Effect of Environmental and Genetic Factors on the Productivity of Crossbred Dairy Cattle in Smallholder Farms in Northeast Tanzania

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Abstract

Cow productivity measured as annual milk, was calculated as lactation milk yield/calving interval x 365. The least squares mean for first lactation annual milk yield was 1803 ± 25.8 l and significant sources of variation were year of calving, genotype, district and herd size. The mean annual milk yield for cows with repeated measurements was 1912 ± 33.6 l and the significant sources of variation were genotype, district and herd size. In the first lactation there was a continuos drop in yield with years, a reflection of deterioration in management. The significant difference between years could as well mean that as more farmers join the system, resources per animal in a given location decrease. The superior genotype was that of animals with $\frac{5}{8}$ B. taurus blood. Animals in the peri-urban district and those in herds of more than one milking animal out-yielded the others.

Introduction

Milk consumption in Tanzania is lower than the recommended level (MOAC, SUA and ILRI, 1998). The low consumption is largely due to low production and inability to import. In order to increase milk production in most tropical countries, one of the steps taken have been crossbreeding between tropical and temperate dairy breeds (Syrstad, 1985). Crossbreeding offers prospects but there are several questions to be answered on which breeds to use, level of breeding and type of management. Both genetic and environmental factors affect the performance of crossbred dairy cattle. The knowledge on the influence of the factors on performance is important for the maximum productivity of the animals in any dairy development project. Lactation milk yield is correlated with the current calving interval (Kifaro, 1995). For better comparison of dairy production under different influences, the best measure is annual milk yield. The trait combines lactation milk yield, lactation length, length of the dry period and calving interval.

This study was carried on in a smallholder dairy farming system in the Northeast of Tanzania. The smallholder dairy system started in 1985 and is being assisted by the governments of Tanzania and the Netherlands. The type of cattle kept are crosses of Friesian to the East African Zebu. In October 1995 the number of recorded animals in the scheme was 5272 with 1750 reporting farmers. An on-farm survey(Msanga, 1997) revealed that 45.4 and 8.8 percent of the farmers practiced mixed farming, had other non farm occupation and relied on dairying respectively. The mean dairy herd size was 4.2 (SD 4.1) of which 1.2 (SD 1.3) were milking.

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The objective of the present study was to analyse the effects of genotype. district. season of calving. year-of calving and herd size on annual milk yield.

Materials and methods

The location of the study area is latitude 5°S and longitude 39°E. Altitude varied from sea level to 2000 m above sea level. Total rainfall ranged from 800 to 2100 with a bimodal type of distribution. Factors considered in the study were district. genotype. season of calving. year of calving. parity and herd size.

District

The study was carried in Tanga region. The region was divided into six districts depending on altitude, rainfall and location. The mean annual rainfall for Pangani. Korogwe. Urban/Peri-urban. Muheza and Amani districts were 1191. 1241. 1266. 1391. 1509. mm. respectively. The mean ambient temperature ranges of the districts were respectively 23 – 37. 20 – 28.5. 24 – 28. 23.3 – 27.6 and 16 – 20°C.

Genotypes

These were grouped according to the level of *Bos taurus* inheritance being either ½. ⅝ or ¾.

The ½ level of *Bos taurus* inheritance were obtained either by crossing mainly Holstein Friesian on East African Zebu or inter semating of the F_1. The ¾ level resulted from backcrossing the F_1 to the sire breed and the ⅝ were the result of mating between the above crossbred lines.

Season

Four seasons were evaluated in the study and these were hot and dry (December to February). long rains (March to May). cool dry (June to August) and short rains (September to November). The mean percentage rainfall distribution were 17.7. 43.0. 15.3 and 24.0 for the four seasons respectively.

Year, parity and herd size

The effect of year included 6 years (1990 – 1995 inclusive) 4 parity groups (1. 2. 3 and above 4) were involved in the model. There were only two herd size groups and these were those with

one animal or more than one animal in the production records.

Data analysis

Individual cow records were extracted from the Tanga Smallholder Dairy Development Programme (TSDDP) recording system for the period 1990/95. Annual milk yield was calculated as lactation milk yield/ calving interval x 365. Most of the data on lactation and calving interval were in first parity. Separate analyses were done for data from first lactations only and for data from cows with records for more than one lactation (repeated records). The study was based on 1086 lactations. Due to the unbalanced factorial designs. appropriate least squares models (SAS. 1988) were used to fit the data for the various measures of performance. Preliminary analysis was done on the spread of residuals. data on first calving interval was found not normally distributed thus a log transformation was done before analysis. Data for calving intervals on repeated measurements was normally distributed and not transformed. The model used for annual milk yield and calving interval was:

$$Y_{ijklmn} = U + A_i + B_j + C_k + D_l + E_m + F_n + AB_{ij} + AD_{jl} + e_{iklmn}$$

Where Y_{ijklmn} = A single performance of an individual.

U = Overall mean

A_i = The effect of the ith district

B_j = The effect of the jth genotype

C_k = The effect of the kth year

D_l = The effect of the lth season

E_m = The effect of the mth herd size

F_n = The effect of the nth parity

AB_{ij} = The interaction between the jth district and the jth genotype

BD_{jk} = The interaction between the jth genotype and the lth season

e_{iklmn} = A random element.

