

Estimates of phenotypic and genetic trends of growth traits in N'dama herd in Nigeria

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Abstract

Data on birth weight (BTHWT), 205-day adjusted weaning weight (ADWNWT), and pre-weaning daily gain (ADG) of N'Dama reared at Fasola Stock Farm between 1947 and 1984 were obtained and used to estimate phenotype and genetic trends of these traits. Estimated phenotypic trend was $0.07 \pm 0.02 \text{ kg/yr}$, $0.18 \pm 0.06 \text{ kg/yr}$ and $-0.005 \pm 0.003 \text{ kg/yr}$ for BTHWT, ADWNWT and ADG respectively. In contrast, all estimated genetic trends were relatively small and not significantly different from zero. They were $0.02 \pm 0.05 \text{ kg/yr}$, $0.02 \pm 0.05 \text{ kg/yr}$ and 0.1 g/yr for BTHWT, ADWNWT and ADG respectively. The sequential polynomial fitting of the data set indicated that quadratic function adequately described the data with the following regression equation:

$$Y = 9.91 + 0.01b^1 + 0.02b^2$$
$$Y = 46.44 - 0.15b^1 + 0.01b^2$$
$$Y = 0.21 - 0.0002b^1 + 1.18b^2 \text{ for}$$

BTHWT, ADWNWT and ADG respectively for phenotypic trend curve while for genetic trend curve $Y = 0.10 - 0.01b^1 - 0.34b^2$ was obtained for BTHWT and ADWNWT and $Y = 0.002 - 0.0002b^1 - 70.85b^2$ for ADG.

Keywords: N'dama cattle, growth, phenotype, genotype, estimate

Introduction

Most African countries have pursued breed evaluation studies in their search for increased livestock production because they form an essential part of successful planning of future breeding scheme, and allow documentation of progress from past selection (Nadaajah *et al.*, 1987). Such an evaluation would require separation of the genetic and environmental portions of the total phenotypic trend. However, what is of interest to the animal breeder is the trend in genetic merit.

Genetic trend studies have interested many groups in dairy cattle population (Van Vleck and Henderson, 1961, Schaeffer *et al.*, 1975). Past efforts to estimate genetic trend in beef cattle have been confined mostly to small, single herd populations (Bailey *et al.*, 1971). However in recent years more emphasis has been given to performance and progeny testing in beef herds in America (Zollinger and Nielsen, 1984). While so much has been reported on genetic trend in the developed countries, it is however sad that little or no information is available on genetic trend of our indigenous beef breeds in the tropics. There is a

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need for investigations of genetic progress in our indigenous stock under varying environment. It was therefore the objective of this study to obtain phenotypic and genetic trends of growth traits in N'Dama cattle reared in the humid tropical zone of Nigeria.

Materials and methods

The N'dama herd from which the data used in this study were obtained were those kept at Fasola Stock Farm, Nigeria between 1947 and 1984. Management details and climatic conditions of the farm have been described (Orheruata and Olutogun, 1994). The data consist of 4153 birth weight (BTHWT) and 1463 actual weaning weight records. Actual weaning weight was adjusted to 205-day weight. Adjustment for sex of calf and age of dam were also made using standard procedures (BIF, 1990). Pre-weaning daily gain was computed as the difference between actual weaning weight and birth weight divided by weaning age.

Statistical analysis

Annual phenotypic mean for all traits was computed using ML procedure (Harvey, 1987) and using the model of Wilson and Willham (1986) represented as

$$Y_i = \sum_k Y_{ij} / n_i$$

Where

Y_i = the phenotypic average for trait X of the calf crop born in the i^{th} year.

Y_{ij} = the record of the trait x of jth Calf in the i^{th} year

n_i = the total number of calves belonging to the i^{th} year.

Annual Genetic merit was computed as the average Expected Progeny Difference (EPD's) of the sires weighted by the number of progeny for each sire added to that of the dams expressed as

$$G_i = \sum_k n_{ik} S_{ik} / n_{ij} + (\sum dij) / n_j$$

Where

G_i = the genetic merit of the calf crop for the trait X in the i^{th} year.

n_{ik} = the number of progeny of the K^{th} sire in the i^{th} year in the herd.

