Breeding Practices and Reproductive Performance of Crossbred Dairy Cattle in the Urban and Peri-urban Smallholder Dairy Production System of Arsi Highland, Oromia National Regional State, Ethiopia

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Abstract

The study was conducted to assess the breeding practice and reproductive performance of crossbred dairy cattle in the urban and peri-urban smallholder dairy cattle production systems of Tiyo, DigeluTijo and LemuBilbilo districts of Arsi. 260 households were selected and data on herd composition, breeding practice and reproduction were collected using questionnaire. A total of 476 cows were studied for reproductive performances. The herd composition comprises cow (2.8±0.1), heifers (1.3±0.1), calves (1.5±0.1) and breeding bull (0.2±0.03) and was significantly higher in the peri-urban but the same among the three districts. Number of cow comprises highest proportion of the herd in the urban (57.0%) and peri-urban (49.9%) production systems. AI and natural bull service is the mating system practicing in the districts. The use of AI or bull service only or combination of AI and bull services was significantly different between the two production systems and among the three districts. Farmers get AI service either calling to AI technicians and get the service in their farm or taking their cows to AI service center. Farmers trek cow 1.1±0.1 km in the urban and 3.1±0.1km in the peri-urban production system to the AI service center. The mean AFM, AFC, CI and NSPC of crossbred dairy cattle were 24.5±0.3 months, 34.5±0.3 months, 17.1±0.3 months, and 1.96±0.050, respectively. The AFM and AFC were significantly different between the urban and peri-urban production system and in the three districts. Long distance travel to AI service center, repeat breeding and absence of AI service during holidays and weekends were major problems challenging dairy production.

Keywords: Herd composition; Artificial Insemination; reproductive performance; breeding

1. Introduction

Cattle genetic improvement strategy depends on the production objective of a farm that plans to achieve a certain goal, available genotypes and environmental factors. Crossbreeding is the fastest genetic improvement and widely implementing in tropics to exploit the advantage of breed complementarities between high milk producing exotic temperate breeds and low milk producing but highly adapted to harsh tropical environment local breeds. Crossbreeding is major mating system of dairy cattle genetic improvement in Ethiopia. The program started in 1950s using Friesian, Jersey and Simmental sire breed and local cattle dam breeds (EARO, 2001). Though, the cross breeding program have been implemented since long period ago, the total number of crossbred cattle has not exceeded 1.2% of the total cattle population (CSA 2014). The low number of crossbred cattle is due to weak AI coverage, limited inputs, and low AI technician efficiency (GebreMedhin et al. 2009).

Artificial insemination (AI) increases wide area coverage of high genetic value sire's semen to large areas and speedups the rate of genetic improvement. However, the quality of semen, AI technician skill and low level of nutrition to dairy cows are common problems of reducing the reproductive performances.

The low input and harsh environmental factors including high temperature, disease prevalence and husbandry practices (Shiferaw et al. 2003) have significant impact on cow fertility. Besides, time of insemination (Dalton et al. 2001), physiological stress (Dobso and Smith 2000), and limited animal health service reduce fertility rate of dairy cattle and hampers the reproductive success. AI service usually is limited to urban areas in Ethiopia, where the district offices are situated. Therefore, farmers are forced to trek their cow long distance to get the service. When cows are trekked long distances, they are exposed to physiological stress and trauma that result to low conception rate (Dobso and Smith 2000). The low reproductive rate reduces annual herd growth and farm productivity that reduces household farm profitability and milk consumption.

Dairy cattle production systems in Ethiopia are classified into four: mixed croplivestock production, pastoral and Agro-pastoral production, urban and Peri-urban smallholder production, and specialized commercial production systems. Though, the urban and Peri-urban smallholder dairy production systems are classified under same categories, the two production systems have quite different characteristics. The urban dairy production is characterized by specialized and intensive production system, in which better production inputs and market are apparently available (Sintayehu et al. 2008). While the peri-urban dairy production system is of extensive type and the dairy farms are generally located around the major towns and supply its milk to the urban market (Ayenew et al. 2009), in the urban dairy production system, the households, on average, own the smallest herd size of all the types with an average of two cows per farm (Yilma et al. 2011) and they are confined in to small area. In the urban and peri-urban production systems, crossbred and high grade cows are used for milk production and the annual milk production per cow is higher as compared to other production system (Tegegne et al. 2013).

Reproductive performance of dairy cattle influences herd productivity that has implication on farm profitability. Delayed age at first calving, long calving interval, and high number of service per conception decrease the number of calf produced per cow and reduce the total milk production per cows' life time. This increase the total farm inputs to manage the unproductive animals in the herd that reduces farm benefit. It is essential to study the breeding practice and reproductive performance of crossbred dairy cattle under smallholder management system and take corrective management measures in order to increase production.Therefore, the objective of this study is to assess the breeding practice and reproductive performance of crossbred dairy cattle in the urban and peri-urban smallholder dairy cattle production system of Arsi highland.

