# Postpartum Anoestrus Interval and Estrus Activity in Relation to Postpartum Body Weight Dynamics in Indigenous and Crossbred Cows at Bako, Ethiopia♣

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## Abstract

Postpartum anoestrus interval (PPAI) and estrus activity measured as probability of getting a cow in estrus within 42 (PPAI42), 63 (PPAI63) and 84 (PPAI84) days postpartum in indigenous and crossbred cows were studied using data from Bako Agricultural Research Center. PPAI was analyzed using the General Linear Model, while PPAI42, PPAI63 and PPAI84 were analyzed using the Categorical Model Procedure of the Statistical Analysis System and LOGMLVAR computer program. The results of the analysis indicated an overall least square mean PPAI of 79.4 ± 1.99 days. Comparisons of the different genotypes, parities, calving seasons and years indicated that Boran x Simmental cross cows (136.9 ± 10.86 day), cows in the first parity (118.3 ± 7.57 days), cows that calved during March to May (105.3 ± 5.78 days) and those that calved in 1984 (128.3 ± 11.01 days) had significantly ($P < 0.001$) the longest PPAI. PPAI was significantly ($P < 0.001$) related to calving weight ($b = -0.53 \pm 0.14$) and body weight gain from calving to three months ($b= -0.04 \pm 0.02$). The overall mean predicted probability for PPAI42, PPAI63 and PPAI84 were 0.33 ± 0.02, 0.53 ± 0.02 and 0.68 ± 0.02, respectively. Among the sire breeds, the Horro and Jersey had significantly (at least $P < 0.05$) the highest PPAI42, PPAI63 and PPAI84 while as a dam breed, the Horro had significantly (at least $P < 0.01$) higher PPAI42, PPAI63 and PPAI84 than Boran cows. Cows in the later parities (5 to 6) had significantly ($P < 0.05$) highest PPAI42, PPAI63 and PPAI84 compared to cows in earlier parities (1-4). Calving weight showed a significant ($P < 0.001$) effect on PPAI42, PPAI63 and PPAI84 and all those traits increased with increase in calving weight. This study indicated the importance of calving weight and postpartum body weight gain in affecting PPAI and estrus activity. Thus, improvement in these traits could be achieved through improvement of the calving weight and postpartum body weight gain.

Keywords: Postpartum anoestrus, calving body weight, crossbred cows, estrus activity, indigenous breeds

## Introduction

Postpartum rebreeding of a cow depends on recovery from the pregnant state, escape from suckling-induced inhibition of gonadotropin secretion, initiation of follicular development, occurrence of estrous with ovulation and adequate luteal lifespan for maternal recognition of pregnancy (Randel, 1990). Anoestrous is a major problem in the tropics and subtropics where inadequate nutrition, high ambient temperature, high parasite burdens and diseases exacerbate the problem. Low body weight and poor body condition compounded with lactation stress, season, age, parity, suckling and management can further extend the postpartum anoestrous period (Wells *et al*., 1986; Mukasa-Mugerwa, 1989). Anoestrous may be caused by lack of cyclic ovarian activity or failure to show and/or detect the external signs of heat. Unobserved heat is related to inefficient heat detection

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and lack of visible external signs of heat. In *Bos taurus* breeds 59-90% of the actual heat can be detected by herdsmen, while in zebu (*Bos indicus*) the relatively short estrous duration and poor manifestation of secondary signs of heat make heat detection more difficult (Vale-Filho *et al*., 1986). Mukasa-Mugerwa *et al.* (1991) observed that ovarian cyclicity resumed 33 days earlier than externally detected; however, due to silent heat or missed unobserved, 35.7% of the heats were not detected. Postpartum anoestrus interval (PPAI) and estrus activity are the major factors that determine breeding thereby calving interval. They are affected by several genetic and non-genetic factors. This study aimed at evaluating the PPAI and estrus activity of indigenous and crossbred cows in relation to calving weight and postpartum body weight gain.

## Materials and methods

The study was conducted using data from Bako Agricultural Research Center of the Oromia Agricultural Research Institute. Detailed description of the study site, herd management and breeding activities was presented earlier (Gebregziabher *et al.,* 2003). Data from pure Boran and Horro and their $F_1$ crosses with Jersey, Friesian and Simmental exotic sire breeds were considered for the study. Postpartum anoestrous interval (PPAI; the period between calving and the first visible postpartum estrus) and postpartum estrus activity (measured as the probability of getting a cow in estrus within a specified period) were considered in this study. PPAI was analyzed using the General Linear Model of the Statistical Analysis System (SAS, 1999). While estrus activity was assessed within 42 (PPAI42), 63 (PPAI63) and 84 (PPAI84) days postpartum. It was coded as zero (success; if the cow comes in heat within the specified period) or one (failure; if the cow didn't come in heat within the specified period) for the purpose of analysis. These traits were analyzed using the CATMOD (Categorical Model) Procedure of the Statistical Analysis System (SAS, 1999) and LOGMLVAR (Rege, 1997). Maximum Likelihood analysis of variance and parameter estimates for each level of the class variables were obtained from CATMOD analysis and the predicted probabilities and standard errors for each predicted probability of each level of all class variables were obtained from the parameter estimates using the LOGMLVAR.

