

Reproductive and Productive Performance of Indigenous Dairy Cows under Smallholder Farmers Management System in North

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Abstract

Evaluations of the productive and reproductive performances of indigenous dairy cows were carried out in Alefa and Quara districts under smallholder farmers management system. To collect data from 376 households, a cross-sectional study were employed via structured questionnaires. To assess the reproductive performance of the dairy cows, age at first services (AFS), age at first calving (AFC), calving interval (CI), days open (DO) and number of service per conception (NSPC) were utilized as an indicator traits. In addition, milk yield per day (MY/D), lactation milk yield (LMY) and lactation length (LL) were considered as an indicator of the performance productive traits. To study the variation on the measured traits the collected data were analyzed using SPSS Version 20. As reported by the respondents, the overall mean of AFS, AFC, CI, DO and NSPC were (43.4 ± 0.47 and 32.8 ± 0.46 months), (52.4 ± 0.81 and 41.8 ± 0.50 months), (26.64 ± 0.60 and 18.72 ± 0.50 months), (17.64 ± 0.70 and 9.72 ± 0.40 months), (1.54 ± 0.55 and 1.82 ± 0.65 times), respectively in Alefa and Quara districts. All of the considered traits for reproductive performances were significantly ($p < 0.001$) differ between the districts. The over mean of MY/D, LMY and LL were reported as (1.30 ± 0.05 and 1.50 ± 0.04 litres), (329.6 and 348.8 litters) and (8.45 ± 0.18 and 7.75 ± 0.15 months), respectively in Alefa and Quara districts. Thus, it could be concluded that the results reported for AFS, AFC, CI, LL and LMY in both districts were below optimum value of dairy cattle production. By and large, management differences (proper feeding, housing, selection of local breeds, adequate health care) are the major limitations for the declining of the reproductive and productive performance of indigenous dairy cattle under smallholder farmer's management system in the sample areas.

Keywords: Alefa; District; Performance; Reproductive and productive parameter; Quara

Introduction

In Ethiopia dairy production mainly depends on indigenous livestock genetic resources; more specifically on cattle that covers the largest contribution (81 %) of the total national annual milk yield [1]. Cattle are very vital livestock species in the mixed crop livestock production systems of the country by supplying chiefly draught power, a small quantity of milk, meat usually when they retire and manure [2]. About 98.59 % of the total cattle in the country are local breeds, the remaining are hybrid and exotic breeds that accounted about 1.22 % and 0.19 %, respectively CSA [3].

The Ethiopian indigenous cattle are well adapted to the hot environment producing under stress of elevated temperature, high disease prevalence and low level of nutritional status. The average lactation milk yield of the indigenous cows ranges from 494 to 850 kg under optimum management practice and cows usually do not produce their first calves earlier than 35-53 months of age and calving interval is about two years [4,5].

The milk production and reproductive performance of dairy cows are the two major determinant factor of profitability. Age at first service (AFS), age at first calving (AFC), calving interval (CI), number of services per conception (NSPC) and days open till conception (DO) are common determinant traits for reproductive performance of breeding animal [4]. However, poor genetic capacity of the indigenous cattle, inadequate feeding, disease outbreak, poor level of management, absence of proper breeding management such as lack of precise heat detection and timely insemination contributed significantly to long days open, late age at first calving, long calving interval, short lactation length and low milk production pressurized the productive and reproductive performance of cattle [6].

To put in place appropriate remedial interventions that would lead to improve productivity of the indigenous dairy subsector, understanding the existing productive and reproductive performance of indigenous dairy cows is very vital. This necessitates the need for generating site specific database under specific production circumstances. In this regard, little research has been done so far to identify the overall productive and reproductive performances of indigenous dairy cows under smallholder farmers management system in Alefa and Quara districts. It is endeavoured to fill this existing information gap. Hence, the objective of this study was to investigate productive and reproductive performance of dairy cows under farmers management condition in the above districts.

