CROSSBREEDING OF GERMAN BROWN x N'DAMA CATTLE – 1V – The trend of milk production by the crossbreds

ABSTRACT

A total 194 records of lactation milk yield from crossbreds and purebred cows of German brown collected from the crossbreeding programme at the University of Ibadan, Nigeria between 1970-1988 were analyzed using the least square means of analysis of variance. The aim was to investigate the benefit resulting from crossbreeding of German brown and local N'dama cattle. Crossbreds GBND (50% N'dama inheritance) and NDB1 (75% N'dama inheritance) had comparable milk yield at 1269.59kg and 1341.72 kg respectively which were significantly (P<0.05) less than the lactation milk yield of 2037.47kg for the GBP (German brown). Mean lactation length was significantly (P<0.05) longer for the GBP with a value of 339.16 days compared to 290.36 days and 224.78 days for GBND and NDB1 respectively, which were significantly (P<0.05) different from the purebred German brown. Sex had no significant (P>0.05) effect on milk yield/lactation length while season, year and parity all significantly (P<0.05) affected milk yield/lactation length. There was significant (P<0.05) effect of genotype on mean daily milk yield; mean daily lactation yield for GBP was 6.01kg/day which was not significantly (P>0.05) different from mean daily lactation yield of 5.97kg/day for the NDB1 but differed significantly (P<0.05) from 4.37kg/day for the GBND. The finding showed that 50% and 75% N'dama crossbreds (meaning 50% and 25% German Brown blood) clearly possessed a superior genetic capacity for milk production compared to the purebred local N'dama cattle. This demonstrates the value of introducing genes from European dairy breed.

Key words: German brown, N'dama, Crossbred genotypes, milk yield, lactation length

INTRODUCTION

Broadly speaking, the developed world has 33.33% of the cattle population and produces over 80% of the milk. The countries of the developing world (Latin America, Africa and Asia) have 66.67% of all the cattle stocks, yet they produce less than 20% of the milk. The reasons for these great disparities are climate, feed resources, cattle types, degree of economic development (FAO 2025). For example, the Bos taurus dairy cattle (European) appear to have a genetic potential for milk production 100% higher than that of Bos indicus, tropical breeds (FAO 2025).

Instructively, exploration of this superior advantage by the European breeds could reduce the earlier mentioned production gap between the developed nations and developing nations through crossbreeding. Crossbreeding in Africa has yielded mixed results, with some programs demonstrating significant improvements in productivity while others have faced challenges related to adaptation and sustainability. While crossbreeding can accelerate genetic progress and increase yields in areas like milk and meat production, it also poses risks to local breeds and may not always be a one-size-fits-all solution due to diverse environmental conditions and farming practices (Kathambi *et al.*, 2025).

To this extent, FAO (2025) in their review of crossbreeding efforts in the tropics reported that the availability of artificial insemination has made crossbreeding between Bos taurus and Bos indicus populations very widely possible and substantial number of crossbreeding trials indicate sufficient advantages, even in stressful conditions, for crossbreds between the two types (FAO 2025). For example, in India, where the accumulated information has led to a change in national policy, which now is aimed at producing crossbreds between Bos taurus and local Bos indicus breeds on a very large scale (20 million). This strategy is being emulated on a smaller scale in many other countries whose native populations are of Bos indicus type.

The most obvious way to exploit this difference would be to simply import Bos taurus cattle to tropical areas. In recent decades, some successes have been achieved, particularly in the dry tropics, where great efforts have been made to control disease, improve nutrition, and reduce climatic impact. In this respect, in Nigeria (and most other countries in West Africa) the purpose of most crossbreeding projects has been to upgrade the local cattle (Bos indicus and Bos taurus) towards a European breed (FAO 2025). In Nigeria, Buvanendran *et al.* (1981) contributing to this genetic difference reported milk yield increased significantly as the proportion of Friesian inheritance was raised from 1/2 Friesian to 7/8 Friesian supported by Sohael (1984). However, at Agege Dairy Farm average milk yields of White Fulani (WF) crossbreds was highest at 75% WF-bred (Laseinde, 1979, quoted by Ngere, 1979 as contained in FAO 2025).

It was on the basis of the adaptation ability of N'dama cattle in humid tropics of southern Nigeria, its capacity to convert poor quality grass to meat that a crossbreeding scheme was initiated between German Brown and N'dama in 1970 with hope to improve its poor milk production ability.

The present study analyses the data collected between 1970 – 1988 from the crossbreeding programme at the University of Ibadan, Nigeria between German Brown and N'dama and their crossbreds to determine the pattern milk production of the crossbreds.

