

# Age at First Service and Calving, Calving Interval, Open Days, and Number of Services Per Conception of Dairy Cows Under Small Holder in Siltie Zone, Ethiopia

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## Research

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## Abstract

The present study aims to assess age at first service and calving, calving interval, open days, and number of service per conception of dairy cows under small holder in Siltie zone, Ethiopia. To do so, a total of one hundred eighty sample size was selected from three selected districts of Siltie zone purposively. Data were collected through interviews with household heads using a detailed and pre-tested questionnaire. All data collected from demographic information and management practices of dairy cows were analyzed using SPSS software, version 27.0 while all data obtained from reproduction performances of dairy cows were analyzed using SAS version 9.4 in the General Linear Model (GLM). In this investigation, we found that long age at first service ( $41.34 \pm 12.23$ ,  $37.561 \pm 85$  and  $30.87 \pm 8.65$ ), for indigenous and ( $31.12 \pm 10.23$ ,  $27.24 \pm 7.35$  and  $25.45 \pm 8.45$ ) for crossbred dairy cows in rural, peri-urban and urban, months, respectively. Generally, the dairy cow were characterized by long time taken to reach age at first services and calving, long calving interval and, open days in the study area. Therefore, selective breeding program should be applied rather than rely only on AI/Bull service crossbreeding. Moreover, supportive materials that used for grinding and mixing feed such as fodder and crop residue should be provided for small holder producers by respective institutions.

## Introduction

Milk is one of the most important sources of animal protein for human diets and dairy production is a key element of agriculture worldwide (FAO, 2018). Milk from dairy cow represents nearly 100% of the milk produced in Latin America and Oceania (FAO, 2019). In Africa, above 75% of the milk comes from cow grazing natural pastures (Gebrekidan et al., 2019). Despite the economic importance of dairy production systems and their major role for the household security of millions of people, the productivity is low (Lobago *et al.*, 2007; FAO, 2019). The total numbers of dairy cattle in the world are in Africa (77%) and Asia and (33%), in Europe and North America (21% and 51%, respectively) of the world's milk production (FAO, 2018).

Ethiopia is the first country in rank that keeping and producing largest population of livestock in Africa (Metaferia et al., 2011; Ayeneshet et al., 2018 and; CSA, 2018; Kasa et al., 2018 and Alemu, 2019). The sector contribute significantly to the national economy and the livelihood of the people especially in the rural area by generating income to the farmers, ensuring food security and contributes to the asset, social, cultural and environmental values in order to sustain the people livelihoods (Anteneh et al., 2010; Azage et al., 2011; Mebratu *et al.*, 2018; FAO, 2019; Gebrekidan et al., 2019). According to the report of CSA (2018), from the total cattle population of the country is estimated to be about 60.39 million; the female cattle constitute about 54.68%, out of this dairy-cows are estimated to be around 6.66 million (11.03%) and 45.32% are male cattle.

Dairy cows offer an important source of cash income, calories and key nutrients, and mitigate the effects of often large seasonal fluctuations in availability of cereals through milk production (Aynalem et al., 2011; Kebede et al., 2017 and Kasa et al., 2018). Milk is a good source of dietary fat, energy, protein and other nutrients in general and provides substantial amounts of nutrients such as calcium, magnesium, selenium, zinc, riboflavin, vitamin B12 and pantothenic acid particularly (Azage et al., 2013; Ayalew, 2017 and Kiros et al., 2018).

Despite the largest population and these importance, the production and reproduction performances of dairy cows are very low due to a number of reasons such, the low genetic capacity of the indigenous cattle for milk and meat production, low adaptation ability of exotic and hybrid dairy cows, substandard feeding, poor health care and other management practices (Belay et al., 2012; Azage et al., 2013; Abunna et al., 2018; Kasa et al., 2018; Mebratu *et al.*, 2018). Consequently, the milk production to be provided from dairy cows is still under expectation throughout the country (Hailu *et al.*, 2012, Ayeneshet et al., 2018 and Alemu, 2019). In order to identify the major factors that affecting the performance efficiency of the dairy cows, the investigation of the all aspects of management practices under small holders in their production systems is very important task to be encouraged (Azage et al., 2013; Belay and Janssens, 2016; Mebratu *et al.*, 2018).

