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Extracted milk yield and reproductive performance of Teso cattle and their crosses with Sahiwal and Boran at Serere, Uganda

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Abstract

A study was carried out to evaluate extracted milk yield and reproductive performance of Teso cattle and their crosses with Sahiwal (S) and Boran (B) at the National Semi-Arid Resources Research Institute (NASARRI), Serere, Uganda. Analysis of variance based on General Linear Model (GLM) of SAS 2002 was used to analyse the data. The overall calving interval was 453 days with a coefficient of variation of 27.7%. F1(BxT) and F1(SxT) crosses had calving intervals of 44.6 and 61.3 days longer than the pure Teso cows. Year of previous calving significantly affected calving interval. Parity, genetic group and season of previous calving were not (P>0.05) important sources of variation. Genetic group-season of previous calving interaction was not significant. Mean lactation length for F1(BxT), F1(SxT) and Teso were 182.9, 165.7 and 148.7 days respectively. F1(SxT) crosses had significantly (P<0.05) higher extracted lactation milk yield (178 kg) than Teso (127.2 kg) and F1(BxT) crosses (125.9 kg). No significant (P>0.05) difference in extracted milk yield was observed between F1(BxT) crosses and purebred Teso cattle. Season of calving had a significant (P<0.05) influence on extracted lactation milk yield. Cows that calved in the dry season had 38.5 kg more extracted lactation milk yield than those that calved in the wet season. Parity had no significant (P>0.05) influence on extracted lactation milk yield. Extracted milk yield of the third month after calving had high correlations 0.80 and 0.93 with 100 days partial milk yield and extracted lactation milk yield, respectively. Selection of animals for improved milk production can be done using the milk yields of the first three months of lactation hence avoiding waiting until the end of lactation.

Key words: *Lactation length; lactation yield; calving interval*

Introduction

Improvement of the East African Shorthorn Zebu (EASZ) in relation to milk production has been dominated by crossing the EASZ with *Bos Taurus* dairy breeds. However, the improvement realised by such crosses depends not only on the level of heterosis but also on concentrate feeding and higher level of management than is ordinarily available among the ordinary farmers. An ideal cattle breed for the ordinary farmers in many farming systems in the tropics is one that is capable of providing moderate milk yield, meat and draft power (ox traction) while feeding on a predominantly roughage diets. The Sahiwal and Boran are thought to be suitable dual-purpose dairy/beef Zebus for low potential areas (Meyn and Walkins, 1974). Therefore, this study aimed at evaluating the Teso Zebu cattle and their F_1 crosses with the Sahiwal and Boran dams in terms of reproduction and extracted milk yield.

Materials and Methods

The study location

The study was carried out at the National Semi-Arid Resources Research Institute (NASARRI), Serere, in Uganda. It is located at 0^0 32' N and 35^0 27' E at 1128m above sea level. The station has got sandy soils with low organic matter content. It receives an annual mean rainfall of 1427mm but is considered to be among the low potential drier areas of Uganda because of the large variation in rainfall between years. The rainfall is bimodal with peaks in April/ May and August/September. The rainfall in March-May is reliable but the second rains (July-September) are unreliable. During the study period, the highest monthly average rainfall was in April (228mm) and lowest in January (26.5mm). The main dry season is from December until March. The mean annual temperature is 24^0C and the mean minimum and mean maximum annual temperatures are 17.9^0C and 29.4^0C, respectively. The relative humidity ranges from 72% to 84%.

Breeding programme at NASARRI

The data for the study was obtained from a crossbreeding programme at NASARRI in Uganda. The data collected covered a period of nine years. In this crossbreeding programme, Teso Zebu (T) females (which belong to the East African Shorthorn Zebu) were mated to Sahiwal (S) and Boran (B) bulls to produce F_1 of SxT and BxT genotypes, respectively. Contemporary pure Teso Zebu calves were also produced alongside. Selected bulls were allowed to run continuously with a specific group of cows to ensure recognition of paternity of calves. Thus calves were born throughout the year.

Raising of calves and dams

Calves were weaned at 9 months of age. After weaning males were separated from the female weaners to avoid premature mating. Heifers were exposed to bulls when about 30 months of age. Calves were left to run with their mothers during the day and penned separately from their dams overnight. This prevented suckling and facilitated partial milking the next morning. Milking was done once a day. Health management involved routine dipping against ticks, deworming and vaccination for the control of Rinderpest and Brucellosis. All the stock was reared under the same grazing environment.