S_k = the expected progeny difference (EPD) for trait X of the K^{th} sire.

D_{ij} = the EPD for trait X of the i^{th} dam in the herd

with a progeny record in the i^{th} year and

n_i = the total number of progeny with records for trait x in the i^{th} year.

EPD's which is one-half the breeding value, is a prediction of how future progeny of a sire or dam are expected to perform for a particular trait as compared to a fixed breed average. It was estimated by multiplying the least squares constant for each sire and dam by the weighting factor as described by Legates and Warwick (1990) and expressed as $EPD = b(X_b - X_n)$

Where b = the regression coefficient (weighting factor) which is dependant on the number of progeny and the heritability of the traits.

$$b = \frac{n}{n + (\sigma^2_s / \sigma^2_e)}$$

X_b = the average of the bull's progeny

X_n = the average of the other progeny in the same herd.

n = the number of progeny

σ^2_s = the variance due to sire, and

σ^2_e = the residual variance.

Phenotypic and genetic trend were then obtained by regressing annual phenotypic and genetic merit on years. Phenotypic and genetics trend curves for the traits were obtained by plotting annual phenotypic merits for each trait for each year that such records were collected and connecting all such points.

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Heritability estimate were estimated with variance components adopting Henderson method I mixed model (Henderson, 1953).

Results

Table 1 shows the annual phenotypic, genetic and environmental trends obtained for birth weight, 205-day adjusted weaning weight and pre-weaning daily gain of N'Dama cattle.

The trend curves for the traits are depicted in Figures 1, 2 and 3 respectively. Heritability estimates of 0.45 ± 0.08 , 0.06 ± 0.04 and 0.07 ± 0.04 were obtained for BTHWT, ADWNWT and ADG respectively. The estimated phenotypic trend of birth weight was relatively large (0.07 ± 0.02 kg/yr) but not significant though in the desired direction. The 205-day adjusted weaning weight had phenotypic trend of -0.18 ± 0.66 kg/yr which was not significant and in the undesirable direction. Pre-weaning daily gain had an absolute value not different from zero (5g/yr) and was not significant. All traits had a genetic trend that was not significantly different ($p < 0.05$) from zero (Table 1). There was a total phenotypic change of 7.43kg, 14.72kg and 77g and a total genetic change of 0.09kg; -0.58kg and -0.3g in BTHWT, ADWNWT and ADG respectively. Trend curves were far from linear. The results of sequential polynomial fitting for birth weight, 205-day weaning weight and pre-weaning daily gain are presented in Tables 2, 3 and 4 respectively.

In all traits the linear function alone was not significant yielding R^2 of 0.04 to 25 percent. It was increased to 100 percent by sequentially adding the quadratic and cubic components. Sequential polynomial R^2 values for genetic merit were not as high as those obtained for phenotypic trend. However, quadratic function was significant for both phenotypic and genetic trend curves.

Discussion

Birth weight trend curves showed a steady increase in the genetic merit of N'Dama calves between 1950 and 1960. The gain was fairly constant between 1961 and 1970 and in 1971 a reduction was observed. Although there were years where pronounced genetic improvement was observed (1952, 1960, 1965, 1970, 1975 and 1980), it could not be sustained as a result of the differential contributions of sire in each year since sire varied in their expected progeny difference (EPD's). The years 1960-1970 seem to have had sires and dams with higher EPD's consequently influencing the genetic merit of the calf crop positively as could be inferred from the genetic trend curve. The trend curve showed that the genetic merit in these years was higher than in other years. The non-systematic fluctuations in the annual phenotypic mean could be explained by the seasonal and yearly variations in climatic condition which affect pasture availability and quality. Annual phenotypic mean varied from

Table 1 Within herd estimates of phenotypic, genetic and environmental trends of birth weight, 205-day adjusted weaning weight and preweaning daily gain in N'dama cattle at Fasola Stock Farm

