PERFORMANCE OF LARGE SCALE AND SMALLHOLDER CATTLE IN THE SOUTHERN HIGHLANDS OF TANZANIA

J.K. Murro[1] and G.C. Kifaro[2]

[1] Uyole Agricultural Centre, PO Box 400, Mbeya, Tanzania, and [2] Sokoine University of Agriculture (SUA), Morogoro, Tanzania

ABSTRACT

Dairy records from both large scale and smallholder farms were analysed to evaluate the performance of improved cattle in the Southern Highlands. In addition, the growth performance and dipping frequency of traditional cattle were monitored at Uyole Agricultural Centre (UAC).

The average calving interval for UAC was 388 days and for the Iwambi Dairy Farming Company (DAFCO) Farm, 392 days. Parturition number (parity), season and year of calving, and origin of the cow were found to be the main factors affecting the calving interval. Similar factors affected milk yield from each lactation. The mean milk yield (average of four lactations) was 2740 kg for UAC and 2497 kg for Iwambi cows. Persistency of lactation varied greatly, mainly as a result of seasonal and annual variations in management.

Variations in the butterfat yield and content of the milk among the UAC dairy herd were due mainly to the age of the cow, the stage of lactation and the season. The butterfat content was inversely related to milk yield.

Milk records from smallholders in Mbozi District showed an average daily yield of 9.1 l for purebred cows and 4.8 l for crossbred cows. Corresponding yields for Rungwe District were 9.7 and 6.7 l. Mean lactation yields for purebred and crosses were 2715 and 1409 l for Mbozi and 2934 and 1958 l for Rungwe, respectively. The results indicated preferential treatment by farmers of purebred cows with respect to the provision of improved fodder and concentrates.

The group of traditional zebu cattle showed large variation in average daily weight gain in December (the onset of the rains). This was attributed to compensatory growth. A group of farmers who were allowed to dip their cattle free of charge dipped more frequently than farmers who had to pay.

INTRODUCTION

The cattle population of the Southern Highlands of Tanzania (Iringa, Mbeya, Rukwa and Ruvuma Regions) is about 1.8 m, of which about 99% are indigenous Zebu (MALD, 1986). However, the genetic constitution of the region's herd is gradually being improved by upgrading or through the purchase of pure dairy cattle. As early as 1970, bull centres and livestock multiplication units were established. Thereafter large scale importation of exotic dairy cattle from Kenya, New Zealand and the USA took place to supplement the supply of crossbred cattle. Most of these purebred animals were kept on large scale government owned farms. Subsequently these farms, together with the livestock multiplication units, became the main sources of improved cattle for the smallholder farmers.

The aim of this paper is to review the evaluation work on the performance of improved cattle both on large and smallscale farms, to highlight the achievements of smallholder farmers in the region and the constraints they face, to prioritise the sequence of innovations for introduction to the farmers, and to guide future research.

Large scale farms

The first analysis of dairy records was carried out by Mchau *et al.* (1983) for herds at the Uyole Agricultural Centre (UAC) and covered a period of 15 years from 1968 to 1982. Kifaro (1984) reanalysed some of the UAC records, together with records from the Iwambi Dairy Farming Company (DAFCO) Farm.

The mean liveweights of UAC female and male dairy cattle at various ages are summarized in Table 1. At all ages except weaning, males were heavier than females. The average daily weight gains for the first 18 months were 458 g for males and 403 g for females. At two years, heifers weighed only 265.5 kg, approximately 10 kg below the minimum recommended weight for breeding at that age.

Mean age at first calving was 970 $\pm$ 9 days (N = 387) at UAC and 1251 $\pm$ 39 days (N = 62) at DAFCO. At UAC, period and season of birth significantly influenced age at first calving. The regression of first lactation milk yield on age at first calving indicated that for every increase of one month in age at first calving there was a corresponding increase of 21 l in milk yield. DAFCO records were too few for any meaningful interpretation.

