Comparative performance of local and crossbred cattle in different production systems of south Gondar zone, northwest Ethiopia

Awoke Melak[1], Kefyalew Alemayehu[2] and Zeleke Mekuriaw[3]

[1]Ethiopian Biodiversity Institute, Addis Ababa, Ethiopia
awoke.melak@yahoo.co.uk
[2]Bahir Dar University, College of Agriculture and Environmental Sciences, Bahir Dar, Ethiopia
[3]International Livestock Research Institute (ILRI), Addis Ababa, Ethiopia

Abstract: The study was conducted in selected districts of south Gondar zone, Amhara Region, to assess the comparative performance of local and crossbred cattle in different production systems and determine factors affecting the performance of local and crossbred cattle in Estie, Farta and Simada districts. A total of 180 dairy cow owners were randomly selected and interviewed to obtain information on reproductive and productive performance of cows. A structured and semi structured questionnaires were used. Descriptive statistics were employed to summarize the data and means were compared statistically using the GLM of SAS version 9.1 and SPSS version 20.0, 2011. Daily milk yield (DMY) in crossbred cows was 6.16±1.29, 5.37±2.06 and 3.74±1.61 liters in urban, peri-urban and rural production systems, respectively. The average value of DMY in locals was 2.32±1.29, 1.42±0.68 and 1.10±0.77 liters in urban, peri-urban and rural production systems, respectively. Lactation length (LL) in crosses was 10.33±2.31, 14.07±4.22 and 10.56±2.47 months in urban, peri-urban and rural production systems, respectively. While in locals, LL was 9.11±2.67, and 9.95±3.30 and 9.02±2.17 months in urban, peri-urban and rural production systems, respectively. The average values of age at first service (AFS), calving interval (CI), number of services per conception (NSC) and days open (DO) of local cows were 50.48±12.26, 701.80±275.36 days, and 1.80±1.25and 344.7±283.2 days, respectively. While in crosses the average values of AFS, CI, NSC and DO were 33.21±13.31, and 637.44±203.95 days, 1.90±1.49, and 222.3±127.8 days, respectively. The main constraints were shortage of feed and grazing land, disease and poor extension service in terms of credit schemes, supply of improved dairy breeds, accessibility to AI/bull service and veterinary services. Farmers and government officials do interactively to alleviate the problems.

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Introduction

Ethiopia is a home for many livestock species like cattle, sheep, goat, poultry, camel, donkey and horses, and suitable for better livestock production. Ethiopia is a home for about 56.7 million cattle, 29.3 million sheep and 29.11 million goats (CSA 2015). From the total cattle population 98.66% are local breeds while the hybrids (cross) and pure exotic breeds were represented by 1.19 and 0.14 percent, respectively (CSA 2015). From the total cattle population, 44.55 percent are males and 55.45 percent females.

From the total cattle population of Ethiopia, 6.5 million are dairy cattle (CSA 2015) which are in the hands of pastoralists, agro-pastoralist, rural crop livestock producer, urban and peri-urban dairy cattle producers. However, the national milk production and the overall milk consumption in Ethiopia are very low, even compared with other least developed African countries (Kasahun Melesse and Fekadu Beyene 2009).

The typical cattle production system in Ethiopia is predominantly pasture-based. Cattle are grazed all year round on natural pastures with minimal feed supplementation. The animals kept in this production system often experience inadequate nutrition and fluctuating nutrient supply affecting their productivity. There is presently limited information on the growth and reproductive performance of the local and crossbred cattle and factors influencing these performance traits (Habtamu Lemma et al 2010).

In Ethiopia most of the crossbreeds are mainly used for milk production purpose. An effective evaluation of the reproductive performance of the local and the crossbreeds in different production system is very important for better breeding strategy (Addisu Hailu 2013).