The General Linear Model used to analyze PPAI included cow genotype, sire breed, dam breed, parity, calving season, calving year and calving weight. Eight genotypes (Horro, Boran, Horro x Jersey, Horro x Friesian, Horro x Simmental, Boran x Friesian, Boran x Jersey, and Boran Simmental); five sire breeds (Jersey for Boran x Jersey and Horro x Jersey; Simmental for Boran x Simmental and Horro x Simmental; Friesian for Boran x Friesian and Horro x Friesian; Boran for pure Boran and Horro for pure Horro); two dam breeds (Boran and Horro; Boran as dam breed for pure Boran and its crosses with Friesian, Jersey and Simmental; and Horro for pure Horro and its crosses with Friesian, Jersey and Simmental); six parities (1 to 6, with the sixth parity including parities six and above pooled together); four calving season categories based on the center's metrological data: *Gana* (main rainy season) from June to August, *Birra* from September to November, *Bona* (dry season) from December to February and *Arfasa* (beginning of the rainy season) from March to May; 19 calving years (1980 to 1998) and five calving weight categories (200-250, 251-300, 301-350, 351-400 and >400 kg) were considered as fixed effects. Besides, body weight gain from calving to three months, calving age and calving body weight were also considered as covariate. Postpartum body weight gain from calving to three months was categorized into seven groups ($\leq$ –200; -199 to –100; -99 to 0; 1 to 99; 100 to 199; 200 to 299; $\geq$300 g/d) to see the trend in PPAI with body weight gain.

## Results

Least squares mean PPAI values are presented in Table 1. The overall mean PPAI was 79.4 ± 2.15 days. Boran x Simmental (136.9 ± 10.86 days) crosses had significantly ($P < 0.05$) the longest PPAI while the Horro (43.1 ± 4.65 days) cows had the shortest PPAI compared to the other breeds. Cows in the first (118.3 ± 7.57 days) and second (111.9 ± 6.42 days) parities had significantly ($P < 0.05$) longer PPAI compared to the later parities (3-6). The effects of calving season ($P < 0.01$) and calving year ($P < 0.001$) on PPAI were significant. Cows that calved in Bona (December – February) returned to estrus earlier (86.7 ± 5.81 days) than cows that calved in the other three seasons. Besides, PPAI was significantly ($P < 0.01$) different across calving years the longest being observed for cows that calved in 1984 (128.3 ± 11.01 days). PPAI was linearly related to calving weight ($b = -0.53 \pm 0.14$; $P < 0.001$) and age of the cow at calving ($b = 2.18 \pm 1.11$; $P > 0.05$) but this latter effect was not significant. Cows that gained higher body weight from calving to three months had shorter PPAI ($b = -0.04 \pm 0.02$; $P < 0.001$) compared to cows that lost weight during this period.

The overall predicted probability for PPAI42, PPAI63 and PPAI84 were 0.31± 0.02, 0.53 ± 0.02 and 0.68 ± 0.02, respectively (Table 2). Among the sire breeds, the Horro and Jersey had significantly (at least $P < 0.05$) the highest PPAI42, PPAI63 and PPAI84 compared with the other sire breeds. Besides, as a dam breed, the Horro had significantly (at least $P < 0.01$) higher values of these three traits compared to Boran cows. Cows in the later parities (5 to 6) had significantly ($P < 0.05$) highest PPAI42, PPAI63 and PPAI84. Calving weight showed a significant effect ($P < 0.001$) on PPAI42, PPAI63 and PPAI84. All these traits tend to increase with increase in calving weight.

