Reproductive and Lactation Performance of Crossbred Dairy Cattle in Kagera Region, Tanzania

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Abstract

This study was done to evaluate reproductive and lactation performance of crossbred dairy cattle in Kagera region, Tanzania. Traits studied were age at first calving (AFC), calving interval (CI), lactation milk yield (LMY) and lactation length (LL). Records for the various traits were compiled covering the period between 1979 and 1999. The General Linear Models Procedure of SAS was used in data analyses. The mean AFC and CI were 39.0 months and 464.7 days, respectively. The mean LMY and LL were 2332.5 kg and 367.2 days, respectively. The influences of year of birth and genetic group on AFC were highly significant (P < 0.001). Heifers having 5/8 Friesian blood tended to calve 3, 4.6 and 5 months earlier than > 5/8 Friesian crosses, F_1 and F_2 respectively. Genetic group, parity, district and the interaction between season and year of calving highly significantly (P < 0.001) influenced CI. Cows in fourth parity out-yielded those in first parity by 276 kg of milk. Year of calving and genetic group x district interaction were highly significant (P < 0.001) sources of variation in LMY. LL was significantly (P < 0.001) influenced by genetic group, parity and year of calving. LL in Bukoba rural district was 28 days longer (P<0.05) than in Biharamulo district. It is concluded that both genetic and non-genetic factors considerably influenced reproduction and lactation performance of crossbred dairy cattle in Kagera region. Increased level of exotic blood has led to having animals with shorter AFC and CI and higher LMY up to 5/8 Friesian blood. Genetic group by district interactions revealed that some genetic groups performed differently among districts reflecting differences in environmental effects between districts.

Keywords:-Reproduction, lactation, crossbred dairy cows, Kagera, Tanzania

Introduction

Tanzania, like most countries in the developing world, is faced with increasing human population, rapid rate of urbanisation and as a consequence, there is a large and increasing demand for food including milk and meat.

The livestock industry in Tanzania depends mostly on traditional livestock genetic resources. Among cattle, the Tanzania Shorthorn Zebu (TSZ) constitutes more than 95% of the national herd. Most of these cattle are managed under pastoral and agro-pastoral production systems with very low inputs. Grazing is based on communal land and no supplementation is done. The availability of fodder is very seasonal. Forages are abundant during the wet season and immediately afterwards, but there is extreme scarcity of forages during the dry season for most parts of the country. Analyses of milk and beef production potential of TSZ under intensive management conditions show that their potential is limited at ap-

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proximately 900 kg of milk per lactation coupled with short lactations, long calving intervals, late age at first calving and small body weights at different ages (Galukande *et al.*, 1962). Attempts to improve productivity of cattle managed in the traditional sector are based almost exclusively on transferring technologies from developed countries or packages developed under experimental station conditions, such as crossbreeding, feeding and disease control.

It has been observed by Syrstad (1985b) that under intensive management there is evidence that crossbreeding *Bos indicus* with *Bos taurus* cattle results in improvement of production potential of crossbred cattle. Previous reviews on dairy cattle crossbreeding results in tropical environments have shown the first generation (F_1) crosses to be superior to lower grades (Cunningham and Syrstad, 1987). However, Syrstad (1996) reported that the optimum point of upgrading for milk production lies somewhere between 50% and 75% exotic inheritance.

In 1982, a small-scale dairy development project was started in Kagera region under Kagera Small Holder Dairy Extension Project (KSHDEP), which later merged with three other projects to form Kagera Livestock Development Project (KALIDEP). The project was initiated in order to improve small-scale dairy production through provision of F_1 (Friesian x Boran) crossbred heifers to interested and willing farmers. The F_1 heifers were being supplied by Kikulula Heifer Breeding Unit (KHBU), which was established in 1976.

This study was carried out to evaluate the reproduction and lactation performance of Kagera herds of crossbred dairy cattle through quantifying sources of variation which influence their productivity.

Materials and methods

Description of the study area

Kagera region is located in the extreme North-western corner of Tanzania. It lies just below the equator between latitudes 1° 00′ and 2° 45′ South. The region covers 40,838 km² of which 28,953 km² is land and 11,885 km² water bodies. The area suitable for agriculture is 20,000 km². Apart from vegetation arising from agricultural activities, the land surface is covered by natural vegetation, e.g. among them grasses which comprise of species like *Cynodon spp, Panicum spp, Eragrostis spp, and Andropogon spp*. Annual rainfall varies between 800 and 2000mm. The region experiences continuous high rainfall from October to May with a slight decrease in the months of January and February. June to August is moderately dry. According to 1998/99 surveys, the livestock population consisted of 667, 745 head of cattle, out of which 15,173 were improved dairy cattle (MAFS, 2001). Like in the rest of Tanzania, smallholder farmers keep the majority of livestock.

