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Factor Affecting Calving Interval of Dairy Cows in Central Highlands of Ethiopia

*Amare Migibe Cherkoes and Dr. Zeleke Mekuria
* Wolaita Sodo University, college of agriculture, animal and range sciences department
Po.Box: 138, Wolaita Sodo Ethiopia

Abstract
The study was conducted to evaluate the factor affecting calving interval of dairy cows in central highlands of Ethiopia. The retrospective study was conducted on 682 cows (crossbred & local cows). Statistical analysis performed using the GLM procedure of SAS 2001, showed significant differences in calving interval value within different factors. The result of analysis of variance showed variations of breed, parity, management systems and AI technicians had a significant ($p < 0.05$) effect on length calving interval. On the other hand, year of calving and calving season had no significant ($p > 0.05$) effect on the length of calving interval The overall mean of calving interval obtained in this study was 568.50 days. The result also showed that calving interval of local breeds (611.92+2.0) of cows was greater than crossbreed cows (525.08+1.7). Furthermore, the result showed that the length calving interval of heifers (648.61+8.3) is higher than first (560.08+3.6), second (542.01+3.3) and third (523.31+2.6) parity of cows. In addition, cows managed under extensive management system (592.54+3.0) were higher number of service per conception than intensive management system (544.47+2.2). Generally, it can be inferred that length calving interval decreased by better feeding, heat detection or time of insemination and management of cows is essential.
Keywords: *Dairy cows;* calving interval

Introduction

Ethiopia's estimated livestock population is often said to be the largest in Africa. The livestock sector contributes about 12% of national GDP, 26% of agricultural GDP (CSA, 2009). Although the country has high population of cattle, their productive and reproductive performance is low as a result of their poor genetic capability and poor traditional management system. (FAO, 2008).

Estimates of calving intervals in Zebu cattle generally range from 12.2 to 26.6 months (Mukasa-Mugerwa 1989). The same outer explain calving interval of 26 months in traditionally raised Ethiopian highland Zebus. The lactation length for the same cattle in the same study was 239 days (8 months). Cows thus failed to conceive for more than 8 months after lactation had ceased. This may be the average period required to gain sufficient body weight and condition to start cycling and conceive again, given the limited nutritional resources of the traditional system.

Calving interval has a very low heritability. Cassell (2001) reported a heritability value of 3% for first calving interval in Holstein dairy cattle. On the other hand, Hailemariam (1994) reported a heritability value of 3.7% for Boran in Ethiopia. Nutritional conditions that vary seasonally and yearly have major effects on calving interval (Oliveira 1974; Oyedipe, 1982; Hailemariam and Kassamersha, 1994)). Calving interval is also influenced by parity. In zebu cattle, calving interval is longest in first calf heifers and older cows and shortest in cows of intermediate age (6-9 years) (Mukassa-Mugrewa 1989; Plasse et al 1972). The fertility rate of cows in central highlands of Ethiopia is low as the result long length of calving interval. Therefore, this particular study was conducted to evaluate the factor affecting calving interval of dairy cows in central highlands of Ethiopia.

Materials and Methods

Description of the Study Area

The study was conducted in two regions; Amahara and Oromiya regions of North Shoa. One district was selected (Kimbibit district) from North Shoa Zone of Oromiya region and two districts (Angolela Tara and Basona Werena districts) from North Shoa Zone of Amahara region. Kimbibit, Angolela Tara and Basona Werena districts were located at 84, 107 and 130 Km from North of Addis Ababa, respectively. All districts were agro-ecologically the same and fall under the high altitude. The altitude of the area was 3360 meters above sea level (masl). It has bimodal rainfall distribution with short and long rainy seasons covering from March to April and June to September, respectively. The inhabitants were generally farmers practicing mixed farming (Ahmed, 2006).

Sampling Design and Sample Size

A total of 682 purposively selected local and crossbreed dairy cows/heifers under AI service in all districts were included in a retrospective study. The numbers of animals fixed for retrospective study were based on breed type, parity of cows, season of insemination, year of insemination, management systems and inseminator category that contained full of information and the practice of AI activity in the recorded data. The total number of local and crossbred cows/heifers for retrospective study is presented in Table 1.

