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Analyses of Some Dairy Traits of Friesian and White Fulani cattle breeds and Their F_1 Crosses

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Original Research article

Abstract
A total of 1488 records of lactation length, lactation yield, and calving interval of Friesian (F), White Fulani (WF), and their crossbreds (FxWF) born and reared between 1991 and 1997 at the West African Milk Company (WAMCO)-Integrated dairy farm, Vom-Jos Plateau state were analysed for means, repeatability estimates and heterosis. Average lactation length, lactation yield, and calving interval were 297.23 days, 4872.45 Kg and 400.86 days, respectively. Friesian had significantly highest lactation length, lactation yield and calving interval followed by the crossbreds, though it had the lowest calving interval. Repeatability estimates of lactation length were 0.48 (F) 0.46 (FxWF) and 0.41(WF). The corresponding values for lactation yield were 0.46, 0.43and 0.38 while those of calving interval were 0.41, 0.41 and 0.43. Heterosis estimates for all the traits and genotypes were all positive and in the desired direction. The values ranged from as low as 2.24% in third calving interval to as high as 41.69% in first lactation yield. The moderately high repeatability estimates obtained in this study for the three performance traits in the three genotypes indicate that cows can be selected on the basis of early records. The high heterosis observed in this study indicates an increase in productivity of white Fulani cows when crossed with Friesian.
Keywords: Calving interval, Heterosis, Repeatability, Cattle, F1

Introduction

Lactation yield, lactation length and calving interval are the performance traits of economic importance in dairy production, and are dependent on each other (Akpa *et al.*, 2006). Milk production depends largely on reproductive efficiency with the best cows being those that calf at early age with little number of services per conception and with minimum calving intervals (Ibeawuchi, 1988). There is no doubt that aside tropical harsh conditions, the poor management practices employed by the local farmers often affect the productivity of these animals. It has been reported that 80 % of variations in quantity and milk yields of dairy cows were attributed to environmental factors which can consequently affect the genetic parameter estimates.

Repeatability is the proportion of an individual's superiority or inferiority for particular traits that are expected to be expressed in future performance (Usman *et al.* 2012). Repeatability estimates of milk fat yields and protein percentages are perhaps some of the traits most extensively studied in dairy cattle. Repeatability estimates are important for selection of animals and to bring about improvement in economic traits in selection and breeding program (Falconer and Mackay, 1997).

Heterosis on the other hand is effect of outbreeding and is the superiority of the outbred animals over the average of their parents in individual merit and is associated with heterozygosity across many loci. The cause for heterosis is typically described as dominance, or the interaction of alleles within a locus. An alternate cause for heterosis is epistasis (interaction between two loci) of the desirable gene combinations in the F1 individual (Sheridan, 1981). As a result of this dominance and epistatic effects, heterosis is typically employed in improving traits that are lowly or moderately heritable (Cartwright *et al.*, 1964), including reproductive efficiency traits in cattle.

Any upgrading programme requires the evaluation of the cross and the pure breeds within the same

environment to show the potential of the exotic for genetic improvement of the locals. The objectives of this study therefore was to assess the effect of genotype on lactation length, lactation yield, and calving interval in Friesian, White Fulani and their crossbreds and to determining their repeatability and degree of heterosis.

Materials and Methods

The data for the study were obtained from West African Milk Company (WAMCO) Integrated dairy farm, Vom-Jos, Plateau state. Vom is situated at an elevation of 1200 m above sea level and lies on latitude 8°45' East and longitude 9°43' North in the guinea savannah of north central Nigeria. The average annual rainfall ranges from 1300 mm – 1500 mm, peaking in July/August with a decline from late August. Mean monthly minimum and maximum ambient temperatures are 13.9°C and 31.1°C, respectively while the relative humidity at noon ranges from 14 – 74% (NVRI, 1990).

The cows were maintained on rotational grazing in the rainy season. During the dry season, hay and silage with concentrate constitute the major feed with the former fed *ad libitum.* Routine vaccination against major endemic and epidemic diseases were strictly observed while deworming was carried out three times a year. The animals were sprayed and dipped to eradicate ectoparasites once a month during the rainy season and every other month during the dry season. The cows were machine-milked twice daily at 6:00 am and 3:00 pm.

Performance records used for the purpose of the study were lactation length, lactation yield and calving interval of three lactations. The data obtained were analyzed using the general linear model of the SAS (2001) package using the following model:

$Yij = \mu + Gi + \text{Ɛ}ij$

Where: $Yij = j^{-th}$ observation

Gi = effect of i^{-th} genotype

μ = over all mean

$\text{Ɛ}ij$ = error term

The means, where significant, were separated using the Least Significant Difference (LSD).

