

Genetic aspects of growth and maturing rate in trypanotolerant beef cattle: N'Dama

O.O. Mgbere¹ and O. Olutogun

Animal Breeding and Genetics Division, Department of Animal Science, University of Ibadan, Ibadan.

Abstract

Genetic parameters for Absolute Growth Rate (AGR), Relative Growth Rate (RGR) and Absolute Maturing Rate (AMR) at various age interval from birth to maturity in N'Dama beef cattle raised in the humid tropics of Nigeria were estimated. Performance data used were accumulated between 1948 and 1964 at Fasola cattle ranch in Oyo, Nigeria and the number of records analysed ranged from 44 to 678. preweaning (B - W) growth and maturing rates in N'Dama calves were 0.377 ± 0.009 kg/day (AGR), 0.643 ± 0.006 %/day (RGR) and 0.120 ± 0.003 %/day (AMR) and fluctuate subsequently, following the animals' state of development and certain physiological stress conditions. At post weaning (W - 12), these rates decreased to 0.249 ± 0.049 kg/day, 0.204 ± 0.029 %/day and 0.075 ± 0.014 %/day for AGR, RGR and AMR respectively. Estimates of heritability at the various age intervals were considered low in these growth traits with values obtained ranging from 0.03 to 0.24 for AGR, 0.03 to 0.21 for RGR and 0.02 to 0.42 for AMR, with high standard errors. The low estimates though, consistent with literature reports were attributed to the poor standard of animal management and production environment at Fasola. It was evident from this study that selection of N'Dama calves based on post weaning (W - 12) growth or maturing rates would yield substantial genetic progress. However, improved animal management and production environment on the ranch would not only improve precision of the genetic parameter estimates but would also enhance N'Dama growth performance generally.

Keywords: Growth rates, maturing rates, genetic parameters, trypanotolerant cattle.

Introduction

The use of trypanotolerant breeds of cattle such as N'Dama is now recognized as a mean to help exploit the tse-tse fly infested but pasture productive areas of Southern Nigeria. Confidence in this approach has been reinforced by the knowledge that trypanotolerant breeds of cattle is an innate characteristic and as such can be exploited genetically (Murray *et al.*, 1982; Trail *et al.*, 1990).

N'Dama Cattle were first imported into Nigeria in 1947 from French Guinea for use in commercial beef production. Consequently, performance traits associated with reproduction and growth will generally affect its economic

viability. While several investigations have been conducted on the growth rates of N'Dama cattle under different management and environmental conditions in Nigeria (Olutogun, 1976; Tizikara, 1988; Zwandor and Akpokodje, 1989; Mgbere, 1995) and the West African sub-regions (Touchberry, 1967; Rugheuberg, 1980; Fall *et al.*, 1982). Many of these studies evaluated pre- and post weaning growth rates or growth rates over a limited age range, with only a few estimating genetic parameters (Olutogun, 1976; Tizikara, 1988). Aspects of growth Rates (RGR) and Absolute Maturing Rates (AMR) from birth to maturity in N'Dama cattle were rarely considered in those studies.

This may have been due to the fact that lifetime weight records required to determine the mature weight of the animals, used in estimating these rates are rarely kept in many cattle herds in Africa due to lack of adequate weighing facilities. In addition, the limited data accumulated in some herds, that are amenable to statistical analysis, often require tedious and expensive procedures in order to nullify many extraneous systems. (Mgbere, 1995). Though, the various genetic and environmental factors affecting AGR, RGR and AMR in N'Dama cattle at various age intervals under Nigeria production environment have been determined and documented in literature (Mgbere, 1995, the genetic parameter estimates of these growth traits remain unknown in the population.

However, in considering selection programmes for future breeding and improvement of this trypanotolerant beef cattle in Nigeria, knowledge of the heritability of these growth and maturing rates and the genetic, phenotypic and environmental correlations between them at a given age interval can be helpful in predicting and understanding the response that may be realized and for evaluating such genetic programmes.

The primary objective of this study therefore was to determine the heritability estimates, genetic, phenotypic and environmental correlations of absolute growth rates, relative growth rates and absolute maturing rates at various age intervals from birth to maturity in N'Dama cattle kept in the humid tropical environment in Southern Nigeria.

