Assessment of Reproductive Performance of Crossbred Dairy Cattle among Dairy Farms in and Around Addis Ababa, Central Ethiopia

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Abstract: Information about the reproductive performances of dairy cows in smallholder urban and peri-urban dairy farms is limited in the tropics in general and Ethiopia in particular. A cross-sectional study design supported by questionnaire survey and observation was carried out from January 2016 to April 2016 at randomly selected dairy farms in and around Addis Ababa, with the specific objectives to assess the reproductive performances of crossbred dairy cattle on dairy farms in Bishoftu town, Akaki Kaliti and Kolfe Keranio subcities. About 389 dairy cows with history of one and more than one parity was purposively selected from 18 dairy farms from large, medium and small scale dairy production systems. Eighteen farm owner/managers and 12 artificial insemination technicians were interviewed. The data was analyzed using the Statistical Package for the Social Sciences version 20 to study variation of the reproductive performances traits among the study sites and scale of production. The mean age at first services (22, 23.2 and 23.2 months), age at first calving (32.7, 33 and 33.3 months), calving interval (431, 439 and 441.7 days), milk yield per day (12.2, 11.2 and 11 liters), lactation length (9.9, 9.7 and 9.8 months), calving to conception interval (151, 159 and 164 days) and number of services per conception (1.9, 1.93 and 1.96 /straw) in Bishoftu, Akaki kality and kolfe keranio, respectively. Age at first service and age at first calving was significantly different ($p<0.05$) among the study sites. The reproductive performance with in large scale production was better than small and medium scale dairy production. It was concluded that most reproductive performance of crossbred cows owned by dairy farms was good as compared to other authors result, but not as expected from commercial dairy herd. Based on the findings, efficient heat detection and timely insemination, good management practice and efficient and committed artificial insemination technicians were recommended to improve reproductive performance over the area.

Key words: Artificial Insemination · Crossbreed Cows · Questionnaire · Reproduction Performance · Addis Ababa

INTRODUCTION

Livestock production plays important role to human health and poverty alleviation in Ethiopia. The cattle production gives multi-purpose role where cattle provide milk, meat, fertilizer, fuel, draft power and also as a means of economic uplift from the sale of milk and milk products [1]. Ethiopia is believed to have the largest livestock population in Africa. The livestock sector has been contributing considerable portion to the economy of the country and still promising to rally round the economic development of the country. The total cattle population for the country is estimated to be about 53.99 million.

Out of this total cattle population, the female cattle constitute about 55.48 percent and male 44.52 percent. On the other hand, 98.95 percent of the total cattle in the country are local breeds. The remaining are hybrid and exotic breeds that accounted for about 0.94 percent and 0.11 percent, respectively [2].

Like most dairy production systems found in the tropics, the Ethiopian dairy production system includes large numbers from small to large sized and subsistence to market oriented farms. The reproductive performance of the breeding female is probably the single most important factor that is a prerequisite for sustainable dairy production system and influencing the productivity [3].

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Genetic improvement of the indigenous cattle basically focusing on cross breeding has been practiced for the last five decades. The success of dairy production in general and crossbreeding programmes in particular needs to be monitored regularly by assessing the productive performances under the existing management system. However, information is limited about the productive performances of dairy cows in smallholder urban and peri-urban dairy farms in the tropics in general and Ethiopia in particular [4].

Artificial insemination service has been considered as a significant vehicle to upgrade the existing reproductive performances of cattle breeds by implementing the crossbreeding programme in order to increase the cattle production. Breeding of cattle is mostly uncontrolled in Ethiopia making genetic improvement difficult and an appropriate bull selection criteria have not yet been established applied and controlled. Although artificial insemination (AI), the most commonly used and valuable biotechnology [5], has been in operation in Ethiopia for over 30 years the efficiency and impact of the operation have not been well documented [6]. Reproductive problems related to crossbreed dairy cows under farmers' conditions are immense. It is widely believed that the AI service in the country has not been successful to improve reproductive performances of the dairy industry [7]. From the previous scanty study, AI service is weak and even declining due to inconsistent service delivery in the smallholder livestock production systems of the Ethiopian highlands [8]. The problem is more aggravated by wrong selection and management of AI bulls along with poor motivations and skills of inseminators [9].