Materials and Methods

This study was carried out in two sites namely Alefa and Quara districts in North Gondar Zone of Amhara region, Ethiopia. The two districts were selected among the many districts due to their high potential for indigenous dairy production.

Alefa district

It is located 80 km far from Bahir Dar and 144 Km from Gondar

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town. The area is located at 110 N latitude and 370E longitude at an altitude of 750-2250 meter above sea level with annual rain fall of 950-1500 mm. It has long rainy season from May to early November with diverse agro ecology. The annual average temperature ranges from 15°C to 38°C with an overall average of 26.5°C soil and climate are similar to those in many mid altitude areas in Ethiopia. Cattle, small ruminant, poultry and equines are the major livestock species kept in the district [7].

Quara district

It is located 360 km far from Bahir Dar and 284 km from Gondar town. The area is located at 120 N latitude and 360 E longitude at an altitude of 530-1900 meters above sea level with annual rain fall of 950-1500 mm. The annual average temperature ranges from 26°C to 42°C with an overall average of 32°C. Cattle, small ruminant, poultry and equines are the major livestock species kept in the district [7].

Sampling Procedure

Initially, discussion was carried out about the potential of dairy production of the study area with district officer's mainly agricultural experts and development agents. Based on this information two potential districts (Quara and Alefa) were selected. Data was collected from both primary and secondary source. The primary sources were obtained through a semi-structured questionnaire; it was pre-tested before the actual data collection. Three kebeles from each district, a total of six kebeles were selected through purposive sampling procedure. Finally, farmers who had at least one lactating cow were selected for interview through systematic random sampling procedure.

By the formula given by Yamane [8], the total household (HH) heads included in this study were determined through 95% confidence level (Figure 1).

$$n = \frac{N}{1 + N(e)^2}$$

Where n=Sample size

N=population size

e =the desired level of precision

Accordingly, from a total of 6750 population size which have lactating dairy cows of six representative Kebeles, 376 households were selected.

Data Collection

To know the socioeconomic situation, major sources of income and type of livestock reared by the communities, questionnaires were designed, translated to local language, pre-tested and administered to collect primary data. Regarding the data on reproductive and productive traits age at first service, age at first calving, calving interval, number of services per conception, daily milk yield, lactation milk yield and lactation length were considered as an indicator trait and accordingly primary data were collected from the sampled respondents.

To strength the reliability of our evaluation focus group discussion with the recommended group size of 8-10 were conducted by gathering district experts, developmental agents (DA's), model farmers, village leaders, elderly female and male members of the society who are known

