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Reproductive Performance for Holstein Friesian × Arsi and Holstein Friesian × Boran Crossbred Cattle

Research Article

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ABSTRACT

The study was carried out at Agarfa ATVET College dairy farm to evaluate the reproductive performance of Holstein Friesian × Arsi and Holstein Friesian × Boran cattle. For the study, records compiled from 1983 to 2012 at the Agarfa dairy farm were used as original data. The effects of breed, bloodlines, season and parity on the reproductive traits were evaluated. Data were analyzed using the general model of the SAS program. The overall mean ± SE of age at first service (AFS), age at first calving (AFC), days open (DO), calving interval (CI), number of service per conception (NSPC), breeding efficiency (BE) and longevity were 32.05 ± 0.57 months, 41.16 ± 0.56 months, 194.62 ± 3.42 days, 475.92 ± 3.44 days, 1.35 ± 0.03 service, 68.67 ± 0.01% and 7.77 ± 0.25 years, respectively. Breed had significant effect (P<0.05) on AFS and AFC. Bloodlines, season and parity had significant effect (P<0.01) on DO and CI. Breed, bloodlines, season and parity had significant effect (P<0.01) on breeding efficiency. Season of insemination significantly affect NSPC (P<0.01). Longevity was only affected by bloodlines. Generally reproductive performances found in this study were lower than the performance reported in many tropical regions. Therefore, due consideration should be given in calf and heifer management, heat detection, accuracy of artificial insemination, feeding and health care.

KEY WORDS Arsi, Boran, crossbred cows, reproductive performance.

INTRODUCTION

Ethiopia has the largest livestock inventories in Africa with livestock ownership supporting and sustaining the livelihood of an estimated 80% of the rural poor (FAO, 2004). The majority of them are indigenous breeds, which are well adapted to the environment in the tropics. *Bos taurus* (European type) is the predominantly specialized dairy breed of the temperate countries. These breeds have high milk yield potentials but lack heat tolerance and disease resistance. Arsi and Boran cattle breeds are the most common indigenous breeds used for crossbreeding with exotic dairy animals for milk production in Arsi and Bale area. The Boran cattle breed is a zebu type originated in the southern lowlands of Ethiopia and it is widely used for milk, meat, draft power and manure production (Alberro and Haile Mariam, 1982). Boran breed is well adapted to semi-arid tropical conditions, has a high degree of tolerance to heat, and diseases prevailing in the tropics (Mensah and Okeyo, 2006). Similarly, Arsi breed is the local dominant type found in the Arsi region of Ethiopia; they are small in size, weighing 200-250 kg (Kiwuwa *et al.* 1983). The animal productivity is also closely dependent of their reproductive potential. For instance, to lactate a cow needs to calve. Therefore, the identification of the various factors affecting the reproductive performance and the evaluation of the reproductive potential of different crossbred cattle indifferent areas and under different management systems is important to recommend the best bloodlines of crossbred animals for a particular area and to revise dairy cattle management practices. Agarfa dairy farm is one of the oldest state farm where crossbred cattle are kept for demonstration and training of the nearby community. Nevertheless, there is limited or no information about the performances of local crossbred animals, particularly in the area where the study was conducted and around the places where dairy heifers are assumed to be distributed. As a consequence, the development of recommendations suitable for the region is impaired. Therefore, this study was conducted to evaluate the reproductive performance of crossbred animals to gather missing information crucial to establish adequate management recommendations for the study area.

MATERIALS AND METHODS

Description of the region

The study was conducted at Agarfa Agricultural Technical and Vocational Education Training (ATVET) College (40.0332' E and 60.1163' N; 2350 meter above sea level), in the Agarfa district in Bale zone of Oromia Regional State, Ethiopia. The study area is located at 458 km south east of the capital city, Addis Ababa. The mean annual rainfall, maximum and minimum temperature are about 836.1 mm and 22 and 8.6 ˚C, respectively (NMSA, 2010). Based on agro climatic condition the area has three seasons. A short rainy season that extends from March to June, a long rainy season extending from July to October and a dry season that extends from November to February (NMSA, 2010).

