Reproductive and milking performance of a herd of Friesian × N'Dama cattle

P. K. KARIKARI, S. A. OSEI, K. ASARE & P. GYAWU

(P.K.K. & K.A.: Dairy Beef Cattle Research Station, University of Science and Technology, Kumasi, Ghana; S.A.O. & P.G.: Department of Animal Science, University of Science and Technology, Kumasi, Ghana)

SUMMARY

Production records of a herd of Friesian × N'Dama cattle reared on-station were examined to assess their potential for use as dairy animals in the tropics. In addition, the radio-immunoassay technique was used to measure plasma progesterone concentrations to determine the attainment of puberty and resumption of ovarian activity *postpartum* in heifers and cows, respectively. A Friesian bull was always used to serve females on heat. Bull calves were significantly ($P< 0.05$) heavier at birth than heifer calves; the respective mean (±SE) weights being 30±1 kg and 27±1 kg. The season of birth also significantly affected birth weight with calves born in the wet season being heavier than their dry season born counterparts (wet = 31±1 kg; dry = 26±1 kg; $P<0.05$). Puberty was attained at a mean age of 704±44 days when the heifers weighed on the average 181±7 kg. Heifers calved for the first time at 990 ±44 days of age and at a mean weight of 250± 6 kg. Ovarian inactivity *postpartum* lasted a mean period of 83±15 days and the mean calving interval was 371±20 days. There was a significant ($P<0.01$) genotype effect on lactation milk yield and length of lactation. First generation (F_1) cows had relatively poor milking performance, producing a mean of 794±260 kg of milk in 159±33 days of lactation as compared to second generation (F_2) cows which produced 1767±137 kg of milk in 298±18 days. Cows which calved in the wet season lactated significantly ($P<0.05$) longer than those which calved in the dry season (260±26 days and 193±20 days, respectively). The effect of the interaction between season and partity on lactation milk yield was also significant ($P<0.05$) with first parity cows which calved in the dry season producing less milk than the others.

Original scientific paper. Received 1 Apr 96; revised 8 Nov 96.

RÉSUMÉ

KARIKARI, P.K., OSEI, S. A., ASARE, K. & GYAWU, P.: *La performance reproductive et laitiére du troupeau Friesian × N'Dama.* Les rapports de la production du troupeau Friesian × N'Dama élevé sur la station étaient examinés pour évaluer leur potentiel d' usage en tant que des animaux laitiers sous les tropiques. De plus, la technique de radioimmunoessai était utilisée pour mesurer les concentrés de la progestérone de plasma afin de déterminer la réalisation de la puberté et la reprise d' activité ovarienne postpartum respectivement dans les génisses et les vaches. Un taureau Friesian etait toujours utilisé pour servir les femelles en rut. Les veaux de taureau étaient consiérablement ($P<0.05$) plus lourds que les veaux de génisse à la naissance; les poids moyens (±SE) respectifs étant 30± 1kg et 27±1kg. La saison de la naissance aussi influençait considérablement le poids natal avec les veaux nés pendant la saisson humide étant plus lourds que leurs contreparties nés-saison-séche. (humide=31±1 kg; sèche=26±1kg; $P<0.05$). La puberté était réalisée à un moyen âge de 704 ± 44 jours lorsque les génisses pesaient 181 ± 7 kg au moyen. Les génisses vêlaient pour la premiére fois à 990 ± 44 jours d' âge et à un moyen poids de 250 ± 6 kg. L' inactivité ovarienne postpartum durait une période moyenne de 83 ± 15 jours et l' intervalle moyen de effet génotype considérable ($P<0.01$) sur le rendement laitier de la lactation et la durée de lactation. Les vaches de la première génération (F_1) avaient une performance laitière relativement faible, produisant un moyen de 794 ± 260 kg de lait en 159 ± 33 jours de lactation comparé aux vaches de la génération second (F_2) qui produisaient 1767 ± 137 kg de lait en 298 ± 18 jours. Les vaches qui vêlaient pendant la saison humide lactaient considérablement ($P<0.05$) plus longue que celles qui vêlaient au cours de la saison sèche (respectivement) 260 ± 26 jours et 193 ± 20 jours). L'effet de l'interaction entre la saison et la parité sur le rendement laitier de lactation était également considérable ($P<0.05$) avec les premières vaches de la parité qui vêlaient au cours de la saison sèche produisant moins de lait que les autres.