MATERIALS AND METHODS

The data used were extracted from the cow performance records at the University of Ibadan Teaching and Research Farm dual purpose herd. The University of Ibadan is located in Ibadan with geographical indices of lying between latitude 7^{o}00'N and 9^{o}30'N and longitude 3^{o}00'E and 4^{o}00'E of the equator. The mean annual temperature is 1258mm and mean temperature is 31.3^{o}C. It experiences two seasons – dry and wet. Dry season starts November and ends February while wet season starts March to October (Adejuwon 2022)

The University of Ibadan farm received its first stock of Brown Swiss (BS) from the German Government 1969 as good gesture. In 1973, additional stocks were imported to meet the increasing demand for meat and milk and their products and research activities.

The crossing of the BS cattle with the N'dama (N'd) started in 1974. The crossbreeding programme was undertaken to incorporate breed tolerance to trypanosomiasis, endemic disease in humid tropics which causes sleeping sickness. Several crossings involving direct, reciprocal and backcrosses of varying degrees were in the process of developing trypanosomiasis-tolerant genotypes.

Management practices

The composite and parent breeds were on range depending mainly on availability of grasses to meet their nutrient requirements. However, feed supplementation with dry brewers grain and concentrates of approximately 10 - 14% crude protein and 11-13KJ of energy were made available to the animals once a day at the rate of 2kg $100kg^{-1}$ of body weight.

Routine management practices were carried out including flushing, deworming, spraying against endo- and ecto-parasites, vaccination against rinderpest, pluero=pneumonia, black quarter, septicaemia, antrax, foot and mouth diseases and weekly weight recording. Lactating animals were milked twice a day (morning and evening) and yield recorded per cow.

Data collection and statistical analysis

The purebreds and crosses are symbolized as follows:

NDL (N'dama born on the farm)	63
NDB1 (Mating of N'dama females to F1 males; 75% N'dama gene)	55

GBND (Pooled F1 and F2; 50% N'dama gene) 23
GBB2 (5/8 GB x 3/8 ND; NDB1 females mated to GB males; 37.5% N'dama) 30
GBB1 (3/4 GB x ¼ ND; mating of GB x GBND; 25% N'dama gene) 40
GBP (German Brown imported and born locally)

A total of 194 lactation records were used comprising of 136 GBP, 43 GBND and 12 NDB1. Three lactation records from the GBB1 and GBB2 genotypes were considered very few and thus eliminated. The purebred N'dama had no record.

The production parameters studied were total lactation yield, average lactation yield, yield per day and average lactation length. The analysis of variance model included genotype, season, year, sex, and parity as fixed factors. The least square model is as written below:

$Yijklmn = \mu + Bi + Tj + Sk + Dl + Pm + eijklmn$

Where

Yijklmn = milk yield

μ = overall mean

Bi = effect of the i^{th} genotype, where i = 1 – 3

Tj = effect of the j^{th} year, where j = 1 – 17

Sk = effect of the k^{th} season, where k = 1- 4

Dl = effect of the l^{th} sex, where l = 1 – 2

Pm = effect of the m^{th} parity, where m = 1 – 11

Eijklmn = random and independent error term distributed normally with zero mean and variance $0e^2$

RESULTS

Table 1 presents the mean lactation milk yield (kg) and lactation length (days) by the different genotypes (GBP, GBND and NDB1) with data for analysis; GBB2, GBB1 and the local N'dama (NDL) were not included because of inadequate records for analysis.

TABLE 1: Mean lactation milk yield by genotypes, sex, year of birth and parity of cow

Genotype	No	LSMean	SEM	Percentage level of exotic German brown gene

GBP	139	2037.77^{a}	95.86	100
GBND	43	1269.59^{b}	98.57	50
NDB1	12	1341.72^{b}	184.19	75
Sex				
Male	93	1674.76^{a}	103.26	
Female	73	1522.66^{a}	111.18	
Season				
Early dry	45	1245.27^{b}	120.51	
Late dry	62	1701.91^{a}	121.03	
Early rain	48	1704.14^{a}	124.57	
Late rain	38	1547.05^{ab}	119.55	
Year				
1970	6	3158.53^{ab}	298.12	
1971	8	3761.18^{a}	248.41	
1972	4	3235.71^{ab}	269.34	
1973	22	2830.29^{bc}	178.00	
1974	16	1639.79^{de}	172.14	
1975	13	2243.70^{cd}	179.85	
1976	19	1699.50^{de}	157.91	
1977	27	1181.42^{ef}	145.95	
1978	24	574.04^{fgh}	142.57	
1979	5	595.08^{fgh}	237.49	
1980	12	11015.91^{efgh}	159.58	
1981	13	834.72^{fgh}	159.05	
1982	8	886.36^{fgh}	191.86	
1983	9	746.90^{gh}	182.84	
1984	4	439.91^{gh}	260.60	
1985	3	345.27^{h}	346.23	
1986	1	2076.94^{a}	588.29	
Parity				
1	42	624.35^{d}	100.63	
2	38	1811.58^{b}	99.75	
3	36	1088.63^{c}	94.18	
4	27	2501.45^{a}	110.81	
5	24	2383.48^{a}	121.40	
6	12	1813.75^{b}	142.04	
7	7	855.17^{dc}	205.67	
8	2	1606.40^{bc}	239.36	
9	2	1032.60^{c}	274.40	
10	2	697.00^{d}	214.27	

Within variable groups, column means with the same letter do not differ significantly (P>0.05)

From mean squares Table 1 above, the exotic GBP had significantly (P<0.05) more milk yield (2037.77kg) than the crossbreds; 1341.72kg for NDB1 and 1269.59kg for GBND which did not differ significantly (P<0.05) from each other.