On average, milking cows at UAC weighed 440 kg. Weight fluctuated with the seasons (with a peak in May) and increased with the age of the cows (358, 403, 443, 473 and 485 kg for cows in their first, second, third, fourth and fifth lactations, respectively).

The average calving interval at UAC was 383 $\pm$ 2 days. Calving interval was significantly affected by season, parturition number (parity) and origin of the cow (P< 0.001). Cows calving between May and August had the shortest mean calving interval (350 days) while those calving between September and December had the longest (379 days). Calving interval decreased with parturition number (395.4 $\pm$ 7 days in the first lactation) and imported cows had longer calving intervals (371 to 403 days) than UAC-born stock (362 days). This has been ascribed to the poor adaptation of exotic stock to tropical environments. At Iwambi, only year and origin significantly influenced (P<0.01) the calving interval. The overall mean calving interval at Iwambi was 392 $\pm$ 3.1 days (N = 739).

Results from UAC data demonstrated that for every one day's increase in calving interval there was an increase of 0.9 kg in the milk yield from the corresponding lactation (r^2 = 0.56), while Iwambi records showed that each day's increase in calving interval was associated with an increase of 3.7 kg in milk yield (r^2 = 0.85). Although a longer interval between calvings results in longer lactations and a larger milk yield, it may not be economically justifiable.

Mean lactation yields as affected by season and year of calving, parity, origin and breed types are summarised in Table 2 for UAC and Table 3 for Iwambi. At both farms locally born cows were inferior to imported stock. In Venezuela, Martinez *et al.* (1982) reported higher liveweights and milk yields in imported cows from USA than in homebred cows. This suggests that locally born cows do not achieve their full potential. Season of calving was not an important source of variation in milk yield at UAC but was significant at Iwambi. Variation reflected seasonal fluctuations in feeding levels, especially for cows whose lactations began early in the dry season (June-August).

Persistency of lactation was studied using a persistency index (p-index) calculated by dividing lactation yield by maximum monthly yield. Season of calving and year were significant sources of variation in the p-indices at Uyole (P<0.01 and P<0.05, respectively) while parity was not. At Iwambi, year and breed significantly influenced p-indices (P<0.001) whereas parity and season of calving did not. Cows calving between June and August yielded the least milk but had the most persistent lactations. These cows reached their peak production in the dry season and so had low peak yields. However, the last third or half of their lactation occurred during the wet season, which boosted and prolonged their milk production. Detailed studies of seasonal influences on persistency of lactation have been conducted by Msanga and Kifaro (1986). They attributed the effect of year on persistency to marked differences in management and feeding regimes between years. They concluded that a large lactation yield was a function of a good milk yield early in the lactation combined with good persistency of lactation.

Table 1. Mean liveweights of male and female UAC dairy cattle from birth to two years old (standard deviation is shown in parentheses)

	Males		Females	
Age (days)	N	Liveweight (kg)	N	Liveweight (kg)
Birth	451	31.1 (± 5.2)	467	30.6 (± 4.9)
105 (weaning)	438	74.3 (± 13.2)	288	76.1 (± 13.6)
365	129	196.7 (± 33.9)	236	184.7 (± 34.1)
547	61	281.6 (± 46.5)	215	251.0 (± 48.9)
731	-	-	139	265.5 (± 59.3)

Source: Mchau *et al.*, 1983.

Table 2. Milk yield per lactation (kg) at Uyole as affected by season and period of calving, parity, and the origin of the cow

Factor	Season of calving	Period of calving	Parity	Origin
1	2757.2 (± 48.0)	2528.0 (± 66.1^{a})	2350.8 (±69.8^{c})	2961.8 (± 93.8^{a})
2	2727.6 (± 48.6)	2988.2 (± 57.3^{b})	2907.3 (±52.0^{a})	2841.3 (± 53.8^{a})
3	2669.7 (± 64.0)	2556.1 (± 38.4^{a})	2864.9 (±56.8^{a})	2575.8 (± 96.8^{b})
4	2690.2 (± 36.8)	2772.4 (± 85.4^{a})	2835.5 (±66.8^{a})	2861.9 (± 68.5^{a})
5	-	-	2597.3 (±66.2^{b})	-
6	-	-	-	2315.1 (± 36.8^{c})
Significance level	NS	P<0.001	P<0.001	P<0.001

