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Productive Performance of Crossbred Dairy Cattle

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የዚህ ጥናት አላማ በሆለታ ግብርና ምርምር ማእከል የወተት ከብቶችን የወተት ምርታማነት ለመገምገም ሲሆን ጥናቱ የተካሄደው በ 6685 የወተት ከብቶች ላይ ነው፡፡ የመረጃ ትንተናው ያተኮረው የምርታማነት ባህርያ (የእለት ወተት ምርት፣ የአለባ ወተት ምርትና የአለባ ጊዜ) ላይ ሲሆን በትንተናው ወቅት የላሟ ዝርያ፣ የወሊድ ቁጥር፣ የወለደችበት አመት እና የወለደችበት ወቅት በምርታማነት ባህርያት ላይ ያላቸው ተጽኖ ሳስ በተባለ የመረጃ ትንተና ሶፍተዌርን በመጠቀም ለመለየት ተሞክሯል፡፡ በአጠቃላ ውጤቱ እንደሚያሳየው አማካኝ የእለት ወተት ምርት 6.88 ± 0.05 ኪ.ግ ፣ የአንድ አለባ አማካኝ ወተት ምርት 2204.05 ± 21.12 ኪ.ግ, እንዲሁም አማካኝ የአለባ ጊዜ 326.69 ± 2.03 ቀናት መሆኑን ተደርሶበታል፡፡ በተጨማሪም የወለደችበት አመት፣ የላሟ ዝርያ እና የወሊድ ቁጥር በሁሉም የምርታማነት በህርያቶቹ ላይ ትጽኖ እንዳላቸው ታውቋል፡፡ የመጀመርያ ትውልድ ሃምሳ ፐርሰንት (75%) ዲቃላ ከብቶች ከሁለተኛ ደረጃ ዲቃል ከብቶች ከፍተኛ ወተት ምርት አላቸው፤፤ በአጠቃላይ በሃምሳ ፐርሰንት ዲቃላ ላሞች መካከል የወተት ምርት በየደረጃው እንደቀነሰ ማለትም ከመጀመር ትውልድ ዲቃላ 2203 ኪ.ግ ከነበረው ወደ ከሁለተኛ ደረጃ ዲቃላ ምርተማነት 1697 ከ.ግ እንደቀነሰ እንዲሁም ከሁለተኛ ደረጃ ዲቃላ 1697 ኪ.ግ የነበረው ወደ የሶስተኛ ደረጃ ዲቃል ወደ 1522 ከ.ግ እየቀነሰ መምጣቱ ተደርሶበታል፡፡ የ75% F_1 መጀመርያ ዲቃላ ዝርያ የወተት ምርት ከ 50% F_1 50% F_2 50% F_3 and 75% ሁለተኛ ትውልድ ጋር ሲነፃፀር በ34.2%, 74.3%, 94.3% እና በ 45.9% እጅ በተከታታይ ይበልጣል፡፡ የ75% F_1 እና የ 50% F_1 ዲቃላ ዝርያ ወተት ምርት ከሌሎች ዝርያዎች ጋር ሲወዳደር ከፍተኛ ሊሆን የቻለው በሄትሮሲስ, ከፍተኛ የውጭ ዝርያ ደምና በ75% እና ረጅም የአለባ ጊዜ ነው፡፡ በአጠቃላይ የ75% ዲቃላ ዝርያ የምርታማነት ግምገማ ማለትም የእለት አማካኝ ወተት ምርት፣ የአንድ አለባ አማካኝ ወተት ምርትና የአለባ ጊዜ መሰራት በማድረግ የውጭ ዝርያ ደም ከፍ በማድረግ የወተት ምርታማነቱ እንደሚጨምር የምርታማነት ግምገማው ያሳያል፡፡