The animals were raised entirely on natural pastures without any supplementary feeding except minerals and *ad-lib* supply of water. The major indigenous grasses were I*mperata cylindrical, Sporobolus pyramidalis, Hyparrenia rufa and Cynodon plectostachyus*. Improved pastures such as *Brachiaria spp*, *Pannicum maximum* and *Chloris gayana* are sparsely and sporadically distributed within the rangeland. A few legumes such as *Centrosema pubescens*, *Siratro spp* and *Stylo gracilis* do exist.

Data classification

Two seasons of calving were identified, that is wet and dry season where by April-May and September- November represented the wet seasons while June- August and December-March represented the dry seasons. Only parity was a derived variable, as it was not recorded as such in these data. It was instead derived by examining birth dates of consecutive calves of each cow. Records for milk production were for three years, that is 2000-2002.

Statistical analyses

Phenotypic correlations

Phenotypic correlations between the growth traits and also the various stages of milk production and lactation curve parameters were evaluated using Multivariate Analysis of Variance (MANOVA) procedure as described in SAS (2002).

Calving interval

Calving interval was calculated as the number of days between two successive calvings. The data for calving interval (CI) was analysed using the general linear model (GLM) procedure of SAS (2002). In analyzing CI, the year and season of previous calving, parity, genetic group, season-year of previous calving interaction and genetic group – season of previous calving interaction were considered as fixed effects.

Milk production performance

Data on milk production traits was analysed using the GLM procedure of SAS (2002). Extracted lactation yield was calculated by addition of extracted daily milk yields for the whole lactation period. Season, year, parity, genetic group, genetic group–season interaction, genotype-year interaction were used as fixed effects while lactation length was included as a covariate. Lactation length was obtained by counting the number of days from the date of calving till the cow ceases to produce milk. Season, year, parity, genetic group, genetic group–season interaction, season-year interaction were used as fixed effects

Results

Calving interval

Least squares means and coefficient of variation for calving interval are presented in Table 1**.** The overall mean calving interval was 453 ± 1.06 days with a coefficient of variation of 27.7%. Parity did not significantly (P>0.05) affect calving interval although cows in their first parity had longer calving intervals than those in the second parity. Year of previous calving significantly influenced (P<0.01) the calving interval. Cows that had previously calved in 2001 had the longest calving intervals followed by those that calved in year 2000. Cows that calved in 2002 had the least calving intervals. Calving interval was not significantly (P>0.05) influenced by genetic group of the cows. However, Sahiwal x Teso crosses had the longest calving intervals followed by Boran x Teso crosses while purebred Teso cows had the least mean calving interval. The effect of season of previous calving was no statistically significant but cow that previously calved in the dry season had longer calving intervals (440 days) than their counterparts that previously calved in the wet season (about 425 days). Genetic group x Season of previous calving interaction as well as genetic group x year of previous calving interactions were not significant (P>0.05).

Extracted lactation milk yield and lactation length

The solutions for fixed effects on extracted lactation milk yield and lactation length are shown in Table 2**.** The overall means extracted lactation milk yield and lactation length were 120.0 ± 3.4 Kg and 173.6 ± 5.0 days, respectively. The respective coefficients of variation were 34% and 34.7%. In both traits parity was not a significant (P>0.05) source of variation. However, extracted lactation yield tended to increase with increase in parity though the increments were marginal while no definite trend was observed with regard to lactation length. Genotype of the cow significantly (P<0.01) influenced extracted lactation milk yield. Sahiwal x Teso crosses significantly produced 52.1 and 50.3 litres of milk more than both Boran x Teso crosses and Teso dams, respectively. No significant (P>0.05) difference was observed between Teso dams and Boran x Teso crosses. Year and season of calving significantly (P<0.05) influenced extracted lactation yield. Cows that calved in year 2002 produced the highest milk yield followed by 2000 calvers and those that calved in 2001 produced the least extracted milk yield. Extracted milk yields in 2000 and 2002 did not differ significantly (P>0.05). Cows that calved in dry season produced 38.5 litres of extracted milk yield more than those that calved in the wet season.