Materials and Methods

Source of Data

The data used for this study were obtained from purebred N'Dama cattle at Fasola Stock Farm in Oyo, Nigeria. The data covered the period between 1948 and 1964. the ranch is located on latitude 7° 54' N and Longitude 3° 43' E and lies in the Southern fringes of derived Savannah zone of Nigeria, at an elevation of 288.6 meters above sea level. The climate of the area is

described as hot and humid with a mean annual temperature of 29°C and a relative humidity of 65%. The rain fall pattern in the area is bimodal with peak rainfall recorded in June and September. The mean annual rainfall during the study period ranged from 838mm to 1608mm. Tse-tse fly challenge on the ranch was described as low to seasonally medium (Mgbere, 1995).

During the 16 year period of data collection, the management of these cattle varied considerably and were described in detail by Mgbere, (1995). However, the management period effects on the animals' performance were recently evaluated by Orheruata and Olutogun (1998). Generally, all the animals were raised entirely on established grass-legume pastures with limited concentrate supplementation during the dry seasons. Therefore, their growth performances depend partly on the nutritional quality and quantity of pasture available, as determined by rainfall pattern on the ranch.

Data preparation and analysis

The weight records taken at 3 months interval from birth to maturity in N'Dama cattle, formed the data base for estimating the growth and maturing rates. These weights were initially adjusted to a constant age using the standard test procedures (BIF, 1990). Only animals born on the farm with valid identification number, sire and dam identification, date of birth, sex of calf, dam age and parity were considered for analyses. Consequently, several records lacking these description were rejected.

Mature weights of the animal were determined according to the methods outlined by Mgbere and Olutogun (2001). The growth and maturing viz: Absolute Growth Rates (AGR), Relative Growth Rate (RGR) and Absolute Maturing Rate (AMR) of the animals at various age intervals were calculated using the formulae given by Fitzhugh and Taylor (1971) and Stobert *et al.* (1987).

The major statistical analyses were carried out using least-squares fixed and mixed model

Genetic aspects of growth and maturing rates of N'Dama

procedures (Harvey, 1990). The number of record eligible for statistical analyses at a given age interval are represented in Table 1.

Table 1 Least-square means and standard error of growth and maturing rates in N'Dama cattle at various age intervals between birth and maturity

Age Interval (Months) ^b	N	Growth trait ^a		
		AGR(kg/day)	RGR(%/day)	AMR(%A/day)
B - W	678	0.377 ± 0.009	0.642 ± 0.006	0.120 ± 0.003
W - 12	258	0.249 ± 0.049	0.204 ± 0.029	0.075 ± 0.014
12 - 15	159	0.197 ± 0.050	0.195 ± 0.044	0.064 ± 0.016
15 - 18	126	0.336 ± 0.072	0.199 ± 0.048	0.103 ± 0.023
18 - 24	101	0.213 ± 0.031	0.110 ± 0.022	0.065 ± 0.009
24 - 30	98	0.159 ± 0.046	0.047 ± 0.018	0.050 ± 0.015
30 - 36	44	0.189 ± 0.050	0.065 ± 0.017	0.063 ± 0.018
B - 18	357	0.262 ± 0.010	0.284 ± 0.003	0.083 ± 0.003
W - 18	221	0.200 ± 0.027	0.141 ± 0.011	0.063 ± 0.005
18 - MT	357	0.081 ± 0.003	0.032 ± 0.002	0.024 ± 0.001

^aAGR= Absolute growth rate; RGR= Relative growth rate; AMR Absolute maturing rate; A = Asymptotic or Mature weight.

^bB= Birth; W = Weaning (at approximately 9 month of age); Mt = Maturity.