Several studies have been carried out only at the top towns in the country level to investigate the production and reproduction performance of dairy cows (Asrat et al., 2013; Belay and Janssens, 2016, Kiros et al., 2018; Alemu, 2019). However, a lot of previous studies neglects the dairy cows being kept under small holder in dairy production systems like rural area (Belay et al., 2012, Ayalew and Feyisa, 2017). Thus, the milk production and its supply in the small towns and rural area needs findings to assess and explore the reproductive efficiency of dairy cows under small holders within the rural, peri-urban and urban dairy production systems (Belay et al., 2012; Azage et al., 2013; Dejene, 2014; Ayeneshet et al., 2018, Ayalew, 2017 and Alemu, 2019).

In Ethiopia, dairy cows play a crucial role in development and represents a significant part of the urban, peri-urban and rural economy (Azage et al., 2013; Alemu, 2019). Unfortunately, the reproductive efficiency of crossbred and indigenous dairy cow is poor in most cattle production systems, mainly because of cows fail to become pregnant primarily due to management problems, shortage of feed and high prevalence rate of reproductive diseases as well as high calf mortality (Belay et al., 2012; Ayneshet *et al.*, 2018). In the study area, there has been a substantial effort to holding crossbred and indigenous dairy cow by smallholder farmers under urban, peri-urban and rural production system (SZLFRD, 2020). However, farmers are being troubled due to the factors such; shortage of feed, feed resources and problem of reproductive diseases. Besides, the reproduction performance of dairy cow has not been studied in the study area. Moreover, the milk demands of the society is still not enough fulfilled in Werabe town of the zone and its surrounded towns. Consequently, there is a need to assess the current reproductive performance of dairy cows. Therefore, the aim of the present study was to assess age at first service and calving, calving interval, open days, and number of service per conception of dairy cows under small holder in study area.

## Materials And Methods

### 3.1. Description of the Study Area

The current study was conducted in Siltie Zone, Southern Ethiopia. Siltie zone has a total area of 3000 sq.km and for administrative purpose; it is structured in to ten districts and three urban town. These include Alichu, Dalocha, Hulbareg, Lanfro, Western Azernet, Eastern Azernet, Eastern Silti, Mito, Sankurra, Silti, Tora, Kebet and Werabe town. Werabe town is the administrative center of the zone which is found 173 kms from Addis Ababa. The land scape of the zone is fairly level and found in northern part of South Nations, Nationalities and People Region (SNNPR) and located in North West of Alaba Zone, North East of Hadiya Zone, West of Oromia and South, South East and South West of Gurage Zone. The zone can be classified into three major climatic zones on the basis of altitude, rainfall and temperature: 20.6% highland, 74.4% Midland and 5% Lowland. Mean annual temperature is between 12-26°C. The rainfall is between 700 and 1818 mm. Agriculture is the main economic activity and the zone has varied ecological zones that range from lowland to highland, which makes possible the cultivation of various crop (SZFEDD, 2020). The main economic source of livelihood is based on both crop production and livestock rearing. Crops which are grown for food consumption as well as for income source in the area are enset, wheat, barley, maize, bean, pea, haricot bean, beetroot, potato, tomato, chills, onion, garlic, cabbage, and some other garden spices.

### 3.2. Study Design, Sampling method and Sample size

Cross-sectional study was conducted to assess age at first service and calving, calving interval, open days, and number of service per conception of dairy cows. In order to get representative sample size from small holder, a three stage sampling technique was used. In the first stage, three districts were selected purposively based on dairy cow production potential. Correspondingly, Dalocha, Lanfro and Sankura were selected from Siltie zone. Dairy cows were stratified into rural, peri-urban and urban dairy production systems per each district. Secondly, nine categorized dairy production systems were selected purposively based on their dairy cow production potential. The selected production systems were: (Gute kutiyo, Shanku Tufa and Andasha Zeko) from rural, (Burka Dilapa, Warsha Shanku and M/Gumbi) from Peri-Urban and (Dalocha town, Tora town and Alem Gebiya) from Urban. Thirdly, a total of one hundred and eighty dairy cow's herd owners small holders were selected to be 55, 53 and 72 from rural, peri-urban and urban, respectively. Secondary data, Key Informant Interviews (KIIs), Focus Group Discussions (FGDs), and Observations were also employed to triangulate and support the primary data which obtained from the sample household head interviews. For this study, sample size was determined according to the formula given by Arsham (2020),  $[N = 0.25/SE^2]$  Where, N = Sample size, SE = Standard error. Therefore, using the standard error of 0.0373% with 95% confidence level, the total number of dairy cow's herd owners small holders sample size was one hundred and eighty.