## Discussion

The PPAI obtained and the breed variations observed in this study are comparable to previous reports (Alberro, 1983; Mukasa-Mugerwa and Azage, 1989; Tesfu, 1990; Pleasants and McCall, 1993; Sawyer *et al*., 1993). Wright *et al*. (1987), however, reported no breed variation in PPAI. Breeds vary in duration and intensity of manifestation of secondary signs of oestrus (Plasse *et al*., 1970; Vale-Filho *et al*., 1986; Mattoni *et al*., 1988) and milk production (Peters, 1984). Oestrus in zebu cows is of shorter duration than *Bos taurus* which makes heat detection in zebu cows more difficult. Vale-Filho *et al.* (1986) conclude that 59-90% of the actual heat in *Bos taurus* cows can be detected by the herdsman. Peters (1984) reported associations between milk yield and reduced fertility and correlation between time to first oestrus or ovulation and milk yield. In dairy cows, energy balance is maximally negative until peak milk yield and then begins returning towards zero, with the magnitude and duration of negative energy balance being quite variable. On average, ovulation and the initiation of the first normal luteal phase occur approximately 10 days after energy balance begun returning towards zero (Butler *et al*., 1981), which suggests that energy balance during the first 20 days of lactation is important in determining the onset of ovarian activity following parturition. Bulman and Lamming (1978), however, found no relationship but great tendency for high yielding cows to stop cycling spontaneously. In a study made in Ethiopia, Sendros *et al*. (1987a,b) and Alemu (1988) reported heavier weight and higher milk yield for Simmental zebu crosses compared to pure zebu (Barca, Boran and Horro) and their Friesian and Jersey crosses. Thus, this might have contributed to the longer PPAI obtained for Boran x Simmental cross cows. Besides, due to their relatively lower energy requirement for the different body functions the smaller sized and relatively low producing Horro cows were in an advantage to fulfil their nutrient needs under the existing grazing conditions of Bako compared to the high yielding and heavier Boran x Simmental crossbred cows. This resulted in shorter PPAI and higher PPAI42, PPAI63 and PPAI84 for Horro cows compared to the other genotypes.

The differences among cows in different parities observed in this study is consistent with previous reports (Lamming *et al*., 1981; Pandey *et al*., 1986; Agyemang *et al*., 1991; Enyew *et al*., 1998) but not with the report of Mekonnen and Goshu (1987). Hopkins (1986) reported that first calf beef and dairy heifers generally had a prolonged PPAI because of the nutrient demand for continued growth and lactation, and because of the reduced ability to withstand the stresses of parturition and lactation. On the other hand, older cows gain body weight and condition quickly after calving than younger cows (Mukasa-Mugerwa, 1989). Thus, this could contribute to the differences among parities and to the longest PPAI for cows in earlier parities compared to later parities. Younger cows require nutrients for both growth and milk production and the feeding management should fulfill the nutrient needs for both body functions. However, this could not be achieved from tropical natural pastures and crop by products that are low in crude protein and energy contents. Lactating cows are unable to meet their nutritional requirements from these types of feeds and lose weight and condition during lactation, which might prolong the lactation anoestrus period in younger cows (Ward, 1968).

The positive relationship between age and PPAI obtained in this study is not in agreement with other reports (Dawuda *et al.,* 1988; Pleasants and McCall, 1993). Dawuda *et al*. (1988) reported that Bunaji cows that had more than two calvings (over six- years-old) had shorter PPAI than those with one or two calvings (three to six-years-old). Similarly, Pleasants and McCall (1993) reported longer PPAI for two-year-old Angus and Hereford Friesian cows than older cows. Heavier cows at calving and those that gained relatively higher weight during the first three months postpartum had shorter PPAI than their contemporaries (Table 1). This is consistent with previous reports (Bellows and Short, 1978; Stevenson and Britt, 1980; Butler *et al*., 1981; Patil and Deshpande, 1981; Peters and Riley, 1982). Cohen *et al.* (1980), however, found direct relationship between calving weight and PPAI. Calving weight and body weight gain are functions of the feeding level before and after calving. Energy restriction during the late antepartum period results in lower calving weight. This extends the PPAI and decreases the likelihood of a the cows exhibiting estrus early in a definite breeding season (Dziuk and Bellows, 1983). Traditionally raised zebu cattle in the Ethiopian highlands (Mukasa-Mugerwa, 1989) and N'Dama (Gyawu, 1988) cows required eight to nine months, respectively, to start cycling after they stopped lactating to attain a body weight and condition that allowed them to re-conceive successfully. Studies that used body weight as an index of nutritional status (Peters and Riley, 1982) found negative correlation between body weight at calving and the length of the acyclic period in beef cows.

