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Liveweight Performance at Maturity in N'dama Cattle Raised on Semi-improved Tropical Pasture

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Target Audience: Cattle farmers, Animal Breeders, Researchers

Abstract

The study examined the Liveweight performance of N'Dama cattle at maturity. Performance data on 54 purebred N'Dama calves born between 1950 through 1955 and reared on semi-improved tropical pasture at Fashola, Nigeria were analysed. The overall least-squares and standard error of mean mature weight (MW) representing N'Dama breed average was 327.37±13.44 kg. Birth year, season of birth, sire, dam parity and age-at-last recorded weight had no significant effect (P>0.05) on the mature weight of N'Dama cattle. Sex of calf was a highly significant (P<0.001) source of variation of weight at maturity, with N'Dama bulls and cows weighing 383.48±17.31 kg and 271.25±14.75 kg, respectively. The results further indicate that though N'Dama males had a higher MW than the females, they attained their physiological maturity at a younger age (69 months) than the females (84 months). Heritability estimate of 0.59±0.28 obtained through paternal half-sibs method for MW was considered moderately high. It was evident that selection based on this trait will yield substantial genetic progress in the herd. But the net economic implications of selecting for mature weight must be considered first; before deciding on the most efficient breeding systems to use, taking into account the production goals.

Keywords: Mature Weight, Mature Age, Environmental Factors, Heritability, and N'Dama Cattle.

Description of Problem

The improvement and multiplication of trypanotolerant livestock such as N'Dama cattle are currently considered to be among the few options available for increasing livestock productivity in the *tse-tse* infested area of Africa. In Nigeria, a breeding programme for N'Dama was first initiated by the then Western government at Fashola in 1947 with the importation of life animals from west and central African countries. The broad objectives of the programme were the multiplication of N'Dama cattle and the supply of breeding stock to local farmers to upgrade the indigenous Keteku and Muturu breeds.

However, since the inception of the beef cattle breeding programme, volumes of data have been accumulated and several studies carried out on the breed's reproductive and productive performance under Nigeria production environment (1, 2, 3, 4, 5). But with respect to

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growth, most of the past studies tended to emphasise single measures of growth over relevant economic time periods rather than considering growth over an animal's lifetime as an integral part of the production system. This situation may not be unconnected with the fact that in most developing countries' cattle breeding programmes, consistent lifetime weight records are rarely kept because of the absence of weighing facilities (6).

Thus, there is a big gap in our understanding of the actual mature age, mature weight and the factors affecting the mature weight of N'Dama cattle under Nigerian production environment. Also, the estimates of genetic parameter for mature weight of N'Dama cattle are currently non-existing. The addition of mature weight to comprehensive records of productive and reproductive performance traits could lead to a more accurate evaluation and assessment of efficiency and progress in a breeding programme. According to Rakes *et al.* (7), genetically mature weight represents the weight potential and summary parameter of growth of many body parts; while economically, it represents a variable cost for maintaining mature breeding animals. These imply that information on N'Dama performance at maturity are not only necessary for planning breeding strategies, but are also relevant for predicting response to selection and for evaluating genetic programmes.

The primary objectives of this study therefore, were to use the available lifetime weight records at Fashola to determine the mature age and weight of N'Dama cattle raised on a semi-improved pasture in the humid tropics of southern Nigeria. Also evaluated were factors affecting mature weight of N'Dama cattle and the heritability estimate of the trait.

Materials and Methods

The data used for this study were extracted from Fashola stock farm performance records on purebred N'Dama calves born between the years 1950 to 1955. The ranch covers a total land area of 1200 hectres and lies in the southern fringes of the derived Savannah in the humid tropics of Nigeria, where there is low to moderate challenge of *tse tse* fly. The environmental conditions and the herd management practices on the ranch have been described in detail (5). Briefly, all animals were raised entirely on semi-improved pasture comprising of grass-legume mixture with limited supplemental feeding during dry seasons.

