American-Eurasian Journal of Scientific Research 10 (5): 278-286, 2015
ISSN 1818-6785

DOI: 10.5829/idosi.aejsr.2015.10.5.1156

Productive and Reproductive Performances of Ethiopian Boran Cattle with Different Levels of Holstein Friesian Inheritance

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Abstract: Data on the Ethiopian Boran and their crosses with Holstein Friesian cows collected over a period of 23 years (1990 to 2012) at Holeta Agricultural Research Center (HARC) were used to determine the effect of genetic and non-genetic factors on the milk production and reproduction performances of Ethiopian Boran cattle with different levels of Holstein Friesian inheritance. Least square analysis of variance was used for the evaluation of the performance of various genetic groups. Genetic group, parity, period and season had significant ($P<0.05$) effects on milk production and reproduction performance. All genetic groups of crossbreeds were superior to Ethiopian Boran in milk production performance. F_1 and 75% Holstein Friesian were also superior to F_2, F_3 and 62.5% Holstein Friesian in milk production performance. Calving interval and days open were significantly shorter in F_1 than Ethiopian Boran, F_2 and 62.5% Holstein Friesian. F_1 had the shortest age at first calving. Both genetic and non genetic factors affected productive performances of Ethiopian Boran crosses. But reproductive performances were less affected by genetic factors. More attention should be given on non-genetic factors to improve reproductive traits. Hence, it was concluded that an elaborative approach to bring breed improvement on indigenous Boran cattle is a change in both genotypes and environments simultaneously or a selection within the local breed under the local environmental condition.

Key words: Breed · Crossbreds · Milk · Production · Reproduction · Traits

INTRODUCTION

Ethiopia believed to have the leading livestock population in Africa. In the country, there were 53.99 million cattle [1]. Out of the total population in the country, 98.95% were local breeds. Hybrid and exotic breeds accounted for about 0.94 percent and 0.11 percent, respectively. The average lactation period per cow is estimated to be about six months and average daily milk yield per head of indigenous cow was 1.32 liters in the sedentary areas of the country [1]. Livestock directly contributes to the livelihoods of more than 70% of Ethiopians [2]. It accounts for 15-17% of national GDP and 35-49% of agricultural GDP.

The national per capita consumption of milk and milk products is about 20 liters per person per year. This is extremely low from the recommended amount of the world health organization (WHO), which is 180 liters. In order to meet the demand of the growing population of Ethiopia, milk production has to be improved through introducing genetic improvement and management intervention options.

Even though few studies have been done on dairy herd of Holeta Agricultural Research Center that assessed cross breeding effects on production and reproduction traits, there is a need to include recent data for timely recommendations. In this study, F_2 particularly F_3 genetic groups have been also included which were not studied by other researchers. Moreover, there is no strategy to maintain the improvement in milk production obtained after 50% crosses. Thus, this study is essential to assess the effect of genetic and non-genetic factors on the milk production and reproduction performances of Ethiopian Boran cattle with different levels of Holstein Friesian inheritance.

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MATERIALS AND METHODS

Description of the Study Area: This study was conducted at Holeta Agricultural Research Center (HARC) of the Ethiopian Institute of Agricultural Research (EIAR) that is located 35 km west of Addis Ababa (38.5°E longitude and 9.8°N latitude) in the high lands of Ethiopia at an elevation of 2400 m above sea level. The minimum and maximum daily temperature of the area is ranging from 5 to 10°C and 18.7 to 24.0°C, respectively. The periods of heavy rainfall may occur during rainy season and the area receives an average rainfall of 1200mm. There are three main seasons in the year; long rainy season from June to September, dry season lasts from October to February followed by short rainy season having light rain from March to May. The principal soil type is vertisol.

Study Animals and Management: Ethiopian Boran and different genetic grades level of their crossbreeds with Holstein Friesian were used in this study. Regular conditions of feeding and management practices were adopted for all animals during the entire experimental periods. Natural grazing, hay and concentrate supplement constitute the major feed supply. There is no biased management option based on the genetic groups or level of milk production [3]. The animals were grazed on natural pasture for about 8 hours during daytime. At night all animals were kept in their barn and supplemented with natural pasture hay. Concentrate composed of 30% wheat bran, 32% wheat middling and 37% noug cake (*Guizotia abyssinica*) and 1% salt. Lactating cows were provided with approximately 3 to 4 kg of concentrates at each milking. Pregnant cows and heifers were kept into maternity pens at night during the last two months of gestation and supplemented with 2 kg of concentrate; no other animal received any regular concentrate supplement. Clean and fresh drinking water was always available in free access. Newborn calves were allowed to suckle their dam freely soon after birth until 24 hours in order to ensure them colostrum feeding. Then they were separated from the dam and bucket feeding was followed till weaning age. Each calf was provided with a fixed amount of 260 kg of whole milk during the pre-weaning period.