Table: - 1. The number cows/ heifers under retrospective study

Breed groups		Numbers
Crossbred	Heifers	22
	Cows	416
Local breeds	Heifers	10
	Cows	234
Total		**682**

Data Collection

Data was obtained from past six years records; from AI certificates and from inseminator's recording book. Data on the date of insemination, date of first service and subsequent services, breed of AI bull and cows/heifers, parity number, year of insemination, season of insemination, observed heat signs and the time of insemination were collected and analyzed.

Data Analysis

The data was analysed using the GLM procedure of SAS (2001). Year of calving, season of calving, parity, breed, management and AI technician were taken as fixed effects. The General Liner Model (SAS, 2001) was used to run ANOVA. Tukey test was used to determine any significant difference between the means because it was better to do unbalanced data and more efficient than other test of mean comparison method. The model for retrospective data analysis was used for number of service per conception of local and crossbred cows presented below;

$Y_{cdijkzx} = \mu + Y_c + S_i + P_j + M_k + B_x + I_z + + e_{cdijkzx}$

Where:

$Y_{cdijkzx}$ = Efficiency of number of service per conception of cows/heifers

μ = over all mean

Y_c = Fixed effect of c^{th} year (c =1, 2, 3, 4, 5, 6).

S_i = Fixed effect of i^{th} season (i=1, 2, 3, 4).

P_j = Fixed effect of j^{th} parity (j = 0, 1, 2, 3).

M_k = Fixed effect of k^{th} for cattle rearing systems (extensive vs. intensive)

B_x = Fixed effect of x^{th} breed cows (crossbred vs. local breeds)

I_z = Fixed effect of z^{th} inseminators (z = 1, 2, 3, 4, 5)

e_{cijzkz} = random error associated with cdijkczx observation

Result and discussion

The result of analysis of variance showed that the variation of breed, parity, management systems, year of calving and AI technicians had significant influence on calving intervals (Table 2).

The overall mean of calving interval obtained in this study was 568.50 days (**Table 3).** This figure is higher than the report of various literatures; 500 ± 13.6 days for zebu cows in pastoral herds in a semi-arid area of Tanzania (Kanuya 2005); 453±45 day for dairy cattle under smallholder management system in North-eastern Amhara Region, Ethiopia (Solomon et al 2009), 445±90.8 days for Holstein Friesian dairy cows in Ethiopia (Tadesse et al 2010), 386.7 ± 6.0 days for indigenous and crossbred cattle at Asella livestock farm, Arsi, Ethiopia (Negussie et al 2011) and 372.8±5.9 days for crossbred dairy cows under smallholder condition in Ethiopia (Hunduma 2012). However, the current result is close to 552 days for crossbred dairy cows in different production systems in the Central Highlands of Ethiopia (Shiferaw et al 2003). This variation may be attributed to the fact that the above mentioned previous studies were all conducted in government farms, urban area and research centre dairy farms where cows are kept under better feeding and management conditions.

Table: 2. Analysis of variance for calving interval

Source of variation	DF	CI Mean Squares	F-Value	P-value
Breed	1	1053968.96	707.96	<.0001
Management	1	341131.34	229.14	<.0001
Party	3	148723.593	99.90	<.0001
Season. C	2	1407.073	0.95	0.3891
Year. C	5	2467.362	1.66	0.1428
AIT	4	18448.46	12.39	<.0001

The difference observed among breed groups with respect to the length of calving interval was statically significant ($p < 0.0001$) (Table 2). The significant effect of breed of cows on CI in this study is in agreement with the finding of Negussie et al (2011) and Asimwe and Kifaro (2007). In contrast, absence of significant effect between breed of cows with the report of Solomon et al (2009) and Ahmed et al (2007).

