

Genetic and Non-Genetic factors affecting age at first calving of N'Dama Heifers

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Target Audience: Livestock Farmers, Researchers and Scientists

Abstract

A total of 1756 N'Dama heifers born on the farm over a period of 29 years (1949 – 1977) were studied, to investigate the effects of their year of birth (BTHYY), season of birth (BTHSN), inbreeding of its calf (CALINB) and inbreeding of the heifer (DAMINB) on their age at first calving (AFC). BTHYY and DAMINB were highly significant ($P < 0.01$) on AFC, BTHSN was significant ($P < 0.05$) while CALINB was not significant ($P > 0.05$) on AFC. AFC in the heifers studied ($N = 1756$) ranged from 26 – 56 months, with a mean AFC of 40.43 ± 0.18 months with a CV of 18.95 percent. Heifers born in 1955 ($n = 152$) had the least AFC (35.51 ± 0.54 months) while those born in 1968 ($n = 5$) had the highest AFC (51.54 ± 2.94 months). Heifers born during the early dry season had the least AFC, while those born during the late dry season had the highest AFC. The mean CALINB and DAMINB in this study were 1.18 percent and 0.29 percent respectively. There was a correlation of 0.06 between both factors. DAMINB had a significant ($P < 0.01$) influence on AFC with a percentage increase in DAMINB resulting in 0.3315 months (about 10 days) increase in AFC of heifers.

Keywords: Age at First calving, Beef Cattle, Heifers, Inbreeding, N'Dama and Reproductive ability

Description of Problem

The increasing demand for protein of animal sources (especially meat) in Nigeria has led to the undertaking of various measures aimed at ensuring constant and adequate supply of beef for the ever-growing population. These measures included investigating various factors (genetic and environmental) affecting the productivity of indigenous stock and improving the status of the livestock industry.

The observed characteristics of an animal is the sum total of both the genotype and the prevailing environmental conditions of the animal. The performance traits of beef cattle

are essentially traits of economic importance and are quantitative in characters. And they are determined by several genes in differing genic combinations [1, 2, 3]. The environment of the animal includes all the non-genetic factors which may influence the performance of the animal, such as; feeding, housing, management practices, pests and diseases and the prevailing climatic conditions. Many components of this environment in developing countries like Nigeria are often inadequate, sub-standard and mostly inimical to the maximum expression of the animal's genetic worth. Thus, our environment being essentially a stressful one, will require our efforts at developing animals

whose fitness and performance traits despite the prevailing environmental conditions are competitive and above average.

Reproductive performance is the most essential trait in livestock enterprise. If there is no calf, there is no economic return. Best cows in the herd are those with low age at first calving, minimum calving interval and live a long time. These are therefore the most important measures of reproductive performance in the females [4, 5, 6, 7, 8, 9, 10]. The age at which an animal had its first calf is the most important single variable for predicting differences in efficiency of production [11, 12, 13, 14].

The N'Dama cattle has been well adapted to this environment and its ability to thrive and survive under excessive heat stress, incidence of diseases, poor management practices, adverse climatic conditions, unavailable and poor quality feed resources had been elucidated. cattle's promising potential as a good beef breed has been well documented [15, 16, 17, 18, 19]. The objective of this study therefore was to identify and investigate all the factors that may affect the age at first calving of N'Dama heifers with a view to proposing ways of improving the reproductive ability of the animals.

Materials and Methods

Study area, history and objectives of the farm.

The study area is Fashola Stock Farm, near Oyo town, Oyo State. The Fashola stock farm was established in 1947 by the then British Colonial Government. The farm is currently owned by the Oyo State Government, under the direct supervision of the Ministry of Agriculture and Natural Resources. The foundation stock in the farm included the

initial 93 heads of N'Dama from the French Guinea (Now Guinea Republic) and those of Ilorin and Ilora farms in Nigeria. The primary objectives of the farm was to be a multiplication centre for the distribution of N'Dama, Keteku and Muturu cattle breeds to local farmers, serve as an experimental research farm to transfer research results to local farmers and serve as a training ground for students and aspiring cattle farmers.