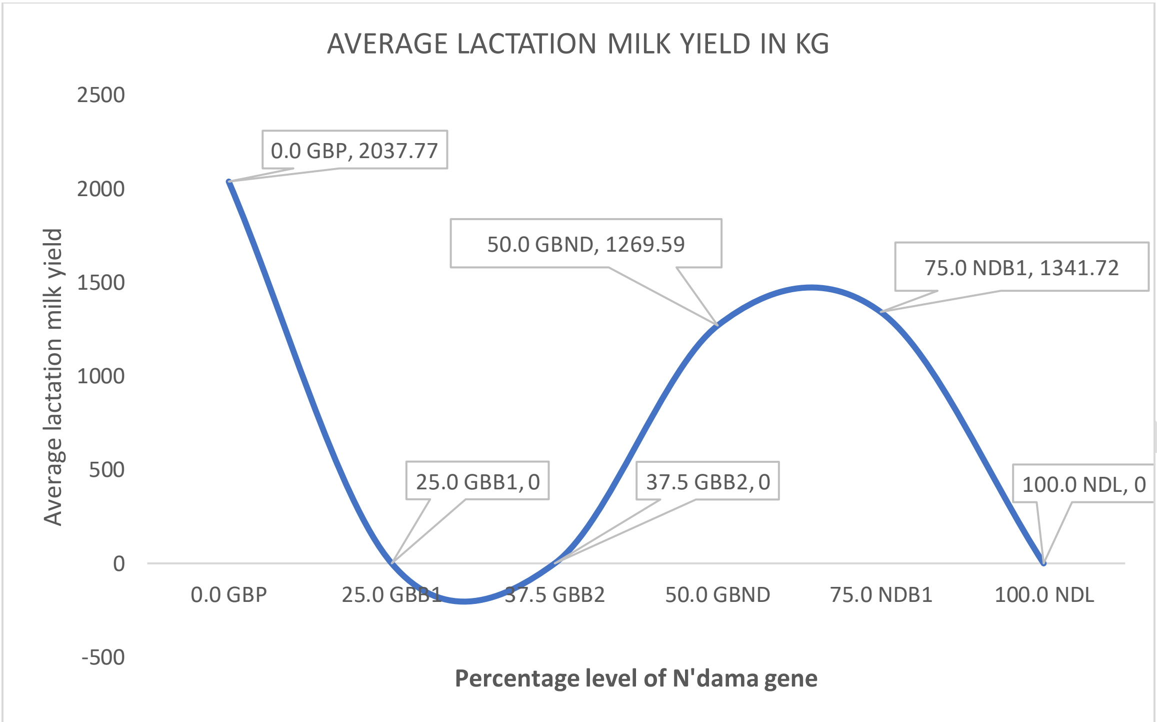

Fig. 1: Line graph of average lactation milk yield of the genotypes

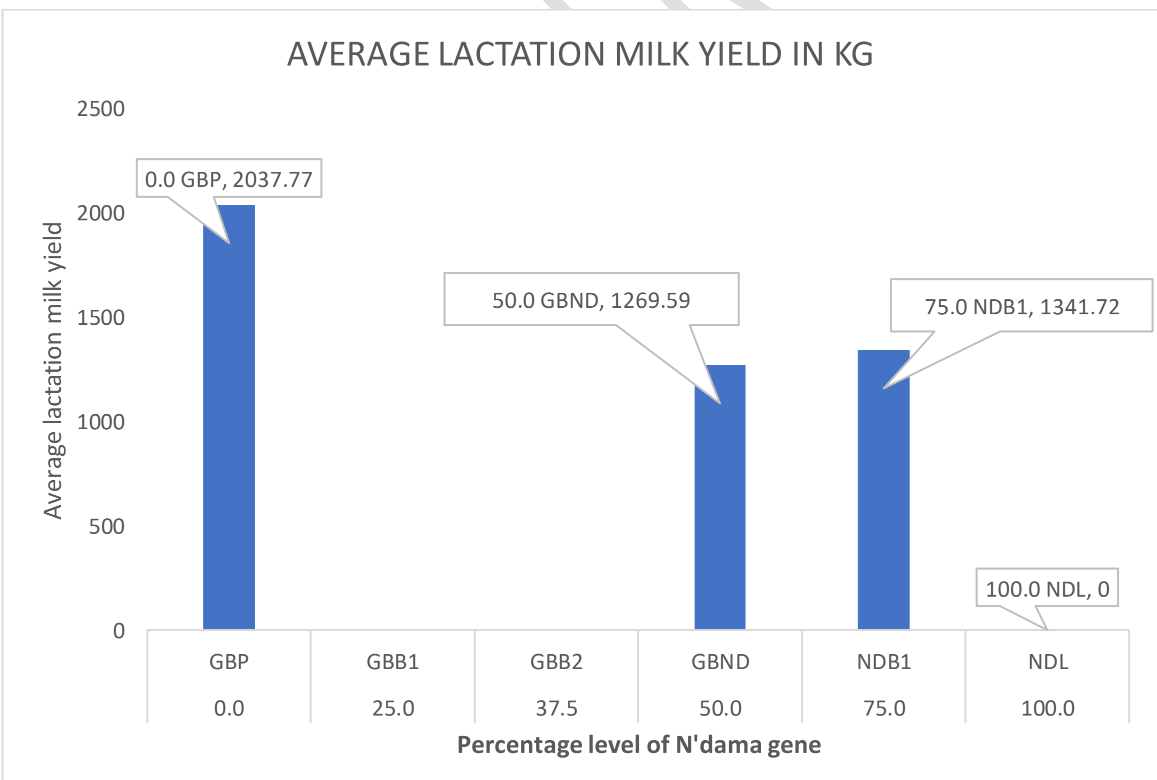

Fig. 2: Bar graph of average lactation length of the genotypes

Figs. 1 and 2 showed the highly significant (P<0.05) performance of the purebred German brown (2037.77kg) over the 75% N'dama-bred cow (1341.72kg) and 50% N'dama-bred cow (1269.59kg). However, what is instructive is that these crossbreds produced milk while the N'dama purebred was not milked at all. It brings out the crossbreeding gain by the improved performance of these crossbreds over the local N'dama cows.

Sex did not have any effect significantly (P>0.05) on milk yield. On other hand, season significantly (<0.05) affected milk yield. Cows giving birth between April – December produced milk (1701.91 – 1704.14kg) significantly (P<0.05) more than those giving birth between January – March (1245.27kg), however their milk yield did not differ significantly (P>0.05) from those delivering between November – December (1547.95kg). The effect of year was significant (P<0.05), milk produced in the early years were more than those produced in the later years. Milk production generally increased from the first parity (704.69kg) to the eight parity (2174.90kg) then declined to the tenth parity (1808.08kg).

In Table 2 below, the lactation length followed the same pattern observed for milk yield. Purebred GBP significantly (P<0.05) stayed in lactation more (339.16 days) than the crossbreds (224.78 days for NDB1 and 240.36 days for GBND) whose lactation days did not differ significantly (P>0.05). Sex did not affect lactation length significantly (P>0.05) but season, year and parity had similar pattern of effect as did in milk yield.

