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Productive and Reproductive Performance of Crossbred Dairy Cows in Tropical Highland, South Western, Ethiopia

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Abstract: The aim of the study was to assess the productive and reproductive performance of crossbred dairy cows in South Western Ethiopia. A total of 60 small-scale dairy farm owners were randomly selected and interviewed with pre-tested structured questionnaire to obtain information on the productive and reproductive performance of cows. The General Linear Model (GLM) procedure of Statistical Analysis Systems (SAS) was used to determine effects of parity, breed group and blood level on milk production and reproductive traits. The results showed that milk production traits were significantly ($p<0.05$) influenced by breed group, parity and blood level. Regarding reproductive traits, age at first calving (AFC), calving interval (CI) and days open (DO) were influenced by breed group and parity, respectively, while number of service per conception (NSC) was not affected by all factors. The least square mean of daily milk yield (DMY), lactation milk yield (LMY) and lactation length (LL) were 7.86±0.09 Kg, 2438.81±98.28 Kg and 306.9±0.43 days, respectively. Least square means of NSC, AFC, CI and DO were 2.18±0.18, 51.09±2.19 months, 20.19±1.62 months and 102.21±19.46 days, respectively. Increment in consumption pattern, population growth and cash of income were identified as major opportunities for dairy production in the region. However, feed shortage (1st), shortage of land (2nd), water shortage (3rd), were found to be the top challenges for dairy production in the area. This might have direct contribution for poor productive and reproductive performances of crossbred cows. Therefore, improving herd management and breeding practices is a key entry point for profitable dairy production.

Key words: Ethiopia · Friesian cross · Guraghe highland · Jersey crosses

INTRODUCTION

The efficiency of dairy farming system depends largely on the productive and reproductive performance of the herd. The livestock subsector in Ethiopia is less productive in general and compared to its potential, the direct contribution to the national economy is limited. The poor genetic potential for productive traits, in combination with the substandard feeding, health care and management practices that animals are exposed to are the main contributors to the low productivity [1]. In order to improve the low productivity of local cattle, selection of the most promising breeds and cross-breeding of these indigenous breeds with high producing exotic cattle has been considered as a practical solution [2]. In this regard, since selections among indigenous breeds is too big and too slow task to bring about the desired genetic change quickly, both governmental and non-governmental organizations have made various efforts to improve the dairy sector by establishing dairy cattle improvement ranches and distributing crossbred F1 heifers to smallholder farmers [3].

The general strategy in animal production should focus on optimization of the productive and reproductive performances according to production factors, the needs of the market, the ecological environment and future

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development. The important parameters that determine dairy cattle productive and reproductive efficiency are age at first calving, total milk yield, average daily milk yield, calving to first service interval and calving [4]. Therefore, producers should develop and identify their own breeding objectives, manipulate production system and breeding stock based on their own commercial conditions rather than taking blueprints from elsewhere [5]. Although there are some studies conducted to evaluate the performance of Friesian crosses in Ethiopia, yet no research has been conducted to investigate the comparative performance of Friesian x Guraghe highland and Jersey x Guraghe highland under the existing farmers management conditions. As a result, dairy sector in Wolkite town need to generate useful information on the major productive and reproductive performances of crossbred dairy cattle to serve as the basis for the exploitation of genetic potential to further dairy industry development in the country. The aim of this study was to assess productive and reproductive performances and constraints of dairy cattle in tropical highland, south western Ethiopia.

MATERIALS AND METHODS

Location of Study Area: The current study was conducted from February to May, 2017 in Wolkite town of the Guraghe Zone, which is located 158 km south west Addis Ababa. According to CSA [6] Wolkite town is geographically located at 8° 17' North latitude and 37° 47' East longitude and has an average altitude of 1850 meter above sea level receiving an average annual rainfall of 1324 mm. The mean annual minimum and maximum temperatures of the area were 13.7°C and 22.7°C, respectively [6].The rainfall pattern in the Guraghe Zone is bimodal in which 80% of rain falls in the rainy period of June to August whereas 20% in the short rainy period of February to May [7].