A typical model used included the fixed effect of year of birth, season of birth, sex of calf, dam age and parity, the random effect of sires and the pooled regression of weighing seasons of the beginning and ending included in the analytical model parameters from paternal half-sibs. Under the conditions of random mating the sire component would be expected to contain one-fourth of the variance due to additive effects of genes, none of the effects of dominance deviation and a small but undetermined amount of the epistatic variance. Heritability estimates were therefore, obtained through paternal half-sibs methods as:

$$h_s^2 = \frac{4\sigma_s^2}{\sigma_s^2 + \sigma_w^2}$$

where h_s^2 = paternal half-sibs estimate of heritability;

σ_s^2 = sire component of variance;

σ_w^2 = within sire component of variance

following the stochastic nature of the results from correlation analyses; viz genetic, phenotypic and environmental; coupled with the impractical estimates obtained in most cases, with high standard errors; the results are not documented in this report. Most of the estimates

appeared to be erroneous and have no biological meaning.

Results

The overall least-square and standard error of AGR, RGR and AMR at various age intervals are presented in Table 1. the results indicate the highest growth and maturing rates in the herd were attained between birth and weaning (B - W) being 0.388 ± 0.009 kg/day, 0.642 ± 0.006%/day and 0.120 ± 0.003% A/day for AGR, RGR and AMR respectively. At post weaning (W - 15), growth and maturing rates in N'Dama calves decreased to an average of 0.233 kg/day (AGR), 0.200%/day (RGR) and 0.070% A/day (AMR).

However, an improved growth performance was recorded between 15 - 18 months of age with calves growing in absolute and relative terms at 0.336 ± 0.072 kg/day and 0.199 ± 0.048% day respectively (Table 1). At this period, their mean proportional gains relative to their mature size (AMR) was 0.203 ± 0.023% A/day. These increases met with a significant decrease in the rate at age interval of 18 - 24 months.

Subsequently, between the age interval of 30 – 36 months, their growth performance improved once again, with values of 0.189 ± 0.050 kg/day, $0.065 \pm 0.017\%$ / day and $0.063 \pm 0.018\%$ A/day recorded for AGR, RGR and AMR respectively. Between 18 months of age and maturity (18 – MT) of the beef cattle, the growth and maturing rates reduced to 0.081 ± 0.003 kg/day for AGR; $0.032 \pm 0.002\%$ /day for RGR and $0.024 \pm 0.001\%$ A/day for AMR.

Estimates of heriability (h^2) and their standard errors for growth and maturing rates at the various age intervals considered are presented in Table 2. with the exception of the impractical estimates greater than one (>1.0) obtained for the rates at the age interval of 30 – 36 months,

other estimates in the present study were generally considered low and close to zero in some cases (Table 2).

The estimate of h^2 ranged from 0.03 to 0.24 for AGR, 0.03 to 0.21 for RGR and 0.02 to 0.42 for AMR with high standard errors. Heritability values less than 0.10 were recorded for AGR, RGR and AMR at B – W and 18 – MT in the herd. At a given interval, the h^2 estimates for AGR, RGR and AMR were similar to each other (Table 2). However, h^2 estimates for age intervals; 15 – 18 months, 18 – 24 months and birth to 18 months (B – 18) and were indeterminate in N'Dama herd at Fasola because of the negative sire components of variance.

Table 2 Heritability estimates (h^2) and standard errors ($se h^2$) of growth and maturing rates at various age intervals in N'Dama cattle^a

Age Interval (Months)	$h^2 \pm se h^2$		
	AGR	RGR	AMR
B – W	0.04 ± 0.05	0.09 ± 0.06	0.08 ± 0.05
W – 12	0.08 ± 0.12	0.05 ± 0.10	0.10 ± 0.13
12 – 15	0.24 ± 0.23	0.21 ± 0.23	0.25 ± 0.24
15 – 18 ^b	-----	-----	-----
18 – 24 ^b	-----	-----	-----
24 – 30	0.17 ± 0.35	0.17 ± 0.35	0.42 ± 0.040
30 – 36	1.46 ± 0.89	1.85 ± 0.82	1.62 ± 0.086
B – 18 ^b	-----	-----	-----
W – 18	0.21 ± 0.19	0.22 ± 0.19	0.18 ± 0.017
18 – MT	0.03 ± 0.08	0.03 ± 0.08	0.02 ± 0.08

^asee footnote in Table for definition of traits

^bEstimate of sire component of variance was negative.