Calves were kept in-doors until the age of six months and were offered concentrate and hay starting two weeks after birth. They were allowed approximately 1kg of concentrate per day and hay ad-libitum until weaning age (in average 3 months). In addition vaccination against Rinderpest, Foot and Mouth disease, Anthrax, Pasteurolsis, Blackleg and Contagious Bovine Pleuropneumonia (CBPP) were given to the farm animals. They are also drenched and sprayed for internal and external parasites at regular intervals. Specific treatments are given whenever any disease occurs.

Artificial insemination with semen produced from locally recruited bulls or imported semen from National Artificial Insemination Centre (NAIC) has been practiced.

Data Collection: The following data that were collected from 1990 to 2012 related to milk production and reproductive performance of the indigenous and crossbreed cows were considered for the study.

- Identification number of each cow
- Parity, breed group, sire of cow, dame of cow.
- Disposal date

Milk Production Traits:

- Daily milk yield (liter)
- Total lactation milk yield (liter)
- Lactation length (day)

Reproduction Traits:

- Calving interval (day)
- Days open (day)
- Age at first calving (day)

Statistical Analysis: Daily milk yield (liters), total lactation milk yield (liter), lactation length (days), calving interval (days), days open (days) and age at first calving (days) were analyzed using General Linear Model (GLM) procedure of SAS (2008) [??]. In this analysis, two types of methods were employed. Method 1 the least square analysis of variance (a breed group model) was used to compare the various breed groups including the effects of non genetic factors such as parity, period of calving and season of calving

Model: the statistical model for analyzing daily milk yield (liters), lactation length (days), total lactation milk yield (liters), calving interval (days) and days open (days) contained main model components (Table 2). It is also mathematically expressed as follows:

Table 1: Grouping year of calving/birth.

Calving period	Duration
Period 1	1990-1993
Period 2	1994-1997
Period 3	1998-2001
Period 4	2002-2005
Period 5	2006-2009
Period 6	2010-2012

Table 2: Summary of model components.

Traits	Model components
Post calving traits DMY, LL, TLMY, CI, DO	Breed groups, cows within breed group, parity, period of Calving, season of calving
Pre-calving traits AFC	breed groups, cows within breed group, period of birth, season of birth

$$Y_{ijklm} = \mu + G_i + P_j + Y_k + S_l + e_{ijklm}$$

Where; Y_{ijklm} = daily milk yield, total lactation milk yield, lactation length, calving interval and days open of an individual animal with parity j, period k, season l of genetic group i.

μ = overall population mean

G_i= the fixed effect of i^{th} genetic group (i=1, 2, 3 …6),

P_j = the fixed effect of the j^{th} parity (j= 1, 2, 3, 4, 5, 6, 7, 8^+),

Y_k= the fixed effect of k^{th} period ($k=P_1, P_2, P_3, P_4, P_5, P_6$),

S_l = the fixed effect of l^{th} season (l=1, 2, 3),

e_{ijklm} = the random residual NID ($0, ó^2_e$)

Genetic Groups:

B: Ethiopian Boran

F_1: BXF (50% of Holstein Friesian)

F_2: BFXBF (50% of Holstein Friesian)

F_3: BFBFXBFBF (50% of Holstein Friesian)

B_1: 5/8FX3/8B or BFFXBF or BFXBFF (62.5% of Holstein Friesian)

B_2: 3/4FX1/4B or BFXF (75% of Holstein Friesian)

Where F: Holstein Friesian, X stands for crosses among different genetic groups.

Parity: Parity is coded as 1, 2, 3.. ……………and 8^+.

Period:

Season of Calving:

- Long dry season (October to February)
- Short rainy season (March to May)
- Long rainy season (June to September).

RESULTS AND DISCUSSION

Effects of Genetic Groups and Non-Genetic Factors: The effects of genetic groups, parity, calving periods and calving seasons on all milk yield traits is presented in Table 3. The least square means is also summarized in Table 3.

Milk Production Performance

Daily Milk Yield (DMY): The least square means indicated that daily milk yield is significantly affected by genetic groups. The overall mean for daily milk was 5.33lt with a coefficient variation of 29.42%. The daily milk production of Ethiopian Boran was significantly ($P<0.01$) lower than any other genetic groups. It has been apparent from the results that crossbreeding with Holstein-Friesian had resulted in improvement of daily milk production traits of the indigenous Ethiopian Boran. Milk yields also showed significant difference among other crosses. The highest daily milk was recorded by F_1 and 75%F genetic groups followed by 62.5%F, F_2 and F_3, respectively.