The base data consisted of information on calf identification, date of birth, sex of calf, sire and dam identification, dam age, parity, birth weight, weaning weight and post-weaning weights taken quarterly up to a maximum of 102 months of age. A total of 72 post-weaning weight records were involved initially. Weight of animals taken during pregnancy, parturition and lactational periods were however, excluded from the available data set used to determined the mature weight (MW). This procedure was adopted in order to have mature weight estimates free of major systemic fluctuations associated with pregnancy, calving and lactation at whatever ages these occurred. Although this procedure may have introduced the element of subjective data selection, the researchers' interest was on determining the representative mature weight of the herd at Fashola. However, Fitzhugh (8) noted that prior adjustment of data for these sources of variation are known to introduced the additional error of estimating adjustment factors and over estimation of the mature weight.

The definition and estimation of mature weight is especially critical because other growth measures such as degree of maturity and maturing rates at all immature ages depend directly on it (5). The requirements for precision in determining mature weight in animal vary according to the hypothesis being studied (9). In this study, the objective was to use a measure of mature weight that best represents the fat-constant asymptotic weight to which an individual animal was growing without adjusting for sources of variation that might also have influenced immature traits. Mature weight of N'Dama cattle was therefore defined after Stobert *et al.* (10), as the mean weight over time after positive growth of skeletal and muscular tissues have reached a plateau and stable condition exists. These points were determined for N'Dama bulls and cows by plotting a graph of weight-age relationships using the mean

weights and were reached at 69 months and 84 months of age for bulls and cows respectively. Thus, the liveweight of animals taken after these ages were pooled to determine the mature weight for each individual within the sex group (5).

At the end of these classifications, only 54 complete records comprising of 17 males and 37 females scaled through the criteria and were eligible for statistical analyses (Table 1). Analyses of the data were carried out using Least-Squares Maximum Likelihood Mixed Model Procedures (11). The main effects comprising of year of birth, season of birth, sex of calf, dam parity and sire were considered fixed except for sire effect which was a random component and the age-at-last recorded weight which was used as covariate in the model.

The statistical model assumed can be represented as:

$$Y_{ijklmn} = m + A_i + R_j + C_k + S_l + BX_{ijklm} + E_{ijklmn}$$

Where: Y_{ijklm} = the n^{th} mature weight of calf of the i^{th} year of birth, of the j^{th} season of birth, of the k^{th} sex, of the 1^{th} sire, of the m^{th} dam parity;

m = an unknown constant common to all observations;

A_i = the effect due to the i^{th} year of birth, (i=1950-1955);

R_j = the effect due to the j^{th} season of birth, (j =1- 4);

C_k = the effect due to the K^{th} sex of calf (k = 1, 2);

S_l = the effect due to the 1^{th} sire (1 = 1-10);

P_m = the effect due to the m^{th} Parity Group (m =1-7);

BX_{ijklm} = pooled partial regression coefficient of age-at-last recorded weight;

E_{ijklmn} = a random error associated with the mature weight

Measurement, which is assumed to be normally and independently distributed (NID) with zero mean and variance $\sigma^2 e$.

Least-square means for each value of an effect were obtained from solutions to the least least-squares equations. These means were individually adjusted for all the effects included in the analytical model; hence they differed slightly from the gross or unadjusted means in Table1. Heritability of the trait was estimated by paternal half-sibs method using sire and residual variance components as:

$$h^2_s = \frac{4\sigma^2_s}{\sigma^2_s + \sigma^2_w}$$

Where: h^2_s = the paternal half-sibs estimate of habitability;

$\sigma^2 s$ = the sire component of variance;

σ^2_w = the within sire (residual) component of variance.