The farm is situated in a low-to-medium tsetse fly risk zone in the derived Guinea Savanna belt of Nigeria. It is situated at an altitude of 228.6m above sea level, on latitude 7° 54'N and longitude 3° 43' E of the Equator. The climatic condition of Fashola stock farm is more of tropical rain forest than the derived savanna. The annual rainfall pattern is influenced by two opposing winds viz. the southwest monsoon and the northeast trade winds. The former is responsible for the periods of high relative humidity due to high rainfall that prevails while the latter is characterized by a drop in the relative humidity, with consequent dryness. There are two major seasons in a year viz.: the wet and dry seasons. However, the bimodal nature of the rainfall distribution in Nigeria (Figure 1), along with its attendant fodder availability and quality, makes imperative the subdivision of the two seasons into four as follows: early wet (April – June), late wet (July – September), early dry (October – December) and late dry (January – March). The seasonal distribution of rainfall in Nigeria during the period of study is presented in Figure 2. The annual minimum temperature is about 21° C while the maximum is 33° C. Relative humidity varies between 52% and 78% depending on the period of the year.

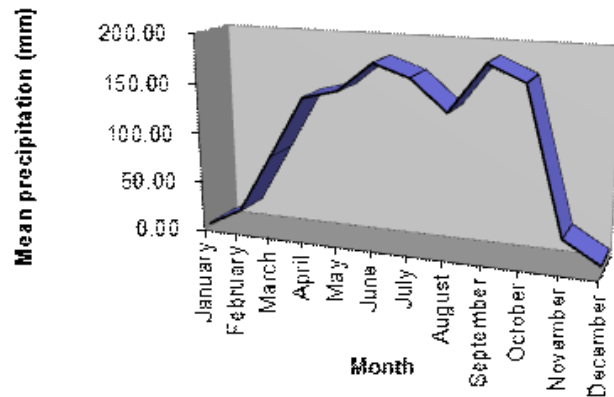


Figure 1: Mean monthly precipitation at Fashola Stock Farm (1949 - 1977)

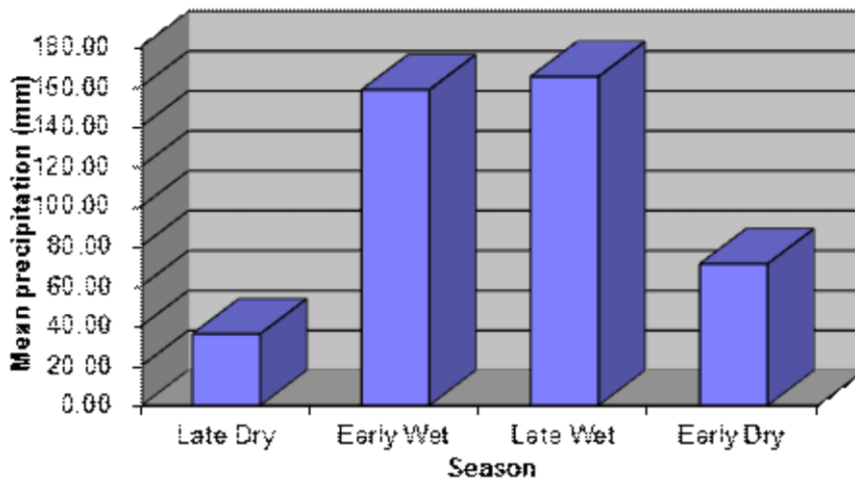


Figure 2: Mean seasonal precipitation at Fashola Stock Farm (1949 - 1977)

Management Practices

Pasture Management. The 340 hectares of land on the farm was divided into 107 paddocks of about 2 hectares each and established with grass-legume mixtures. The species of grasses were Elephant grass (*Pennisetum purpureum*), Guinea grass (*Panicum maximum*), Giant Star grass (*Cynodon plectostachium*) and Gamba grass (*Andropogon gayanus*). The legumes were

Centro (*Centrosema pubescens*), Stylo (*Stylosanthes gracilis*) and Calopo (*Calopogonium mucunoides*). Maintenance of pasture included slashing, mowing and occasionally pastures invaded by weeds are burnt in the dry season and ploughed back into the soil.