Discussion

Growth and maturing rates from birth to weaning are important measures of performance that can be used to evaluate the preweaning development of calves. In this study, growth and maturing rates fluctuated over the various intervals considered based on the length of the interval, stage of development and age of the

animal (Table). The AGR obtained during preweaning (B – W) period compared favourably with those reported for N'Dama calves at Upper Ogun ranch (Olutogun, 1976; Olutogun and Deumers, 1977) and Fasola Stock farm (Tizikara, 1988) and fell within the range of 0.335 – 0.385 kg/day generally reported for N'Dama calves in West African sub-regions (Fall *et al.*, 1982; Tuah and Danso, 1985; FAO,

Genetic aspects of growth and maturing rates of N'Dama

1987). Relative growth rate in N'Dama calves at this period (0.642 %/day) was lower than 0.935%/day reported by Winder *et al.* (1990) for Red Angus cattle, while the AMR (0.120% A/Day) was similar to the value of 0.16% A/day reported for Hereford and Angus cattle (Smith *et al.*, 1976).

During preweaning period, the calves were almost entirely dependent on milk production of their dam for nourishment. Therefore, the animals' growth and maturity rates depended on the mothering abilities of their dam. The decrease in growth performance between W - 15 (transitional period) followed the physiological effects of weaning. During this period, the calves had to eat enough to influence their growth and maturing rates as self-nourishing animals. This situation resulted in 40.8%, 68.8% and 41.7% decrease in AGR, RGR and AMR respectively during this postweaning period (Table 1).

However, the increase in AGR, RGR and AMR between 15 - 18 months of age resulted from full adaption of N'Dama calves to the new environment (self-nourishing) for development. Similar pattern of effects have been documented for Hereford and Angus cattle with a higher growth and maturing rates (Fitzhugh and Taylor, 1971; Smith *et al.*, 1976). The decrease of 25.4% in AGR; 57.3% in RGR and 23.1% in AMR observed between 18 - 24 months of age may have been due to physiological stress following puberty attainment in the animals. This had persisted till the age interval of 24 - 30 months, since puberty is a gradual quantitative phenomenon rather than an acute and qualitative endocrinological event (Mukasa-Mugerwa, 1989). Mgbere, (1995) reported that N'Dama females attained puberty at the age of 22 months, while a range of 19.0 - 23.5 months was estimated as age at puberty for sokoto Gudali cattle in Nigeria by Oyedipe *et al.* (1982). But Zwandor and Akpokodje, (1989) argued that the onset of puberty in heifers and young bulls were related to body weight than age.

On complete development of the secondary sexual characteristics between 30 - 36 months, the animals became adapted physiologically and increased in growth and maturing rates. The reduced rates (AGR, RGR and AMR) obtained between 18 months of age and maturity (18 - MT) in N'Dama cattle was consistent with values reported for Hereford, Angus and Shorthorn cattle at similar age interval to the effects of the interval length and the ageing process. As the animals approach maturity, gains decreased, thereby decreasing the rate of maturity in the individual (Mgbere, 1995).

The heritability estimates of growth and maturing rates in this study, though considered low fell within the limit of estimates reported for growth traits in N'Dama cattle (Touchberry, 1967; Olutogun, 1976; Leigh *et al.*, 1984; Tizikara, 1988) and other tropical breeds (Trail *et al.*, 1971; Mwandotto, 1987). However, the mean heritability estimate of 0.23 reported for AGR, RGR and AMR at age interval of 12 - 15 months was similar to h^2 estimate of 0.24 documented for AGR and RGR at 12 - 18 months was similar to h^2 estimates of 0.24 documented for AGR and RGR at 12 - 18 months in Hereford and Angus cattle (Fitzhugh and Taylor, 1971).

There was trend for h^2 estimate of the rate (AGR, RGR and AMR) to be lower at the preweaning stage (mean $h^2 = 0.07$) than during postweaning (up to 19 months), mean $h^2 = 0.20$). this trend was consistent with changes in the environment to which the calves were exposed to during the different periods of development. N'Dama calf's genotype effect may have been masked greatly by strong influence of maternal environment during the preweaning period. In a study involving N'Dama calves, Mgbere (1995) maintained that suckling gain was a poor indicator of subsequent postweaning gains. It may therefore, be proper to select N'Dama calves for growth and maturing rates during postweaning stage, preferably based on growth performance at 12 - 15 months of age. The benefits of evaluating

animals after the maternal and compensatory effects have diminished have also been emphasized by Mwandotto (1987).