Abstract

This study was conducted to evaluate the productive performances of crossbred dairy cattle at Holetta agricultural research center's dairy farm. A total of 6685 performance records were used and analyzed to determine the effect of period of calving, season of calving, parity and genetic group. Parameters used as indicator of productive performances were lactation milk yield (LMY), daily milk yield (DMY) and lactation length (LL). The GLM procedure of SAS 2004 was used for analysis. The overall least square means and standard errors for Lactation milk yield (LMY), daily milk yield (DMY) and lactation length (LL) were 2204.05 ± 21.12 kg, 6.88 ± 0.05 kg and 326.69 ± 2.03 days, respectively. Result of fixed effect analysis indicated that calving period, genetic group and parity were significantly ($p<0.001$) influenced all productive traits. LMY, DMY, and LL were sensitive to seasonal variation. Comparisons among the crosses revealed a clear-cut difference among the genetic groups. Milk production in the first generation crosses increased more compared to second generations. There were marked decline in performance among 50% F_1 (Borena dam x Holstein Friesian sire), F_2 (F_1 dam x F_1 sire) and F_3 (F_2 dam x F_2 sire) from 2203kg of milk to 1697 and 1522 kg, respectively. The 75% first generation was superior LMY compared with other genetic groups and produced about 34.2 %, 74.3%, 94.3% and 45.9% more milk than 50% F_1, F_2, F_3 and 75% second generations, respectively. The higher milk yield of 75% first generation and 50% F_1 crosses from other genetic groups could be associated with higher heterosis effect in F_1, higher milk gene in 75% and longer lactation length. Based on the productive performances evaluation, the results of LMY, DMY, and LL for high grade (75% first generation) in the present study revealed that performances were continued to increase with increasing proportion of exotic gene.

Introduction

The importance of livestock is growing over the years because of increment of human population, rising incomes and urbanization in developing countries. These factors fuel a massive increase in demand for foods of animal origin. Dairy products are among some of the most important commodities from the livestock sector and the strongest growth in demand for milk and milk products is anticipated to come from developing countries. World production of milk is forecasted to grow by an annual rate of slightly over one percent and the largest increment is expected in developing countries (Griffin, 1999). 2017). However, breed improvement and development programs have been directed mainly on crossbreeding activities through research stations, few government stock multiplication centers and private farms (MOARD, 2007). This was mainly attributed to the assumption that the genetic gain expected from selection of indigenous cattle is 1-2 percent per year (Braännäng and Person, 1990) which is too slow to support the immediate high demand of milk in the country. In this regard, the introductions of exotic breeds have been suggested as one option to improve milk production and fill the gap between milk demand and supply in the country. However, exotic breeds become expensive and risky because they are susceptible to diseases and the cost of milk production is often greater than the gross income that can be obtained (Tesfaye, 1990).

Crossbred cows have been reported to be more productive than purebred cows in the tropics (McDowell, 1985; Cunningham and Syrstand, 1987). Despite the promising productive performance of crossbred dairy cattle, high demand for milk and efforts to multiply in Ethiopia, well-organized and successful crossbreeding programs could not generate significant number of improved crossbred dairy cattle compared to the proportion of indigenous breeds and remains few. It has been one implication that out of 60.39 million head, only 1.54% is crossbred (CSA, 2017) over 80 years of crossbreeding activities in the country. This could be associated with less efficient service delivery and lack of suitable breeding program to generate adaptive and productive generations.

A long-term crossbreeding program initiated in 1974 at Holetta Agricultural Research Center has been produced several generations of crosses between the indigenous Boran and Holstein Friesian breeds with the aim of combining productivity and adaptability in the crossbreds. This crossbreeding effort resulted in the development of various genetic groups (50% F_1, F_2, $F_{3,}$ and 75% first and second generations) which intervened for improving the breeding program. The effect of exotic blood level, random change of environments and introducing of management factors could influence the productive performances of crossbred dairy herd in the research center. Although, some research have been conducted to evaluate the performance of Friesian and Borena crosses at Holetta, regular evaluation of productive performances of the herd is a key indicator of sustainability of a dairy cattle research and the breeding program and this performance evaluation is depends on LMY, DMY and LL parameters of economic important traits. The objective of this study was therefore, to evaluate trend of productive performances of crossbred dairy cows over the years and to estimate the extent of non-genetic and genetic factors affected the long-term crossbred dairy cattle performances at the research center.