### 3.3. Data Types and Collection Method

#### Primary Data

The primary data were collected from structured smallholder dairy cow farmers' interviews via pre-tested questionnaire. The study was based on smallholder farms mainly found in rural, peri-urban and urban areas. Data were collected during interviews with household heads using a detailed and pre-tested questionnaire, which was previously developed and checked for clarity of the questions prior the interview and respondents were briefed to the objective of the study. For this study the questionnaire was adopted

according to prevailing circumstances before data collection. Structured sample household head interviews employed to generate household level data on the small holder demographic information, dairy cow management practices, production performance of dairy cows.

### **Secondary data**

Secondary data were collected from zonal, districts and each production systems agricultural administrates' documents, review of different documents including research works, books, journals, articles, report that had been written by different scholars on related issues. documents from various official websites such as; Ministry of Agriculture, Livestock Resource (MoALR), Ethiopian Institute of Agricultural Research (EIAR), Central Statistical Agency (CSA), National Metrological Agency (NMA) were reviewed.

### **Focused Group Discussions (FGDs)**

A focus group discussion was hold with those who have been holding crossbred and indigenous dairy cows and organized in each production systems; youngsters, women, leaders, and socially respected individuals who are known to have a better knowledge on the present and past social and economic status of the study area. In order to gain more detail information, and triangulate the data obtained from the questionnaire-based household interviews, nine FGDs were conducted at Gute kutiyo, Shanka Tufa, Andasha Zeko, Burka Dilapa, Warsha Shanka, M/Gumbi, Dalocha town, Tora town and Alem Gebiya. In all the nine FGDs, a total of fifty six dairy cow's herd owners participated to discuss on current status of milk production and management practices of their dairy cows. Six persons, as representatives of dairy cows herd owners were selected by development agents in consultation with livestock experts of each district. Members of the FGDS were selected from dairy producers who were reported to be capable of answering questions related to production performance and management practices of dairy cows in order to collect accurate information or data in the study area. The researchers have facilitated and monitored the discussions, and take note via closely followed the discussions. The discussants were allowed to freely express themselves with minimal interruptions on issues raised and the facilitated ensured that every member of the group was given fairly equal chances to express their ideas. A checklist guided the sequence of information to be collected from the FGDs. Discussion started with introduction of the study team and explanation of the purpose of the study. Participants were then asked to discuss the challenges and constraints they face in their dairy cow's herds. At the beginning, participants were asked to identify management practices that they were offering. At the end, possible means to increase the milk production efficiency of their dairy cows were discussed.

### **Key Informant's Interviews (KII)**

In this study there were a total of 12 KII(3 from zonal livestock and fishery resource office and 9 from three districts, 3 from each district). In all sub-sectors, 1 person was selected to be a head office, and the left two persons were selected from dairy breed improvement and feed resource classifications.

### **Observation**

In addition to the above data collection methods, the field observation was carried out to validate the information provided through primary and secondary data collection tools. As well as information like socioeconomic condition of the study area was explored by field visit.

## **3.4. Data-Analysis System**

All data collected from demographic information and management practices of dairy cows were analyzed using Statistical Package for Social Sciences (SPSS) software, version 27.0. Descriptive statistics such as mean and percentages were used. Besides, Chi-square tests were performed to test the significance difference existence between categorical variables via cross tabulations. Otherwise, One-way ANOVA was performed for continuous variables. On the other hand, all data obtained from production performances of dairy cows were analyzed using Statistical Analysis Software, SAS version 9.4 in the General Linear Model (GLM). Furthermore, Dancan was used to examine the differences between levels of significance between the effect of interaction between breed and production systems. Statistical significance between variables was examined using P-values at critical probability of  $P < 0.05$ . In case of rank, index calculation was performed using Cambria Math equation in Excell. 2010.

Models Used for the current Study

Models statement regarding the effect of different fixed effects on various performances parameters of dairy cows were two models.

**Model 1.** Model used in case of demographic information and management practices of dairy cows

$$Y_{ij} = \sqrt{\text{varvec}}\mu + \text{pi} + \sqrt{\text{varvec}}\epsilon_{ij} \text{ Where;}$$

$Y_{ij}$  = Response variables

$\mu$  = is the overall mean,

$\text{pi}$  = is fixed effect of production system ( $i$  = rural, peri urban and Urban).

$\epsilon_{ij}$  = is the residual error.

