

## Effect of Breeds on Milk Yield and Persistency of Cows Raised under Extensive Management System in Nigeria

<sup>\*1</sup>Ayuba Dauda and <sup>2</sup>Yusuf Idi

<sup>1</sup>Department of Animal Production and Health Federal University Wukari, Taraba State Nigeria

<sup>2</sup>Department of Animal Science College of Agriculture Federal University Agriculture Zuru, Nigeria

\*Corresponding author email: ayubadauda87@gmail.com

### Abstract

*Milk persistence in dairy cows is an economically important trait that will determine profit for the dairy industry and will help to overcome immeasurable diseases in dairy cows. This study looked at the best breed that will maintain persistency for a certain time and ranked the animals based on milk yield and persistency. The study used a total of 60 nursing cows, 20 Sokoto Gudali, 20 White Fulani, and 20 Red Bororo were used for the daily milk collection. The total milk collected in a week was added together and divided by seven days to get the average daily milk yield for each breed (Sokoto Gudali, White Fulani and Red Bororo). The duration of the milking periods was recorded in days. Persistency of milk yield was computed by the ratio of the lactation period and divided into four equal periods of 30 days each. The total 30-day milk yield of each period per cow was calculated. Data collected were analyzed using the general Linear Model of the SAS program while significant means were separated using the Duncan Multiple Range Test. The results revealed that the Sokoto Gudali cows yielded significantly ( $P < 0.05$ ) higher daily milk (4.13 - 4.31 L/day) whereas Red Bororo (0.72 - 0.94 L/day) was lowest in week 1. At week two, Sokoto Gudali (4.09 - 4.31 L/day) had the highest milk whereas Red Bororo (0.82 - 1.04 L/day) was the least. At week three, Sokoto Gudali (4.19 - 4.39 L/day) had a significantly ( $P < 0.05$ ) higher daily milk whereas Red Bororo (0.74 - 0.90 L/day). In week 4 same trends were also observed. Sokoto Gudali (4.19) was ranked to be superior (1), followed by the White Fulani (1.62) with the breed (2) whereas the Red Bororo (0.89) was the least (3) in terms of total milk yield. The average weekly milk yield persistency showed that Sokoto Gudali and the Red Bororo breeds were maintained at high persistency from week one through week four without a significant decline. Breeds influenced daily milk yield from week 1 to week 4. The overall ranking of breeds on milk yield revealed that Sokoto Gudali was ranked the highest followed by White Fulani and the least was Red Bororo.*

Keywords: Milk Persistency, Breeds, Ranking, Cattle

## 1.0 Introduction

The rate at which output starts to fall following peak milk production is the standard definition of lactation persistence. A moderate rate of production reduction is related with high lactation persistency, whereas a quick decline is associated with low breastfeeding persistency. When yield and lactation persistency are associated, cows with more lactation persistency are more profitable than normal cows, however the differences are minimal until reproductive performance is very subpar (Dekkers et al., 1997).

Early lactation requires less energy for persistent animals, allowing for better use of inexpensive roughage (Sölkner and Fuchs, 1987). According to Appuhamy et al. (2007, 2009), there are unfavorable genetic associations between the persistence of milk and fat yields and a number of metabolic illnesses. Illnesses also tend to considerably affect lactation persistence rather than persistence affecting disease onset. Unfavorable genetic connections between persistency and metabolic disorders were also reported by Harder et al. (2006).

The rate of change in milk output between test days is measured as milk persistence. It is defined as one test's milk yield expressed as a percentage of another test's milk production (DHI, 2017). Low persistency is connected with a rapid reduction in milk yield, whereas high persistency is associated with a delayed decline in milk yield (Jingar et al., 2014).

In terms of economic value, persistence will define the shape of the lactation curve. Persistency gives vital information on the volume of milk produced over one lactation phase, which represents the biological features of the cow, farm management, and cost-effectiveness (Widyas et al., 2018). Lactation persistency is influenced by environmental and genetic factors such as genetic group, sire effect, herd management, lactation number, food, gestation, and animal calving season (Koloi et al., 2018). Knowledge of milk yield persistency is critical because it is one of the key features defining the form of the lactation curve, in addition to being connected with starting output (El-Faro, 1996). The goal of this study was to assess the milk yield persistency and breed effect on milk yield in (days) of White Fulani, Sokoto Gudali, and Red Bororo cattle in Nigeria under extensive management.