2. Material and Methods

2.1 Study Area

This study was conducted in three woredas /districts of Arsi highland; Tiyo, DigeluTijo, and LemuBilbilo districts in the urban and peri-urban areas of each Woredas' administrative towns. Asella, Sagure and Bekojie are the administrative towns of Tiyo, DigeluTijo, and LemuBilbiloWoredas, respectively. The three towns are located 175 km (Asella), 203 km (Sagure), and 231 km (LemuBilbilo) from Addis Ababa to the Southeast Ethiopia. The latitude and longitude location of the areas are in the range 7°57′N 39°7′E (Asella), 07°45′N 39°09′E (Sagure) and7°35′N 39°10′E (Bekoji). The agro-ecology of the districts are highland with altitude range from 2,430m (Asella), 2568m (Sagure) and 2810m (Bekoji) and the average minimum and maximum annual temperature in the districts ranges from 10.5-22.8^{o}C (Asella) and 7.9-18.6^{o}C (Bekoji). The districts are characterized by bimodal rain fall in which the main rainy season is from June to September while the short rainy season is from February to April. The average rainfall in the main rainy season is 1147mm at Asella, 1150mm at Sagure and 1033mm at Bekoji (http://en.climate-data.org).

2.2. Dairy Cattle Management

Mixed crop-livestock production is the main agriculture production system in the rural areas of the three districts. Wheat, Barley, Faba bean, and Pea are the major crops produced, while, cattle; sheep, horse and donkey are the main livestock species reared by the rural smallholder farmers. Crossbred dairy cattle are kept for milk production purpose in the three districts and they are more concentrated in the urban and peri-urban dairy production system of the districts. In these production systems, crossbred cattle are fed on natural pasture and industrial by-products. Straw, industrial and local flour milling by products and local brewery residues contribute major feed sources for crossbred dairy cattle in the two production systems. Cattle in the peri-urban area are provided to graze on grazing pasture during wet season and crop aftermath during crop harvesting season. However, in the urban production system, dairy cattle are entirely dependent on indoor feeding.

Crossbreeding is the major cattle genetic improvement for milk production in the areas and crossbred bull and Artificial Insemination are the mating system for crossbreeding purpose. AI is being performed mainly by government AI technicians. However, a few number of private AI technicians provide the service intermittently due to availability and access of AI inputs. Government AI centers are usually established in the towns along with district agriculture offices. Therefore, farmers from all over the areas bring their cow to the AI center in order to get the service. Though the AI centers are located in the towns, some AI technicians travel to rural area weekly and provide the service to the rural communities.

2.3. Sampling Procedure

Three districts (Tiyo, DigeluTijo and LemuBilbilo) are selected because of the high concentration of smallholder crossbred dairy farms. Smallholder dairy producers that have more than one crossbred dairy cow were selected purposely. From the total listed households, 260 households (140 urban and 120 peri-urban production systems) were randomly selected from the three districts.. Household heads or elders in the family were interviewed using pre-tested semi-structured questionnaires. Data on breeding practice such as mating system, how farmer get AI service, and distance travel to AI service center were collected from the households. A total of 476 cows were studied for reproductive performances (age at first mating, age at first calving, calving interval and number of service per conception). The reproductive performance data were collected from crossbred dairy cattle owners. The owners responded by recalling each cow's previous performance.

2.4. Data Analysis

The data collected using questionnaire survey was entered, cleaned and analyzed using statistical package for social studies, SPSS, software (SPSS 2006). Data on breeding practices such as mating system, place of AI service delivery and current AI delivery satisfaction were analyzed using descriptive statistics and the distribution between the two production systems and across the three districts were tested using Chi-square test. Data on herd composition, distance to AI service center and reproductive performance of crossbred cow such as age at first mating, age at first calving, calving interval and number of service per conception were analyzed using general linear model procedure between the two production systems and among the three districts using the model below. The significant difference of the means among the variables was tested using Tukey-Kramer test of at P<0.05. Bar chart is used to show the average number of crossbred cattle (cow, heifer, calf and breeding bull) owned by smallholder crossbred dairy farmers in the two production systems of the three districts.

$Y_{ij} = \mu + a_i + b_j + e_{ij}$ where, Y_{ij} is observed reproductive performance (AFM, AFC, CI and NSPC) value due to the difference of i^{th} production system, j^{th} districts and e_{ij} is the error in the i^{th}production system and j^{th} districts. $\mu$is the overall mean, $\mathbf{a}_i$ is the effect of i^{th} production system (urban and peri–urban), $\mathbf{b}_j$is the difference in j^{th} districts (Tiyo, DigeluTijo and LemuBilbilo) and e_{ij}random error.