Source of data and data collection

Data was obtained from KALIDEP monitoring unit and at KHBU in Kagera Region. The improved dairy cattle dealt with in this study involved crosses of Friesian x Boran only. The in-calf F_1 heifers raised by KHBU were distributed to farmers by KALIDEP. The F_2 were born on-farm through *inter se* mating of F_1. Higher grades were obtained by either using bulls with 75% Friesian blood or by using pure Friesian bulls through natural mating or artificial insemination. Data collection process involved four levels: At farm level, information regarding insemination or mating dates, pregnancy test and calving dates were indicated on fertility calendar. The next level was extension workers' level. The extension workers collected all data in specially designed forms or computer printout. Extension workers reported to their superiors at district level on a monthly and quarterly basis. At District level, the reports were checked thoroughly and compiled by District livestock monitoring officers. He/she entered the data in a tailor-made database. At the regional level, the monitoring officer collected data from all districts. The final compilation, data analyses and production of various reports was done at the regional monitoring office.

Data classification

Seasons of birth and calving were categorised into four classes as heavy wet season (March-May), light wet season (Septermber -December), early dry season (January-February) and late dry season (June-August). Genetic groups of cows that were included in the analyses were F1

(½Friesian½Boran), F2 (F1 x F1), 5/8 Friesian crosses and >5/8 Friesian crosses. Districts involved were six i.e. Bukoba rural, Bukoba urban, Muleba, Karagwe, Biharamulo and Ngara. Parturition numbers were coded 1 to 5 for parity one to five and code 6 included 6th and above parturitions. Year of birth and year of calving covered periods from 1979-1996 and 1982-1999, respectively. The total number of crossbred dairy cows was 4899 but only 2956 cows with known genetic groups were used in the analyses.

Data analyses

All data on reproductive and lactation performance were analysed by using GLM Procedures of SAS (2000). Model I was used in analyzing age at first calving (AFC) and model II was employed in the analyses of calving interval (CI), lactation milk yield (LMY) and lactation length (LL).

Model:

$$Y_{ijklm} = \mu + \alpha_i + \delta_j + \gamma_k + \chi_l + e_{ijklm}$$

Where;

Y_{ijklm} = Age at first calving; μ = Overall mean; α_j = Effect of genetic group (1,2,3,4)

δ_j = Effect of district (1…6); γ_k = Effect of year of birth (1979…1996)

χ_l = Effect of season of birth (1,2,3,4); e_{ijklm} = Random residual effect $N(0, \sigma_e^2)$

Model II:

$$Y_{ijklmn} = \mu + \alpha_i + \beta_j + \delta_k + \chi_l + \gamma_m + (\alpha\delta)_{ik} + (\gamma\chi)_{lm} + e_{ijklmn}$$

Where;

Y_{ijklmn} = An observation on trait (CI, LMY, LL); μ = Overall mean; α_i = Effect of genetic group (1,2,3,4); β_j = Effect of parity (1…6); δ_k = Effect of district (1…6); χ_l = Effect of season of calving (1,2,3,4); γ_m = Effect of year of calving (1983…1999); $(\alpha\delta)_{ik}$ = Interaction of genetic group and district; $(\chi\gamma)_{lm}$ = interaction between season and year of calving; e_{ijklmn} = Random residual effect $N(0, \sigma_e^2)$

Results

Age at first calving (AFC)

The overall mean AFC was 39.0 ± 0.2 months (Table 1 and 2) with a coefficient of variation (CV) of 20.9 %. The influences of year of birth and genetic group on AFC were highly significant ($P < 0.001$). Season of birth was another significant source of variation in AFC. Heifers having 5/8 Friesian blood tended to calve 3, 4.6 and 5 months earlier than > 5/8 Friesian crosses, F1 and F2, respectively. On visual inspection of least squares means of AFC (Table 2) no trend in AFC according to year of birth could be discerned. However, on regressing AFC on year, there was a significant relationship between year and AFC. It was clearly observed that AFC was declining by approximately 15 days every year. Heifers born in the light wet season (i.e. during September to December) calved for the first time 2 months earlier than those born during the early dry season (January to February).