## 2.0 Materials and Methods

### Study Location

The study was carried out in Maiduguri and its environs. Maiduguri is the capital of Borno State, North Eastern Nigeria. The state lies between latitude 11°32' North and 11°40' North and longitude 13°20' East and 13°25' East between the Sudan Savanna and Sahel Savanna vegetation zones (Borno State Ministry of Land and Survey, 2016).

### Experimental Animals and Management

A total of 60 cows (20 Sokoto Gudali, 20 White Fulani and 20 Red Bororo) were used for the daily milk collection. The animals were raised under an extensive management system, with

little or no provision for shelter in the day and night. The animals were allowed to graze on natural pasture containing forages such as Northern Gamba grass (*Andropogon gayanus*), Stylo (*Stylosanthes gracilis*) and Leucaena (*Leucaena leucocephala*) during the daytime.

### Average Daily Milk Yield

A hand milking method was used in milk collection in this study; the total milk collected in a week was added together and divided by seven days to get the average daily milk yield for each breed on the same parity (Sokoto Gudali, White Fulani and Red Bororo). The animals were ranked based on milk collected per week, from the first week to the fourth week. The animal with the highest yield was ranked first, the animal with the second highest yield was ranked second and the animal with the lowest milk yield ranked third.

### Lactation Length

The duration of the milking periods was noted in days.

### Persistency

The persistency was derived from the ratio-based persistency index approach developed by Ludwick and Peterson (1943). The lactation time was split into four equal segments, each lasting 30 days. Each period's 30-day milk production per cow was calculated. The ratios listed below were calculated:

$$R_1 = X_2; R_2 = X_3; R_3 = X_4 \dots \dots \dots \text{Equation 2.1}$$

Where:

$X_1; X_2; X_3; X_4$  refer to the total milk yield in the four consecutive periods. These ratios were added as  $X_1 + X_2 + X_3$  and weighting factors were calculated as:

$$W_1 = R_1; W_2 = R_2; W_3 = R_3 \dots \dots \dots \text{Equation 2.2}$$

$$R_1 + R_2 + R_3$$

By using  $W_1, W_2$  and  $W_3$ , the persistency index (PI) of each cow was calculated as:

$$PI = (W_1 R_1 + W_2 R_2 + W_3 R_3) / 100 \dots \dots \dots \text{Equation 2.3}$$

$$\text{Dairy Merit (DM)(\%)} = NEE \times \text{FCM/day} \dots \dots \dots \text{Equation 2.4}$$

$$\text{FCM/day} + 0.173W^{0.75}$$

(Brody, 1945).

## Data Analysis

The SAS program's General Linear Model (GML) approach was used to evaluate the traits of interest in order to find connections (SAS, 2000). Using the Duncan Multiple Range Test (DMRT), significant means were separated.

$$Y_{ijk} = \mu + B_i + e_{ijk} \dots\dots\dots \text{Equation 2.5}$$

Where:

$Y_{ijk}$  = milk yield

$\mu$  = the overall mean

$B_i$  = the fixed effect of the  $i^{\text{th}}$  breeds ( $i$  = Sokoto Gudali, White Fulani and Red Bororo)

$e_{ijk}$  = the random residual error.

## 3.0 Results and Discussion

Effects of breeds on daily milk yield at week one is presented in Table 3.1. The results showed the effect of breeds on daily milk yield at week one. The Sokoto Gudali cows yielded significantly ( $p < 0.05$ ) higher daily milk (4.13 - 4.31 L/day) than the White Fulani (1.26 - 1.70 L/day) and the Red Bororo (0.72 - 0.94 L/day).

The effects of breeds on daily milk yield at week two are presented in Table 3.2. At week two, breeds had a significant ( $P < 0.05$ ) effect on daily milk yield. Sokoto Gudali (4.09 - 4.31 L/day) had the highest milk yield followed by the White Fulani (1.67 - 1.86 L/day) while the Red Bororo (0.82 - 1.04 L/day).

The effects of breeds on daily milk yield at week three are shown in Table 3.3. The results showed that the Sokoto Gudali (4.19 - 4.39 L/day) had a significantly ( $P < 0.05$ ) higher daily milk yield followed by the White Fulani (1.80 - 1.99 L/day) and the Red Bororo (0.74 - 0.90 L/day) had the least daily milk yield.