The present daily milk yield estimate was close to the estimate value of 2.7 to 6.3 kg [4], 1.7 to 6.9 [5] and 1.99 to 5.31 kg [6]. The daily milk yield was more or less different in the different parities. There were significant ($P<0.01$) differences among the daily milk in first parity, second parity and third to eighth parities. The lowest daily milk yield was recorded in the first parity.

Daily milk has increased significantly in the second parity compared to the first. Though there were no significant ($P>0.05$) differences in daily milk yield subsequent to the second parity, the daily milk yields has increased significantly in contrast the first two parities. Dairy cattle that attained the later parities (i.e. seventh and eighth parity) kept on higher daily milk production than earlier parities. The daily milk yield was consistently higher towards the end parities because cows with low milk production and less resistance have been culled up before reaching later parities and only strong and high productive dairy cattle were maintained in the farm.

Calving period has highly significant ($P<0.01$) effect on average daily milk yield. In this comparison, the highest daily milk was recorded in calving period 6 (2010-2013) where as the lowest daily milk yield was produced in period 1 (1990-1993). There were no differences in daily milk yield between calving period 2 (1994-1997), calving period 4 (2002-2004) and calving period 5 (2006-2009). This difference might be due to difference in climate change and grazing land productivity of the year.

Table 3: Analysis of variance of daily milk yield, lactation length and total lactation milk yield

Source	DF	Daily milk yield (MS)	Lactation length (MS)	Total lactation milk yield (MS)
Genetic group	5	1620.92**	412412.49**	205654828**
Parity	7	57.72**	24747.86**	4145584**
Period	5	140.10**	112419.90**	6307808**
Season	2	12.86*	21908.48*	2717810*
Error	1868	2.45803	4879.35	414639

M.S = Means squares DF = Degrees of freedom,* = p<0.05, ** = p<0.01.

Table 4: Least-square means (LSM ± SE) of daily milk yield (DMY), lactation length (LL) and total lactation milk yield (TLMY) of Boran breeds and their crosses with Holstein Friesian

Variable*	N	DMY (lt) LSM±SE	LL(days) LSM±SE	TLMY(lt) LSM±SE
Overall mean		5.33	301.18	1683.34
CV (%)		29.42	23.19	38.25
Genetic Groups				
B	524	1.76± 0.08^{e}	246.22±3.46^{c}	447.73±31.87^{d}
F_1	929	7.14± 0.06^{a}	332.54±2.82^{a}	2369.95±26.04^{a}
F_2	202	5.70±0.12^{c}	298.68±5.17^{b}	1681.24±47.66^{c}
F_3	127	5.05± 0.15^{d}	299.90±6.46^{b}	1542.38±59.57^{c}
B_1	63	6.16± 0.21^{b}	302.50±9.23^{b}	1917.80±85.08^{b}
B_2	43	6.91± 0.25^{a}	331.02±11.12^{a}	2292.36±102.55^{a}
Parities				
1	476	4.52± 0.09^{d}	317.36 ± 3.94^{a}	1462.44±36.35^{c}
2	357	5.09 ±0.10^{c}	312.95± 4.43^{a}	1645.45±40.83^{b}
3	311	5.52 ± 0.10^{b}	299.57 ±4.58^{b}	1729.49±42.20^{ab}
4	233	5.65 ±0.11^{ab}	308.74±5.09^{ab}	1797.79±46.90^{a}
5	179	5.65 ±0.13^{ab}	307.29± 5.75^{ab}	1813.00±53.03^{a}
6	131	5.66± 0.15^{ab}	297.90±6.51^{b}	1751.11±60.03^{ab}
7	96	5.63 ± 0.17^{ab}	285.03±7.71^{bc}	1704.08±71.10^{ab}
8^{+}	105	5.91 ± 0.17^{a}	285.62±7.55^{bc}	1765.25±69.58^{ab}
Calving period				
Period-1	155	4.17±0.13^{d}	322.57±5.97^{a}	1403.19±55.07^{d}
Period-2	165	5.17±0.13^{c}	322.94±5.72^{a}	1716.46±52.76^{bc}
Period-3	405	6.11±0.11^{b}	307.28±4.78^{b}	1934.32±44.05^{a}
Period-4	339	5.45±0.11^{c}	300.84±5.0^{bc}	1698.18±45.87^{c}
Period-5	426	5.34±0.10^{c}	292.54±4.63^{c}	1684.04±42.71^{c}
Period-6	398	6.47±0.12^{a}	264.70±4.77^{d}	1815.27±44.00^{b}
Season of calving				
Long dry season	897	5.57±0.08^{a}	303.20±3.45^{a}	1723.29±31.83^{a}
Short rainy season	566	5.30±0.09^{b}	294.65±3.90^{b}	1628.90±35.82^{b}
Long rainy season	425	5.50±0.09^{ab}	307.60±4.22^{a}	1773.54±38.92^{a}

N: number of observation; B: Boran; F: Holstein Friesian; F: Holstein Friesian; F1: BXF; F_2: BFXBF; F_3: BFBFXBFBF; B_1: BFXBFF or BFF X BF (62.5%F); B_2: 3/4FX1/4B or BFXF or 75%F; Long dry season: October to February; Short rainy season: March to May; Long rainy season: June to September; period 1: 1990-1993; period 2:1994-1997; period 3:1998-2001; period 4: 2002-2004; period 5: 2005-2008; period 6: 2009-2013.