[1]Factors 1-6 are as follows: for season of calving, 1=Dec-Feb, 2=March-May, 3=June-July, and 4=Sept-Nov; for period of calving, 1=<1974, 2=1974-76, 3=1977-79, and 4=1980-81; for parity, 1-5 represent successive lactations; for origin 1=imported from Kenya, 2,3 and 4=imported from New Zealand at different times, 6=Uyole-born.
Source: Kifaro, (1984).

Table 3. Mean yield per lactation (Kg) at Iwambi as affected by season and year of calving, parity, and origin and breed of cow

Factor	Season of calving	Year	Parity	Origin	Breed
1	2448.3 (± 77.2^{a})	1842.5 (± 82.4^{a})	2091.4 (± 45.5^{a})	2623.4 (± 58.8^{a})	2956.5 (± 53.0^{a})
2	2244.6 (± 82.9^{ab})	2206.6 (± 50.7^{b})	2555.3 (± 63.2^{b})	1865.9 (± 68.3^{b})	1927.0 (± 55.7)
3	2192.2 (± 74.4^{b})	2509.1 (± 70.8^{c})	2946.4 (± 78.9^{c})	-	2440.5 (± 78.5^{c})
4	2638 (± 53.0^{c})	2925.9 (± 90.1^{d})	2396.7 (± 99.6)	-	1801.8 (± 56.0)
5	-	2313.6 (± 97.4^{bc})	-	-	-
Significance level	P<0.001	P<0.001	P<0.001	P<0.001	P<0.001

[1]Factors 1-5 are as follows: season of calving and parity see Table 2; for year, 1=1977, 2=1978, 3=1979, 4=1980 and 5=1981; for origin, 1=imported, 2=local; for breed, 1=Friesian, 2=Jersey, 3=Friesian x Jersey, 4=Other breeds.
Source: Kifaro, (1984).

In Tanzania, butterfat content has little or no influence on the price of whole milk. However, it is important as a criterion for selection and feeding purposes. Kifaro and Mchau (1987) analysed UAC data on the milk fat of Friesian cows sampled every 15 days over an eighteen month period. Factors studied included stage of lactation, parity, and month/season of recording. Stage of lactation had a significant influence on butterfat content and yield ($P<0.001$) (Table 4). On average, daily milk yield decreased by about 0.75 l a month, while butterfat content increased by approximately 0.07% each month. The overall effect was that cows produced 26 g less of butterfat in total as each month of lactation elapsed.

In the Kifaro and Mchau study, an increase of 1 kg in milk yield was associated with a decline of 0.07% in the butterfat content, whereas an increase of 1 kg in milk led to an increase of 3.4 g in butterfat yield. The mean daily milk yield was 9.7 ± 4.2 kg, the percentage butterfat $4.1 \pm 1.0\%$ and the butterfat yield 348.9 ± 177 g. Over a 305 day lactation the total milk yield was 2891 kg while the butterfat yield was 115.6 kg.

In the same study (Kifaro and Mchau, 1987) age of cow and parturition number significantly influenced butterfat content and yield ($P<0.001$). Butterfat content was highest in the first lactation, followed by the third lactation. The yield of butterfat and the milk yield per lactation both increased with parturition number up to the third lactation and then declined (Table 4).

The month or season of the year determines concentrate and forage availability and quality. In the Kifaro and Mchau study, month or season of recording had a highly significant effect on both the yield and content of butterfat ($P<0.001$). The dry season months, June-November, produced the largest butterfat content but the lowest milk yields. The opposite was true for the period December-May, the wet season in the Southern Highlands.

Age of the cow and stage of lactation also had a marked influence on butterfat content and yield. When a herd has evenly distributed parities and stages of lactation, and all the milk is mixed together, butterfat content and yield do not vary much at each recording. A mean butterfat content of 4.1% could therefore safely be used to check milk adulteration. However, from the values of two standard deviations above and below the mean (2.1 and 6.1%, respectively), it is evident that there is a fairly wide variation in butterfat content among Friesian cows at UAC.