Figures 1 and 2 presented a change in mean calving weight from 216 to 432 kg reduced PPAI by 48 days, while an increase in gain from –473 g/d (loss) to 536 g/d (gain) reduced PPAI by 18 days. This indicates the relative importance of calving weight and postpartum gain in reducing the PPAI. Cows with an average body weight of 216 kg gained higher weight (164 g/d) during the postpartum period. However, as the calving weight increased to 327 kg the body weight gain reduced to 17 g/d, while an increase of calving weight from 327 to 432 kg increased body weight gain from 17 to 89 g/d. Although it is possible to reduce PPAI by further increasing the calving weight to 432 that increase may not be economically feasible. Thus a calving weight of 327 kg (range 301 to 350 kg) could be used as a target calving weight during antepartum feeding of such cows for early onset of visible estrus. Cows that lost higher weight were those cows, which were heavier at calving, thus had longer PPAI (Figure 2). As the gain increased, the PPAI was reduced. For cows with a mean calving weight of 296 and 304 kg maintaining the calving weight during the first three months postpartum could result in a relatively shorter PPAI.

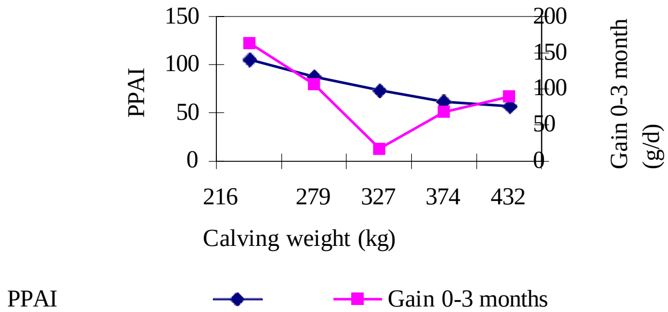


Figure 1 Relationships of calving weight with body weight gain and PPAI during the first three months postpartum and PPAI

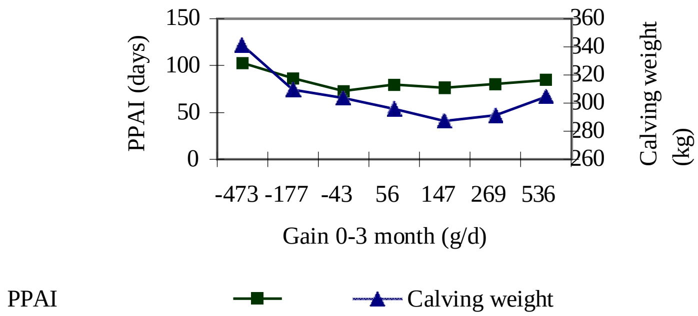


Figure 2 Relationships of body weight gain with calving weight and PPAI during the first three months postpartum

## Conclusion

PPAI obtained in this study is very long. Genotype of dam and non-genetic factors such as parity, age, body weight and body weight gain significantly affected PPAI. An improvement in PPAI and estrus activity was observed for cows that had heavier calving weight and for cows that gained higher weight during early postpartum period. Hence, significant gains can b achieved in these traits through improvement of calving weight and postpartum body weight gain.

Table 1. Least square mean postpartum anoestrus interval (days)

| Source | N | PPAI ± S.E |
|---|---|---|
| Overall mean | 752 | 79.4 ± 2.15 |
| Cow genotype | | *** |
| Boran | 39 | 120.4 ± 11.34 [ab] |
| Boran x Friesian | 68 | 129.0 ± 9.70 [a] |
| Boran x Jersey | 57 | 86.5 ± 9.08 [c] |
| Boran x Simmental | 49 | 136.9 ± 10.86 [a] |
| Horro x Friesian | 79 | 102.6 ± 7.69 [bc] |
| Horro | 317 | 43.1 ± 4.65 [d] |
| Horro x Jersey | 93 | 56.7 ± 6.83 [bc] |
| Horro x Simmental | 50 | 92.9 ± 10.01 [d] |
| Parity | | * |
| 1 | 150 | 118.3 ± 7.57 [a] |
| 2 | 154 | 111.9 ± 6.42 [a] |
| 3 | 154 | 94.6 ± 6.26 [b] |
| 4 | 127 | 86.1 ± 6.69 [b] |
| 5 | 82 | 83.0 ± 9.07 [b] |
| 6 | 85 | 82.2 ± 11.27 [b] |
| Calving season | | * |
| Gana (June – August) | 153 | 95.9 ± 6.39 [ab] |
| Birra (September – November) | 168 | 96.1 ± 6.25 [ab] |
| Bona (December – February) | 187 | 86.7 ± 5.81 [b] |
| Arfasa (March – May) | 244 | 105.3 ± 5.78 [a] |
| Calving year | | *** |
| 1980 | 76 | 86.5 ± 7.98[bc] |
| 1981 | 80 | 94.7 ± 7.43[bc] |
| 1982 | 97 | 122.6 ± 6.51[a] |
| 1983 | 35 | 112.8 ± 10.52[ab] |
| 1984 | 33 | 128.3 ± 11.01[a] |
| 1985 | 47 | 81.9 ± 9.25[bc] |
| 1986 | 64 | 74.8 ± 8.09[c] |
| 1987 | 52 | 85.3 ± 9.04[bc] |
| 1988 | 26 | 79.8 ± 12.65[bc] |
| 1989 | 14 | 117.1 ± 17.19[ab] |
| 1990 | 23 | 83.5 ± 13.92[bc] |
| 1992 | 25 | 99.8 ± 13.37[abc] |
| 1993 | 20 | 109.6 ± 14.94[ab] |
| 1994 | 41 | 84.9 ± 11.43[bc] |
| 1995 | 40 | 103.0 ± 11.43[ab] |
| 1996 | 34 | 87.2 ± 12.29[bc] |
| 1997 | 35 | 101.6 ± 11.49[ab] |
| 1998 | 10 | 75.0 ± 19.72[bc] |
| Regression variables | | |
| Calving weight | | -0.53 ± 0.14 *** |
| Calving age | | 2.18 ± 1.11 ns |
| Gain 0-3 month postpartum | | -0.04 ± 0.02 *** |

