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Days To First Service, Conception Rate And Service Period Of Indigenous And Crossbred Cows In Relation To Postpartum Body Weight Change At Bako, Ethiopia

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Abstract

Days to first service (DFS), conception rate to first service and service period of indigenous and crossbred cows were studied using data from Bako Agricultural Research Center. The overall least square mean DFS was 150.3 ± 3.41 days and was significantly (at least $P < 0.05$) influenced by cow genotype, calving year, cow parity, calving weight and postpartum body weight gain. The effect of age on DFS was not significant ($P > 0.05$). Boran (192.7 ± 17.55 days) and Boran x Simmental crosses (200.1 ± 16.84 days) and first parity cows (202.0 ± 11.77 days) had significantly the longest DFS. DFS among the calving years ranged from 102.9 to 254.3 days. DFS was linearly related to calving weight of the cow (b = -0.39 ± 4.21) and postpartum body weight gain (b = -0.03 ± 2.81). The overall predicted probability of conception to first service was 0.7 ± 0.03. It was significantly influenced by mating weight ($P < 0.01$) and age of the cow ($P < 0.001$). The highest probability of conception was recorded for heavier cows (>400kg) at mating (0.8 ± 0.07) and youngest (<4 years) cows (0.8 ± 0.04) at calving compared to the other weight and age groups. A service period of zero was observed in 69.6% of the cows while 22.2% of the cows had very long service period (>48 days). From this study it can be recommended that from the DFS contributed the highest share to the prolonged days open in the center. A mating weight of 251-300 kg resulted in a drastic change in conception rate. Thus, attaining this target mating weight through proper postpartum feeding management and culling of old cows and repeated breeders could improve all traits considered in this study.

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Introduction

The main determinant of calving interval in individual cows is the days open, which is a function of the interval from parturition to first insemination (days to first service) and service period. Days to first service is an indirect measure of the estrus detection efficiency. With effective estrus detection program days to first breeding should be 20 to 28 days past the voluntary waiting period (Radostities *et al.*, 1994). A cow after calving needs some rest period for the uterus to involutes and normal cycle to take place. For this reason, a voluntary waiting period (VWP) ranging from 45 to 60 days is allowed before the cow is inseminated or bred. This prolongs the days to first service. Days to first service has low heritability (Batra *et al.*, 1986), which indicates that the trait is mainly influenced by non-genetic factors. Days to first service could be prolonged due to longer postpartum anoestrus interval (Batra *et al.*, 1986), when estrous activity ceases after a cow manifests its first postpartum estrous (Dawuda *et al.*, 1988) and due to low level of nutrition (Sasser *et al.*, 1988). Other factors such as the breeding management of a farm and genetic and non-genetic factors such as age, parity, season and calving year contribute to prolonged days to first service (Garcia *et al.*, 1990).

Service period depends on many genetic and environmental factors, which affect conception, embryo survival and heat detection efficiency. It is affected by the rates of conception to first and/or subsequent inseminations as well as the time intervals between successive inseminations. Generally repeated services per conception (Azage Tegegn *et al.*, 1981), long inter-service interval (Mukassa-Mugerwa *et al.*, 1991; Gemechu Wirtu, 1992; Gebregziabher Gebreyohannes *et al*., 2003), long estrous cycles (Alberro, 1983) and embryonic mortality (Wood, 1976; Kummerfield *et al.*, 1978) influence the length of service period. First service conception rate was affected by postpartum energy and/or protein intake of the cow (Randel, 1990). Peters (1984) reported a positive relationships between nutritional status, body weight and body condition score and fertility in both dairy and beef cows. Lactation status at the time of mating affects fertility (Hetzel *et al.*, 1989), which is largely a manifestation of the extra nutritional demand of lactation. Therefore, this study is designed to asses the days to first service, service period and conception rate to first service and factors affecting in indigenous and crossbred cows and recommend appropriate improvement strategies for better postpartum reproductive efficiency.