Reproductive performances of cattle are influenced by feed, genetics, disease and management practices [10]. Livestock productivity in Ethiopia is poor due to a number of reasons among which is the low genetic capacity of the indigenous cattle to be blamed. In Ethiopia, the poor genetic potential due to substandard feeding, poor healthcare and management practices are the main contributors to low productivity of dairy cattle [11].

Currently, a large number of smallholder dairy farms are operating in the study areas. However, information on productive and reproductive performance of crossbred dairy cows in the study area is not well documented and is relatively limited. Hence, there is a need to periodical evaluation of reproductive and productive performance of dairy cattle and factors affecting their performance. Therefore the present study was undertaken to assess the reproductive performances of crossbred dairy cattle in Bishoftu, Akaki kaliti and Kolfe keranio at large, medium and small scale production.

General objectives of this paper was to assess the reproductive performance of crossbred dairy cows kept in small, medium and large scale dairy production in urban and peri-urban dairy farms in and around Addis Ababa.

The specific objectives of the study were:

- To evaluate the reproductive performances of crossbred dairy cows on farmers' perspective with in selected farms at Bishoftu, Akaki kaliti, kolfe keranio.
- To compare reproductive performance of dairy cows based on scale of production system.
- To identify major artificial insemination service problems at study area

MATERIALS AND METHODS

Study Area: The study sites were purposively selected because they are national milk belt of Ethiopia. Moreover, breeding in these areas is predominantly done by AI and it is source of improved breeds to the new establishments of dairy farms. The study was conducted in randomly selected small, medium and large / commercial dairy farms located in and around Addis Ababa (Akaki Kaliti, Kolfe Keranio and Bishoftu) from January to April 2016.

Addis Ababa: Addis Ababa is a capital city and administration center for federal democratic republic of Ethiopia. It lies between 8°55´ and 9º07´North and 38º4´and 38º50´East situated in the central highlands of Ethiopian. The altitude of Addis Ababa is 2500m above sea level and has an estimated human population of more than three million. The long rainy season extends from June to September with annual average rainfall of 1000 mm and 16°C annual daily temperature. Addis Ababa has a relative humidity varying between 70 and 80 percent during rainy season and between 40 and 50 during dry season [12].

Bishoftu: Bishoftu is located at 45 km along South East of Addis Ababa. The area is located at 9°N latitude and 40°E longitude with an elevation of 1850 m above sea level, with annual rain fall of 866 mm of which 84% is in the long rainy season namely June to September [13]. The annual average temperature ranges from 12.3 ºC to 27.7 ºC with an overall average of 18.7 ºC. The soil and climate are similar to those in many highland areas in Ethiopia. It is an important town where most governmental institutions, national and international research centers are located. Cattle, small ruminant, poultry and equines are the major livestock species kept with fast growing small holder dairy production [14].

Study Design: Cross-sectional study design which was supported by questionnaire survey and observation was carried out from January to April 2016 in dairy farms found in and around Addis Ababa.

Study Population: The study population was the dairy cattle population found in Akaki Kaliti, Kolfe Keranio and Bishoftu town, dairy cows with one and more than one parity was selected for the study from large, medium and small scale dairy production system. The sampling unit was individual dairy cows owned by dairy farms.

Sampling Procedures: Eighteen dairy farms were selected randomly from three study sites. From each study sites six farms with different scale of production were selected (three small, two medium and one large scale dairy production). From these farms 389 cows with one and more than one parity were purposively selected. Dairy farms were selected by making use of multistage sampling e. i. Sub-cities, Woredas, Kebeles and dairy farms. An individual cow was considered as elementary / sampling units.

Data Collection

Questionnaire Survey: Structured questionnaires were prepared for dairy farm owners (farm managers), to gather information about individual cow data and farm data and artificial insemination technicians (AITs') to get information on Artificial insemination (AI) service problems. The questionnaire was pretested with a pilot study, which was conducted in Fiche town other than the current study areas for clarity and incorporation of relevant points.

During the interview process, every respondent included in the study were briefed about the objective of the study before starting presenting the actual questions.