**Model 2.** Model performed to calculate the production performance of dairy cows

$$Y_{ijk} = \sqrt{\text{varvec}}\mu + \text{pi} + \text{bj} + \text{pbijk} + \sqrt{\text{varvec}}\epsilon_{ijk} \text{ Where;}$$

$Y_{ijk}$  = is the responses parameters estimated for  $i^{\text{th}}$  cross and indigenous breeds (age at first service and calving, calving interval, open days, and number of service per conception) in rural, peri-urban and urban of  $j^{\text{th}}$  production systems and  $k^{\text{th}}$  interaction between breeds and production systems.

$\mu$  = is the overall mean,

$\text{pi}$  = is fixed effect of production system that affects performance of cows ( $i$  = rural, peri urban and urban)

$\text{bj}$  = is fixed effect of breed that affects performance of cows ( $i$  = crossbred and indigenous)

$\text{pbijk}$  = is fixed effect of interaction between production systems and breeds.

$\epsilon_{ijk}$  = is the residual error.

## Results

Table 1 shows the demographic information of respondents (gender, age, house hold size, educational status, total land holding, land holding for crop/forage production and land holding for pasture). There is no significance difference exist within gender however, age of the respondents differed significantly ( $P < 0.05$ ) among the three production systems with the mean values ( $40.31 \pm 0.95$ ,  $40.09 \pm 0.72$  and  $41.40 \pm 0.95$ , in rural, peri-urban and urban, respectively). And also, the total mean of respondent's educational status was fall with  $8.40 \pm 0.23$ . The total land holding of the small holders differed significantly ( $P < 0.05$ ) in all production systems with the values ( $1.43 \pm 0.10$ ,  $1.19 \pm 0.08$ ,  $0.85 \pm 0.06$ , in rural, periurban and urban, respectively).

Table 1  
Demographic Information of Respondents

Variables	Production Systems	N	Mean	Std. Error	95% CI for Mean		Min	Max	P-value	
					LB	UB				
Gender (%)	Rural	M	33	60.00	0.08	-	-	-	-	0.717
		F	22	40.00	0.71	-	-	-	-	
	Peri-Urban	M	32	60.40	0.91	-	-	-	-	
		F	21	39.60	0.72	-	-	-	-	
	Urban	M	41	56.90	0.91	-	-	-	-	
		F	31	43.10	0.10	-	-	-	-	
	Total		180							
Age	Rural		55	40.31	0.95	38.41	42.21	31	60	0.039
	Peri-Urban		53	40.09	0.72	38.66	41.53	31	49	
	Urban		72	41.40	0.95	39.52	43.29	25	70	
	Total		180	40.68	0.52	39.66	41.71	25	70	
House hold size	Rural		55	7.09	0.23	6.62	7.56	3	10	0.001
	Peri-Urban		53	7.11	0.23	6.65	7.58	3	12	
	Urban		72	6.90	0.29	6.32	7.48	3	12	
	Total		180	7.02	0.15	6.72	7.32	3	12	
Educational status	Rural		55	6.53	0.51	5.50	7.55	0	12	0.000
	Peri-Urban		53	8.11	0.25	7.61	8.61	4	12	
	Urban		72	10.04	0.27	9.51	10.58	6	15	
	Total		180	8.40	0.23	7.95	8.85	0	15	
Total land holding (ha)	Rural		55	1.43	0.10	1.23	1.63	0.3	3	0.000
	Peri-Urban		53	1.19	0.08	1.03	1.35	0.5	2.5	
	Urban		72	0.85	0.06	0.74	0.96	0.25	2.1	
	Total		180	1.13	0.05	1.03	1.22	0.25	3	
Land holding for crop/forage production (ha)	Rural		55	0.81	0.07	0.68	0.94	0	2	0.004
	Peri-Urban		53	0.74	0.06	0.62	0.87	0	2	
	Urban		72	0.39	0.04	0.31	0.46	0	1.6	
	Total		180	0.62	0.03	0.55	0.69	0	2	
Land holding for pasture (ha)	Rural		55	0.66	0.05	0.55	0.77	0.1	2	0.001
	Peri-Urban		53	0.44	0.04	0.37	0.51	0.02	1	
	Urban		72	0.46	.03736	0.39	0.54	0.00	1.75	
	Total		180	0.52	0.026	0.46	0.57	0.00	2.00	

CI = Confidence interval ,F = female, ha = hectare, LB = Lower Bound, M = male, Min = minimum, Max = maximum, N = number of observation, UB = Upper Bound and %= percent

Table 2 shows the herd structures of dairy cows that there is no significance difference among them except only for calves.