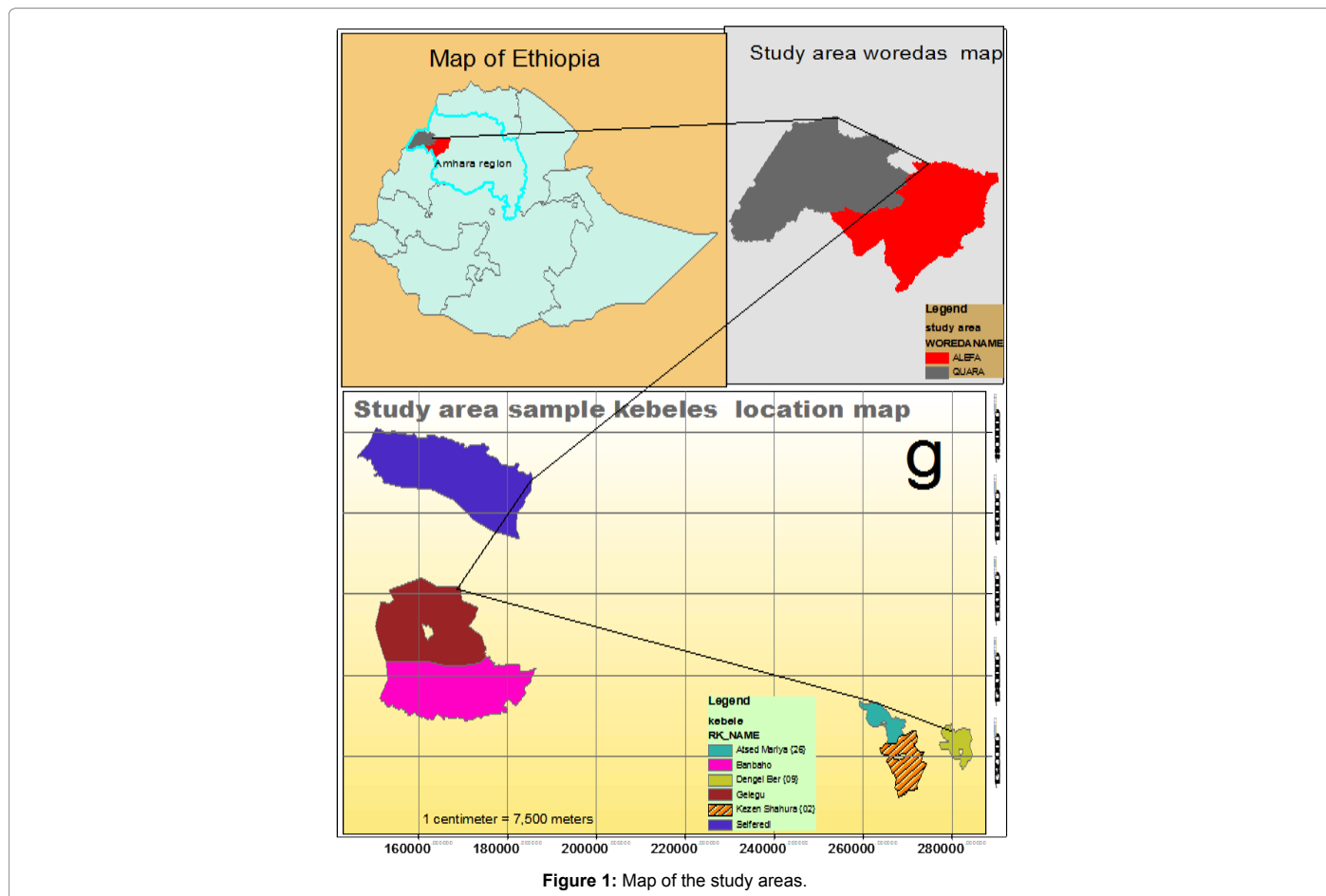


Figure 1: Map of the study areas.

to have better knowledge on the present and past social and economic status of the area (Table 1).

Statistical Analysis

The primary data which were collected from the field were analyzed by using descriptive statistics of SPSS version 20 [8]. Reproductive and productive traits such as AFS, AFC, CI, NSPC, DO as well as MY/D, LMY and LL were considered as dependent variables, while, districts were fitted as independent factors. In addition, productive performance of dairy cows was analyzed by using GLM model procedure.

Results and Discussion

Age at first service

It is the age at which the breeding heifers reach for sexual maturity and accepting mating for the initial period. The economy of the farm can be feasible by showing estrous as early as possible for female animal [2]. The overall mean of AFS of indigenous dairy cows for Alefa and Quara districts were reported by the respondents as 43.7 ± 0.47 and 32.8 ± 0.47 months, respectively. As indicated in Table 2, there was highly significant difference on age at first service between Alefa and Quara districts ($p < 0.001$). Considerably, lower estimate of 26.16 ± 4.32 months AFS in the Borana zone [9] was reported. However the current results were lower than 45.6 months for Kereyu breed [10] and 45 ± 0.6 months for highland zebu cows in Metema district.

