Reproductive and productive performance of crossbred dairy cows kept in different production systems in Morogoro Municipality, Tanzania

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SUMMARY

Crossbred cows are the main type of cattle used for milk production on smallholder and medium farms in urban and peri-urban areas of Morogoro Municipality. A study was undertaken on four medium-scale and forty five smallholder farms to investigate the reproductive and productive performance of crossbred maintained under farmer's management. Retrospective data on age at first calving (AFC), calving interval (CI), days open (DO), number of service per conception (NSC), lactation length (LL) and total lactation milk yield (TLMY) obtained from 311 cows for lactations (1-6) during seven years (2009-2015) were analyzed. Overall mean of AFC, CI, NSC, DO, LL and TLMY were 30.9 ± 0.8 months, 405±15.4 days, 2.5 ± 0.6 numbers, 119 ± 15.9 days, 333 ± 26.7 days and 4026 ± 1158 liters, respectively. The results of all traits showed variation between the two production systems (medium-scale versus smallholder farms). However, AFC, CI and TLMY parameters only differed among the medium-scale farms. It is concluded that reproductive and productive performance of crossbred cows in the present study were low to moderate so, it is required to improve management practices atall the farms under the study for better reproductive and productive performance.
Key words: calving interval, days open, lactation length, milk yield, services per conception

INTRODUCTION

Tanzania has the largest cattle population in Africa after Ethiopia and North Sudan. The country has 23 million heads of cattle, out of which 97% are zebu (*Bos indicus*) cattle and the remaining 3% composed of exotic and cross breeds including Jersey, Ayrshire, Friesian and their crosses (MLFD, 2015). Despite the large cattle population, productive and reproductive performance is very low. The low production coefficients of cattle are partly responsible for the growing gap between demand and supply of milk and other dairy products. Studies on reproductive performance of crossbreed dairy cows in several parts of Tanzania reported average calving interval ranged from 420 to 680 days (Kanuya *et al*., 2000; Msanga *et al*., 2001;Lyimo *et al*., 2004). The cows' lactation period in the country ranges from 321 to 360 days (Kifaro, 1995; Chenyambuga and Mseleko, 2009; Mgeni, 2010). Milk production has been reported to range from 2 to 3 liters per cow/day in Zebu cows and 6 to 20 liters/cow per day for improved crossbreed dairy cows (Epaphras *et al*., 2004; Lyimo *et al*., 2004; Kurwijila *et al*., 2012). The overall per capita milk consumption in Tanzania is only 43 liters, which is relatively low compared to the recommended world per capita milk consumption of 200 liters (MLFD, 2015).

To increase milk production and thus meeting the country's demand for milk, the government of Tanzania introduced several projects including direct importation of *Bos*

taurus dairy breeds, crossbreeding of Zebu cattle with *Bos taurus*, countrywide use of artificial insemination for crossbreeding the indigenous cattle, distribution of high quality dairy cattle, and establishment of dairy heifer breeding units (Njombe and Msanga, 2008). The productivity of dairy cattle breeds depends mainly on their reproductive performance. Among reproductive performance traits include age at first service, age at first calving, number of service per-conception, calving interval, days open and calving rate (Mukasa-Mugerewa, 1989). Milk production performances are affected by genetic and non-genetic factors such as the breed of the cow, year and season of calving, geographical location, nutrition and management (Kifaro,1995; Balikowa, 1997; Msanga *et al.,* 2001). The effects of these factors might result into low productive and reproductive performance of cattle reared in Tanzania.

Small-scale and medium-scale dairy farming is an important source of food and income, and has attracted a lot of peri-urban families in Morogoro Municipal. However, it has not been able to improve the livelihood of these farmers because of their poor performance. There is lack of documentation on the productive and reproductive performance of crossbreed dairy cattle reared in medium scale and smallholder farms in Morogoro Municipal. The present study was, therefore, planned to assess andcompare the productive and reproductiveperformance of crossbreed dairy cattle kept at medium-scale and smallholder farms in Morogoro Municipal, Tanzania.

MATERIALS AND METHODS

Study Area

The study was carried out in Morogoro Municipality, Tanzania. Geographically, the municipality extends between longitude 35.6 to 39.5^{o} E and latitude 5.7 to 10^{o}S at an elevation of 500 to 600 m above sea level and is about 200 km west of Dar es Salaam. The municipality has a mixture of warm and cool temperatures ranging between 27 to 33.7^{o}C in the dry/warm season and 14.2 to 21.7^{o}C in cool/wet season. Morogoro Municipality experiences a sub-humid tropical climate with a bimodal rainfall pattern characterized by two rain seasons in a year with a dry season separating the shortrains (October to December) and long rains (which fall from March to May/June). There are about 6months of dryness, the peak being September. The mean annual rainfall is about 870 mm and total annual evapotranspiration is about 1300 mm.