On the other hand there was no uniform genetic distribution throughout experimental period which means the higher producers individuals might be on production in period 6 and the higher producers individuals might not be on production in period 1.

Season of calving had significant effect (P<0.05) on daily milk yield. This difference was observed in daily milk yield between long dry season and short rainy season. On the other hand daily milk yield did not show significant difference between long rainy season and long dry season. The lower daily milk yield was observed in short rainy season than long dry season. The short rainy season is the transition time from long dry season to long rainy season. As a result the lower daily milk yield might be associated with the weather condition change and the declining of pasture productivity during this season.

Table 5: Analysis of variance of calving interval, days open and age at first calving

Source	DF	Calving interval (MS)	Days open (MS)	DF	Age at first calving (MS)
Genetic Group	5	107679.82**	1109001.40**	5	906385.29**
Parity	7	35823.43**	39467.94*		
Calving period	5	166752.82**	154271.49**	5	1236862.86**
Calving season	2	29079.98*	27314.56*	2	442088.50 *
Error	1605	9274.47	9230.38	403	67272.64

M.S = Means squares D.F = Degrees of freedom * = p<0.05 ** = p<0.01 ns = not significant.

Table 6: Least square means (Mean ± SE) of calving interval (days), days open (days) and age at first calving (days)for Boran breeds and their crosses with Holstein Friesian

		CI (days)	DO (days)		AFC (days)
Variable	N	LSM±SE	LSM±SE	N	LSM±SE
Overall		461.34	184.72		1206.77
CV (%)		20.87	52.01		22.20%
Genetic Grades					
B	571	476.48±4.66^{ab}	200.24±4.65^{ab}	16	1388.11±72.92^{b}
F_1	649	433.33±4.51^{c}	155.97±4.50^{c}	223	1188.25±24.35^{c}
F_2	112	457.49±9.63^{b}	181.81±9.60^{b}	91	1387.46±29.78^{b}
F_3	73	451.84±11.66^{bc}	175.88±11.63^{bc}	59	1417.00±80.55^{ab}
B_1	44	499.24±15.38^{a}	219.49±15.34^{a}	15	1623.55±78.62^{a}
B_2	19	447.03±23.28^{abc}	166.61±23.22^{abc}	12	1393.76±35.94^{b}
Parities					
1	324	488.01±7.08^{a}	211.93±7.06^{a}		
2	292	472.06±7.31^{b}	194.75±7.30^{b}		
3	232	463.87±7.81^{bc}	186.57±7.79^{b}		
4	200	466.12±8.23^{b}	188.71±8.21^{b}		
5	159	459.13±9.0^{bc}	181.16±8.96^{bc}		
6	118	453.29±10.30^{bc}	175.17±10.27^{bc}		
7	62	445.57±13.63^{bc}	167.44±13.59^{c}		
8^+	81	439.16±12.29^{c}	160.93±12.26^{c}		
Periods					
Period-1	154	474.52±8.60^{a}	197.42±8.58^{a}	40	1602.89±44.25^{a}
Period-2	138	440.59±9.36^{b}	163.12±9.34^{b}	54	1478.61±37.15^{b}
Period-3	341	434.30±8.21^{b}	157.90±8.19^{b}	12	1519.65±81.13^{ab}
Period-4	260	491.24±8.55^{a}	213.31±8.53^{a}	56	1221.70±44.78^{c}
Period-5	330	486.32±7.86^{a}	206.67±7.84^{a}	139	1198.24±35.89^{c}
Period-6	245	438.43±8.8^{b}	161.60±8.78^{b}	115	1377.05±37.96^{b}
Seasons of calving					
Long dry	717	454.3±6.26^{b}	177.26±6.25^{b}	162	1334.71±30.90^{b}
Short rainy season	419	469.63±6.93^{a}	191.72±6.92^{a}	156	1413.34±30.76^{a}
Long rainy season	332	458.35±7.22^{ab}	181.02±7.20^{ab}	98	1451.02±35.52^{a}

N: number of observation; CI: calving interval; DO: days open; AFC: age at first calving; LSM: least square mean s; CV: coefficient of variation; B: Ethiopian Boran; B_1: 62.5%Holstein Friesian; B_2: 75%Holstein Friesian; F_1: first generation; F_2:second generation; F_3: third generation Long dry season: October to February; Short rainy season: March to May; Long rainy season: June to September; period 1: 1990-1993; period 2:1994-1997; period 3:1998-2001; period 4: 2002-2004; period 5: 2005-2008; period 6: 2009-2013.