Table 2  
Dairy cow's Herd Structure

Variables	Production Systems	N	Mean	Std. Error	95% CI for Mean		Min	Max	P-Value
					LB	UB			
Dairy cow's herd structures	Rural	55	11.87	0.337	11.20	12.55	7	18	0.891
	Peri-Urban	53	11.91	0.320	11.26	12.55	7	17	
	Urban	72	12.19	0.314	11.57	12.82	7	20	
	Total	180	12.01	0.187	11.64	12.38	7	20	
No of Cows	Rural	55	7.073	0.283	6.506	7.640	4	13	0.500
	Peri-Urban	53	6.698	0.270	6.156	7.240	4	12	
	Urban	72	7.139	0.283	6.575	7.703	4	15	
	Total	180	6.989	0.163	6.668	7.310	4	15	
No of Heifers	Rural	55	2.218	0.124	1.970	2.466	1	4	0.631
	Peri-Urban	53	2.170	0.134	1.901	2.439	1	4	
	Urban	72	1.889	0.102	1.686	2.092	1	4	
	Total	180	2.072	0.069	1.937	2.208	1	4	
No of Calves	Rural	55	1.309	0.063	1.183	1.435	1	2	0.001
	Peri-Urban	53	1.717	0.099	1.519	1.915	1	3	
	Urban	72	1.847	0.094	1.660	2.035	1	4	
	Total	180	1.644	0.054	1.538	1.751	1	4	
CI = Confidence interval, LB = Lower Bound, Min = minimum, Max = maximum, N = number of observation, UB = Upper Bound and %= percent									

Table 3 shows the age at first service, age at first calving, calving interval, open days and number of services per conception of dairy cows. Age at first services for indigenous dairy cows differed significantly ( $P < 0.05$ ) in all production systems with the mean values ( $41.34 \pm 12.23$ ,  $37.561 \pm 3.85$  and  $30.87 \pm 8.65$  in rural, peri-urban and urban, respectively). Similarly, age at first services for crossbred dairy cows differed significantly ( $P < 0.05$ ) in all production systems with the mean values ( $31.12 \pm 10.23$ ,  $27.24 \pm 7.35$  and  $25.45 \pm 8.45$  in rural, peri-urban and urban, respectively). Age at first calving for indigenous dairy cows differed significantly ( $P < 0.05$ ) in all production systems with the mean values ( $53.71 \pm 10.41$ ,  $49.81 \pm 12.68$  and  $41.50 \pm 6.52$  in rural, peri-urban and urban, respectively). Similarly, age at first calving for crossbred dairy cows differed significantly ( $P < 0.05$ ) in all production systems with the mean values ( $42.95 \pm 9.13$ ,  $39.49 \pm 5.62$  and  $37.82 \pm 5.70$  in rural, peri-urban and urban, respectively). Calving interval for indigenous dairy cows differed significantly ( $P < 0.05$ ) in all production systems with the mean values ( $26.42 \pm 1.33$ ,  $25.49 \pm 1.09$  and  $25.57 \pm 1.33$  in rural, peri-urban and urban, respectively). Similarly, calving interval for crossbred dairy cows differed significantly ( $P < 0.05$ ) in all production systems with the mean values ( $25.47 \pm 1.35$ ,  $25.60 \pm 1.23$  and  $24.15 \pm 1.71$  in rural, peri-urban and urban, respectively). Open days for indigenous dairy cows differed significantly ( $P < 0.05$ ) in all production systems with the mean values ( $5.55 \pm 1.14$ ,  $4.19 \pm 0.90$  and  $4.35 \pm 0.86$  in rural, peri-urban and urban, respectively). Similarly, open days for crossbred dairy cows differed significantly ( $P < 0.05$ ) in all production systems with the mean values ( $4.18 \pm 0.92$ ,  $4.38 \pm 0.97$  and  $3.51 \pm 0.98$  in rural, peri-urban and urban, respectively). Number of services per conception for indigenous dairy cows differed significantly ( $P < 0.05$ ) in all production systems with the mean values ( $2.07 \pm 0.63$ ,  $1.81 \pm 0.44$  and  $2.29 \pm 0.78$  in rural, peri-urban and urban, respectively). Similarly, number of services per conception for crossbred dairy cows differed significantly ( $P < 0.05$ ) in all production systems with the mean values ( $2.29 \pm 0.66$ ,  $1.77 \pm 0.42$  and  $1.64 \pm 0.54$  in rural, peri-urban and urban, respectively).

