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Study on Reproductive Efficiency of Boran and its Crosses at Holetta Research Farm: Effect of genotype, management and environment

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Abstract

Reproductive data obtained during 1989-1999 from nine genetic groups, originated from local Boran cows, and their crosses with Friesian and Jersey were studied on 1025 records at Holetta Research Center. Least squares means for number of services per conception (NSC) for all genetic groups was 1.72 $\pm$ 0.14. Year of conception affected (P<0.001) NSC. The total conception rate (CR) of the herd was 76%. Among cow genetic group the NSC tended to decrease with increasing exotic blood level. Hence, the highest NSC (2.06) were required for Boran cows and the lowest for5/8 Jersey-Boran /5/8 JBO/ (1.37). Friesian- Boran /F_1FBO/ andF_1Jersey-Boran /F_1JBO/ required 1.74 and 1.65 NSC respectively.

Least squares means for days open till conception (DOC) was 181 $\pm$20 and was affected by genetic group and year of calving (P<0.05). Boran cows had 34 days longer days open than the F_1 crosses. The shortest mean value for DOC was found for the 3/4 Jersey-Boran (3/4JBO) (121 days) followed by 5/8 Jersey-Boran/ 5/8JBO/(123 days), F_1 Jersey- Boran (F_1JBO) (143 days) and F_1 Friesian- Boran /F_1FBO/ (144 days) while 5/8 Friesian-Boran (5/8FBO) cow had the longest (221 days).

Least squares mean pospartum anoestrus interval (PPAI) was 149 $\pm$ 21 days. Longest anoestrus interval was recorded for 5/8Jersey-Boran/5/8FBO/cows (188 days) while the shortest (114 days) was for3/4JerseyBoran/3/4JBO/. F_1 Friesian Boran/F_1 FBO/ and F_1 Jersey Boran / F_1 JBO/ required 115 and 121 days respectively. Generally, Jersey crosses were superior in reproductive efficiency than Friesian crosses. 5/8 Jersey-Boran /5/8 JBO/ and3/4Jersey Boran /3/4JBO/ crosses manifested better reproductive performance than the rest.

The estimated least square means NSC shows seasonality, Cows bred during the dry, short and main rainy seasons required 1.55, 1.47 and 1.87 services per conception, respectively.

Keywords: Reproductive Efficiency, Breed, Borana, Friesian and Jersey inheritance.

Abbreviation: AI, Artificial insemination; BO, Boran; CR, Conception rate; CV, Coefficient of variation; DF, Degree of freedom; DOC, Days open to conception; DS, Dry season; FBO, Friesian-Boran; F_1, First generation crossbred; F_2 , Second generation /inter se mating/crossbred; HARC, Holetta Agricultural Research Center; JBO, Jersey-Boran; LRS, Long rain season; N , Number of observation; NM , Natural mating; NSC, Number of service per conception; MS, Mean square; PPAI, Post partum anestrus interval; SE, Standard error; SP, Service period; SRS, Short rain season.

Introduction

Economic return from milk production is maximized with a calving interval of 12 months, a dry period of approximately 60 days and days open of 85 days. It has been reported that a 12-month calving interval (85 days open) can be achieved with a 45-day voluntary waiting period, 70% estrous detection efficiency and 60% conception rate (Radostits *et al.*, 1994). However, calving interval in Ethiopian Zebu range from 12 to 24 months (Mekonnen and Goshu, 1987; Kiwuwa *et al.*, 1983, Azage *et al.*, 1981) which varies among breeds and animals within a breed. A daysopen of 248.4, 211.1, 253.0 for Boran, Horro and Barka cattle respectively has been reported (Azage *et al.*, 1981).

Although crossbreeding and/or upgrading of cattle in Ethiopia has been done for last 30 years the performance and adaptability of crossbred cattle have not yet been clearly described. Comprehensive information on factors influencing the reproductive performance is, however, scanty under tropical conditions. Thus, in this study an attempt was made to investigate the genetic factor affecting the reproductive effeciency of indigenous Boran cows and their crosses with Jersey and Friesian Sires at the Holetta Agricultural Dairy reasearch Farm, west of Addis Ababa, Holetta, Ethiopia.