Data Collection: A total of 60 small scale dairy farmers were randomly selected from 71 small scale dairy producers registered at least for two years in Wolkite town municipality Bureau of Urban Agriculture. The questionnaire was developed in accordance with the objectives of the study and designed in a simple manner to get accurate information from the dairy farm owners. The questions were asked in a very simple way with explanation when necessary and the responses were recorded. The farmers under the study areas were maintained under intensive management system in back-yard operation utilizing free space in the residential area. Daily milk yield (DMY), lactation length (LL) and lactation milk yield (LMY) as productive performance and age at first calving (AFC), calving interval (CI), days open (DO) and number of services per conception (NSC) were traits taken as the measures of reproductive performance. Furthermore, constraints and opportunities of dairy production were collected. Data for both productive and reproductive traits were obtained from records, farm owner interviews and personal observations.

Data Analysis: The data on milk production performance (DMY, LMY and LL) and reproduction performance (AFC, CI, DO and NSC) of crossbred dairy cows were analyzed using GLM procedure of SAS [8]. The presence of any significant differences were tested using Tukey Kramer multiple comparison tests at $p<0.05$. All the interaction effect were tested and which were not significant for all traits. The model equations for productive and reproductive traits were:

$$Y_{ijkl} = \mu + B_i + Z_j + P_l + e_{ijkl}$$

where:

Y_{ijkl} = observation on DMY, LMY, LL, AFC, CI, DO or NSC.
μ = Overall mean
B_i = Fixed effect of i^{th} breed group (Friesian x Guraghe highland, Jersey x Guraghe highland);
Z_j = Fixed effect of j^{th} blood level (50%, 75%);
P_k = Fixed effect of k^{th} parity of dam (1,2,3)
e_{ijkl} = Random error

In ranking of constraints and opportunities of dairy production, index was computed using weighed averages and indexes were ranked using auto ranking with MS-Excel 2007. The following formula was used to compute index as employed by Musa *et al*. [9].

$$\text{Index} = R_n * C_1 + R_{n-1} * C_2 + \ldots + R_1 * C_n / \Sigma R_n * C_1 + R_{n-1} * C_2 + \ldots + R_1 * C_n;$$

where R_n= Value given for the least ranked level (example, if the least rank is 7^{th}, then $R_n=7$, $R_{n-1}=6$ and …, $R_1=1$); C_n= Count of the least ranked level (in the count of the 1^{st} rank = C_1). The opposite matching for R and C value can be presented as follows;R_1 for R_n, R_2 for R_{n-1}…, $R_n$for R_1 and C_1 for C_n, $C_2$for$C_{n-1,\ldots,}$ $C_n$for C_1.

RESULTS AND DISCUSSION

Daily Milk Yield: The average daily milk yield of crossbred cows was found to be 7.61±0.16 Kg per

Table 1: Least square means and standard errors of Daily milk yield, Lactation length and lactation milk yield

	Traits					
	DMY (Kg)		LL (month)		LMY (Kg)	
Factor	N	LSM±SE	N	LSM±SE	N	LSM±SE
Overall	107	7.86±0.09	107	10.23±0.43	107	2438.81±98.28
CV(%)		6.99		25.05		25.06
Parity		**		**		***
1	35	7.61±0.11^{b}	35	8.77±0.51^{ba}	35	1988.72±116.89^{a}
2	56	7.79±0.09^{b}	56	8.63±0.43^{b}	56	2002.62±98.29^{b}
3	16	8.17±0.24^{a}	16	13.30±1.01^{a}	16	3325.08±234.26^{c}
Blood level		**		**		***
75	24	8.27±0.13^{a}	24	9.41±0.54^{a}	24	2532.65±115.39^{b}
50	83	7.46±0.46^{b}	83	11.05±0.49^{b}	83	2344.97±125.59^{a}
Breed group		**		**		***
HF x GH	93	8.10±0.09^{a}	14	10.45±0.67^{a}	14	2430.92±154.56^{a}
Jersey x GH	14	7. 30±0.16^{b}	93	9.01±0.37^{b}	93	2364.70±85.06^{b}

*HF= Holstein Friesian, GH= Guraghe highland, CV= coefficient of variation, DMY= daily milk yield, LL= lactation length, LMY= Lactation milk yield.*p<0.05; p<0.001; **p< 0.01.*

day/cows. The average daily milk yield observed in this study was comparable with the reported values of 7.8±0.19 in Northern Ethiopia [10] and 7.8±0.19 Kg in mid Rift valley of Ethiopia [11]. However, the finding of this study is lower than 11.6±3.1Kg per day/cows in Bishoftu town, Ethiopia [12]. Similarly, Sena *et al* [13] reported higher average daily milk of 9.91 Kg per day/cows for Fogera x Holstein Friesian cows in Debre tabor town. The discrepancy might be due to difference in adaptation, herd size, breed and management conditions.