Briefing was carried out by the principal investigator. Then self administered questions were presented to the respondents with Oromiffa and Amharic language based on the interest of respondents and the data also taken from records (for farm which had record books).

Data Management and Statistical Analysis: All data were entered in to Ms-Excel spread sheet after the completion of data collection work from the study area. The data were properly coded and screed to avoid errors. The analysis was conducted by using of SPSS version 20. The data was summarized using descriptive statistics and the statistical difference of reproductive performance traits among study sites and different scale of dairy production system were indicated by Chi-square (χ^2).

RESULTS

Description of Study Animals and Farms: A total of 389 crossbred dairy cows from small, medium and large scale dairy production system were assessed in the study. The farms were categorized in to small, medium and large based on their herd size. That is dairy farm with < 10 head of cattle were categorized as small, farm with >10 and <50 head of cattle categorized as medium while farm with <50 head of cattle were classified as large scale dairy production system [15]. The dairy farms observed were predominantly small scale types (Table 1). The reproductive performances of the crossbred dairy cows in the three sites were compared to assess their suitability to different scale of production system and management practices. Reproductive traits were age at first service, age at first calving, calving interval, calving to conception interval and number of service per conception.

Table 1: Number of observed dairy farms and their sizes of production

Farm site	No. of cows	percentage	Scale of production			
			Large	Medium	Small	Total
Bishoftu	148	38	1	2	3	6
Akaki kaliti	110	28.3	1	2	3	6
Kolfe keranio	131	33.7	1	2	3	6
Total	389	100	3	6	9	18

Table 2: Reproductive performances of crossbred cows based on study sites

Sites	AFS (m)	AFC(m)	MY(L)	CI (dy)	LL(m)	DO (dy)	NSC/straw
Bishoftu	22±2.2	32.7±1.5	12.2±2.7	431±27	9.9±.6	151±27	1.9±0.3
AK	23.2±1.4	33±1.3	11.2±2.9	439±26.8	9.7±.8	159±27	1.93±.4
KK	23.2±1.5	33.3±1.2	11±1.2	441.7±27	9.8±.8	164±36	1.96±.5

Notes: AK = Akaki Kaliti, KK = Kolfie Keranio, m= month, L= litre, dy= days

Table 3: The overall reproductive performances crossbred cows in Addis Ababa and Bishoftu

Rep. traits	Min	Max	Mean	SD	X²	P-value
AFS(months)	15	28	22.76	1.87	46	0.02
AFC(months)	29.2	39.2	33.2	1.35	85.5	0.00
MY(litres)	5	20	11.48	2.8	38.09	0.147
CI(days)	380	510	437	27.45	73.5	0.06
LL(months)	7	11.2	9.8	.83	35.2	0.319
CCI(days)	100	210	157.8	30.87	66.5	0.039
NSC/straw	1	5	1.93	.503	7.7	0.46

Notes: Min=minimum, Max=maximum, SD= standard deviation, P-value=probability value, X²=chi square, Rep. = Reproductive

Reproductive Performance Based on Study Sites: Reproductive performance of crossbred cows were recorded in terms of parameters that include Age at first calving (AFC), Number of service per conception (NSC), Calving interval (CI) and Age at first service (AFS), Milk yield (MY), Day open (DO) and lactation length (LL). The details of each were presented in Table (2) with their mean± standard deviation (SD) in each study sites. The reproductive performance AFS and AFC was statistically significant among study sites (Table 3).

Reproductive Performance Based on Scale of Production: The reproductive performance of cows based on farm size was summarized from the observation of individual cow record (for those who had record book) and interviewed from the farm managers/owners. The productive and reproductive performance of dairy cows when compare their mean at different farm scales large scale dairy production system was with good reproductive performance and followed by medium and small scale dairy production system respectively. There was significantly different (p<0.05) all reproductive traits among different farm scales (Table 4).

Major Artificial Insemination Service Problems: Artificial insemination service in study area has been occupied with different problem that limit successful and improved reproductive performances of the dairy industry. The main constraints of artificial insemination service were described under (Table 5 and 6). Lack of record keeping of the dairy farms and unsatisfied AITs due to poor salary was the main problems (Table: 5) as forwarded by AITs' working over the area. AITs' shortage, uncommitted AITs' and poor government attention was major AI problems of dairy farms as informed from farm managers/owners (Table 6).