The Amhara Region has huge livestock resources. However, this resource is not providing the expected value due to several constraints, one of which is poor genetic performance of the local breed. In order to improve this low genetic potential, crossing

with exotic breeds has been carried out for the past 30 years. But, most farmers have complaint that AI service generates more male animals, this result revealed the contrary with 50.5% females (BoARD 2007). North Shoa, South Wollo, North and South Gondar have the largest crossbred animals in the region. Dessie, Debre Birhan, Gondar, Debre Tabor and Debre Markos towns have the largest urban and peri-urban crossbred animals. However, the performance of cows in the region as well as in south Gondar zone is very low. The performance of cows in different production systems in south Gondar zone doesn't well identified.

The main objective of this study was to evaluate and compare the productive and reproductive performance of local and crossbred cattle in different production systems and to know also the factors that influence the productive and reproductive performance of local and crossbred cattle in the study areas.

Materials and methods

Description of the study areas

The study was conducted in three districts of south Gondar zone (Estie, Farta and Simada), Northwest Ethiopia (Figure 1). The climate of south Gondar zone is characterized as medium with minimum of 9.1 and maximum of 22.5 ºC with bimodal heavy rainfall which is uniform in amount and distribution, ranging from 700-1300 mm per annum, with short and main seasons occurring from mid-February to May and June to September, respectively. In normal years, the rainy season extends from mid-February to early October. The study districts are further described in Table 1 and Figure 1.

Estie district

Estie is one of the districts of south Gondar administrative zone. Part of the Debub Gondar Zone, Estie is bordered on the south by the Abay River which separated it from the Misraq Gojjam Zone, on the west by Dera, on the northwest by Fogera, on the north by Farta, on the northeast by Lay Gayint, and on the east by Simada. Maize, Finger millet, Sorghum, Teff, Barley, Wheat and Niger seed are the main crops growing in the study district.

Simada district

Simada is one of the districts of south Gondar administrative zone, Amhara Region of Ethiopia. Part of the south Gondar zone, Simada is bordered on the southeast by the Bashilo River which separates it from the south Wollo zone, on the southwest by the Abay River which separates it from the east Gojjam zone, on the west by Estie, on the north by Lay Gayint and on the northeast by Tach Gayint. The major town in Simada is Wegeda. The main crops growing in this district are Maize, Finger millet, Sorghum, Teff, Barley, Wheat and Niger seed.

Table 1. Geographic coordinates of the sampling location, human and livestock population

					Cattle population		Other livestock population		
Districts	Altitude	T° in ºC	ARF	H/ popn	local	Crossbred	Sheep	Goats	Chicken
Estie	1500-4231	8.3-25	1307.7-1500	393,243	149,09	22,360	114,833	105,507	112,985
Farta	2700-2870	9-25	1250-1599	243,629	165,388	26,540	104,612	39,834	228,819
Simada	1196-3801	23	900-1100	254,020	142,334	247	96,102	106,521	78,721

Popn=Population, ºC =Degree Celsius, T°=Temperature, ARF=Annual Rain Fall, H/ popn = Human Population

Farta district

Farta is one of the districts in south Gondar zone, the Amhara region of Ethiopia. Part of the south Gondar zone, Farta is bordered on the south by Estie, on the west by Fogera, on the north by Ebenat and on the east by Lay Gayint. Towns in Farta include Gasay and Kimir Dingay. Maize, Finger millet, Sorghum, Teff, Barley, Wheat and Niger seed are the main crops growing in the study district.

Method of sampling and data collection

The districts were selected purposively based on the availability of local and crossbred cattle in the study areas. A total of 9 rural kebeles were selected, three kebeles from highland, four kebeles from midland and two kebeles from lowland; and from each kebele 20 households who owned local and crossbred lactating cows and a total of 180 households were used for the survey study. The selection criterion for the monitoring data was purposive based on infrastructure, agro-ecology, farmer willingness, lactation stage and parity of the cow.

Data collection: Both primary and secondary data were collected for the study. Secondary data were collected from zonal administrative and NGO's, the districts and 'kebele' offices. Primary data were collected using structured and semi-structured questionnaire, checklists and field observations. The questioner had been pre-tested before administration and training was given for kebele development agents and enumerators to collect the data. The data collected by the survey includes milk production, reproduction performance and constraints of dairy production in the area. A total of three focus group discussions with 12 members per group from elders, youths, female households and kebele administrators were implemented to understand the origin and distribution of the breed, production system and overall management practices implemented in the districts.