Crossbreeding has long been practised in country to bring about the desired genetic change quickly, to combine the high productivity of exotic and better adaptability of indigenous breeds in the crossbreeds.

Low pregnancy rate to Artificial Insemination (AI) in most African countries is attributed to poor semen quality, semen handling procedures, inadequate insemination skills, poor oestrus detection and wrong time of insemination, (Mukasa- Mugerwa *et al*., 1991a).

Study at ILCA (1988) indicated that improving the management status of Zebu and their crosses increased the reproductive performance. It is obvious that improved management combined with the right genotype bring a substantial change in livestock productivity. However, the choice of genotype in combination with proper management remains a challenge in many African countries. Therefore, it was the objective of this study to analyse data on reproductive performance of Boran and its crossbred at the Holetta Research farm.

The objectives of this study were to evaluate the effect of genotype, management and environment on reproductive traits for number of service per conception (NSC), conception rate (CR), days open till conception (DOC), service period (SP), and postpartum anestrus interval (PPAI) between Boran and its Holstein-Friesian and Jersey crosses and to examine the effect of mating season, year and parity on conception in the above genotype.

Materials and Methods

Description of the study area

The data for the study was obtained from a long term cattle crossbreeding experiment of Dairy Breeding Program of the Ethiopian Agricultural Research Organisation (EARO) at Holetta Research Center which is located in the Central highlands of Ethiopia, 45 kms West of Addis Ababa. The Holetta Farm is located at an altitude of 2400 m.a.s.l. It receives an annual rainfall of 1100 mm and the area is characterized by mild subtropical weather with minimum and the maximum temperature ranges from 5 to 10 and 18.7 to 24.0^{0}C respectively. The rainfall pattern is bimodal, with a short rainy period from February to April and a long rainy season from June to September. The long dry season lasts from October to January. The predominant soil type is vertisol. Sufficient area of natural pasture is available for grazing and forages were grown for haymaking at the center. The vegetation cover consists mainly of annual legumes and perennial grass species. The pastures, dominated by *Hyparrhenia*, *Andropogon* and *Trifolium* species, were of moderate quality. The dam breed considered for this study were Boran, Friesian-Boran, Jersey-Boran and the sire breeds were Friesians and Jersey.

Reproductive traits

The reproductive traits studied were conception rate to first service (percent of cows confirmed pregnant to first service), days open (the period from calving to date of effective service), Service period (the period from first service to conception), Postpartum anoestrus interval (the period from calving to first services)

Genotypes

The Breed and crossbred groups used in the study were Zebu (Borana),F_1 crosses of 50% *Bostaurus* X 50% *Bos indicus*(½ Friesian ½ Borana -F_1FBO and ½ Jersey ½ Borana-F_1JBO), F_2 interse mating (½ Friesian ½ Borana -F_2FBO and ½ Jersey ½ Borana -F_2JBO),F_2 backcrosses to ¾ *Bos taurus* (5/8 Friesian 3/8 Borana - F(2(FBO) and 5/8 Jersey3/8 Borana -J(2(JBO), and F_2 backcrosses -75% *Bostaurus* (3/4 Friesian 1/4 Borana -F(FBO) and 3/4 Jersey1/4Borana -J(JBO).

Herd management

All calves were weighed at birth and identified by ear tag. Calves were separated at birth and were reared artificially using bucket feeding. Calves were kept in-doors in individual pens and were offered concentrate and hay starting 2 weeks after birth. Calves were allowed up to a maximum of 2 kg of concentrate per day and hay ad-libitum until weaning (3 months). Station born heifers were first mated on their third cycle of estrous. Special treatment was given to pregnant cows and heifers. They were separated into maternity pens at night during the last two months of gestation and supplemented with 2 kg of concentrate. Cows were milked twice daily by hand milking without the presence of their calves. Milking cows were managed under a loose -housing arrangement and fed native grass-hay indoors. Heifers and dry cows however were run on pasture during the daytime and supplemented with hay and concentrate in the evening. At times, milking cows were also run on pasture whenever shortage of grass-hay was encountered. During milking, however, cows were supplemented with balanced concentrate (Noug Cake with wheat middling and wheat bran) at the rate of 1kg per 2kg of milk produced.