Introduction

Milk has long been recognized as a complete food and has been used to improve the nutrition of peoples all over the world. Much of the milk consumed by humans has come from the cow, and special breeds of cows have been developed for the purpose. Several countries without indigenous diary breeds have attempted to improve local milk production by importation of dairy cattle from abroad, but very few have achieved any measure of success (Preston, 1989). In Ghana, attempts to set up a dairy industry based on exotic cattle dates back from 1958, but have not been successful (Kabuga, 1989). The main problems have been high susceptibility of exotic cattle to prevailing diseases, inadequate nutrition and lack of replacement stock (Kabuga, 1989).

Crossing local cattle, which are hardy but produce very little milk, with exotic dairy breeds is a viable strategy for improving local milk production (Preston, 1989), especially in places where indigenous dairy animals do not exist and the environment is stressful and resources are inadequate. In Ghana, one of such crossbreeding projects involving the local N'Dama (*Bos taurus*) and the exotic Friesian cattle has been carried out at the Dairy/Beef Cattle Research Station of the University of Science and Technolgy (UST) in Kumasi. The management of the cattle was fashioned after the specialized dairying model of the industrialized countries whereby cows are confined and milked in the absence of their calves.

The study was undertaken to assess the potential of the Friesian ; N'Dama crosses for use as dairy animals. The reproductive and milking performance of the herd are described. Also, the effect of season, parity and genotype on performance are assessed. The parameters studied included calf birth weight, age and weight at puberty, age and weight at first calving, duration of ovarian inactivity *postpartum*, calving interval, milk yield and lactation length.

Materials and methods

Sources of data and animals

Production records of 24 Friesian × N'Dama cows compiled from 1979 to 1992 at the Dairy/Beef Cattle Research Station of the University of Science and Technology (UST) in Kumasi, Ghana, were analyzed. Also, 15 prepubertal heifers and 13 postparturient cows at the Station were used to determine age at puberty and duration of *postpartum* acyclicity, respectively. The Ghana Meteorological Service Station in Kumasi provided climatological data.

Study area

The UST Dairy/Beef Cattle Research Station is located some 10 km from Kumasi at 06 °43'N, 01° 36'W. The area lies in the semi-deciduous forest zone of Ghana and is characterized by hot humid climate. The mean annual rainfall is about 1300 mm and follows a bimodal pattern. March-July is the major rainy season with September and October constituting the minor rainy season. August is quite dry but the actual dry season lasts from November to February. Daily temperatures range from 18.6 °C (January) to 35.4 °C (February) with a mean of 26.4 °C. Relative humidity varies from 97 per cent (06:00 h) during the wet season to as low as 20 per cent (15:00 h) during the dry season.

Routine herd management

Dams and their calves were weighed within 48 h after parturition and then once every month. The animals were dipped and dewormed regularly to control ecto- and endo- parasites, respectively. They also received annual vaccination against rinderpest. Potable water was supplied *ad libitum*.

Calves stayed with their dams for 48-72 h after birth to drink colostrum and were then separated and bucket-fed with 2 kg of milk twice daily. They were given access to concentrate and cut forage from 3 weeks of age till weaning at 10-12 weeks of age.

Weaned animals were grazed from about 08: 00 h to 11:30 h and then sent indoors where they received additional cut forage. The main forage

species were *Pennisetum purpureum* (Elephant grass), *Panicum maximum* (Guinea grass), *Andropogon gayanus* (Gamba grass), *Cynodon plectostachyus* (Giant star grass) and *Centrosema pubescens*. Cow were supplementary fed with wet brewer's spent grain, and each also received about 2 kg of concentrate feed at milking time. The cows on heat were served at pasture during morning grazings with a Friesian bull. A service bull was fitted with a chin ball marker (The Great Outdoors Co. Ltd., Hamilton, New Zealand) to enhance service detection. First generation (F_1) cows were defined as those having 50 per cent genetic material each from N'Dama and Friesian cattle. The second generation (F_2) cows were those having 25 per cent N'Dama and 75 per cent Friesian blood.