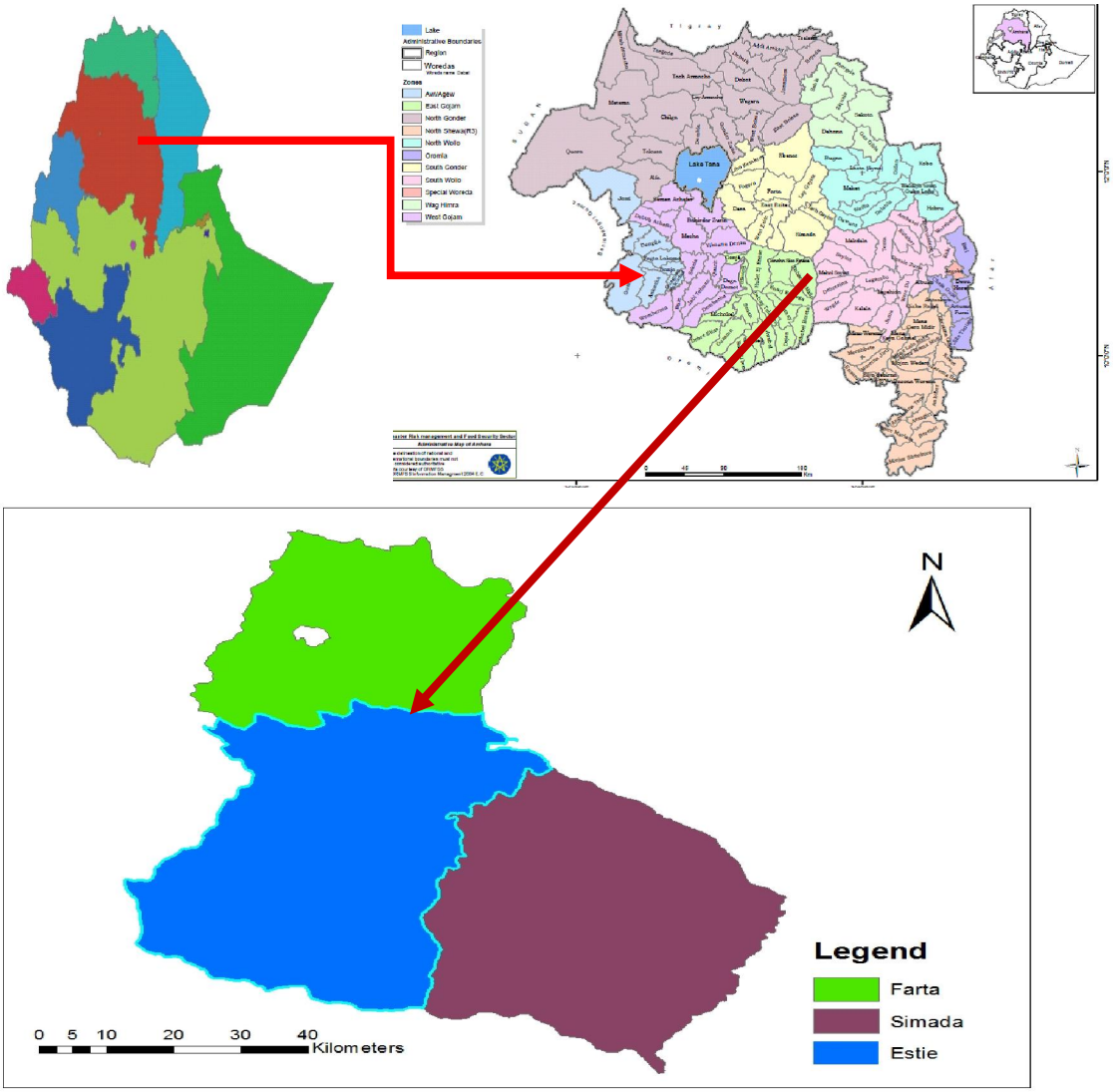

Figure 1. Map of Ethiopia (top right) map of Amhara region (top left) and map of the study districts (bottom) indicating the study sites Este, Farta and Simada