Trends	Traits		
	BTHWT (kg)	ADWNWT (kg)	PDG (kg)
Phenotypic	0.07 ± 0.02	-0.18 ± 0.66	0.005 ± 0.003
Genetic	0.02 ± 0.05	0.02 ± 0.05	0.00001
Environmental	0.5 ± 0.03	0.20 ± 0.35	0.005 ± 0.003

BTHWT = birth weight; ADWNWT = 205-day adjusted weaning weight;
ADG = pre-weaning daily gain

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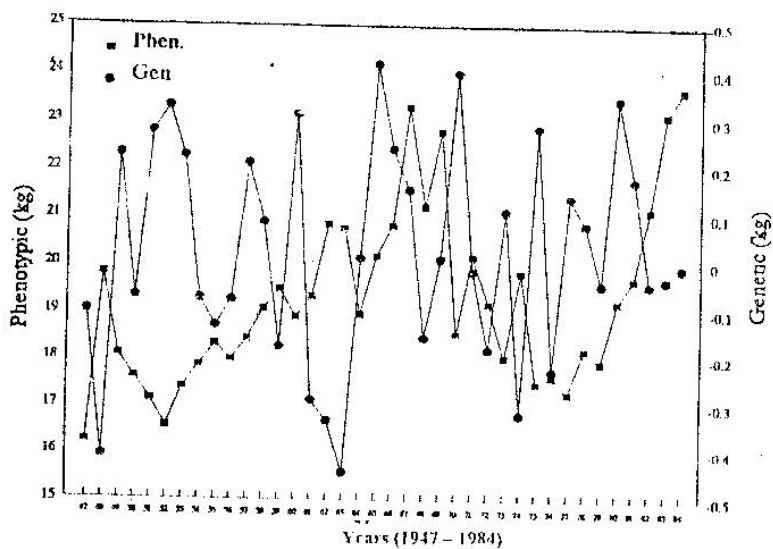


Figure 1 Phenotypic and genetic trendlines of birth weight of Ndama calves at Fasola Stock Farm between 1947 and 1984

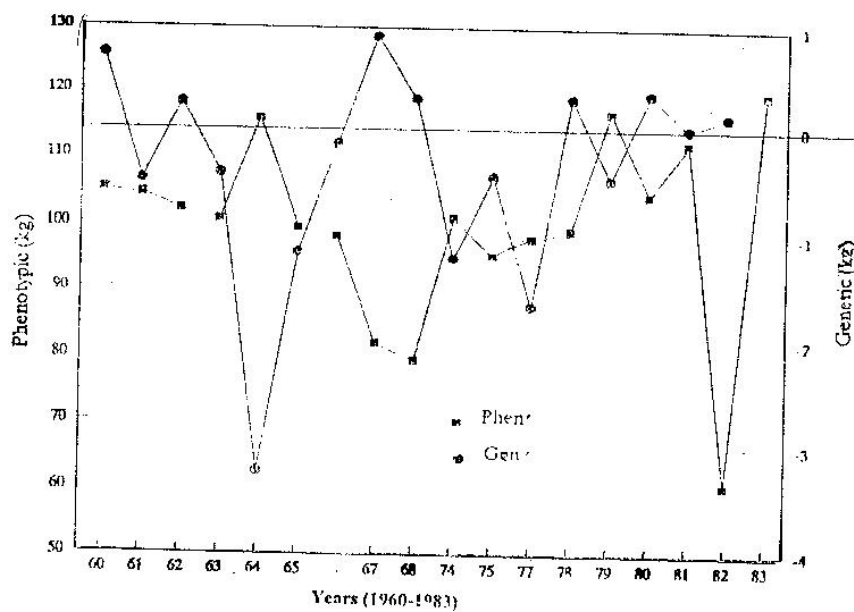


Figure 2 Phenotypic and genetic trendlines of 205 day adjusted weaning weight of Ndama calves at Fasola Stock Farm between 1960 and 1983