TABLE 2: Mean lactation length by genotypes, sex, year of birth and parity of cow

Genotype	**No**	**LSMean**	**SEM**	**Percentage level of exotic German brown gene**
GBP	139	339.16^{a}	13.13	100
GBND	43	290.36^{b}	13.50	50
NDB1	12	224.78^{c}	25.23	75
Sex				
Male	93	280.24^{a}	14.14	
Female	73	273.59^{a}	15.23	
Season				
Early dry	45	224.73^{b}	16.51	
Late dry	62	283.38^{a}	16.58	
Early rain	48	293.44^{a}	17.06	
Late rain	38	270.85^{ab}	16.38	
Year				
1970	6	468.15^{a}	40.84	
1971	8	484.82^{a}	34.03	
1972	4	362.26b^{c}	36.90	
1973	22	395.61^{ab}	24.38	
1974	16	305.03^{bcde}	23.58	
1975	13	322.58^{bcd}	24.64	
1976	19	287.36^{cdef}	21.63	
1977	27	221.04^{efgh}	19.99	
1978	24	148.11^{hi}	19.53	
1979	5	197.64^{fgh}	32.53	

1980	12	230.79^{efgh}	21.86
1981	13	194.70^{fgh}	21.79
1982	8	233.82^{defgh}	26.28
1983	9	175.90^{ghi}	25.04
1984	4	182.92^{ghi}	35.70
1985	3	182.92^{ghi}	47.42
1986	1	251.87^{defg}	64.09
Parity			
1	42	187.55^{bc}	13.78
2	38	282.63^{b}	13.66
3	36	352.63^{a}	12.98
4	27	324.74^{a}	15.18
5	24	349.27^{a}	16.63
6	12	332.92^{a}	19.46
7	7	202.90^{bc}	28.17
8	2	280.12^{b}	46.48
9	2	142.50^{c}	51.28
10	2	133.30^{c}	56.81

Within variable groups, column means with the same letter do not differ significantly (P>0.05)

Furthermore, Figs. 3 and 4 below, showed significant (P<0.05) difference between the purebred German brown and crossbred genotypes. GBP had average lactation length of 339.16 days compared to 240.36 days for GBB1 (25% Ndama-bred) and 224.78 days (75% N'dama-bred) cows. The more the days in lactation, the more the lactation milk yield.