Analysis of variance revealed that parity had a significant effect on daily milk yield (Table 1). The present study revealed that the mean daily milk yield of the herd increased from parity one to the third parity. The increasing trend in DMY might be due to the fact that cows calving in the first parity were not mature enough to produce more milk due to different physiological conditions like udder development and energy reserve for both body maintenance and milk production, however, in later parities with the attainment of maturity an increased production was observed for Friesian cows [14]. Likewise, breed group and blood level showed a significant effect on DMY. The present outcome revealed that Friesian crosses produced significantly higher DMY than Jersey crosses. This difference might be due to difference in milk production ability of these distinct breeds. In this study, as the exotic blood level increased from 50% to 75%, DMY also increased. This might be due to the reason that the milk production potential of exotic breed is better than that of the local breeds [15]. Contrary, 50% crossbred cows performed better than the 75% exotic blood level cows since 50% crosses developed adaptive traits for disease resistance, heat tolerance and ability to utilize poor quality feed under village conditions [16, 17].

Lactation Milk Yield: The overall mean of lactation milk yield in this study was 2438.81±98.28 Kg. This finding is in agreement with Belay *et al*.[18], they reported 2333.63 Kg for crossbreds in Jimma town. The mean lactation milk yield observed in the present study was lower than 2705.43Kg for crossbred dairy cows in Debre tabor town [13]. On the other hand, lower estimates of 1661.35±15.17 Kg were reported for Friesian×Deoni crossbred cows in India[19] and 1925 and 2136 Kg/cow were reported for Friesian x Arsi and Friesian ×Boran crosses, respectively [15]. These variations in milk yield for crossbred cattle in different production environments could be attributed to variation breeds and managerial practices such as nutrition, disease control in addition to the effect of climatic conditions.

Parity, blood level and breed group significantly (p<0.001) influenced LMY (Table 1). First lactation cows had the lowest milk production and the highest production was observed in third parity. The present findings are in agreement with the other cross breed cows in Ethiopia [15]. The main reason of variation attributed to the physiology of lactation in the given set of genes and their reaction with non-genetic factors [19]. LMY appeared to be increased when the exotic blood level increased from 50 % to 75%. McDowell [20] concluded that the crosses with 75% exotic breeds were superior in milk production compared to F_1 crosses. Similarly, another study revealed that cows with exotic blood levels higher than 50% were found to be more productive in Ethiopia [15, 21]. Friesian crosses produced significantly higher LMY than Jersey crosses. This is due to the fact that milk production potential of Friesian cows is higher than Jersey cows.

Table 2: Least squares means and standard errors of age at first calving, calving interval, days open and number of service preconception

	Traits							
	AFC (month)		CI (month)		DO (days)		NSC	
Factor	N	LSM±SE	N	LSM±SE	N	LSM±SE	N	LSM±SE
Overall	107	51.09±2.19	107	20.19±1.62	73	102.21±19.46	107	2.18±0.18
CV (%)		23.95		28.87		61.49		45.73
Parity		NS		**		**		NS
1	35	50.81±2.60[a]	19	16.96±3.19[a]	19	114.35±15.14[a]	35	2.21±0.22[a]
2	60	52.68±2.17[a]	45	20.61±1.27[ab]	45	104.05±43.44[b]	60	2.33±0.19[a]
3	12	49.77±5.21[a]	13	23.02±3.65[b]	13	88.23±37.88[c]	12;;	2.02±0.45[a]
Blood level		NS		NS		NS		NS
75	24	51.96±2.93[a]	17	19.41±1.97[a]	24	96.94±23.44[a]	24	2.19±0.24[a]
50	83	50.21±2.57[a]	56	20.98±1.79[a]	83	107.47±21.12[a]	83	2.17±0.22[a]
Breed group		*		NS		NS		NS
HF x GH	14	53.60±3.44[a]	10	20.49±1.72[a]	10	98.55±25.93[a]	14	2.22±0.29[a]
Jersey x GH	93	48.57±1.89[b]	63	19.91±2.18[a]	63	105.86±20.44[a]	93	2.14±0.16[a]

*HF =Holstein Friesian, GH= Guraghe highland, CV= coefficient of variation, DMY= daily milk yield, LL= lactation length, LMY= Lactation milk yield.*p<0.05; p<0.001; **p< 0.01.*

Lactation Length: The average lactation length for crossbred cows was 10.23 months (Table 1). This finding was comparable with the mean lactation length of crossbred cows in the Bishoftu and Akaki which were 276.6±35.1days and 280.7±19.3 days, respectively [12]. Similarly, a comparable estimate of 10.1 months was reported in the Central Highlands of Ethiopia [22]. The present finding confirmed commonly accepted standard lactation length of 305 days to take advantage of 60 day dry period.