The effects of breeds on daily milk yield at week four are presented in Table 3.4. The results showed that the Sokoto Gudali (4.01 - 4.18 L/day) had significantly ( $P < 0.05$ ) yielded the highest daily milk in week four. The White Fulani (1.33 - 1.52 L/day) cow's milk yield was lower than the daily yields of the Sokoto Gudali but above the daily yields of the Red Bororo (0.88 - 1.06 L/day) breed.

The results of the overall ranking of breeds on milk yield are shown in Table 3.5. The results showed that Sokoto Gudali (4.19) was ranked to be superior (1), followed by the White Fulani (1.62) with the breed (2) while the Red Bororo (0.89) was the least (3) in terms of total milk yield. The corresponding degree of variability (coefficient of variation) increases with a decrease

**Table 3.1: Daily milk yield of Sokoto Gudali, Red Bororo and White Fulani cows at week one**

Day	Sokoto Gudali			Red Bororo			White Fulani		
	Mean	SEM	COV	Mean	SEM	COV	Mean	SEM	CV
Monday	4.13 <sup>a</sup>	0.23	16.41	0.80 <sup>c</sup>	0.12	34.23	1.70 <sup>b</sup>	0.25	44.99
Tuesday	4.31 <sup>a</sup>	0.16	10.85	0.78 <sup>c</sup>	0.12	33.19	1.39 <sup>b</sup>	0.17	35.72
Wednesday	4.13 <sup>a</sup>	0.21	15.68	0.94 <sup>b</sup>	0.16	38.80	1.40 <sup>b</sup>	0.18	37.80
Thursday	4.30 <sup>a</sup>	0.20	14.15	0.90 <sup>b</sup>	0.17	42.31	1.47 <sup>b</sup>	0.19	39.61
Friday	4.22 <sup>a</sup>	0.16	11.28	0.72 <sup>c</sup>	0.17	48.51	1.26 <sup>b</sup>	0.17	41..79
Saturday	4.28 <sup>a</sup>	0.17	11.85	0.84 <sup>c</sup>	0.19	50.23	1.44 <sup>b</sup>	0.22	45.28

<sup>abc</sup> means in the same row with different superscripts are significantly different (P<0.05) SEM=Standard Error of Mean, CV=Coefficient of Variation

**Table 3.2: Daily milk yield of Sokoto Gudali, Red Bororo and White Fulani cows at week two**

Day	Sokoto Gudali			Red Bororo			White Fulani		
	Mean	SEM	CV	Mean	SEM	CV	Mean	SEM	CV
Monday	4.09 <sup>a</sup>	0.20	13.80	0.86 <sup>c</sup>	0.19	48.36	1.67 <sup>b</sup>	0.19	33.54
Tuesday	4.24 <sup>a</sup>	0.22	14.21	1.04 <sup>c</sup>	0.12	30.86	1.76 <sup>b</sup>	0.17	29.89
Wednesday	4.31 <sup>a</sup>	0.16	10.62	0.82 <sup>c</sup>	0.10	26.44	1.83 <sup>b</sup>	0.14	23.62
Thursday	4.19 <sup>a</sup>	0.20	15.55	0.94 <sup>c</sup>	0.06	14.27	1.67 <sup>b</sup>	0.20	36.74
Friday	4.25 <sup>a</sup>	0.28	18.87	0.94 <sup>c</sup>	0.11	26.70	1.67 <sup>b</sup>	0.20	36.74
Saturday	4.24 <sup>a</sup>	0.16	10.47	1.00 <sup>c</sup>	0.14	30.82	1.86 <sup>b</sup>	0.21	34.73

<sup>abc</sup> means in the same row with different superscripts are significantly different (P<0.05) SEM=Standard Error of Mean, CV=Coefficient of Variation

in ranking. Besides, Red Bororo and White Fulani have high coefficients of variation 36.54 and 34.37 respectively. The results of weekly milk yield persistence of Sokoto Gudali, Red Bororo and the White Fulani breeds are presented in Figures 3.1, 3.2 and 3.3. The results showed that the average weekly milk yield of the Sokoto Gudali and the Red Bororo breeds were maintained at high persistency from week one through week four without a significant decline as shown in figures 3.1 and 3.2 respectively. The White Fulani breed attained peak milk yield in week two and production persisted to drop down to week three and decline thereafter in week four as shown in figure 3.3.

