N'Dama cattle productivity at Teko Livestock Station, Sierra Leone and initial results from crossbreeding with Sahiwal

S.F. Carew[1], J. Sandford[2], Y.J. Wissocq[2], J. Durkin[3] and J.C.M. Trail[2]
[1]Ministry of Natural Resources, Sierra Leone
[2]Livestock Productivity and Trypanotolerance Group,
ILCA, P.O.Box 46847, Nairobi, Kenya
[3]Computer Unit, ILCA, P.O.Box 5689, Addis Ababa, Ethiopia

Summary

ANALYSES WERE *carried out on the productivities of N'Dama cattle, introduced Sahiwal cattle, and Sahiwal x N'Dama crossbreds at the Teko Livestock Station, Sierra Leone. Data were available for a range of performance traits for the period 1971 to April 1980. All cattle were maintained for meat production. Environmental and genetic effects relating to breed group, month and year of parturition or birth, age, sex, individual cow, etc., were evaluated as appropriate for each performance trait.*

In N'Dama cattle, age at first calving was 46.5 months, calving interval was 17.9 months and cow productive life was 7.4 years in the breeding herd, 11.3 years in total. Calf mortality rates were 2.0% perinatal, 6.4% from birth to weaning at 9 months and 1.5% per 6 months thereafter. The breeding cow mortality rate was effectively zero, and the average generation interval was 7.6 years. Calf growth rate was 194 g per day from birth to 6 months of age and 146 g per day from birth to 18 months of age. Mean cow body weight was 208 kg. The characters of reproductive performance, cow and calf viability, and cow and calf body weights, were combined to build three productivity indices. The overall herd productivity was 35.0 kg of 6-month old calf per cow per year; 19.7 kg of 6-month old calf per 100 kg of cow body weight per year; and 80 kg of 6-month old calf per 100 kg cow metabolic body weight per year.

Herd productivities of N'Dama cows with Sahiwal-sired calves were 10% higher than those with N'Dama-sired calves, mainly due to the 30% faster growth of Sahiwal-sired calves. In spite of very preferential management and health treatment the herd productivity of pure Sahiwals was 3% lower per 100 kg of cow body weight per year and only 12% higher per 100 kg of cow metabolic weight per year than N'Damas with Sahiwal-cross calves. There would appear to be little future for purebred Sahiwals in this environment.

Introduction

There are over 334 000 cattle in Sierra Leone, all of the N'Dama breed. More than 80% of the national herd are found in Northern Province where the Teko Livestock Station is located and where production information has been recorded since the early 1970s. In 1974, 25 Sahiwal cattle were imported from Kenya and crossbreeding work started between the N'Dama and Sahiwals.

In 1982/83, the International Livestock Centre for Africa (ILCA) provided a scholarship for a research scientist from the Ministry of Natural Resources, Sierra Leone, to spend 5 months extracting, analysing and interpreting the data available in collaboration with the ILCA Breed

Productivity and Trypanotolerance Group in Nairobi. This report presents an analysis of the productivity data collected between 1974 and 1980.

The Teko Veterinary Research Station was established in the late 1940s. From then until the late 1960s, research was carried out on disease control in cattle. This consisted of identifying prevalent diseases such as rinderpest, black quarter, contagious bovine pleuropneumonia and anthrax, and, where possible, producing vaccines against them. In the early 1970s, interest grew in the breeding and selection of cattle for increased beef production. In 1974 Sahiwal cattle were introduced and a crossbreeding programme was started with Sahiwal being used on N'Dama cattle, with the aim of increasing the productivity of cattle. Data were collected on reproductive performance, mortality and growth, adaptation to environmental stress and resistance to disease.

Teko livestock station

Environment

The station covers approximately 800 hectares and is situated at an altitude of about 500 m, latitude 8° 50' N, longitude 12° 00' W. It lies 3 miles southeast of Makeni in the Bombali district of the Northern Province of Sierra Leone. The station is basically flat but has a number of streams and swamp areas.

There are two distinct seasons: the dry season lasts from November to April, and the wet season from May to October. The heaviest rain falls between July and September. Table 1 shows monthly rainfall (mm) from 1971 to 1979. The widest daily temperature variation occurs from December to March during the dry season, when both the lowest and the highest temperatures of the year are recorded. The relative humidity is highest from May to October, during the wet season.

Table 1. *Monthly rainfall at Teko Livestock Station, 1971–1979*.