Season of calving, year of calving as well as genotype of the calf did not significantly (P>0.05) influence lactation length. However, Sahiwal x Teso crosses were observed to have longer lactation lengths followed by the Teso cows and Boran x Teso crosses had the least lactation lengths. Cows that calved in the wet season had longer lactation lengths (8 days) than those that calved in the dry season. Cows that calved in year 2002 had the longest (168 days) lactation length followed by 2001 and 2000 in that order. Year x season interaction was significant ($P<0.05$) for extracted milk yield and significantly different ($P<0.001$) for lactation length. Genotype x season interactions were not significant ($P>0.05$) for both traits.

Phenotypic correlation among milk production traits

Phenotypic correlation coefficients (r_c) between monthly extracted milk yields with l00-day partial milk yield ranged from 0.35 to 0.84 (Table 3). The correlation coefficient between monthly extracted milk yields in the second month of lactation and 100 days milk yield was the highest ($r_{c=}0.84$). All correlations were highly significant ($P<0.01$) except for the sixth month of lactation, which was significant at $P<0.05$. The correlations increased from the first month up to the second and thereafter decreased in the subsequent months. Correlation coefficient between the monthly extracted milk yields and partial lactation milk yield were high ranging from 0.67 to 0.93.All correlations were significant ($P<0.01$) with monthly partial milk yields in the third month of lactation having the highest correlation (r_c =0.93). Correlation coefficient between 100-day and total extracted milk yield was 0.78

Discussion

Calving interval

The influence of genetic group was not important ($P>0.05$) in this study, which is contrary to earlier reports by Mahadevan *et al*. (1962); Mahadevan (1965), Kasonta (1992) and Mwatawala (2001). However, Sahiwal and Boran crosses had longer calving intervals than purebred Teso cows an observation that was also reported by those workers mentioned above. The calving intervals for the respective breeds in this study are longer than those reported by Mahadevan *et al*. (1962) but shorter than those reported by both Kasonta (1992) and Mwatawala (2001). The differences between the findings of the present study and those reported earlier could be attributed to differences in management especially failure to detect heat on time and late weaning (9 months) of the calves resulting in extended calving intervals. The relatively large standard errors associated with the present study on calving interval could be due to the effects of small number of animals and the low standards of animal management.

Lack of seasonal effects on calving interval in this study supports the findings of Wilson *et al*. (1987), Nkala (1992), Udo (1993), and Million and Tadelle (2003). However, animals that previously calved in the dry season had longer calving interval than their counterparts that previously calved in the wet season. Mwatawala (2001) reported calving intervals of 15.7 ± 0.21 and 15.2 ± 0.18 for dry and wet season respectively. The shorter calving intervals associated with cows that previously calved in the wet season, in this study, is attributed to better availability of forage during this period hence cows returned to estrous earlier as a result of minimum nutritional and lactation tress.

Calving interval was longer in cows of first parturition than those in the second parturition. This was consistent with previous findings (Buck, *et al*., 1976; Hinojosa *et al*., 1980; Trail and Gregory, 1981; Udo, 1993, Mwatawala, 2001). The longer calving interval in the young cows is probably due to delay in onset of oestrous after calving in lactating heifers (Warnick, 1963, cited by Hinojosa *et al*., 1980) and is reflecting a higher nutritive requirement because they still had a nutritive requirement for growth in addition to lactation and maintenance.

Significant influence of year of previous calving has been reported elsewhere (Trail and Gregory, 1981a; Trail *et al*., 1985a; Miranda *et al*., 1982; Choudhuri *et al.,* 1984; Kasonta, 1988; Ageeb and Hillers, 1991). In this study, cows that previously calved in 2001 had significantly ($P<0.05$) longer caving interval than those that calved in 2000 and 2002. In the previous studies above, longer calving intervals between years were attributed to the severe drought conditions, which likely resulted in greater nutritive stress. However, in the present study the differences could be due to management rather than drought because highest total rainfall (1600mm) was received in 2001 but had longer calving interval.