Materials and Methods

The study area

This research was conducted at Holetta Agricultural Research Center (HARC). Holetta is located in the central highland of Ethiopia at 29 km west of Addis Ababa (9^0 00' N latitude and 38^0 30' E longitude) with an altitude of 2400 meter above sea level. The average annual rainfall is 1100 mm and average annual temperature is 15 ^{o} C with minimum 6 ^{0} C and maximum 24 ^{0} C, respectively (Yohannes *et al.,* 2016). The average monthly relative humidity is 60% (Gebregziabher *et al.,* 2013).

Data collection

Data were obtained from long-term (1974 to 2017) crossbreeding research of dairy cattle herd composed of Ethiopian Borena x Holstein Friesian crossbreds that had been maintained at the research station and therefore, different exotic gene inheritances ranging from 50% to 75% of HF (Holstein Friesian) were considered.

Animal management

The cattle were herded based on breed, pregnancy, lactation stage, sex and age. Uniform feeding and management practices were adopted for all animals within each category. Natural grazing, hay, and concentrate supplement constituted the major feed supply. During the day time animals were allowed to graze on pastureland from early morning 8.00 AM to 4.00 PM. Natural pasture hay was provided as additional feed during the evening. Concentrate mixture composed of wheat middling (32%), wheat bran (32%), noug (*Guizocia abyssinica*) cake (34%), and salt (2%) was supplemented based on their body weight, productivity, and physiological categories. Milking cows, heifers and calves were supplemented with concentrate mixture at a rate of 4.1-1.5 and 0.25-1kg per day, respectively depending up on availability of supplemental feed. The cows had free access to clean tap water all the time.

Calves were allowed to suckle their dam immediately after birth for about four days to receive colostrum. Weighting and ear tagging were also engaged within 24 hours after birth. After 4 days, calves were taken in to calf rearing pen and continued to feed recommended amount of whole milk for 98 days through artificial rearing system (bucket feeding) except the F1 calves, which have been suckling their dams until winning since 2002. Weaned calves were transferred to other pen and kept indoor until 6 months.

Milking has been practiced by hand until 2001. In 2002 milking machine has been installed and since then cows have been milked with milking machine twice daily (early morning and evening). The animal management was also supported with vaccination against major disease and treatment to control any incidence of diseases.

Breeding program

Pure Borena dams were mated with pure Friesian semen to produce the 50% F_1 crosses while the 50% F_1 is back crossed with pure Friesian semen to produce the 75% first generation. The later generations, F_2, $F_{3,}$ and 75% second generation were produced by *inter se* mating 50% male with 50% female and 75% male with 75% female. The Borena cattle used as a foundation stock for crossbreeding were brought from Borena pastoralists in the southern Ethiopia (there center of origin) and reared on station then inseminated randomly with semen from NAIC (national artificial insemination center) and WWS (worldwide sire) to produce required generations.

Seasonal breeding has been undertaken until 2000. Since then the mating practice was changed and has been undertaking throughout the year using AI (artificial insemination) with semen from locally recruited crossbred bulls or pure Friesian semen from NAIC and WWS. Sometimes natural service has been used when animals became repeat breeder with AI. In addition to herdsmen, teaser bull was reared with cows for heat detection. Cows detected in heat were mated using artificial insemination by qualified technicians. Cows not seen in heat after service for longer were diagnosed for pregnancy after 60 days of service.

Data management

Screenings of data were made to avoid manmade errors during data entrance on individual animal card or in the computer writing. The minimum truncation point for LL in this study was 100 days which regarded as incomplete lactation for analysis of LMY, DMY, and LL. Lactation records of above eighth parities were pooled together in parity eight because of few records. The animals that had abnormal calving, i.e., abortions and stillbirths were not included in the analysis.

Data analysis

The General Linear Model (GLM) procedure of Statistical Analysis System (SAS 2004) version 9.0 was employed to determine and compare the fixed effects of different genetic group, calving periods, calving seasons and parity for LMY, DMY and LL traits. Genetic group included in the analysis were broadly classified in to two based on the exotic blood levels (50% F_1, F_2, F_3 and 75% first and second generations).