Monitoring of milk yield of individual cows were held for six months (from February to July) by trained enumerators living within the community that complete secondary education by the help of supervisors. A total of 65 lactating cows were classified by stage of lactation (early = 1-2 months; mid = 3-4 months and late = 5-6 months) and parity (parity 1, 2, 3, 4 and 5). Due to small number of cows, cows above parity 5 are included and considered as parity five. Hand milking was practiced to milk cows. Daily milk yield (morning and evening) was measured by using calibrated plastic Jogs/ measuring cylinder/ for a period of six months, three days/month.

Data analysis for questionnaire survey and monitoring study

The raw data collected from the formal survey was entered in to Microsoft Excel (2007) for data arrangement. The entered data was transported and analyzed using descriptive statistics of statistical package for social sciences (SPSS version 20.0, 2011) software and the General Linear Model (GLM) procedure of Statistical Analysis System (SAS Version 9.1) software. The reproductive performance of the cattle was considered as the effects for the analysis of quantitative traits. The traits that measure reproductive performances such as number of service per conception (NSC), calving interval (CI), age at first service (AFS), age at first calving (AFC) and days open (DO) were expressed by descriptive statistics such as means and percentages. Correlation analysis

was used to correlate the milk productions of survey data and monitoring data.

The following models were used to analyze the data.

Model 1: For reproductive traits (AFS and AFC) to evaluate local and crossbred dairy cattle in the study districts.

$Y_{ijkm} = \mu + B_i + Sj + Y_k + Qm + (BQ)\,im + e_{ijkm}$, Where, Y_{ijkm} = n^{th} record of i^{th} breed type, j^{th} birth season and k^{th} birth year; μ= overall mean

B_i= fixed effect of i^{th} breed type (i= local and cross)
Sj = fixed effect of j^{th} birth season (long rainy, short rainy and dry season)
Y_k = fixed effect of k^{th} birth year
Qm= fixed effect of production system of the area (m= urban, peri-urban and rural)
(BQ)im = effect of interaction between the i^{th} breed type and the m^{th} production system of the study areas
e_{ijkm} = random error associated with each observation

Model 2: For milk production traits (LMY and LL) and reproductive traits (DO, CI and NSC) to evaluate local and crossbred dairy cows.

$Y_{ijklm} = \mu + B_i + S_j + P_k + H_l + Qm + (BQ)im + e_{ijklm}$, Where,
Y_{ijklm}= observation on LMY, LL;
μ = overall mean
B_i= fixed effect of i^{th} breed type (i= local and cross);
S_j=fixed effect of j^{th} calving season (long rainy, short rainy & dry season);
P_k =fixed effect of k^{th} parity of dam (1, 2…5);
$H_{l=}$ fixed effect of L^{th} calving year
Qm= fixed effect of production system of the area (j= urban, peri-urban and rural)
(BQ)im = effect of interaction between the i^{th} breed type and the m^{th} production system of the study areas
e_{ijklm}= random residual error

Model 3: For morning and evening daily milk yield of monitoring data of local and crossbred cows.

$Y_{ijkl} = \mu + B_i + Sj\ Y_k + Pl + (BP)\,il + e_{ijkl}$, Where, $Y_{ijk\,l}$= n^{th} record of i^{th} breed type j^{th} parity class and k^{th} phase of lactation;

μ= overall mean
B_i = fixed effect of i^{th} breed type (i=local and cross)
Sj = fixed effect of j^{th} parity class (j= 1, 2, 3...5)
Y_k= fixed effect of k^{th} phase of lactation (1, 2 and 3)
Pl = fixed effect of production system of the area (l= urban, peri-urban and rural)
(BP)il=effect of interaction between the i^{th} breed type and the l^{th} production system of the study areas.
e_{ijkl} = random error associated with each observation

Results and discussion

Age at first service

The overall average age at puberty of local cows for the study areas was 50.48±12.26 months and for crossbred dairy cows, the average value of age at puberty was 33.21±13.31 months. The overall average value of age at puberty obtained in this study for the local cows was 50.48±12.26 months, which is not compatible for the wide range of age at puberty reported by Zewdie Wondatir (2010) for Zebu cattle 54.3 months. For crossbred dairy cows, the average value of age at puberty obtained was 33.21±13.31 months, which is higher than 24.30±8.01 months for Zebu X HF crossbred dairy cows in Jima as reported by Belay Duguma (2012).