Extracted lactation milk yield and lactation length

The overall extracted lactation milk yield (120 kg) reported in the present study is lower than values reported for extracted milk yields of *Bos indicus* cattle from traditional pastoral production systems which range from 200 kg per lactation from the Maasai in Kenya (Semenye and De leeuw, 1984) to 235 kg per lactation for the Mali transhumant system (Diolla *et al*., 1981) to 312 kg per lactation for the Borana in Ethiopia (Nicholson, 1983). The differences between the present study and the previous studies could be due to differences in management system related to the amount of milk extracted and breed differences. Substantial amount of milk could have been left in the udder for calf suckling hence higher pre-weaning weights (100±0.48) in contrast to 65 kg weaning weight reported for Kenyan Maasai cattle (Semenye and De leeuw, 1984) and 61 kg weaning weight for nomadic pastorists in Mali (Diolla *et al*., 1981).

Significant genetic group influence on extracted lactation milk yield was observed in this study. Sahiwal x Teso crosses produced on average 52.1 and 50.3 kg of milk more than the Boran x Teso crosses and Teso dams respectively. Mahadevan and Galukande (1962) reported a 55% increase in milk yield by Sahiwal x EASZ crosses over the indigenous EASZ. In the present study, a 39.4% increase was observed. The difference in the genetic merit of Sahiwal over Boran breed in terms of milk production could have contributed to the variation in performance of their crosses with the Teso breed.

When the overall extracted lactation milk yield is divided by the overall lactation length (173 days) to obtain the average daily extracted milk yield (691g/day), the performance was higher than 510g reported by Rege *et al*. (1993) and comparable to average daily gains of 670-791g in White Fulani cattle in agropastoral herds in Nigeria (Otchere, 1993) and 875g in Fulani cattle in Accra plains in Ghana (Okanth, 1992).

Parity is one of the major sources of variation in milk yield. In the present study, the highest partial lactation milk yield was observed in cows in fourth parity followed by those in lactation numbers 3, 2 and 1 in that order. Although not significant, the trend in extracted lactation milk yield in the present study is consistent with normal lactations with minor differences. Million and Tadelle (2003) reported significant effects of parity on milk yield and observed higher milk yields in the third lactation than in the subsequent parities in the Zebu and Holstein Friesian and their crosses in Ethiopia. Trail and Gregory (1982) reported similar observations in Sahiwal and Aryrshire breeds and their crosses. Cattle in the tropics attain peak production in their third or fourth lactation, which is earlier than the exotic dairy cattle (Okantah, 1992; Million and Tedelle, 2003; Rege *et al*., 1993). This is attributed to the late age at first calving in the tropics (Mahadevan, 1966).

Dams that calved in the dry season produced more extracted lactation milk yields than their counterparts that calved in the wet season an observation that is consistent with Kiwuwa's (1969) report but contrary to Ageeb and Hillers (1991) findings. The observed seasonal effects in the present study are related to quality and quantity of forage available to the animals prior to and after calving periods. The bimodal type of rainfall in the study area makes it possible for dry season calvers to benefit from grazing on abundant and high quality pasture as a result of rains prior to calving. This high plane of nutrition corresponds to the last third of pregnancy during which time reserve energy is being built up. On the other hand, wet season calvers go through much of their late pregnancy on relatively poor pastures, which are characteristic of the dry season. After calving, seasonal effects are such that for animals calving in the dry season, the lactation peak, which occurs between one and two months after calving, coincides with the pasture of high feeding value. Those calving in the wet season reach the maximum milk production when the quality and availability of pasture is poor. Dry season calvers experience a relatively poor nutritional period towards the end of the lactation but their production requirements at this time are not high since daily milk yield decreases. This phenomenon can clearly be seen in Figure 2.

The lactation curve for season showed as alternate pattern in milk production between the dry and the wet season of calving. Mchau and Syrstad (1991) reported a similar trend in Mpwapwa cattle. The reason for this kind of pattern is explained by the fact that favourable seasons occur at different stages of lactation among the wet and dry season calvers.

Significant ($P<0.05$) year effects on extracted lactation milk yield were observed in the present study, which concurs with a report in previous work by Wilson *et al*. (1987). However, the trend of extracted milk yields associated with year of calving in this study does not follow the annual rainfall pattern in which case high annual rainfall is translated into high quality and quantity of pastures and hence high milk production. Extracted milk yield of 2001 was the lowest and yet this year received the highest amount of rainfall (Appendix Table 8). This indicates that the between year partial milk yield fluctuations were probably due to changes in management practices such as inconsistent milking but not changes in levels of feed availability per se.