All animals were vaccinated for Rinderpest, Foot and Mouth disease, Anthrax, Pasteurolsis, Blackleg and Contagious Bovine Pleuropneumonia (CBPP). Animals were also drenched and sprayed for internal and external parasites at regular intervals.

Heat detection was done twice a day once early in the morning (6-8 AM) and late after noon (5-6 PM). Animals observed in heat were bred either naturally or inseminated with frozen semen at 7 AM or 3 PM depending when an animal observed in heat. Those which were bred but not returned to oestrus were checked for pregnancy after two months, and if confirmed to be pregnant they were separated from the herd and kept indoor in the maternity paddock from 7 months pregnancy stage limited grazing in near by paddocks. The cows were weighed every month.

In this study to account breed difference nine genetic groups were made based on the blood levels. These were Boran; F_1, F_2, 5/8 and 3/4 of Friesian-Boran and Jeresy-Boran. Since management system varied between years, it was grouped into two periods to account for these variations. These are 1989 to 1996 (period I) and 1997 to 1999 (period II), during which continuous calving herd and natural synchronised breeding programs were followed respectively. Based on climatic data and pasture condition of Holetta, months of the year were grouped into three seasons covering the short rainy (February - April), the long (big) rainy (June-September), and the dry season (October-February and May).

Data Collection

Data used for this study were cover the period of 1989 and 1999 years on reproductive performance of Boran and their Friesian and Jersey crosses. The study focussed on the reproductive efficiency that is NSC, DOC, SP and PPAI. A total of 319 cows with 1025 records have been involved in the study. Out of these 100 were Boran (Zebu origin) and 219 were crosses (121 Friesian and 98 Jersey). Number of records were 270 for Boran and 755 for crosses, (409 Friesian and 346 Jersey). The genetic groups considered for this study were, Local Zebu (Boran) and crossbreeds with 1/2, 5/8 and 3/4 blood levels of Friesian and Jersey. All available records on the above traits were included, with the exception of some missing data, which resulted in unequal number of records for the various traits.

Individual record of each cow and each calving were used for analysis. These include date of calving, date of estrus, time of heat detection, time of insemination (service), date of effective service, service type, parity and pregnancy.

Statistical analysis

The data on reproductive efficiency traits collected from 1989 to 1999 at the research station were used for the analyses. The fixed effects used were genetic group(B), season(S), year(Y) parity(P), and mating type(Q). The data were analysed using general linear model SAS (1999). ($Y_{ijklm} = \mu + B_i + S_j + Y_k + P_l + Q_m + BS_{ij} + SQ_{jm} + e_{ijklm}$) where: Y_{ijklm} = the observation of m^{th} mating of the l^{th} parity of the k^{th} year of the j^{th} season of the i^{th} genetic group. $(BS)_{ij}$= interaction of breed and season.$(SQ)_{jm}$= interaction of season and mating type. e_{ijklm} = random error

Results and Discussion

Number of Services per Conception (NSC)

The overall mean NSC was 1.72 $\pm$ 0.12 (Table 1). The genetic group had no significant effect on the number of services required per conception. However, a clear trend of improvement in fertility with increasing levels of exotic inheritance was observed (Table1). The NSC tended to decrease with increasing exotic blood (Friesian and Jersey) inheritance among cow breeds. Hence, the highest NSC (2.06) was found for Boran cows and the lowest (1.34) for $5/8^{th}$ Jersey cows. This is in agreement with Mekonnen and Goshu (1987) who evaluated the reproductive performance of Zebu, Friesian and their crosses, and reported that the number of services required per conception tended to decrease with increasing Friesian inheritance among dam breeds. The genetic group did not show any significant difference on NSC. The result obtained showed that Boran cows needed more NSC than the F_1 crossbred cows. Similarly, Azage (1981) reported that in Zebu and their crosses with temperate breeds the NSC decreased in the crosses as compared with the Zebu breeds. Mekonnen (1987) also reported a non-significant effect of breed group on NSC.