Age at first calving

It is one of the important reproductive traits contributing to the economic return in dairy cows. A reduction in AFC will minimize the raising costs, shorten the generation period, and consequently take full advantage of the number of lactations per head. Earlier first calving enhanced lifetime productivity of cows. It is an important factor in determining the overall productivity of dairy cows [11]. The overall mean of AFC of indigenous dairy cows for Alefa and Quara districts were reported by the respondents as 52.4 ± 0.81 and 41.8 ± 0.5 months, respectively (Table 2). There was highly significant variation on age at first calving between Alefa and Quara districts ($p < 0.001$). Considerably, lower estimate of 49.8 months of AFC by Assefa and

50 months by Tegegne et al. [12] were reported for local dairy cows in different districts of the country. However the current result were lower than 57.4 months at Mecha districts [13], 53.52 months at Bure district [14]; 58.08 months in mid-altitude area of Borena zone [9] and 59.76 months in Guduru district [15]. The longer age at first calving observed here may be related to environmental situation and farming practices which may effect on the cattle growth. Mureda and Zeleke [16] reported environmental factors, especially nutrition, decide pre-pubertal growth rates, reproductive organ development, and onset of puberty and following fertility. Extensive evidence exists that dietary supplementation of heifers during their growth will minimize the interval from birth to first calving, most likely because heifers that grow faster cycle earlier and express apparent estrus.

Calving interval

It is the time between two successive parturitions, and preferably should be in the range of 12 to 13 months. Calving interval has a great economic importance on the life time milk production and productive life of dairy animals, which ultimately affects the economics of the owners. It is known that the extended calving intervals detrimentally affect the longevity as a productive life, since the cow with longer calving interval has fewer lactation numbers throughout the same age of herd life compared with cows with shorter calving intervals. The overall mean of calving interval of indigenous dairy cows for Alefa and Quara districts were reported by the respondents as 26.64 ± 0.6 and 18.72 ± 0.5 months, respectively (Table 2). There was highly significant difference on CI between the two districts ($p < 0.001$). CI of Alefa district was higher than 15.96 and 25.92 months for lowland areas of Mieso and rural high land area of Bure [12]. In contrast, longer estimates of CI for indigenous dairy cows than Quara district were reported by and Tegegne et al. [12] as 25.92 ± 0.36 and 21.36 months, respectively. The longer calving interval reported in this study almost certainly related to poor management practices and other environmental stress that could affect the cows return to oestrus, heat detection, servicing and conception in the two districts.

Number of services per conception

It shows that how many services are required for a successful conception of breeding animals and it is calculated by dividing the number of conceptions with the number of inseminations [17]. Lack of knowledge, in appropriate time of insemination, unqualified technician, hygienic problem, and disease are the most common reasons for frequent breeding [18]. The average Number of services per conception of dairy cows for midland (Alefa) and low land (Quara) districts were reported by the respondents as 1.54 ± 0.55 and 1.82 ± 0.65 , respectively (Table 2). There was significant difference on NSPC between districts ($p < 0.01$). The average NSPC of both districts were higher than 1.28 ± 0.06 for Fogera cattle at Metekel Ranch [19], 1.13 ± 0.03 in Tach

Districts	Kebeles	Representative	Number of groups
		Sample size	Discussion held
Quara	Gelegu	69	1
	Banbaho	70	1
	Selferedi	69	1
Alefa	Kezenshahura	56	1
	Astedemarim	56	1
	Dengelber	56	1
Total	6	376	1

Table 1: Summary of sampling procedure.

Reproductive parameters	Districts		Overall	P-value
	Alefa	Quara		
	Mean \pm SE (N=168)	Mean \pm SE (N=208)	Mean \pm SE (N=376)	
Age at First Service (month)	43.4 ± 0.47	32.8 ± 0.46	38.10 ± 0.47	0.000***
Age at First Calving (month)	52.4 ± 0.81	41.8 ± 0.50	47.10 ± 0.66	0.000***
Calving Interval (month)	26.64 ± 0.60	18.72 ± 0.50	22.67 ± 0.55	0.000***
Days Open (month)	17.64 ± 0.70	9.72 ± 0.40	23.68 ± 0.55	0.000***
Service Per Conception (No)	1.54 ± 0.55	1.82 ± 0.65	1.68 ± 0.60	0.004**

N: Number of respondents; SE: Standard Error.