Lactation Length: The overall mean for lactation length was 301.18 days with a coefficient of variation of 23.19%. This mean of 301 days is close to the ideal 305 days of lactation as described by Kiwuwa *et al.,* (1983) [4]. The effect of genetic groups on lactation length was significant (P<0.05). The F_1 and 75% Holstein Friesian genetic groups revealed significantly higher lactation length than others (P<0.05) with estimate values of 332.54±2.82 and 331.02±11.12 days respectively. However, there were no significant differences in lactation length among 62.5% Holstein Friesian, F_2 and F_3. The lactation length was also significantly (P<0.05) declined in F_2 and F_3 generations compared to F_1 generation and this might be associated with heterosis effect. The lactation length of

Boran was 246.22±3.46. The lactation length of Boran was significantly lower than any other genetic groups (P<0.01). Thus, crossbreeding has also improved lactation length. The estimate value of the present lactation length was in comparable with estimate of 272 to 411 days [4], in the range of 240±4 to 355±11 days [5] and 198±11 to 374±8 days [7].

Lactation length was found to be affected significantly by parity (P<0.01). Longer lactation lengths were observed in the earlier parties and shorter lactation lengths were recorded in the later parities. Calving period had significant (P<0.05) effect on lactation length. Though there were no clear trends in lactation length differences due to the effect of calving period, the lactation length in calving period 1 (1990-1993) and calving period 2 (1994-1997) were significantly longer than any other calving periods. The shortest lactation length was recorded in calving period 6 (2010-2013). This might be due management differences from one year to another. More over there was no uniform distribution of individuals throughout the experimental period based on their production performance. The analysis of variance revealed a significant effect of calving season in lactation length (P<0.05). The lactation length in short rainy season was shorter than the lactation length of long dry and long rainy seasons.

Total Lactation Milk Yield: The overall mean of total lactation milk yield was 1683.34 with a coefficient of variation of 38.25%. Total lactation milk yield was significantly (P<0.01) affected by genetic groups. F_1 and 75% Holstein Friesian produced more milk yield per lactation than the other genetic groups. There was no improvement in milk production rather than deteriorating in the F_2 and F_3 generations when compared to F_1 generation. This was most probably associated with hybrid vigor deterioration in the second and third generations due to the effect of recombination loss. The total milk yield per lactation of Boran was significantly smaller than any other genetic groups and this indicated that crossbreeding of Holstein Friesian with indigenous cattle has improved milk production at different Holstein Friesian inheritance. The total lactation milk yield obtained in this study was ranged between 447.73±31.87lt (for Boran) to 2369.95±26.04lt (for F_1) which was in close agreement with estimate value of 507±39kg (for Boran) to 2366±91kg (for 87.5% Holstein Friesian) [6], 809kg (for Arisi) to 2374kg (for 75%Friesian 25%Arsi) [4] and 771±99kg (for Boran) to 2312±135kg (for 75% Holstein friesian25%Boran) [7].

The total lactation milk yield in the first parity was significantly (P<0.01) lower than the other parities. Though there were no significant (P>0.05) differences in total lactation milk yield from the third parity to the eighth parity, the values showed a slightly increasing trend in total lactation milk yield from the first to the fifth parity and it declined subsequently thereafter fifth parity.

Calving periods had significant effect on total lactation milk yield. The total lactation milk yield obtained in the calving period 1 (1990-1993) was significantly lower than the other periods. The total lactation milk yield of calving period 3 (1998-2001) was significantly higher from other calving periods. Total lactation milk yield is the product of daily milk yield and the days of lactation. Thus total lactation milk yield differences might be also associated with management and climate change differences during experimental period. Season of calving also affected the total lactation milk yield significantly. Accordingly, the total lactation milk yield in short rainy season was significantly lower than the long dry and long rainy seasons. On the other hand, total lactation milk yield did not show difference in long dry and long rainy seasons.

The findings of [4, 6] were in disagreement with the present study that season of calving had no significant effect on milk production traits of their work. The effect of season could be insignificant for animals maintained under good management. The significant effect of season found in this work might be related with weather condition and management differences.