The inestimable nature of h^2 at age interval 15-18, 18-24 and B-18 months, following negative sire components of variance were attributed to lack of variation due to sire effects (Olutogun, 1976; Tizikara, 1988) and the data structure of the herd, especially with respect to the numbers of progeny per sire (Mgbere, 1995). However, this observation conformed to the conditions set by least-square-routine for genetic parameter estimates (Harvey, 1990).

Though the results are not presented here, for reason adduced earlier, findings indicate that the AGR, RGR and AMR in most age intervals were genetically highly correlated positively. These possibly imply that many genes at a given age interval are common to these growth traits and that selection based on any of these measures will result in a corresponding response in the other. There was also tendency for postweaning genetic correlations of the rates to be negative in sign, due possibly to the interruption of the maturing pattern by the stress of weaning and lowered nutritional intake. These probably gave rise to the exhibition at preweaning stage, during the postweaning period.

Generally, the low heritability estimates with high standard errors obtained for the rates in this study, were attributed to the poor standard of production environment with regard to variations in seasonal feed availability, disease incidence, poor management policies; lack of planned breeding and selection programmes; lack of research supports and in particular lack of organized record keeping systems. All these led to large temporary environment components and consequently, most of the variations observed in this study were largely non-genetic.

Conclusion

The growth and maturing rates of N'Dama cattle varied over the intervals considered depending on the age of the animals and their stage of

development in the growth process. Since genetic parameters are characteristics of a population structure and also dependent on the environment, the low heritability estimates noted in this study, may also be associated with the limited data size and the small effective number per sire at the age intervals considered. However, these estimates generally indicate that the relative significance of additive genetic factor is low and that most of the genetic improvement in growth and maturing rates of N'Dama cattle herd would come from emphasis on improved animal management and production environment. These would not only improve precision of genetic parameter estimates but would also improve the growth performance of N'Dama cattle. Other sources of genetic variation due to non-additive dominance and epistatic effects could be exploited through cross breeding N'Dama beef cattle with appropriate proven breeds.

References

- BIF.** 1990. Beef Improvement Federation Guidelines for Uniform beef improvement programs. Sixth Edition, USDA Ext. Serv. Prog. AID 1020, 89pp.
- Brown, J.E., Brown, C.J. and Butts, W.T.** 1972. Relationships among measures of growth from birth to maturity in Hereford and Angus cattle. *Ark Agric. Expt. Stat. Bull* No. 773. 77pp.
- Fall, A., Diop, M., Standford, J., Wissocq, Y.J., Durkin, J. and Trail, J.C.M.** 1982. Evaluation of the productivities of Djallonke sheep and N'Dama cattle at the center de recherches zootecniques, Kolda, Senegal. *ILCA Research Report* No. 3, Addis Ababa. 70 pp.
- Fitzhugh, H.A. Jr., and Taylor, C.S.St.,** 1971. Genetic analysis of degree of maturity. *J. Anim. Sci.* 33(4): 717 - 725