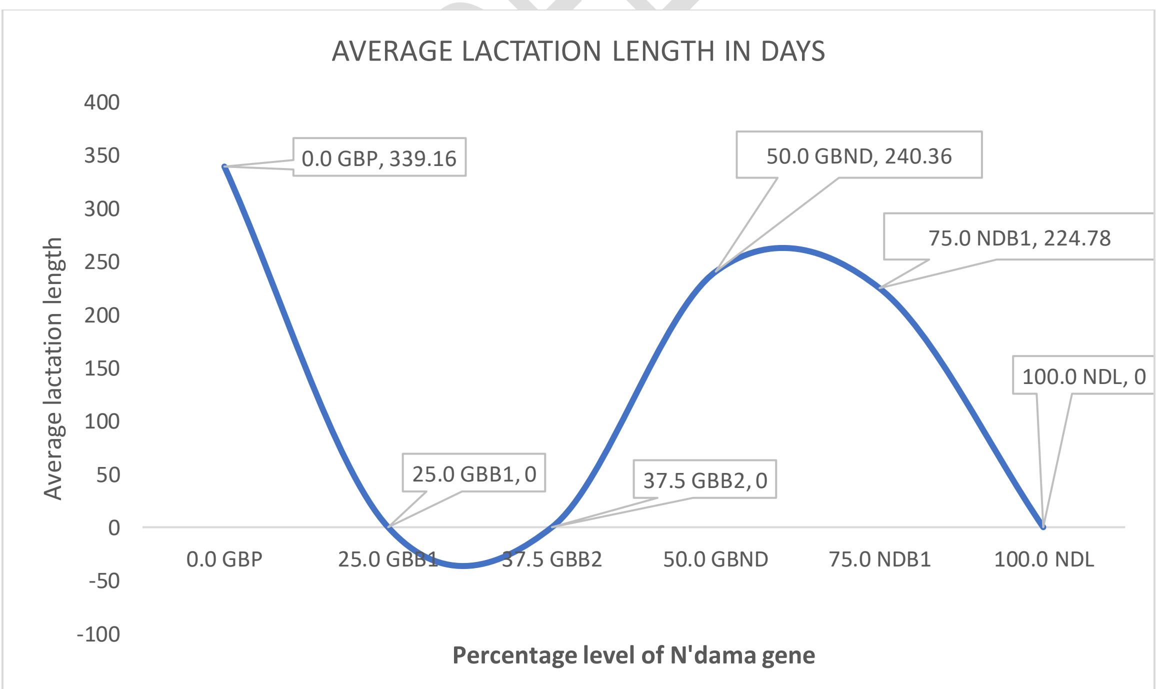

Fig. 3: Line graph of average lactation length of the genotypes

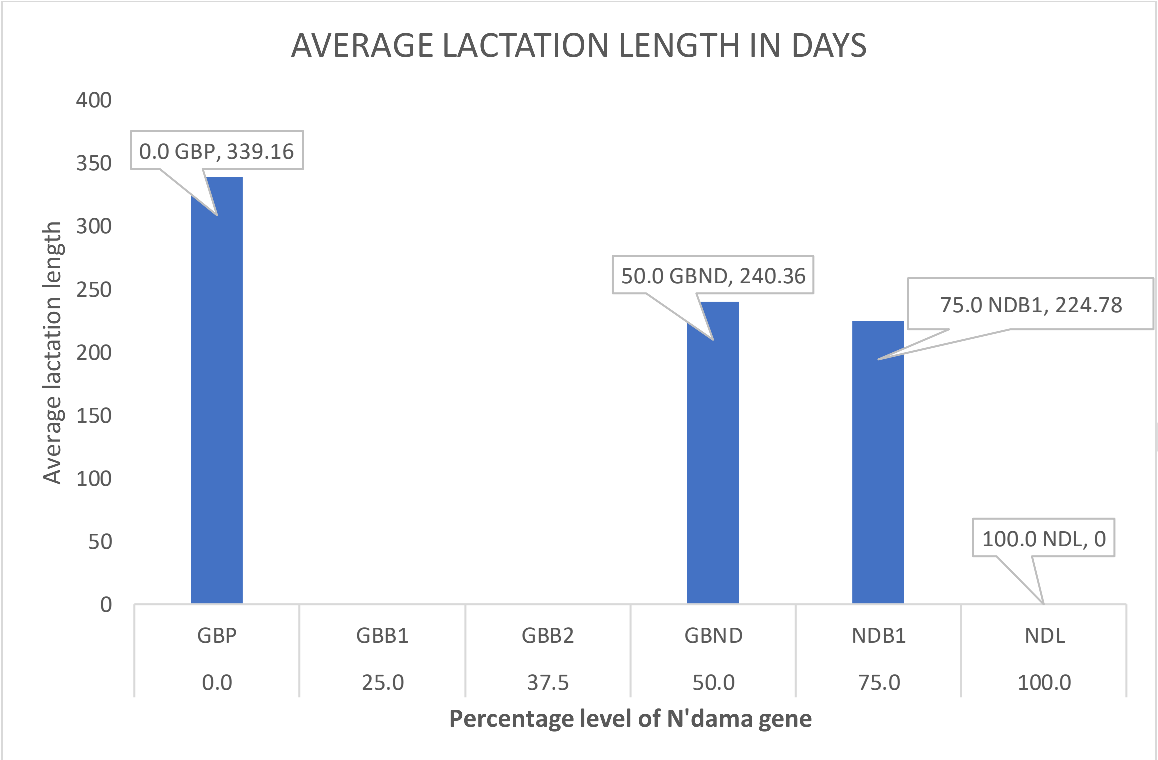

Fig. 4: Bar graph of average lactation length of the genotypes

The significant ($P<0.05$) genotypic effect on milk yield and lactation length was broken down to within genotype to see the pattern of effect in Table 3 below. It was observed that the exotic GBP was significantly ($P<0.05$) better than the crossbreds from 1st parity to the 6th parity and thereafter, from the 7th parity to the 10th parity, crossbred NDB1 was significantly ($P<0.05$) better than GBP and GBND. In fact, at the 8th, 9th and 10th parity, only the NDB1 cows lived to produce milk.

TABLE 3: Average lactation yield (kg) and length(days) by genotype

	MILK YIELD			LACTATION LENGTH		
PARITY	**GBP**	**GBND**	**NDB1**	**GBP**	**GBND**	**NDB1**
1	$1045.35^{a}\pm112$	$457.60^{b}\pm22$	$370.10^{b}\pm12$	$300.95^{a}\pm35$	$141.00^{b}\pm14$	$120.40^{b}\pm12$
2	$2504.05^{a}\pm98$	$1490.80^{b}\pm12$	$1439.90^{b}\pm15$	$388.20^{a}\pm10$	$249.55^{b}\pm19$	$210.13^{b}\pm10$
3	$3867.90^{a}\pm89$	$1716.40^{b}\pm14$	$1549.50^{b}\pm13$	$375.30^{a}\pm11$	$394.50^{a}\pm21$	$288.10^{b}\pm10$
4	$3818.25^{a}\pm45$	$1994.10^{b}\pm18$	$1692.00^{b}\pm23$	$371.80^{a}\pm13$	$391.11^{a}\pm13$	$211.30^{b}\pm12$
5	$3695.75^{a}\pm56$	$1670.10^{b}\pm23$	$1784.60^{b}\pm21$	$370.20^{a}\pm23$	$390.30^{a}\pm12$	$287.30^{b}\pm15$
6	$2506.65^{a}\pm44$	$1134.40^{c}\pm25$	$1800.20^{b}\pm26$	$381.35^{a}\pm21$	$330.10^{a}\pm17$	$287.30^{b}\pm21$
7	$698.00^{b}\pm34$	$423.70^{b}\pm12$	$1443.80^{a}\pm34$	$186.00^{b}\pm11$	$136.00^{b}\pm23$	$286.70^{a}\pm20$
8			1606.40 ± 35			280.12 ± 23

9	1032.60±42	142.50±14
10	697.00±44	133.3±23