	Monthly rainfall (mm)									Monthly average
	1971	1972	1973	1974	1975	1976	1977	1978	1979	
January	–	–	–	–	–	–	–	9	33	5
February	11	–	–	–	–	10	–	97	–	32
March	4	46	6	28	–	3	4	11	–	11
April	266	97	52	81	105	139	48	153	6	101
May	171	223	289	125	259	147	207	279	235	215
June	229	597	301	332	343	598	471	377	435	409
July	230	545	370	509	573	387	532	475	768	488
August	832	720	635	426	589	318	481	848	545	599
September	569	361	432	455	429	585	752	591	509	520
October	339	480	502	466	449	532	425	442	570	467
November	222	3	194	163	57	208	37	129	203	135
December	61	–	4	–	34	27	3	1	37	19

Annual total	2894	3072	2785	2585	2838	2954	2960	3412	3341	3001

Vegetation consists mainly of bush savanna with trees along the riverbanks. There is plenty of growth during the wet season but during the dry season vegetation becomes fairly sparse. Common grasses include *Chosmopodium* spp., Guinea grass and Pueraria grass. The main source of forage is natural pasture, but in the dry season both quality and quantity are limiting. No improved pastures have been planted. Some maize and sorghum are grown to provide supplementary feed through the dry period but quantities are small. The main supplementary concentrate feed is rice bran. Brewers grains from breweries in Freetown and wheat mill cake and palm-kernel cake from the palm kernel industry have sometimes been fed to the cattle but these are expensive. Cattle are routinely vaccinated against anthrax, black quarter, contagious bovine pleuropneumonia and haemorrhagic septicaemia. Regular blood and faecal examinations are made to identify internal parasites and control measures are carried out. The animals are treated with acaricides to control external parasites. The acaricides are changed regularly to prevent possible build-up of resistance by ticks.

Herd management

Prior to 1974, there was only one herd of N'Damas on the station. Cattle were exchanged or transferred between this herd and herds at the Musaia and Newton livestock stations and at the University farm at Njala. From 1970 to 1980 the number of animals in the herd fluctuated between 120 and 300 due to the issue of cattle on loan to farmers through the extension services.

In October 1974, 25 Sahiwal cattle, comprising 20 heifers and 5 bulls, were introduced from Kenya. A crossbreeding programme was set up to attempt to improve the productivity of the indigenous N'Dama and three herds were formed; herd I consisting of pure-breeding Sahiwals; herd II consisting of N'Damas mated to Sahiwal bulls; herd III consisting of pure-breeding N'Damas.

In all three herds a single bull is used at a time. Cows are pregnancy tested about 60 days after service and, if pregnant, are moved into in-calf herds. After calving, cows are put into dam/calf herds until the calves are weaned. At weaning (6 months in herds I and II, 8–9 months in herd III) the dams are returned to the main herd. After weaning the management system differs slightly in each herd group. In herd I, weaners (heifers and bulls) are kept together until they are 20–24 months old. After selection the best 1 or 2 bulls and all the heifers are kept, the heifers being served at about 24 months old, when they are put into the main herd I. The remaining bulls are used in the extension services. In herd II, weaners (heifers and bulls) are kept together until they are 18 months old. Most of the crossbreds are then used by the extension services. Only a few heifers are kept and served at 22–24 months when they are put into main herd II. Bull calves are castrated only in herd III. At weaning in herd 111, bulls and heifers are put into separate weaning groups. The best 1 or 2 bulls are kept for breeding on the station. Other bulls are used in extension services. The remaining male weaners are castrated at about 9 months old and are either used as draught oxen or fattened for slaughter. The heifers are selected and the best kept and served at 30–36 months old. The remainder go to the Musaia and Newton Livestock stations or are culled. In all herds, selection is carried out on growth and conformation. In herd III the culling age is 10–12 years and in all herds cows are culled on poor performance or health.

The original foundation Sahiwal herd (20 heifers and 5 bulls) was purchased in Kenya and airfreighted to Sierra Leone in October 1974. As considerable expense had been involved it was decided that the pure Sahiwals should get preferential treatment in order to minimise losses and maximise expansion of the herd. The pure Sahiwals were regularly given prophylactic treatment for trypanosomiasis, drenched against intestinal parasites and sprayed for tick control. They were given the best grazing on the station and also received regular supplementary feeding (rice bran, brewers grains), not available to the N'Damas. The performance of the pure Sahiwals therefore cannot be compared directly with that of the pure N'Damas and Sahiwal x N'Dama crosses.

Daily activities, identities of sick animals, mortalities, abortions, post-mortem results, treatments, vaccinations and routine anthelminthic treatments are all recorded. Calving dates are noted and all calves are given their dam's number until weaning. The calf sex and birth weight, and dam and sire breed and numbers are recorded. All animals are weighed monthly except calves which are weighed twice a month until 3 months of age. Rainfall, temperature and relative humidity are recorded.

Data preparation and analysis

Individual records were built up for each cow for each parturition. These gave identification number, date of birth and breed of the cow, the current parturition date, previous parturition date, sex of calf, sire of calf, perinatal and pre-weaning viability of calf, and calf weight at birth and 3, 6 and 9 months after parturition. From these data the age at first calving, calving interval, cow mean weight and three productivity indices were computed. Disposal or death of the cow was recorded. All available causes of death were obtained from periodic reports and treatment sheets.