Genetic aspects of growth and maturity rates

- Harvey, W.R.** 1990. User's guide for least Squares and maximum likelihood Mixed Model computer programme (LSMIMM). PC - 2 Version, Iowa State University, Ames, LA, U.S.A.
- ILCA,** 1979. Trypanotolerant livestock in West and Central Africa. Monograph 2. International livestock center for Africa, Addis Ababa, Ethiopia, 147 pp.
- Leigh, A.O., Akinokun, O. and Adeyanju, S.A.** 1984. Genetic Aspects of Prewaning performance of N'Dama. *Nig. J. Anim. Prod.* Vol. 11 (1,2): 151 - 155.
- Mgbere, O.O.** 1995. Genetic characterization of growth of N'Dama cattle in Nigeria. Ph.D Thesis. University of Ibadan, Ibadan, Nigeria. 305pp.
- Mgbere, O.O. and Olutogun, O.** (2001). Livestock performance at maturity in N'Dama cattle raised on semi-improved tropical pasture. *Trop. J. Anim. Sci.*, (In Press).
- Mukasa-Mugerwa, E.** 1989. A Review of Reproduction performance of females *Bos indicus* (Zebu) cattle. ILCA Monograph No. 6. ILCA Addis Ababa, Ethiopia. 134pp.
- Murray, M., Morrison, W.I. and Whitelaw, D.D.** 1982. Host susceptibility to African trypanosomiasis: Trypanotolerant. *Adv. Parasitol.* 21:1 - 68.
- Olutogun, O.** 1976. Reproductive performance and growth of N'Dama and Keteku cattle under ranching conditions in the Guinea Savannah of Nigeria. Ph.D. Thesis, University of Ibadan, Ibadan. 292pp.
- Olutogun, O. and Dettmers, A.** 1977. Heritability estimates of Liveweights from an extensively managed beef cattle population in Southern Guinea Savannah of Nigeria. *Nig. J. Genet.* (1): 62 - 68.
- Orheruata, A.M. and Olutogun, O.** 1998. Management period influence on performance of N'Dama cattle at Fashola stock farm Nigeria. *Proceedings of 3rd Annual Conference of ASAN.* September 22 - 24, 1998, Lagos. P 174 - 176.
- Oyedipe, E.O., Osori, D.I.K., Aderejola, O. and Saror, D.** 1982. Effects of level of nutrition on onset of puberty and conception rates of zebu heifers. *Theriogenology.* 18: 525 - 539.
- Ruthenberg, H.** 1980. Beef production on artificial pastures in Southern Guinea Savannah and derived Savannah of West Africa. *Anim. Res. Dev.* 2:43 - 63.
- SAS,** 1987. Statistical Analysis System User's guide for personal computers SAS/STAT. Version 6 Edition, SAS Institute Inc. Cary, N.C. U.S.A.
- Smith, G.M., Fitzhugh, J.R., H.A., Cundiff, L.V., Cartwright, T.C and Gregory, K.E.** 1976. A genetic analysis of maturing patterns in straight bred and cross bred Hereford, Angus and Shorthorn cattle. *J. Anim. Sci.* 43: 389 - 395.
- Stober, H., Bessett, J.W., Cartwright, T.C. and Blacwell, R.L.** 1986. An analysis of body weights and maturing patterns in western range ewes. *J. Anim. Sci.*, 63: 729 - 740.
- Tizikara, C.** 1988. Evaluation of genetic parameters of some growth and reproductive traits in N'Dama cattle and their crosses. Ph.D Thesis, Obafemi Awolowo University, Ile Ife, Nigeria. 160pp.
- Touchberry, R.W.** 1976. A study of N'Dama cattle at Mussia Animal husbandry station in Sierra Leone. *Illinois Exp. Stat. Bull.* No. 724. 40pp.

- Trail, J.C.M., Sacker, G.D and Fisher, I.I.** 1971. Crossbreeding beef cattle in Western Uganda. 3: Genetic analysis of body weight. *Anim. Prod.* 13:153 – 163.
- Trail, J.C.M., D'ieteren, G.D.M., Feron, A., Kakiese, O. Muhingo, M. and Pelo, M.** 1990. Effect of trypanosome infection, control of parasitaemia and control of anaemia development on productivity of N'Dama cattle. *Acta. Trop.* 48: 37 – 45.
- Tuah, A.K. and Danso, Y.N.** 1985. Preliminary studies on the performance and productivity indices of N'Dama and West African Shorthorn cattle in Ghana. *Trop. Anim. Hlth. Prod.* 17:114 – 120.
- Winder, J.A., Brinks, J.S Bourdon, R.M. and Golden, B.L.** 1990. Genetic analysis of Absolute growth measurements, Relative growth rate and Restricted selection indices in Red Angus cattle. *J. Anim. Sci.* 68:330 – 336.
- Zwador, N.J and Akpokodje, J.U.** 1989. relationship between size and reproduction in N'Dama cattle (*Bos taurus*) under small scale holding system. II: Growth Rates and Reproductive Periods. *Trop. Vet.* 7:196 – 202.

(Received 8 August 2000; Accepted 27 September 2001)