3. Result

3.1. Herd Composition

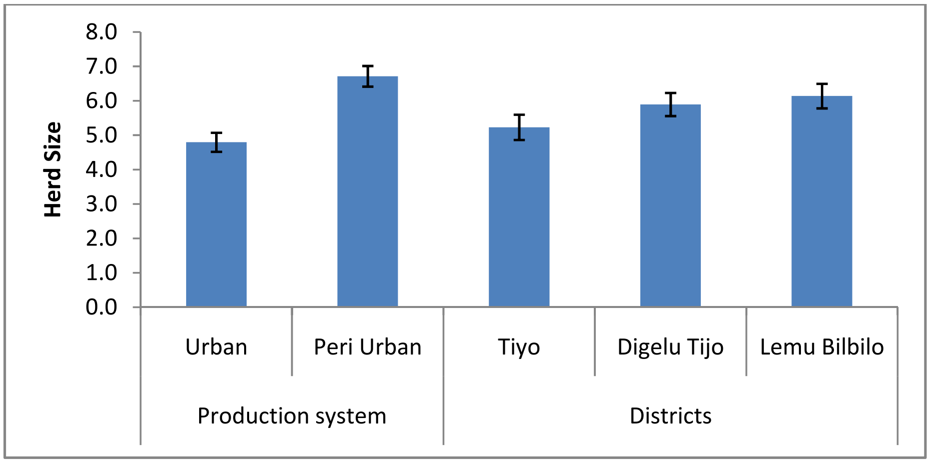
The main objective of smallholder crossbred cattle producers is milk production. From the 260 smallholder herds, total of 1474 crossbred dairy cattle were studied. From these herd, the number of cows, heifers, calves and breeding bulls were 724, 321, 377 and 52, respectively. The overall herd size per household in the study districts was 5.6±0.2 and it was significantly different in the urban (4.8±0.3) and peri-urban (6.7±0.3) at P<0.001 but same across the three districts. Each household in average possess 2.6±0.2, 2.8±0.2, and 2.9±0.2 crossbred cows in Tiyo, DigeluTijo and LemuBilbilo districts, respectively. The mean number of crossbred cows per household in the urban and Peri-urban production systems were 2.6±0.1 and 3.1±0.1, respectively and the number is significantly different (P<0.01) between the two production systems. The number of cows comprises 53.6% of total herd (57.0% in the urban and 49.6% in the Peri-urban production systems). The mean number of calves, heifers and bull in the three districts are 1.5, 1.3 and 0.2, respectively, and the herd composition is significantly different (P<0.01) in the two production systems. Few households in the peri-urban production system keep crossbred bull (Figure 1). The number of bull comprises 3.5% of the total herd and keeps for natural mating when AI service is inaccessible.

Table 1, Mean ± SE of mean of crossbred dairy cattle in the urban and peri-urban smallholder production system

Variables	**Class of crossbred cattle**			
	Cow	**Heifers**	**Calves**	**Breeding Bull**
Overall mean	2.8±0.1	1.3±0.1	1.5±0.1	0.2±0.03
Districts	ns	Ns	ns	Ns
Tiyo	2.6±0.2	1.1±0.1	1.2±0.1	0.2±0.1
DigeluTijo	2.8±0.2	1.2±0.1	1.6±0.1	0.3±0.1
LemuBilbilo	2.9±0.2	1.4±0.1	1.5±0.1	0.2±0.1
Production system	**	**	**	**
Urban	2.6±0.1	0.9± 0.1	1.2± 0.1	0.1± 0.04
Peri Urban	3.1± 0.1	1.6± 0.1	1.7± 0.1	0.3± 0.1

Se = Standard error; ns = non-significant; * significant at P<0.05; ** significant at p<0.01

Figure 1, Smallholder crossbred dairy cattle herd composition in the urban and peri-urban production system of Arsi



3.2. Breeding Practices

The type of cattle breeding practice in the present study districts is crossbreeding. The mating system is artificial insemination (AI) and natural mating (Table 2). Large proportion of smallholder dairy farmers in the urban production system uses AI service only (93.6% in Tiyo, 80.9% in DigeluTijo and 58.7% in LemuBilbilo districts) as compared to households in the Peri-urban production system (24.2% in Tiyo, 50.0% in DigeluTijo and 23.7% in LemuBilbilo). While, high proportion of farmers (47.1%) in the Peri-urban production system uses both AI and bull services,the use of AI service, natural mating or both AI service and natural mating were significantly different in the urban and peri-urban production systems ($\chi2=21.13$; $P<0.001$) and in the three districts ($\chi2=54.73$; $P<0.001$). Farmers usually use bull service when a cow failed to conceive after repeat AI service or if AI service was not available.