The inferior performance of Boran cows than their crosses with Holstein Friesian in daily milk yield, lactation length and total lactation milk yield of this work supported by the report [4] on Arsi cows and Zebu; [8] on Arsi cows; [6] on Barka cows; [5] on Boran cows; [7] on Boran cows). The superiority of 75% Holstein Friesian and particularly F_1 genetic groups have been found in all milk production traits considered in this study. Some comparable evidence from Ethiopia and other tropical countries: the work by [8] agreed with the present work in that F_1 showed the highest performance for milk/LL and milk/CI; [4] indicated that the clear superiority of all crossbreds over the indigenous breed groups; [7] selected 3/4Holstein Friesian1/4Boran genetic group as the best producer in daily milk yield, lactation length and total lactation milk yield; the similarity in performance of the 75% *Bos taurus* and the 50% *Bos taurus.* [5] presented that lactation milk yield, 305 days yield and daily milk yield were significantly higher for 75% Holstein Friesian and

87.5% Holstein Friesian crosses compared to 50% Holstein Friesian and 62.5% Holstein Friesian. the present work was in disagreement with [5] because he reported the higher performance of 75% Holstein Friesian and 87.5% Holstein Friesian inheritance than 50% Holstein Friesian inheritance without separating 50% Holstein Friesian inheritance in first, second and third generations.

Though F_2 and F_3 genetic groups seem to be similar in Holstein Frisian inheritance with F_1, F_1 was significantly higher than F_2 and F_3 in milk production performance. This was might be associated with the weakening of hybrid vigor (heterosis) due to recombination loss in F_2 and F_3. With the same reason F_2 was also superior to F_3 in milk production performance. So that there is no need of use of second, third and so on generations rather than use of alternative crossbreeding practices.

Reproduction Traits: The lifetime productivity of a cow is influenced by its reproductive effectiveness. Calving interval and days open are most likely the best indicator of a cattle herd's reproductive success whereas first calving marks the beginning of a cow's productive life and closely related to generation interval. The results of this study revealed that all genetic and non-genetic factors considered in this study significantly (P<0.05) affected reproduction traits (Table 7 and 8).

Calving Interval: The mean calving interval was 461.34 days with a coefficient variation of 20.87%. As depicted in Table 7 the effects of genetic groups on calving interval were significant (p<0.01).The calving interval of F_1 was significantly shorter than the Ethiopian Boran, F_2 and 62.5%Holstein Friesian whereas F_1 were not significantly different in calving interval from F_3 and 75%Holstein Friesian. F_1 was significantly shorter in calving interval than F_2 but it was not different from F_3. This might be associated that heterosis effect was declined from F_1 to F_2.Though declining of heterosis is expected, F_3 was not different from F_1. This might be associated with the strong individual cows maintained in F_3 and weak individual cow might be culled from the herd. The present calving interval estimate was in agreement with previous work reported as 393 days for 1/2exotic X 1/2Arsi to 525 days 7/8 Friesian X 1/8 local (Kiwuwa *et al*., 1983) and fairly closer to the estimate value of 422±10 (50% Holstein Friesian) to 446±12 days (62.5% Holstein Friesian) (Aynalem, 2006). The present estimate was comparable with estimate value of 417±6 days (for 1/2F:1/2B (F_1)) to 473±7 days (for Boran) [9].

The days of calving interval more or less decreased as the parity has increased. The calving interval obtained in the first parity was significantly longer than other parities. The calving interval in the eighth parity was significantly shorter than the first, second and fourth parities. This indicated that as the parity advanced the poor performing cows were culled from herd due to their own less adaptability and the strong ones remained in the farm. Calving period was another overall effect in calving interval differences. The longer calving interval was observed in period 1 (1990-1993), period 4 (2002-2005) and period 5 (2006-2009) whereas the shorter calving interval was observed in period 2 (1994-1997), period 3 (1998-2001) and period 6 (2010-2013). Season of calving period had significant effect on calving interval. The calving interval obtained in short rainy season was longer than that of long dry season.

Days Open: The overall mean for days open (DO) was 184.72 days with a coefficient variation of 52.01%. Days open was significantly (p<0.01) affected by genetic groups. F_1 had significantly shorter days open than that of Ethiopian Boran, F_2 and 62.5%Holstein Friesian. The days open obtained in 62.5%Holstein Friesian showed significantly longer days than that of F_1, F_2 and F_3. The present estimate was similar to the estimate value of 181±20 days [10] whereas higher than the estimate value of 131±15 days (for 5/8HF:3/8B) to 158±8 days (for Boran) [9].

Parity had significant (p<0.01) effect on the days open, where it resulted in considerably higher days open in the first parity. The days open in the second parity was significantly (p<0.01) higher than the days open of seventh and eighth parities. This indicated that there was an improvement in days open when the parities advances. The period of calving significantly (p<0.01) changed the days open. The days open vary between 159.90±8.19 (calving period 3) to 213.31±8.53 (calving period 4). Season of calving had significant effects on days open. The days open in short rainy season was longer than that of long dry season.