Different genetic groups were developed in different years depending on the objective of the research station (research direction) during the last 40 years. The years of calving ranged from 1978 to 2017 were grouped into 8 periods considering the similarity within year group. Thus, each year group consisted 5 periods. For season of calving, months of the years were classified into 3 seasons based on rainfall distribution as dry season from October to February, short rain season from March to May, and main rain season from June to September. The presences of any significant differences among fixed effects (genetic and non-genetic factors) were checked using least square mean separation of SAS procedure. The three productive traits (LMY, DMY and LL) were analyzed by the following model

$Y_{ijkln} = \mu + Y_i + S_j + G_k + P_l + e_{ijkln}$ Where;

Y_{ijkln} =n^{th} record of, i^{th} period, j^{th} season, k^{th} genetic group and l^{th} parity

μ = overall mean

Y_i = effect of i^{th} period of Calving

S_j = effect of j^{th} Season of Calving.

G_k = effect of k^{th} Genetic group (50% F_1, F_2, F_3 and 75% first generation, second generation)

P_l = effect of l^{th} Parity of Dam (1, 2, 3, 4, 5, 6, 7, 8)

e_{ijkln} = random error associated with each observation

Results and Discussion

The overall mean with standard error of LMY of Borena x HF crosses in the present study was 2204.05 ± 21.12 kg. Results of the least square means and standard errors for fixed effects of genetic group, calving period, calving season, and parity are summarized in Table 1. LMY was significantly ($p<0.001$) affected by genetic group, calving period, calving season and parity.

Table 1. Least square means and standard errors of lactation milk yield

Effect	Number of observations	LMY LSM ± SE (kg)
overall	2313	2204.05 ± 21.12
Genetic group		
50% F_1	1598	2203.23^{b} ± 38.13
50% F_2	234	1697.09^{c} ± 71.82
50% F_3	139	1522.67^{c} ± 90.07
75% first generation	299	2957.46^{a} ± 72.98
75% second generation	43	2027.16^{b} ± 152.15
Calving period		
1977-1982	23	1943.44^{bcd} ± 203.80
1983-1987	75	2105.72^{bc} ± 118.81
1988-1992	167	1670.22^{d} ± 79.92
1993-1997	183	2030.62^{c} ± 74.07
1998-2002	272	2373.78^{a} ± 72.94
2003-2007	370	2229.95^{ab} ± 67.88
2008-2012	565	2233.15^{ab} ± 60.69
2013-2017	659	2065.28^{c} ± 57.13
Calving season		
Dry season	1071	2162.46^{a} ± 54.70
Short rain season	626	2018.17^{b} ± 60.97
Main rain season	616	2063.93^{b} ± 61.55
Parity		
1	690	1811.16^{d} ± 53.76
2	488	1983.23^{c} ± 60.86
3	347	2063.57^{bc} ± 66.98
4	245	2193.50^{ab} ± 75.37
5	187	2238.52^{a} ± 82.31
6	150	2136.28^{abc} ± 90.91
7	98	2111.67^{abc} ± 108.49
8	108	2114.25^{abc} ± 106.69

Different superscripts ($^{a, b, c, d}$) in the same fixed effect indicate differences among sample means, LMY = lactation milk yield

Results of the least square means for fixed effects of genetic group, calving period, calving season and parity for DMY and LL are summarized in Table 2. The overall mean and standard error for DMY was 6.88 ± 0.05 kg and for LL 326.69 ± 2.03 days. Both DMY and LL were significantly ($p<0.001$) affected by genetic group, calving period, calving season and parity.