Table 4: Reproductive performances of crossbred cows based on scale of production in Addis Ababa and Bishoftu

Scale	AFS (months)	AFC (months)	MY (liters)	CI (days)	LL (Months)	DO (Days)
Large	22.3±2.09	32.6±1.5	12.6±2.4	428±23.6	9.9±0.6	149.6±31.8
Medium	23±1.5	33.2±0.9	11±2.25	442.9±27.9	9.7±0.7	163±27.7
Small	23.7±1.3	34.03±1.1	8.5±2.97	452±28	9.5±1	172±27
X²	46.5	95.3	196	94	70.4	108
P-value	0.02	0.00	0.00	0.00	0.01	0.012

Table 5: Summarized artificial insemination service problems forwarded by AITs' in Addis Ababa and Bishoftu

AI service Problems	Yes	percent (%)	No	Percent (%)
AITs' who works on week end	9	75	3	25
AITs' who satisfied with their job	7	58.3	5	41.7
Input shortage(semen and nitrogen)	3	25	9	75
Farmers report heat sign on time	8	66.7	4	33.3
Lack of record keeping	10	83.3	2	16.7

Table 6: Summarized artificial insemination service constraints forwarded by farm owners/managers

AI Service problem	yes	percent (%)	No	percent (%)
Poor government attention	4	22.2	14	77.8
Satisfied with AI service	10	55.5	8	44.5
Input shortage	8	44.5	10	55.5
AITs' shortage	7	38.8	11	61.2

DISCUSSION

The respondents reported that the mean± SD ages at first service were 22±2.2, 23.2±1.4 and 23.2±1.5 months old for crossbred cattle reared by the dairy farms in Bishoftu, Akaki Kaliti and Kolfe Keranio, respectively. AFS were significantly different (p<0.05) among the study sites. The mean estimate of AFS observed in this study was shorter than the findings of Belay *et al*. [16] where the AFS in cross breed dairy cows were 24.30±8.01 in Jimma town and 27.5 months reported by Zewdie [17] in the highlands and central rift valley of Ethiopia. The mean age at first service revealed in this study is shorter than the mean of 36.8 ± 0.8 months reported by Gebeyehu *et al*. [18]. The largest age recorded in these areas could have resulted from the low level of management and poor feeding of calves and heifers at the earlier stages which consequently had reduced growth rate and delayed puberty.

In the present study the average of AFC were 32.7±1.5, 33.±1.3 and 33.3±1.2 at Bishoftu, Akaki Kaliti and Kolfe Keranio, respectively. AFC were significantly different (p<0.05) among the study sites. Present results were shorter than AFC of 3.37 years reported by Asaminew and Eyasu [19]. In this study the average age at first calving is higher than AFC of 31.9±0.22 months which is reported by Yifat *et al*. [20] for cross breed cattle in Zeway. Moreover; the mean result of the age at first calving in this study was lower than that of Hunduma [21] in Assela, Kumar and Tkui [22] in Mekelle who reported 34.8±4 and 36.4 ±1.7 months, respectively for crossbreed cows. The high age at first calving observed here may be related to environmental conditions and husbandry practices which may have effect on the growth of cattle. These may retard growth rate, delay puberty, reduced fertility and conception. Thus, the high age at first calving was observed in exotic breed. Hence, there should be concerted efforts to improve the feeding and nutrient profile of feeds offered to the animals, housing, disease prevention and management especially during harsh climatic conditions in order to improve the age at first calving.

The average calving intervals in this study were 431± 27, 439±26.8 and 441.7±27 days at Bishoftu, Akaki Kaliti and Kolfe Keranio, respectively. There was no statistically significant (P>0.05) difference in the mean length of calving interval in the three areas. The mean calving interval observed in the present study was longer than the findings of previous studies for crossbreed cows in different regions of Ethiopia.

In this study, the relatively longer calving interval might be indicative of poor nutritional status, poor breeding management, poor artificial insemination services, longer open days, diseases and poor management practices and lack of own bull. The present finding in relation to calving interval is higher than the previous findings of Hunduma [21] with 372.8±5.9 days (12.4) months) in Assela town. However, the mean calving interval observed in this study is shorter than 17.8 months reported by Meruda and Zeleke [23] lowland area of eastern Ethioipia, Dire Dawa.