Age at First Calving: The mean age at first calving for 416 heifers was 1218.58 days with a coefficient of variation of 21.28%. The effect of genetic group on age at first calving was significant (P<0.01). The earliest age at first calving (1188.25±24.35) was achieved by F_1 crosses while the longer age at first calving (1623.55±78.62) was recorded for 62.5% Holstein Friesian. There were no significant (P<0.05) different among Ethiopian Boran, F_2, F_3 and

75%Holstein Friesian in age at first calving. This estimate value when converted to months ranged between 39.6±0.8 months to 54±2.6 months which was higher than the estimate value of 31.3 months for 75% exotic: 25% Arsi to 35.7 months for 87.5% Friesian: 12.5% local (Kiwuwa *et al*., 1983), 36±0.4 months (F_1) to 42.5±0.5 months (Boran) [9] and 39.9±1.3 months (87.5% Holstein Friesian to 43.5±1.5 months (Boran) [5].

Period of birth had highly significant effect on age at first calving. The age at first calving ranged from 1198.24±35.90 to 1602.90±44.25. The heifers which were born in the fourth period (1995-1998) and fifth Period (2003-2006) showed the shorter age at first calving whereas; the heifers which were born in first period (1983-1986) showed a delay age at first calving. Season of birth had also significant effect on age at first calving. The heifers which were born during long dry season had significantly shorter age at first calving than that of short and long rainy seasons.

The influence of genetic and non-genetic factors on reproductive traits were close to [4] that presented significant effect of breed groups and parity, year and season of calving on reproductive traits (calving interval and age at first calving) in crosses between Arsi, Zebu, Holstein Friesian, Exotic breed and Jersey breeds in Ethiopia. [10] reported reproductive efficiency of Boran crosses with different Friesian and Jersey blood level and have found significant effect of breed group on days open. The work by [5] on the reproductive performance of different Ethiopian Boran and Holstein Friesian crosses revealed an overall mean of calving interval of 435±11 days and genetic group and non-genetic factors affected calving interval except season of calving. [11] studied crosses of Hariana (H), Holstein Friesian and Jersey breeds in India and they found significant effect of calving period, calving season, order of lactation and genetic group on reproduction traits. The study conducted by [9] on Boran and their crosses with different levels of Friesian or Jersey blood found significant effect of genetic group on calving interval, days open, number of services per conception and age at first calving. [12] studied different genetic groups of Zebu X Friesian crosses (25, 37.5, 50, 62.5 and 75% Friesians) in Sudan for reproduction traits (calving interval and age at first calving) and reported a significant ($P<0.05$) effect of genetic group on age at first calving which was in agreement to the present study.

Based on the evidences obtained in this study, F_1 attained first calving earlier than other genetic groups. The shorter calving intervals were also recorded by F_1, F_3 and 75%Holstein Friesian. Comparable works are reviewed in order to contrast the previous work with this work. [6] reported that the high graded and pure Holstein Friesian cows had significantly longer calving intervals while F_1 and the Barca breed had lower calving intervals. [5] reported that shorter calving interval was recorded in 50% and 87.5 % crosses compared to the 75% crosses and his study did not reveal a clear-cut report on age at first calving. [4] presented that the 3/4Exotic 1/4Arsi grades calved significantly earlier (31.3 months) than ½Jersey ½Arsi, 1/2Friesian1/2Arsi, 1/2Friesian 1/2Zebu, 3/4Friesian 1/4Arsi, ¾Friesian 1/4 Zebu and 7/8 Friesian 1/8local and ages at first calving ranged from 33.6 to 35.7 months, which was shorter than the age at first calving of this study. The 1/2 Jersey 1/2 Arsi (403 days) and the 1/2 Exotic 1/2 Arsi (393 days) had significantly shorter calving intervals than the pure Arsi (439 days). [9] revealed that there is an improvement in performance among crossbreds with increasing *Bos taurus* genes from 50% to 75% performing better than all other levels of exotic inheritance. Animals with these levels of *Bos taurus* blood, calve earlier than the indigenous stock, produce more milk and have longer lactations and shorter calving intervals. [13] found that performance of crossbreds in terms of age at first calving and calving interval were improved as the percentage of Holstein genes increased up to 50%. However, all 50% Holstein Friesian inheritance were not equally important in performance in this study. The F_1 had better productive and reproductive performance than the other groups. Superiority of the F_1 over all the Holstein Friesian back crosses was more marked under low levels of management [14]. Lemos *et al*. (1992) studied comparative performance of six Holstein Friesian X Guzera grades (1/4 Holstein Friesian 3/4 Guzera, 1/2 Holstein Friesian ½ Guzera, 5/8 Holstein Friesian 3/8 Guzera, 3/4 Holstein Friesian 1/4 Guzera, 7/8 Holstein Friesian 1/8 Guzera and increased backcross to Holstein Friesian) in Brazil for age at first calving and reported that F_1 heifers had the lowest age at first calving and superiority was more marked in the low management level farms [15].