Breeds revealed a significant ( $p < 0.05$ ) difference in average daily milk yield from week one to four with Sokoto Gudali recording the highest average milk yield. The report from this study was lower than the 5.3 kg/liters reported for Sokoto Gudali by Aboagye (2002). The observed differences in milk yield among breeds might be due to environmental effects concerning the individuality of cows' milk production. The range of 1.12 to 2.01 L/kg/cow/day for White Fulani cows raised in the open without concentrate supplementation and the range of 1.47 to 2.23 kg/cow/day for White Fulani cows receiving concentrate supplementation was almost identical for White Fulani cows' average daily milk yield from week one to week four reported by Tona et al. (2017). The values obtained in this investigation fell below the range (2.29 to 3.28 kg/cow/day) in this current study and were lower than values reported by Tona et al. (2015a) for grazing White Fulani cows fed 0, 20 and 30% dietary levels of soya milk residue. The values observed in this study for Red Bororo 0.72 - 1.06 liters were higher than the ranged values 0.16 - 0.46 kg/cow/day reported by Ndubueze et al. (2006).

**Table 3.3: Daily milk yield comparison between the Sokoto Gudali, Red Bororo and White Fulani cows at week three**

Day	Sokoto Gudali			Red Bororo			White Fulani		
	Mean	SEM	CV	Mean	SEM	CV	Mean	SEM	CV
Monday	4.19 <sup>a</sup>	0.19	12.14	0.90 <sup>c</sup>	0.19	46.48	1.99 <sup>b</sup>	0.13	18.13
Tuesday	4.31 <sup>a</sup>	0.22	9.69	0.76 <sup>c</sup>	0.15	43.24	1.91 <sup>b</sup>	0.11	16.87
Wednesday	4.39 <sup>a</sup>	0.15	9.07	0.78 <sup>c</sup>	0.19	53.17	1.94 <sup>b</sup>	0.11	16.54
Thursday	4.24 <sup>a</sup>	0.10	8.94	0.80 <sup>c</sup>	0.11	45.80	1.80 <sup>b</sup>	0.09	16.77
Friday	4.26 <sup>a</sup>	0.14	8.90	0.74 <sup>c</sup>	0.19	58.59	1.94 <sup>b</sup>	0.12	17.43
Saturday	4.29 <sup>a</sup>	0.16	9.18	0.78 <sup>c</sup>	0.13	53.17	1.99 <sup>b</sup>	0.33	18.13

*abc means in the same row with different superscripts are significantly different ( $P < 0.05$ ) SEM=Standard Error of Mean, CV=Coefficient of Variations*

**Table 3.4: Daily milk yield comparison between the Sokoto Gudali, Red Bororo and White Fulani cows at week four**

Day	Sokoto Gudali			Red Bororo			White Fulani		
	Mean	SEM	CV	Mean	SEM	CV	Mean	SEM	CV
Monday	4.18 <sup>a</sup>	0.13	9.63	0.88 <sup>c</sup>	0.08	23.11	1.47 <sup>b</sup>	0.19	38.42
Tuesday	4.11 <sup>a</sup>	0.14	10.14	0.95 <sup>c</sup>	0.14	35.70	1.52 <sup>b</sup>	0.21	41.13
Wednesday	4.11 <sup>a</sup>	0.15	11.04	0.92 <sup>c</sup>	0.15	41.06	1.46 <sup>b</sup>	0.20	42.09
Thursday	4.03 <sup>a</sup>	0.14	10.22	1.06 <sup>b</sup>	0.15	34.38	1.33 <sup>b</sup>	0.20	43.89
Friday	4.06 <sup>a</sup>	0.20	14.59	0.92 <sup>b</sup>	0.09	26.20	1.39 <sup>b</sup>	0.21	44.59
Saturday	4.01 <sup>a</sup>	0.14	10.39	0.92 <sup>b</sup>	0.15	41.06	1.41 <sup>b</sup>	0.20	41.54

<sup>abc</sup> means in the same row with different superscripts are significantly different (P<0.05) SEM=Standard Error of Mean, CV=Coefficient of Variation