Table 1: Least squares means (LSM) ± standard errors (s.e) of AFC, CI, LMY and LL for effects of genetic group, parity and district

Factor	Levels	N	AFC(months)	N	CI (days)	N	LMY (kg)	LL (days)
Overall		2 221	39.0±0.2	6 388	464.7 ± 1.3	6302	2313 ± 23.4	367.2 ± 1.7
Genetic group								
	F_1	1 638	39.8 ± 0.3[a]	4 496	448.9 ± 2.7[a]	4665	2313.9 ± 23.4[a]	356.4 ± 2.3[a]
	F_2	124	41.0 ± 0.8[a]	424	478.5 ± 5.5[b]	368	2073.9 ± 87.6[b]	345.8 ± 5.3[b]
	5/8 Friesian	214	35.1 ± 0.6[b]	940	430.2 ± 4.3[c]	845	2442.4 ± 63.5[c]	345.6 ± 4.0[b]
	>5/8 Friesian	245	38.2 ± 0.8[c]	528	440.5 ± 5.4[a]	424	2393.6 ± 88.2[ac]	342.8 ± 5.2[b]
District								
	Bukoba rural	530	38.2 ± 0.4	1 447	457.5 ± 3.8[a]	1463	2410.6 ± 48.2[a]	359.1 ± 3.2[a]
	Bukoba rural	615	37.8 ± 0.4	2 206	444.4 ± 3.0[b]	2244	2671.0 ± 30.6[b]	353.1 ± 2.7[ab]
	Muleba	164	39.2 ± 0.7	393	444.6 ± 5.6[b]	453	2252.2 ± 76.0[a]	346.6 ± 5.0[b]
	Karagwe	613	39.1 ± 0.4	1 588	449.7 ± 3.8[b]	1500	2356.8 ± 44.5[a]	348.9 ± 3.4[b]
	Biharamulo	111	38.5 ± 0.9	298	440.5 ± 6.7[b]	248	1807.4 ± 150.9[c]	331.2 ± 6.6[c]
	Ngara	188	38.2 ± 0.7	456	460.8 ± 5.7[a]	394	2337.6 ± 102.1[a]	347.1 ± 5.5[b]
Parity								
	1			2293	473.6 ± 3.2[a]	2197	2161.9 ± 38.7[a]	375.2 ± 2.9[a]
	2			1547	453.4 ± 3.0[b]	1577	2227.1 ± 41.2[b]	348.8 ± 3.3[b]
	3			971	450.5 ± 4.2[b]	1024	2322.1 ± 45.1[c]	344.5 ± 3.8[b]
	4			618	443.8 ± 5.0[b]	609	2437.8 ± 51.4[de]	346.3 ± 4.5[b]
	5			414	440.3 ± 5.8[b]	399	2383.5 ± 58.7[ce]	340.1 ± 5.4[bc]
	≥6			545	435.1 ± 5.4[bc]	496	2303.4 ± 56.0[b]	331.0 ± 5.2[c]

Means with one or more superscripts in common within a column and a factor do not differ significantly (P>0.05)

Calving interval (CI)

The overall mean calving interval was 464.7 ± 1.3 days (Table 1 and 2) with a CV of 21.1 %. Genetic group, parity and district highly significantly ($P < 0.001$) influenced CI. There were no significant differences between F1 and crosses having more than 50 % Friesian inheritance, however 5/8 Friesian crosses had 10 days shorter CI than > 5/8 Friesian crosses. Cows in Biharamulo district had the lowest (440.5 days) CI while those in Ngara district had the longest (461 days) CI. In the present study it was revealed that CI decreased with parity. Mean CI in 6th parity was 38 days shorter compared to the 1st parity. There was no particular trend in CI among different years. On regressing CI on year the relationship was found to be insignificant ($P > 0.05$).