CONCLUSIONS

The results of the present study in milk production and reproduction traits were all in favor of the F_1 and so it is more feasible to maintain 50% exotic inheritance at farmer level. Both genetic and non genetic factors affected performances of Ethiopian Boran crosses. But reproductive performances were less affected by genetic factors; so more attention should be given on non-genetic factors to improve reproductive traits. Generally, it was concluded that an elaborative approach to bring breed improvement on indigenous Boran cattle is a change in both genotypes and environments simultaneously or a selection within the local breed under the local environmental condition.

REFERENCES

1. CSA (Central Statistical Agency), 2013. Agricultural Sample Survey 2012, Volume II report on livestock and livestock characteristics. Addis Ababa, Ethiopia.
2. Ethiopian Agricultural Transformation Agency (EATA), 2014. Livestock resources: Ethiopian Agricultural Transformation Agency. html.
3. Effa, K., Z. Wondatir, T. Dessien and A. Haile, 2012. Genetic and environmental trends in the long-term dairy cattle genetic improvement programmes in the central tropical highlands of Ethiopia. J. Cell and Animal Biol., 5(6): 96-104.
4. Kiwuwa, G.H., J.C.M. Trail, M.Y. Kurtu, Getachew Worku, F. Anderson and J. Durkin, 1983. Crossbred dairy cattle productivity in Arsi Region, Ethiopia. ILCA Research Report II, International Livestock Centre for Africa, pp: 1-29.
5. Haile, A., 2006. Genetic and Economic Analysis of Ethiopian Boran Cattle and their Crosses with Holstein Friesian in Central Ethiopia. A Ph.D. Thesis division of dairy cattle breeding National dairy research institute, Karnal-132001 (Haryana), India, pp: 65-146.
6. Tadesse, M. and T. Dessie, 2003. Milk production performance of Zebu, Holstein Friesian and their crosses in Ethiopia. Livest. Res. Rural Develop., 15(3): 31-40.
7. Demeke, S., F.W.C. Neser, S.J. Schoeman, G.J. Erasmus, J.B. Van Wyk and A. Gebrewolde, 2000. Crossbreeding Holstein-Friesian with Ethiopian Boran cattle in a tropical highland environment: preliminary estimates of additive and heterotic effects on milk production traits. S. Afr. J. Anim. Sci., 30 suppl.,1:32. http://www.sasas.co.za/Sajas.html.
8. Tadesse, M. and T. Dessie, 2004. Estimation of crossbreeding parameters for milk production traits of crosses between Holstein Friesian and local Arsi breed in the highlands of Ethiopia. Ethiopian J. Anim. Prod., 3(1): 25-35.
9. Demeke, S., F.W.C. Neser and S.J. Schoeman, 2004a. Estimates of genetic parameters for Boran, Friesian and crosses of Friesian and Jersey with the Boran cattle in the tropical highlands of Ethiopia: reproduction traits. J. Anim. Breed. Genet., 121: 57-65.
10. Tessema, G., A. Gebrewold and Jayaparakash, 2003. Study on reproductive efficiency of Boran and its crosses at Holetta Research Farm: effect of genotype management and environment. Ethiopian Journal of Animal Production, 3(1): 89-107.
11. Dahiya, O.S., R.P. Singh and A.S. Khanna, 2003. Genetic group differences and the effect of non-genetic factors in cross bred cattle for reproduction traits. Indian J. Anim. Res., 37(1): 61-64.
12. Ahmed, M.K.A., A.B. Teirab, L.M.A. Musa and K.J. Peters, 2007. Milk production and reproduction traits of different grades of Zebu X Friesian crossbreds under semi-arid conditions. Arch. Tierz. 50(3): 240-249.
13. Martinez, M.L., A.J. Lee and C.Y. Lin, 1988. Age and Zebu-Holstein additive and heterotic effects on lactation performance and reproduction in Brazil. J. dairy Sci., 71: 800.
14. Madalena, F.E., A.M. Lemos, R.L. Teodoro, R.T. Barbosa and J.B. Monteiro, 1990. Dairy Production and Reproduction in Holstein-Friesian and Guzera Crosses. J. Dairy Sci., 73: 1872-1886.
15. Lemos, A.M., F.E. Madalena, R.L. Teodoro, R.T. Barbosa and J.B.N. Monteiro, 1992. Comparative performance of six Holstein Friesian X Guzera grades in Brazil. 5. Age at first calving. Brazil J. Genetics., 15(1): 73-83.