The cross breed in general, and the5/8 Jersey crosses in particular, required relatively few number of services per conception than cows with 1/2 and 3/4 exotic inheritance. The lowest mean number of services required per conception was obtained for 5/8JBO crosses (1.34 $\pm$ 0.25). This could be due to small size of Jersey crosses that might make them compatible to the local environment as compare to Friesian.

The NSC showed seasonality that cows bred during the dry, short and main rainy seasons required 1.55, 1.47 and 1.87 services per conception, respectively. Thus, cows inseminated during the short rainy seasons required low NSC than those cows bred in the main rainy season. This could be due to the favorable climatic conditions and abundant green fodder availability. This is in agreement with Azage (1981) and Swensson et al (1981) who have reported that NSC increases in the dry months of the year as compared with rainy months of the year in Zebu and their temperate crosses in Ethiopia.

Mean NSC of 1.72 did not differ between all factors considered in the model except for year differences which required more NSC in the later years (1.77) than the earlier ones (1.45). This could be due to the change of composition of the herd due to purchase of foundation herd (Boran) in 1996 and the management of the farm. Among the factors considered, only year of conception had significant ($p<0.01$) influence on NSC. The relatively fewer number of services required per conception during the dry and short rainy seasons were consistent with the higher total number of conception in these two seasons. Saeed *et al.* (1987) also reported that Kenana cows in the Sudan required fewer numbers of services per conception. In general, the NSC in the present study was 1.5 to 2.5 which is within the range given for crossbred cows in Ethiopian (Azage Tegegne et al, 1981; Kebede Beyene, 1992; Kiwuwa *et al.*, 1983). However, considering this in relation to the long PPAI (149days) and DOC (181days) the value may not reflect the true breeding status of the herd as many heats may not have been detected by herd attendants.

Days Open till conception (DOC)

The overall mean days open was 181$\pm$ 20 days (Table 1). The result in this study showed that days open till conception (DOC) was significantly influenced ($p < 0.05$) by genetic group. Boran cows had 34 days and 35 days longer days open than the F_1- Friesian and F_1-Jeresy crosses respectively (Table 1). Similarly, Azage Tegegne (1981) reported that crossbred cows had

81.8 days shorter DOC than the local cows. Different researchers have reported a variable results for DOC. Tesfu Kassa (1990) who studied on crossbred and Zebu cows in the central highlands of Ethiopia reported mean intervals for calving to conception of 157.8 and 199.8 days, respectively. Estimates of days open till conception have been reported to range between 130 to 300 days in Zebu and crossbred cows under management conditions of research centers in Ethiopia (Azage Tegegne et al., 1981). The longer interval for the Boran cows could have been due to difficulties in heat detection, occurrence of silent heat and short oestrus period which is a common phenomena among Zebu cows (Trail *et al.* 1971).

Table 1. Mean and standard error (SE) for DOC, PPAI, SP, NSC, and CR of breed group in Holleta Agricultural Research Center (HARC).

Variable Genetic grp	**DOC (days) Mean + SE**	**PPAI (days) Mean + SE**	**SP (days) Mean + SE**	**NSC (No.) Mean + SE**	**CR (%) Mean + SE**
BOxBO	178 ± 22^{b} (161)	123 ± 19 ^{b} (162)	65 ± 10.83 (266)	2.06 ± 0.12 (267)	70 ± 3.12 (267)
BOxF	144 ± 19^{b} (73)	115 ± 17 ^{b} (73)	30 ± 10.31 (109)	1.74 ± 0.14 (109)	72± 3.55 (109)
BOFxBOF	183 ±22^{ab} (108)	150 ± 19^{ab} (112)	36 ±10.47 (171)	1.58± 0.12 (169)	78 ±3.27 (169)
5/8BOF	221 ± 30^{a} (41)	188 ± 26^{a} (42)	48 ± 14.23 (64)	1.78± 0.18 (64)	79 ±4.66 (64)
3/4BOF	164 ± 26^{ab} (39)	146 ± 22^{ab} (41)	38± 13.66 (137)	1.52 ± 0.18 (57)	80 ±4.74 (57)
BOXJ	143 ± 23^{b} (89)	121 ± 20^{b} (93)	30+ 12.50 (57)	1.65 ± 0.14 (119)	76± 3.48 (119)
BOJXBOJ	185 ±23^{ab} (79)	160 ± 20^{ab} (81)	37 ± 11.09 (117)	1.59 ± 0.13 (137)	78± 3.48 (137)
5/8BOJ	123 ±41^{b} 21)	119 ± 36^{b} (21)	37 ± 22.81 (33)	1.34 ± 0.24 (33)	87± 6.29 (33)
3/4BOJ	121 ± 34 ^{b} (20)	114 ± 30^{b} (20)	21 ± 17.58 (31)	1.41 ± 0.25 (31)	83± 6.46 (31)
Mean	181	149	38	1.72	76
SE	20	21	11.25	0.14	3.12
F-test	*	*	ns	ns	ns
C.V (%)	64.56	68.44	197.68	68.36	38.96