Based on the rainfall records from 1971 to 1979, the months of the year were grouped into four subseasons; the first and second parts of the dry season and the first and second parts of the wet season:

Months	Season	Average rainfall (mm) per month
Nov–Jan	First part of dry	53
Feb–Apr	Second part of dry	48
May–Jul	First part of wet	371
Aug–Oct	Second part of wet	529

All characters were analysed by least-squares procedures (Harvey, 1977) using both fixed and mixed models. In the analysis, some parameters were measured for further study in their own right and some were measured to account for variation arising, in order that less biased estimates of other parameters could be obtained. Unequal and disproportionate subclass numbers gave unbalanced factorial designs for which conventional analysis of variance techniques were not applicable.

A considerable number of the foundation animals had no sire or dam records. In addition, the use of individual sires was often confounded with season and year of use, so use could not be made of sire group in analyses at this time. Typical models used included the fixed effects of breed type; age at parturition; year of birth or parturition; season of birth or parturition; sex of

calf; and the random effects of individual cow. The specific factors included in the model used will be evident when results are presented for each character analysed.

The residual mean square was used as the error term to test the significance of all differences evaluated. Linear contrasts of least-squares means were computed to determine the significance of differences between groups for all characters where the difference among groups was significant in the analysis of variance. More comparisons were made using the least-squares means than there are independent degrees of freedom for the characters where the group differences were significant in the analysis of variance. Therefore, not all of the comparisons are independent and the error rate over the entire set of comparisons may be different from that indicated by the level of probability. Tests of significance associated with the linear contrasts, although not independent, can be taken as guides as to whether the observed values could have occurred by chance. Repeatabilities were calculated using the variance components between and within cows.

Reproductive performance

Reproductive performance is the most important trait in beef cattle enterprises, since if there is no calf, there is no economic return. Clearly, the best cows are those that have their first calf at an early age, have minimum calving intervals and live a long time. Thus, the most important measures of reproductive performance in the females are age at first calving, length of calving interval and length of the productive life of the cow.

Age at first calving

The mean age at first calving for 79 females born between 1966 and 1976 was 43.1± 0.6 months, a coefficient of variation of 7%.

Among the factors studied, only breed of the cow had a significant effect on age at first calving (Table 2).

Table 2. *Analysis of variance of age at first calving*.

Source	d.f.	Mean squares x 10
Cow breed	2	5115**
Season	3	5
Year of birth	10	132
Remainder	63	114

** = P <0.01

The estimated least-squares means show that age at first calving was 46.5 ± 0.7 months for the N'Dama, 37.7± 1.2 months for the Sahiwal and 32.4 ± 2.1 months for the 4 Sahiwal x N'Dama crossbreds. The 46.5 months for the N'Damas is 18% longer than the 39.4 months reported by Touchberry (1967) for N'Dama cattle at Musaia Animal Husbandry Station.

Calving interval

The mean calving interval for 140 records between 1971 and 1978 was 515 ± 11 days, a coefficient of variation of 24%. Only season of calving had a significant effect on calving interval (Table 3), although the effect of cow age approached significance.

Table 3. *Analysis of variance of calving interval.*

Source	d.f.	Mean squares x 10^{-2}
Breed	1	111
Season of calving	3	655**
Year of calving	7	71
Age	4	309
Remainder	124	146

** = P<0.01

Cows that calved at the end of the dry season (February to April) had significantly longer subsequent calving intervals than all others (83 days or 15% longer than average). This was probably due partly to cows calving at this period being 6% lighter at parturition than those that calved during all other periods (see Table 10). The effect of age approached significance, with subsequent calving intervals of cows calving at 3 years of age (actual mean 36.6 months) being 117 days or 23% longer than the average of all later ages. The mean calving interval for the N'Dama breed was 545 days, which is 16% longer than the 467 days reported by Touchberry (1967) at Musaia Animal Husbandry Station.

The distribution of 140 conceptions calculated from the recorded calving dates between 1971 and 1978 showed that 69% of conceptions occurred during the 6-month dry season (November to April). Touchberry (1967) reported that 67% of N'Dama cows at Musaia Animal Husbandry Station calved between September and February, the corresponding figure from Teko of 70% showing close agreement.

Length of productive life of N'Dama cows

As the oldest records are for cows born in 1966, it is rather early to assess this trait completely. However, in 1981 the average age of the first 26 cows born between 1966 and 1970 was 11.3. years, and 70% were still in production. The remaining 30% had either died or been culled. Thus, until more information is available, it is tentatively suggested that N'Dama cows have an average productive life of at least 7.4 years (11.3–3.9). Using the mean calving interval of 545 days, cows would thus have an average of 5 parturitions in the herd. This complete replacement of the cow herd each 7.4 years would represent a turnover of 13.5% per annum.

Mortality

Mortality data were based on 248 calves born over a 9-year period, and included perinatal deaths. The significance of environmental influences on perinatal mortality, preweaning

mortality and the two together are indicated in Table 4. The sex of calves that died perinatally was not recorded.