Table 2, Mating system (%) of crossbred dairy cattle in the urban and peri-urban smallholder production system

Variables	Mating method			$\chi2$	P Value
	Natural /use of bull	AI service	Both AI and Bull		
Districts					
Tiyo	15.0	65.0	20.0		
DigeluTijo	6.3	65.3	28.4	21.13	0.001
LemuBilbilo	7.1	42.9	50.0		
Production system					
urban	1.4	77.9	20.7		
Peri urban	18.5	34.5	47.1	54.73	0.001

$\chi2$ = chi-square value; P value = probability of significance difference

Smallholder crossbred dairy farmers get AI service either calling to the AI technician or they take cows to AI service center (Table 3). The result revealed that most farmers (84%) in DigeluTijo and LemuBilbilo districts take their cow to the AI service center. While, large percentage of crossbred dairy farmers in the Tiyo district (74.6%) call to the AI technicians and get the service in their farm. In spite of the different methods how the farmers get AI service, large proportion of crossbred dairy farmers (74.4%) in the urban production system revealed that they are satisfied with the current AI service provided in the area, while, 59.2% of the farmers in the peri-urban production system was not satisfy with the AI service. As a result, crossbred dairy cattle producers in the urban production system get better AI service than crossbred dairy farmers in the peri-urban production system ($\chi2$ = 26.6; $P<0.01$). However, the AI service providing across the three districts are not significantly different ($\chi2$ = 2.39; $P>0.05$).

Table 3, Place where crossbred dairy farmers get AI service (%) in the urban and peri-urban production system of Arsi Highland

Variables	Place farmers get AI service		χ2	P value
	AI service Center	On-farm		
Districts				
Tiyo	25.4	74.6		
DigeluTijo	84.1	15.9	74.43	0.000
LemuBilbilo	84.2	15.8		
Production system				
Urban	61.0	39.0		
Peri Urban	75.8	24.2	5.52	0.019

As it is described in Table 3, smallholder dairy farmers get AI service either taking their cow to AI service center or calling the AI technicians and get the service in their farm. Large proportion of crossbred dairy cattle owners take their cows to the AI service center and the AI service is significantly different ($\chi2=5.52$; $P<0.05$) in the two production systems. Comparing the three districts, most dairy farmers in the Tiyo districts (74.6 %) call to the AI technician and get the service in their farm, while smallholder dairy farmers in DigeluTijo (84.1%) and LemuBilbilo (84.2%) take their cows to AI service center and the service is different in the three districts ($\chi2=74.4$; $P<0.001$). The mean distance farmers trek cows to get service in the urban and peri-urban production systems was 1.1±0.1km and 3.1± 0.1km, respectively (Table 4). The distance farmers travel to get the AI service were significantly different ($P<0.05$) in the three districts; Tiyo (1.9±0.2 km), DigeluTijo (2.1±0.1 km) and LemuBilbilo (2.3±0.1km). The least distance a cow travel to AI service center was in the Tiyo district. The maximum distance farmers take their cows to the center was in the peri-urban production system of DigeluTijo and LemuBilbilo districts (range of 0.2 to 7km).

Repeat breeding and absence of AI service during holidays and weekends challenge the breeding practice of crossbred dairy cattle under smallholder management system. The smallholder dairy farmers in the Tiyo (71.4%), DigeluTijo (74.7%) and LemuBilbilo (82.1%) districts revealed that they frequently encountered repeat breeding problem. 86.1% of the urban and 63.3% of the peri-urban smallholder crossbred dairy farmers reported repeat breeding problem. Concerning the regularity of AI service, 31.8% smallholder dairy producers in the urban and 68.2% in the peri-urban production system do not get regular AI service during holidays and weekends. The distribution of farmers that did not get regular AI service is 37.3, 56.8 and 57% in the Tiyo, DigeluTijo and LemuBilbilo districts, respectively.

Table 4, Mean±SE, minimum and maximum distance farmers take their cow to AI service center in the Urban and Peri-urban production system of Arsi Highland

Variables	Mean distance	Minimum	maximum
Overall	2.1±0.1	0.13	7.0
Districts	*	-	-
Tiyo	1.9±0.2[a]	0.20	5.0
DigeluTijo	2.1 ±0.1[b]	0.20	7.0
LemuBilbilo	2.3±0.1[b]	0.13	7.0
Production system	**	-	-
Urban	1.1±0.1	0.13	3.0
Peri Urban	3.1± 0.1	0.20	7.0

SE = standard Error; * significant at P<0.05; ** significant at P<0.01; means with different superscript letter are different

Table 5, Percentage of smallholder crossbreed dairy farmers satisfied with the current AI service in the urban and peri-urban production system