Table 3  
Reproduction and Production Performance of Dairy cows in the Study area

Breeds	Production Systems	N	AFS		AFC		CL		OD		NSPC	
			Mean	Std Dev	Mean	Std Dev	Mean	Std Dev	Mean	Std Dev	Mean	Std Dev
Indigenous	Rural	55	41.34 <sup>a</sup>	12.23	53.71 <sup>a</sup>	10.41	26.42 <sup>a</sup>	1.33	5.55 <sup>a</sup>	1.14	2.07 <sup>b</sup>	0.63
	Peri-Urban	53	37.56 <sup>b</sup>	13.85	49.81 <sup>b</sup>	12.68	25.49 <sup>b</sup>	1.09	4.19 <sup>b</sup>	0.90	1.81 <sup>c</sup>	0.44
	Urban	72	30.87 <sup>cd</sup>	8.65	41.50 <sup>cd</sup>	6.52	25.57 <sup>b</sup>	1.33	4.35 <sup>b</sup>	0.86	2.29 <sup>a</sup>	0.78
Crossbred	Rural	55	31.12 <sup>c</sup>	10.23	42.95 <sup>c</sup>	9.13	25.47 <sup>b</sup>	1.35	4.18 <sup>b</sup>	0.92	2.29 <sup>a</sup>	0.66
	Peri-Urban	53	27.24 <sup>de</sup>	7.35	39.49 <sup>de</sup>	5.62	25.60 <sup>b</sup>	1.23	4.38 <sup>b</sup>	0.97	1.77 <sup>c</sup>	0.42
	Urban	72	25.45 <sup>e</sup>	8.45	37.82 <sup>e</sup>	5.70	24.15 <sup>c</sup>	1.71	3.51 <sup>c</sup>	0.98	1.64 <sup>c</sup>	0.54
R-Square			34.45		30.55		20.71		28.71		16.31	
Coefficient of Variation			15.65		19.45		5.40		22.24		30.35	
(a,b,c,d, e, f) = Means within a row with no common superscripts differ significantly, *,** = significantly differ at p-value (0.05 and 0.0, respectively), 1AFS = age at first service, AFC = age at first calving, CL = Calving interval, DMY = daily milk yield, LG = longevity, LL = lactation length, OD = open days, N = number of observation, Std Dev = standard deviation												
<b>8.2. Appendix 1. List of Figures</b>												

## Discussions

The current study is the first to provide information on the reproductive performances of dairy cows in various production systems under small holder dairy cow's herd owners in Siltie zone, Ethiopia. In our investigation, we found the level of reproductive performance of dairy cows.

### 5.1. Demographic Characterization of the Respondents

There is no significance difference exist within gender however, age of the respondents differed significantly ( $P < 0.05$ ) among production systems with the mean values ( $40.31 \pm 0.95$ ,  $40.09 \pm 0.72$  and  $41.40 \pm 0.95$ , in rural, peri-urban and urban, respectively). And also, the total mean of respondent's educational status was fall within  $8.40 \pm 0.23$ . The total land holding of the small holders differed significantly ( $P < 0.05$ ) in all production systems with the values ( $1.43 \pm 0.10$ ,  $1.19 \pm 0.08$ ,  $0.85 \pm 0.06$ , in rural, periurban and urban, respectively). The overall, 58.89 and 41.11% of the respondents were male and female-headed households, respectively, however, there was no significance difference ( $P > 0.05$ ) among production systems (Table 1). Female-headed household's proportion in the current study was lower than the 47.7 % and higher than 24.1 % of the results reported from Hawassa town (Haile et al. 2012), Jimma town (Duguma and Janssen, 2016, respectively). Overall, mean age of the household heads was found to be  $40.68 \pm 0.52$  years. The present result indicated that farmers with 60–70 ages were involved in dairy production in the study area (Table 1). The overall mean household size was  $7.02 \pm 0.15$  (Table 1). The mean educational status of respondents differed significantly ( $P < 0.05$ ) in all production systems with the values ( $6.53 \pm 0.51$ ,  $8.11 \pm 0.25$  and  $10.04 \pm 0.27$ , in rural, peri urban and urban, respectively) (Table 1). Majority of the respondents in this study had formal education that is very important to understand extension messages and to realize the importance of new technologies within a moment. The total land holding of the small holders differed significantly ( $P < 0.05$ ) in all production systems with the values ( $1.43 \pm 0.10$ ,  $1.19 \pm 0.08$ ,  $0.85 \pm 0.06$ , in rural, peri urban and urban, respectively). This indicates that there is an opportunities to increase dairy production to medium-scale production systems.