Table 4. Mean butterfat (BF) content and yield as affected by parturition number (parity) and season of recording at UAC

	Parity					Season	
	1	2	3	4	5	Dec.-May	June-Nov.
BF content (%)	4.2	4.2	4.2	4.0	3.7	3.9	4.4
BF yield (g)	310	402	427	397	385	369	403
Daily milk yield (kg)	7.6	9.9	10.4	10.0	10.9	9.8	9.5
Est. lact. yield (kg)	2339	2986	3163	2910	3163	-	-
Est. lact. BF yield (kg)	98.8	123.9	132.2	116.7	118.3	-	-
N	167	177	182	136	77	238	132

Source: Kifaro and Mchau, (1987).

Smallholder farms

In Tanzania, systematic milk recording is still restricted to large scale farms, where it is used mainly for management purposes. On small scale dairy farms, which contain the majority of improved dairy cattle in the country, routine milk recording is non-existent.

Soon after the presentation of results from a pilot milk recording scheme in Rungwe District (Mchau and Mwakatumbula, 1983), the livestock extension service in Mbeya Region introduced a milk recording scheme covering certain dairy farming zones in Rungwe, Mbeya, Mbozi and Ileje Districts. Mchau *et al.* (1985) analysed the monthly milk records from small scale dairy farms in Mbozi District (469 records) and Rungwe District (1,333 records). As expected, this analysis showed that purebred cows outyielded crossbred cows in both districts (Table 5). Cows in Rungwe district had higher milk yields and lactation persistence than those in Mbozi, probably reflecting a more even availability of feed throughout the year in Rungwe. The 305 day lactation yields (mean of four lactations) were 2740 for UAC cows and 2497 kg for Iwambi cows.

The yields of purebred cows in this study were comparable to those of cows in large commercial farms on Mbeya region (Mchau *et al.*, 1983; Kifaro, 1984). This can be explained by the higher degree of motivation on the part of the farmer and the greater attention directed towards individual cows on smallholder farms, attributes difficult to achieve on large farms run by paid labour, especially on government farms. Similar findings have been reported by Donald (1984) on smallholder dairy production farms in Arusha, Kilimanjaro and Tanga Regions.

Milk production, lactation levels and lactation curves seemed to reflect rainfall patterns in both Mbozi and Rungwe Districts. Rainfall has been found to have a dominant influence on ruminant production in the tropics because of its effect on the availability of pasture. An attempt was made to determine the use and effect of improved fodder (a combination of Napier, Rhodes and Guatemala grass and desmodium) and concentrate supplementation on milk production. Farmers were visited once a month and asked if they had used improved fodder and/or concentrate in the previous month. In both districts, the number of positive responses was greater for farmers with purebred cows than for those with crossbreeds (Table 6). This suggests a tendency among farmers to treat purebred cows preferentially, probably in expectation of higher returns. It may also imply that a larger proportion of farmers with crossbred cows has yet to be reached by the extension services.

Both improved fodder and concentrate had a significant effect on milk yield in both districts ($P<0.001$) (taking breed into account). The effect of improved fodder was an overall increase in daily milk yield of about 1 l while that of concentrates was an increase of about 2 l (Table 7).

The smallholder farm study shows that the extension service can be used to collect valuable information on dairy production in rural areas on a systematic and continuous basis with relatively little investment and organisation required. In so doing, they can generate periodic data against which the Government and donor agencies can set development targets and quantify achievements. Such information will also make it possible to quantify the impact of technological innovations as practised by farmers themselves.

Table 5. Means monthly milk yields (l) for crossbred and purebred cows in Mbozi and Rungwe Districts (standard deviations are shown in parenthesis)

	Crossbred cows		Purebred cows
		Mbozi	
Monthly milk yield	4.8 (± 2.8)		9.1 (± 3.1)
No. of observations	267		202
		Rungwe	
Monthly milk yield	6.7 (± 3.0)		9.7 (± 4.8)
No. of observations	335		998

Source: Mchau *et al.*, (1985).