Materials and Methods

The study was based on reproduction data obtained from Bako Agricultural Research Center of the Oromia Agricultural Research Institute. Detailed description of the study area livestock management, feeding, heat detection and breeding are presented in a previous work (Gebregziabher Gebreyohannes *et al*., 2003, 2004). Data from pure Boran and Horro and their F_1 crosses with Jersey, Friesian and Simmental exotic sire breeds were used to calculate DFS (period from calving to date of first service), service period (period from date of first service to date of effective service) and conception rate to first service (predicted probability of conception to first service). DFS was analyzed using the General Linear Model, while conception rate to first service was coded as zero (success) for cows that conceived or one (failure) for cows that didn't conceive to first service and analyzed using the Categorical Model Analysis (SAS, 1999). Maximum Likelihood analysis of variance and parameter estimates for each level of the class variables were obtained as an output of the CATMOD procedure of SAS. The predicted probability of conception and standard errors for each level of class variables was then calculated from the parameter estimates obtained from SAS using the LOGMLVAR computer program (Rege, 1997).

Cow breed (genotype), parity, calving year and season were considered as fixed effects and calving weight, age of the cow and body weight gain (postpartum body weight gain from calving to three months postpartum) as a covariate to analyze days to first service. Eight genotypes (Horro, Boran, Horro x Jersey, Horro x Friesian, Horro x Simmental, Boran x Friesian, Boran x Jersey and Boran x Simmental), six parities (1 to 6 with the sixth parity including parities six and above), four calving season categories based on the centers rainfall data (*Gana* (June to August); *Birra* (September to November); *Bona* (December to February); *Arfasa* (March to May)); 18 calving years (1980 through to 1998 except 1991) were considered for the analysis of DFS. For the analysis of conception rate to first service, the eight cow breeds (genotypes) were grouped into five sire breeds (Friesian, Jersey, Simmental, Horro and Boran) and two dam breeds (Horro and Boran) categories. Besides, to simplify the analysis, the mating weight was categories into five classes (<250, 251-300, 301-350, 351-400 and >400 kg) and calving age into five classes (<4, 4-6, 6-8, 8-10 and >10 years). Then sire and dam breed, mating weight and age were considered as fixed effects. Because of the very low number of observations the calving year 1991 was excluded from the analysis.

Results

The overall least square mean days to first service was 150.3 ± 3.41 days (Table 1). DFS was significantly (at least $P < 0.05$) affected by cow breed (genotype), calving year, cow parity, calving weight and postpartum body weight gain. The effect of age on DFS was not significant ($P > 0.05$). Boran (192.7 ± 17.55 days) and Boran x Simmental cross (200.1 ± 16.84 days) cows and first parity cows (202.0 ± 11.77 days) had significantly ($P < 0.001$) the longest DFS compared to their contemporaries. DFS ranged from 102.9 ± 30.59 days for cows that calved in 1998 to 254.3 ± 16.27 days for cows that calved in 1983. DFS was linearly related to calving weight ($b = -0.39 \pm 4.21$; $P < 0.001$) and postpartum body weight gain ($b = -0.03 \pm 2.81$; $P < 0.01$, Table 1). DFS declined at a rate of 0.39 and 0.03 days for a unit increase in calving weight and age respectively.

Conception rate to first service was analyzed as the probability of conception to first service. Accordingly, the overall predicted probability of conception to first service was 0.7 ± 0.03 and it was significantly affected by mating weight ($P < 0.01$) and age of the cow ($P < 0.001$; Table 2). The effect of sire and dam breed were not significant ($P > 0.05$). Besides, the maximum likelihood ratio was not significant indicating that the model provided good fit to the data. Conception rate ranged from 0.7 ± 0.05 for Simmental crosses to 0.6 ± 0.04 for pure Horro cows. The Boran (0.7 ± 0.03), as a dam breed, was not significantly different from Horro (0.7 ± 0.03). Heavier cows at mating (> 400 kg) had significantly ($P < 0.01$) the highest probability of conception compared to the lightest (< 250 kg) cows at mating (0.8 vs. 0.5). Cow age had significant ($P < 0.001$) and the highest probability of conception (0.8 ± 0.04) was observed for younger (<4 years) cows.