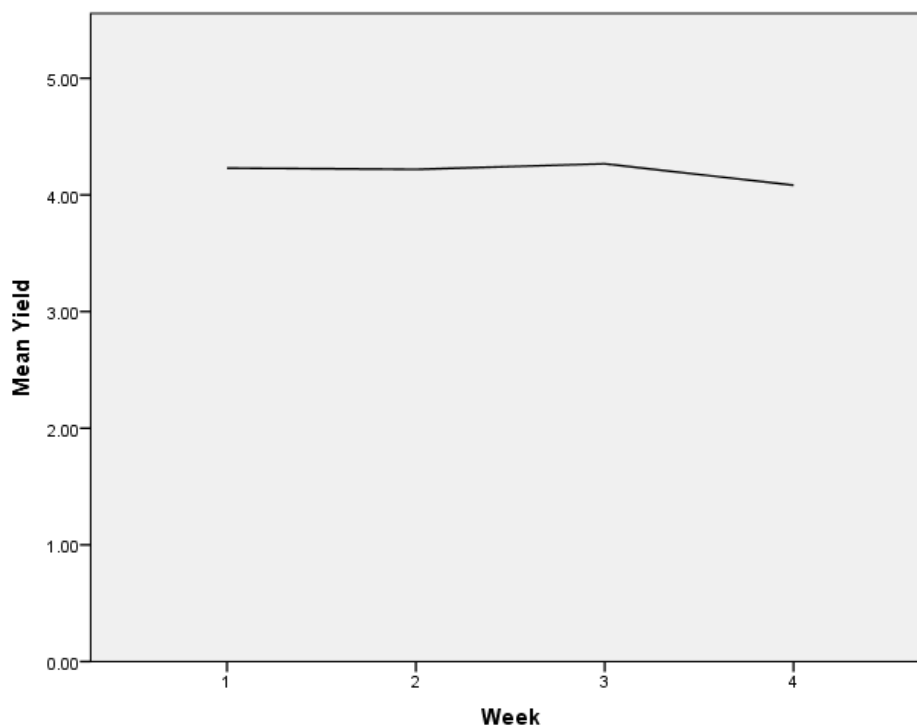
The difference in milk yield between the three breeds (Sokoto Gudali, White Fulani and Red Bororo) could be due to the differences in the genetic potentials of the animals. According to Johnson (1991), milk yields are the product of animal genetic and environmental interactions (Dandare et al., 2014; Oladapo and Ogunekun, 2015). The ranking of breeds on milk yields showed that Sokoto Gudali was ranked to be superior, followed by the White Fulani and the least was Red Bororo in terms of total milk yield. The corresponding degree of variability (coefficient of variation) increases with a decrease in ranking. Besides, Red Bororo and White Fulani have a high coefficient of variation. This implies that nature is varied and hence has more potential for genetic improvement through selection. Therefore, the variation that exists in the milk yield of Red Bororo and White Fulani could be exploited for selection and improvement of milk yield. There are differences in the ranking of cows, regarding different persistency measures and milk yield (Bankizadeh et al., 2015). Milk yield is the most commonly used trait for the ranking of cows, and cows with high milk yield are ranked superior to the one with low milk yield (Roessler, 2019). The average weekly milk yield of the Sokoto Gudali and the Red Bororo breeds were maintained at high persistency from week one through week four without a significant decline as shown in figures 3.1 and 3.2 respectively.

The White Fulani breed attained peak milk yield in week two and production persisted drop down to week three and decline thereafter in week four. The capacity to maintain the level of production is to use persistency as a measure based on the lactation curve's form after the peak (Jamrozik et al., 1998). On a practical herd level, the benefits of raising dairy cattle's persistence are undeniable. Longer high-production phases are brought about by more persistent lactation. The persistency measure's connection with the 305-day milk output is a crucial feature (Strapáková et al., 2016).