Significant difference ($p < 0.01$), *Significant difference ($p < 0.001$).

Table 2: The reproductive performance of dairy cows across districts.

Gayint District, but NSPC for dairy cows of Alefa district was almost similar with 1.54 ± 0.69 in North Gondar [20]. Gebrekidan et al. [21] illustrated that, number of services per conception is influenced by availability of feed and high environmental temperature.

Days open

It is the interval between date of calving and date of conception. It is one of the best indicator variables, which is most commonly used to measure fertility performance in dairy cattle [22]. Days open directly affect CI, which plays a vital role in the achievement of dairy farms. Days open is the part of the calving interval that can be shortened by improved herd management. Long days open and consequently, prolonged CI may affect the overall economic revenues of the dairy herd [23]. The average number of DO of indigenous dairy cows for Alefa and Quara districts were reported by the respondents as 17.64 ± 0.7 and 9.72 ± 0.4 months, respectively as reported by the respondents (Table 2). There was significant different on DO between districts ($p < 0.001$). The current result were higher than Niraj [24] in and around Mekelle town and Tegegne et al. [12] in Jimma Town as 6.2 ± 1.70 and 5.19 ± 1.72 months of DO for local dairy cow breed, respectively.

Productive performance of indigenous dairy cows

a) **Lactation milk yield:** Performance of dairy cows could be judged from the milk it produces during a specified period of lactation. Variation observed in lactation milk yield from lactation to lactation in the same animal. The main cause of difference attributed to the physiology of lactation is the specified set of genes and their response with non-genetic factors. The lactation performance of dairy cattle is usually measured by determining total milk yield per lactation or per year, average daily milk yield, lactation length, persistency of milk production and milk composition. The overall mean of LMY of indigenous dairy cow were reported by respondents as 329.6 and 348.8 liters, respectively in Alefa and Quara districts (Table 3). There was highly significant variation across districts on lactation milk yield ($p < 0.001$).

The current results were higher than 277.2 liters for indigenous dairy cows at national level [23]. On the contrary, it was lower than 457.89 ± 86.4 liters reported for local cows in North Shoa Zone [24], 464.34 ± 41.75 liters in local cows in and around Mekelle [24].

b) **Daily milk yield:** Daily milk yield is a very important production efficiency trait, which is a combination of milk yield and lactation length. Cows with high milk yield per day of lactation length (MY/DLL) are cost-effective producers and have extra lactation milk yield. In the estimates of MY/DLL, milk yield on average basis of the lactation length were calculated without taking into account the initial low production, peak yield and the declining in production in the last phase of the lactation. The overall mean of daily milk yield of indigenous dairy cow were reported by respondents as 1.30 ± 0.05 and 1.50 ± 0.04 litres, respectively in Alefa and Quara districts (Table 3). There was highly significant difference across districts on lactation milk yield ($p < 0.001$). In the current study daily milk yield is strongly affected by season of calving, stage of lactation and parity (age of the Dam) (Table 3).

c) **Lactation length:** Lactation length is an important production trait as it influences the total milk yield. In the majority of improved dairy farms, a lactation length of 305 days usually accepted as a benchmark. This standard allows for calving every 12 months with a 60-day dry period. The 12-month interval has considered "Ideal" for many years. If a cow milked longer than 305 days, her yield for the first 305 days taken as the lactation yield. Some cows are not milked for a