Table 4. *Analysis of variance of calf mortality*.

Source	Perinatal mortality		Preweaning mortality		Perinatal and preweaning mortality	
	d.f.	MS x 10^3	d.f.	MS x 10^3	d.f.	MS x 10^3
Breed	2	54	2	571**	2	678**
Season of birth	3	44	3	144	3	232
Year of birth	8	75	8	42	8	98
Age of dam	4	38	4	231*	4	399
Sex	–	–	1	5	–	–
Remainder	230	52	215	85	230	119

* = P<0.05 ** = P<0.01

Perinatal mortality. The mean perinatal mortality was 5.6 ± 1.4%, a coefficient of variation of 24%. There were no significant environmental or genetic effects.

Preweaning mortality. The mean mortality from birth to 6 months of age was 9.8 ± 3.2%, a coefficient of variation of 32%. Breed and age of dam had significant effects on preweaning mortality. Pure Sahiwal calves had very much higher mortality (25.5%) than both N'Dama and Sahiwal x N'Dama calves, which averaged 2.7%. Calves from younger cows had lower mortality rates than those from older cows.

Perinatal and preweaning mortality. The total perinatal and preweaning mortality was 14.9 ± 6.0%, a coefficient of variation of 40%. Breed and age of dam had significant effects on total mortality. Pure Sahiwal calves had much higher mortality (30.2%) than both N'Dama and Sahiwal x N'Dama calves, which averaged 6.7%. Calves from younger cows had lower mortality rates than those from older cows.

Post-weaning mortality. The mean mortality of N'Dama calves from 6 months to 12 months of age was 1.5%.

Mortality rates in relation to genetic improvement of N'Damas

An appropriate definition of mortality rate in the context of genetic progress is the percentage of females that die before calving. Applying the post-weaning mortality rate of 1.5% per 6 months to the period to first calving gives a total mortality of 17.4% {8.1 + (1.5 x 6.2)}. The rearing proportion is the proportion of births that produce a heifer that survives and is fertile. The rearing proportion here is about 0.41. This means that once in 2.5 calving a cow produces a heifer calf that will reach lactation in the herd. The average length of reproductive life is 5 calving: therefore, approximately 50% of the females born are required as replacements to maintain herd size. High mortality rates slow down genetic progress; if they can be reduced, a higher intensity of selection can be applied.

Genetic improvement per unit of time is more important than per cow generation, and high mortality rates have a marked effect on generation interval. The average age at first calving of N'Dama cows was 46.5 months, and the average calving interval 17.9 months. To replace herself, a cow calves 2.5 times: thus, the average generation interval is 91.2 months or 7.6 years.

Cow mortality

The mean annual cow mortality for 248 cow records from 1971 to 1979 was 3.2 ± 0.6%, a coefficient of variation of 17%.

Only breed had a significant effect on cow mortality (Table 5). While virtually no deaths were recorded among pure N'Dama cows, pure Sahiwals had 16.6 % mortality per year. A mixed infection of demodectic mange and streptothricosis was the main factor involved.

Table 5. *Analysis of variance of cow mortality*.

Source	d.f.	Mean squares x 10^3
Breed	1	793**
Season of calving	3	47
Year of calving	8	37
Age	4	9
Remainder	231	28

** = P<0.01

Body weights

Environmental and genetic effects on calf weights

Weights at birth and at 3 and 6 months of age were available for 180 calves; at 6, 9 and 12 months of age for 145 calves; and at 12, 15 and 18 months of age for 110 calves, born in the years 1974–1979, 1974–1979 and 1974–1978, respectively. Analyses of variance laid out in Table 6 show the significance of effects on calf weight at these different stages. The estimated least squares means for body weight at the different stages are shown in Table 7

Table 6. *Analysis of variance of weights at different ages*.

Source		Mean squares				Mean squares				Mean squares		
	d.f.	Birth	3 mo.	6 mo.	d.f.	6 mo.	9 Mo.	12 mo.	d.f.	12 mo.	15 mo.	18 mo.
Breed	2	95**	6539**	20147**	2	17075**	28920**	42211**	2	39769**	59288**	81368**
Season of birth	3	2	7	462	3	428	613	1176*	3	590	1002	490

Year of birth	5	8	173*	138	5	139	275	341	4	503	1957**	2734**
Age of dam	4	8	61	140	4	138	220	420	4	667	864	824
Sex	1	76**	6	14	1	22	13	1	1	12	1391	1800
Remainder	164	9	75	175	129	167	316	389	95	361	512	612

*= P<0.05
** = P<0.01

Table 7. *Estimated least squares of weights at different ages*.