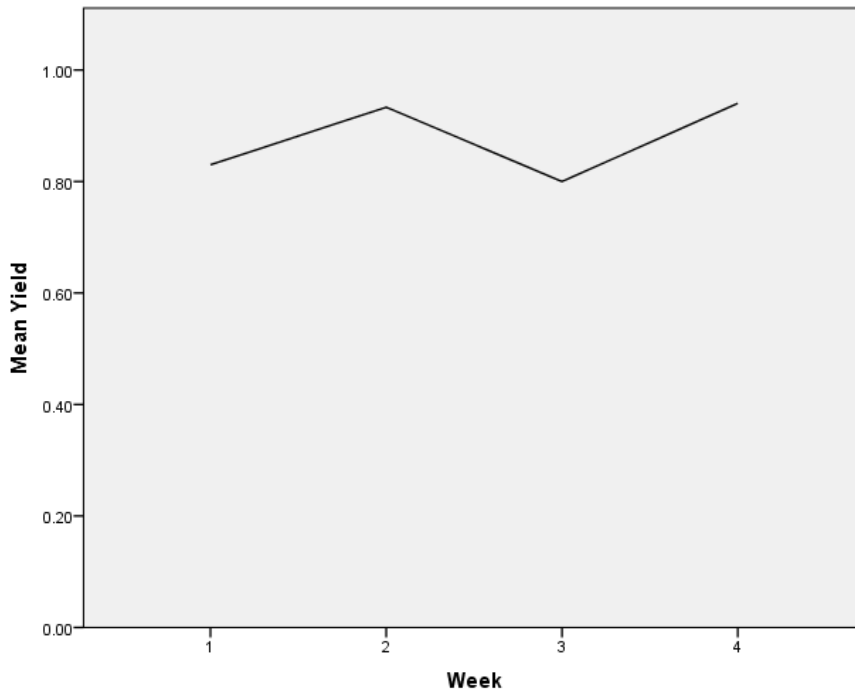
**Table 3.5: Overall Ranking of Breed on Milk Yield**

Breed	Mean	SEM	CV	Rank
Sokoto Gudali	4.19 <sup>a</sup>	0.04	11.85	1 <sup>st</sup>
Red Bororo	0.89 <sup>c</sup>	0.03	36.54	3 <sup>rd</sup>
White Fulani	1.62 <sup>b</sup>	0.04	34.37	2 <sup>nd</sup>

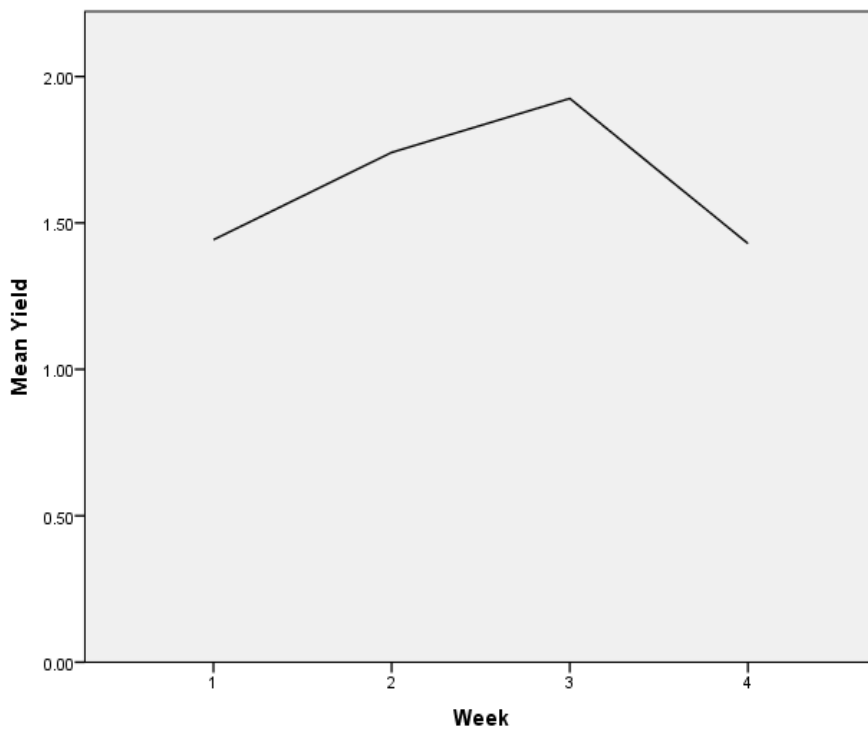
<sup>abc</sup> means in the same row with different superscripts are significantly different ( $P < 0.05$ ) SEM=Standard Error of Mean, CV=Coefficient of Variation