* $P<0.05$ ns = not significant SE = Standard error C.V.= Coefficient of variation
Means with in the same column followed by the same letter or no letter do not differ from each other significantly ($P>0.05$) Figures in parenthesis are number of records.

The reproductive performance of the F_1-Friesian crosses was better than either the pure Boran, F_2, 5/8th or 3/4th Friesian crosses. The poor reproductive performance of 3/4th crosses was consistent with studies in the tropic. McDowell, (1985) and Kebede Beyene(1992), suggested that the management level at the station was just good enough to support animals below 3/4 Friesian inheritance. The wide variability in reproductive performance among the year-groups (periods) indicate that, genetic group evaluation needs to be done under more or less uniform management over years. Significant ($p<0.05$) effect of breed group was also observed in DOC and PPAI. The estimated least squares means presented in (Table 1) showed that first crosses, especially, the F_1 Boran Friesian crosses (F_1FBO) had shorter DOC and PPAI than crossbred with F2, 5/8 and 3/4 exotic inheritance. The fact that crossbreds with higher levels of exotic inheritance had longer DOC is in accordance with the reports of El-Amin *et al.* (1986). However ¾ Boran-Jersey crosses had shorter periods of DOC and PPAI than crossbreds with F_1 F_2, and 5/8 exotic inherence.

Days open was significantly influenced ($p < 0.05$) by year of calving but not by season of calving and parity (Tables 2,3 and 4). The non significant effect of season on DOC was substantiated with the result of Azage (1981). The long DOC (179 days) observed in the first period (continous calving herd) could be due to non availability of proper feed through out the year related to reduced dry period feed supplementation. In other words cows calving during the first period (1989/1996) had longer days open (179 days) while those calving in the second period (1997/1999) had shorter interval (146 days) (Table 4). The long days open in the first period was due to delay in the onset of estrus as reflected by the longer PPAI 157 $\pm$ 14.7 days (Table 4). Which may be due to shortage of proper feed through out the year. The long PPAI due to improper nutrition was also substantiated by (Tesfu Kasa and Azage Tegegne , 1992; Tesfu Kasa *et al.,* 1993).

Service period (SP)

The over all mean service period found in this study was 38 $\pm$ 11.25 days (Table1). However there is no significance difference among the genetic group. The estimated least squares means showed that first crosses, especially, the F_1 Boran x Friesian crosses (F_1FBO) had shorter service period than crossbreds of F_2 and 5/8 exotic inheritance. However, ¾ Boran x Jersey crosses had shorter service period (21 $\pm$ 17.58) than crossbreds of F_1, F_2 and 5/8 exotic inherence. This could be due to the small size of Jersey crosses that the Jersey, being small breed, may be more drought resistant and may have a better feed efficiency as compared to the other large breeds and besides, may adapted better to warmer regions (Kebede Beyene et al., 1977, Kebede Beyene, 1992). In dairy cattle, extended service period and long DOC would increase the generation interval, limiting the number of lactations and calves born. On the other hand, too short a service period and a DOC would adversely affect the length of lactation. It is therefore necessary that an optimum service period and DOC commensurate with normal reproduction so that economic production could be obtained.