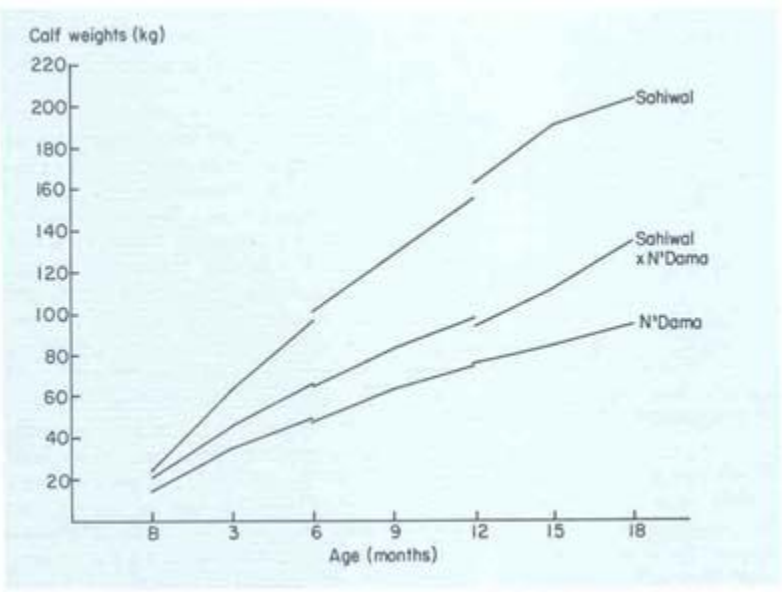
Variable	No.	Estimated l.s.m.[a] (kg)			No.	Estimated 1. s. m. (kg).			No.	Estimated 1. s. m. (kg).		
		Birth	3 mo.	6 mo.		6 mo	9 Mo	12 mo		12 mo	15 mo	18 mo
Overall mean	180	20.3	47.8	71.4	145	71.4	92.0	109.9	110	111.6	129.4	149.3
Breed												
N'Dama	84	14.9a	35.3a	49.9a	69	49.2a	63.0a	75.5 a	55	76.3a	84.5 a	94.4a
Sahiwal	34	23.8b	62.5b	97.9b	28	100.4b	129.6b	152.2b	23	163.9b	191.36	218.8b
Sahiwal x N'Dama	62	22.0c	45.8c	66.4c	48	64.7c	83.5c	98.0c	32	94.5c	112.6c	134.7c
Season of birth												
November–January	74	20.2	47.9	76.3	58	76.6	97.4	118.3b	34	118.9	129.8	148.4
February–April	42	20.0	48.5	71.5	38	73.1	96.7	106.4a	31	110.8	130.6	153.7
May–July	15	20.7	47.5	68.6	12	67.8	82.6	102.9a	11	103.8	119.0	141.5
August–October	49	20.0	47.4	69.2	37	68.2	91.3	111.8ab	34	112.6	138.3	153.5
Year of calving												
1974	13	19.8	44.9ab	69.1	9	71.4	97.1	118.4	9	118.3	146.0a	165.6a
1975	32	19.9	44.1a	68.0	27	67.3	86.5	109.2	22	106.3	123.5ab	145.6ab
1976	26	19.8	46.6ab	73.1	23	74.0	96.0	114.0	23	115.8	136.8a	160.9a
1977	28	21.4	50.7b	73.7	26	74.9	93.0	110.1	26	112.1	125.9ab	140.6b
1978	54	20.2	50.66	70.5	52	71.4	93.1	108.4	30	105.2	114.96	133.8b
1979	27	20.4	50.1b	74.0	8	69.5	86.3	99.2	–	–	–	–
Age of dam												
3 years	18	19.7	44.9	66.2	15	66.4	84.9	98.9	13	98.2	114.2	133.2
4 years	37	19.7	47.4	71.1	31	70.1	91.1	109.8	26	111.3	128.2	150.1
5–6 years	46	20.8	49.0	72.2	40	73.4	95.1	112.2	28	110.9	129.7	150.0
7–8 years	42	20.7	49.7	73.8	31	74.4	94.0	113.1	20	119.9	136.2	154.9
9 + years	37	20.5	48.2	73.6	28	72.9	94.9	115.3	23	117.5	138.9	158.3
Sex												
Male	101	20.9a	47.6	71.1	78	71.0	91.7	109.8	56	111.9	133.1	153.5
Female	79	19.6b	48.0	71.7	67	71.8	92.3	110.0	54	111.2	125.7	145.1

Within variable groups, row means followed by the same letter do not differ significantly (P<0.05). No letter indicates variable group did not show a significant difference in the analysis of variance
[a]Least squares mean.

The mean weights of all calves at birth, 3, 6, 9, 12, 15 and 18 months of age were 20.3, 47.8, 71.4, 92.0, 109.9, 129.4 and 149.3 kg, respectively, with corresponding coefficients of variation 16, 19, 20, 21, 19, 20 and 19%.