**Figure 3.1: Mean weekly average milk yield persistency of the Sokoto Gudali breed**





**Figure 3.2: Mean weekly average milk yield persistency of the Red Bororo breed**



**Figure 3.3: Mean weekly average milk yield persistency of the White Fulani breed**

High-persistence cows could experience more stress during lactation, which might hurt reproduction or longevity (Mostert et al., 2008). Therefore, selection for persistency will be especially helpful in circumstances when disease resistance cannot be readily quantified. Thus, local variables and the type of production systems used will determine the actual economic worth of persistency (Jensen, 2001). Lactation persistence is crucial for milk production because there are some stated benefits to breeding programs (Dekkers et al., 1996). According to Harder et al. (2006), animals with low lactation persistency may have excessive feed consumption, reproductive issues, and other health issues, all of which drive up production costs.

## 4.0 Conclusion

Breeds influenced daily milk yield from week 1 to week 4. Sokoto Gudali had a higher ability to maintain consistency in milk yield from week one after calving to week 4. Red Bororo also, had the same ability while White Fulani maintained consistency in milk yield from week one after calving to week 2 and then declined. The overall ranking of breeds on milk yield revealed that Sokoto Gudali was ranked 1st (highest) followed by White Fulani 2nd and Red Bororo 3rd (lowest). Red Bororo and White Fulani had high coefficient of variations which implies there is room for improvement in the two breeds for milk yield.

## References

- Appuhamy, J.A.D.R.N., Cassell, B.G. DeChow, C.D. and Cole, J.B. (2007). Phenotypic relationships of common health disorders in dairy cows to lactation persistency estimated from daily milk weights. *Journal of Dairy Science*, 90: 4424-4434
- Appuhamy, J.A.D.R.N., Cassell, B.G. and Cole, J.B. (2009). Phenotypic and genetic relationships of common health disorders with milk and fat yield persistencies from producer-recorded health data and test day yields. *Journal of Dairy Science*, 92:1785-1795
- Bankizadeh, F., Emam, N., Kashan, J., Eghbalsaied, S. and Safari, R. (2015). Genetic Evaluation of Lactation Persistency and Milk Yield in Iranian Holstein Dairy Cattle Using Random Regression Models. *Journal of Animal and Plant Sciences*, 25(6): 1527-1531
- Borno State Ministry of Land and Survey, (BMLS) (2016). Annual Report 15-58
- Brody, D. (1945). *Bioenergetics and growth*. Hafner Publishing Co. Inc. New York. Page 1025.
- Dandare, S. U., Ezeonwumelu, I. J. and Abubakar, M. G. (2014). Comparative analysis of nutrient composition of milk from different breeds of cows. *European Journal of Applied Engineering and Scientific Research*, 3 (2):33-36.
- Dekkers, J. C. M., Jamrozik, J., Ten Hag, J. H., Schaeffer, L. R. and Weersink, A. (1996). Genetic and economic evaluation of persistency in dairy cattle. Proc. Int. Workshop on