Service period was longest in long rainy season (47 days), shortest in dry season (19 days) calvers and intermediate in short rainy season (45 days) (Table 2), but differences between means were not significant. The long SP in long rainy season calvers may be attributed to scarcity of green fodders since the grazing are protected for hay making and water logging problemes. Khidir *et al*., (1979) reported that well grown Kenana heifers, fed diets short of green fodders, suffered silent heat and they attributed it to vitamin A deficiency. These arguments lend support to the conclusion that SP may be reduced through better environmental and feeding management. These include adequate supply of green or conserved fodders in long rainy season, and /or addition of vitamin A supplement, and protection from heat in dry seasons (Alemu Gber Wold, 1984). In the hot season night grazing may be an attractive practical proposition.

Table 2. Effects of parity on reproductive parameters of dairy cows at Holetta Agricultural Research Center.

Parity	DOC (days) Mean ± SE	PPAI (days) Mean ± SE	SP (days) Mean ± SE	NSC (No.) Mean ± SE	CR (%) Mean ± SE
1	172 + 18.1	148 ± 15.7^{a}	41± 10.21	1.67 ± 0.12	76 ± 3.00
	(179)	(181)	(260)	(258)	(258)
2	174 + 18.2	154± 15.8^{a}	44 ± 10.50	1.60 ± 0.12	78 ± 3.03
	(147)	(150)	(225)	(226)	(226)
3	141 ± 19.9	116 ± 17.3^{b}	42 ± 10.99	1.77 ± 0.13	77 ± 3.22
	(91)	(93)	(166)	(166)	(166)
4	152 + 21.7	120 ± 18.9^{b}	45 ± 12.32	1.58± 0.14	80 ± 3.78
	(66)	(67)	(236)	(99)	(99)
5^{+}	146 ± 19.0	124 ± 16.5^{b}	44 ± 10.65	1.67 ± 0.12	76 ± 3.12
	(148)	(154)	(98)	(237)	(237)
F-test	ns	*	ns	ns	ns

* P< 0.05 ns = not significant
Mean within the same column followed by the same letter or no letter do not differ from each other significantly (P>0.05) Figures in parenthesis are number of records. 5^{+} Five and above

Post partum anestrus interval (PPAI)

Post partum anestrus interval is a variable determining both calving interval and calving rate of a herd. The result obtained demonstrated that PPAI was significantly affected by genetic group (P<0.01). The overall mean of

149 $\pm$ 21 days for PPAI found in this study (Table 1) was longer than the ideal interval of 45 days (Lamming and Darwash, 1989). An interval of 97.5 $\pm$ 25.1 days for resumption of postpartum ovarian activity was reported for crossbred dairy cows under smallholder management conditions in Ethiopia (Tesfu Kasa, 1990). On the other hand the average PPAI for crossbred dairy cows was

53.5 $\pm$ 32 days and ranged from 22 to 135 days as reported by (Yoseph Mekasha, 1999). The estimated least squares means presented in this study showed that first crosses, especially, the F_1 Boran Friesian crosses (F_1FBO) had shorter PPAI than the F_2, 5/8 and 3/4 exotic inheritance. The fact that crossbreds with higher levels of exotic inheritance had longer PPAI is in accordance with the reports of El-Amin *et al*. (1986). However ¾ Boran-Jersey crosses had shorter PPAI than crossbred with F_1, F_2 and 5/8 exotic inherence. This could be due to the fact that Jersey has a better adaptability to the local environment as compared to Friesian. Kebede Beyene *et al (*1977) reported that Jersey, being a small breed, might be better in feed efficiency and adaptation to local environment as compared to the large exotic breeds.

The result obtained demonstrated that PPAI was significantly affected by parity and period of calving (Tables 2 and 4). Highly significant year effects ($p<0.001$) were observed on PPAI. Cows calving during the first period (1989/1996) had the longest PPAI (157 days) while those calving in the second period (1997/1999) had the shortest interval (118 days) (Table 4). The possible reasons for shorter intervals recorded for PPAI during period II (1996-99) could be in response to improvement of management and seasonal breeding practices carried out at the center. Parity exerted a significant effect ($p<0.05$) on PPAI. This has indicated a clear trend of decreasing after the first and second parity (Figure1). Thus, PPAI decreased from 160 days in first parity to 122 days 3rd parity. Further, it was observed that the trend beyond the 3rd parity was increasing PPAI.