The observed CI (611.92+2.0) for indigenous cows in this study is far longer than 435 days for Boran cattle in Ethiopia (Haile et al 2009) and 410.7 ± 9.3 days for Arsi cattle in Ethiopia (Negussie et al 2011). On the other hand, the CI found for crossbred dairy cows (525.08+1.7) in the present study was longer than 480 days for smallholder dairy production system in Bukoba district in Tanzania (Asimwe and Kifaro 2007), 516 days for smallholder crossbred dairy cattle in central highlands of Ethiopia (Lobago et al 2007), 412 days for crossbred dairy cattle under smallholder conditions in and around Zeway, Ethiopia (Yifat 2009) and 445±90.8 days for Holstein Friesian dairy cows in Ethiopia (Tadesse et al 2010). However, the mean values of CI for crossbred dairy cows were better than 534 days for crossbred dairy cows in eastern lowlands of Ethiopia (Emebet and Zeleke 2007). This longer CI is mainly attributed to the result of longer CFSI and ISI obtained which could be related to environmental factors, mismanagement practices like poor housing, poor nutrition or failure to detect heat by the farmer and absence of AI service.

The reason for difference in CI between indigenous and crossbred cows in this study could be due to the variations of management practices (feeding, heat detections and housing) among breed (indigenous and crossbred) cows and farmers give special attention to crossbred cows. Moreover, the shorter CI for crossbred cows related to the superiority of F_1 crosses over indigenous cows could be due to heterosis exhibited by the F_1 crosses and the additive genetic effect from the exotic blood that have improved reproductive performance traits of crossbred cows (Negussie 2011). The postpartum anestrus interval for traditionally raised Ethiopian highland Zebus cattle usually exceeds 8 months and most breeding cows do not start ovarian cyclic activity before weaning their calves at 8 months of age (Azage 1989; Mukasa-Mugerwa and Azage 1989). Cows thus failed to conceive for more than 8 months after lactation had ceased (Mukasa-Mugerwa 1989). This may be the average period required to gain sufficient body weight and condition to start cycling and conceive again, given the limited nutritional resources of the traditional system

Parity had significant (p < 0.0001) effect on the length of calving interval (Table 2). The significant effect of parity observed in the present study agrees with the various reports (Mwatawala and Kifaro 2009; Fekadu *et al.,* 2011; Negussie et al 2011). On the other hand, the significant effect of parity on the length of calving interval was refuted by Maarof et al (1987) and Agyemang and Nkhonjera (1990).

The least squares means value of parity effect on the length of calving interval decreased linearly as the age of the cow increased up to the third parity (Table 3). This means heifers and first parity cows have longer CI than 2nd and 3rd parity cows. The same result was observed with artificially and naturally bred Boran heifers and cows under ranch conditions in Tanzania by Mwatawala and Kifaro (2009) where there was a decrease the length of CI with increase in parturition number up to 4th parity and then increased considerably in subsequent parities. The causes of these parity-related differences may be lactation stress in young growing cows in their early parities and the ability of the advanced parity cows to gain body weight and condition quickly after calving. The prolonged CI for first culver has been reported to be physiologically necessary to allow animals to replenish their fat reserves depleted during lactation and this allows them to put on weight prior to the next calving (Negussie et al 2011).

Table: 3. Least squares mean calving interval

Factors	N	CI (Days+SE)	Factors	N	CI (Days+SE)
Breed		***	**Year of calving**		**NS**
Crossbreds	438	525.08+1.7a	2006	59	570.96+6.0
Local breeds	244	611.92+2.0b	2007	125	571.45+3.8
Parity		***	2008	124	577.47+5.1
Heifers	32	648.61+8.3a	2009	165	567.16+3.9
First	187	560.08+3.6b	2010	107	560.37+4.1
Second	181	542.01+3.3c	2011	102	563.60+4.8
Third	282	523.31+2.6cd	**Technician**		**
Management systems		***	1	141	587.39+3.8a
Extensive	261	592.54+3.0a	2	128	555.95+4.8d
Intensive	421	544.47+2.2b	3	263	562.10+3.0c
Season of calving		NS	4	119	567.42+3.6bc
Dry season	250	565.63+3.2	5	31	569.65+9.5b
Small rainy season	190	571.09+3.2	**Overall mean**		**568.50**
Long rainy season	242	568.79+3.1			

*N = Number of cows/heifers inseminated; NSC= number of service per conceptions; NS = Non significant at (p > 0.05); ** = Significant at (p<0.05); *** = significant at (P < 0.0001); CI = Calving interval and Means separated by different letters under the same factor in a column are significantly different (P <0.05).*