Results

The calving interval for first lactation was 446 d (log lsm 2.65 ± 0.01) and was significantly affected only by year of calving ($P < 0.05$). For repeated records the mean calving interval was 465 days and significantly affected by year of calving ($P < 0.05$) and herd size ($P < 0.001$). Least squares means by years in days for calving interval are shown in Table 1

Table 1: Least squares means (log1sm ± se) in days for calving intervals by years

Year	1st interval			Repeated records		
	n	Mean		n	Mean	se
1990	99	491^c(2.69 ± 0.04)		38	472^{abc}	53.2
1991	167	482^a(2.68 ± 0.03)		109	512^{ab}	32.6
1992	248	513^c(2.71 ± 0.03)		138	531^b	27.7
1993	74	419^b(2.62 ± 0.02)		40	449^{cc}	25.4
1994	120	395^c(2.60 ± 0.02)		48	390^c	38.5

The mean annual milk yield for the first parity cows was 1803 ± 25.8 l and was significantly affected by district (P<0.001), genotype (P<0.05), year (P<0.001) and herd size (P<0.01) (Table 2). There was a continuous drop in milk yield with years. The model for first lactation records accounted for 0.18 of the variation in annual milk yield, to which district 0.17, genotype 0.09, year 0.45 and herd size 0.23 contributed. The mean annual milk yield for cows with more than one record was 1913 ± 33.6 l. The model for cows with more than one record accounted for 0.24 of the variation in annual milk yield, and significant factors were district (P<0.001), herd size (P<0.01) and genotype (P<0.05). Despite the fact that season of calving had no significant effect on annual milk yield in either first or repeated lactation, the trend was to have higher yields in animals calving in the long rains season. For both first lactation and repeated measurements all the interaction were

non significant and for repeated measurements parity had no significant effect.

The least squares means for annual milk yield by factors for the first lactation and repeated records are presented in Table 2. The difference in first lactation milk yield between the best (Amani) and the poorest (Korogwe) district was 659 l while for repeated records the difference between the best (Muheza) and the poorest (Korogwe) districts was 785 l.

For both first lactation and repeated records the best genotype was that with $^5_8$ *Bos taurus* inheritance and the poorest was that with ¾. For first lactation records there was a drop of 932 l of annual milk yield in the five years of record.

Regression analysis of lactation yield on lactation length gave the relationship Y = -61.1 (se = 92.5) + 2.3 (se = 0.3)X, where Y = lactation milk yield and X = lactation length.

Table 2: Annual milk yield: Least squares means and SE (kg)

Variable	n	1ᵗ Lactation LS mean	SE	n	Repeated LS mean	SE
Overal	708		25.8	373	1912	33.6
District:		***			***	
Pangani	61	1622ᵃ	134.0	32	1791ᵃᵇ	119.5
Korogwe	81	1421ᵇ	91.3	65	1534ᵃ	84.0
Urban	210	1813ᵃ	64.2	103	1999ᵇ	70.8
Peri-urban	109	1949ᵃᵇ	119.9	57	2255ᶜ	96.3
Muheza	184	1893ᵃᶜ	54.8	103	2319ᶜ	72.8
Amani	63	2080ᵃᶜ	92.4	13	1716ᵃᵇ	176.6
Genotype:		*			*	
50%	354	1723ᵃ	44.5	223	1789ᵃ	66.1
62%	127	1966ᵃᵇ	90.1	56	2267ᵇ	99.4
75%	197	1699ᵇ	59.5	94	1751ᵃ	83.8
Season:		ns			ns	
Hot dry	180	1796	64.7	103	1863	87.1
Long rain	136	1866	69.4	83	1987	90.9
Cool dry	204	1794	63.9	82	1952	86.3
Short rains	188	1728	63.0	105	1941	79.6
Year:		***			ns	
1990	99	2084ᵃ	79.0	38	1993	132.1
1991	167	1966ᵃᵇ	63.5	109	1881	93.1
1992	248	1904ᵇ	56.2	138	1952	80.8
1993	74	1668ᶜ	87.0	40	2178	115.3
1994	120	1358ᵈ	71.4	48	1774	106.1
Herd size:		**			**	
1	350	1703	48.3	231	1816	68.7
2	358	1889	53.3	142	2055	75.2

Means within a column with different superscript letters are statistically significantly different p<0.05. Ns=not significant; * P<0.05; ** P<0.01 ***P<0.001

Discussion

The mean annual milk yield for first lactation of 1803 ± 25.8 l and 1912 ± 33.6 l for repeated measurements is within reported ranges (Kiwuwa, *et al.* 1983; Kifaro 1995). In Ethiopia Kiwuwa *et al* (1983) reported values of 1595 and 1673 kg in smallholder system and on station respectively. A very distinct feature, especially for first lactation annual milk yield, is gradual decline in yield with years. Similar trends were reported by Agyemang and Nkhonjera (1990) under smallholder conditions in Malawi and by Kifaro (1995) for large farms in Tanzania. It has been suggested (Syrstad. 1987) that this could be due to a decline in management standards and lack of selection for breed-

ing stock. This could also be explained by the fact that as more farmers in a limited land area join the dairy production system there is a decrease of feed (pastures) per animal. Consequently drop in production with increase of years. The significant difference in production between districts could be explained by differences in feed supply and climate. Amani has got a subtropical climate suitable for dairy production (Mc Dowell, 1985; Syrstad. 1985). Both Amani and Muheza have got sufficient rainfall thus good supply of fodder. The results in this study favour the genotype with ⅝ *Bos taurus* inheritance. This was contributed partly to short calving interval for the genotype. These results are similar to those reported from Kenya. Jamaica and Cuba by Mc Dowell (1985).

Season of calving was found to have no significant effect on annual milk yield and this is supported by results of other workers (Buvanendran et al. 1981; Kasonta, 1988). The bimodal nature of rainfall distribution in the study area could account for the lack of statistical significance in the difference between seasons.

Conclusion

From the study it can be concluded that for higher productivity crossbred cattle with ⅝ *Bos taurus* blood are the best. Season of calving have no effect on milk production and farmers should be guided by other factors on when deciding when to mate their cows. There is need of having a standard management for dairy cattle to avoid year variations in yield.

Acknowledgements

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