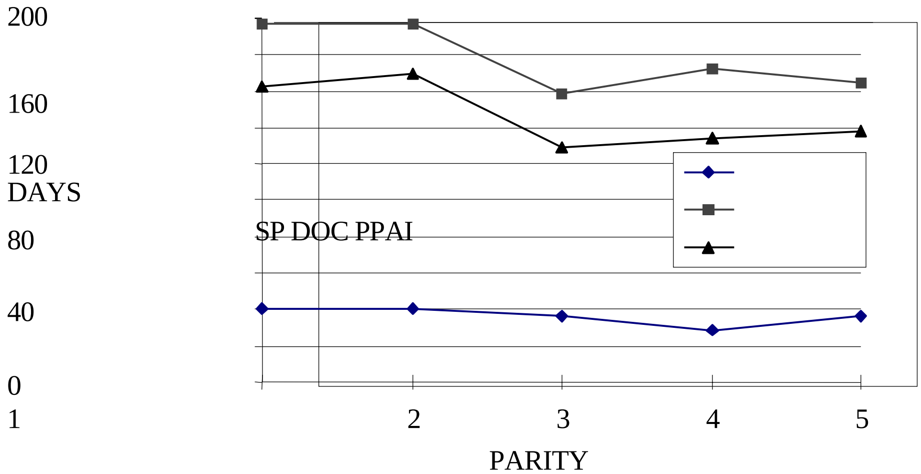

Figure 1. Effect of Parity on DOC, PPAI and SP

In the first parity cows, the causes of this age related difference in PPAI be due to delayed resumption of ovarian activity after calving. This may be a result of longer resting period they need to recover from stress of parturition and to cope with the increased nutritional demand of growth and lactation during their early ages. After the 5+ parity the changes are attributed to age related delays. This latter increasing number of PPAI could be due to the tendency of older and weaker cows to take longer time to recover from effects of the past pregnancy and lactation stresses. This is in disagreement with (Enyew Negussie, 1992) who also stated that the trend of decreasing DOC over the parities up to 5th parity and gradual increase there after. For the dairy herd experiencing long PPAI exceeding 40-45 days, nutritional program should be examined (Ferguson, 1996), as the quality and quantity as well as feeding systems have a far reaching impact on the reproductive performance of dairy cows. The longer PPAI observed in this study could be the result of poor feeding management.

Seasonality of conception (SC)

The total of 986 conceptions of all genetic groups over the period of ten years 1989 to 1999 showed that the highest percentage (total of 42 %) occurred in the short rainy season between February and April. The percentage of conceptions for the other two seasons, long and dry season ranged from 25 % (June to September) to 33 % (October to January). This is in agreement with Michalak *et al* (1983) who have indicated that 54.3 % of all conception occurred

between January and May at Abernossa farm in Southern Rift Valley of Ethiopia. The highest percentage of conceptions per month during the short rainy season is consistent with the results reported in Ethiopia (Michalak *et al.*, 1983; Makonnen and Goshu, 1987) and in Sudan (Saeed *et al.*, 1987). Michalak *et al* (1983) related the seasonality of conception to increase in day light hours that occurs in March in Ethiopia (Spring equinox). Also, other, workers (Plasse *et al.,* 1970; Makonnen and Goshu 1987) related elevated conception rates to months of high temperatures which also coincides with increase in day length. However, the above observation is in disagreement with the views of Hafez (1980) who concluded, after reviewing several studies that high temperature depresses conception rate and increases the number of services required per conception. Michalak *et al* (1983) showed that temperature, rainfall, and average day length (h) had variable effects on seasonality when considered singly but their combined effect accounted for 86-
99 % of the variability in seasonality of conception in the high lands of Ethiopia. This seems to be true when the feed supply throughout the year is reasonably uniform. Otherwise rainfall distribution, through its effect on pasture growth and nutrition, could have an important influence on conception pattern (Wilson and Clarke, 1976). The reason for such a relationship and their possible uses in improving reproductive efficiency need to be studied.