Study animals and their management

A total of 311 [106 from four medium-scale farms and 205 animals from smallholder dairy farmers (n=50)] crossbreed dairy cows were included in this study. All animals were maintained under farmer's management system. Medium-scale farms had an average of 20 to 50 female dairy stock (of breedable age) while smallholder farms had an average of 3 to 8 female dairy stock (of breedable age). All dairy cattle included in this study used natural mating system either using neighbor's bulls or own bulls. The farmers were selected based on the criteria of owning crossbreed dairy cows (*Bos taurus*x Zebu) and having complete (4 to 8 years) records on individual animals. In most farms, deworming was practiced every three months in calves and after every 4 months in adult animals. Dipping or spraying with acaricides was practiced once per week to control ticks.

In medium-scale dairying, cattle were grazing on natural pasture for about 8 hours and were returned to housing pallor in the afternoon. Lactating cows were either hand-milked (three farms) or machinery-milked (one farm) twice daily. Milking cows were supplemented with home-made concentrate composed of maize bran and rice polish, (60-70%), sunflower seed cake or cotton seed cake (25%), mineral supplement 2% and 1% salt during milking. The amount of concentrate offered depended on the volume of milk produced from each cow. Newborn calves were taken away from their dams shortly after getting colostrum and were bucket-fed.

In smallholder dairying, most farmers used zero-grazed and stall fed with native grass. Few farmers had zero-grazing combined with outdoor grazing during day time. Milking cows were supplemented with varying amount of homemade concentrate mixture of cereal grain i.e. maize bran and sunflower seed cake or cotton seed cake and mineral supplement. The amount and type of supplement utilized varied from farm to farm and from season to season. Cows were milked twice daily and calves were either allowed to suckle before milking (to stimulate milk let -down) and after milking (to feed the calf).

Data collection and derivation of study variables

Data collection included information on birth dates, calving dates, dates of first and subsequent heats and insemination dates. Pregnancy diagnoses dates and their results were noted. Records of milk yield produced during the whole lactation period were also transcribed from individual cow records. From the collected information, the following variables of interest were derived (Table 1); age at first calving (AFC), calving interval (CI), number of services per conception (NSC), days open (DO), lactation length (LL), andtotal lactation milk yield (TLMY).In addition, individual interview using a structured questionnaire was used to collect information from the owner of animals in accordance with the objectives of the study. The information collected through questionnaire included; any histories of abortion, dystocia and retention of fetal membrane, source and distance to breeding bull (in kilometers) and awareness and monitoring of heat signs.

Statistical analysis

Data from the questionnaires and field records were stored in computer, using Microsoft Excel spread sheet program 2010. The data were analyzed using Statistical Package for Social Science software version17.0 (SPSS Inc. Chicago, Illinois, USA). Descriptive statistics such as mean, and standard error (SE) were generated. Furthermore, t-test was used to examine differences between levels of significance between the variables. Differences were considered to be significant at the level $p<0.05$.

Table 1. Reproductive and productive traits considered and their definitions

Trait	Definition
Age at first calving	Number of months from birth date to first calving date
Calving interval	The interval in days between two consecutive calvings
Number of service per conception	The number of services the cow was mated until she conceived

Days open	The interval in days between calving and conception
Lactation length	The period of days when a cow starts to secrete milk after parturition to the time of drying off.
Total lactation milk yield	The total amount of milk recorded from a cow starting from calving date to dry off date.

RESULTS

Reproductive performance traits

The overall mean age at first calving was 30.9 ± 0.8 months with a range of 29.4 to 34.2 months (Table 2). The AFC was significantly different (P ≤ 0.05) among cows managed under medium scale and smallholder farming systems. The cows under medium scale farms had the shortest AFC when compared with cows in smallholder farms. There was no significant difference (P>0.05) in AFC of cows maintained within the smallholder.The average calving interval observed in this study was 401.9 ± 15.4 days. However, the mean CI was significantly higher (p < 0.05) in small holder farms than for medium-scale farms. Also the CI was found to be significantly longer (P≤0.05) in cows beyond fifth party as compared to the rest parity groups.

The overall mean number of service per conception revealed in the present study was 2.5 ± 0.6 and it was (2.7± 05 and 2.1 ± 0.7 in smallholders and medium farms, respectively. Interestingly, a significant difference (p <0.05) was noted in NSC between animals reared in smallholders and medium scale farming systems.The number of service per conception increased with parity of animals; cows with parity six and above required significantly higher (p ≤0.05) NSC as compared to cows categorized in the five and less parity groups. The overall mean length of the days open was 119.1 ± 15.9 days with a range of 75 to 170 days and a significant difference (p <0.05) was noted between medium scale and smallholder farms. However, no significant difference (p > 0.05) was noted between individual farms I in regards with DO.