Variable	Are you satisfied with current AI service?		$\chi 2$	P-Value
	Yes	No		
Districts				
Tiyo	53.5	46.5		
DigeluTijo	60.7	39.3	2.39	0.302
LemuBilbilo	66.2	33.8		
Production System				
Urban	74.4	25.6		
Peri Urban	40.8	59.2	26.6	0.001

$\chi 2$ = chi-square value; P value = probability of significance difference

3.3 Reproductive Performance

The mean and standard deviation of crossbred dairy cow reproductive performance in the urban and peri-urban production system is summarized in Table 6. The age at first mating (AFM) of crossbred dairy heifer in this study is 24.5±0.3 months. The AFM vary across the three districts ($P<0.05$) and the urban and peri-urban production systems ($P<0.01$). Heifers mate at earlier age in the urban production system (23.6±0.4 months) as compared to in the Peri-urban production system (25.5±0.4 months). Early AFM of crossbred dairy heifer was observed in the DigeluTijo district (23.4±0.5 months) and late AFM was found in LemuBilbilo district (25.7±0.5 months). The AFC of crossbred dairy cattle was found 34.5±0.3 months and the trait is significantly different ($P<0.01$) in the urban (33.7±0.4) and peri-urban (35.4±0.4) production systems and across the three districts ($P<0.05$). The highest AFC was observed in LemuBilbilo district (36.0±0.5 months) and in the per-urban production system of the three districts (35.4±0.4 months).

The mean calving interval of 435 crossbred cows under smallholder management was 17.1±0.3 months. The CI performance of crossbred dairy cow was not significantly deferent (P>0.05) between the urban (16.8±0.4 months) and peri-urban (17.4±0.4 months) production systems and across the three districts (Table 6). The study result revealed that the number of service per conception is 1.96±0.05 and it was found no significant difference among the three districts (P>0.05). However, the NSPC in the urban production system is 2.1±0.1 and is significantly higher (P<0.01) than the performance of crossbred cow in the peri-urban production system (1.8±0.1).

Table 6, Mean ± SE of reproductive performance of crossbred dairy cow in the urban and peri-urban production system

Variables	AFM	AFC	CI	NSPC
N	467	466	430	449
Overall mean	24.5±0.3	34.6±0.3	17.1±0.3	1.9±0.05
Districts	*	*	ns	ns
Tiyo	24.6 ± 0.5^{ab}	34.1 ± 0.5^{b}	16.6±0.5	1.9±0.1
DigeluTijo	23.4 ± 0.5^{b}	33.7 ± 0.5^{b}	17.3±0.5	1.8±0.1
LemuBilbilo	25.7 ± 0.5^{a}	36.0 ± 0.5^{a}	17.5±0.5	2.1±0.1
Production System	**	**	ns	**
Urban	23.6±0.4	33.7±0.4	16.8±0.4	2.1±0.1
Peri-Urban	25.5±0.4	35.4±0.4	17.4±0.4	1.8±0.1

AFM = age at first mating; AFC = age at first calving, CI = calving interval; NSPC = number of service per conception; N = Number of animal; SE = Standard Error; means with different superscript letters are different; ns = non significant *significant at P<0.05; ** significant at P<0.001

4. Discussion

4.1. Herd Composition

The proportion of crossbred dairy cattle in a herd indicates the number of individual cattle actively involved in production. Productive herd comprises more number of milk producing cow and growers for future herd replacement. The proportion of cows in the herd comprises 53.6% of the total herd. However, the urban smallholder crossbred dairy farmers' posses 57% of cows in the herd, which is similar to the report of Weleregay et al. (2012) in Hawassa city urban dairy farm. As it is described in Table 1, the households in the urban production system possess significantly low ($P<0.01$) number of cows, heifers and calves as compared to the peri-urban production system. However, the number of crossbred cattle has no difference across the three districts. The smallholder dairy cattle farmers kept more number of calves and heifers for herd replacement. Male calves in urban production system are culled from the herd at their early age to minimize farm expense. Therefore, female calves hold the higher proportion of the total calf number in this production system. However, male calves in the peri-urban production system retain in the herd for future use as source of power and bull for natural service (Figure 1). The variation in the number of crossbred dairy cattle in the two production systems could be due to available land size, feed source and inputs (Sintayehu et al. 2008; Weleregay et al. 2012). Households that have large land size, better feed source and enough labor hold large number of crossbred dairy cattle. Crossbred cattle in the urban production system are kept under small and much confined area, which is constructed in the compound usually appended to the main living house. Milk market availability also determines the number of crossbred dairy cattle per household. In the present study, districts cost of animal feed exceed the price of milk sold at market. Unavailability of feed and high cost challenge dairy production under smallholder farmers' management system. As a result, farmers are forced to reduce the number of crossbred animals in their farm.