Blood sampling and analysis

Fifteen prepubertal heifers between the ages of 8 and 12 months were blood-sampled twice weekly till puberty while 13 postparturient cows (3-10 years old) were sampled at 10-day intervals till pregnancy. Jugular blood was obtained by venipuncture into 7-ml vacutainers containing ethylenediamine-tetracetic acid (EDTA). Samples were chilled on ice after collection. Plasma obtained by centrifugation was stored at - 20 °C until assayed for progesterone using the FAO/IAEA progesterone radioimmunoassay kit of solid phase coated tubes and ^{125}I-labelled tracer (FAO/IAEA, 1993). The intra-and inter-assay coefficients of variation were 6.3 per cent and 8.6 per cent, respectively. Progesterone concentration ≥ 2 nmol l^{-1} in two or more consecutive samples was considered as evidence of ovarian activity. Pregnancy was confirmed by rectal palpation 8 weeks postmating.

Milking

Lactating cows were hand-milked twice daily in the absence of their calves. Cows which produced <0.5 kg of milk per day for about a week after calving were considered not to have "extractable milk" and were not milked again. Lactation yield for each cow was computed from day 4 *postpartum*.

Statistical analysis

The data were subjected to the analysis of variance using the multivariate general linear hypothesis module of the Systat statistical computer software (Wilkinson, 1990). Milk yield and lactation length were analyzed separately as response variables. The two models, however, contained the same independent variables: genotype of dam, season of calving, parity of dam, and a season × parity interaction term.

Results

The mean birth weights of bull and heifer calves are shown in Table 1. Birth weight was significantly

TABLE 1

Liveweight Development and Reproductive Performance of Friesian × N'Dama Cattle

Parameter	*LS mean ± SE*	*Number of observations*
Birth weight (kg)		
Sex		
Male	30.4 ± 1.3[a]	26
Female	26.8 ± 1.1[b]	35
Season		
Wet	30.5 ± 1.4[a]	31
Dry	26.1 ± 0.9[b]	30
Weight development of females (kg)		
3 months	67.1 ± 2.2	31
6 months	94.2 ± 3.9	30
9 months	117.3 ± 3.7	27
12 months	137.9 ± 5.4	23
5 years	387.0 ± 12.5	10
Reproductive performance		
Age at puberty[†] (d)	704.3 ± 44.4	15
Weight at puberty (kg)	181.3 ± 7.4	15
Age at first calving (d)	990.0 ± 44.3	14
Weight at first calving (kg)	250.2 ± 5.8	13
Gestation length (d)	280.2 ± 0.9	13
Period of ovarian inactivity *postpartum* (d)	82.7 ± 15.3	13
Calving interval (d)	370.8 ± 20.4	27

[a,b] difference is significant ($P<0.05$).

[†]Defined as age at which two or more consecutive blood samples had plasma progesterone concentration of 2 nmol l^{-1} or more.

influenced by the sex of calf as well as the season of birth at the 5 per cent level. Bull calves were 13.4 per cent heavier than heifer calves while calves born in the wet season were on the average 16.9 per cent heavier than those born in the dry season. Some reproductive characteristics of the animals are also presented in Table 1. Sixty-two per cent of cows showed ovarian activity by day 85 *postpartum* and all cows were cycling by day 150 *postpartum* (Fig. 1). Pregnancy rate was 85 per cent at first natural service and 100 per cent at second service. The calving pattern of the herd and the rainfall distribution of the study area are shown in Fig. 2.