Table 2: Least squares means (LSM) ± standard errors (s.e) of AFC, CI, LMY and LL for effects of season and year of birth and calving

Factor	Levels	N	AFC (Months)	N	CI (day)	N	LMY (kg)	LL(days)
Overall		2221	39 ± 0.2	6388	464.7 ± 1.3	6302	2332.5 ± 12.4	367.2 ± 1.2
Season of calving and birth								
	Heavy rain season	589	38.7 ± 0.5^{a}	1 583	451.2 ± 4.3	1550	2302.0 ± 42.4	348.4 ± 3.5
	Light rain season	724	37.7 ± 0.4^{b}	2 201	443.8 ± 4.7	2179	2298.3 ± 41.0	347.4 ± 3.3
	Early dry season	414	39.5 ± 0.5^{a}	1 074	457.6 ± 4.7	1057	2324.8 ± 45.6	347.7 ± 3.9
	Late dry season	494	38.2 ± 0.6^{ab}	1 551	445.7 ± 5.4	1516	2298.5 ± 42.3	347.0 ± 3.5
Year of calving and birth								
	1979	55	48.1 ± 1.2^{a}					
	1980	65	39.1 ± 1.1^{b}					
	1981	79	37.8 ± 1.0^{c}	57	443.1 ± 17.9^{a}			
	1982	134	40.1 ± 0.8^{d}	50	468.7 ± 16.5^{b}			
	983	164	42.4 ± 0.8^{e}	81	445.8 ± 11.8^{a}	145	1858.1 ± 87.6^{a}	324.2 ± 8.5^{a}
	1984	120	39.8 ± 0.4^{b}	158	464.6 ± 9.2^{b}	185	2291.6 ± 73.9^{bc}	346.7 ± 7.8^{b}
	1985	118	38.6 ± 0.8^{bc}	170	450.0 ± 8.9^{a}	228	2303.8 ± 73.9^{bc}	332.9 ± 7.1^{a}
	1986	105	38.4 ± 0.8^{b}	275	439.9 ± 7.3^{ac}	352	2239.6 ± 63.4^{bc}	333.5 ± 5.9^{a}
	1987	136	40.0 ± 0.7^{d}	321	444.0 ± 6.4^{a}	414	2282.4 ± 59.9^{bc}	334.3 ± 5.5^{a}
	1988	206	37.6 ± 0.6^{c}	411	450.0 ± 5.8^{a}	420	2266.6 ± 58.5^{bc}	332.8 ± 5.4^{a}
	1989	200	38.6 ± 0.6^{c}	408	448.8 ± 5.6^{a}	369	2223.8 ± 59.7^{bc}	332.0 ± 5.4^{a}
	1990	200	39.4 ± 0.6^{b}	490	480.6 ± 5.2^{d}	498	2383.7 ± 53.6^{b}	360.5 ± 4.7^{cd}
	1991	206	35.7 ± 0.6^{f}	547	471.5 ± 5.1^{b}	580	2328.3 ± 51.2^{b}	364.7 ± 4.4^{cd}
	1992	138	36.5 ± 0.7^{f}	661	461.9 ± 4.6^{b}	701	2361.5 ± 48.2^{b}	361.2 ± 4.1^{cd}
	1993	117	35.8 ± 0.8^{f}	719	460.6 ± 4.3^{b}	767	2319.8 ± 46.3^{b}	351.7 ± 3.9^{cd}
	1994	57	39.2 ± 1.1^{b}	735	469.2 ± 4.1^{b}	776	2203.3 ± 46.5^{c}	350.6 ± 3.8^{b}
	1995	55	34.1 ± 1.1^{g}	673	474.3 ± 4.4^{b}	433	1683.5 ± 54.7^{a}	370.7 ± 4.8^{d}
	1996	66	31.6 ± 1.1^{b}	317	430.6 ± 6.4^{a}	75	1376.7 ± 112.6^{d}	349.1 ± 11.1^{b}
	1997			130	418.9 ± 9.2^{c}	82	2980.4 ± 107.4^{e}	359.5 ± 10.5^{bc}
	1998			103	442.6 ± 10.0^{a}	150	3039.9 ± 82.2^{e}	355.2 ± 7 9^{bc}
	1999			82	376.5 ± 15.3^{d}	127	3057.7 ± 87.7^{e}	350.2 ± 8.6^{bc}

Means one or more superscripts in common within a column and a factor do not differ significantly ($P > 0.05$)

Total lactation milk yield

The overall mean total LMY was 2332.5 ± 12.4 kg with a CV of 42.3 %. The estimated least squares means are shown in Table 1 and 2. Parity, year of calving and the interaction between district and genetic group were highly significant ($P < 0.001$) sources of variation in LMY. Figure 1 illustrates the interaction between genetic group and district for LMY. The effect of season of calving was not significant. Total LMY was increasing with parity and reached maximum in the 4th parity. The regression of LMY on year indicated that LMY was increasing by about 30 kg per year but this relationship was not significant ($P > 0.05$).