Table 6. Mean number of cattle given improved fodder and concentrates in Mbozi and Rungwe Districts

	Mbozi District		Rungwe District	
	Cross	Purebred	Cross	Purebred
Improved fodder				
No	192	98	142	210
Yes	75	104	193	788
Concentrates				
No	94	12	143	307
Yes	173	190	192	691

Source: Mchau *et al.*, (1985).

Table 7. Effect of improved fodder and concentrates on daily milk yield per cow (L) in Mbozi and Rungwe Districts, 1985[1]

	Mbozi District			Rungwe District		
	Crosses	Purebred	Combined	Crosses	Purebred	Combined
Improved fodder						
Without	4.5	8.7	6.3	5.7	9.3	8.3
With	5.5	9.4	7.2	7.4	9.9	9.2
Concentrates						
Without	3.4	5.6	4.8	5.6	8.0	7.5
With	5.9	9.3	7.2	7.5	10.5	9.8

[1]Comparisons are valid only between means within the same district and breed.
Source: Mchau *et al.*, (1985).

EVALUATION OF TRADITIONAL ZEBU CATTLE

In 1985, a bull and demonstration centre was established by UAC at Nsalaga village (about 15 km east of Mbeya Town) to facilitate and monitor the shift from traditional cattle practices to improved cattle production systems. Insemination, dipping and technical advice were made available to interested smallholder farmers. From 1988 to June 1992, a total of 41,632 cattle were dipped (by immersion) and 67 exotic, 44 crossbred and 54 zebu cattle were mated.

Mchau and Kifaro (1987) monitored the growth and dipping frequency of traditional zebu cattle for a period of one year. A sample of 16 farmers with traditional herds were selected from more than 200 farmers that had used the dip. The selected farmers were identified either as participating or non-participating. Participating farmers were allowed to dip their herd free of charge.

The results for mean liveweights are shown in Table 8 and for growth rates in Table 9. Females had both higher mean liveweight and average daily gain than males. The overall poor growth rates explain the long time taken for the traditional cattle to attain mature size.

Differences in dipping frequency between farmer categories were highly significant ($P<0.001$). Participating farmers averaged 3.8 dippings a month while non-participating averaged less than one dipping a month. Dipping frequency also varied significantly with calender month. It was low between February and June and in September and October. The large differences in dipping frequency between participating and non-participating frmers is a clear indication that the cost of dipping is the most important factor influencing the use of dips in the country. However, factors other than the economic ones are also involved, such as cropping season, presence of growing crops in the fields, distance from the dip, and value and vulnerability of the animal to tick-borne diseases.

Table 8. Mean liveweight and growth rate for males, females and steers of traditional cattle at various stages of growth (standard deviations for daily weight are shown in parentheses)

	N	Mean liveweight (kg)	Average daily gain (kg)
		Initial liveweight <100 kg	
Male	61	74.3	0.15 (± 0.02)
Female	99	83.6	0.16 (± 0.02)
Steer	12	85.8	0.14 (± 0.04)
Overall	172	80.5	0.16 (± 0.01)
		Initial liveweight 100-200 kg	
Male	43	172.1	0.17 (± 0.04)
Female	293	169.0	0.08 (± 0.01)
Steer	45	149.7	0.13 (± 0.04)
Overall	381	167.1	0.09 (± 0.01)
		Initial liveweight >200 kg	
Male	45	273.6	0.01 (±0.05)
Female	231	220.6	0.00 (±0.02)
Steer	246	276.6	0.06 (±0.02)
Overall	522	251.5	0.05 (±0.01)

Source: Mchau and Kifaro, (1987).