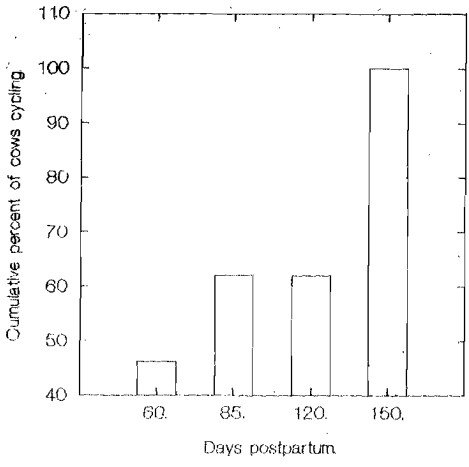

Fig. 1. Cumulative percentage of cows cycling *postpartum*

While calvings occurred throughout the year, the majority occurred in the dry season (51.5 %). November (14.9 %) and December (20.3 %) were peak calving months. The correlation between month rainfall and calvings was, however, not statistically significant (r = -0.53; P >0.05). It was estimated that breeding was intense at the start of the major rainy season.

The parity of cows apparently had no effect on intercalving intervals; the intervals being 353±15 days, 385±42 days and 381±54 days following the first, second and third calvings, respectively. Also,

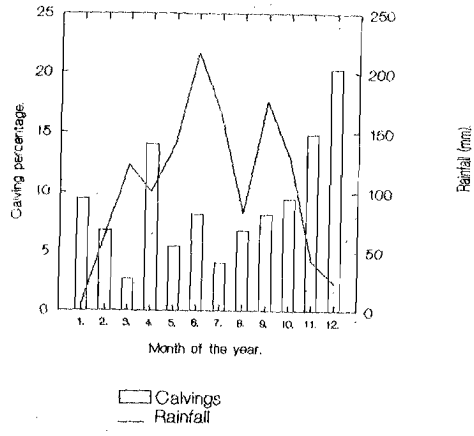

Fig. 2. Calving pattern of Friesian × N'Dame crosses and rainfall distribution of study area

calving intervals were similar for cows calving in the wet and dry seasons (371±30 days and 371±27 days, respectively). About 8 per cent of calves died before 3 months of age while 11.5 per cent died after 6 months of age. Fifty per cent of deaths were due to heartwater which affected both F_1 and F_2 animals. Accident accounted for 8.3 per cent of the deaths and weakness at birth 16.7 per cent. The causes of 25 per cent of deaths could not be ascertained. Data on lactation performance of the cows are presented in Table 2. Cows produced a mean (±SE) daily milk yield of 5.4 ±0.3 kg with a range of 2.8-11.1 kg. The overall mean (±SE) lactation length was 254.3±17.3 days with the range 32-475 days.

There was a significant (P<0.05) season × parity interaction effect on lactation milk yield. First parity cows which calved in the dry season produced less milk (475 kg) than the rest of the cows (range: 1048-1705 kg). Only two out of nine primiparous F_1 cows produced extractable milk while 14 out 15 F_2 counterparts produced extractable milk. In all, 16 out of 25 lactations of the F_1 cows from parities one to three did not produce extractable milk compared to one out of 31 lactations in the case of their F_2 counterparts.

TABLE 2

Lactation Milk Yield and Lactation Length of Friesian × N'Dama Crosses according to Genotype, Season ans Parity of Dam

	Lactation milk yield LS mean ± SE (kg)		*Lactation length LS mean ± SE (d)*	
Genotype		*Genotype*		
F_1 cows	793.6 ± 260.1**(8)	F_1 cows	159.4 ± 33.4**(8)+	
F_2 cows	1767.1 ± 137.3**(30)	F_2 cows	298.3 ± 17.6**(30)	
Season		*Season*		
Wet	1376.2 ± 209.2(16)	Wet	260.4 ± 25.8*(16)	
Dry	1184.5 ± 156.8(22)	Dry	192.6 ± 20.4*(22)	
Parity		*Parity*		
1	975.6 ± 242.0(14)	1	219.7 ± 31.1(14)	
2	1210.5 ± 197.3(15)	2	207.5 ± 25.4(15)	
3	1654.8 ± 225.6(9)	3	259.4 ± 29.0(9)	

*$P < 0.05$; **$P < 0.01$.

+ Figures in brackets denote number of observations.

Discussion

The N'Damas at the UST Dairy/Beef Cattle Research Station have a mean birth weight of 17 kg and calve for the first time at a mean age of 1046 days. The Station's N'Dama heifer calves grow at an average rate of 390 g day^{-1} for the first 3 months of age and thereafter grow at about 210 g day^{-1} up to 12 months of age (Karikari, 1990). The Friesian × N'Dama crossbred calves, however, gained 450 g day^{-1} for the first 3 months and thereafter gained 260 g day^{-1} till a year old.