The difference in AFS of local and crossbred cattle was due to feed management and genetic makeup of animals.

Calving interval

Calving interval is the interval from the birth of one calf to the birth of the next calf. It is a measure of performance and is useful to monitor our ability to get cows pregnant from year to year. It is the period between successive parturitions and is a function of postpartum anoestrus period (from calving to first estrus), service period (first postpartum estrus to conception) and gestation length (Tewodros Bimrew

2008). In this study results showed that the overall calving intervals (CI) of local and crossbred cows were 701.80±275.36 and 637.44±203.95 days, respectively.

Table 2. least square mean and standard deviation of age at first service (months), age at first calving (months), calving interval (days), number of services per conception and days open (days)

Factors		N	AFS	CI	NSC	DO
Production system			*	NS	NS	NS
Urban	Local	32	50.98± 11.44	674.14±190.77	1.68±0.62	265.7±143.2
	Cross	44	25.82±9.8	603.99±150.91	1.72±0.88	179±141.07
Peri-urban	Local	45	53.1±11.72	754.78±263.13	1.81±1.45	386.1±257.3
	Cross	16	40.08±13.52	659.41±263.60	2.10±1.89	318.15±190.5
Rural	Local	39	51.75±11	702.13±254.07	1.82±0.91	319.6±158.1
	Cross	23	41.59±7.9	685.34±227.59	1.97±1.24	212.85±77.55
Breed						
Local		110	50.48±12.26	701.80±275.36	1.80±1.25	344.7±283.2
Cross		84	33.21±13.31	637.44±203.95	1.90±1.49	222.3±127.8

AFS= Age at First Service, CI= Calving Interval, NSC=Number of Services per Conception, DO= Days Open, N= Number of records and *= Significant ($p<0.05$)

Genetic factors, year and season of calving, nutrition and age of cow are known to have significant effects on calving interval (Mukasa-Mugerwa 1989). Lower CI of local cows was reported by Zelalem Abera et al (2015) 240 days for Boran breed. Higher values for CI were also reported by Zelalem Abera et al (2015) 869 days for Barka cattle and 748 days (Mulugeta Ayalew and Belayeneh Asefa 2013) at Angolellantera. Shorter CI of crossbred cows reported 397.8 and 467.1 days in Markos urban and rural areas, respectively (Zemenu Yayeh et al 2014). Greater CI in crossbred cows was reported 555 days at Bahir Dar and Gondar urban and peri-urban, respectively (Ayenew Alemayehu et al 2009) and lower CI was reported in Bishoftu (390 days) and Akaki Towns (414 days), respectively. This difference might be due to poor management, poor feed quality, environmental difference, difficulties in oestrous detection, genetic variation, and silent heat, long DO, timely insemination and difference in forage production**.**

Calving interval in the study areas was significantly affected by breed type ($p<0.05$). Crossbred dairy cows gave the second calf earlier (637.44 days) than local cows (701.80 days). In the present study, there was significant difference ($p<0.05$) in CI between local cows and their crosses, which is in agreement with the report of McDowell (1985), who stated that in an extensive review of the merits of crossbreeding Bos Taurus and Bos indicus cattle, found that crosses with European breeds calved earlier than local herd-mates, gave more milk per lactation, milked for more days and had slightly shorter calving intervals. Crosses generally performed better than local breeds and had fewer health problems. This finding is in agreement with (Dessalegn Genzebu 2016) who reported shorter values of CI in crossbred cows. The reason for difference in CI between local and crossbred cows could be due to the difference of genetic makeup and management practices (feeding, housing and breeding) for both local and crossbred cows and giving of special attention to crossbred dairy cows. This finding is not in agreement with the finding of (Zelalem Abera et al 2015).