Lactation length

The overall mean lactation length (LL) was 367.2 ± 1.2 days with a CV of 25.7 %. The generated least squares means are presented in Table 1 and 2. District, parity and year of calving highly significantly ($P < 0.001$) influenced LL. The effect of season of calving and genetic group on lactation LL was insignificant. F1 cows lactated longer than all other genetic groups. There was a steady decline in LL with age (parity) up to 3rd parity. The longest (359.1 days) LL was observed in Bukoba rural district while cows in Biharamulo district had the shortest (331.2 days) LL. Regression of LL on year revealed that the association was significant ($P < 0.05$) demonstrating that LL was increasing yearly by about two days.

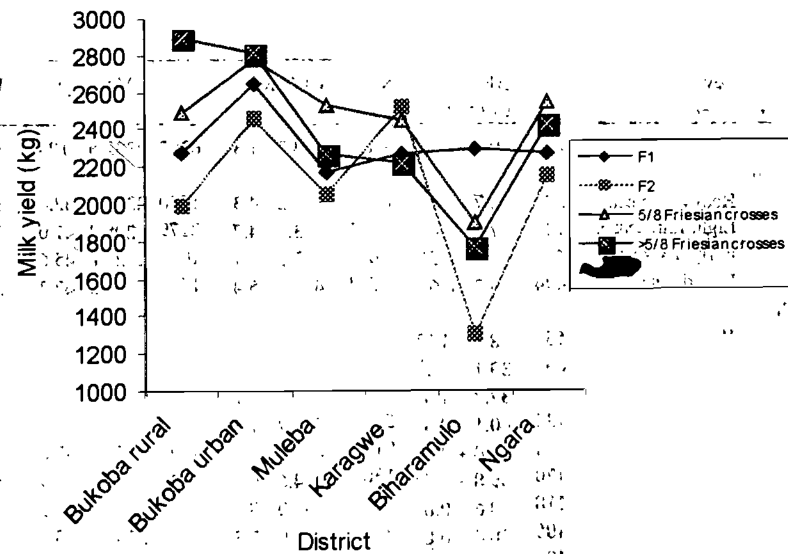

Figure 1: Genetic group x district interaction for LMY

Discussion

AFC of 39.0 months observed in the present study is higher than 36.7 months reported by Balikowa (1997) in Southern highlands in Tanzania, Ageeb and Hillers (1991) in Sudan (38.4 months) and 36.7 months found by Msuya (2002) in Northwestern Tanzania. However, the AFC in this study is lower than the mean (41.8 months) reported by Haile-Mariam (1994) working with Boran, Friesian and their crosses in Ethiopia. Probably poor feeding and veterinary care during early stages of growth at KHBU could be possible reasons leading to higher AFC observed in the current study. According to Sivarajasingam and Kumar (1993) better quality feed and a less stressful environment, which is free of ticks and internal parasites, are useful attributes in early growth and development of animals. AFC observed in this study was lower for crosses having >50% Friesian inheritance. This agrees with the observations by other workers (Msuya, 2002; Balikowa, 1997). The superiority of crosses having >50% Friesian blood could be attributed to better husbandry practices offered to these animals by farmers. The non-significant effect of district on AFC in this study may probably be due to the influence of F1 heifers from Kikulula ranch, which were distributed to all districts as in-calf heifers, and these comprised a large proportion of the total number of cows in the whole region. These animals were raised under the same conditions before being distributed to farmers hence no apparent difference on AFC was expected. Further, farmers most likely adopted one recommended feeding package and thus less variation among them.

The significant influence of season observed in this study may probably be related to the quality and quantity of forage available to heifers when they were born, which in turn affect their growth performance. Also heifers born during light rain and late dry seasons entered breeding activities during the heavy rain and early dry seasons which are better in terms of quality and quantity of pastures, hence they have good chances of showing signs of oestrus and conceiving on first service. Variation of AFC between years could be attributed to effects of climate and changes in animal management among the different years.