The overall lactation length reported in this study is lower than those reported in for *Bos indicus* cattle in the region (Mahadevan, 1966; Sackers and Trail, 1966; Kiwuwa and Kyomo, 1971). The coefficient of determination (R^2) was 0.24 and with the exception of season x year interaction, all other fixed effects included in the model were not significant. This indicates that other important factors might have been left out of the model used for data analysis.

Sahiwal x Teso crosses had relatively longer lactation lengths than either Boran x Teso crosses or Teso pure breed. This is in agreement with Mahadevan's *et al*. (1962) findings.

Season of calving was not significant in the present study confirming previous observation by Kifaro (1995) and Rege *et al*. (1993). However, lactations starting in the wet season were longer than those that started in the dry season. This was similar to Ageeb and Hillers (1991b) but contrary to Kasonta (1988).

Correlation coefficients between milk yields at different stages

Correlation coefficients between extracted lactation milk yield and the various monthly extracted milk yield showed a maximum in the third month of lactation and decreased towards the end of lactation. Mchau and Syrstad (1991) reported a similar observation while studying the production characteristics of Mpwapwa cattle in Tanzania. The observed high correlation between the extracted lactation milk yield and the extracted milk yield in the third month indicates that selection can be done based on the extracted milk yield of the third month. This would allow early selection of better producing cows rather than waiting for total lactation yield. The high correlation between the 100-day yield of lactation and the extracted lactation yield suggests that cows produced much of their total milk yield during their first hundred days of lactation. Mchau and Syrstad (1991) reported that Mpwapwa cattle produced 46.6% of their 305-days' milk yield during their first 100 days while Auran (1973) reported 43.9% in the temperate breeds.

Table 1. Estimated Least-squares means (LSM) and standard errors (s.e) for calving interval (days)

	Calving interval (days)		
Effect	**N**	**LSMean**	**S.e**
Overall	134	453.0	1.06
CV (%)		27.7	
Year of previous calving		**	
2000	54	432.2[b]	29.09
2001	75	499.7[a]	21.80
2002	5	365.1[b]	65.93
Parity		**NS**	
1	114	447.7	29.09
2	20	416.9	36.56
Genetic group		**NS**	
Boran x Teso	6	441.6	56.19
Sahiwal x Teso	18	458.3	35.36
Teso	110	397.0	23.51
Season of previous calving		NS	
Wet season	77	424.6	35.06
Dry season	57	440.0	47.08

Levels of significance **=P<0.01, and NS= not significant

Table 2. Estimated least squares means (LSM) and standard errors (s.e) for extracted milk yield and lactation length

	Trait			
	Extracted lactation milk yield (Kg)		Lactation length (days)	
Effect	N	**Mean**	N	**Mean**
Overall	145	120.0 ± 3.4	145	173.6 ± 5.0
CV (%)		34.0		34.7
Genotype		**		NS
F_1(BxT)	8	125.9[b] ± 16.3	8	148.7 ± 24.0
F_1(SxT)	14	178.0[a] ± 12.0	14	182.9 ± 17.7
Teso	123	127.7[b] ± 6.0	123	165.7 ± 8.9
Year		*		NS
2000	56	145.3[a] ± 10.3	51	151.0 ± 15.0
2001	69	119.3[b] ± 7.7	70	169.3 ± 11.3
2002	20	166.7[a] ± 14.4	20	177.0 ± 21.3
Season		*		NS
Wet	91	124.5[a] ± 8.5	55	169.8 ± 12.6
Dry	52	163.0[b] ± 12.9	98	161.8 ± 19.0
Parity		NS		NS
1	37	136.8 ± 9.5	37	168.9 ± 14.0
2	55	145.2 ± 9.0	55	171.2 ± 13.3
3	41	145.3 ± 9.6	41	162.9 ± 14.2
4	12	147.7 ± 14.2	12	160.1 ± 20.9

Levels of significance ** =P<0.01, * =P<0.05 and NS= not significant

Table 3. Phenotypic correlation coefficients between monthly extracted milk yields and 100-days partial yield and extracted lactation yield

	Correlation coefficients	
Milk yields	**100-day**	**Extracted lactation milk yield**
Month one	0.79 **	0.83 **
Month two	0.84 **	0.86 **
Month three	0.80 **	0.93 **
Month four	0.66 **	0.79 **
Month five	0.56 **	0.83 **
Month six	0.35 *	0.67 **
100-day		0.78 **

Levels of significance **=P<0.01, *=P<0.05

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