The analysis of variance showed that parity, blood level and breed group had a significant ($p<0.01$) effect on lactation length (Table 1). Lactation length increased slightly with increase in parity of cow. This might be related to short DO and CI of heifers that were able to conceive early to give subsequent parturition. Lactation length showed a marked difference among breed groups and exotic blood levels. Friesian cross showed longer lactation length than Jersey crosses. Friesian crosses of 50% and 62.5% blood level have shown numerically higher lactation length than 75% and above exotic blood level groups ranging from 0.2-10% [23]. Likewise, lactation length decreased slightly with increasing exotic blood level in which the lactation length of 50% crosses was the highest compared to the 75 % exotic blood levels. This might be due to the ability of 50% crosses to withstand poor nutrition, diseases prevalence and poor management practices of tropical environment, but 75% crosses are more sensitive for such difficulties in tropics and eventually forced to stop lactation at early stage of lactations.

Reproductive Performances

Age at First Calving: The least square mean of age at first calving was 51.09 months which is longer than the reported value of 32.3 months for 50% crosses and 33.9 months for 75% crosses at Bishoftu [12] and AFC of 3.37 years in Northern Ethiopia [10]. The prolonged AFC of crossbred cows in present study compared to literature results could be attributed to factors such as poor nutrition and management practices including poor heat detection at the time of mating the heifers. With good nutrition it is expected that heifers would exhibit fast growth and attain higher weights at relatively younger ages. In this study, age at first calving on different blood levels and parities found to be non-significant, however, breed group had a significant ($p<0.05$) effect on age at first calving (Table 2). Similar to the current finding, the non significant ($p>0.05$) effect of blood level on AFC were reported for Friesian cows in Ethiopia [24].

Calving Interval: In this study, the average calving interval was 20.19 months (Table 2). It agreed with the reported value of 20.73 month for Boran x Friesian crosses in Tatesa cattle breeding center [25]. However, this finding was higher than the mean calving interval of 15.5 months in Arsi, Ethiopia [16] and 439.03 days in Gonder [26]. However, it is lower than 26.8 month [16] and 34.17 months for Zebu x Friesian crosses [27]. The relatively longer calving interval might be indicative of poor nutritional status, poor breeding management, lack of own bull and artificial insemination service, longer days open, diseases and poor management practices.

Table 3: The rank of major constraints to milk production in the study area (n=60)

	Level of constraint 1-7									
Constraint	1	2	3	4	5	6	7	Sum	Index	Rank
Disease prevalence	0	0	1	1	3	2	15	37	0.02	7
Feed shortage	21	28	7	4	0	0	0	366	0.22	1
Inefficient AI service	0	0	0	0	12	32	6	106	0.07	6
Lack of extension services	9	12	10	22	5	2	0	292	0.18	4
Poor breeding management	0	0	4	13	31	11	1	176	0.11	5
Shortage of land	25	15	10	7	2	0	0	349	0.22	2
Water shortage	5	5	26	14	7	3	0	278	0.17	3

**Index= sum of single livestock species sale ranks [(7 for rank 1) + (6 for rank 2) + (5 for rank 3) + (4 for rank 4) + (3 for rank 5) + (2for rank 6) + (1 for rank 7)] divided by sum of all weighed constraints mentioned by the respondents.*

In this study calving interval was not affected by breed group and blood level, while parity had a significant effect on CI. Similar to the current study, parity affected significantly CI [28]. Conversely, the non significant effect of parity on the length of CI was reported for crossbred cows under smallholder conditions in mid Rift valley of Ethiopia [25].

Days Open: The overall mean of DO of crossbred cows was 102.21±19.46 days. This result was comparable with the reported value of 93 days for crossbred dairy cows in Debre tabor town [13]. The present finding is lower than the reported value of 148 days for pure Friesian cows in central highlands, Ethiopia [21, 24]. In contrast, 85.6 days was reported under smallholder condition in Ethiopia [29]. Feed shortage, silent estrus and lack of proper heat detection might have contributed considerably to the long days open reported in the study among many other traits. In this study breed group and blood level had no a significant (p>0.05) effect, while parity had significant (p<0.01) effect on DO. The longer DO for cows calved in parity one followed by those in second and third parities are in agreement with findings reported by Million *et al.* [24] who had reported similar trend of DO tending to decrease with advancement in age. This could be due to physiological stress experienced by the first parturition in early lactation and delayed calving to first service interval and eventually influencing the number of DO.