### 5.2. Dairy cows' Herd Structures

In the present study, there is no significance difference exist among herd structures of the dairy cows except only for calves (Table 2). A larger number of cattle might be kept under Peri-Urban and Rural production systems, relatively than urban production system. On the other hand, the total number of crossbred and indigenous cattle was lower in rural than Urban and peri-urban production system



i.e. the proportion of crossbred cattle is very low in rural dairy production system, better in peri-urban and higher in urban dairy production system (Azage et al., 2013)

## 5.3. Reproductive Performance of Dairy cows in the Study Area

### 5.3.1. Age at first services

Age at first services for indigenous dairy cows differed significantly ( $P < 0.05$ ) in all production systems with the mean values ( $41.34 \pm 12.23$ ,  $37.561 \pm 3.85$  and  $30.87 \pm 8.65$  in rural, peri-urban and urban, respectively). Similarly, age at first services for crossbred dairy cows differed significantly ( $P < 0.05$ ) in all production systems with the mean values ( $31.12 \pm 10.23$ ,  $27.24 \pm 7.35$  and  $25.45 \pm 8.45$  in rural, peri-urban and urban, respectively)(Table 8). According to Desselegn *et al.*(2016) reported that the average age at first service was  $18.7 \pm 3.7$  and  $18.7 \pm 3.5$  months for cross breed cattle reared by the farmers in Bishoftu and Akaki, respectively. Moreover, Belay et al., (2012) where report that the AFS for crossbred dairy cows were  $24.30 \pm 8.01$  in Jimma town and 23.2 months in Gonder town (Kumar et al., 2014). The irregularities in feed supply and differences in management systems could be contributed to bring about variations in age at first service in different areas.

### 5.3.2. Age at first calving

Age at first calving for indigenous dairy cows differed significantly ( $P < 0.05$ ) in all production systems with the mean values ( $53.71 \pm 10.41$ ,  $49.81 \pm 12.68$  and  $41.50 \pm 6.52$  in rural, peri-urban and urban, respectively). Similarly, age at first calving for crossbred dairy cows differed significantly ( $P < 0.05$ ) in all production systems with the mean values ( $42.95 \pm 9.13$ ,  $39.49 \pm 5.62$  and  $37.82 \pm 5.70$  in rural, peri-urban and urban, respectively) (Table 8). According to the Taju (2018), the overall age at first calving (AFC) of indigenous dairy cow was  $48.9 \pm 0.259$  months or approximately 4 years in Dawro zone. Higher AFC was reported by Kebede et al., (2017) who reported that  $4.7 \pm 1.31$ , years for Gofa cattle. The overall estimated average age at first calving was found to be  $40.9 \pm 6.6$  months, of which  $47.16 \pm 8.7$ months for indigenous dairy cows, and  $37.95 \pm 9.4$  months for crossbreed cows, which was higher than the expected to be achieved (Taju, 2018).

### 5.3.3. Calving interval

Calving interval for indigenous dairy cows differed significantly ( $P < 0.05$ ) in all production systems with the mean values ( $26.42 \pm 1.33$ ,  $25.49 \pm 1.09$  and  $25.57 \pm 1.33$  in rural, peri-urban and urban, respectively). Similarly, calving interval for crossbred dairy cows differed significantly ( $P < 0.05$ ) in all production systems with the mean values ( $25.47 \pm 1.35$ ,  $25.60 \pm 1.23$  and  $24.15 \pm 1.71$  in rural, peri-urban and urban, respectively)(Table 8). The calving interval (CI) is a function of a day's open and gestation length and shorter in crossbred than indigenous cows under proper management of animals (Desalegn *et al.*, 2016; Demitie *et al.*, 2016 and Mebratu *et al.*, 2018). According to Belay et al., (2012) in North Showa zone and Jimma Zone indicated that crossbreds have calving interval of 660 and  $640.8 \pm 3.84$  days, respectively. On the other hand, longer CI of 54.1months (Dejene, 2014) and  $18.72 \pm 0.5$ months (Ayneshet *et al.*, 2018) for Karrayu and cattle around Gonder area, respectively, was reported. The variation could be due to feed shortage, calving season and lack forage availability in both indigenous and crossbred dairy cows reported in different parts of the country.