4.2. Breeding Practices

Crossbreeding is the sole means of cattle genetic improvement for milk production in Ethiopia. It is the fastest way of genetic improvement and employs breed compatibility of two genetically different genotypes; high milk producing temperate breed with low producing but tropical environment adapted local breeds. This breeding strategy is comparatively used in the tropics in wide range of areas and Artificial Insemination is the mating system in the crossbreeding program. However, due to limited distribution and in accessibility of AI service, farmers use available crossbred bull for alternative breeding purpose. In this study, 77.9 % crossbred dairy farmers in the urban production system use AI service, while 1.4 % farmers use bull service only. In this production system, 20.7% farmers use both AI and bull service. These farmers use bull service when AI service is not available or when a cow failed to conceive of repeated AI service. The number of farmers who keep breeding bull is very few especially in the urban production system. This might be due to limited land size and feed source (Mugisha et al. 2014)

The highest proportion of crossbred dairy cattle farmers in the peri-urban production system (74.4%) revealed that they were not satisfied with the current AI service being provided in the area. The study revealed similar result with the report of GebreMedhin et al (2009), in which 93.1% of farmers dissatisfied with the AI service in Ethiopia. This might be because farmers travel long distance to the AI service center and absence of AI service during weekends and holidays (GebreMedhin et al. 2009). Though, farmers in the peri-urban production system reported that they were not satisfied with the AI service, the NSPC found significantly low ($P<0.01$) as compared to smallholder crossbred farmers who replied that most of them was satisfied with the current AI service in the urban production system (Table 5). As a result, the farmers in the production system use bull service either as the only mating system (18.5%) or both bull and AI service (47.1%).

Farmers in Tiyo district (74.6 %) call the AI technicians to get the service in their farm. Rather than calling to AI technicians, large proportion of smallholder crossbred dairy farmers (84 %) in the DigeluTijo and LemuBilbilo districts take their cows to the AI service center. As a result, farmers in the peri-urban production system travel on average 3.1 km to AI service center. The AI service center of the districts is usually located in the urban areas. However, AI technician of some districts travel to the peri-urban areas and provide the AI service on a weekly based insemination program. This program might result in an untimely insemination and cause low pregnancy rate. The present finding revealed farmers' travel lower distance to get the AI service as compared reports from other districts in the country, in which they travel nearly 28km to the AI service area (GebreMedihin et al. 2009).

Besides long distance farmers travel to get AI services, repeat breeding and absence of AI service during holidays and weekends challenges crossbred dairy producers. Repeat breeding is reported a major challenge in urban (86.1%) and peri-urban (63.3%) production systems. The comparative low repeat breeding problem in the peri-urban production system might be due to the fact that the dairy farmers in this production system usually use bull when a cow failed to conceive after AI service or AI service not available.

4.3. Reproductive Performance

4.3.1. Age at first mating

The present finding revealed that the age at first mating of crossbred dairy heifers was 24.5±0.3 months, which vary from 23.6±0.4 months in the urban to 25.5±0.4 months in the Peri-urban production systems. This finding is in line with the previous reports; 25.6 months (Mureda and Mekuriaw 2007) and 24.9 months (Dinka 2012) under smallholder management systems in DireDawa and in Asella towns, respectively. The report also found the same with crossbred dairy cattle in the urban and Peri-urban areas of Mekele town (Mekonin, 2015) Ethiopia, while slightly lower age at first mating (23.2 months) was reported to crossbred dairy cattle in Gondar town (Nuraddis et al. 2011).

A higher AFM, was reported for different exotic gene levels of crossbred dairy cattle in on-station management, 30.9 months in Assela livestock dairy farm (Negussie et al. 1998), and 32.9 months in Cheffa state farm of South Wollo districts (Goshu and Hagde 2003). The variation on age at first mating of heifer might be dependenton the difference in cattle management, feed availability, genetic group, season of calving (Birhanu et al. 2015, Tesfaye et al. 2015). Poor nutrition reduces the physiological maturity and delay the age at first mating and conception (Butler 2000). The lower age at first mating in the urban production systems might be due to better animal management as compared to the Peri-urban production system. Cattle management including better feeding, animal health care and housing system is relatively better in the urban production system as compared to peri-urban production system.

4.3.2. Age at first calving

The age at first calving of crossbred dairy cow under smallholder management vary with the production system and across the three districts. Late at first mating increase the age at first calving and this reduces the number of calves per cows' life time. The present report on the age at first calving of dairy heifers was found same with different report under smallholder management system in the country. Previous report on AFC trait of crossbred dairy cow in Asella town was 34.8 months (Dinka 2012). Similarly, the AFC of crossbred cows in the urban and peri-urban area of Mekele town was reported 35.3 months (Mekonnin 2015). However, other on-farm reports in different production systems revealed low AFC of crossbred dairy cows as compared to the present result; 32.1 months in and around Zeway town (Yifat et al. 2009), 32.4 months in and around Gondor town (Moges. 2012). The on-farm reports on AFC of crossbred dairy cows were found lower than AFC on station reports; 40.6 months (Birhanuetal. 2015), and 42.5months (Efra et al. 2011). The differences might be due to type of management, breed group, year and season of calving (Effa et al. 2011, Birhanu et al. 2015). The high AFC of on-station report implied private smallholder dairy cattle farmers manage the reproduction of their cattle mate heifers at earlier age as compared to the on-station government owned dairy farms.