Herd Management. The system of husbandry on the farm is semi-intensive. The animals were grouped into paddocks according to their

sex, age and physiological status. There were usually six major divisions with each under direct supervision of two herdsmen. Pasture mating was adopted on the farm, where a bull is allowed access to the breeding cows throughout the year in each fenced paddock. Bull to cow ratio for pasture mating fluctuates between 1:20 and 1:30. Heifers were first introduced to bulls between the ages of two and three years and nursing cows were introduced into the breeding paddocks at 45 –

60 days post partum. Routine operations included castration, spraying, deworming and vaccination. A veterinary unit attached to the farm carried out all necessary disease control measures and emergencies. Sick animals were kept in the sick bay and post-mortem of dead animals was done to identify probable cause of death. Animals were identified soon after birth by any of these methods; tattooing, neck-tag, ear notching or branding.

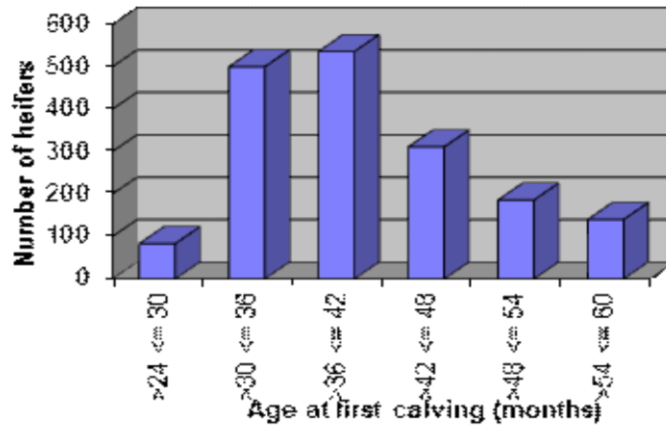


Figure 3: Frequency distribution of N'Dama heifers by age at first calving at Fashola Stock Farm (1949- 1977)

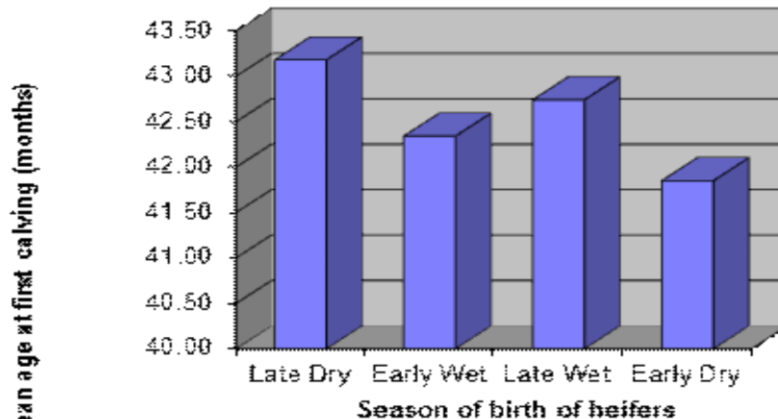


Figure 4: Season of birth effect on age at first calving at Fashola Stock Farm (1949 - 1977)

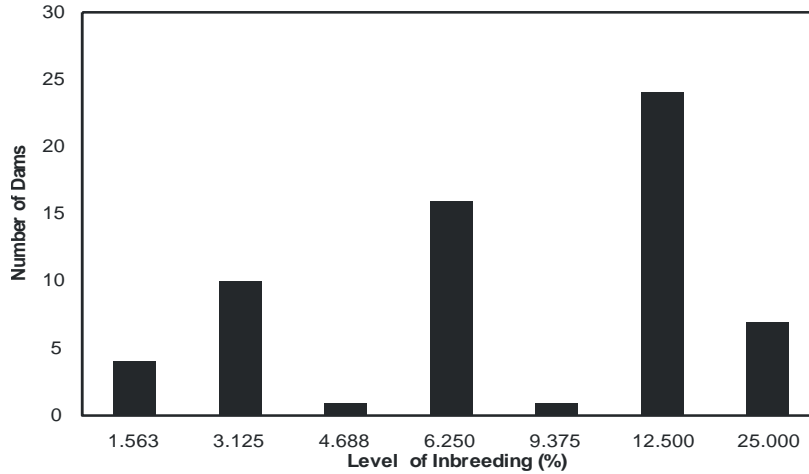


Figure 5: Frequency distribution of inbred dams by level of inbreeding at the Fashola Stock Farm (1949 - 1977)

Data Collection, Preparation and Statistical Analyses

Data Collection. Data used in this study were extracted from records kept in a series of field books, collected since the inception of the farm in 1947 up to 1984. Major records kept on the farm were those of calving, weight and mortality. Information contained in the records are calf identification number, calf breed, date of birth, sex of calf, sire identification number, sire breed, dam identification number, dam breed, birth weight of calf, weaning weight of calf and age of calf at weaning.

