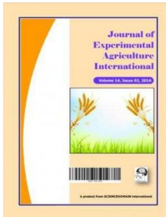

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# Genetic Parameter Estimates for Milk Yield, Udder and Body Conformation Traits of Jersey Cattle in the New Derived Guinea Savannah Zone of Nigeria

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***Authors' contributions***

*This work was carried out in collaboration between all authors. Author ROO designed the study. Author SIO proofread the manuscript. Author OMA performed the statistical analysis and the correspondence. Author OTO wrote the protocol. Author LU wrote the first draft of the manuscript. Author HYA managed the literature searches. Author MN managed the data collection. All authors read and approved the final manuscript.*

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## ABSTRACT

Despite the huge potential of utilising Jersey cattle as diary animals in the tropical countries, the genetic basis of the relationship between milk yield and conformation traits has been scarcely described in the literature especially in West Africa. This trial therefore set a layout to estimate the additive genetic correlations, heritabilities and repeatabilities of milk, udder and body conformation

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traits for Jersey cattle in the Derived Guinea Savannah zone of Nigeria. Our study used a total of 4200 lactation records for milk yield and conformation traits of Jersey cows. The milk and conformation traits data was analysed by fitting and solving a multiple trait animal model solutions using average information restricted maximum likelihood algorithm. Traits with moderate to high heritabilities and repeatabilities estimates were milk yield (0.35; 0.53), body condition score (0.25; 0.31), chest ligament (0.72; 0.75), chest width (0.23; 0.28), body depth (0.61; 0.65), udder circumference (0.44; 0.45), rear udder height (0.38; 0.41), rear udder width (0.52; 0.63) and teat length (0.34; 0.40), respectively. Milk yield had the highest additive genetic correlation with body weight (0.86). We concluded that the heritability was high enough to consider the traits in selection programs. The high additive genetic correlation between milk yield and bodyweight in the derived Guinea Savannah Zone of Nigeria validates the need to considering bodyweight in selection programs geared towards improvement of milk yield of Jersey cattle born in Nigeria.

*Keywords: Jersey; udder; Aireml; milk yield; conformation traits.*

## 1. INTRODUCTION

The improvement of cattle for milk production in Africa through selective breeding had been successful through the exploitation of additive genetic variance in the population. Jersey cattle had been extensively used for crossbreeding in Africa due to their high level of adaptability and robust coping strategy to the tropical climate. In Africa, milk volume has been the most important breeding objective, with minimal emphasis on functional traits [1]. The functional plan for genetic improvement of milk had relied solely on the use of imported semen from high merit sires and the importation of pregnant heifers from the United States, Germany and the Netherlands [2]. Ben Gara et al. [3] found a genetic correlation of near zero between bodyweight and milk yield in Jersey cattle in Tunisia. Several researchers [3,4,5] had reported low to high heritability estimates for milk yield in Jersey cattle in tropical and temperate countries. [6,7] reported heritability estimate of 0.17 to 0.36 for milk yield in Jersey cattle while permanent environmental effect ranged from 0.13 to 0.17. In response to the quest for protein sufficiency in Nigeria due to population explosion, there is a need to establishing an effective and robust breeding program for improvement of milk yield from adapted temperate and tropical dairy cattle. Therefore, this study aim to estimate the genetic parameters for milk yield and conformation traits in Jersey cattle born in Nigeria.

## 2. MATERIALS AND METHODS

The database of Farm 10 purebred Jersey cattle production was assessed for pedigree information of the biometric traits of 1080 cows born between 2009 and 2014. The number of Jersey cows with records was 1080 with 3047 animals in the genetic relationship matrix. Cow were sired by 12 bulls in a random mating and artificial insemination techniques. The variable milk yield was adjusted for 305 days lactation length using multiplicative correction factors [8]. Lactation records in the database were analyse to clean up the outliers detected from short or extended lactations. Four thousand and two hundred (4200) lactations were used after cleaning the data for animals who met the criteria of maintaining consistency in subsequent lactations which was fed multiple trait animal model and solved using average information restricted maximum likelihood algorithm. The variable body weight was measured directly by placing the cows on the weighing bridge and was expressed in kilogram (kg). The body conformation (chest ligament, chest width, body depth, stature, rump width and heart girth) and udder (udder clearance, rear udder height, rear udder width and teat length) traits were all measured in centimeters using flexible tape calibrated for cattle measurement [9].

### 2.1 Statistical Analysis

Milk yield and conformation traits were modeled as repeated measures across lactations. The model used [10] was:

$$y = Xb + Wpe + Za + e$$

Where y are the vector of observations for milk yield and conformation traits across the lactations; $b$ = vector of fixed effects (herd, number of calving, and season). $pe$ = vector of random environmental effect that is permanent; $a$ = vector of random animal effects; $e$ = vector of random residual effects; $X$, $W$, and $Z$ = incidence matrices that establish relationships between the records and the effects. The model assumed that random and residual effects are independently distributed with mean zero and constant variance $\sigma^2_e$, $\sigma^2_a$, respectively. The convergence iterations and statistical analysis were done in python 3.7.1 environment to estimate the heritabilities, repeatabilities, genetic and environmental correlations.