Farm description and animal management

Agarfa dairy farm was established in 1983 with stock of 127 founders. This stock were F_1 crosses of Friesian × Arsi and Friesian × Boran purchased from Assela Research Center and Abernosa farm, respectively. The objectives of the Agarfa farm were to serve as a demonstration site for farmers, to give extension service such as artificial insemination and veterinary service for neighboring breeders associations and also to be a source of income for the College. They practiced artificial insemination by bringing pure Holstein Friesian semen from the National Artificial Insemination Center, Ethiopia. Both lactating and non-lactating cows are left to grazing land during the day; the lactating cows are supplemented with wheat bran and silage during milking while non-lactating cows are supplemented with hay. The major indigenous grasses in the grazing area include *Hyparrenia rufa*, *Cynodon plectostachyus*, *Pannicum maximum*, *Chloris gayana and Rhodes grass*. The animals´ selectionwas performed on the basesof its phenotypic performance rather than on the genetic performance. Animals were annually vaccinated against anthrax, blackleg, pasteurulosis, foot and mouth disease and lumpy skin disease. In addition to vaccination, animals were sprayed against external parasite weekly and dewormed against internal parasite at three-months interval.

Data collection

Data collected in the period from 1983 to 2012 were used in the study; data was compiled from individual records. Records had details on date of entry, identification number, sex of animal, date and reason of culling, service date, calving date, calf ID, dam and sire number, daily milk yield and drying date.

The compiled record cards were checked for their completeness and were discarded when unclear or containingin complete data. The fixed effect of breed on the dam line, bloodlines, season, and parity on reproductive parameters were observed.

Volumes of exotic lines (Friesian) in Arsi and Boran cattle were kept at 50%, 75% and 87.5%. In order to look for the effects of the season of birth, insemination and calving dates, the months of the year were distributed in to three seasons based on rain fall distribution; the long rains (July-October), the short rains (March-June), and the dry (November-February) seasons. The maximum parity in the original data was 7 (lactation 1 to7). However, when 7 lactations were considered in the model, cows that had lactation 6 and above were too small; also, the estimated least square means for lactation numbers 5 and greater were almost similar. Therefore, all parities above 5 were pooled together in parity ≥ 5.

Data analysis

Data were analyzed using the general model of SAS (2004). The model used include fixed effects of breed, bloodlines, season and parity. The following model was used to analyze: the age at first service (AFS) and age at first calving (AFC), days open (DO), calving interval (CI) and number of services per conception (NSPC), the breeding efficiency (BE) and longevity.

$$Y_{ijklmn} = \mu + B_i + Z_j + S_k + T_l + D_m + P_n + e_{ijklmn}$$

Where:

Y_{ijklmn}: observation on AFS, AFC, DO, CI, NSPC, BE and longevity.

μ: overall mean

B_i: fixed effect of i^{th} breed group (HF×Arsi and HF×Boran).

Z_j: fixed effect of j^{th} bloodlines (½, ¾ and $^7/_8$ Friesian).

S_k: fixed effect of k^{th} season of birth (l, 2 and 3), for AFS, AFC and longevity.

T_l: fixed effect of l^{th} season of calving (l, 2 and 3).
D_m: fixed effect of m^{th} season of insemination (l, 2 and 3), for NSPC.
P_n: fixed effect of n^{th} parity of dam (1…5).
e_{ijklmn}: random error.

RESULTS AND DISCUSSION

Age at first service and age at first calving

The overall mean age at first service in the present study is presented in Table 1. This was higher than the report of Shiferaw *et al.* (2003) who found that AFS was 29.58 months for crossbred dairy cows in central highland of Ethiopia. Also Belay (2012) reported a lower AFS (24.30±8.01 months) for Zebu × Holstein-Friesian crossbred dairy cows in Jimma. Emebetand Zeleke (2007) observed that the overall mean age at first service (AFS) was 25.6 months for crossbred dairy cows in eastern lowlands of Ethiopia which is lower than the current finding.Breed had significant effect (P<0.05) whereas bloodline and season of birth had no significant effect (P>0.05) on AFS.