A lactation period of 305 days is recommended to take advantage of 60 days dry period. The mean ± SD lactation length of cross breed cows in the present study was found to be 9.9, 9.7 and 9.8 months at Bishoftu, Akaki Kaliti and Kolfe Keranio, respectively. The lactation length observed was shorter than the lactation length of 10.1, 10.1 and 11.7 months reported by Asaminew and Eyasu [19] Adebabay [24] and Yitaye *et al*. [25] in northwest and central Ethiopia, respectively.

The average milk production per day were 12.2±2.7, 11.2±2.9 and 11±1.2 liters per cow/day at Bishoftu, Akaki Kaliti and Kolfe Keranio, respectively which was higher than Adebabay [24] finding, who reported that the average daily milk production of crossbreed cows was 8 liters/day. The average daily milk yield observed in this study was higher than the average values reported by Asaminew and Eyassu [19] and Yitaye *et al*. [25] which were 7.8 ± 0.19 and 7.8 ± 0.19 liters, respectively. In this study, the main reasons for low daily milk yield as indicated by the respondents were shortage of feed and the interaction of poor health, housing and management. Dairy cows remain open after calving for long time before they conceive. In this study the mean of calving to conception interval were 151, 159 and 164 days at Bishoftu, Akaki Kaliti and Kolfe Keranio, respectively, this findings were lower than 179.7 days reported by Lemma and Kebede [26]. The interval from calving to conception is influenced by factors such as source of labour, types of mating systems (natural, AI), calving season and location (urban/peri-urban). According to Msangi *et al*. [27] it took higher days (223) for cows to conceive. Dairy cows calving during the dry season when the availability of forages was low showed a negative correlation between body condition score at calving and CCI.

The average services per conception in this study were 1.9, 1.93 and 1.96 in Bishoftu, Akaki Kaliti and Kolfe Keranio, respectively. The present result is higher than the number of services per conception reported for tropical conditions of 1.3 for crossbred cows by

Rhman *et al*. [28]. The results of this study were higher than the average service per conception of 1.8 for crossbreed cows reported by Tadesse *et al*. [29] and 1.6 and 1.7 reported by Lobago *et al*. [4] in the highlands of Ethiopia. It is lower than 2.2 reported by Mureda and Zeleke [23] in eastern low land, Dire Dawa and 2.1 reported by Lemma and Kebede [26] at Addis Ababa. The number of service is an indication of postpartum reproductive problems, poor heat detection skills, inefficiency of AI and/or poor body condition of the cows at mating. Shortage of AITs', input shortage (semen and liquid nitrogen), unexperienced AITs' and low semen quality might be the main problem which results failure to conceive with first insemination over the area.

CONCLUSION AND RECOMMENDATIONS

The results obtained for AFS, AFC, CI, CCI and MY were found to be low as expected from commercial dairy herd. The reproductive performance traits were comparatively good within large scale production and followed by medium and small scale dairy production system. Feed shortage especially roughages (both in terms of quantity and quality), lack of access to land, disease prevalence, low level of management, poor knowledge of feeding, lack of proper breeding management such as lack of accurate heat detection and timely insemination, uncommitted and less experienced AITs' and lack of record keeping might have contributed considerably to delayed age at first service, long days open, late age at first calving, long calving interval and low milk production. This calls for a planned technical and institutional intervention for improved support and services.

From the above conclusion the following recommendations were forwarded:

- Efficient heat detection and timely insemination by experienced AITs' with quality semen should be given to increase effectiveness of artificial insemination as well as improving reproductive performance.
- Genetic improvement through crossbreeding and better health management should go hand-in-hand to keep with right reproductive performance traits of dairy cattle.
- Dairy cow should get good quality feed source supplements and improved management practices to stay with good reproductive performance for long time.

- Artificial insemination technicians and agricultural livestock expert should be committed and give awareness on reproductive performance traits and factors affect the traits to dairy farm owners to improve the reproductive performance.
- Artificial insemination technician should be trained practically and improve input supply like semen and liquid nitrogen to increase effectiveness of artificial insemination.

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