Number of services per conception

The overall average values of NSC for the study areas of local and crossbred dairy cows were 1.80±1.25 and 1.90±1.49, respectively. The overall mean value of NSC is 1.80, which was closer to 1.79 reported by Habtamu Lema et al (2010) for Jersey cattle and the overall mean value of 1.90 found for NSC in this study for crossbred dairy cows was higher than reported for Friesian x Zebu, 1.56 Belay Duguma et al (2012).

Number of services per conception for the study areas was not significantly affected by breed type ($p>0.05$) (Table 2). The numbers of services that need for conception are almost the same 1.80 and 1.90 for local and crossbred dairy cows, respectively. The Number of services per conception depends largely on the breeding system used; being higher under uncontrolled natural breeding and lower where hand-mating or AI is used (Mukasa-Mugerwa 1989).

Number of services per conception in the study areas was not significantly affected by production system for both breeds. In case of local breed, NSC was not significantly affected by production system $p>0.05$. Local cows in the urban and rural production system have almost equal value of NSC. In case of crossbred dairy cows, NSC was not also significantly affected by production system ($p> 0.05$). Crossbred cows in the peri-urban and rural production system have almost equal value of NSC. This finding is in agreement with Million Tadesse et al (2010) who

reported that NSC was not affected by production system.

Days open

The overall average value for days open in the study areas for local dairy cows was 344.7±283.2 days and for the crossbred dairy cows, DO was 222.3±127.8 days. The "days open" period should not exceed 80-85 days, if a calving interval of 12 months is to be achieved (Peters 1984). However, this study showed that the overall mean values of days open of the study areas was 344.7 and 222.3 days for local and crossbred cattle, respectively which is much greater.

Days open in the study areas was significantly affected by breed type (p<0.05) Crossbred dairy cows had short period of days open (222.3 days) than the local cows (344.7 days). Local cows had 122.4 days longer days open than the crossbred cows in the study areas. The finding is in agreement with Melku Meluye (2016), who reported that local cows had longer days open than crossbred cows.

Days open for the study areas was not significantly affected by production system for both breeds. In case of local breeds day open was not significantly affected by production system (p>0.05).

Production traits

Milk yield

The overall average value of daily milk yield of crossbred cows was 5.27±2.13 liters per day, which is less than the report of Dessalegn Genzebu et al (2016) who reported that 11.6±3.1 and 10.8±2.4 liters per day/cows in Bishoftu and Akaki towns, respectively. The average daily milk yield (1.76±0.86 liters) of local cows in the present study was less than from that, reported by Tsegay Lijalem and Gebreegziabher Zeru (2016) which was 1.99 ± 0.06 liters per day per cow, and greater than that, reported by (CSA 2008), which was 1.54 liters in the country. The variation in milk yield across production systems was due to management practices and genetic variations of breeds.

Table 3. The least square mean (LSM) and standard deviations of milk yield at the early lactation (liters), at the mid lactation (liters), at late lactation (liters) and lactation length (months) over the fixed effect of production system and breed type

Factors		N	*	*	*	*	NS
Production system							
Urban	Local	32	2.86±1.44	2.59±1.48	1.52±0.94	2.32±1.29	9.11±2.67
	Cross	44	7.25±2.89	6.54±2.62	4.7±2.06	6.16±2.52	10.33±2.31
Peri-urban	Local	45	1.88±0.63	1.44±0.59	0.95±0.82	1.42±0.68	9.95±3.30
	Cross	16	6.38±2.59	5.26±2.07	4.47±1.52	5.37±2.06	14.07±4.22
Rural	Local	39	1.86±0.57	1.71±0.59	1.12±0.62	1.10±0.77	9.02±2.17
	Cross	23	4.7±1.72	3.65±1.60	2.87±1.52	3.74±1.61	10.56±2.47
Breed			**	**	**	**	*
Local		110	2.2±0.88	1.91±0.89	1.17±0.8	1.76±0.86	9.32±2.67
Cross		84	6.27±2.47	5.35±2.17	4.18±1.75	5.27±2.13	11.28±3.37

MYEL=milk yield at early lactation, MYML= milk yield at mid lactation, MYLL= milk yield at late lactation and LL= lactation length **= significant (p<0.01), *= significant (p<0.05), and N= number of records

Daily milk yield at the early, mid and late of lactations for the study areas was significantly affected by breed type. Crossbred dairy cows had significantly higher daily milk yield at all stages of lactation than local cows (p<0.05).