Table 1 presents the overall mean age at first calving in the present study. It was in agreement with the findings of Berhanu *et al.* (2011) that reported AFC at 40.9 ± 0.33 months. However, the value of AFC reported in the present study was higher than those reported by Emebet and Zeleke (2007) and Yifat *et al.* (2009) (36.2 and 32.1 months, respectively).

Friesian × Boran crosses had significantly shorter (P<0.05) AFS and AFC than Friesian × Arsi crosses. Apossible explanation for as horter AFS and AFC of Friesian × Boran cross may be the faster growth and early attainment of puberty in Boran breed compared to Arsi breed. The significant effect of breed on AFC in the current finding is in agreement with the previous findings of Demeke *et al.* (2004) and Kefena *et al.* (2006) in Ethiopia.

Bloodline, season of birth and dam parity had no significant effect (P>0.05) on AFC. The non-significant effect of season of birth on AFC in the current study is in agreement with Habtamu *et al.* (2010) and Tadesse *et al.* (2010). Contrasting to our results, Million *et al.* (2006) in Ethiopia and Chenyambuga and Mseleko (2009) in Tanzania found significant effects of season of birth on AFC.

Days open and calving interval

The overall mean calving interval (CI) and days open (DO) in the present study are shownon Table 1. Results gathered in the current study were comparable with the 459 ± 4 days interval reported by Kiwuwa *et al.* (1983) and 456 ± 5.4 days by Gebeyehu *et al.* (2007) and it was lower than the 562 days reported by Amene *et al.* (2011). Still, CI in our study was higher than the intervals referred by Yifat *et al.* (2009) and Nuraddis *et al.* (2011) (412 days 13.93 months, respectively) in Ethiopia. This was also higher than 453 days and 402.6 ± 3.0 days reported by Mulindwa *et al.* (2006) and Chenyambuga and Mseleko (2009), respectively.

In the study presented herein, DO was 200.13 ± 25.55 days, which is lower than 280 ± 3.4 and 285 ± 4.3 days reported by Melaku *et al.*(2011), respectively. However, the current finding for days open was longer than the reported by Chenyambuga and Mseleko (2009) (100.7±3.6 days) orby Yifat *et al.* (2009) (135 days).

The present work also indicated that the bloodline, season of calving and parity significantly affect the DO and CI length (P<0.01), while the breed was devoid of effects (P>0.05). The shortest DO and CI were found in ¾ Friesian cross while the longest DO and CI were recorded for $^7/_8$ Friesian cross (Table 1). The longest DO and CI in F_1 Friesian crosses might be due to higher levels of the local genetics in F_1 cross, which are recognized to possess longer DO and longer CI. The longer DO and CI in $^7/_8$ Friesian cross might be explained by the fact that higher infusion of exotic genetics resulted in increased body size with increased requirements for better management practices in terms of nutrition and reproduction, suggesting that the present management practices in the farm might be insufficient for optimum performance.

The shortest DO and CI were obtained for cows that calved in the short rainy season, whilst the longest DO and CI were found in cows calved in the dry season. The longest DO and CI found for cows calved in the dry season might be associated to the feeds shortage in both quality and quantity during the season, which may impact the ovarian activity and subsequent resumption of estrus. The current finding agreed with Yifat *et al.* (2009) and Melaku *et al.* (2011) but discords with Getinet *et al.* (2009), Habtamu *et al.* (2010) and Tadesse *et al.* (2010).

The significant effect of parity reported in the present study is in line with previous reports (Embetand Zeleke 2007; Chenyambuga and Mseleko 2009; Yifat *et al.* 2009), but contrasts with those of Melaku *et al.* (2011), who refer the existence of non-significant effects of dam parity on DO. The age related differences in DO detected in the present study may be attributed to the effect of ltheactation stress in young growing cows in their first pregnancy due to the additional nutritional requirements for growth of cows during early lactation life and the ability of middle-aged cows to gain body weight condition quickly after calving.

Breeding efficiency

Breeding efficiency (BE) is an important reproductive parameter that reflects the regularity of calving and the adaptability of the breed to its environment.