Row means in the same subset with the same letter do not differ significantly (P>0.05)
± = Standard error

To make it clearer, the milk yield was analyzed on the basis of daily milk production shown in Table 4 below. In the 1st lactation, the GBND produced significantly (P<0.05) more milk (8.72kg) than the GBP (5.90kg) which in turn produced more milk than the NDB1 (0.91kg). However, from the 2nd lactation to the 6th lactation, the GBP produced significantly (P<0.05) more milk than the GBND crossbred on daily basis, while producing significantly (P<0.05) more than NDB1 at the 3rd, 4th and 5th parities. By the 7th lactation, the daily milk production did not differ significantly (P>0.05) between the genotypes.

TABLE 4: Average lactation yield (kg) per day by genotype

LACTATION NUMBER	GBP	GBND	NDB1
1	3.47±0.12	3.24±0.15	3.07±0.05
2	6.45±0.23	5.97±0.13	6.85±0.21
3	10.31^{a}±0.01	4.35^{b}±0.11	5.38^{b}±0.12
4	10.27^{a}±0.14	5.10^{c}±0.24	8.01^{b}±0.32
5	9.98^{a}±0.21	4.28^{c}±0.15	6.21^{b}±0.13
6	6.57^{a}±0.25	3.44^{b}±0.17	6.27^{a}±0.44
7	3.75^{b}±0.02	3.12^{b}±0.16	5.04^{a}±0.13
8			5.73±0.26
9			7.24±0.17
10			5.23±0.18
Average Daily Yield	7.26^{a}±0.05	4.21^{b}±0.11	5.90^{b}±0.06

Row means with the same letter do not differ significantly (P>0.05) ± = Standard error

Instructively, from Table 4, the average daily milk yield from the 1st to 6th lactation differed significantly (P<0.05) between GBP (7.26kg) and the crossbreds (NDB1 5.90kg and GBND 4.21kg). From the 7th lactation crossbred NDB1 produced significantly (P<0.05) more milk on daily basis than purebred GBP (3.75kg) and crossbred GBND (3.12kg). However, from the 8th - 10th lactation only crossbred NDB1 survived to produce milk.