Table 2. Least square means and standard errors of daily milk yield and lactation length

Effect	Number of observations	DMY LSM ± SE (kg)	Lactation length LSM ± SE (days)
Overall	2186	6.88 ± 0.05	326.69 ± 2.03
Genetic group			
50% F_1	1543	6.69^{b} ± 0.083	343.62^{b} ± 3.56
50% F_2	234	5.66^{c} ± 0.16	319.42^{c} ± 6.68
50% F_3	139	5.02^{d} ± 0.19	319.25^{c} ± 8.37
75% first generation	236	8.70^{a} ± 0.17	374.05^{a} ± 7.24
75% second generation	34	6.72^{b} ± 0.37	303.12^{c} ± 15.73
Calving period			
1977-1982	23	6.18^{cd} ± 0.44	316.06^{cd} ± 18.98
1983-1987	75	5.88^{d} ± 0.26	407.35^{a} ± 11.13
1988-1992	167	4.60^{e} ± 0.18	374.99^{b} ± 7.50
1993-1997	183	5.55^{d} ± 0.16	369.94^{b} ± 6.94
1998-2002	272	7.58^{b} ± 0.16	314.78^{c} ± 6.95
2003-2007	370	6.99^{c} ± 0.15	316.77^{c} ± 6.50
2008-2012	565	7.65^{b} ± 0.14	286.66^{d} ± 5.85
2013-2017	531	8.08^{a} ± 0.14	268.56^{e} ± 5.80
Calving season			ns
Dry season	1027	6.67^{a} ± 0.12	333.26 ± 5.30
Short rain	585	6.40^{b} ± 0.13	329.03 ± 5.90
Main rain	574	6.61^{a} ± 0.14	333.39 ± 5.96
Parity			
1	653	5.24^{e} ± 0.12	348.67^{a} ± 5.22
2	454	5.83^{d} ± 0.14	347.73^{a} ± 5.92
3	318	6.52^{c} ± 0.15	330.45^{b} ± 6.50
4	234	6.72^{bc} ± 0.17	341.44^{ab} ± 7.23
5	181	6.99^{ab} ± 0.18	332.22^{b} ± 7.85
6	147	6.79^{bc} ± 0.20	328.12^{b} ± 8.62
7	94	7.04^{ab} ± 0.24	322.03^{bc} ± 10.34
8	105	7.37^{a} ± 0.24	304.46^{c} ± 10.14

Different superscripts ($^{a, b, c, d, e}$) in the same fixed effect indicate differences among sample means, DMY = lactation milk yield, ns; not significant

Lactation milk yield

The overall mean result obtained in this study was slightly higher than the report of Gebrgziabher *et al.* (2014) who found 2111.91 ± 16.88 kg for Borena x HF in central Ethiopia and Kumar *et al.* (2014) who reported 2123.43 ± 65.67 kg for crossbred in Gondar, Ethiopia. Lower values were reported by various studies (Djoko *et al.*, 2003; Ali *et al.*, 2004; Haile *et al.*, 2009; Kefena *et al.*, 2011; Ashutosh *et al.*, 2013) with 1703 ± 12.1 kg for crossbred in Ghana, 1336.88 ± 60.23 kg for Friesian x local in Bangladesh, 1798 ± 25 kg for Borena x HF crosses, 2088.7 ± 29.4 kg for Borena x HF crossbred in central highland of Ethiopia and 1506.75 ± 71.37 kg for HF x local in Bangladesh, respectively. However, comparatively higher values of LMY were reported by Dash *et al.* (2015) 3976.77 ± 41.03 kg for HF x Keran Fries in India and 3446 ± 1112 SD (standard deviation) by Kahi *et al.* (2000) for Sahiwal with temperate breed crosses. The difference of the present result from the authors reported elsewhere could be associated with animal management system followed by farms such as quality and quantity of feed ingredients provided, disease manifestation on each location, its control and prevention, type of breeds involved for crossbreeding and difference in level of exotic gene inheritance being studied in each location. Climate factors in which animals were managed might be also other source of variation among these studies.

In this study, the 75% first generation could produce significantly higher (p<0.05) milk yield per lactation compared with other genetic groups and the difference was about 34.2%, 74.3%, 94.3% and 45.9% more milk than 50% F_1, F_2, F_3 and 75% second generations, respectively. This might be due to up grading of the level of exotic inheritance from 50% to 75%, which consequently increased the milk gene. It can also indicates that the level of management (feeding, health and other husbandry) provided by the farm was good to support the crossbred cows to express their genetic potential. The superiority of 75% genotype over 50% was also reported by some other studies conducted in the tropics (Million and Tadelle 2003; Haile *et al.,* 2009). However, studies by Demeke *et al.* (2004), Kefena *et al.* (2006) and Gebregziabhere *et al.* (2013) could not detect significant difference between 50% F_1 and 75% first generation. LMY was radically reduced by 506 kg (23%) from 50% F_1 to F_2 and 930 kg (31 %) from 75% first generation to75% second generation. This might be because of the significant recombination losses (lack selection of elite sires for *inter se* mating and segregation effect, which causes decrease in heterosis on *inter se* mated generation). Demeke *et al.* (2004) on his study indicated that 526 ± 192 kg of LMY was lost due to recombination effect when Borena was crossed with HF.

