears to be difficult to maintain over a long period of time with a large number of animals. This explains the variations in AFC across different years of calving.

Calving interval

The non-significant effects of calving season, year and parity on CI are shown in tables 1, 2, 3 and 4. A similar set of results has been published by Das et al. (1990) in Jersey cows. The fact that CI depends more on physiological activities in the cow related to early return to oestrus, number of inseminations before conception and the length of the cow's lactation probably explains the non-significant effect of season, year and parity. The average of 390 ± 3.2 days obtained in this study was in close agreement with the range of 342-402 days reported in Black Pied cows in Nigeria (Sada and Hoffmeisterova, 1990), 383-393 days reported in Friesian-Bunaji cows (Buvanendran et al., 1981) and 394.6 days in Sahiwal cows (Taunk et al., 1990).

Conclusion

From the results of this study, it can be concluded that the Shika Friesian × Bunaji crossbreeding programme was beneficial in that the F_1 crosses calved at an early age, produced twice as much milk, had longer lactations and slightly shorter calving intervals than the pure Bunaji cows.

Acknowledgement

The authors are grateful to the Director, National Animal Production Research Institute, Shika, Nigeria, for permission to publish this work.

Literature Cited

Adeneye, J. A. and A. K. Adebanjo. 1978. Lactational characteristics of imported British Friesian cattle in Western Nigeria. Journal of Agricultural Science (UK) 91:645-651.

Alhassan, W. S., V. Buvanendran and O. W. Ehoche. 1985. Seasonal influences on milk production in Friesian × Bunaji crosses in Northern Nigeria. Journal of Agricultural Science (UK) 104:231-233.

Buvanendran, V., M. B. Olayiwole, K. I. Piotrowska and B. A. Oyejola. 1981. A comparison of milk production traits in Friesian × White Fulani crossbred cattle. Animal Production 32:165-170.

Das, G. C., D. Das and A. Aziz. 1990. Productive and reproductive performance of Jersey cows in Assam. Livestock Adviser 15:3-7.

Dettmers, A. and B. Laseinde-Olotu. 1978. Performance of crossbred and purebred cattle in selected Nigerian dairies. Proceedings of the first national seminar on dairy development, Vom, Nigeria. (Eds E. A. Olaloku and K. B. David-West.) pp. 90-103.

Hayatnagarkar, D. D., S. S. Yeotikar, K. S. Deshpande and S. K. Auradkar. 1990. Non-genetic and genetic factors affecting some production traits in rural crossbred cows. Indian Journal of Dairy Science 43:515-520.

Kafidi, N., P. Leroy, C. Michaux and A. Francois. 1991. Non-genetic and genetic factors affecting milk production during the first three lactations in Belgian Black Pied cattle. 2. Effects of calving season, age at calving and calving interval. Annales de Medicine Veterinaire 134:479-487.

Kumar, V. P., C. H. Rao, A. Venkatramaiah and K. N. Naidu. 1990. Genetic group differences in the performance of the various crosses of Ongole with Friesian, Brown Swiss and Jersey breeds. Indian Journal of Dairy Science 43:46-48.

Laseinde, B. 1979. Milk production of various cattle breeds. Ph. D. Thesis. University of Ibadan, Nigeria.

Lecky, T. P. 1951. Genetic improvement in dairy cattle in the tropics. Ph. D. Thesis. University of Edinburgh, Scotland.

Licitra, G., P. A. Oltenacu, R. W. Blake, A. Lanza and G. D'Urso. 1990. Season of calving and parity effects on milk yield and reproduction of Modicana and Holstein cows in Sicily. Journal of Dairy Science 73:224.

Madalena, F. E., A. F. Freitas and M. L. Martinez. 1978. Comparative evaluation of milk production in Holstein-Friesian × Gir cows. Proceedings IVth World Conference on Animal Production, Buemos Aires, Argentina, Vol. II pp. 650-658.

Malau-Aduli, A. E. O. and B. Y. Abubakar. 1992. Estimation of 305-day yield from total milk yields of Bunaji and Friesian-Bunaji crosses. Nigerian Journal of Animal Production 19:141-5.

Mbap, S. T. and L. O. Ngere. 1991. Breed and environmental factors affecting the performance of some imported and crossbred cattle in Ibadan, Nigeria. Tropical Agriculture (Guilford) 68:181-185.

McDowell, R. E. 1985. Crossbreeding in tropical areas with emphasis on milk, health and fitness. Journal of Dairy Science 68:2418.

Moon, S. J. and J. H. Kim. 1989. Studies on dry period and days open affecting the shape of the lactation curve and estimation of milk yield by the lactation curve in dairy cattle. Korean Journal of Animal Science 31:293-301.

Morales, F., R. W. Blake, T. L. Stanton and M. V. Hahn. 1989. Effects of age, parity, season of calving and sire on milk yield of Carora cows in Venezuela. Journal of Dairy Science 72:2161-2169.

Mudgal, K. C., C. M. Taylor and A. Singh. 1990. Factors affecting milk yield in crossbred cattle. Indian Veterinary Journal 67:182-184.

Odedra, B. A., S. N. Kaushik and B. G. Katpatal. 1978. Sources of variation in milk production in Gir cattle. Indian Journal of Animal Science 48:1-6.

Olayiwole. M. B., G. Zemmelink and B. A. Koch. 1973. Performance of Friesian and Friesian-Bunaji dairy cows at Shika Research Station. Samaru Agricultural Newsletter 15:76-81.

Reddy, K. M. and R. Nagarcenkar. 1990. Genetic and non-genetic factors affecting dry period in Sahiwal cows. Livestock Adviser 15:33-40.

Sada, I. and R. Hoffmeisterova. 1990. Evaluation of lactations in Black Pied dairy cows in Nigeria. Agricultura Tropica et Subtropica 23:95-106.

Singh, R. and S. S. Tomar. 1991. Performance characteristics of Karan Fries cows. Indian Journal of Animal Science 61:192-195.

Sohael, A. S. 1984. Milk production potentials of cattle on the Jos Plateau. Nigerian Livestock Farmer 4:13-14.

Syrstad, O. 1988. Crossbreeding for increased milk production in the tropics. Norwegian Agricultural Science 2:179-185.

SYSTAT. 1988. The system for statistics. Evanston, Illinois; SYSTAT Inc.

Taunk, A. K., S. V. Loharkare, R. M. Zinjarde and S. N. Deshmukh. 1990. A study on the incidence of calving in relation to calving interval and lactation yield in Sahiwal cows. Livestock Adviser 15:20-24.

Voh Jr., A. A. and E. O. Otchere. 1989. Reproductive performance of Zebu cattle under traditional management in Northern Nigeria. Animal Reproduction Science 19:191-203.