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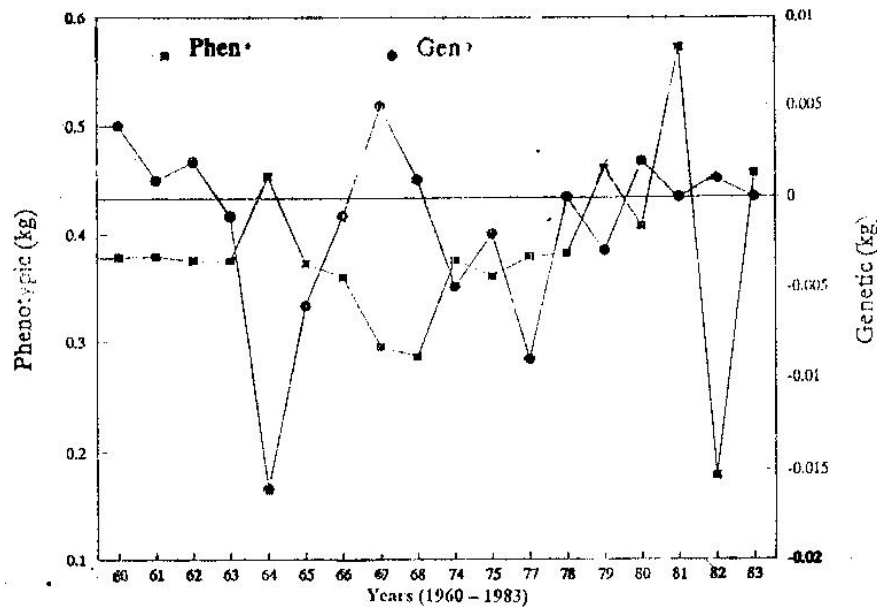


Figure 3 Phenotypic and genetic trendlines of pre-weaning daily gain of Ndama calves at Fasola Stock Farm between 1960 and 1983

16.22 to 23.65kg a difference of over 7kg in birth weight, thus confirming the differential contribution of sires and the fluctuations in feed availability since phenotype is influenced by both genotype and environment. Years where sires with higher EPD's contributed more offspring and such animals were exposed to favourable climatic condition and abundant feed availability, the resultant effect would be better phenotypic value.

Although the obtained phenotypic trend of $0.07 \pm 0.02\text{kg/yr}$ for birth weight was higher than the 0.03kg/yr reported by Tumwasom *et al.*, (1968) for birth weight of Angus the genetic trend of 0.048 kg/yr reported for birth weight of Angus was higher than 0.02kg/yr obtained in the present study for N'Dama. The phenotypic and genetic trend curves of ADWNWT and ADG were similar (Figs. 2 and 3). In the first few years, there was favourable genetic merit that dropped with time. Their phenotypic trend was more sporadic as a result of the environmental influence on weaning weight and pre weaning daily gain performance of the

animals. With the obtained positive genetic trend one would have expected corresponding positive phenotypic trend but because of the masking effect of the environment this was not possible. This may have probably been responsible for the wide variation observed in both traits (60.36 to 119.53kg in ADWNWT and 178 to 569 in ADG). The environmental influence allowed ADWNWT and ADG to continue increasing up to 1984 before reducing and increasing in a non-systematic manner. Though the genetic trend was positive the negative environmental trend masked the effect of the genetic trend. In the pre-weaning and weaning performance of Ndama calves, an increase in the genetic merit resulted in an increase in phenotypic value hence for years where genetic merit showed an increase, such increase was reflected in the phenotype and vice versa. Consequently, 205-day adjusted weaning weight and pre-weaning daily gain declined between 1960 and 1965. The 0.02 and -0.20kg/yr genetic and environmental trends obtained for 205-day adjusted weaning weight in this study are low when compared with 0.25

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and 0.30kg/yr reported by Aaron *et al.* (1986) and 0.30kg/yr genetic trend by Nadarajah *et al.* (1987) for Angus weaning weight though an exotic beef breed. The difference can be attributed to the intense selection that has taken place in the temperate breeds. The generally low heritability estimate of 0.06 ± 0.04 for ADWNWT and 0.70 ± 0.04 for ADG may also have accounted for the poor genetic trend. Genetic trends estimated from these data sets suggest that selection practices had not been very successful. If there was any selection it varied since the traits exhibited trends that were far from linear because quadratic and cubic functions were best fit. Similar observation was

also reported in Angus weaning weight data (Wilson and Willham, 1986).