DISCUSSION

Milk Production

The 75% N'dama inheritance (NDB1) showed remarkable improvement in milk yield compared to purebred N'dama (NDL) which is known to be a beef cattle and other crossbreds like GBB2 (37.5% N'dama inheritance) and GBB1 (25% N'dama inheritance). These latter crossbred genotypes did not have adequate data to be included in the analysis. The 50% N'dama inheritance (GBND) producing on the average 1269.59kg milk per lactation compared favorably with the 75% N'dama inheritance (NDB1) which produced 1341.72kg. They however, produced significantly (P<0.05) less than the purebred GBP (2037.77kg). It would seem that milk production among the crossbreds increased with increased N'dama inheritance. This finding supports earlier works of Letenneur (1983) and Reaves *et al.*, (1985) that crosses from exotic x local cattle perform better than their indigenous parents, in this case, the N'dama local breed. Galukande *et al.* (2013) found that crossbreeding significantly increased milk production in tropical dairy cattle, with the 50% *Bos taurus* crossbreds performing optimally**.** However, the success of this approach is highly dependent on sufficient management and infrastructure.

When the comparison was on the basis of daily milk produced, GBP significantly (P<0.05) produced higher than the crossbreds while the performances of the crossbreds did not differ significantly (P<0.05). It implied that the exotic GBP was more persistent than the crossbred NDB1 and GBND in daily milk production for longer lactation length. In other words, an increased lactation length for NDB1 would have made its milk yield per lactation equal the performance of the exotic GBP. However, the 2037.77kg milk produced per lactation for the GBP falls short of its production in the temperate region. This McDowell *et al* (1976) and McDowell (1985) reported that the European breeds exhibit lower milk production when imported into the tropics due to the effect of harsh tropical weather (Williamson and Payne 1978).

The significant year effect agrees with the works of Mačuhová *et al.*, (2023) and Mellado *et al.*, (2011). The observed trend of more milk yield in the early years than the later years could be attributed to change in management resulting to feeding challenges and herd environment like climatic conditions as Mačuhová *et al.*, (2023) observed that changes in the climatic environment of the herd could lead to lowered performance.

The seasonal effect observed showed higher milk produced during the rainy season (April-September) compared to the dry seasons (October-March). This implied that cows giving birth by early rains had access to the resurging pasture to aid the physiological development of the mammary glands as well maintain good health for care of the young. This is in partial agreement to the works of Habibi *et al.*, (2021) and Susanto *et al.*, (2019) who reported that the most favorable periods of calving for high milk production were the later fall-winter months, which includes November and December. They further reported that the seasonality of lactation yield is more nutritional than meteorological. Cows calving in early dry season had significantly (P<0.05) shorter mean lactation length compared to cows calving in late dry season and early rainy season, but not significantly (P>0.05) different from cows calving in late rainy season. This differences in mean lactation length between seasons may be in response to availability of lush pasture prior to conception; while early rainy season and late rainy season calvers will be ready for mating in the dry season, the early dry season calvers will be ready for mating in the early and late rainy seasons, thus having a greater chance of feeding on lush pasture. This may have been responsible for the shorter lactation lengths observed for the dry season calvers as compared to the rainy season calvers.

There was a significant (P<0.05) difference in mean lactation yield between parities in line with literatures (Vijayakumar *et al.*, 2017; Habibi *et al.*, 2021; Donald 2023; Begna 2023). The increase was up to the 4th & 5th parities before decreasing which was in partial agreement to the above literatures (Vijayakumar *et al.*, 2017; Habibi *et al.* 2023 Begna 2023). Vijayakumar *et al.*, (2017) and Begna (2023) reported that the increase was to the 3rd parity while Donald. (2021) reported the increase to be to the 2nd parity. This increase with age of cow, they attributed to mammary gland development as the cow matures. However, Gurmessa and Melaku (2012) reported non-significant (P>0.05) effect of parity on milk yield. Furthermore, milk yield decreased for the exotic GBP from the 1st to the 5h lactation number while for the crossbreds, GBND milk yield increased from the 1st to the 4th lactation and then declined. For crossbred NDB1 milk yield increased from the 1st to the 6th and then declined. It followed that between the genotypes there was no trend regarding the trend of increase or decrease. However, the trend observed agrees with the work of Galukande *et al.,* (1962) who reported that milk yield increased from the 1st to the 5th lactation number before declining.