Lactation length

The overall average lactation length of local and crossbred cows was 9.32±2.67 and 11.28±3.37 months, respectively (Table 3). The lactation length of local cows observed in this study was greater than Gebrekidan Tesfay et al (2012) which were 6.5±1.63 and 7.20±2.50 months in urban and peri-urban production systems, respectively. The lactation length of crossbred cows observed in this study is significantly longer than the lactation length of 9.22±1.17 and 9.36±0.64 months reported for crossbred cows in Bishoftu and Akaki towns, respectively (Dessalegn Genzebu et al 2016). Similarly, another study conducted in North Showa zone indicated that local breeds had shorter lactation length (9.13 months) than crossbreds (11.13 months) (Mulugeta Ayalew and Belayneh Asefa 2013).

Lactation length in the study areas was significantly affected by breed type (p<0.05). Crossbred dairy cows had longer lactation length (11.28±3.37 months) than local cows (9.32±2.67 months) (Table 3). This is in agreement with Niraj Kumar et al (2014) who reported better performance of crossbred dairy cows than local cows in Gondar this was due to management genetic factors.

Results of monitoring study

The average daily milk yield of local cows that was obtained from the monitoring study in the study areas was 1.96±0.450, 1.92±0.405 and 1.89±1.070 liters in urban, peri-urban and rural production

systems, respectively, with an overall average milk yield of 1.91±0.752 liters (Table 4). The average daily milk yield of crossbred dairy cows that was obtained from the monitoring study in the study areas was 7.34±0.81, 6.27±1.19 and 5.42±0.44 liters in urban, peri-urban and rural production systems, respectively, with an overall average milk yield of 6.34±0.81 liters (Table 4).

Table 4. The least square mean (LSM) and standard deviations of average daily milk yield in liters in urban, peri-urban and rural production systems

Blood level	Urban	Peri-urban	Rural	Overall
Local	1.96±0.450	1.92±0.405	1.89±1.070	1.91±0.752
Cross	7.34±0.81	6.27±1.19	5.42±0.44	6.34±0.81

Conclusion

The reproductive performances of dairy cows in all the production systems in the study areas were significantly affected by breed type. Age at puberty, calving interval and days open of crossbred dairy cows in the study areas were shorter than the local breeds; whereas number of service per conception has no significant difference between local and crossbreds. Local and crossbred dairy cows in the urban production system have shorter age at puberty and age at first calving than local and crossbred cows in rural production system. Calving interval, number of service per conception and days open were not significantly affected by differences of production systems for both breeds. The productive and reproductive performance of dairy cows in the rural production system was lower as compared to urban and peri-urban production systems. The production performance at all stage of lactation (early, mid and late) and lactation length of dairy cows in the study areas were significantly affected by breed types. Average milk yield at early, mid and late stages of lactation and lactation length of crossbred dairy cows in the study areas was higher than the local breeds. Daily Milk yield was higher in crossbred dairy cows than local dairy cows. Milk yield at early, mid and late stage of lactation was significantly affected by production system. Milk yield at early, mid and late stages of lactation was higher in local and crossbred cows in urban production than rural production system. However, lactation length was not significantly affected by production system.

The result of monitoring study on milk production per day of dairy cows in the study areas supports the survey study. In all production systems, it was identified that the main constraints for the dairy production were shortage of feed and grazing land (decreased both in size and productivity), then it is disease and poor extension service in terms of credit schemes, supply of improved dairy breeds, accessibility to AI/bull service and veterinary services.

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