- Genetic Improvement of Functional Traits in Cattle. Gembloux, Belgium. INTERBULL Bulletin No. 12, 97-102
- Dekkers, J. C. M., Ten Haag, J. H. and Weersink, A. (1997). Economic aspects of persistency in dairy cattle. *Livestock Production Science*, 53:237-252
- DHI (2017). Persistency of milk production. Information sheet western Canadian Dairy herd improvement services. [http://www.agromedia.ca/ADM\\_Articles/content/DHI\\_persist.pdf](http://www.agromedia.ca/ADM_Articles/content/DHI_persist.pdf)
- El-Faro, L. (1996). Study of a Caracu rebaho's lactation curve. Doctoral dissertation. Jaboticabal. Jaboticabal: UNESP Faculdade de Ciências Agrárias e Veterinárias. Animal Reproduction College of Brazil (CBRA) Belo Horizonte, MG, Brazil. Pp 153
- Harder, B., Bennewitz, J., Hinrichs, D. and Kalm, E. (2006). Genetic parameters for health traits and their relationship to different persistency traits in German Holstein dairy cattle. *Journal of Dairy Science*, 89(8): 3202–3212.
- Harder, B., Bennewitz, J., Hinrichs, D. and Kalm, E. (2006). Genetic parameters for health traits and their relationship to different persistency traits in German Holstein dairy cattle. *Journal of Dairy Science*, 89:3202-3212
- Jakobsen, J.H. (2000). Genetic correlations between the shape of the lactation curve and disease resistance in dairy cattle. Ph.D. thesis. Dept. of Animal Breed. Genet. Danish Institute of Agricultural Sciences, Research Centre, Foulum, Denmark. Pp 185
- Jamrozik, J., Janse, G., Schaeffer, L.R. and Liu, Z. (1998). Analysis of persistency of lactation calculated from a random regression test day model. INTERBULL Bulletin No. 17, 64-69.
- Jensen, J. (2001). Genetic evaluation of dairy cattle using test-day models. *Journal of Dairy Science*, 84:2803-2812.
- Jingar, S., Mehla, R. K., Singh, M. and Roy, A. K. (2014). Lactation Curve Pattern and Prediction of Milk Production Performance in Crossbred Cows. *Journal of Veterinary Medicine*, 20(14):1- 6 <https://doi.org/10.1155/2014/814768>
- Johnson, H. D. (1991) .The lactating cow in the various ecosystems: environmental effects on its productivity.FAO Animal Production and Health Paper, 86: 9-21.
- Koloi, S., Pathak, K., Behra, R., Mandal, D. K., Karunakaran, M., Dutta, T. K. and Mandal, A. (2018). Factors affecting the persistency of milk production in jersey crossbred cattle. *Journal of Dairy Veterinary Animal Resources*, 7(6):268-271.
- Ludwick, R. M. and Peterson, W. Z. (1943). A measure of persistency of lactation in dairy cattle. *Journal of Dairy Science*, 26:439-445.
- Mostert, B. E., van der Westhuizen, R. R. and Theron, H. E. (2008). Procedures for estimation of genetic persistency indices for milk production for the South African dairy industry. *South African Journal of Animal Science*, 38 (3):224 - 230

- Ndubueze, A. I., Ukachukwu, S. N., Ahamefule, F. O. and Ibeawuchi, J. A. (2006). Milk yield and composition of grazing White Fulani cows fed poultry waste-cassava peel based diets. *Pakistan Journal of Nutrition*, 5 (5):436-440.
- Oladapo, A. F. and Ogunkun, T. O. (2015). Quality Assessment of Fresh Milk from Traditionally Managed Nigerian Bunaji and Bokolooji Breeds of Cattle. *The Pacific Journal of Science NNLRS and Technology*, 16(1): 280 -285
- Roessler, R. (2019). Selection Decisions and Trait Preferences for Local and Imported Cattle and Sheep Breeds in Peri-/Urban Livestock Production Systems in Ouagadougou, Burkina Faso. *Animals*, 9:207
- SAS (2000). Statistical analysis system, multiple incorporation. Users Guide Statistical version. Cary, NC, USA.
- Sölkner, J. and Fuchs, W. (1987). A comparison of different measures of persistency with special respect to variation of test-day milk yields. *Livestock Production Science*, 16:305-319
- Strapáková, E., Strapák, P. and Candrák, J. (2016). Genetic Trend Of Length Of Productive Life In Holstein And Slovak Simmental Cattle In Slovakia. *Brunensis Mendeliana Silviculturae Et Agriculturae Universitatis Acta*, 67(5):1227 – 1234
- Strapáková, E., Candrák, J. and Strapák, P. (2016). Genetic relationship of lactation persistency with milk yield, somatic cell score, reproductive traits, and longevity in Slovak Holstein cattle. *Archiv of Animal Breed*, 59:329-335,
- Tona, G. O., Adewumi, O. O. and Ojo, F. O. (2015). Early lactation milk yield and composition of grazing White Fulani cows fed dietary levels of soya milk residue in the Southern Guinea Savanna of Nigeria. *International Journal of Agriculture and Biosciences*, 4(6): 22-26.
- Tona, G. O., Ogunbosoye, D. O., Babalola, D. D. and Oladimeji, R. T. (2017). Milk yield (offtake) and composition of White Fulani cows under free range grazing without and with concentrate supplementation. *Journal of Agriculture and Veterinary Science*, 10(8): 22-27
- Widyas, W., Putra, F. Y., Nugroho, T., Pramono, A., Susilowati, A., Sutarno, A. and S Prastowo, S. (2018). Persistency of milk yield in Indonesian Holstein cows. IOP Conference Series: *Earth and Environmental Science*, 142: 012005