*Journal of Applied Life Sciences International*

***15(3): 1-7, 2017; Article no.JALSI.37786***
***ISSN: 2394-1103***

# Effects of Non-genetic Factors Affecting the Productive Performance of White Fulani and Friesian x White Fulani Genotypes in Kaduna, Nigeria

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***Authors' contributions***

*This work was carried out in collaboration between all authors. Author OMM designed the study, author DB performed the statistical analysis, wrote the protocol, and wrote the first draft of the manuscript. Authors SDG and DB managed the analyses of the study. Author DB managed the literature searches. All authors read and approved the final manuscript.*

***Article Information***

DOI: 10.9734/JALSI/2017/37786
Editor(s):
(1) Rohit Saluja, Department of Dermatology and Allergy, Charité – Universitätsmedizin Berlin, Germany.
Reviewers:
(1) R. Bharathesree, Tamil Nadu Veterinary and Animal Sciences University, India.
(2) Ayse Deniz Cardak, University of Adnan Menderes, Turkey.
Complete Peer review History: http://www.sciencedomain.org/review-history/22366

***Original Research Article***

***Received 28th October 2017***
***Accepted 23rd November 2017***
***Published 19th December 2017***

## ABSTRACT

This research was conducted to assess the effects of genetic and non genetic factors on the productivity of commercial dairy herd in Kaduna. Nigeria. Data on 252 calving which comprised, 100 white Fulani calves (male 46, female 54) and 152 Friesian × white Fulani calves (male 66, female 86) obtained from records routinely kept for each lactating cow from 2009 to 2014, inclusive were used for the study. The data was subjected to the General Linear Model (GLM) procedure of statistical analysis system. The least squares mean of total milk yield, daily milk yield, lactation length, calving interval, gestation length and age at first calving were 676.39±0.45 kg, 3.54±0.02 kg, 191.07±0.27 days, 382.36±0.59 days, 270.85±0.16 days, and 46.20±2.49 months, for white Fulani breed respectively while the corresponding values for the Friesian × White Fulani crossbred were 1108.22±0.06 kg, 4.84±0.03 kg, 228.97±0.28 days, 366.50±0.65 days, 270.93±0.12 days and 38.80±0.29 months. The age at first calving and parity of dam had significant (P<0.05) effects on

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both total milk yield and average daily milk yield in both breeds. In addition to the above mentioned breeds, year of calving was significant in the crossbred. However, season of calving had no significant (P>0.05) effect on total milk yield as well as average daily milk yield in both genotypes.

*Keywords: Friesian; genetic; milk yield; non-genetic.*

## 1. INTRODUCTION

One of the major food problems in Nigeria is the gross deficiency in animal protein intake. The low animal protein intake has been responsible for reduced human productivity with high incidence of infant mortality, severe malnutrition and general debility of the human body, which pre-dispose people to diseases, low health status and shorter lifespan Mbanasor [1]. In Nigeria, the average consumption of animal protein per caput is lower than the minimum 35 g recommended by the Food and Agriculture Organization FAO [2]. The country specific analysis of FAO data for 1988 to 1990 also found that Nigeria was among the list of countries whose fat-to-energy ratio (FER) fell below the minimum recommendation of 15% dietary energy supply from animal fat [3].

Despite the importance of the dairy sector in providing (important amino acids, some level of energy required for daily activities, synthesis of certain hormones, enzymes and body products in both man and animals) is still under-developed in Nigeria, existing only as small scale enterprises. These small scale dairies are expected to take up the challenges of improving the consumption of dairy products by the teeming populace as well as supply those nutrients which are deficient in most available staples foods such as cereals, roots and tubers. However, the dairy sector has not been able to fulfill this aspiration in terms of quality and quantity of dairy products. The obvious reason for the failure of the sector to meet up with the challenges of providing enough dairy products in both quality and quantity could be ascribed to the twin factors of genetic (quality of stock used for dairy production) and environment. Milk production of dairy animals can be increased either by increasing the number of milch animals or improving environmental conditions, management practices, and breeding practice [4].

In Nigeria, zebu (*Bos indicus*) cattle maintained under agro-pastoral system constitute the main source of animals used for milk production. The poor potential of zebu breeds has led to the adoption of crossbreeding programmes using superior *Bos taurus* breeds as a means of rapidly improving milk production [5].

Environmental (non-genetic) factors such as plane of nutrition, thermal stress, disease condition, management, age of dam or parity, season of birth, and season of lactation among others affect dairy productivity. The extent of the effects of these factors on the productivity of the commercial dairy herd in Kaduna has not been assessed.