The highest average LMY (2373.78 kg) was observed during 1998-2003 while the lowest LMY (1670.22kg) was recorded during the period 1988-1992. The three-period of calving (1998-2002, 2003-2007 and 2008-2012) were the most favorable periods for animals to perform better LMY. The variation in LMY from one period of calving to other could be attributed to changes in herd size, change of the climate, and inconsistent management practices across period of calving. The source of fund for animal management (for feed, veterinary inputs purchase and other husbandry cost) was based on the yearly budget allocated by the state government and the amount varies across the years. As a result, the performance of the cows varies among the periods of calving as the level of management fluctuates over the year depending on availability of the fund. The inconsistent of period of calving trend over LMY was in agreement with (Million and Tadelle 2003; Demeke *et al.,* 2004).

We found that LMY was sensitive to seasonal variation. Higher average LMY was exhibited in dry season but the other two seasons were no significant effects. Seasonal variation on animal performance was expected to be primarily a manifestation of variation in feed quality and quantity. According to the farm management practices of this herd, the cows were not allowed for grazing during rainy season as the pastureland was protected for hay production. In addition, sometimes there were shortages of feed during main rainy season due to delays of annual budget release to purchase feeds and veterinary inputs. Thus, cows that calved during the dry season might enjoyed better management as they were allowed for grazing on pastureland and supplemental feed and veterinary inputs were more available than other two seasons in the farm.

The analysis of variance revealed that LMY significantly (p<0.001) differed among parities. Similar finding in Borena x HF crosses were reported by (Kefena *et al.,* 2006;

Haile *et al.,* 2009; Gebregziabhere *et al.,* 2013; Gebregziabher *et al.,* 2014). Maximum LMY was observed in parity five and minimum yield was recorded in parity one. LMY was increased from parity one to five by 23% and constant then after. The gradual increased in milk yield from first to five parities might be attributed to the growth with respect to body size and increase in the active of secretory tissues of udder due to recurring pregnancies. Unlike the present study, Belay *et al.* (2012) reported decreasing trend of LMY when parity increases.

Lactation length

The mean LL estimated by this study (326.69 ± 2.03 days) is almost similar with finding of Kahi *et al.* (2000), Kumar *et al.* (2014) and Dash *et al.* (2015) with the values of 326 ± 72 (SD) days for Sahiwal with temperate breed crosses, 325.12 ± 61.28 days for crossbred in Ethiopia and 326.57 ± 2.60 days for HF x Keran Fries in India, respectively. Suhban *et al.* (2000), Ali *et al.* (2004) and Kefena *et al.* (2006) reported slightly higher estimation from the present result with values of 503.0 ± 6.36 days for Pakistani crossbred, 338.19 ± 9.98 days for Bangladesh crossbred and 360.76 ± 6.11 days for Ethiopian crossbred dairy cattle, respectively. However, lower estimation of 204 ± 27.8 and 234.0 ± 24.0 days were reported by Djoko *et al.* (2003) and Ashit *et al.* (2013), respectively. The differences in LL might be attributed to variance in farm management system that some dairy farms have their own criteria to dry their cows. In addition, the types of breeds involved for crossbreeding and level of exotic gene inheritance could make difference on length of lactation period.