A service period of zero was observed in 69.6% of the cows indicating that the cows conceived with one service while 22.2% of the cows had very long service period (>48 days) suggesting that these cows required repeated services to conceive. About 1.5% of the service period was within a range of 1 to 17 and 25 to 35 days interval (Table 3).

Table 1. Least squares mean (± SE) days to first service (days) in indigenous and crossbred cows

Source	N	Mean ± SE
Overall mean	752	150.3 ± 3.41
Cow genotype		***
Boran	39	192.7 ± 17.55 [a]
Boran x Friesian crosses	68	178.7 ± 15.08 [ab]
Boran x Jersey crosses	57	146.3 ± 14.02 [bc]
Boran x Simmental crosses	49	200.1 ± 16.84 [a]
Horro x Friesian crosses	79	170.1 ± 11.93 [ab]
Horro	317	147.2 ± 10.56 [bc]
Horro x Jersey crosses	93	148.0 ± 15.58 [bc]
Horro x Simmental crosses	50	120.5 ± 7.20 [c]
Parity		**
1	150	202.0 ± 11.77 [a]
2	154	178.9 ± 9.96 [ab]
3	154	158.6 ± 9.73 [bc]
4	127	176.4 ± 10.78 [ab]
5	82	137.1 ± 14.08 [c]
6	85	124.7 ± 17.51 [c]
Calving year		***
1980	76	145.1 ± 12.28 [de]
1981	80	132.3 ± 11.54 [de]
1982	97	192.9 ± 10.04 [bc]
1983	35	254.3 ± 16.27 [a]
1984	33	221.8 ± 17.03 [ab]
1985	47	125.2 ± 14.36 [de]
1986	64	147.5 ± 12.48 [de]
1987	52	152.7 ± 13.96 [de]
1988	26	236.5 ± 19.65 [a]
1989	14	176.5 ± 26.67 [bcd]
1990	23	164.8 ± 21.66 [cd]
1992	25	216.9 ± 20.76 [abc]
1993	20	145.9 ± 22.98 [de]
1994	41	128.5 ± 17.76 [de]
1995	40	131.9 ± 17.78 [de]
1996	34	112.3 ± 19.06 [e]
1997	35	144.9 ± 17.80 [de]
1998	10	102.9 ± 30.59 [e]
Regression variables (covariates)		
Calving weight		-0.39 ± 4.21 ***
Age of the cow		4.91 ± 1.64 NS
Body weight gain		-0.03 ± 2.81 **

Means in a column within a group followed by different superscript vary significantly (*** = P < 0.001, ** = P < 0.01 and NS (Not Significant) = P > 0.05)

Table 2. Predicted probability of conception to first service

Effect	N	Probability of conception to first service (± SE)
Intercept	864	0.7 ± 0.02
Sire breed		NS
Friesian crosses	146	0.7 ± 0.04
Jersey crosses	151	0.7 ± 0.04
Simmental crosses	97	0.7 ± 0.05
Boran	91	0.7 ± 0.05
Horro	379	0.6 ± 0.04
Dam breed		NS
Boran	263	0.7 ± 0.03
Horro	601	0.7 ± 0.03
Mating weight group		**
1. <250 (224 kg)	230	0.5 ± 0.03
2. 251-300 (279 kg)	236	0.7 ± 0.04
3. 301-350 (325 kg)	223	0.7 ± 0.04
4. 351-400 (373 kg)	106	0.7 ± 0.04
5. >400 (435 kg)	65	0.8 ± 0.07
Age group		***
1. ≤ 4 (3.5 year)	186	0.8 ± 0.04
2. 4.1-6 (5.1 year)	233	0.6 ± 0.03
3. 6.1-8 (7.0 year)	226	0.7 ± 0.03
4. 8.1-10 (8.8 year)	125	0.6 ± 0.04
5. >10 (12.1 year)	94	0.7 ± 0.05