Crossbreeding, therefore, increased the N'Dama birth weight by over 60 per cent. It improved growth rate and, consequently, reduced the age at first calving by about 2 months. Heifers attained puberty at about 700 days old when they were about 47 per cent of their mature weight. The present age at puberty was longer than the 15 months reported by Galina & Arthur (1989a) for crosses between *Bos indicus* and *Bos taurus* in the tropics. Inadequate feeding of calves postweaning may account for the delayed attainment of puberty in the present herd. Crossbreeding resulted in a considerable improvement in interacalving intervals. The mean calving interval of 512 days reported for N'Dama on the same Station (Karikari, 1990) declined to about 370 days in the Friesian × N'Dama crossbred. The calving interval recorded in this study compares favourably with the range of 15-18 months reported for crosses between *Bos taurus* and *Bos indicus* in the tropics (Galina & Arthur, 1989b). Genetic constitution may be implicated in accounting for the improvement over the N'Dama, but the effects of better nutrition and management cannot be ruled out. The Friesian × N'Dama crossbred calves were reared indoors and so were protected from the vagaries of inclement weather. They were also provided with some supplementary concentrate feed which though inadequate, may have ensured better growth rate than in their N'Dama counterparts.

The significant difference noted between the weights of bull and heifer calves at birth corroborates earlier reports (Roy, 1970; Saeed *et al.*, 1987). Thermal stress resulting in reduced feed intake of dams and probably a reduction in the blood flow to the uterus may be the cause of the lowered birth weight of calves born in the dry season (Bearden & Fuquay, 1984; Thatcher *et al.*, 1986).

While the present period of ovarian inactivity *postpartum* is long compared to the 14-70 days range reported for nonsuckled cows (Wells *et al.*, 1985; Hanzen, 1986), the cows resumed ovarian activity within 3 months *postpartum* and produced "one calf per cow per year", suggesting that, once cows showed overt oestrus, establishment of pregnancy did not pose a major problem. Wells *et al.* (1985) found no difference between the intervals from parturition to conception for cows which resumed ovarian activity at day 18.1±5.2 and those which resumed at day 53.2±19.7, indicating that conception soon after parturition may be poor (Bearden & Fuquay, 1984). The intense breeding occurring at the start of the rains emphasizes that

rising plane of nutrition gives a fillip to reproductive processes in cows.

Improved feeding of cows may account largely for the attainment of one calf per cow per year by the present herd. The lack of seasonal effect on calving intervals suggests that any disparity in feed between the wet and dry seasons may not be large enough to affect reproductive activity in this environment. The high mortality recorded in cattle 6 months of age was due mainly to heartwater disease. Animals were exposed to tick infestation when they started grazing after weaning and, therefore, suffered from heartwater attack. Tick control should, therefore, be a priority in managing these crosses.

Low milk yield and improved nutrition may explain the apparent shorter intercalving interval recorded for primiparous cows. The poor milk yield of first parity cows calving in the dry season is an indication that young and growing cows are less capable of coping with stressful environmental conditions. It is obvious that the F_1 cows are poor milkers. The bad temperament of the F_1 cows and the strong bond observed between them and their offspring, factors which impair milk letdown in the absence of the calf, may account for the failure of most of them to produce extractable milk. A partial suckling system whereby calves are used to stimulate milk letdown and then consume the residual milk is, therefore, likely to improve the milk yield.

The N'Dama is reported to produce up to 500 kg of milk during lactation which lasts between 150 and 300 days (Payne, 1990). Gyawu, Asare & Karikari (1988) also reported that imported Friesians kept at the UST Dairy/Beef Cattle Research Station obtained a 305-day milk yield of 4683 kg while their offspring produced 2650 kg for the same period. The Friesian × N'Dama crossbreds could, therefore, be better used as dual purpose (meat and milk) animals in Ghana. The F_2 cows showed better potential for milk production and may be the genotype to use in systems where the calf is given no place in stimulating milk letdown. Data from Preston (1989) confirm that about 75 per cent of genes from European dairy breeds are needed in crossbreeds to ensure adequate milk letdown, without stimulation from the calf, and to overcome short lactations.