Lactation Length

Crossbreds GBND and NDB1 were 48.8 and 114.38 days shorter in mean lactation length from their exotic parent. McDowell (1972) stated that the average lactation length for most tropical indigenous cows was 50-100 days shorter than for the European breeds. The finding from this study, showed similarity to the finding of McDowell (1972). Instructively, that the N'dama cows were not milked at all meant that there was a remarkable improvement in lactation through crossbreeding. Sohael (1984), Wilkins (1984) and Alba and Kennedy (1985) reported increases in lactation length of crosses over their indigenous parents but lower than their exotic parents which agrees with the present study. However, it is contrary to the work of Letenneur (1983) who reported increase in lactation length from ½ - bred to ¾ - bred Jersey inheritance.

Lactation Yield and Length

It would be observed that higher mean milk yields were recorded in lactation periods with the longest lactation length and lower mean milk yields were at shortest milking days. This supports the reports by Alkoyak and Öz (2020), Kramarenko *et al.,* (2025) and Syrstad (2025) that high positive correlation values were obtained between lactation yield and lactation length. To this extent, the average daily milk yield in this study shows persistency with days in milk.

The current study revealed the benefit impacted through crossbreeding on the performance of crossbreds (50%- and 75%- local blood inheritance) from German brown x N'dama crossing. Galukande *et al.* (2013) found that crossbreeding significantly increased milk production in tropical dairy cattle, with the 50% *Bos taurus* crossbreds performing optimally**.** However, they suggested that the success of the programme was highly dependent on sufficient management and infrastructure. In their study, at 50% Bos taurus blood, lactation milk yields were 2.6, 2.4 and 2.2 times higher than those of local cattle in the Highland, Tropical Wet and Dry, and Semi-Arid climatic zones, respectively; lactation lengths increased by 1.2, 1.2 and 1.9 months in the above-mentioned climatic zones, respectively. In recent years, Osei-Amponsah *et al.,* (2020) reported that crossbreeding indigenous tropical cattle with exotic breeds like Holsteins improves milk production by leveraging heterosis (hybrid vigor)**,** resulting in higher yields. Crossbred cows, particularly those with up to 50% *Bos taurus* genes, show significantly higher milk yields compared to indigenous breeds. These literatures support the current study revealing that the 50%- and 75% N'dama-bred significantly ($P<0.05$) produced more milk than the indigenous N'dama cow which was not milked at all. It was evident that the performance of the crossbreds was influenced by the dominance effect of genes which is interpreted as hybrid vigor (Essien 2003). In addition, the high performance of the 75% N'dama-bred could be explained on the principle of additive gene effect (Essien 2003). The implication therefore was that the milk yield trait of the 50%- and 75% N'dama-bred crossbreds was influenced both by additive and heterotic effects for optimal performance.

CONCLUSION

In summary, the exercise successfully demonstrated that crossbreeding is a viable strategy to improve milk production in the N'dama population, provided that appropriate management is in place to support the higher-producing animals. Hence it is concluded that the genetic improvement through crossbreeding significantly enhanced milk production potential under the Ibadan environment and typical semi-intensive management conditions. Specifically:

- Genetic Superiority: The 50% and 75% N'dama crossbreds (meaning 50% and 25% German Brown blood) clearly possessed a superior genetic capacity for milk production compared to the purebred local N'dama cattle. This demonstrates the value of introducing genes from European dairy breed.
- Management Matters: The fact that the local N'dama was "not milked at all" highlights a critical difference in management practices. The crossbreds were managed allowing for milking and recording production, which was to ascertain their genetic potential. The local N'dama, under the management, showed no *measured* milk yield, emphasizing that both genetics and management are essential for dairy performance.
- Optimal Crossbreeding Level: The superior performance of the crossbreds over the local N'dama indicates that a specific level of introgression (introduction of new genes) was effective. The 50%- and 75% N'dama-bred animals performed well, suggesting that these particular genetic blend might be well-suited to the local environment while still expressing high milk yield traits.

RECOMMENDATIONS

The following are recommended:

- For Commercial Milk Production: Focus on maintaining a breeding scheme that targets intermediate exotic blood levels (around 50-75% N'dama blood), as these animals demonstrate a strong productive advantage in milk off-take under managed conditions. These systems should have:

- Adequate supplementary feeding (concentrates, improved forage) to support higher milk yield.

- Avoid Indiscriminate Crossbreeding: Implement a well-planned, structured breeding program to avoid random crosses which can lead to unpredictable and potentially poor performance in later generations due to genetic segregation and lack of stabilization.

DISCLAIMER (ARTIFICIAL INTELLIGENCE)

Author(s) hereby declares that NO generative AI technologies such as Large Language Models (ChatGPT, COPILOT, etc) and text-to-image generators have been used during writing or editing of this manuscript.

COMPETING INTERESTS

Author has declared that no competing interests exist.

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