Values in parenthesis are mean values of the group

Significance level *** = P < 0.001, ** = P < 0.01 and NS (Not Significant) = P > 0.05

Table 3. Distribution of service periods to different inter-service interval categories

Category (days)	No cows	Percent
0	624	69.6
1-17	8	0.9
18-24	29	3.2
25-35	5	0.6
36-48	31	3.5
≥48	199	22.2
Total	896	100

Discussion

First breeding after calving depends mainly on the breeding management of the farm. Any farm has a Voluntary Waiting Period (VWP) where the breeder retains a cow seen in heat unbred to allow sufficient time to recover from parturition stresses. Unless heat detection is poor, the average days to first breeding should be within 30 days after the VWP (Radostitis *et al.*, 1994). The VWP at Bako Agricultural Research Center ranges from 45 to 60 days, hence, the DFS**,** according to Radostities *et al.* (1994), had to be within 75 to 90 days. However, the DFS recorded in this study is very long, which could be resulted from poor heat detection, poor breeding and due to the influences of genetic (breed) and non-genetic (parity, calving year, calving age and weight, body weight gain) factors. Heritability of days to first breeding is generally low (Batra *et al.*, 1986) which suggests that improvement of the DFS is mainly possible through the improvement of non-genetic factors.

Days to first service is influenced by the postpartum anoestrus period. According to previous work by Gebregziabher Gebreyohannes *et al*. (2004) the postpartum anoestrus interval for the same herd was 79.4 days. This has contributed to the prolonged. Long DFS could also be due to cessation of estrus activity after a cow manifested its first postpartum estrus or cows observed in heat were not bred due to different reasons. Dawuda *et al.* (1988) observed that Bunaji cows stopped cycling and become anoestrus after three to four cycles which they partly attributed to seasonal fluctuations in nutrition. According to Gebregziabher Gebreyohannes and Mulugeta Kebede (1996) 64% of the observed heat in Horro and crossbred cows was not bred due to reasons associated with the bull, the cow or other external factors. This might contribute positively to the long DFS.

The breed and parity differences in DFS observed in this study are in agreement to the work of Garcia *et al.* (1990). Garcia *et al*. (1990) reported
176.8 ± 19 and 260.6 ± 26.7 days for European x Zebu crossbreds kept at the experimental and private farms and older cows (at least four calving) had about 100 days shorter DFS compared to first calvers. Differences among calving years could be associated to variations in breeding management and to variations in rainfall, humidity and temperature, which directly or indirectly affected the trait.

Calving body weight and postpartum body weight gain were inversely related to DFS. Heavier cows at calving and cows that gained weight during the first three months postpartum are in a positive energy balance which enabled them to return to normal estrus cycle and breeding within shorter period of time compared to lighter cows at calving and those cows that lost weight during this period.

The effect of sire and dam breed on the probability of conception to first service was not significant. This contradicts with the reports of Franke (1980) and Garcia *et al*. (1990). Franke (1980) reported significantly lower fertility for Brahmans and Brahman derived breeds than *Bos taurus* breeds. Similarly, Garcia *et al.* (1990) reported significant effect of parity and year on conception rate to first service.

The effect of mating weight on conception rate obtained in this study (Table 2) is consistent with the findings of Buck *et al.* (1976) and Sawyer *et al.* (1993). Buck *et al.* (1976) reported that cows weighing less than 300 kg at the beginning of mating season achieved a 50% calving and this increased to 85% as the body weight increased to 430 kg. Sawyer *et al.* (1993), however, reported high pregnancy rate of 93 to 94% for cows with the highest average live weight at conception in nulliparous heifers of both Angus and Angus Friesian heifers. Mating weight is a function of the feeding system before the mating season. For instance, Little *et al.* (1991) reported that N'Dama cows supplemented with ground nut cake reduced their body weight loss and this resulted in doubling the conception rate within 12 months of calving from 36 to 64% (Little *et al*., 1991). Peters (1984) also reported a positive relationship between body weight and fertility. Mackinnon *et al.* (1989), however, reported a curvilinear response in fertility to increased live weight at mating with the response tend to be greatest in two-year-old heifers, in which maximum calving rates were achieved when the mating weight exceeded approximately 325 kg. Comparisons of the different weight groups showed that the change in conception rate increased drastically from the first (0.5 ± 0.03) to the second (0.7 ± 0.04) mating weight group, while the change from the second to third (0.7 ± 0.04) and fourth (0.7 ± 0.04) mating weight categories was not big. Therefore, the advantage in conception rate to be obtained through feeding the cows for higher mating weight need to be looked from the economic point of view. The opportunity cost of getting heavier body weight has to be weighed to the advantage in conception rate expected. Therefore, the mating weight 251 to 300 kg could be recommended as a target weight for higher probability of conception.