The sequential polynomial fitting of the trend curves showed that quadratic function was a better fit of the phenotypic curves because this function was able to account for about 98 per cent in the total variance in all traits. The quadratic function though significant for the fitting of genetic curve however yielded R^2 of about 70%. In order to fully account for changes in genetic merit of a calf crop over time, higher polynomial fitting would be a better fit to the data set. This finding therefore

Table 2 Results of sequential polynomial fitting of birth weight trend curves in N'dama cattle at Fasola Stock Farm

Variable	Regression	Parameter	Estimate		
Polynomial	A	B ¹	B ²	B ³	R ² (%)
Linear	17.88	0.07 ± 0.02	-	-	19.60
	-0.54	0.02 ± 0.05	-	-	1.18
Quadratic	9.91	0.001 ± 0.002	$0.02 \pm .002^{**}$	-	99.71
	0.10	-0.01 ± 0.03	$-0.03 \pm 0.06^{**}$	-	70.21
Cubic	6.57	0.0001 ± 0.0001	$0.05 \pm 0.0003^{***}$	$-0.001 \pm 0.00^{**}$	100.00
	0.18		-0.54 ± 0.35	-0.06 ± 0.11	70.99

a = intercept, b¹ – b³ partial regression coefficients. Values on top are for phenotypic trend while those below are for genetic trend

* P<0.05

** P<0.01

Table 3 Results of sequential polynomial fitting of 205-day adjusted weaning weight trend curves in N'dama cattle at Fasola Stock Farm

Variable	Regression	Parameter	Estimate		
Polynomial	A	B ¹	b ²	b ³	R ² (%)
Linear	100.98	0.18 ± 0.66	-	-	0.45
	0.54	0.02 ± 0.05	-	-	1.18
Quadratic	46.44	0.15 ± 0.06	$0.01 \pm 0.0001^{**}$	-	99.00
	0.10	0.01 ± 0.03	$0.34 \pm 0.06^{**}$	-	70.21
Cubic	28.81	0.0003 ± 0.01	$0.01 \pm 0.0002^{**}$	0.00^{**}	99.99
	0.18	0.01 ± 0.03	0.54 ± 0.35	0.06 ± 0.11	70.99

a = intercept, b¹ – b³ partial regression coefficients. Values on top are for phenotypic trend while those below are for genetic trend.

* P < 0.05

** P < 0.01

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Table 4 Results of Sequential polynomial fitting of pre-weaning daily gain curves in N'dama cattle at Fasola stock farm

Variable Polynomial	Regression	Parameter	Estimate		R ² (%)
	A	b ¹	b ²	b ³	
Linear	0.34	0.005 ± 0.003	28.93 ± 1.80**	-	20.28
	0.002	-0.000	-	-	0.00
Quadratic	0.21	0.0002 ± 0.0004	1.18 ± 0.04**	-	98.59
	0.002	-0.0002 ± 0.0001	70.85 ± 11.99**	-	71.37
Cubic	0.13	-0.000	2.42 ± 0.04**	-1.90 ± 0.06**	99.98
	0.002	-0.0002	-68.41 ± 64.70	0.06 ± 0.11	71.37

A = intercept, b¹ – b³ partial regression coefficients. Values on top are for phenotypic trend while those below are for genetic trend

* P < 0.05

** P < 0.01

suggest that the relationship between phenotypic and genetic progress in growth traits of N'Dama and time is very complicated. A progression in time will not necessarily result in increase in these traits since the total variance of such trait cannot be accounted for by time.

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