Table 1 Least square mean (LSM±SE) of age at first service, age at first calving, days open, calving interval and breeding efficiency over breed, bloodline, season of birth and calving and parity at Agarfa ATVET College dairy farm Oromia, Ethiopia

Variable	N	AFS (months)	AFC (months)	N	Days open (days)	Calving interval (days)	Breeding efficiency (%)
Over all	226	32.05±0.57	41.16±0.56	551	194.62±3.42	475.92±3.44	68.67±0.01
Breed	-	*	*	-	NS	NS	**
Friesian × Arsi	135	33.62±0.71	42.84±0.84	310	193.77±4.06	475.48±4.08	67.51±0.01[b]
Friesian × Boran	91	30.47±0.85	39.49±0.83	241	195.47±4.74	476.36±4.73	69.83±0.01[a]
Bloodline	-	NS	NS	-	**	**	**
½ Friesian	83	31.67 ± 0.84	41.01±0.82	258	198.33±4.46[a]	477.71±4.48[a]	68.76±0.01[ab]
¾ Friesian	104	31.45±0.79	40.55±0.77	227	181.96±4.03[b]	459.84±4.05[b]	70.02±0.01[a]
$^7/_8$ Friesian	39	33.02±1.25	41.93±1.21	66	203.57±7.87	490.21±7.92[a]	67.23±0.02[b]
Season	-	NS	NS	-	**	**	**
Main rain	81	32.62±0.86	41.93±0.84	160	192.20±5.02[b]	471.47±5.04[b]	69.03±0.01[a]
Short rainy	62	31.75±1.03	40.37±1.00	185	184.63±5.02[b]	466.44±5.34[b]	69.99±0.01[a]
Dry season	83	31.76±0.89	41.19±0.87	206	207.01±5.36[a]	489.85±5.05[a]	67.00±0.01[b]
Parity	-	NS	NS	-	**	**	**
1	55	31.79±1.08	40.64±1.05	159	217.22±5.12[a]	497.84±5.14[a]	57.61±0.01[e]
2	49	33.65±1.12	42.78±1.08	137	209.49±5.66[a]	488.86±5.69[a]	65.67±0.01[d]
3	40	31.94±1.26	41.09±1.23	109	188.38±6.39[b]	469.28±6.43[b]	70.32±0.01[c]
4	39	31.65±1.25	40.99±1.22	86	169.91±7.13[b]	452.03±7.17[b]	76.86±0.01[a]
5	43	31.20±1.99	40.31±1.67	60	188.10±8.47[b]	471.59±8.55[b]	72.89±0.01[b]

The means within the same column with at least one common letter, do not have significant difference (P>0.05).
* (P<0.05) and ** (P<0.01).
NS: non significant.
N: number of observations.
AFS: age at first service and AFC: age at first calving.

The overall least square means (±SE) of BE in the present study are presented in Table 1. The mean BE reported in this study was nearly comparable with those reported by Getinet *et al.* (2009) (BE of 69.6%) and Goshu (2005) (BE of 70.9±0.04, 69.9±0.03 and 63.5±0.03 percent for F_1, ¾ HF, $^7/_8$ HF, respectively for Friesian-Boran crossbred cows at Cheffa farm). However, it was lower than the 81.9% reported by Berhanu *et al.* (2011).

Breed, bloodline, season of calving and parity significantly affected BE (P<0.01). Friesian × Boran presented significantly better BE than Friesian × Arsi cross that might be explained by the genetic differences in Boran and Arsi breed son respect to age at puberty and to resume heat after calving. Among bloodlines, $^3/_4$ Friesian cross attain higher BE than ½ Friesian and $^7/_8$ Friesian cross. The lower BE in F_1 and $^7/_8$ Friesian crosses might be due to the longer AFC and CI.

The highest BE was recorded for cows that calved during the short rainy season while, the lowest BE was recorded in cows calving in the dry season. This may be due to the increased green forage availability during short rainy season that enables a cow to come in heat early after calving and to conceive.

In contrast, during the dry season both quality and availability of forage is low, thus negatively affecting the ovarian activity. This agrees with Goshu (2005) and Berhanu *et al.* (2011) but not with Hammoud *et al.* (2010).

The highest BE was found in parity four while the lowest BE was recorded in parity one.