Data Preparation. The extracted data were coded and entered using database management software [20] and the database file was used for preliminary descriptive analyses to verify and validate recorded data using “Procedure summary” of SAS [21]. Some variables not originally present in the field books were then computed. Based on the date of birth of calves, their month of birth was used in assigning them to the different seasons and also heifers born on the farm and whose date of birth were known, had their age at first calving computed from the difference between the day they calved and the day they were

born. After arranging all births chronologically and by dam, the parity and ages of dam whenever they calve were calculated. Inbreeding coefficient of both dam and its calf was calculated using a computer program developed to handle animals with minimal parental information by using the Wright [22] method of path searching [23].

Statistical Analyses. The validated data was analyzed using the General Linear Model Procedure [21]. Year of birth and season of birth of heifer were used as fixed effects, while the inbreeding of the foetus and inbreeding of the heifer are used as covariates. The general model describing the age at first calving of N'Dama heifers was:

$$Y_{ijk} = \mu + R_i + S_j + Cb_1 + Db_1 + e_{ijk}$$

Where Y_{ijk} = Individual heifer’s age at first calving

- μ = Population mean
- R_i = Year of birth ($i = 1, 2, \dots, 29$)
- S_j = Season of birth ($j = 1, 2, \dots, 4$)
- Cb_1 = Regression of inbreeding coefficient of calf
- Db_1 = Regression of inbreeding coefficient of heifer
- e_{ijk} = Residual random error

Results

Age at First Calving

The mean age at first calving (AFC) for the 1756 N'Dama heifers used in this analysis was 40.43 ± 0.18 months with a coefficient of variation of 18.95 percent. The least squares analysis of variance for age at first calving are presented in Table 1. The N'Dama heifers studied had varying AFC, with a range of between 26 and 56 months. The frequency distribution of the various AFC groups is presented in Figure 3.

The AFC of heifers born between 1949 and 1977 vary significantly from the lowest (35.51 months) in 1955 to the highest (51.54 months) in 1968 (Table 2). Fluctuations in

AFC due to season of birth are presented in Figure 4.

Of the 1756 heifers studied, 63 were inbred (representing 3.59% of the total heifer population) to varying degrees (1.56% - 25%), the frequency distribution of inbred heifers is presented in Figure 5. The mean inbreeding coefficient of the calf (CALINB) was 1.18 percent, while the mean inbreeding coefficient of the heifer (DAMINB) was 0.29 percent. The correlation between CALINB and DAMINB was 0.06, while the correlation between AFC and CALINB was -0.01 and between AFC and DAMINB, it was -0.09 . The intercept of the regression line was 40.53 months and the slope of the regression line was 0.3315.

Table 1: Least squares analysis of variance for age at first calving of N'dama heifers at the Fashola Stock Farm (1949 - 1977)

Source	df	Mean Square
Year of birth	28	1003.29**
Season of birth	3	130.69*
<u>Regressions</u>		
Calf's Inb. Coeff.	1	5.74 ^{ns}
Dam's Inb. Coeff.	1	549.67**
Error	1722	42.64

**= $P < 0.01$, *= $P < 0.05$, ^{ns} = Not Significant

Discussion

Age at First Calving

Year of birth and heifer's inbreeding coefficient (DAMINB) significantly ($P < 0.01$) affected age at first calving, while season of birth of heifer exerted significant ($P < 0.05$) influence on its age at first calving.