Means in a column within a group with different superscripts vary significantly at $p < 0.05$.

*** = $P < 0.001$, * = $P < 0.05$, ns = not significant.

Table 2. Predicted probabilities (±SE) for oestrus activity within 42 (PPAI42), 63 (PPAI63) and 84 (PPAI84) days postpartum

| **Effect** | **N** | **PPAI42** | **PPAI63** | **PPAI84** |
|---|---|---|---|---|
| Intercept | 975 | 0.31 ± 0.02 | 0.53 ± 0.02 | 0.68 ± 0.02 |
| Dam breed | | *** | *** | *** |
| Boran | 302 | 0.22 ± 0.02 | 0.41 ± 0.03 | 0.59 ± 0.03 |
| Horro | 673 | 0.43 ± 0.03 | 0.65 ± 0.03 | 0.75 ± 0.03 |
| Sire breed | | *** | *** | *** |
| Friesian crosses | 170 | 0.21 ± 0.03 | 0.41 ± 0.04 | 0.57 ± 0.04 |
| Jersey crosses | 168 | 0.40 ± 0.04 | 0.65 ±0.04 | 0.82 ± 0.03 |
| Simmental crosses | 117 | 0.30 ± 0.04 | 0.61 ± 0.05 | 0.55 ± 0.05 |
| Boran | 103 | 0.24 ± 0.05 | 0.46 ± 0.06 | 0.57 ± 0.06 |
| Horro | 417 | 0.42 ± 0.04 | 0.53 ± 0.04 | 0.82 ± 0.03 |
| Parity | | * | * | * |
| 1 | 212 | 0.25 ± 0.04 | 0.44 ± 0.04 | 0.59 ± 0.04 |
| 2 | 184 | 0.22 ± 0.03 | 0.44 ± 0.04 | 0.58 ± 0.04 |
| 3 | 188 | 0.31 ± 0.03 | 0.53 ± 0.08 | 0.65 ± 0.04 |
| 4 | 167 | 0.37 ± 0.04 | 0.55 ± 0.042 | 0.71 ± 0.04 |
| 5 | 111 | 0.38 ± 0.04 | 0.59 ± 0.05 | 0.78 ± 0.04 |
| 6 | 113 | 0.36 ± 0.04 | 0.64 ± 0.04 | 0.74 ± 0.04 |
| Calving weight category | | *** | *** | *** |
| <250 (219 kg) | 213 | 0.13 ± 0.03 | 0.24 ± 0.04 | 0.38 ± 0.05 |
| 250 –300 (279 kg) | 303 | 0.25 ± 0.03 | 0.37 ± 0.03 | 0.51 ± 0.04 |
| 301 – 350 (326 kg) | 263 | 0.35 ± 0.03 | 0.54 ± 0.03 | 0.69 ± 0.03 |
| 351 – 400 (374 kg) | 127 | 0.42 ± 0.05 | 0.72 ± 0.04 | 0.83 ± 0.03 |
| > 401 (432 kg) | 69 | 0.55 ± 0.07 | 0.78 ± 0.05 | 0.86 ± 0.04 |
| Intercept | | 84.5*** | 2.4 NS | 73.4*** |
| Likelihood ratio | | 178.9 NS | 156.6 NS | 181.3 NS |

Figures in parenthesis are mean calving weight of the group; Significance levels:

*** = P < 0.001, * = P < 0.05

Note: the Likelihood ratio in all cases is non-significant indicating that the model provided a good fit to the data.

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