Repeatability of traits (lactation length, lactation yield and calving interval) was calculated according to Becker (1985) as follows:

$$R = \frac{\sigma_i^2}{\sigma_i^2 + \sigma_e^2}$$

Where: R = Repeatability

σ_i^2 = Individual variance component

σ_e^2 = Variance due to error

$(\sigma_i^2+\sigma_e^2)$ = Total phenotypic variance

Heterosis was calculated as: $H_{F1} = \frac{\dot{X}_o - \dot{X}_p}{\dot{X}_p}\ x\ 100$

Where: H_{F1}= Heterosis

$\dot{X}_o$ = mean of offspring

$\dot{X}_p$= Mean of parents

Results and Discussion

Least Squares Means of Dairy Performance Traits

Least square means ± S.E of effect of genotype on some dairy performance traits of Friesian, White Fulani, and crossbreds are represented in Table 1. The results show significant genotype differences ($p<0.05$) in all the traits studied. Friesian had the longest length of lactation, highest yield, and longest calving interval, while the white Fulani had the lowest length and yield. The crossbreds however had the lowest calving interval.

Lactation length recorded in this study for the Friesian is lower than 366.5 days reported for the same breed in subtropical condition (Usman *et al.*, 2012) but similar to the mean of 322.1 days in Sudan (Ageeb and Hayes, 2000). The values obtained were however, longer than 292.0 days reported for the same breed in Nigeria (Mbap and Ngere, 1989). Madalena *et al.* (1990) reported 268±20 days as the mean lactation length of Friesian-Guzera crossbreds which is similar to the values obtained for crossbreds in this study. Lactation length of 209 days obtained for white Fulani in this study is slightly lower than the value of 220 days reported by Tawah and Rege (1996) and 224 days reported by Djoko *et al.* (2002) for the same genotype. The differences in the values obtained may be due to differences in environmental conditions, feeding, and management.

There was a significant difference ($p<0.05$) in lactation yield of the three genotypes. Least square means from Table 1 show that Friesian had the highest yield (6792.37 Kg) per lactation followed by the crossbreds and lastly, White Fulani. Lactation yield of Friesian in this study is greater than the range of 2042-6557 Kg reported by Usman *et al.* (2012) but within the range of 2271-7012 Kg reported by M'hamdi *et al.* (2012) in Tunisia. Lactation yield of 4407 Kg obtained in this study for Friesian crossbreds is much higher than 2953 Kg reported by Madalena *et al.* (1990) in Brazil for Friesian- Guzera crossbreds and 1273.48 Kg (Oni *et al.,* 2001) reported for Friesian-White Fulani crossbreds in Nigeria. However, the yields of 1288.60 Kg obtained in this study for the White Fulani cows is similar to the yields of 1211.4 Kg (Oni *et al.,* 2001) and 1288.6 Kg (Djoko *et al.,* 2002). The yields were, on the other hand, higher than the range of 626-1034 Kg reported by Tawah and Rege (1996) for white Fulani cows. The differences in the values obtained in all the genotypes may be due to feeding, management and environmental conditions.

Table 1 Least squares means ±SE of lactation length, lactation yield and calving interval of Friesian, Friesian-White Fulani crossbreds and White Fulani cattle.

Genotype	Lactation length	Lactation yield	Calving interval
Overall	297.23±10.25	4872.45±201.93	400.86±10.49
Friesian	337.63±9.31^{a}	6792.37±285.36^{a}	417.57±11.28^{a}
Friesian x white fulani	290.23±6.463^{b}	4407.34±178.319^{b}	389.99±8.315^{b}
white Fulani	208.78±14.993^{c}	1288.60±142.111^{c}	400.86±11.869^{ab}

a, b, and c = means within the same row bearing different superscripts are statistically significant ($p< 0.05$).

Calving intervals of the three genotypes differed significantly ($p<0.05$). Least squares means (Table 1) show that Friesian and White Fulani had the highest means. Mean calving interval of 417.57±11.3 days observed in this study in Ftiesian cows is similar to 412.2 days reported by Amani *et al.* (2007) in Kenya but longer than 399, days and 396 days reported by Ojango and Pollott (2001) and Oni *et al.* (2001), respectively for Friesian at Shika-Zaria, Nigeria. The mean calving interval of Friesian-White Fulani crossbreds obtained in this study is similar to the range of 336.5-458.7 days reported by Oni *et al.* (2001) at Shika-Zaria. The value is however, lower than 426 days reported by Oyedipe *et al.* (1982). The mean calving interval of 360 days reported by Tawah and Rege (1996) for White Fulani cows is lower than the 400.86±11.869 days reported in this study but is similar to 399±6.6 days reported by Oni *et al.* (2001). Differences in calving interval differ by strain within breed, feeding, environmental conditions and management. Longer interval has been reported to be usually associated with pure breed and also with breeds having high milk production.

Repeatability Estimates of Lactation Yield and Length, and Calving Interval

Repeatability of dairy performance traits of the three genotypes are represented in Table 2. The repeatability estimates of lactation length were 0.484, 0.479 and 0.458 for Friesian, Friesian-white Fulani and White Fulani cows, respectively. The values obtained are similar to 0.48 for Friesian reported by Mc Dowell *et al*. (1978) but lower than 0.51 for Friesian cows by Mustafa *et al.* (2005) in Pakistan. In contrast, El-Barbary *et al.* (1999) reported lower estimates of 0.06-0.22 for Friesians while 0.08 was reported by Adeoye and Ogundipe (2011) for the same breed. The latter authors also reported 0.15 and -0.46 for Friesian-Wadara and Wadara cows, respectively. Differences in estimates of repeatability could be due to methods of data analysis, breed, management, effects of season and parity.