The effect of age on probability of conception to first service was significant (Table 2). Earlier reports (Reynolds *et al.,* 1979; Hillers *et al.,* 1984; Azzam *et al.,* 1989; Amsalu Sisay *et al.*, 1998) also indicated similar results. The reduced probability of conception to first service with increased age could partly be attributed to the exposure of the cows to different reproductive diseases. Similarly, Amsalu Sisay *et al.* (1998) reported a 9.2% higher pregnancy rate to first insemination/service in heifers than cows.

A service period of zero was observed in 69.6% of the cows indicating that these cows required one service to conceive. Since the highest numbers of the cows had a service period of zero, it was not possible to subject the remaining data to analysis of variance so that see the effect of the different factors. However, service period is related to the number of services required per conception, conception rate to first or subsequent services, inter-estrus and inter-service intervals and heat detection efficiency. Any thing that affects one or a combination of these traits can affect service period. Breeds vary in the number of services per conception (Azage Tegegn *et al.*, 1981; Eneyew Negussie *et al.*, 1998), estrus cycle length (Alberro, 1983; Mekonnen Haile-Mariam and Goshu Mekonnen, 1996; Yoseph Mekasha *et al.*, 2000), fertility to first service (Mackinnon *et al.*, 1989) and duration of estrus (Mattoni *et al.*, 1988). Breed difference also demonstrate a genetic component to fertility (Mackinnon *et al.*, 1989), for instance the problem of low fertility of Brahmans can be partly improved by crossing with *Bos taurus* breeds. An influence of parity on the length of the service period was also reported. However, the effect of parity on service period could be related to its effect on number of services per conception (Eneyew Negussie *et al.*, 1998), conception rate (Hillers *et al.*, 1984; Ron *et al.*, 1984; Garcia *et al.*, 1990) and estrus cycle (Mukassa-Mugerwa *et al.*, 1991) thereby influencing the service period. Heifers do not conceive as readily as other cows and they require more services per conception than cows in the later parities (Eneyew Negussie *et al.*, 1998). The cause of the age related difference in cows in the first parity may be due to delayed resumption of ovarian activity after calving as a result of the longer resting period needed to recover from parturition stress and to cope-up with the increased demand for growth and lactation (Eneyew Negussie *et al.*, 1998). Moreover, the length of the service period could also be affected due to embryonic mortality (Kummerfield *et al.*, 1978). Hillers *et al.* (1984) and Azzam *et al.* (1989) reported poor fertility and conception in older than younger cows.

Conclusion

DFS was found very long which could be the result of poor heat detection efficiency, poor breeding management and other genetic and non-genetic factors. Cow breed, parity, calving year, calving weight and postpartum body weight gain had an influence on DFS.

Service period also contributed to the prolonged days open. In this study, 69.6% of the cows conceived with one service and their corresponding service period was zero indicating that service period contributed little to the long days open of the herd.

Conception rate to first service could be improved through an improvement in calving weight and culling of aged cows and repeated breeders. Furthermore, the fertility of the breeding bull need to be studied since its contribution to wards conception is equally important as that of the cow. Among the mating weight groups, mating weight of 251 to 300 kg (average 279) resulted in high conception rate. Thus, attaining this target mating weight postpartum through proper feeding management could contribute to shorter high conception rate.

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