## 2. MATERIALS AND MATHODS

### 2.1 Location of the Study

The study was conducted at a privately owned commercial dairy enterprise located at Km. 26 Dogon Dawa Road, Kaduna State. Kaduna is located between latitudes 9° 03' and $11^0$ 32' North of the Equator and longitudes 6° 05' and $8^0$ 38' East of the Greenwich meridian, NACD [6]. The study area has three distinct seasons, namely the dry harmattan season which last, from November to February, dry hot season from March to April and the rainy season, which is cool and lasts between 5-6 months starting from May to October. The mean annual rainfall is about 1800 mm and the mean monthly temperature is 25℃, while the relative humidity is about 63% [7].

### 2.2 Experimental Animals and Their Management

Animal were grazed either on sown pasture in a fenced paddock containing mixture of guinea grass (*Panicum maximum*), giant star grass (*Cynodon datylon*) and *Andropogon spp* for Friesian × White Fulani while the White Fulani were taken out for grazing on open natural pasture (grassland), for about 6 - 8 hours daily and returned to the sleeping barn in the evening. Calves were weighed within 24 hours of life and weekly thereafter, they were allowed to suckle their dams to obtain colostrum for the first 5 days, after which they were bucket fed. Water was given ad-libitum while mineral lick was given

periodically. Vaccinations were normally carried out against major diseases (Black quarter, Anthrax and Contagious Bovine Pleura Pneumonia) and routine management practices such as deworming and spraying against endo and ecto-parasites respectively, were normally done.

### 2.3 Data Collection and Analysis

One hundred (100) lactation records of white Fulani cows which calved 46 bull calves and 54 cow calves as well as one hundred and fifty two (152) lactation records of Friesian × white Fulani crossbred cows which comprises of 66 bull calves and 86 cow calves were used for the study. The lactation records span from 2009 to 2014, inclusive. Data of calving interval, season of calving and parity were used. Others were age at first calving, gestation length, lactation length and milk yield per lactating cow. Individual cow identity was established with respect to pedigree.

### 2.4 Analysis of Effects of Genetic and Non Genetic Factors

The general linear model (GLM) procedure of the Statistical Analysis System SAS, [8] was used to analyze the data for fixed factors. The fixed effect factors evaluated for the dairy productivity of the herd included genotype ( white Fulani, Friesian × white Fulani crossbred), age at first calving, parity of dam (1, 2, 3, 4) year of calving (1, 2 . . . 6) and season of calving (1, 2, 3).

The following fixed effect model was fitted to the data:

$$Y_{ijklmn} = \mu + B_i + A_j + P_k + Y_l + S_m + e_{ijklmn}$$

Where

$Y_{ijklmn}$ = single observation

$\mu$ = mean of the population

$B_i$ = fixed effect of the $i^{th}$ breed (i = 1, 2)
$A_j$ = fixed effect of the $j^{th}$ age at first calving
$P_k$ = fixed effect of the $k^{th}$ parity of dam (k = 1, 2, . . .4)
$Y_l$ = fixed effect of the $l^{th}$ year of calving (l = 1, 2, . . .6)
$S_m$ = fixed effect of the $m^{th}$ season of birth (m = 1, 2, 3)
$e_{ijklmn}$ = random residual error

## 3. RESULTS

### 3.1 Lactation Yield and Reproductive Performances of FRIESIAN × WHITE Fulani and White Fulani Cows in Kaduna

Table 1 shows the Mean ± SEM of lactation yield and some reproductive performances of the two dairy breeds in Kaduna from 2009 to 2014, inclusive. The Friesian × white Fulani performed significantly ($P<0.05$) higher than the white Fulani breed in lactation yield, lactation length, calving interval and age at first calving. The gestation length was, however, the same ($P\geq0.05$) for both genotypes.

### 3.2 Means of Non-genetic Factors Affecting Milk Yield on Commercial Farms Kaduna

Tables 2 and 3 shows the least squares mean ± SEM of non-genetic factors affecting milk yield of White Fulani and Friesian × White Fulani cows, respectively. In both breeds, age at first calving and parity of dam significantly ($P<0.05$) affected total and average daily milk yields. Additionally, year of calving significantly affected the two parameters ($P<0.05$) in Friesian × White Fulani. However, season of calving and sex of the calf did not show any significant effect on milk yield of the two breeds. Lower parities favoured higher milk yield in both breeds while year of calving had no particular trend in the Friesian × White Fulani cows.