Effect of breed. Breed had a highly significant effect on calf weight at all stages from birth to 18 months of age (Table 6). Sahiwal x N'Dama calves were heavier than N'Dama calves by 7.1 kg (47%) at birth, 10.5 kg (30%) at 3 months old, 16.5 kg (33%) at 6 months old, 20.5 kg (32%) at 9 months old, 22.5 kg (30%) at 12 months old, 28.1 kg (33%) at 15 months old and 40.3 kg (42%) at 18 months old. Similarly, Sahiwal calves were heavier than N'Dama calves by 8.9 kg (60%) at birth, 27.2 kg (77%) at 3 months old, 48.0 kg (96%) at 6 months old, 66.6 kg (105%) at 9 months old, 76.7 kg (101%) at 12 months old, 106.8 kg (126%) at 15 months old and 124.4 kg (131%) at 18 months old. The mean growth of all three breeds from birth to 18 months of age is illustrated in Figure 1.

Figure 1. *Mean body weights from birth to 18 months of age for Sahiwal x N'Dama and Sahiwal calves.*



Effect of season of birth. Season of birth had a significant effect on calf weight at 12 months of age only (Table 6). The effects of season of birth on later body weights are usually related to the stage in the wet and dry weather cycle at which an animal reaches a given age: and relative rankings of season of birth groups might be expected to change from stage to stage.

Effect of year of birth. Year of birth had a significant effect on body weight of animals at 3, 15 and 18 months of age (Table 6). The weight differences between extreme years at the three stages were 14%, 24% and 21%, respectively, of the mean weights. Causes of variation between years in this environment can be the effect of annual rainfall on pasture availability or on disease incidence, changes in management practices, genetic progress etc.

Effect of age of dam. There were no significant effects associated with age of dam at any stage from birth to 18 months.

Effect of sex. Sex of the calf had a significant effect on birth weight only (Table 6), when males were 1.3 kg (6%) heavier than females. At 15 and 18 months the effect of sex approached significance, males being 6% heavier than females at both ages.

Repeatability of early calf weights. The repeatabilities of calf birth, 3-month and 6-month weights considered as a characteristic of the cow were small and non-significant, being 0.08 ± 0.13 for birth weight, 0.05 ± 0.13 for 3-month weight and zero for 6-month weight. Data were from 146 calves born to 66 cows.

Phenotypic correlations between calf weights at different ages. The phenotypic correlations between calf weights are shown in Table 8. These were all positive, correlations among birth and early weights being lower than those between weights at all other ages.

Table 8. *Phenotypic correlations between calf weights*.

Trait	3 mo.	6 mo.	9 mo.	12 mo.	15 mo.	18 mo.
Birth	0.77	0.75	0.71	0.69	0.67	0.69
3 mo.		0.92	0.87	0.82	0.75	0.76
6 mo.			0.95	0.91	0.84	0.85
9 mo.				0.95	0.88	0.87
12 mo.					0.95	0.93
15 mo.						0.97

Cow body weights

Weights at calving, and at 3, 6 and 9 months after calving, were available for 89 cow records from 1976 to 1979. The mean cow weights were 267 ± 26 kg at calving, 229 ± 25 kg 3 months after calving, 227 ± 30 kg 6 months after calving and 234 ± 31 kg 9 months after calving. Coefficients of variation were 10%, 11%, 13% and 13%, respectively. The significance of genetic and environmental influences on cow weights at these four stages is indicated in Table 9.

Table 9. *Analysis of variance of cow weights at calving and 3, 6 and 9 months after calving.*

Source	d.f.	Mean squares			
		Calving	3 mo. After calving	6 mo. After calving	9 mo. After calving
Cow group	2	159680**	112995**	92263**	113270**
Season of calving	3	1888*	2139*	737	299
Year of calving	3	645	1002	1797	1953
Cow age	3	3668**	2558**	2595**	2280
Calf sex	1	68	93	1410	563
Remainder	76	682	613	928	959

* = P<0.05
** = P<0.01

Cow group effects were significant at all stages, season of calving had a significant effect at two stages and cow age had a significant effect at three stages. The estimated least-squares means for cow weights are laid out in Table 10.

Table 10. *Estimated least squares means of cow weights at calving, and at 3, 6 and 9 months after calving*.

Variable	Number	Cow weights (kg)			
		At calving	3 mo. After calving	6 mo. After calving	9 mo. After calving
Overall mean	89	286.2	245.4	240.1	247.4
Cow group					
N'Dama with N'Dama-sired calf	29	225.1 a	192.6a	188.7 a	191.1a
N'Dama with Sahiwal-sired calf	42	238.4a	206.9a	210.3b	213.3b
Sahiwal with Sahiwal-sired calf	18	395.2b	336.7b	321.3c	337.7c
Season of calving					
November–January	39	281.9b	234.6b	231.7	247.3
February–April	20	274.0b	237.9b	237.6	248.4
May–July	7	289.8ab	251.4ab	248.2	240.6
August–October	23	299.3a	257.7a	243.0	253.2
Year of calving					
1976	18	287.7	250.4	257.4	264.3
1977	24	279.9	241.0	240.9	251.6
1978	39	292.5	253.9	240.7	240.2
1979	8	284.8	236.3	221.5	233.4

Age					
4 years	19	265.2a	229.6a	223.0a	229.4
5–6 years	28	286.6b	245.8ab	243.4ab	247.2
7–8 years	19	289.6b	245.4ab	240.0ab	253.2
9+years	23	303.6b	260.8b	254.1b	259.8
Calf sex					
Male	51	285.3	246.5	244.4	250.1
Female	38	287.1	244.3	235.9	244.7

Within variable groups, row means followed by the same letter do not differ significantly (P<0.05). No letter indicates variable group did not show a significant difference in the analysis of variance.