Seasonality in quality and quantity of the fodder is closely related to the intake and digestibility of the feed and animal performance. During the rainy season pasture is abundant, and the quality, intake and digestibility of the pasture are high enough to meet maintenance, growth and reproductive requirements of the animals. In the dry season, both intake and digestibility are low and the available nutrients do not match the requirement of the animals. The ability of the animal to reproduce is highly affected by nutritional status and this could be improved through supplementation mainly during the dry season.

Season in general had no statistically significant effect on most of reproductive traits considered in this study. However, cows calved during the long rainy season showed lower conception rate than those calved during the short rainy and dry season. This could be due to seasonality in feed availability since cows calved during the main rainy season will have to pass most of their critical period in the long dry season. This is in agreement with the result (Mekonnen and Goshu, 1987; Eneyew Negussie et al 1999). Although the effect of season was not statistically significant, cows calving at the end of the dry and during the short rainy seasons had a relatively shorter DOC and PPAI than those calving during the main rainy season (Table 3). The main advantage of calving during this period is related to better nutritional status in the subsequent favorable months of the rainy seasons to meet the higher nutrient requirements of postpartum cows for maintenance, growth and lactation.

The possible reasons for shorter intervals recorded for both traits, DOC and PPAI, during period II (1997-99) (Table 4) could be improvement in management, and seasonal breeding practices carried out at the center. However, a marked increase was observed for the NSC during this period. The possible reasons for the observed annual variability and marked increase in the NSC could be either a bull effect or it could be due reproductive problem among the herd or it could be due to the change of composition of the herd and management.

Table 3. Effects of season on reproductive parameters of dairy cows at Holetta Agricultural Research Center.

Seasons	Season of calving			Seasonal services	
	DOC (days)	PPAI (days)	SP (days)	NSC (No.)	CR (%)
	Mean + SE	Mean + SE	Mean + SE	Mean + SE	Mean + SE
Dry season (Oct- Jan)	174 + 21 (367)	139 + 28 (378)	19 + 6.11 (576)	1.55 + 0.14 (325)	81+ 3.12 (325)
Short rainy season (Feb_ Apr)	129 + 29 (163)	108 + 25 (163)	45 + 14.62 (250)	1.47 + 0.14 (410)	83 + 3.58 (410)
Long rainy season (June- Sep)	185 + 32 (101)	166 + 28 (104)	47 + 16.00 (159)	1.87 + 0.17 (251)	71 + 4.45 (251)
F-test	ns	ns	ns	ns	ns

ns = not significant
Figures in parenthesis are number of records

Table 4. Effects of period (Year) reproductive parameters of dairy cows at Holetta Agricultural Research Center.

Pattern of calving	Season of calving			Seasonal services	
	DOC (days)	PPAI (days)	SP (days)	NSC (No.)	CR (%)
	Mean ± SE	Mean ± SE	Mean + SE	Mean ± SE	Mean ± SE
1989-96 (Continuos calving)	179 ± 15[a] (409)	157 ± 13[a] (418)	33 ±7.92 (530)	1.49 ± 0.09[b] (528)	81 ± 2.43[a] (528)
1997-99 (Seasonal calving)	146 ± 17[b] (222)	118 ± 14[b] (227)	41 ± 9.28 (455)	1.77 ± 0.09[a] (458)	75 + 2.52[b] (458)
F-test	*	***	ns	**	*

*** P <0.001 ** P <0.01 * P< 0.05 ns= not significant
Mean within the same column followed by the same letter or no letter do not differ from each other significantly (P>0.05) Figures in parenthesis are number of records.

Conclusions

Therefore, this study concluded that if the reproductive efficiency of Boran cows is to be improved, cows must be genetically up-graded to the level 50%. There is also an indication that upgrading Boran cattle up to 75% exotic inheritance preferably with Jersey sires could be taken up at least for better reproductive efficiency provided the level of management is good enough to meet the relatively higher managerial demand of these animals. In general, the observed seasonal trend indicated an obvious advantage of planned seasonal breeding so as to avoid a decline in reproductive performance associated with the seasonal fluctuations. Therefore, it is suggested that under such environmental conditions, if animals are to be bred seasonally on consideration of reproductive performance alone, improved performance would be realized if mating is planned to take place during the wet months preferably just before the beginning of main rainy season. However more intensive studies on physiological parameters in Zebu cows need further investigation

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