Management had significant ($p < 0.0001$) effect on the length of calving interval (Table 2). The estimated least square means presented in Table 3 shows that the prolonged calving intervals of cows/heifers kept under extensive management systems in the study area. This may be attributed to the fact that poor management which is frequently associated with nutrition, heat detection, disease pattern and other managerial factors by farmers under extensive management systems. Moreover, distance of beneficiaries from the AI centers, problems of communication and transportation and early embryonic mortality may be the factors implicated for the longer calving intervals of cows/heifers kept under extensive management systems.

Year of calving had no significant ($p > 0.05$) effect on the length of calving interval (Table 2). In contrast, the report of Tadesse et al (2010) who mentioned that the progressive reduction in CI from 485 days for cows calving during the period of 1987-92 to 436 days for cows calving from 2003-07. This could be a sign of improvement in the ability of farmers to manage their dairy cattle, and to the adaptation of the breed to the prevailing environment through time.

Calving season had no significant ($p > 0.05$) effect on the length of calving interval (Table 2). This is in general agreement with previous findings (Gifawosen 2001; Hailu and Tadele 2003; Mohamed, 2004; Tadesse *et al.,* 2010). However, on the contrary Yifat (2009) and Fekadu et al (2011) reported that cows calving during long and short rainy seasons had a significantly lower CI than those calved during the dry season. Probably, during the wet season there is sufficient dry matter from pasture and cows have abundant feed supply for them to gain body weight. Whereas, during the dry season, nutritional deficiencies cause cows to lose weight resulting in postpartum anestrous and delayed resumption of ovarian activity and hence longer CI (Madibela et al 2001). On the other hand, the shorter calving interval of cows which had their calves during the dry season was observed (Lobago et al 2007).

AI technicians had statically significant ($p < 0.05$) effect on the length of calving interval (Table 2). The estimated least square means presented in Table 3 shows that the different numbers of AI technician inseminated cows/heifers had different length of calving interval. This could be related to absence of service during weekend and holidays, shortage of inputs and transportations, used low quality semen, improper heat detections and inseminations, distance of beneficiaries from the AI centers, skill variations between AI technicians and several outlandish speculations such as lack of interest for the job due to small salary and absence of career advancement can be thought low efficiency of AI service.

Cows are poor reproductive efficiency during AI service may be relate to low skill of insemination technique by AI technicians. This is in agreement with the report of a number of outers; for instance, the report of Toleng *et al.* (2001) who observed that conception rate achieved by the five technicians ranged from 57–68%. There was a significant difference in conception rate between the two sites of semen deposition: 55.7% for deposition in the cervix and 64.5% for deposition in the uterus. The conception rate was 64% where the passage of the pipette was easy, whereas it was 25% when passage was difficult. Furthermore, Senger et al (1984) who reported the success of AI was related to the time necessary for the acquisition of abilities for the insemination techniques and points to the need of re-training programmes for inseminators There appears to be a relationship between the site of semen deposition and the number of viable sperm inseminated necessary to attain optimum fertility, e.g., higher numbers of sperm are necessary for inseminates deposited in the vagina than for those deposited into the uterine body or uterine horns. Comparing AI and natural service, Senger (1993) argued that deposition of semen into the uterus allowed much lower sperm numbers in each dose of semen, by virtue of passing the most formidable barrier to sperm transport, the cervix. On the other hand, Seguin (1986) who recommended that depositing semen in the bifurcation of uterine body just inside the internal cervical opening might help for better success rates in AI service.

Conclusion

The result of analysis of variance showed that variations of breed, parity, management, and AI technicians had a significant ($p < 0.05$) effect on length of calving interval. Calving interval of local breeds of cows were greater than crossbreed cows. The result also showed that length of calving interval of heifers was longer than first, second and third parity of cows. In addition, cows managed under extensive management system were longer calving interval than intensive management system. Furthermore, calving interval was longer when cows inseminated by AI technicians. Generally, it can be concluded that length of calving interval decreased by better feeding, heat detection and management of cows is crucial.

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