Number of Service per Conception: The average NSC of this study was 2.18 months (Table 2). The present finding was higher than the number of services per conception of 1.8 for indigenous and Friesian crossbred dairy cows in Gondar [26] and 1.52 under small holder condition in Ethiopia [29], 1.62 for Zebu x Friesian in the central highlands of Ethiopia [30], 1.67 from mid Rift valley of Ethiopia [25]. Number of service per conception higher than two should be considered as poor [31]. The analysis of variance revealed that breed group, blood level and parity of the cow had no significant effect on NSC (p>0.05). The findings of the present study on NSC suggested comparatively poor service per conception at the herds under the study during the period of the study. This might be due to factors related to management, quality of semen, skill of the inseminator, proper time of insemination and cows related factors. Body condition of the animal, nutrition and climate conditions may also affect the success of insemination [24, 32].

Constraints of Dairy Production in Wolkite Town: Cattle productivity in the study area is affected by a number of factors. The most important constraints associated with milk production as prioritized by the respondents in the study area were indicated in Table 3. The major constraints facing dairy farmers were feed shortage, lack of water and shortage of land were ranked first, second and third, respectively. Similar findings were reported in central high lands and south western parts of Ethiopia [17, 33]. Other constraints for dairy production was lack of extension services, poor breeding practice, inefficient AI and disease were noted by the respondents. Additionally, Belachew and Jemberu [34] noted that under development and lack of market-oriented production, lack of adequate information on livestock resources, inadequate permanent trade routes and other facilities like feeds, water, holding grounds, lack or non-provision of transport, ineffectiveness and inadequate infrastructural and institutional set-ups, prevalence of diseases, are generally mentioned as some of the major reasons for the poor performance of this sector.

Opportunities of Livestock Production in Wolkite Town: Dairy production in the studied area showed many opportunities. The most important opportunities of dairy production in the studied area were rapid urbanization, population growth, access to credit services and increase

Table 4: The rank of major opportunities for milk production in the study area (n=60)

	Level of rank 1-6								
Opportunity	1	2	3	4	5	6	Sum	Index	Rank
Rapid urbanization	5	3	10	9	23	10	168	0.13	5
Population growth	13	23	11	10	1	2	271	0.21	1
Access to credit services	10	3	5	21	10	11	189	0.15	4
High milk consumption	21	17	5	8	3	6	267	0.21	2
Immediate cash income	6	11	21	8	7	7	220	0.17	3
Diverse genetic resource	7	4	8	4	17	20	160	0.12	6

**Index=sum of single livestock species sale ranks [(6 for rank 1) + (5 for rank 2) + (4 for rank 3) + (3 for rank 4) + (2 for rank 5) + (1for rank 6)] divided by sum of all weighed opportunities mentioned by the respondents.*

in demand for milk consumption, immediate cash income, good animal genetic resources and employment opportunities. However, among these opportunities population growth, increase in demand for milk consumption and immediate cash income were ranked first, seconded, third respectively (Table 4). This result is comparable with the finding reported in Dire Dawa, Ethiopia; there is high demand for milk, milk consumption tradition of the society, presence of people with different cultural and religious backgrounds, availability of cheap labor for dairy farms and milk vending activities [35]. Asrat *et al*. [36] also reported similar results to current study in Boditi, Ethiopia where the major opportunities of dairy industry described as rapid urbanization, substantial population growth and change in the living standard of the dwellers have a tendency to the increasing demand for milk and milk products.

CONCLUSIONS

Evaluation of productive and reproductive performances of dairy cattle is substantial for successful dairy industry development. The result of the study showed that productive and reproductive performance of crossbred cows in south western Ethiopia is substandard. Unlike reproductive traits, production traits are affected by breed group and exotic blood level of the cow. Thus, the high graded Friesian x Guraghe highland has an opportunity to produce more milk than Jersey x Guraghe highland cows on the existing management. Scarcity of resources (i.e. Feed, land and water), lack of extension services and poor breeding practices are the main limiting factors for dairy production in the study area. Therefore, governmental and nongovernmental organization should be involved in input supply, training and awareness creation particularly on feed improvement, disease prevention and breeding management of dairy cattle.

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