Production performance parameters

The overall mean LL of cows in the present study was found to be 333.3 ± 26.7 days (Table 2). Crossbred cows under medium-scale farms had shorter (p < 0.05) LL than those in smallholder farms. However, the length of the lactation period was found to increase with parities. Animals in their first parity had shorter lactation length by 55.6 days compared to those in the fourth parity. The mean TLMY obtained in this study was 4026 kg/cow with 4495 ± 503 and 3228 ± 949 kg/cow in smallholders and medium farms, respectively. Lactation milk yield increased with parity from 1545.8 ± 10.4 in the first parity to 5125.7 ± 96.4 litres in the fourth parity. The differences among parity fiveand six were not significant however, after parity six a declined trend was observed.

Table 2: Means and standard deviations of reproductive and productive traits of crossbred cow kept in smallholder and medium-scale farms in Morogoro municipality, Tanzania

Production system	Reproductive and productive traits*					
	AFC (Months)	CI (days)	NSC (no)	DO (days)	LL (days)	TLMY (liters)
Overall mean (n=311)	30.9 ± 0.8	402 ± 15.4	2.5 ± 0.6	119 ± 15.9	333 ± 26.7	4026 ± 1158
Smallholders (n=205)	31.0 ± 1.0[a]	409 ± 11.7[a]	2.7 ± 0.5[a]	126 ± 11.5[a]	349 ± 11.7[a]	4495 ± 503[a]
Total medium scale farms (n=106)	30.6 ± 0.3[b]	391 ± 14.3[b]	2.1 ± 0.7[b]	108 ± 15.8[b]	307 ± 25.4[b]	3228 ± 949[b]
Animal Research Unit (n=15)	30.9 ± 0.2[a]	400 ± 13.5[b]	2.2 ± 0.8[b]	109 ± 16.7[b]	332 ± 16.7[b]	2460 ± 504[b]
University Farm (n=17)	30.8 ± 0.2[a]	391 ± 15.8[b]	2.3 ± 1.0[b]	111 ± 21.6[b]	334 ± 21.6[b]	2449 ± 386[b]
Dairy Research Farm (n=34)	30.6 ± 0.3[b]	389 ± 14.6[c]	2.0 ± 0.7[b]	106 ± 14.6[b]	329 ± 14.6[b]	4484 ± 830[c]
Prison Dairy Farm (n=40)	30.5 ± 0.3[b]	391 ± 12.6[c]	2.1 ± 0.6[b]	108 ± 12.6[b]	331 ± 12.6[b]	3222 ± 489[d]

Values in the same column with different letters in the superscript were significantly different ($p < 0.05$), while numbers with the same letters did not differ significantly (chi-square test and Fisher's exact two-tailed test).

* AFC, age at first calving; CI, calving interval; NSC, number of service per conception; DO, days open; LL, lactation length;
TLMY, total lactation milk yield.

DISCUSSION

First calving marks the start of productive life of a cow. The age at first calving is closely related to generation intervals; it differs among cattle breeds and is affected by genetic and non-genetic factors (Mukasa and Mugerwa, 1989).The average age at first calving (30.9±0.8 months) observed in in the present study is within the range 28.5 to 38.9 months that has been reported for various crossbred dairy cattle kept under smallholder production system in Tanzania (Kishinhi, 1999). However, the values obtained in this study are lower than those found by several authors from tropical countries (Sattar *et al*., 2005; Asimwe and Kifaro, 2007; Chenyambuga and Mseleko, 2009; Dinka, 2012). Besides, the AFC values in the present study were higher than the 823 days (27.2 months) that reported in Holstein Friesian cows in Pakistan (Niazi and Aleem, 2003), 29.58 months reported in crossbred dairy cows in different production systems in the central highlands of Ethiopia (Shiferaw *et al*., 2003), and 29.3 months that was reported for Tunisian Friesian-Holstein cows (Ajili *et al*., 2007).Variation in AFC reported in different studies could be attributed to the difference of environment, management (poor heat detection) and nutrition where the animals are kept.

The calving interval is a single most important element in maintaining

milkproduction in a dairy herd and is affected by both genetic and non-genetic factors. However, non- genetic effects such as management factors are more important because the trait has low heritability and repeatability (Mwatawala, 2006). The mean calving interval (401.9 ± 15.4 days) observed in this study is comparable to the results obtained by Chenyambuga and Mseleko, (2009) for Tanzanian Ayrshire and Boran crossbred, and Kenyan Ayrshire crosses (Kahi *et al*., 2000). However, this value is lower than the calving interval reported in previous studies performed in crossbred dairy cattle in different parts of Tanzania (Swai *et al*., 2007; Kanuya *et al*., 2000; Asimwe and Kifaro, 2007) and are above the recommended interval of 365 days expected on a commercial dairy farm (Syrstad, 1995). Discrepancies in CI reported in different studies could be accredited to many factors such as environment, management, nutrition and genetic levels of animals.