The age related difference in reproductive performance might be due to delayed resumption of ovarian activity after calving in younger animals derived from the accrued nutrient requirements for the compensatory growth and milk production that might influence conception. Similar age related differences were reported by Goshu (2005) and Berhanu *et al.* (2011).

Number of service per conception (NSPC)

Number of services per conception (NSPC) is the number of services required for a successful conception. Table 2 presents the overall mean value (±SE) of NSPC. The value of NSPC reported in the present study was comparable to those described by Nibret (2012), in urban and peri-urban areas of Gondar (NSPC of 1.3 and 1.5 respectively), but-lower than the reported by Gebeyehu *et al.* (2007) (1.720±0.056) or by Yifat *et al.* (2009) (1.67).

NO effects were found between breed and parity of cows over NSPC (P>0.05). Also Nuraddis *et al.* (2011) failed to evidence significant effects of parity on NSPC, contrasting to the results of Gebeyehu *et al.* (2007) and Yifat *et al.* (2009) whom found significant effects of parity on NSPC. Cows inseminated during the dry season had significantly higher (P<0.01) NSPC than cows inseminated during short rainy and main rainy season.

Table 2 Least square mean (LSM±SE) for thenumber of services per conception (NSPC) and longevity over breed, bloodline, season of insemination/birth and parity at Agarfa ATVET College dairy farm Oromia, Ethiopia

Variable	N	NSPC	N	Longevity (years)
Overall	572	1.35±0.03	136	7.77±0.25
Breed group	-	NS	-	NS
Friesian × Arsi	320	1.32±0.06	92	7.51±0.28[b]
Friesian × Boran	252	1.39±0.05	44	8.02±0.39[a]
Bloodline	-	NS	-	**
½ Friesian	270	1.41±0.08	42	9.41±0.42[a]
¾ Friesian	215	1.28±0.06	66	7.27±0.33[b]
$^7/_8$ Friesian	87	1.36±0.07	28	6.62±0.48[b]
Season	-	**	-	NS
Main rainy season	168	1.35±0.05[b]	51	7.32±0.38
Short rainy season	204	1.24±0.05[b]	33	8.46±0.45
Dry season	200	1.46±0.05[a]	52	7.32±0.38
Parity	-	NS	-	-
1	152	1.39±0.06	-	-
2	150	1.32±0.05	-	-
3	113	1.28±0.06	-	-
4	81	1.34±0.07	-	-
5	76	1.44±0.07	-	-

The means within the same column with at least one common letter, do not have significant difference (P>0.05).
** (P<0.01).
NS: non significant.
N: number of observations.

The lowest NSPC for cow's inseminated in short rainy season might be attributed to the nutritional effects imposed by the reduced availability of green forage during the dry season compared to the rainy season, which influence the fertility of cows. These findings are supported by Yifat *et al.* (2009) studies.

Longevity

Longevity is the period in years from birth until the animal is disposed of from the herd either by interest of the owner or due to disease, injury and other accidents. Longevity of cows in the present study was found to be 7.77 ± 0.25 years (Table 2). This was in line with Goshu (2005) reported longevity of 7.9 years, but was lower than 8.35 ± 0.29 years reported by Gebeyehu *et al.* (2007). Breed and season of birth had no significant effect (P>0.05) on longevity whereas longevity was significantly affected by bloodline (P<0.01). Non-significant effects of season of birth on longevity are in agreement with the findings of Gebeyehu *et al.* (2007). Cows belong to ½ Friesian bloodline stayed longer on farm, contrasting with the shortest longevity obtained from $^7/_8$ Friesian bloodline. The Friesian bloodline increased the longevity of cows decreased, which may reflect differences in the lactation potential as well as the ability to adapt to harsh environmental condition.

CONCLUSION

In general, the reproductive performance of cows kept in Agarfa dairy farm was low, as evident from long AFC, DO and CI. The BE obtained in this study was far away from the standard value of 100%. Therefore, due consideration should be given in calf and heifer management, heat detection, accurate timing of artificial insemination, feeding and health care to improve reproductive performance. Furthermore, the performance of Boran cross was better than Arsi cross while among the Friesian bloodlines ¾ Friesian crosses were better than other Friesian bloodlines kept in the study area in all reproductive parameters except longevity.

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