Effect of breed. At 3, 6 and 9 months after parturition, N'Dama cows were 31 kg (13%), 32 kg (14%) and 29 kg (13%) lighter than at parturition, respectively. Corresponding values for Sahiwal cows were 58 kg (15%), 74 kg (19%) and 57 kg (14%).

Effect of season of calving. Season of calving had significant effects on cow weights at calving and at 3 months after calving (Table 9). Cows that calved in August–October (the second half of the wet season) were significantly heavier at parturition and at 3 months after parturition than cows that calved during the November to January and February to April dry seasons.

Effect of age. Age of cow had significant effects on cow weights at calving and at 3 months and 6 months after calving (Table 9). Four-year-old cows were significantly lighter at calving than all other age groups, and significantly lighter than 9-year-old cows at 3 months and 6 months after calving (Table 10).

Repeatability of N'Dama cow weights. The repeatability of cow parturition weight and weights at 3, 6 and 9 months after parturition were 0.62 ± 0.15, 0.66 ± 0.14, 0.16 ± 0.30 and 0.02 ± 0.34, respectively. Thus, repeatability of cow weight was high and significant at parturition and 3 months after parturition only.

Phenotypic correlations between N'Dama cow weights. The phenotypic correlations between cow weights at the four stages were high and ranged from 0.96 to 0.89.

Phenotypic correlations between calf preweaning weights and N'Dama cow weights. The phenotypic correlations between calf preweaning weights and cow weights ranged from 0.72 to 0.49.

Productivity

Indices of cow productivity

The characters of reproductive performance, calf viability, calf 6-month weight and cow weight, were combined to build three productivity indices. Index 1, the weight of 6-month-old calf per cow per year, was computed for each cow parturition as the product of weight of 6-month old calf x 365 ÷ the interval to the next parturition. Index 2, the weight of 6-month-old calf per 100 kg

of cow per year, was computed as index 1 ÷ average weight of the cow x 100. Index 3, the total weight of 6-month-old calf per 100 kg of metabolic weight of cow per year, was computed as index 1÷ cow average weight$^{0.73}$ x 100. Data were available on 83 parturitions between 1975 and 1978.

The mean productivity indices were:

Index 1: 50.1 ± 14.8 kg of 6-month-old calf per cow per year

Index 2: 22.3 ± 5.4 kg of 6-month-old calf per 100 kg of cow per year

Index 3: 96.0 ± 23.8 kg of 6-month-old calf per 100 kg $^{0.73}$ of cow per year.

The significance of environmental influences on the three productivity indices is indicated in Table 11.

Table 11. *Analysis of variance of productivity indices*.

Source	d.f.	Mean squares		
		Index 1	Index 2	Index 3
Cow group	2	8622**	135*	6516**
Season of calving	3	653*	91 *	1852*
Year of calving	3	30	18	262
Age	4	938*	58	1388
Remainder	70	219	29	567

* = P<0.05
** = P<0.01

The estimated least squares means for the three productivity indices are laid out in Table 12.

Table 12. *Estimated least-squares means for productivity indices*.

Variable	Number	Index 1 (kg)	Index 2 (kg)	Index 3 (kg)
Overall mean	83	52.0	22.2	97
Cow group				
N'Dama with N'Dama-sired calf	35	35.0a	19.7a	80a
N'Dama with Sahiwal-sired calf	31	39.6a	21.8ab	90a
Sahiwal with Sahiwal-sired calf	17	81.3b	25.3b	121b
Season of calving				
November–January	31	58.8a	24.8a	108a

February–April	18	45.9b	19.9b	86b
May–July	9	53.5ab	22.8ab	99ab
August–October	25	49.7ab	21.5ab	93ab
Year of calving				
1975	14	51.2	22.0	96
1976	21	50.5	21.0	92
1977	25	52.4	22.4	97
1978	23	53.8	23.6	102
Age				
3 years	7	29.5 a	19.3	77
4 years	15	54.4b	22.8	100
5–6 years	23	54.8b	24.0	105
7–8 years	16	63.8b	24.6	110
9 + years	22	53.7	20.5	92

Within variable groups, row means followed by the same letter do not differ significantly ($P<0.05$). No letter indicates that the variable group did not show a significant difference in the analysis of variance.