### 5.3.4. Open days

In the present study, open days for indigenous dairy cows differed significantly ( $P < 0.05$ ) in all production systems with the mean values ( $5.55 \pm 1.14$ ,  $4.19 \pm 0.90$  and  $4.35 \pm 0.86$  in rural, peri-urban and urban, respectively). Similarly, open days for crossbred dairy cows differed significantly ( $P < 0.05$ ) in all production systems with the mean values ( $4.18 \pm 0.92$ ,  $4.38 \pm 0.97$  and  $3.51 \pm 0.98$  in rural, peri-urban and urban, respectively)(Table 8). Open day (OD) is the part of the calving interval that can be shortened by improved herd management and interval between date of calving and date of conception (Lobago *et al.*, 2007; Desalegn *et al.*, 2016; Demitie *et al.*, 2016). A herd average of less than 85 open days indicates that cows are being breed early, 85 to 115 days considered as optimum for dairy herd, 116 to 130 days indicate slight problem, 131 to 145 days moderate problems, while more than 145 open days is considered as sever reproductive problem in the dairy herd(Azage et al., 2013; Ayneshet *et al.*, 2018).

Factors like delayed resumption of ovarian activity after calving, longer interval to first estrus and brief shorter duration of estrus along with its silent symptoms, scarcity and deterioration of available feeds, might have contributed to difficulty in heat detection and timely insemination of the cows resulting in prolonged OD (Melaku et al., 2011, Abunna et al., 2018 and Mebratu *et al.*, 2018). The variation could be attributed to differences in management practices like lack of giving attention for local animal; feed shortage and lack of proper heat detection might be contributory factors for long day open in local dairy cows reported in this study

Table 8 shows the number of services per conception of dairy cows.

### 5.3.5. Number of services per conception

Number of services per conception for indigenous dairy cows differed significantly ( $P < 0.05$ ) in all production systems with the mean values ( $2.07 \pm 0.63$ ,  $1.81 \pm 0.44$  and  $2.29 \pm 0.78$  in rural, peri-urban and urban, respectively). Similarly, number of services per conception for crossbred dairy cows differed significantly ( $P < 0.05$ ) in all production systems with the mean values ( $2.29 \pm 0.66$ ,  $1.77 \pm 0.42$  and  $1.64 \pm 0.54$  in rural, peri-urban and urban, respectively)(Table 8). Number of services per conception (NSPC) is one of the measurements for reproductive efficiency, expresses the fertility level of cows and depends largely on the breeding system used and it is higher under uncontrolled natural breeding than hand-mating and artificial insemination (Azage et al., 2013; Kumar et al., 2014; Abunna et al., 2018; Gabrikedan *et al.*, 2019). Lack of knowledge, in appropriate time of insemination, unqualified technician, hygienic problem, and disease are the most common reasons for frequent breeding (Desselegn et al., 2016, Ayneshet *et al.*, 2018). According to Kumar et al. (2014), indigenous cows had the significantly higher NSPC ( $2.2 \pm 0.2$ ) than that of HF crossbreds ( $1.5 \pm 0.3$ ) in Gonder under small holder management system.

## Conclusion And Recommendation

Although dairy production is the most important activities in the study area, the production and reproduction performance of dairy cows have been limited for a long period of time due to a number of constraints. Consequently, the dairy cow were characterized by long time taken to reach age at first services and calving, long calving interval and, open days, and low daily milk yield in the study area while daily milk demands and, price of one liter of milk is increasing dramatically every day. In this investigation, we found that long age at first services and calving interval and open days. Based on these results, the following recommendation should be forwarded for better future supplementation of dairy cows.

It had better if selective breeding would be applied rather than rely only on AI/Bull service crossbreeding in order to mitigate low genetic potential of breeds.

Supportive materials that used for grinding and mixing feed such as fodder and crop residue should be provided for small holder producers by Governmental as much also by Non-governmental institutions to increase the quantity and quality of animal feed.

## Declarations

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## Authors' Contributions

Both authors contributed to the study conception and design, data collection and analysis. The first draft of the manuscript was written by Bayesa Tolasa Itafa and Eyob Onto Andure commented on previous versions of the manuscript.

## Data Availability

Data used to support this study are available from the corresponding author upon the request.

## Ethical Clearance

This work was approved by institutional ethical review board of Werabe University Research and Publication, Werabe University (Ref. No.: WRU/A/V/P/L/02/1204/20).

## Consent to Participate

Consents from study participants were obtained.

## Consent for Publication

Not applicable.

## Conflict of Interest

The authors have declared that no conflict of interest.

## Code Availability

Not applicable.

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