Results

The unadjusted means, Standard Deviation (S.D.) and coefficient of Variance (C.V) of mature Weight (MW) of N'Dama cattle are presented in Table 1. The results indicate that N'Dama bulls and cows weighed 385.79±22.50 kg and 273.56±32.06 kg with C.V. of 5.8% and 11.72%, respectively at maturity. The bulls attained these fits at the age of 69 months and the cows at a slightly longer age of 84 months. Shown in Table 2 are the means squares from the least-squares analysis of variance for MW of N'Dama cattle. Of all the factors considered in the analytical model, only sex of the animal had a highly significant ($P<0.001$) influence on the final weight attained at maturity in N'Dama cattle. All other factors namely: year of birth, season of birth, sire, dam parity and age-at-last recorded weight used as a covariate had no appreciable influence ($P>0.05$) on MW, though numerical differences were observed within the factors when solutions to the least-squares equations were presented (Table 3). The overall least-square means (LSM) and Standard Error (S.E.) representing N'Dama breed average, was 327.37±13.44 kg. N'Dama males weight were significantly ($P>0.001$) heavier than their female counterparts at maturity being 383.48±17.31 kg and 271.25±14.75 kg, respectively. The heritability estimate (h^2) of 0.59±0.28 obtained through paternal half-sibs method for N'Dama mature weight was considered moderately high.

Table 1: Number of Records, Unadjusted Means, Standard Deviations (S.D.) and Coefficient of Variation (C.V.) for Mature Weight (MW) of N'Dama Cattle.

Parameter	Male	Female	Breed average
No of records	17	37	54
Mean MW (kg)	385.79	273.56	329.68
S.D. (kg)	22.50	32.06	38.58
C. V. (%)	5.83	11.72	11.70
Mature Age (months)	69.0	84.0	76.5

Table 2: Mean Squares from Least-squares Analysis of Variance for Mature Weight (MW) of N'Dama Cattle

Source of Variation	DF	Means Squares
Birth year	5	472.61^{ns}
Birth season	3	381.03^{ns}
Calf sex	1	15766.60***
Sire	9	507.73^{ns}
Dam Parity	6	199.11^{ns}
Regression[a]		
Age	1	666.43^{ns}
Error	28	390.50

[a]Linear regression of age-at-last recorded weight
*** = P< 0.001; ns = Not significant (P > 0.05).

Discussion

The non-significance of most of the factors considered on mature weight of N'Dama cattle collaborate with earlier reports in literature that weights at early ages were influenced more by environment effects than were weights at later ages including maturity (3, 12, 13). Since the magnitudes of environmental effects are related to the age and degree of development of the animal (14). It seems therefore that the net reduction in the environmental effects on mature weight of N'Dama cattle may be attributed to compensatory effects and the adaptation of the animals to the humid production environment at Fashola. It is also possible that a fixed set of environmental factors different from those included in the analytical model may have some level of influence on MW of N'Dama cattle.

The highly significant difference (P<0.001) between the MW of male and female N'Dama cattle was expected considering that they were growing towards genetically different MW (Table 3). In an earlier study on the same ranch (5), a consistent superiority of 6.8 to 36.5% was noted in N'Dama males' weights over that of their females' counterpart from birth to 36 months of age. In the present study, N'Dama bulls were 112.23 kg heavier than the cows at maturity and the cows' weight represented only about 70.73% of the bulls' weight. However, the observed MW of N'Dama bulls and cows (Table 3) were heavier than the MW of 370 kg and 230 kg reported for N'Dama males and females in Sierra Leone respectively (15); N'Dama cow weights of 237 kg and 250 kg reported in Senegal and Cote d'Ivoire, respectively under traditional management conditions (16). The

mature weight of N'Dama males in this study was similar to those reported for other tropical breeds of cattle. The MW of Wadara breed was estimated as 372 kg (17), while MW of 385kg and 370kg were reported for Boran and Ankole breeds in Uganda (18). Nevertheless, the higher MW of N'Dama observed as compared to those reported by other researchers in West African sub-region, may be attributed to the improved production environment in Nigeria. Animals at Fashola were raised on semi-improved pastures, which were available all year-round.