Effect of breed on cow productivity. Breed group had highly significant effects on the productivity of surviving cows (Table 12). N'Dama cows with Sahiwal-sired calves produced 13% more 6-month-old calf per cow per year, 11% more 6-month old calf per 100 kg of cow per year, and 12% more 6-month-old calf per 100 $kg^{0.73}$ of cow per year than N'Dama cows with N'Dama-sired calves. Surviving Sahiwal cows with Sahiwal-sired calves produced 105% more 6-month-old calf per cow per year, 16% more 6-month-old calf per 100 kg of cow per year, and 34% more 6-month-old calf per 100 $kg^{0.73}$ of cow per year than N'Dama cows with Sahiwal-sired calves.

Effect of season of calving on cow productivity. Season of calving had a highly significant effect on all three productivity estimates (Table 12). Cows that calved in the first part of the dry season (November–January) had significantly higher productivity than those that calved in the second part of the dry season (February–April). Cows that calved in November–January produced 28% more 6-month-old calf per cow per year, 24% more 6-month-old calf per 100 kg of cow per year, and 25% more 6-month-old calf per 100 $kg^{0.73}$ of cow per year than cows that calved in February–April.

Effect of age on cow productivity. Cow age had a significant effect on index 1 only, cows aged 4 years or over producing 95% more 6-month-old calf per cow per year than 3-year-old cows.

Herd productivity

Adjustment of the three cow productivity indices to account for cow viability gives the most accurate estimates of overall herd productivity. The effect of breed is indicated in Table 13, the effect of season of calving in Table 14.

Table 13. *Herd productivity indices (kg) by breed group*.

Breed group	Index I[a]	Index 2[b]	Index 3[c]
N'Dama cows with N'Dama-sired calves	35.0	19.7	80
N'Dama cows with Sahiwal-sired calves	39.6	21.8	90
Sahiwal cows with Sahiwal-sired calves	67.8	21.1	101

[a]Weight of 6-month-old calf per cow per year.
[b]Weight of 6-month-old calf per 100 kg of cow per year.
[c]Weight of 6-month-old calf per 100 kg $^{0.73}$ of cow per year.

Table 14. *Herd productivity indices (kg) by season of calving*.

Season of calving	Index I[a]	Index 2[b]	Index 3[c]
November–January	53.8	22.7	99
February–April	40.2	17.4	75
May–July	52.0	22.2	96
August–October	46.3	20.0	87

[a]Weight of 6-month-old calf per cow per year
[b]Weight of 6-month-old calf per 100 kg of cow per year
[c]Weight of 6-month-old calf per 100 kg 0.73 of cow per year.

Implications for beef cattle breeding

With the amount of information available, herd productivity indices 2 and 3 provide the most meaningful way of comparing overall productivities. The important traits of reproductive performance, cow and calf viability, growth and cow body weight, have been used to build up the indices of weight of 6-month-old calf produced per 100 kg of cow and per 100 kg metabolic weight of cow, per year. Their merit is that they relate all the important performance traits back to the actual weights of breeding cow that have to be supported, these being closely connected with maintenance costs.

The results reported here have a number of implications for beef cattle breeding work in this trypanosomiasis-risk situation.

1. In N'Dama cattle, the levels of the important performance traits at Teko (except calf growth) are generally similar to those in other comparable situations throughout West Africa (ILCA, 1979, Volume 1, p.91). Calf growth at Teko appears, however, to be considerably lower, and is, for example, 35% to 45% lower at all stages from 3 to 18 months than the values reported by Touchberry (1967) at Musaia Animal Husbandry Station. The biological reasons for these particularly low growth rates must be identified.

2. The herd productivities (indices 2 and 3) of N'Dama cows with Sahiwal-sired calves are 10% higher than those of N'Dama with N'Dama-sired calves, mainly due to the 30% faster growth of the Sahiwal-sired calves. Considerable effort should be put into evaluating reproductive performance and maternal ability of these F_1 crosses in this environment.
3. In spite of very preferential treatment, the herd productivity of Sahiwal cows is 3% lower for index 2 and only 12% higher for index 3 than the productivity of N'Dama cows with Sahiwal-sired calves.
4. Cows calving in the first part of the dry period (November–January) show markedly superior herd productivity, 14% above the rest of the year for indices 2 and 3, and 30% above the poorest quarter (February to April). This major effect must be carefully taken into account when planning development operations.

Acknowledgement

The authors wish to thank Dr J. Isabirye for major data recording inputs at Teko Station.

References

Harvey W R. 1977. *Users' guide for least-squares and maximum likelihood computer program.* The Ohio State Univ., Columbus.

ILCA. 1979. Trypanotolerant livestock in West and Central Africa. *Monograph 2*. ILCA, Addis Ababa.

Touchberry R W. 1967. A study of the N'Dama cattle at the Musaia Animal Husbandry Station in Sierra Leone. *Univ. Illinois Agric. Expt. St. Bull.* 724.