Estimates of repeatability of lactation yield were 0.458, 0.434 and 0.383 for Friesian, Friesian-White Fulani and White Fulani cows, respectively. The values are within the range of 0.353-0.796 reported for Friesian and Friesian-White Fulani crossbreds by Alphonsus and Essien (2012) and 0.43 reported for Friesians by Mustafa *et al.* (2002).

Table 2 Repeatability estimates of lactation length, lactation yield and calving interval of Friesian, White Fulani and their Crossbreds

Genotype	Lactation length	Lactation yield	Calving interval
Friesian	0.48±0.03	0.46±0.05	0.41±0.06
Friesian x white fulani	0.48±0.07	0.43±0.08	0.41±0.06
White fulani	0.46±0.04	0.38±0.05	0.43±0.08

The estimates are slightly higher than 0.21, 0.30 and 0.30, respectively for Friesian, Bunaji, and Friesian-Bunaji crossbreds reported by Johnson (1987). The estimates are also higher than 0.361 - 0.354 reported for Red Sindhi cows by Muhammad *et al.* (2002) but similar to 0.46 and 0.40 reported for Sahiwal cattle in Kenya and India by Wakhungu *et al.* (1991) and, Gandhi and Gurnani (1992), respectively.

Repeatability estimates of calving interval of 0.414, 0.413 and 0.425 were obtained for Friesian, Friesian-white Fulani and white Fulani cows, respectively. The estimates are lower than 0.51 but similar to 0.42 reported for Friesian and their crossbreds, respectively by Adeoye and Ogundipe (2011). In contrasts, Osman and El-Amin (1971) reported lower values of 0.03-0.31 for tropical cows. Also lower estimates of 0.167 for Friesian and 0.10 for Red Sindhi cattle of India were reported (Muhammad *et al.,* 2002), and 0.14±0.01 for Sahiwal cattle in the same country (Gandhi and Gurnani, 1992). The moderate to high repeatability observed in this study suggests that cows can be selected based on early records.

Heterosis of Lactation Yield and Length, and Calving Interval

Table 3 shows the heterosis in dairy performance traits in Friesian- White Fualni cows. The result shows positive heterosis in all the traits under study in the three lactation records. This is in the desired direction, which indicates reduced ages at calving, shorter calving intervals, increased milk yield and longer days in lactation in the F1. The results obtained in this study for yield and lengths of lactation are higher than those reported by Turton (1981), Sheridan (1981), Katpatal (1982) and Syrstad (1986) for different *Bos taurus* and *Bos indicus* crossbreds. This might be due large divergence between the two strightbreds as reported by Syrstad (1986). Other factors such as management and adaptability to the environment also affect heterosis, because Cunningham and Syrstad (1987) reported that superiority of heterozygotes is enlarged when the European breeds are subjected to tropical environmental stress. Heterosis estimates for *Bos indicus* x *Bos taurus* crosses may be heavily influenced by low performance of the unselected *Bos indicus* parent, resulting in these high estimates.

Table 3. Heterosis Estimates of age at calving (months), lactation yields (Kg), lactation lengths (days) and calving intervals (days) in Friesian-White Fulani crosses

Trait	White Fulani (WF)	Friesian (F)	F1 (FxWF)	Mid parent	Heterosis (%)
Age at 1st calving	60.05	29.72	31.46	44.88	29.92
1st yield	1195.95	6331.08	5353.32	3765.62	41.69
1st length	214.18	346.24	322.16	280.21	14.97
1st Calving Interval	430.60	394.10	402.23	412.35	2.45
Age at 2nd calving	71.57	42.50	44.00	57.03	22.85
2nd Lactation yield	1301.73	7027.41	4393,90	4164.57	5.51
2nd lactation length	212.06	347.88	277.20	279.97	0.99
2nd Calving Interval	400.50	432.97	346.23	416.74	16.92
Age at 3rd calving	87.89	54.80	56.23	71.35	21.18
3rd lactation yield	1359.00	6609.33	4127.07	3984.51	3.59
3rd lactation length	193.89	319.20	282.53	256.55	10.13
3rd CalvingInterval	376.47	402.67	398.30	389.57	2.24

Conclusion

Holstein Friesian cows had high potentials of milk production compared to White Fulani and their crossbreds in all the dairy performance traits (lactation length, yield and calving interval) studied. In the same vein, the repeatability estimates of lactation length, yield and calving interval were moderately high in all the genotypes. High repeatability estimates obtained in this study signifies high possibilities of improvement for these traits. Heterosis was positive in all the traits studied and was highest in the first lactation which tends to decline in the subsequent lactations.

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