Only 4.74 percent of the 1756 heifers calved before 30 months of age, 28.47 percent calved between 30 and 36 months, while 30.52 percent of these N'Dama heifers calved between 36 and 42 months. 17.71 percent calved between 42 and 48 months, 10.59

percent first calved between 48 and 56 months while only 7.97 percent calved after 54 months. Although an age at first calving of 3½ - 4 years was reported for zebu cattle in the tropics [24], however a range of 26 - 36 months was reported for N'Dama heifers under improved management [25]. The mean AFC obtained in this study agrees with that reported on a subset of N'Dama cattle at the Fashola Stock Farm with mean AFC of 40.60 months [26]. It is also very close to the 39.40 months reported on the Sierra Leone N'Dama [27] and that of 39.80 months in Senegal [18].

However, the value obtained in this study is relatively lower than 47.60 months obtained at Upper Ogun Cattle Ranch [28]; 45.60 months at the Accra plains of Ghana [29] and 46.50 months at the Teko Livestock Station in Sierra Leone [15].

Table 2: Effect of year of birth of heifers on age at first calving (AFC) at the Fashola Stock Farm (1949 - 1977)

Year of birth	N	L.S.Means (Months)	S.E.
1949	92	43.65 ^{bcdefg}	0.69
1950	110	40.39 ^{fgh}	0.63
1951	140	44.48 ^{abcdef}	0.56
1952	117	39.91 ^{fgh}	0.61
1953	110	40.24 ^{fgh}	0.63
1954	135	40.41 ^{efgh}	0.57
1955	152	35.51 ^h	0.54
1956	102	37.97 ^{fgh}	0.65
1957	154	36.27 ^{gh}	0.54
1958	169	36.62 ^{gh}	0.51
1959	95	37.02 ^{fgh}	0.68
1960	31	49.71 ^{abc}	1.18
1961	32	49.96 ^{ab}	1.16
1962	26	42.51 ^{cdefgh}	1.28
1963	2	39.33 ^{fgh}	4.62
1964	4	39.56 ^{fgh}	3.28
1965	7	51.22 ^a	2.47
1966	2	35.89 ^h	4.63
1967	2	39.94 ^{fgh}	4.62
1968	5	51.54 ^a	2.94
1969	2	48.88 ^{abcd}	4.62
1970	8	48.43 ^{abcd}	2.32
1971	80	47.32 ^{abcde}	0.76
1972	36	40.37 ^{fgh}	1.09
1973	41	42.60 ^{cdefgh}	1.02
1974	40	44.28 ^{abcdef}	1.05
1975	45	47.32 ^{abcde}	0.98
1976	12	39.67 ^{fgh}	1.89
1977	5	42.28 ^{defgh}	2.92

Means with different superscripts differ significantly (P<0.05), S.E. = Standard Error

Several factors have been advanced for the difference in these values. For example, the Upper Ogun Cattle Ranch was purely commercial while others were in similar management set-up as that of Fashola Stock Farm. Basically, age at first calving in this study is affected by both environmental and genetic factors. It was reported that heat stress imposed on the animals as a result of increased ambient temperature, suppressed feed intake and growth rate of such animals, which consequently delay puberty and age at first calving [30]. It was also noted that an ambient temperature above 27°C lengthens the estrus cycle, decreases duration and intensity of estrus, reduces fertility and increases embryonic mortality and consequently increases the age at first calving [31].

Fashola Stock farm environment is essentially tropical and may exert the same inimical effects on maximum expression of the genetic worth of these animals in their reproductive ability [32]. This may be the reason why animals in the humid tropics especially calve at a relatively older age when compared with the temperate breeds. Over heating affects reproduction, creates unfavorable endocrine balance and reduced feed intake. These assertions substantiate the reports of researchers who recounted that high ambient temperature and relative humidity reduces feed intake and reproductive performance of N'Dama cattle in Ghana [33].

Year of birth. The heifers covered in this analysis were those born between 1949 and 1977 only. The foundation heifers whose actual age could not be ascertained were excluded from this analysis.

The least-squares-mean of age at first calving in this study was 42.53 ± 0.41 months. Heifers born in 1955 had the least AFC (16.51 percent less than mean AFC) while heifers born in 1968 recorded the highest age at first calving (21.19 percent greater than mean AFC).

The pre-independence era (before 1960) recorded more heifers than the post-independence era (after 1960). Heifers born between 1949 and 1959 (11 years) accounted for 78.36 percent of the total heifers used in this analysis while those born between 1960 and 1977 (18 years) accounted for only 21.64 percent of the total heifers investigated in this analysis.