4.3.3. Calving interval

Calving interval (CI) is the period between two consecutive calving. It is determined by the number of service per conception and the onset of postpartum estrous. The mean calving interval of crossbred cows under smallholder management was 17.1±0.3 months. As it is described in Table 5, the CI in this report did not show significant difference between the urban and peri-urban production systems and across the three districts. The mean calving interval of crossbred dairy cow in this report was found higher than the report of Dinka (2012) in Asella town, Yifat et al (2009) in the rift valley area, and Moges (2012) and Kumaret al (2014) in Northwest Ethiopia under smallholder crossbred dairy cattle management systems. The difference might be due to management (Tesfaye et al. 2015). Genetic differences have significant effect on calving interval in which local breed cow show the highest CI as compared to their crosses with exotic dairy breeds (Biranu et al. 2015). Though, the management system in the urban and peri-urban production systems in the present study seems different, the trait found the same in the two production systems. The result agrees with and supported by the report of Fekede and Mekasha (2014). They have concluded that production system had no effect on CI. However, Moges (2012) has reported significant difference CI of crossbred dairy cattle between the urban and peri-urban production system in Gondor, Northwest Ethiopia. Availability of feed has significant effect on CI. Poor feeding cause negative energy balance of high producing cow and delays postpartum estrus (Butler 2000; Butler 2003) that prolong calving interval.

4.3.4. Number of service per conception

The mating system in the present study production systems was found only AI or combination of AI and natural mating. Therefore, the mean and standard deviation of NSPC in the present study was 1.96±0.05 and the result was found significantly higher ($P<0.01$) in the urban (2.1±0.1) as compared to the peri-urban (1.8±0.1) production systems. The difference between the two production systems might be due to the mating system, in which large proportion of farmers (65.6%) use either natural mating only or both AI and natural mating. Therefore, natural mating might reduce the number of service per conception as compared to use of sole AI service. Beside to mating system, absence of AI service during weekends and holidays increase the NSPC of cow due to untimed insemination.

The present result does not agree with the report of Ayenew et al. (2009) and Kumar et al. (2014), which revealed that NSPC of crossbred dairy cattle in urban production system is lower than peri-urban production system. Similarly, the NSPC in this report was found to be higher as compared to 1.88 (Gebremedihin et al. 2009), 1.8 (Kumar et al. 2014), 1.63 (Yifat et al. 2009), 1.62 (Shiferaw et al. 2003), and 1.5 (Dinka 2013) in smallholder crossbred dairy farm management system. However, this finding is in line with the NSPC report on crossbred dairy cow under on-station management system (Negussie et al. 1998) and it was lower than the NSPC of dairy cattle in urban farm (Lemma and Kebede 2011). The variation of NSPC among the different reports could be due to genotype, management system and breeding method. Cow fertility determines NSPC and fertility is influenced by nutrition (Butler 2003), management system, AI inputs, and poor semen quality (Bekana et al. 2005, Gebremedihin et al. 2009). Beside, the NSPC vary with genotype, age of cow, season of insemination and production system (Yifat 2009, Kumar et al. 2014).

5. Conclusion

Crossbred dairy herd composition indicates the number of cattle involved actively in production and number of growers for future herd replacement. Smallholder crossbred dairy farmer keep more number of cows and heifers to ensure the continuity of farm productivity. The number of cattle in the herd varies in each production systems. The peri-urban smallholder dairy producers possess higher number of crossbred cattle than urban producers. The peri-urban farmers own male cattle to use as source of power for crop production and bull for natural service due to limited AI service. Urban crossbred dairy producers are much closer to the urban milk market. As a result they posses higher proportion of cows (57.0%) in the herd as compared to farms in the peri-urban production system (49.6%).

Artificial Insemination and natural bull services are the two major mating systems being implemented in the urban and peri-urban production system of the three districts. The smallholder farmers in the peri-urban system commonly use natural mating as compared to crossbred cattle producers in the urban production system. This is because the inaccessibility of AI service due to long distance they travel to AI service center, repeat breeding and absence of service during holidays and weekends. These are major problems of urban smallholder crossbred dairy farmers. However, due to limited availability of bull service in the urban production system the NSPC is the highest in this production system.