## 4. DISCUSSION

### 4.1 Total and Average Daily Milk Yield of the Lamda Farm Herd

The total milk yield obtained in this study for White Fulani cows and Friesian × White Fulani crossbred cows are in close agreement with the findings of Mrode [9] who reported a total yield of 810.89 kg, for White Fulani and 1018.25 kg for the Friesian × Bunaji crossbred over a lactation period of 230.68 and 249.67 days, respectively. The author also reported a corresponding daily yield of 3.35 kg and 4.09 kg, similar to the findings of the present study. However, Isaac and Olatogun [10] reported higher values of total yield 1060.10 kg for White Fulani and (4118.39 kg) for Friesian × White Fulani crossbred over a

mean lactation length of 211.00 and 293.54 days, respectively. The difference between the findings of this study and those of earlier researchers could be due to differences in climatic and management factors which could differ from Farm to Farm. Generally, the total milk yield obtained in this study falls with the range of 635 – 1225 kg reported by Payne [11].

**Table 1. Lactation yield and some reproductive performance of White Fulani and Friesian × White Fulani cows in Kaduna**

| Traits | White Fulani | Friesian ×White Fulani |
|---|---|---|
| Total milk yield (kg) | 676.39±0.45[b] (87) | 1108.22±0.06[a] (148) |
| Daily milk yield (kg) | 3.54±0.02[b] (87) | 4.84±0.03[a] (148) |
| Gestation length | 270.85±0.16 (100) | 270.93±0.12 (151) |
| Lactation length (days) | 191.07±0.27[b] (87) | 228.97±0.28[a] (148) |
| Calving Interval (days) | 382.36±0.59[b] (67) | 366.50±0.65[a] (116) |
| Age at first calving (months) | 46.20±2.49[b] (100) | 38.80±0.29[a] (152) |

*( ) = Values in parenthesis are number of observation. a,b = means with different superscript within a row are significantly different (P<0.05)*

**Table 2. Least square means of non-genetic factors affecting milk yield of White Fulani cows in Kaduna**

| Factors | No. of observation | Total milk yield | Daily milk yield |
|---|---|---|---|
| Age at first calving | | * | NS |
| 44.20-45.26 | 11 | 689.00±14.79[a] | 3.61±0.07[a] |
| 45.40-45.97 | 22 | 600.82±7.89[c] | 3.51±0.02[a] |
| 46.07-46.57 | 35 | 609.08±8.00[bc] | 3.50±0.03[a] |
| 46.87-47.83 | 19 | 631.38±11.60[b] | 3.56±0.04[a] |
| Parity of dam | | * | * |
| 1 | 24 | 657.96±5.49[c] | 3.46±0.03[b] |
| 2 | 28 | 656.16±5.75[c] | 3.45±0.02[b] |
| 3 | 18 | 715.07±8.16[a] | 3.68±0.41[a] |
| 4 | 17 | 692.87±9.96[b] | 3.67±0.05[a] |
| Year of Calving | | NS | NS |
| 2009 | 13 | 660.10±8.04 | 3.49±0.04 |
| 2010 | 15 | 688.99±8.90 | 3.62±0.04 |
| 2011 | 12 | 671.99±5.04 | 3.51±0.02 |
| 2012 | 15 | 672.75±12.2 | 3.49±0.06 |
| 2013 | 16 | 677.81±14.3 | 3.54±0.06 |
| 2014 | 16 | 678.89±10.1 | 3.56±0.05 |
| Season of Calving. | | NS | NS |
| DCH | 31 | 676.92±7.59 | 3.54±0.03 |
| DHH | 18 | 669.64±9.50 | 3.51±0.05 |
| RS | 38 | 677.25±6.29 | 3.55±0.04 |

**= (p<0.05), NS = not significant, a,b= means with different superscripts in a column within factor sub-group are significantly different (p<0.05), DCH =Dry hot season, DHH= Dry Harmattan season, RS= Raining season.*