Lactation length was significantly ($p<0.001$) varied among genetic groups. The 75% first generation was longest (374.05 ± 7.24 days) lactation length followed by 50% F_1 crosses (343.62 ± 3.56 days). Lactation length increased as proportion of Friesian gene increased in this study. This could be associated with longer calving interval and higher milk yield potential of 75% Friesian inheritance. The shortest lactation length was recorded with 75% second generation. However, no significant ($P>0.05$) differences were observed among 50% F_2, F_3 and 75% second generations. LL was declined from F_1 to F_2 and F_3 crosses although the proportions of exotic genes are similar to that of F_1 crosses.

Trend analysis of LL based on calving period showed that there is a decreasing pattern across 1983-1987 to 2013-2017, which might be a management decision in which cows are milked 305 days to bring standard lactation length since 2003, which means involuntary drying off cows. Highest and lowest LL recorded in 1983-1987 and 2013-2017, respectively. However, no significant ($P>0.05$) values were observed among calving period of 1998-2002, 2003-2007 and 2013-2017.

Lactation length was not significantly affected ($p>0.05$) by season of calving. This result is in line with the finding of (Demeke *et al.,* 2004; Haile *et al.,* 2009; Kefena *et al.,* 2006). On the other hand least square mean showed that significant ($p<0.05$) differences were observed among parities on LL. The longest LL was observed in first parity and the shortest LL was observed on eighth parity. Cows at first parity was prolonged open period due to lactation stress mainly during the first lactation trimester and thus the farm management could allow the cows for more days on lactation to be economical. Similar with present study, decreasing trend of LL was observed from parity one to eight (Lateef, 2007; Haile *et al.,* 2009).

Daily milk yield

Daily milk yield obtained from 75% first generation (8.70 liter) was significantly (P<0.05) higher compared to other genetic groups. The present result is comparable with the report of (Haile *et al.,* 2009). However, Demeke et al. (2004) and Gebregziabher et al. (2013) who reported that upgrading from 50% to higher Friesian fractions for HF x indigenous crosses had shown no significant differences for milk yields contradict the significant difference observed in this study with studies. The difference of the present study from others literature could be due to management difference and number of observation studied. The 75% first generation was produced 23.1 and 22.8% more DMY than 50% F_1 and 75% second generations, respectively. However, no significant (P>0.05) difference was observed between 50% F_1 and 75% second generations in this study. DMY was decreased from 50% F_1 to F_2 and F_3 and from 75% first generation to second-generation crosses. This might be reduction of heterosis and increase of recombination loss during gamete recombination at time of crossing between the two breeds. In support of this, Demeke *et al.* (2004) on his study indicated that 3.0 ± 0.4 kg of DMY was lost due to recombination effect when Borena was crossed with HF breed.

Period and season of calving had significant (P<0.05) effect on daily milk yield. Higher and lower DMY was recorded during the period 2013-2017 and 1988-1992, respectively. Cows calved during dry and main rain season were produced better DMY than short rain season. Variation in availability of supplemental feed and access to pasture during the calving period, season, and variability of weather across years and season could be the determinate factors, which affects daily milk of study population. This result is contradicted with Haile *et al.* (2009) who found seasonal variation had not significant (p>0.05) effect on DMY.

Significantly (P<0.05) higher DMY was observed in parity eight and lower yield was observed at parity one. Even though, no clear significant difference was observed from forth to eighth parity, DMY was increased as parity increase in this study. The present result indicated that cows are produced more milk as they became matured enough (associated with growth in body size and secretory tissues of udder and adaptation to lactation stress).

Conclusion

This study showed that the productive traits were influenced by different environmental factors. The traits measured showed significant variation among genetic groups, calving period, calving seasons, and parities. This indicate that a remarkable improvement can be achieved through better management decision and rigorous selection. Milk production in the first generation crosses increased more compared to second and third generations. Backcrossing of the F_1 generation to the European breed could bring an increase in milk yield. The results of grades higher than 50% F_1 exotic gene (75% first generation) in the present study revealed that performance in productive traits (LMY, LL and DMY) continued to increase with increasing proportion of Friesian gene. On the other hand, performances in the F_2, F_3 and backcrossed second generations were declined, which might be due to gene segregation at time gamete recombination. Therefore, intense selection on both parental lines for F_1 and 75% first generation genotypes should be implemented to improve overall milk production and associated trait (lactation length).

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