The mean CI of 464.7 days observed in this study is similar to the mean CI reported by Mulangila (1997) in Tanzania and Haile-Mariam et al. (1993) in Ethiopia. However, it is higher than the average reported by Haile-Mariam (1994) who reported CI of 442 days. Cows in Kagera region have slightly longer CI than the ideal one of about 13 months (or 390 days). Further, the mean CI translates into a calving rate of 78.5% which is also slightly lower than the recommended rate of 80%. Farmers in Kagera should therefore put more emphasis on heat detection to ensure that cows conceive within three months of calving. In the current study CI tended to decline as the level of exotic blood increased. Balikowa (1997) and Msuya (2002) have reported that high-grade cows tended to have shorter CI than F1. This is contrary to the report by Syrstad (1996) who reported that as level of *Bos taurus* increased CI also increased. The higher CI for F2 compared to F1 could be ascribed to reduction of heterosis as a result of segregation and recombination of genes. In F2 generation there is always a 50% reduction in heterosis compared to F1. Longer CI for cows in first parity in this study could be attributed to calving stress and physiological stress in early lactation. Also there is partitioning of nutrients for growth, milk production and reproductive functions in heifers than in older cows (Kifaro, 1984, 1995). Difference in CI between the district with the longest CI and district with shortest CI was 20 days only. The lack of seasonal effect on CI in this study may imply that supplementary feeding obviated the effects of season. Similar findings have been reported from various studies (Kifaro, 1995; Balikowa, 1997; Msuya, 2002). Year of calving contributed significantly to the variation of CI in this study though no trend could be discerned. Other workers (e.g. Mulangila, 1997; Ageeb and Hillers, 1991; Balikowa, 1997) have reported significant effects of year of calving on CI. The effect of year of calving could be attributed to variability in management and climate especially rainfall between different years.

The mean LMY in the present study is higher than that reported by some other workers (Mulangila, 1997; Mchau, 1991). Variation with other studies might be contributed by the readily available extension and technical services, climatic conditions and management practices. It was observed in the current study that milk yield increased from F1 to 5/8 Friesian inheritance and then declined. This is in agreement with report by Haile-Mariam (1994). However, this observation does not agree with report by Msuya (2002) who reported that cows with 50% Friesian blood performed better than those with more than 50% exotic blood. The higher milk yield among cows having more than 50% Friesian blood in the present study is indicative of a rather better management standard and higher production potential of these animals. Parity influenced LMY significantly. This finding is in agreement with other results (Kiwuwa 1973; Kifaro, 1984; Balikowa, 1997). In this study the highest LMY was attained in 4th lactation, which would coincide with maximum development of the udder and hence high milk yield. The difference in LMY among different districts suggests differences in agro-ecological features, management, access to inputs and availability of market outlets for milk. The non-significant effect of season of calving on LMY might be due to the fact that almost all animals are stall-fed and if there is proper nutrition of cows across seasons then influence of season on LMY can be less apparent. Similar observation was reported by Haile-Mariam (1994). The influence of year of calving in LMY is often associated with variations in management, nutrition, rainfall pattern and changes in herd size among the different years.

The mean LL of 367.2 days is relatively higher than the average LL for *Bos taurus* and crossbred cattle in most parts of the tropics which range between 280 and 345 days (Syrstad, 1985a; Udo et al., 1995). Balikowa (1997) and Msuya (2002) also reported equally high mean LL for crossbred cattle in Tanzania. Cows with >50% Friesian inheritance had shorter LL than F1 despite of the fact they had shorter dry period. The observation is contrary to the report by Buvanendran et al. (1981) who found that the duration of lactations increased with increasing proportion of *Bos taurus* blood. LL were observed to be longer in early than the later lactations. This does not conform to the findings by Kifaro (1995) and Kasonta (1988) who observed that lactation number had no significant effect on the duration of lactation. The significant effect due to district could be associated mainly to differences in levels of management and feeding. Non-significant effect of season of calving on LL in this study is in agreement with other previous findings (Kifaro, 1995; Balikowa, 1997). The significant variation of LL with years could be attributed more to changes in climatic factors than to changes in management levels. Other workers (Kifaro, 1995; Kasonta, 1988) have reported similar results.

Conclusions

It can be concluded that 62.5% Friesian blood is optimal for good performance of crossbred dairy cattle under existing environmental and management conditions in Kagera Region. Further, it has been substantiated that it is not advisable to produce F2 crosses due to their inferior on-farm performance. For traits considered in this study, the performance level of the crossbred cattle has not differed much from levels reported elsewhere in the tropics. Both genetic and non-genetic factors have shown to contribute considerably to the variation in reproduction and lactation performance of crossbred dairy cattle in Kagera Region.

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