Findings from this study show that N'Dama bulls and cows are physiological mature at the ages of 69 and 84 months, respectively. These ages being the age at which positive growth of skeletal and muscular tissues have reached plateau and a stable condition exists (10). The result therefore, indicates that N'Dama bulls attained their mature weight at a younger age than N'Dama cows. This observation confirms an earlier assertion that N'Dama bulls are early maturing and attain high final weights on artificial pastures in West Africa (19). Similarly, Hereford sires were noted to be earlier maturing than dams, even though the bulls were 60% heavier at maturity (14). It is suspected that inherited variation in the endocrine system of both sexes may be a major factor in the physiological basis for genetic variation in age at maturity. However, the mature ages noted in this study compares favourably with those reported in literature. Ferjani, (20) reported that Hereford cows continue to add weight through 84 months of age, while Holstein and Jersey breeds were reported to have reached maximum body weight at approximately 82 and 72 months of age, respectively (7). Brown *et al.* (14) studied growth of Angus and Hereford cattle and noted that maximum weights were attained between 5 and 9 years of age. Also, mature weight of British Friesian, Charolais and Aberdeen Angus bulls were also estimated with sufficient accuracy using weights recorded to the age of at least 6 years (21).

Although there are no known reports on the heritability estimates (h^2) of MW in N'Dama cattle, the estimate of 0.59±0.28 obtained in this study, agree with those reported in literature for some temperate breeds of cattle (22). This estimate was similar to h^2 value of 0.57 reported for MW of Hereford cattle (9, 23) and 0.52 reported for MW of polled Hereford cattle (24), but was lower than within-breed h^2 estimate of 0.6 and between-breed h^2 estimate of 0.91 for mature weight of multi-breed synthetic cattle (25). Though, the present estimate was from a limited number of records, the value obtained (h^2_s = 0.59) no doubt indicate that response to selection for mature weight in N'Dama cattle would be effective depending on the selecting intensity and herd management practices.

However, due to the high genetic correlations reported between MW and weight at some economic points such as birth, weaning and yearling (14, 23, 24), it was recommended that further studies be carried out on the genetic, environmental and phenotypic relationships between the MW of N'Dama cattle and their immature growth traits. Knowledge of these relationships would enable cattle breeders to decide on the choice of traits for relative emphasis and the development of the most efficient breeding systems, taking into account the production goals.

Conclusions and Applications

1. Since unrestrained increases in mature weight could result in increase maintenance requirements for breeding stock, the advisability of increasing or decreasing mature weight in N'Dama cattle must be evaluated from the standpoint of net economic return.
2. Information on the physiological age and weight at maturity in N'Dama cattle, if properly used would provide a direct approach for commercial cattlemen to seek optimum sire-dam combinations for their respective situations and systems of reproduction.
3. Though the heritability estimate of MW of N'Dama in this study is moderately high, it would be necessary to consider the consequences of selecting for this trait in the production system.
4. The producer must decide if it is economically efficient for him to increase growth rate in slaughter cattle at the expense of increasing mature weight of females retained for

Table 3: Least-Squares Means (LSM) and Standard Error (SE) of Mature Weight (MW) of N'Dama Cattle

Factor	N	LSM (Kg)	SE (Kg)
Overall	54	327.37	13.44
Birth Year			
1950	6	314.31	26.63
1951	8	331.53	21.70
1952	5	342.36	14.92
1953	11	314.36	14.81
1954	10	350.20	11.48
1955	14	311.45	35.24
Birth Season			
Late dry	12	321.00	21.70
Early Wet	10	339.33	13.69
Late Wet	20	327.63	13.46
Early dry	12	321.50	13.20
Sex			
Male	17	383.48[a]	17.31
Female	37	271.25[b]	14.75
Dam Parity			
1st	7	322.68	16.05
2nd	6	354.20	22.30
3rd	10	326.16	13.52
4th	8	316.39	13.88
5th	9	319.49	15.80
6th	6	318.69	22.58
7th	8	333.94	33.79
Regressions[a]			
Age (Linear)	1	-7.99	6.11

[a] Linear regression of age-at-last recorded weight.
Within a factor, LSM (SE) with different superscripts differ significantly ($P < 0.05$).

breeding, which may increase his cost of producing a kilogramme weight of calf.

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