Smallholder crossbred dairy farmers access AI service either calling to the AI technician and get the service at their farm or taking their cows to AI service center. The AI centers are found in the town of the districts and the AI service is usually provided in the center. As a result, the AI technicians usually provided the AI service at the service center. Farmers in the peri-urban production system trek their cow long distance to get the AI service in the town. The long distance causes physiological distress that affect cows' fertility. Repeat breeding, absence of AI service during weekends and holidays resulted in most farmers to dissatisfy on the current AI service. Delayed AFM and AFC of crossbred dairy cattle were observed in the urban and peri-urban production system. However, the CI and NSPC of the dairy cattle in the two production systems are within the normal range as compared to different reports. Besides, the AFM and AFC are lower in the urban production system as compared to the peri-urban production system. This difference is due to the urban production system employee better animal management, better feed available and access to regular AI service.

6. References

Ayenew YA, WurzingerM, Tegegne T and ZollitschW, 2009. Performance and limitation of two dairy production systems in the North western Ethiopian highlands. Tropical Animal Health and Production, 41(7): 1143-1150.

Bekana M, Gizache A and Regassa F, 2005. Reproductive Performance of Fogera Heifers Treated with Prostaglandin F2a for Synchronization of Estrus. Tropical Animal Health and Production, 37, 373-379.

Birhanu T, Mohammed T, Kebede K and Tadesse M, 2015. Productive and Reproductive Performances of Ethiopian Boran Cattle with Different

Levels of Holstein Friesian Inheritance. American-Eurasian Journal of Scientific Research, 10 (5): 278-286.

Butler WR, 2003. Energy balance relationships with follicular development, ovulation and fertility in postpartum dairy cows. Livestock Production Science, 83(2–3): 211–218.

Butler WR, 2000. Nutritional interactions with reproductive performance in dairy cattle. Animal Reproduction Science, 60–61: 449–457.

CSA, 2014. Federal Democratic Republic of Ethiopia CentralStatistical Agency Agricultural Sample Survey, Volume II. Report on Livestock and Livestock Characteristics (Private Peasant Holdings). Statistical Bulletin, 578. PP188.

Dalton JC, Nadir S, Bame JH, Noftsinger M, Nebel RL and Saacke RG, 2001. Effect of Time of Insemination on Number of Accessory Sperm, Fertilization Rate, and Embryo Quality in Non lactating Dairy Cattle. Journal of Dairy Science, 84:2413–2418.

Dinka H, 2012. Reproductive performance of crossbred dairy cows under smallholder condition in Ethiopia. International Journal of Livestock Production, 3(3): 25-28

Dobson, H. and Smith, R.F., 2000. What is stress, and how does it affect reproduction? Animal Reproduction Science, 60–61: 743–752.

Effa K, Wondatir Z, Dessie T and Haile A, 2011. Genetic and environmental trends in the long-term dairy cattle genetic improvement programmes in the central tropical highlands of Ethiopia. Journal of Cell and Animal Biology, 5(6):96-104.

Ethiopian Agricultural Research Organization (EARO), 2001. Back ground paper on developing animal breeding policy. A working paper. January, 2001. 21pp

Fekade N and Mekasha Y, 2014. Assessment of milk production and reproductive performances in urban and secondary town dairy production systems in Adama milk shed, East Shoa Zone, Oromia National Regional State, Ethiopia. International Journal of Agricultural Sciences, 4 (2): 106-110.

GebreMedhin D, Bekana M, Azage A and Belihu K, 2009. Status of Artificial Insemination Service in Ethiopia. In Climate change, livestock and people: Challenges, opportunities, and the way forward. ZelalemYilma and Aynalem Haile (Eds). In Proceedings of the 17th annual conference of the Ethiopian Society of Animal Production (ESAP), held in Addis Ababa, Ethiopia, September 24 to 26, 2009

Goshu G and Hagde BP, 2003. Age at first calving, calving interval and milk yield performance of Friesian-Boran crossbred cattle at Chefa state farm, Wollo, Ethiopia. Bulletin of Health and Production in Africa, 51:190-197.

Kumar N, Eshetie A, Gebrekidan B and Gurmu EB, 2014. Reproductive performance of indigenous and HF crossbred dairy cows in Gondar, Ethiopia. Journal of Agriculture and Veterinary Science, 7(1): 56-61.

Lemma A and Kebede S, 2011. The effect of mating system and herd size on reproductive performance of dairy cows in market oriented urban dairy farms in and around Addis Ababa. Revue Médecine Vétérinaire,162 (11): 526-530.

Mekonnin AB, Harlow CR, Gidey G , Tadesse D, Desta G, Gugssa T and Riley SC, 2015. Assessment of Reproductive Performance and Problems in Crossbred (Holstein Friesian X Zebu) Dairy Cattle in and Around Mekelle, Tigray, Ethiopia. Animal and Veterinary Sciences, 3(3): 94-101.