Conclusion

The Friesian × N'Dama herd studied showed a good reproductive performance. An appreciable amount of milk could also be extracted from the cows with 75 per cent Friesian and 25 per cent N'Dama germplasm in the absence of their calves. The potential for such crosses to be used as conventional dairy animals in the tropics is, therefore, high.

The 50 per cent Friesian ×N'Dama cows, however, had poor milk production record under the present management system. It was suggested that the partial suckling system whereby the calf is made to stimulate milk letdown could be used to improve milk extraction in the 50 per cent Friesian × N'Dama crossbreds.

Acknowledgement

The authors are grateful to the FAO/IAEA for support under Research Contract 4825/NL.

REFERENCES

Bearden, H. J. & Fuquay, J. W. (1984) *Applied animal reproduction*, 2nd ed. Reston, Virginia: Reston Publishing Company, Inc.

FAO/IAEA (1993) Progesterone RIA kit. Pre-coated tube method. Assay protocol version 2.0. *Joint FAO/IAEA Programme in Animal Production and Health, Agricultural Laboratory, Seibersdorf, Austria.*

Galina, C. S. & Arthur, G. H. (1989a) Review of cattle reproduction in the tropics. Part 1. Puberty and age at first calving. *Anim. Breed. Abstr.* **57**(7), 583-590.

Galina, C. S. & Arthur, G. H. (1989b) Review of cattle reproduction in the tropics. Part 2. Parturition and calving intervals. *Anim. Breed. Abstr.* **57**(8), 679-686.

Gyawu, P., Asare, K. & Karikari, P. K. (1988) The performance of imported Holstein Friesian cattle and their progeny in the humid tropics. *Bull. Anim. Hlth Prod. Afr.* **36**, 362-366.

Hanzen, C. (1986) Endocrine regulation of *postpartum* ovarian activity in cattle. A review. *Reprod. Nutr. Develop.* **26**(6), 1219-1239.

Kabuga, J. D. (1989) The dairy industry in Ghana: retrospects and prospects. *Proc. Ghana Soc. Anim.*

Prod. 2nd Ann. gen. Meet. Fac. Agric., Univ. Ghana, Legon, 6-7 July, 1989, pp. 1-26.

Karikari, P. K. (1990) *A study of the factors influencing the reproductive performance of female N'Dama and Friesian × N'Dama cattle in the hot humid forest zone one of Ghana* (MSc Thesis). Faculty of Agriculture, University of Science and Technology, Kumasi, Ghana.

Payne, W. J. A. (1990) An *introduction to animal husbandry in the tropics*, 4th ed. Essex, England: Longman Group UK Limited.

Preston, T. R. (1989) The *development of milk production systems in the tropics*. Wageningen, Netherlands: Technical Centre for Agricultural and Rural Co-operation.

Roy, J. H. B. (1970) *The calf-management and feeding*, Vol. 1, 3rd ed. London: Ilife books Ltd.

Saeed, A. M., Ward, P. N., Light, D., Durkin, J. W. & Wilson, R. T. (1987) Characterisation of Kenana cattle at Um Banein, Sudan. *ILCA Res. Rep.* No. 16, Addis Ababa, Ethiopia.

Thatcher, W. W., Collier, R. J., Beede, D. K. & Wilcox, C. J. (1986) Interaction of environment and reproductive processes in cattle. In *Nuclear and related techniques for improving productivity of indigenous animals in harsh environments*, pp. 61-73. Vienna: IAEA.

Wells, P. L., Holness, D. H., Freymark, P. J., McCabe, C. T. & Lishman, A. W. (1985) Fertility in the Afrikander cow. 2. Ovarian recovery and conception in suckled and non-suckled cows *postpartum*. *Anim. Reprod. Sci.* **8**, 315-326.

Wilkinson, L. (1990) *Systat: The system for statistics*, pp. 114-341. Evanston, Il.: Systat, Inc.