The number of services per conception depends largely on the mating system being practiced. It is always lower under uncontrolled natural breeding and higher where hand mating or artificial insemination is used (Mukasa-Mugrewa, 1989). The overall mean number of service perconception revealed in the present study (2.5 ± 0.6 (2.7± 05 and 2.1 ± 0.7 in smallholders and medium farms, respectively), is in close agreement with a previous studies that reported NSC of from 2 to 3 in dairy cattle in Tanzania (Kanuya *et al*., 2000; Chenyambuga and Mseleko, 2009) and Ethiopia (Mureda and Zeleke, 2007; Haile *et al*., 2009). Nevertheless, the NSC in the present study is slightly higher than that observed by Asimwe and Kifaro (2007) for dairy cattle (1.59 – 1.66 NSC) under smallholder production system in Bukoba district, Tanzania, and 1.68 to 1.73 NSC reported by Mwatawala and Kifaro (2009) in artificially and naturally bred Boran heifers and cows under ranch condition in Tanzania. The different in NSC reported in various studies could be attributed to many factors including accuracy of detection of heat, availability of bulls, method of mating system used, and nutritious status of cows at time of service.

The overall mean length of the days open period (119.1 ± 15.9 days) observed both in medium scale and smallholder farms is comparable to findings have been reported by Chenyambuga and Mseleko, (2009) and Irshad *et al*. (2011) for Tanzanian Ayrshire and Boran crossbred cattle and Pakistan Holstein-Friesian cows, respectively. However, the value of present finding is inconsistent with the report of Kanuya *et al*. (2000) and Dinka, (2012) who found longer DO (202 - 205.2 days) in Tanzania and shorter DO (85.6 ± 5.6 day) in Ethiopia, respectively for dairy cattle under smallholder production systems.These differences may be due to several variables,including parity, body weight at calving, poor nutrition during post-partum period, milk yield and management. The higher DO (125.7 days) for smallholder cows compared to medium-scale kept cows (107.7) may be due management factors such as restricted calf suckling practices in smallholders as previously observed by Mejia *et al* (1998) in dual purpose Mpwapwa cattle. However, Sanh *et al*. (1995) studied the effects of restricted suckling versus artificial rearing on performance and fertility of *Bos taurus* and *Bos indicus* cows and calves in Tanzania and proved that there were no significant difference on reproductive performance of cows between restricted suckling and artificial rearing systems.

The overall mean lactation length observed in this study is higher than that of 258 - 288

days reported by previous studies in Tanzania (Chenyambuga and Mseleko, 2009) and 318 to 329 days of lactation length reported for Ayrshire crosses in Kenya (Kahi *et al*., 2000). However, the lactation length observed in this study is lower than 364.2 days reported by Balikowa (1997) in F1 Boran crosses (364.2 days) in Mbeya and Iringa regions, Tanzania.The probable reason for variation in LL might be nutrition, environmental and management systems where animals kept. High milk production is the ultimate goal of dairy sectors to attain milk self-sufficiency and to maximize the profitability of dairy industry.The mean TLMY of 4026 kg/cow obtained in this study is lower compared to 5557 kg/cow in Kenyan Holstein Friesian cattle (Ojango and Pollott, 2001), 4791 kg/cow reported in Holstein Friesian breed in Zimbabwe (Makuza and McDaniel,1996), 5905 kg/cow in Tunisian Holstein Friesian cow (Ajili *et al*., 2007) and 5152 kg/cow in Holstein Friesian population in Canada (Jairath *et al*., 1995). However, the TLMY observed in this study is higher than 1381 liters/cow reported by Chenyambuga and Mseleko (2009) in Aryshire and Boran crossbred cattle, 1870 kg/lactation in dairy cattle under smallholder farming system in Zimbabwe (Ngongoni *et al*., 2006) and 3710 kg/cow obtained in Holstein Friesian dairy cows in Ethiopia (Tadesse *et al*., 2010). The differences could be ascribed to differences in production environment, herd management, quality and quantity of forage where the animals are kept.

The study reveals that the overall reproductive and productive performance of crossbred cows kept under medium-scale and smallholder farms in urban and peri-urban in Morogoro Municipality are low to moderate. To harvest the better results in reproductive and productive efficiency of *Bos taurus* and *Bos indicus* crossbred cows in tropical environment, proper management is necessary to let these animals enjoy an enhanced productive life to exhibit their genetic potentials. Therefore, further detailed investigation is needed to examine the effect of farmers' husbandry practices on the reproductive and productive performances of crossbred dairy cows with the purpose of developing and subsequent implementation of appropriate intervention measures.

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