There was a sharp drop in number of heifers born in 1959 and this may be attributed to the gradual withdrawal of the colonial administrators of the farm prior to independence. However, the inconsistent distribution observed between 1963 and 1970 may be attributed to the political crisis within the Western region in 1966 up to the civil war era of 1967 to 1970. Another factor that may be responsible for this inconsistent pattern of distribution may be explained by the fact that this project only takes into consideration the Purebred N'Dama population and all those Crossbred calves produced between 1964 and 1968 were not included in these analyses.

The heifer distribution increases from 1972 to 1975 when it sharply declined in 1976 and 1977. This marked decline in number of calves dropped in 1976 was as a result of the fractionalization of the herd due to asset sharing among the three new states created from the old Western region in 1975.

Based on the values obtained in this study, it will be observed that the least square means of AFC of N'Dama heifers follow the same trend when grouped into management period. Least squares mean of AFC between 1949 and 1954 was relatively higher than the values obtained between 1955 and 1959. Although AFC for the years 1960 and 1962 were higher than the preceding year group but the intermittent lower values obtained in 1963-1964 and 1966-1967 does not give any specific or consistent pattern. It was observed that values obtained between 1949 and 1959 were relatively consistent when compared to values

obtained after 1960. This may be due to several factors but the most notable ones being a reflection of changing farm management, the irregular and lower frequency distribution of heifers' peculiar to the post-independence era and the varying environmental conditions over the years.

The effect of year of birth of White Fulani heifers was significant on their AFC at Ibadan [3]. Also year of birth of N'Dama heifers significantly affected their age at first calving [10, 28, 34].

Season of birth. The frequency distribution of heifers across the seasons is relatively steady. The early dry season had about 29.44 percent of the 1756 heifers examined while the late dry had 22.67 percent; early wet had 28.70 percent and late wet had 19.19 percent.

The early dry season recorded the least AFC and it was 1.60 percent less than the mean AFC while the late dry season had the highest AFC and it was 1.53 percent greater than mean AFC. The values obtained between the early wet and late wet seasons are not significantly different. These differences across seasons was a reflection of changing environmental conditions as expressed in the amount of precipitation, temperature, relative humidity and availability of fodder for the animals.

The reason why animals born in the early dry season had the least AFC can be explained by the fact that the animal will still be sucking its dam throughout the early and late dry seasons. Lush pastures will be available as at the time it shall be weaned and thus shall have access to this forage during the early and late wet seasons. This implies that it will grow faster and as such attain puberty earlier. Also, the presence of rains during this critical period will attenuate the effect of heat stress usually associated with the humid tropics, thereby stabilizing the hormonal balance in the animal and ensuring longer duration of estrous [10, 28, 30, 34].

Effect of Inbreeding. It can be concluded that inbreeding affects the AFC of N'Dama heifers at Fashola Stock Farm. This result agrees with earlier works [35, 36, 37] where similar effects were reported on heifers. The consensus in literature is that inbreeding depresses AFC and other reproductive traits of heifers [7, 38, 39, 40, 41].

Conclusions and Application

1. Most of the factors affecting age at first calving of N'Dama heifers at the Fashola Stock Farm are essentially environmental in nature, rather than genetic. The animals have innate capabilities to produce but the environment is inimical to the maximum realization of this potential.
2. Productivity traits are quantitative in nature and as such are greatly influenced by environmental factors. Any effort aimed at improving the performances of animals at the Fashola Stock Farm must initially be directed at improving the prevailing environmental constraints.
3. Animals reared in this part of the world are mostly sustained on fodder and pastures, whose availability is essentially seasonal, with attendant surplus and scarcity of feed according to the dictates of the seasons. In order to have even growth and development across the seasons, efforts must be made to supplement the feed resources of the animals especially during the period of scarcity.
4. Provision of supplemental feeding during period of forage scarcity will ensure steady and uniform reproductive performances of the animals. The provision of supplemental feeding during period of shortages would stem the tide of animals been herded by nomads to

other people farms, thereby drastically reducing the incidence of farmer / herdsman clashes, which has become a problem of National concern.

5. N'Dama cattle promises to be a good breed of cattle if its immediate environmental conditions are properly catered for.

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