Fixed factors	Alefa	Quara	Over all	p-value
	mean \pm SE, N=168	mean \pm SE, N=208	mean \pm SE, N=376	
Milk yield (litter/day)				
Season				
JUN-AUG	1.53 \pm 0.07	2.39 \pm 0.06	2.00 \pm 0.05	0.000***
SEP-NOV	1.45 \pm 0.05	1.99 \pm 0.06	1.75 \pm 0.04	0.000***
DES-FEB	0.92 \pm 0.05	0.58 \pm 0.04	0.73 \pm 0.03	0.000***
MAR-MAY	0.46 \pm 0.03	0.15 \pm 0.03	0.28 \pm 0.03	0.000***
Lactation stage				
Early	1.58 \pm 0.06	2.21 \pm 0.05	1.93 \pm 0.04	0.000***
Middle	1.10 \pm 0.05	1.76 \pm 0.06	1.46 \pm 0.04	0.000***
Last	0.47 \pm 0.02	0.30 \pm 0.03	0.36 \pm 0.01	0.000***
Age				
3-5 years	1.52 \pm 0.05	1.78 \pm 0.04	1.66 \pm 0.04	0.000***
6-9 years	1.95 \pm 0.05	2.27 \pm 0.04	2.13 \pm 0.03	0.000***
>10 years	1.97 \pm 0.05	1.96 \pm 0.03	1.96 \pm 0.03	0.818NS
Average DMY	1.30 \pm 0.05	1.50 \pm 0.04	1.40 \pm 0.05	0.000***
Average LMY	329.6	348.8	339.2	0.000***
Age				
3-5 years	8.17 \pm 0.20	7.40 \pm 0.17	7.73 \pm 0.13	0.004**
6-9 years	8.30 \pm 0.16	7.30 \pm 0.13	7.76 \pm 0.10	0.000***
>10 years	8.90 \pm 0.19	8.57 \pm 0.17	8.76 \pm 0.13	0.119NS
Average LL	8.45 \pm 0.18	7.75 \pm 0.15	8.08 \pm 0.12	0.000***

SE: Standard Error; LL: Lactation Length; N: Number of respondents; NS: Non-significant.

***Significant difference ($p < 0.001$), **Significant difference ($P < 0.01$).

Table 3: Effect of season, lactation stage, and age on milk yield and lactation length.

full 305 days because they go dry or the lactation terminated for any of several reasons. These short records projected to a 305 days equivalent [25]. In general the mean of lactation length of indigenous dairy cow were reported by respondents as 8.45 ± 0.18 and 7.75 ± 0.15 months, respectively in Alefa and Quara districts (Table 3). There was highly significant difference across districts on lactation length ($p < 0.001$). In the current study lactation length is strongly affected by age of the dam (Table 3). The present time of lactation length for both districts was longer than 6.45 ± 0.63 months for local dairy cows [21] and 6.7 ± 0.28 months for highland zebu [14]. However, it was shorter than the optimum value of 305 days (10 months) required to maintain the desired calving interval of 12-13 months [26-34].

Conclusion

The smallholder dairy productions are vital, where they help to maintain the large variation between milk and milk product demand and supply in Ethiopia. From the result of this study, it can be generalized that inferior reproductive and productive performances were reported by the sampled respondents namely, AFS, AFC, CI, DO, LL and LMY were below the standard when compare to the various earlier research findings. Management differences (proper feeding, housing, absence of selection of better local breed for breeding, adequate health care) are the major bottleneck to decline the reproductive and productive performance of indigenous dairy cattle in the study areas. The significant effects of season of calving on the performance of traits suggested that improvement in feed and management is the key factor for further improvement of these local breeds. The presence of variation within the local cows in the two districts indicates the presence of higher scope for improvement through selection of local breed. In order to improve the relatively the poor milk yield, the extended AFC and CI, as well as the short LL, improving the feeding system, providing better health management, genetic improvement of local bred through

crossbreeding are necessary so as to further exploit the optimum level of reproductive and productive performance of indigenous.

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