## 3. RESULTS AND DISCUSSION

The fat corrected milk yield of Jersey cattle had a moderate (0.35) heritability with high repeatability estimates of 57% (Table 1). The estimate of heritability (35%) in milk yield obtained for Jersey cows was within the range of 30-35 % under low and high input production system [11,12] but higher than the 30% reported by Missanjo et al. [13] when the parity were pooled for genetic parameter estimation in Zimbabwe but lower to heritabilities and repeatabilities estimates of 0.54, 0.56 and 0.36, 0.38 for milk yield in Zimbabwean Jersey cows, respectively as reported by Banga [14] and Makuza et al. [15]. The differences between our estimates and the estimate obtained by Makuza et al. [15] might be a consequence of different data cleaning and statistical model. However, our heritabilities were slightly higher than those reported by Makuza et al. [15] in Jersey cattle population in a subtropical environment. However, the most heritable type trait was CL (0.72) while BW (0.02) had the least heritability estimate. The repeatabilities estimate of linear type traits varied between 0.03 (BW) to 0.75 (CL) for body conformation traits. The low to high heritabilities (2-72 %) for conformation traits were within the range reported by several researchers [16,17] in dairy cattle. Body conformation traits had positive, significant (P<0.05) correlations with 305 d fat corrected milk yield. The environmental correlations was recorded between CL and BD (0.90) which implies that both chest ligament and body depth are driven by similar environmental factors.

Table 2 shows that udder conformation traits had positive and significant correlations with fat corrected milk yield. Udder conformation traits showed positive, significant (P<0.05) moderate to high correlation with fat corrected milk yield. This implies that improvement of udder conformation will cause a corresponding increase in milk production which agreed with the report of [16,17]. The strongest and positive genetic correlations was between TL and RUH (0.93). Environmental correlations among udder conformation traits were weak with the exception of TL and RUH (0.22) and TL and RUW (-0.22) which were positive, negative, with moderate associations. Moderate to high repeatability estimates for milk yield, body condition score, chest length, chest width, body depth, hearth girth, rear udder height and width were implicated with low variability within lactations; implying that all the measurements taken on the body conformation traits were closely related to bone structure of the cows. The positive genetic correlation between milk yield and TL suggest that correlated responses from selection on milk yield would result in longer teat length probably due to the prolonged effect of milking.

**Table 1. Heritability (diagonal), repeatability (*R*), genetic (above diagonal) and environmental correlations (below diagonal) of milk yield and body conformation traits in Jersey cattle**

| Traits | Milk yield | BW | BCS | CL | CW | BD | ST | Rump | HG |
|---|---|---|---|---|---|---|---|---|---|
| Milk yield | **0.35** | 0.86* | 0.21* | 0.42* | 0.70* | 0.67* | 0.65* | 0.69* | 0.52* |
| BW (kg) | 0.01 | **0.02** | 0.04 | 0.36* | -0.33* | -0.68* | 0.71* | 0.43* | -0.39* |
| BCS (cm) | 0.05 | -0.09 | **0.25** | -0.34* | 0.79* | 0.23* | 0.99* | -0.39* | 0.53* |
| CL (cm) | -0.02 | 0.48* | 0.64* | **0.72** | 0.67* | 0.64* | 0.48* | 0.37* | 0.14 |
| CW (cm) | -0.03 | -0.05 | -0.03 | 0.77* | **0.23** | 0.10 | -0.36* | -0.37* | -0.14 |
| BD (cm) | 0.38* | 0.53* | 0.56* | 0.90* | 0.81* | **0.61** | 0.98* | 0.87* | 0.96* |
| ST(cm) | 0.35* | 0.27* | 0.83* | 0.73* | -0.17 | -0.37* | **0.12** | 0.95* | 0.77* |
| Rump(cm) | 0.01 | 0.05 | 0.77* | 0.68* | -0.25* | -0.38* | 0.08 | **0.04** | 0.02 |
| HG(cm) | 0.25* | 0.26* | 0.54* | -0.16 | 0.74* | 0.65* | 0.06 | 0.08 | **0.09** |
| ***R*** | ***0.57*** | ***0.03*** | ***0.31*** | ***0.75*** | ***0.28*** | ***0.65*** | ***0.18*** | ***0.05*** | ***0.14*** |

*BW-Bodyweight, BCS-Body condition score, CL-Chest ligament, CW-Chest width, BD-Body depth, ST-stature, HG-Heart girth. *-p<0.05*

**Table 2. Heritability (diagonal), repeatability (*R*), genetic (above diagonal) and environmental correlations (below diagonal) of fat corrected milk yield and udder conformation traits in Jersey cattle**

| Traits | Milk yield | UC | RUH | RUW | TL |
|---|---|---|---|---|---|
| Milk yield | **0.35** | 0.29* | 0.42* | 0.10 | 0.34 |
| UC (cm) | 0.56* | **0.44** | -0.03 | 0.34* | 0.42* |
| RUH(cm) | 0.64* | -0.03 | **0.38** | -0.28* | -0.81* |
| RUW(cm) | 0.94* | -0.09 | -0.14 | **0.52** | 0.93* |
| TL (cm) | 0.34* | 0.14 | 0.22* | -0.20* | **0.34** |
| ***R*** | ***0.57*** | ***0.45*** | ***0.41*** | ***0.63*** | ***0.40*** |

*UC-Udder circumference, RUH-Rear udder height, RUW-Rear udder width, TL-Teat length, *-p<0.05*

## 4. CONCLUSIONS

Milk yield, body condition score, chest ligament, chest width, body depth, udder circumference, rear udder height, rear udder width and teat length were genetically determined which suggest strong signature for improvement in any of these traits when modeled with milk yield in the selection index program. Our study also detected strong genetic correlation between milk yield and conformation traits estimated in the present study, which reignite the importance of including conformation traits most especially body weight in dairy breeding programs.

## COMPETING INTERESTS

Authors have declared that no competing interests exist.

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