**Table 3. Least square means of non-genetic factors affecting milk yield of Friesian × White Fulani cows in Kaduna**

| Factors | No. of observation | Total milk yield | Daily milk yield |
|---|---|---|---|
| Age at first calving | | * | * |
| 38.47 – 38.63 | 12 | 1102.03±30.84[a] | 4.85±0.12[a] |
| 38.70 – 38.80 | 55 | 1111.10±9.01[a] | 4.86±0.03[a] |
| 38.83 – 38.97 | 67 | 1117.20±10.35[a] | 4.89±0.04[a] |
| 39.00 – 39.17 | 14 | 1032.19±12.69[b] | 4.57±0.05[b] |
| Parity of Dam | | * | * |
| 1 | 34 | 1119.1±6.73[d] | 4.54±0.03[d] |
| 2 | 47 | 1079.3±5.79[c] | 4.78±0.03[c] |
| 3 | 35 | 1183.8±12.4[a] | 5.15±0.04[a] |
| 4 | 23 | 1152.4±12.4[b] | 4.97±0.05[b] |
| 5 | 9 | 1138.5±17.1[b] | 4.90±0.07[b] |
| Year of Calving | | * | * |
| 2009 | 27 | 1076.3±9.08[c] | 4.80±0.0[4b] |
| 2010 | 25 | 1137.7±20.9[ab] | 4.99±0.08[a] |
| 2011 | 27 | 1143.3±18.1[a] | 4.96±0.07[a] |
| 2012 | 22 | 1097.5±15.6[bc] | 4.77±0.06[b] |
| 2013 | 25 | 1071.7±11.5[c] | 4.72±0.04[b] |
| 2014 | 20 | 1093.4±14.1[b] | 4.79±0.05[b] |
| Season of Calving | | *NS* | NS |
| DCH | 50 | 1106.02±10.77 | 4.34±0.08 |
| DHH | 32 | 1099.73±14.95 | 4.34±0.10 |
| RS | 65 | 1110.36±10.27 | 4.36±0.06 |

**= (P<0.05), NS= Not significant, a,b= mean with different superscript in a column within factor sub-group are significantly different (P<0.05), DCH= Dry hot season, DHH= Dry harmattan, RS= Raining season.*

The superiority of milk yield of the Friesian × White Fulani crossbred cows over the White Fulani pure breed has been demonstrated in this study. Adeneye [12] observed that Friesian × White Fulani crossbred had excellent performance in average milk yield than the White Fulani pure breed. Malau-Aduli [13] observed significant effect of breed on milk yield and noted that the beneficial effects of crossbred reflected in the milk yield of the cross compared to the pure Bunaji.

## 4.2 The Effects of Non-genetic Factors on Milk Yield

Dobos et al. [14] and Zewdu et al. [15] reported significant effect of age at first calving on milk yield of cows. This observation has been supported by the findings of the present study in Friesian × White Fulani crossbred cows. The no significant effect of age at first calving on daily milk yield of White Fulani in the present study could be as a result of sample size used in this study. The significant influence (P<0.05) of parity of dam on total milk yield and average daily milk yield performance of both breeds in the present study is in agreement with the findings of El-Habeeb [16], Malau-Aduli et al. [13], Bajwa et al. [17], Musa et al. [18] and Zewdu et al. [15], but contrasts with Kara and Joshi [19], Njubi et al. [20] and Usman et al. [4] who reported no significant effect of parity of dam. The influence of parity on milk yield could be attributed to the effects of cow's age on the development and progressive efficiency in the physiological functions of the secretory tissue on the mammary gland. In this study, the total and daily milk yields increased with increasing parity and reached its peak in the third parity and thereafter started to decline with increase in parity. This agreed with the findings of Chaudhry [21] who observed similar trend on Buffaloes and Malau-Audil et al. [13] in cattle.

The year of calving had no influence (P<0.05) on milk yield of White Fulani cows. This is in agreement with the findings of Usman et al. [4] who observed non-significant effect of year of calving on milk yield of Holstein Friesian in China and noted that the non-significant influence of year on lactation milk yield was due to lack of variation in management practices during the

years. However, milk yields were significantly (P<0.05) affected by year of calving in the crossbred which confirmed previous findings by Mbap and Ngere, [5], Malau-Aduli et al. [13] and Bajwa et al. [17]. These workers noted that the significant influence of year of calving was due to the variations in management and quality of fodder supply during the years.

The non-significant (P<0.05) influence of season of calving on total as well as average daily milk yield in both breeds, in this study is supported by the work of Usman et al. [4], but contradicted Bajwa et al. [17] who reported significant influence of season and noted that winter calvers produced more milk than the summer calvers.

## 5. CONCLUSION

The Friesian × White Fulani crossbred demonstrated superiority in milk yield over the pure breed White Fulani cattle thereby revealing the beneficial effects of crossbreeding as compared to the pure breed White Fulani. Among the non-genetic factors age at first calving, parity order of dam and year of calving had significant effect on total milk yield and daily milk of the crossbred while year of calving was not significant on daily milk yield of the White Fulani. However, season of calving had not influenced the parameters measured on both breeds. For that, performance records of these animals had to be corrected or adjusted for all the known factors which differently affect performance in the two breeds.

## COMPETING INTERESTS

Authors have declared that no competing interests exist.

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*Peer-review history:*
*The peer review history for this paper can be accessed here:*
*http://sciencedomain.org/review-history/22366*