Table 9. Mean seasonal liveweight and daily weight gain (kg) of traditional cattle at various stages of growth (standard deviations for daily weight gain are shown in parentheses)

Season	N	Mean liveweight (kg)	Average daily gain (kg)
		Initial liveweight <100 kg	
March	31	98.6	0.39 (± 0.29)
June	71	78.1	0.15 (± 0.02)
Sept.	32	66.6	0.46 (± 0.30)
Dec.	38	81.7	0.68 (± 0.32)
Overall	172	80.5	0.15 (± 0.02)
		Initial liveweight 100-200 kg	
March	65	180.9	0.39 (± 0.32)
June	154	167.6	0.86 (± 0.02)
Sept.	83	156.8	0.18 (± 0.32)
Dec.	79	165.6	0.92 (± 0.41)
Overall	381	167.1	0.09 (± 0.01)
		Initial liveweight >200 kg	
March	92	251.4	-0.16 (± 0.40)
June	214	254.4	0.03 (± 0.02)
Sept.	115	249.1	0.53 (±0.43)
Dec.	101	247.5	0.63 (±0.59)
Overall	522	251.5	0.03 (±0.02)

Source: Mchau and Kifaro (1987).

REFERENCES

De Castro, J.J., Cunningham, M.P., Dolar, T.T., Dansfield, R.D. Newson R.M. and Young, A.S. (1985a). Effects on cattle of artificial infestations with the tick *Rhipicephalus appendiculatus*. *Parasitology* 90:21-33.

De Castro, J.J. Young, A.S., Dransifield, R.D., Cumingham, M.P. and Dolan, T.T. (1985b). Effects of tick infestations on Boran cattle immunised against Theileriosis in an endemic area of Kenya. *Research in Veterinary Science* 39: 279-288.

Donald, R. (1984). Report to the World Food Program Interministerial Board on Smallholder Dairy Survey (Project 13/83/1). FAO URT 81/016. Mimeograph.

Kifaro, G.C. (1984). Production Efficiency of *Bos taurus* Dairy Cattle in Mbeya Region. MSc Thesis, Sokoine University of Agriculture.

Kifaro, G.C. and Mchau, K.W. (1987). Factors influencing milk fat variations among Friesian cows. In *TVA Proceedings* 5:305-14.

MALD (1986). 1984 National Livestock Count Final Results. Preliminary release. (Unpublished). Tanzania: Ministry of Agriculture and Livestock Development.

Martinez, N., Galindo de Rarinez, S. and Canbella, J. (1982). Reproductive and productive performance of a Holstein herd in Maracay - Venezuela. *Tropical Animal Production* 7:31-39.

Mchau, K.W. and Kifaro, G.C. (1987). Growth and dipping aspects of traditional zebu herds in villages surrounding the Nsalaga Bull Centre, Mbeya Region. In *Proceedings of the 14th Scientific Conference of the Tanzania Society of Animal Production:* 23-36.

Mchau, K.W. and Mwakatumbula, I.D.A. (1983). Dairy recording on small scale farms in Rungwe District, Tanzania. *Uyole Agricultural Centre Report No.40*. Mbeya: Uyole Agricultural Centre.

Mchau, K.W., Ibbe, S.N., Leggejager, M. and Kifaro, G.C. (1985). Some preliminary results from Mbeya region small scale dairy recording scheme. In *Proceedings of the 12th Scientific Conference, of the Tanzania Society of Animal Production* 12:78-94.

Mchau, K.W., Ngallo, A., Temu, A. and Mwakatumbula, I.D.A. (1983). The performance of the Uyole Dairy Herd 1968 - 1982. *Uyole Agricultural Centre Research Report No. 41*. Mbeya: Uyole Agriculturl Centre.

Msanga,Y.N. and Kifaro, G.C. (1986). Study on lactation persistency in the Northern Coast and Southern Highlands of Tanzania. In *Proceedings of the 13th Conference of the Tanzania Society of Animal Production* 13:210-5.

Pegram, R.G. Lenche, J., Chizyuka, H.G.B., Sutherst, R.W., Floyd, R.B., Kerr, J.D. and Mc Cosker, P.J. (1989). Effect of tick control on liveweight gain of cattle in Central Zambia. *Medical and Veterinary Entomology* 3:313-320.